



## **Presentation Memoir**

# **CONSTRUCTION WORKS FOR HEAVY WATER TRITIUM REMOVAL FACILITY**

- English translation -

**2019**

**APPROVED**CHIEF EXECUTIVE OFFICER  
S.N. NUCLEARELECTRICA S.A.  
COSMIN GHITA**Endorsed by:**

<b>Name and Surname</b>	<b>Position held/ working place</b>
ANDREI Veronica	Inginer Specialist/ DSN-SNN Bucuresti
ANGELESCU Dan	Inginer Operare CNE Principal/SMPC-CNE Cernavoda
APOSTOL Catalin	Inginer Operare CNE/SMPC-CNE Cernavoda
BODNARAS Norvina	Inginer Operare CNE Principal/ SCPI-CNE Cernavoda
DAVID Edmond	Inginer Operare CNE Principal/CNE Cernavoda
PETRISOR Sanda	Inginer Specialist/ DSN-SNN Bucuresti
PREDA Andrei	Inginer Principal/ SST-SNN Bucuresti
VILCU Diana	Inginer Specialist/ DSN-SNN Bucuresti

**Verified:**

<b>Name and Surname</b>	<b>Position held/ working place</b>
BOBRIC Elena	Expert CNE I - CNE Cernavoda
MACOVEI Emil	Sef Serviciu/ SST-SNN Bucuresti
NEDELICU Alexandru	Sef Departament/ DRSM PSI-CNE Cernavoda
TRANTEA Nicolae	Sef Serviciu/ SMPC-CNE Cernavoda

**Checked**Inginer Sef, DSN-SNN Bucuresti  
Sef Comitet Protectia Mediului-SNN  
JELEV Adrian**Checked**Inginer Sef,  
DDI-CNE Cernavoda  
COJANU Adrian**Checked**Sef Departament,  
DDMSM-CNE Cernavoda  
MARIN Florenta

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## Presentation Memoir

### I. Project's title

**„ Construction works for the Heavy Water Tritium Removal Facility” (from now on called/ abbreviated CTRF)**

### II. Owner

**Name of the company:** Societatea Națională Nuclearelectrica SA (SNN SA –Cernavodă Nuclear Power Plant Subsidiary (Cernavodă NPP)

**Adress:**

- SNN-SA: 65 Polonă Street, District 1, București, postal code 010494
- CNE Cernavodă: 2 Medgidiei Street, Cernavodă town, postal code 905200, Constanța county

**a) Phone, fax number and e-mail adress, internet page of the owner:** email: [office@nuclearelectrica.ro](mailto:office@nuclearelectrica.ro); <http://www.nuclearelectrica.ro>; tel. +40 21 2038200; fax: 021 3169400 and e-mail: [Simona.Albu@cne.ro](mailto:Simona.Albu@cne.ro); tel. 0241 801001; fax: 0241 239266;

**b) Legal reprezentatives/authorized persons for replacing the representatives,with their identification data:** Cosmin Ghita – Chief Executive Officer of SNN-SA, email: [office@nuclearelectrica.ro](mailto:office@nuclearelectrica.ro); tel. +4021 2038200; fax: +4021 3169400 and Dan Bigu – Director of Cernavodă NPP; e-mail: [Simona.Albu@cne.ro](mailto:Simona.Albu@cne.ro); tel. +40241 801001; fax: +40241 239266

**c) Environmental Licensing Representative at Cernavoda NPP:** -Sef Departament Dezoltare si Monitorizare Sisteme de Management - Irina Florenta MARIN; e-mail: [Florenta.Marin@cne.ro](mailto:Florenta.Marin@cne.ro); tel. +40241 801505; fax: +40241 239266.

**d) Contact person:** Inginer operare CNE Cernavoda - Norvina Bodnaras; e-mail: [Norvina.Bodnaras@cne.ro](mailto:Norvina.Bodnaras@cne.ro); tel. +40241 802592; fax: +40241 239266.

### III. Entire project's description of physical characteristics

#### III.a) CTRF Project Summary

Cernavoda Tritium Removal Facility (CTRF) from Cernavodă NPP will be implemented with the purpose to reduce the tritium concentration within Units 1 and 2 of Cernavodă NPP.

The Project's principle of the tritium removal method consists in tritium removal out of the tritiated water (DTO) by using Liquid Phase Catalytic Exchange (LPCE) and Cryogenic Distillation (CD) processes, followed by tritium storage in safe state (metallic hydride).

Briefly, the main processes within CTRF for tritium concentration reduction in the heavy water and its separation for the storage of tritium (T2) are:

- Before being transferred to the tritium removal facility, the tritiated heavy water coming from the nuclear systems within Unit 1 and 2 Cernavoda NPP, is purified to meet the

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quality parameters requested for supplying the Liquid Phase Catalytic Exchange (LPCE) columns by removing mechanical impurities and retention of radionuclides, other than tritium, through a purification unit.

- The Tritiated Deuterium (DT) / Deuterium (D2) / Deuterated Hydrogen (HD) gaseous flux resulting from the Catalytic Isotopic Exchange (LPCE) process - where tritiated heavy water circulate countercurrently with a deuterium gaseous stream (D2) – is passed through a Purification-Drying System, where the traces of heavy water vapours (DTO) and traces of gases (nitrogen and oxygen) are being retained. Afterwards the flux is transferred to a cascade of columns from the Cryogenic Distillation System (CD).
- Gaseous deuterium (D2) and gaseous tritium (T2) are being separated by passing through the cryogenic distillation system (CD) columns located in a cold-box that provides the thermal insulation necessary to maintain the cryogenic process' temperature (24 K) and that comprises cryogenic cycle's components (cryogenic adsorbers, heat exchangers, condensers, etc.). The T2 extracted at the base of the last cryogenic distillation column is transferred to the tritium handling and storage system located in a special glove box where it is fixed on a titanium tritide bed.
- The gaseous deuterium (D2) - having tritium removed-, that is coming from the CD system, is recirculated to the LPCE. The necessary cooling required for the distillation of the deuterium / tritium mixture is ensured by a helium gas cycle and a refrigeration/cryogenic unit, based on a helium cooling cycle.

The project includes the entire CTRF technological process and equipment related to the handling and storage of process products and other installations / systems necessary for the operation of the tritium removal facility, process and radioactive emission control equipment, technological pipelines, electrical power cables and low currents ones, as well as roads, platforms, fencing and gates.

The project also includes equipment for monitoring liquid and gaseous releases, as well as facilities/equipment for fire prevention and fire extinguish and required utilities (potable water / sewage/ storm sewer and electricity).

Project implementation involves the following main steps: construction and assembly works, technological tests and commissioning, operation and decommissioning, which will start once the owner has obtained all the agreements / permits / authorizations stipulated by the legislation in force.

The responsible entity for project implementation is SNN-SA.

The design of the tritium removal facility at Cernavoda NPP was carried out by the National Institute of Cryogenics and Isotopic Separation Rm. Valcea (ICSI Rm. Valcea) together with a number of subcontractors, companies that, through their own expertise, have national and international experience in designing, implementation and the operation of similar facilities (OPEX-OPerating EXperience) have ensured the fields and specialties necessary for the design of the CTRF, so that the facility will meet all the nuclear safety measures according to the latest requirements of the National Commission for Nuclear Activities Control (CNCAN), Ministry of Environment (MM) either in accordance with the specific European Union (EU) legislation and International Atomic Energy Agency's (IAEA) applicable standards.

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SNN-SA updated in 2018 the Strategy for the Implementation of the Investment Project "Cernavoda Tritium Removal Facility" based on the Feasibility Study, approved through the Decision no. 9 / 22.08.2018 of the Extraordinary General Assembly of the Shareholders of Nuclearelectrica S.A., which considers that CTRF's implementation will be done with the following benchmarks:

- Facility's implementation will be based on an EPC (Engineering Procurement and Construction) contract, through the selection of a general contractor with experience in implementation of a such project;
- Contracting „Owner's Engineer" (OE) Services; SNN-SA will include in the Project an organization (OE) with proven experience in design, commissioning and operation that will provide consulting support services, technical assistance, know-how implementation and project management in all phases of Project's implementation, respectively in the CTRF's authorization process.

\*Note: It is worth mentioning that at the elaboration of the Presentation Memoir, were considered the initial data and information from the environmental documentation and the feasibility study corresponding to the conceptual project of the CTRF and available at the level of 2013. The Presentation Memoir presents updated and complete information at the level of 2018, as well as on the technical project as on the environmental and nuclear safety, including information from accident analysis.

Cernavoda NPP contributes to the technical support for the pre-operational activities of CTRF. Cernavoda NPP will ensure the operation of the facility through qualified personnel in specific areas.

SNN SA – Cernavoda NPP Branch holds ISO 14001 certificate and in 2018 obtained the EMAS registration certificate (EMAS - Eco-Management and Audit Scheme, is a premium management instrument developed by the European Commission for companies and other organisations to evaluate, report, and improve their environmental performance.).

### **III.b) Project's necessity justification**

SNN SA - Cernavoda NPP Branch currently owns a nuclear power plants with two units , Unit 1 being in commercial operation since December 1996, and Unit no. 2 since October 2007, each of them being a Canadian Deuterium Uranium 6 - Pressurized Heavy Water Reactor (CANDU 6 -PHWR) with a thermal power output of 2061.4 MWt and a turbogenerator with an electric power output of 706.5 MWe. For Units 1 and 2 Cernavoda NPP, the Environmental Permit was issued through Government Decision no.84 / 2019.

The CTRF project reflects Cernavoda NPP's ongoing concern to improve the environmental safety. The project itself ensures the reduction of professional exposure to tritium of the workers, it has a positive impact on the health state of the personnel and causes a decrease of the tritium concentration in effluents, with a positive impact on the protection of the population and the environment.

Project's implementation helps avoiding the classification of tritiated heavy water as a radioactive waste at the end of nuclear reactors lifetime and includes the management steps of radioactive heavy water waste in the decommissioning plan of Cernavoda NPP Units 1 and 2, avoiding the need to manage larger volumes of radioactive waste, as well as their final disposal



CTRF's implementation has a positive impact as it allows a significant reduction of the total inventory of tritium (tritium is a radioactive isotope of hydrogen) within the CANDU nuclear power plant, with a positive impact on:

- reducing the risk of generating tritium radioactive effluents and emissions in the environment, risks associated with the circulation of a large quantity of heavy water with increased concentration of tritium through the nuclear systems of the plant,
- minimizing tritium concentrations in radioactive waste generated within nuclear power systems using heavy water at Cernavoda NPP Unit 1 (U1) and Unit 2 (U2).

In a CANDU reactor heavy water is used in its nuclear systems as a moderator and a primary heat transfer agent (cooling agent); the whole amount of tritium is produced by transforming some of the deuterium (the isotope of hydrogen in the heavy water) into tritium, under the influence of neutron fluxes, resulting in tritiated heavy water (DTO). In the normal operation of a CANDU reactor, the concentration of tritium produced in heavy water increases up to a stationary level, where tritium production is balanced by its radioactive decay.

For the typical CANDU-6 reactor, the stationary level of tritium is reached after 2/3 of the reactor's lifetime cycle. By operating CTRF, the tritium concentration value will be reduced from 80-90 Ci / kg to approximately 10 Ci / kg for the Moderator System and below 2-2.5 Ci / kg for the Primary Heat Transport System

The CTRF facility envisaged to be implemented through this Project will take over alternatively and ensure tritium removal from the heavy water used in the nuclear systems of the U1 and U2 Cernavoda NPP reactors.

CTRF will also be used for the U1 and U2 Cernavoda U2 lifetime extension phase (U 1 and U2 lifetime extension will be done in the future through refurbishment projects) and in Cernavoda NPP U1 and U2 decommissioning phase.

It is worth mentioning that the CTRF facility can ensure the tritium removal from the tritiated heavy water even from the nuclear systems of the future Units 3 and 4 Project at Cernavoda NPP, and in this case shall be determined the value of tritium concentration reduction in the moderator for each of these 2 units and the means to ensure the heavy water transfer from Units 3 and 4 to CTRF.

### **III.c) Investment value**

The estimated value of CTRF Project: around 190 MEuro.

### **III.d) Implementation timeline**

The following major milestones of CTRF project's implementation are estimated as follows:

- "Engineering Procurement Construction" Contract Award– 2020
- Detailed design's completion in order the contractor to initiate "long lead items" supply procedure – 2021
- Start of construction and assembly works – 2022
- Commissioning phase start– 2025
- Trial run – 2025 – 2026 (6 months from end of commissioning phase)
- Transfer to operation – 2026

### III.e) Drawings representing the boundaries of project's site, including any land area required for temporary use (site plans and locations)

The following figure shows the placement of the CTRF facility within the Cernavoda NPP perimeter.

Fig. III.1 CTRF location within Cernavoda NPP site



### III.f) Project's physical characteristics description, project's physical forms (drawings, buildings, other structures, construction materials and others)

Project's specific elements are presented as follows.

#### III.f)-a) Profile and production capacities

The purpose of the Project is to build up, commission and set into operation a tritium removal facility on Cernavoda NPP's site.

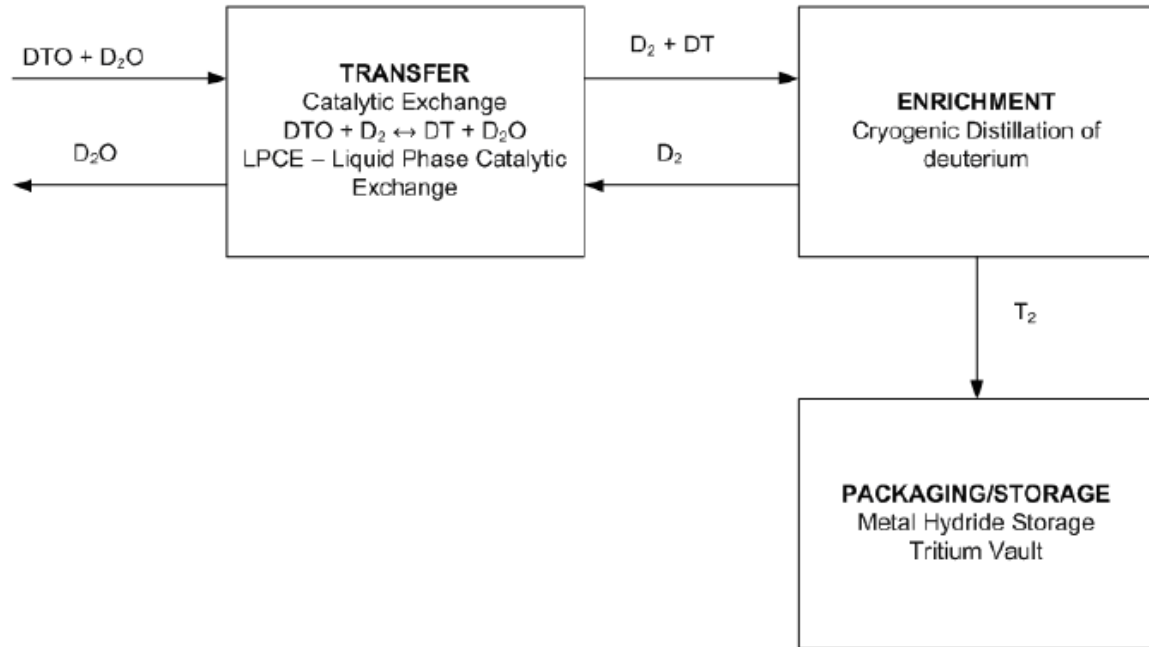
Through the implementation of the facility the high contribution of tritium to the doses received by Cernavoda NPP personnel will be limited, by tritium removal from U1 and U2 reactors systems and maintaining a low-level stationary tritium concentration, respectively 10 Ci / kg in the moderator system and below 2.5 Ci / kg in the primary heat transfer system.

The tritium removal and retention / storage solution adopted within the project is based on the liquid phase catalytic isotope exchange and cryogenic distillation (commonly known as LPCE-CD / Liquid Phase Catalytic Exchange and Cryogenic Distillation). In principle, the process has three stages:

- Tritium transfer from the tritiated heavy water (liquid state) into gaseous state;
- Tritium final gathering/collection through cryogenic distillation

- Tritium safe storage as a metallic hydride.  
The simplified process scheme is shown in the following figure:

**Fig. III.2 Project's simplified process scheme**



**The main process features and capabilities are:**

- Feed flow: 40 kg/h of tritiated heavy water
- Tritium concentration in heavy water supply: max. 54 Ci/kg for the heavy water in the moderator system, respectively 2.5 Ci/kg for the heavy water in the heat transport system
- Tritium removal factor: 50-100
- Deuterium flow (D2) in the cryogenic loop = 72 Nm<sup>3</sup>/h
- Deuterium (D2) inventory within the facility= 34 kg (aprox. 203 Nm<sup>3</sup>)
- Tritium inventory during the process = 1.7 x 10<sup>4</sup> TBq (aproximatively 45.9 g tritium)
- Stored tritium concentration: minim 99%
- Tritium is extracted in batches for storage in an ITC container (Immobilized Tritium Container – spongy titanium storage container)
- Estimated facility lifetime = 40 years
- Estimated ITCs' storage lifetime: 100 de ani
- Tritium storage capacity: for all the amount of tritium recovered over the lifetime of U1 / U2
- The process uses low temperatures and advanced vacuum (< 10<sup>-8</sup> torr, 24 K)
- Systems with high level of tightnesshaving a leak flow rate < 10<sup>-8</sup> atm cc/sec helium

- leakage degree: minim  $10^{-6}$  mbar l/s
- Equipment under pressure, demountable and non-demountable assemblies with leakage rates lower than  $10^{-6}$  mbar l/s

### III.f)-b) Description of the facility and technological fluxes existing on site (if applicable)

The estimated territorial inventory for the area where the CTRF Project will be implemented is shown in the table below:

**Tab. III.1 Territorial inventory needed for the CTRF project**

Category	Area (sq meters)	Percentage out of the total area (%)
Total land area	1350	100
Built area	591	44
Land area estimated to be temporarily occupied (site organization)	50	4

The implementation of the project will include special measures to avoid any impact on the normal operation of Cernavoda NPP, namely:

- The project will be implemented in such a way that during the construction-phase, technological tests, commissioning and operation it will not impact on U1 and U2 operation;
- The project will be implemented in compliance with the requirements foreseen in the Construction License and the Environmental and Operation Permits of Cernavoda NPP.

Related to Normative P100-1 / 2013 the CTRF building is classified as class I of importance – high importance, and according to Law no.10 / 1995 and GD no.766 / 1997 in the category A of importance - exceptional importance, its construction following to be carried out on the basis of the Construction License issued by CNCAN in accordance with the Norm regarding the authorization for the construction of nuclear facilities, NCN-01, approved by CNCAN President Order No. 407/2005. According to STAS 10100 / 0-75 the structure is included into class I of importance.

The construction of the CTRF building, with a height of approximately 25 m, represents a production and storage facility, DBE (Design Basis Earthquake) seismic qualified and consists of:

- Infrastructure: C16 / 20 reinforced concrete foundation and to 2-level basement, which will consist of a rigid structure with C25 / 30 reinforced concrete elements (walls, pillars, beams and floor).
- Multilevel steel structure developed on 5 levels (ground floor, 3 levels and 2 partial levels), the steel structure elements will be made of OL52.2k steel, the floors and of the roof will be of reinforced concrete C25 / 30. The celings in the technological area are from metal grates mounted on steel beams and braced horizontally. External closures execution will be correlated with the class of importance, fire and explosion protection degree required, made of brick, ROMPAN panels or explosion blow-out panels.

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Apart from CTRF itself building, other facilities required for its operation will be installed within the CTRF's enclosure:

- Nitrogen tank platform
- Helium tank
- Storage of inergen cylinders (inert gas for fire extinguish)
- Storage of oxygen cylinders
- Storage of helium cylinders
- Ventilation stack
- Standby Diesel-Generators Building
- Medium voltage transformers.

The radioactive effluents resulted from the process are discharged through a dispersing stack located outside CTRF building, with a height of about 50 m.

The driveway within the CTRF area will be covered with concrete all over its surface.

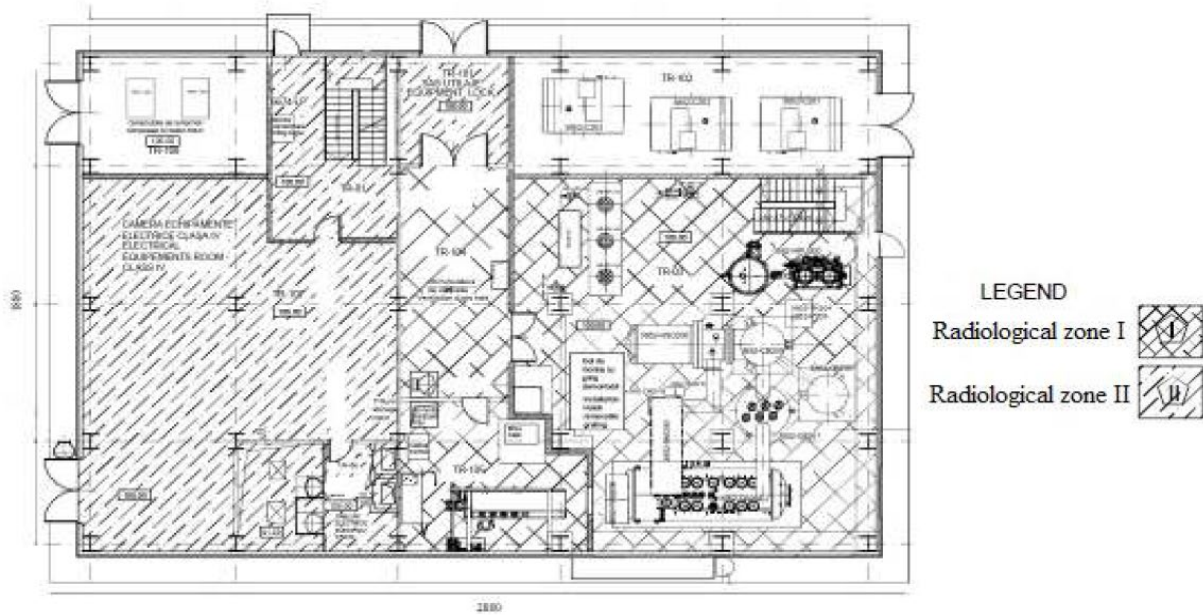
Besides roads, platforms and fences, on site are foreseen technological networks, power electric and low currents cables, water supply and sewage systems. The transfer of heavy water, demineralized water and active liquid drainage between CTRF and NPP's existing systems will be accomplished through the pipelines installed inside the buildings and on the existing structures.

The area where CTRF's construction is proposed is located on Cernavoda NPP's site, in the vicinity of Unit 1 and is limited by the slope towards Saligny hill and the main road in within NPP's enclosure which allows access from PCA 1 gate towards the Water Treatment Facility - WTF. On two sides, the land is partially surrounded by a reinforced concrete wall having an anti-explosion protection role (Appendix no. 1 – Development Site Plan).

CTRF building radiologic zones are as per below figure.

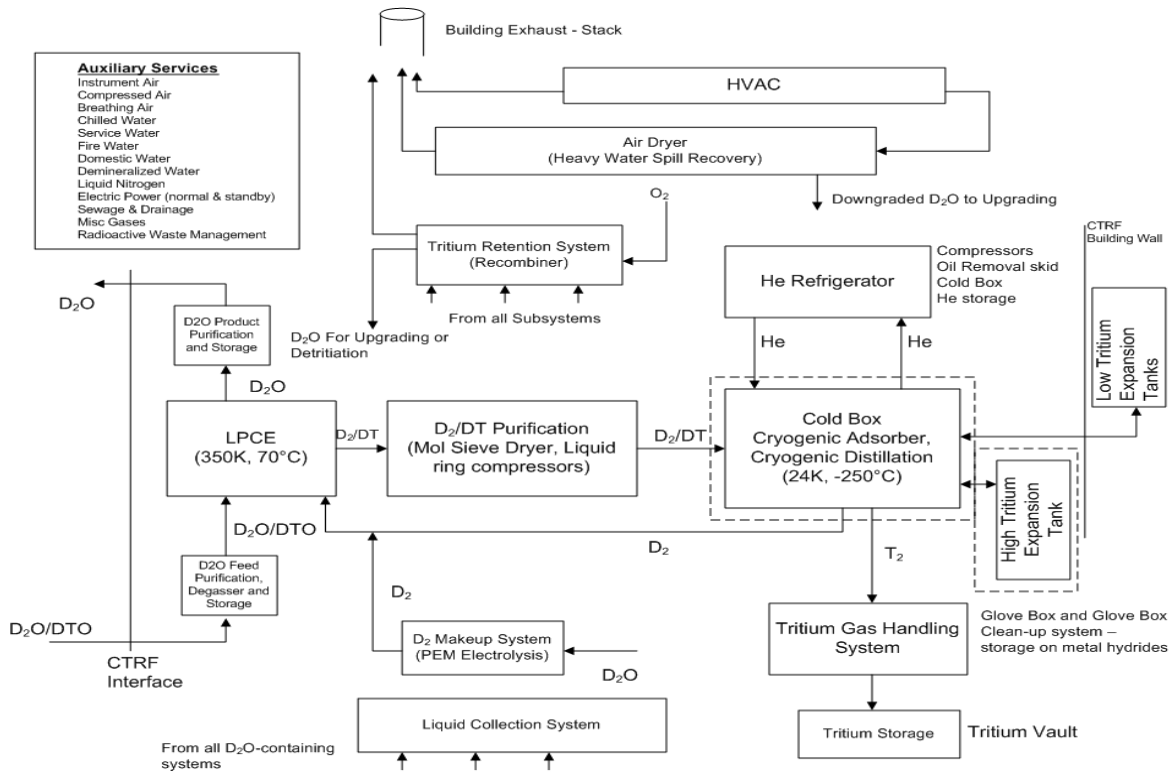


Fig. III.3 CTRF building radiological zones



CTRF's technological flows are presented below in the Block diagram:

Fig. III.4 CTRF's block diagram



### III.f)-c) Envisaged project's production processes description, related to the investment specificity, the products and by-products obtained, its size, its capacity

The technology flow of the Project includes the following main processes:

#### Storage, purification and transfer of tritiated heavy water from reactor systems in order to supply CTRF

- The tritiated heavy water from the reactor systems may contain mechanical impurities and dissolved chemical products (that may include active beta-gamma impurities, mainly due to the activation of corrosion products), and their removal is necessary for the functioning of the catalytic columns.
- This purification is foreseen to be carried out by the HWFS (Heavy Water Feed System) which consists of 2 tanks of 3 m<sup>3</sup> each and two ion exchangers columns, that will ensure the required quality level of heavy water for the LPCE isotopic exchange columns supply.
- For continuous operation and separate management of heavy water inventory from U1 and U2, there were foreseen 2 similar HWFS installations, one for each unit, which are located in the building of the respective units. The flowchart of the process system are presented for U1 and U2 in the following figure.

Fig. III.5 Tritiated Heavy Water Feed System HWFS (Unit 1)

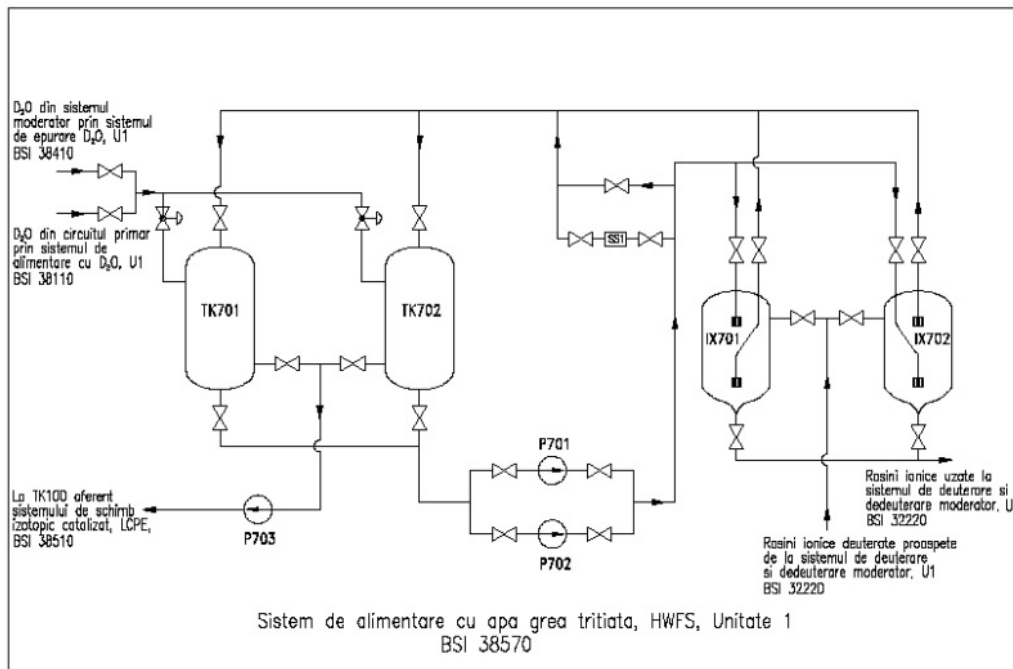
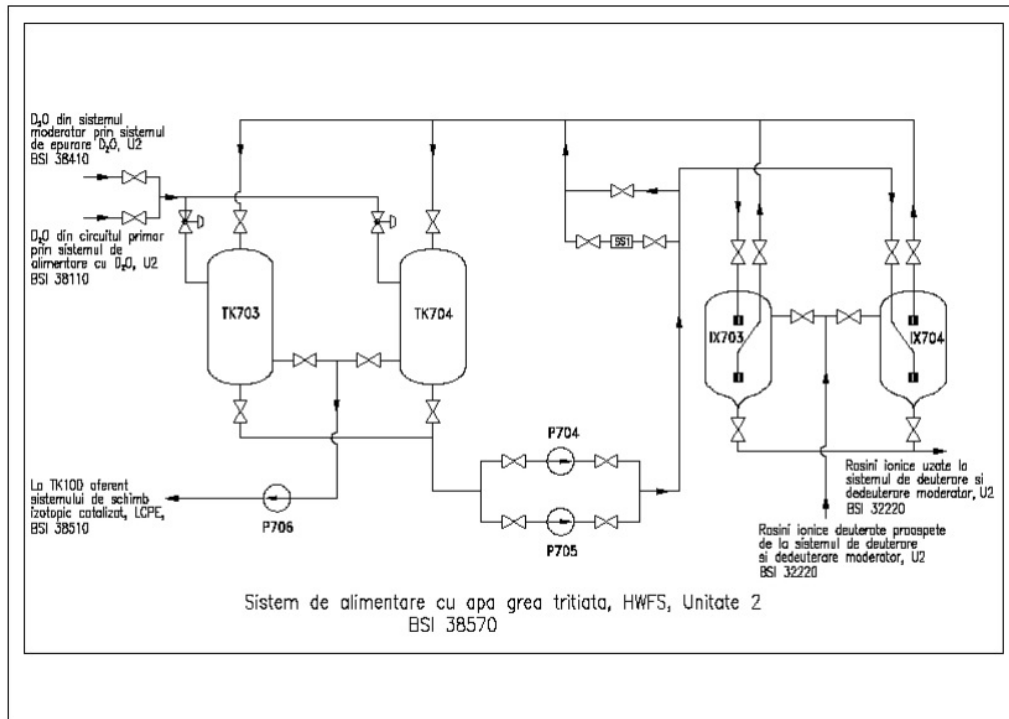


Fig. III.6 Tritiated Heavy Water Feed System HWFS (Unit 2)



The system allows quality control sampling of the heavy water contained in the tanks during the purification process.

CTRF's supply with tritiated heavy water from HWFS tanks is accomplished through a stainless steel pipe network, pipe-in-the-pipe type, in the following conditions:

- 3000 kg tritiated heavy water in batches;
- Each batch is divided in batches of 1000 kg tritiated heavy water which are transferred to the supply tank of the following main system (LPCE)
- Tritium concentration in CTRF's heavy water supply coming from moderator – max. 54 Ci/kg
- The feed is made at a flow rate of 40 kg / h.

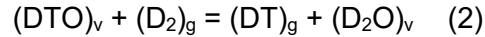
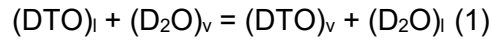
The entire tritiated heavy water supply transfer system ("double wall pipe") from U1 / U2 to CTRF is provided with a heating system in order to avoid the heavy water to freeze and is also monitored to identify accidental leakage along the way.

**Catalyzed Isotopic Exchange - LPCE that ensures tritium transfer from liquid phase (DTO) to gaseous phase (DT / HD / D2)**

The tritium transfer process takes place in the LPCE columns, where the tritiated heavy water coming from HWFS circulates in countercurrent to an upward/ ascending flow of D<sub>2</sub> heated at 70 ° C in the presence of a catalytic packing, having two components, a hydrophilic packing and a hydrophobic catalyst.



Actually, tritium transfer from heavy water to deuterium gaseous state is the result of the combination of a classical water distillation process (1) in the presence of hydrophilic packing with the isotopic exchange reaction (2) in the presence of hydrophobic catalyst, as follows:



The hydrophobic catalyst rejects liquid water but allows both heavy water vapor and gaseous deuterium to reach catalytic active centers and to accelerate the isotopic transfer process.

Several types of catalysts, used in industrial installations, pilot plants, or laboratory-only tests, have been developed worldwide, with comparable performance on isotopic transfer coefficients \*, some of which are presented below:

- i) The single coat mixed catalytic filler developed by ICSI Rm. Valcea comprises a filler of hydrophilic stainless steel profiled strips arranged in the form of cylindrical packages and the hydrophobic catalyst in the form of platinum pills deposited on carbon and polytetrafluoroethylene - Teflon (Pt / C / PTFE), placed between the metal strips. Mixed catalytic filler packs have a height of 100 mm and a diameter of 302 mm to ensure both the filling of the columns as well as the possibility of inserting and removing them from the interior of the column.
- ii) A similar variant of the mixed catalytic filler is the structured filler developed by AECL (Canada), alternating with stainless steel hydrophilic plates, with identical strips coated with a thin layer of platinum-on-carbon and Teflon catalyst.
- iii) Another potential solution for the LPCE catalyst is the one used in the Wolsong tritium removal facility, consisting of separate platinum catalyzer on styrene-divinyl benzen and the Sulzer CY hydrophilic filler..

\*wetability = water adherence capacity to the surface of the hydrophilic filler and hydrophobic catalyst

An analysis of the technical characteristics of the catalysts presented above indicates the following general technical performance:

Specification / Catalyst type	ICSI	Wolsong	AECL
Height of the equivalent theoretical plate– HETP (cm)	26 - 31	30	Unavailable
Isotopic transfer coefficient - $K_s$ (mol/g*sec)	$1.9 \cdot 10^{-4}$	$1.6 \cdot 10^{-4}$	$1.6 \cdot 10^{-4}$
Tritium removal efficiency (*)	≥ 98%	97%	97%

(\*) NOTE: Tritium removal efficiency from the tritiated heavy water is a characteristic of the installation and depends on the detritiation factor (the ratio of tritium concentrations at the input / output of the isotopic exchange columns) set as design date. The detritiation factor of 50-100, set for CTRF (vs. 35, chosen for Darlington-Canada and Wolsong-South Korea) can be obtained by appropriately dimensioning the equivalent number of the isotopic-catalytic exchange columns (3 columns at CTRF, respectively 2 columns at WTRF) with any of the types of catalyst presented.

It should be noted that the presence of liquid water upon contact with the catalyst has the disadvantage of deactivating it over time, which may lead to the need to reactivate it, or to replace a part of the catalyst during the lifetime of the facility and implicitly to generate different amounts of waste and increased operating expenses. Therefore, in order to avoid deactivation of the catalyst, at the Wolsong facility, a more elaborate internal structure of the LPCE columns was

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chosen, whereby the liquid water is directed as the water contact directly only the hydrophilic component bypassing the catalyst bed . In this way, the use of the Wolsong catalyst offers the advantage of generating smaller amounts of radioactive waste and lower operating costs. Other advantages and disadvantages are related to catalyst price, manufacturing duration, supplier stability and availability for purchase throughout the life of the facility, each of which may favor one catalyst or another.

Considering that for similar technical performances, the initial costs and the operating costs differ depending on the type of catalyst chosen but also the other specific advantages and disadvantages. The choice of the catalyst to be used for CTRF will be made following a feasibility study to be achieved before the project's implementation. By establishing the type of catalyst the input data can be provided for the detailed design of the LPCE columns. Differences between the possible variants and the conceptual design (shown in the figures below) may occur in relation to the arrangement inside the columns and possibly, with the height of the columns, without having any impact on the height of the building, which is dictated by the Cold Box dimensions.

It is worth mentioning that the resulted radioactive waste quantity (catalyst used in the installation, tritium-contaminated) foreseen in the Presentation Memoir to Chapter VI.a.-h) is more than comprising and represents the maximum possible quantity for the ICSI Rm Valcea's catalyst from point (i) above.

For the Wolsong catalyst solution - point (iii) above, the operating experience proved that in 12 years of operation no replacement of any part of the catalyst was needed.

Fig. III.7 Isotopic catalytic exchange columns. Vertical section through CTRF building

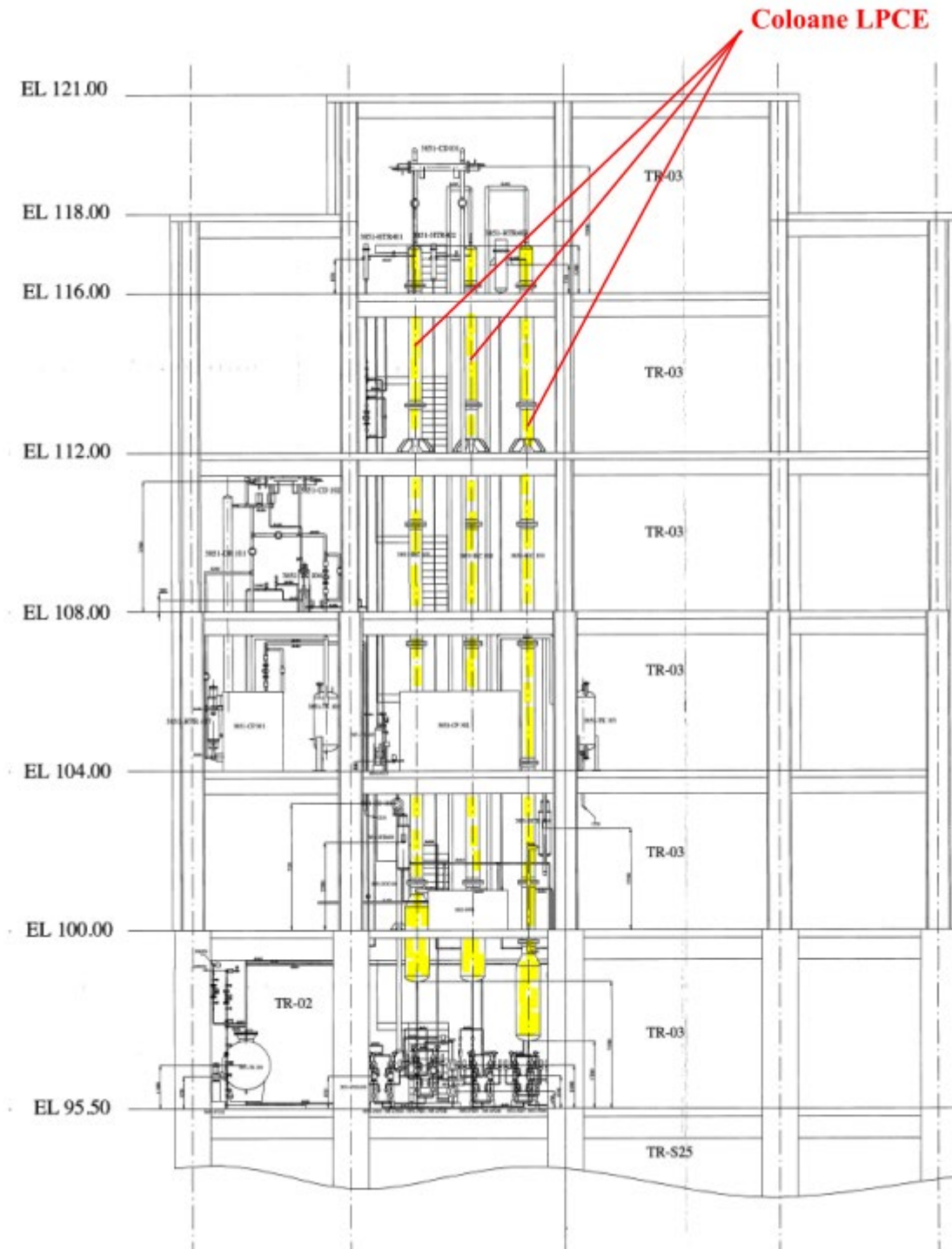
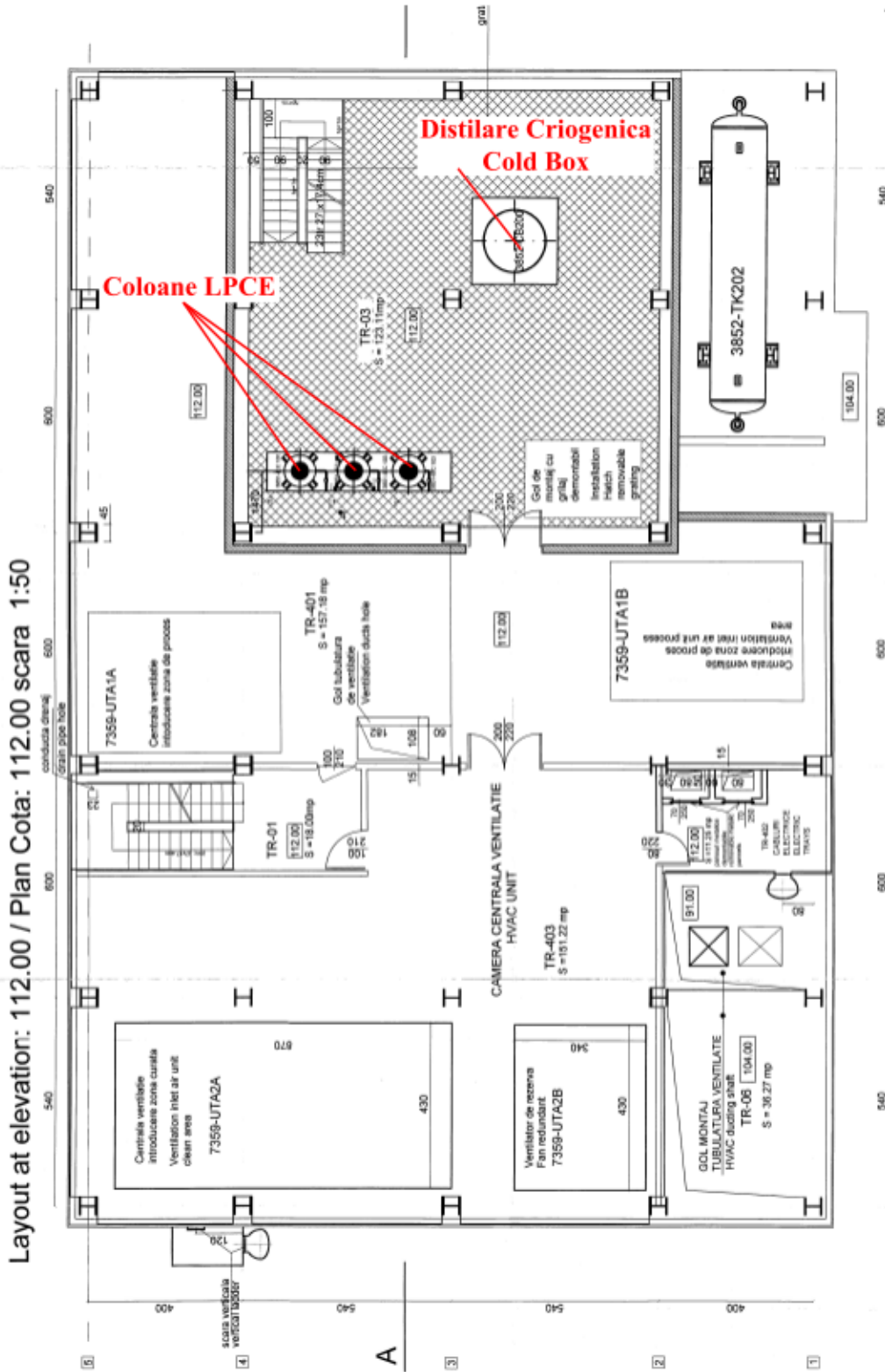


Fig. III.8 Isotopic catalytic exchange columns. Horizontal section through CTRF building



The chemical requirements for the two process fluids are as follows:

- Gaseous deuterium must be at least 99.3% D<sub>2</sub> purity and should not contain elements that could potentially "poison" the isotopic exchange columns of the catalyst.
- The moderator heavy water must have a minimum isotopic content of 99.75% D<sub>2</sub>O and the primary heat transfer system (PHT) water should have a minimum isotopic content of 99% D<sub>2</sub>O and a maximum conductivity of 2 μS / cm .

**Purification of the D<sub>2</sub> / DT / HD gaseous stream** is accomplished through:

- Moisture retention by Molecular Sieve Desiccant(type 13X) at ambient temperature, removal of nitrogen and oxygen traces through adsorption at low temperature (cryogenic temperature).

**Cryogenic distillation** ensures tritium separation and concentration from gas D<sub>2</sub> / DT / HD stream coming from the LPCE by using a cascade of cryogenic distillation columns and two types of chemical equalizers having the purpose to balance the deuterium-tritium mixture and produce tritium.

Also, at this stage, purification of the D<sub>2</sub> / DT / HD gaseous stream is ensured by a final retention on activated charcoal cryoadsorbents, in the 50K-60K range, of any left traces of nitrogen and oxygen, before feeding the first cryogenic distillation column.

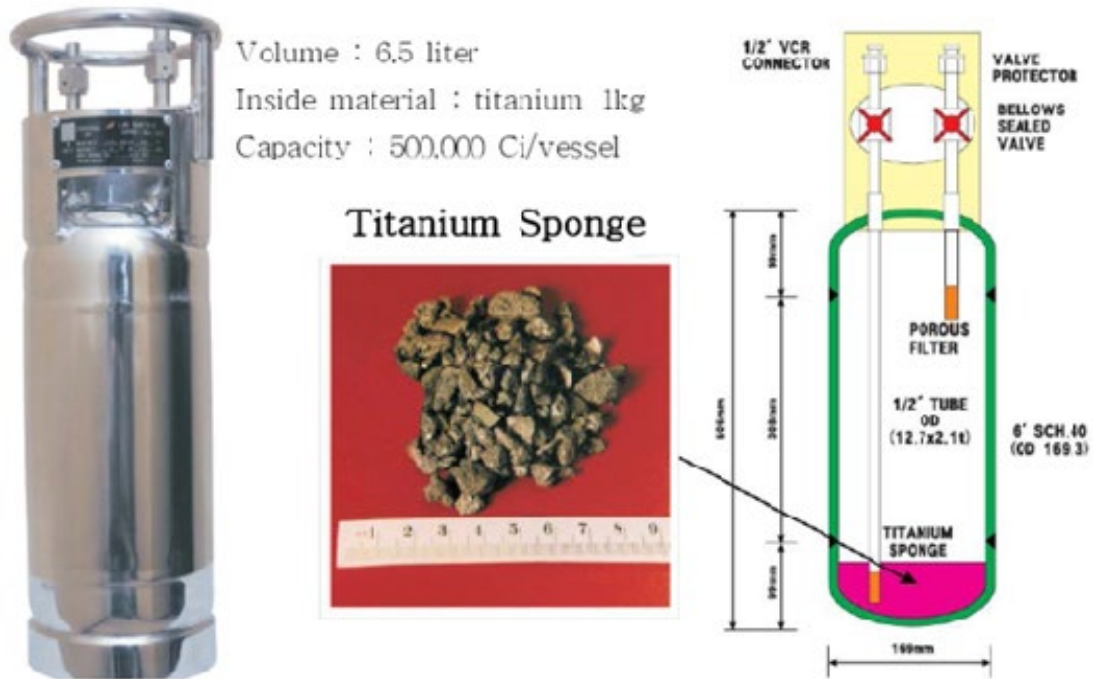
Chemical Requirements:

- The gaseous stream coming from LPCE will have a minimum isotopic content of 99.3% deuterium / tritium.
- The tritium (T<sub>2</sub>) concentration extracted from the cryogenic distillation column shall be above > 99%

**Storage** Gaseous tritium is stored (T<sub>2</sub>) on a titanium storage bed consisting of a 6.5 l capacity vessel, filled with titanium spongy. For tritium immobilization, the metallic titanium spongy is used due to the low equilibrium pressure of gaseous tritium within titanium at normal storage temperature (<1 Pa at 25 °C), the ease with which the reaction between titanium and tritium at ambient temperature occurs, as well as tritium storage safety, because it is necessary to heat the metallic tritium at high temperatures (> 400°C) for tritium release to occur.

The tritium storage container on titanium spongy is able to store 52 g (500 kCi) of tritium containing 1% DT in T<sub>2</sub> and can retain all <sup>3</sup>He (light isotope of Helium having an atomic mass number of 3) generated by tritium disintegration. As the tritium retained on the titanium spongy bed disintegrates, the partial pressure of <sup>3</sup>H increases. The whole amount of tritium absorbed in the titanium spongy bed disintegrates in <sup>3</sup>He in about 6 half-lives (a half-life for tritium is about 12.3 years) which means that the maximum pressure in the container will be of about 6.0 MPa (the container will be designed to withstand a pressure of 7.4 MPa at 38° C).

Fig. III.9 Container model for tritium storage on titanium bed at WTRF-Korea



**The purification and transfer of heavy water produced** (detritiated heavy water) resulting from isotope-catalyzed exchange (LPCE) process aims to provide high-quality nuclear heavy water before it is reintroduced into NPP's D<sub>2</sub>O supply systems.

The purification is accomplished by recirculating heavy water, at a flow rate of 0.4-0.7 l / s, through the batteries of two ion exchange columns, related to the detritiated heavy water management system - the heavy water product system (HWPS - Heavy Water Product System).

The purification process' end is determined by tracing the electrical conductivity value by sampling and analyzing it.

For separate management of tritium removed heavy water inventories at U1 and U2, there were foreseen 2 similar HWPS installations, one for each unit, which are located in the service building of the respective units.

The schematic flowcharts of the this process are presented separately for Unit 1 and Unit 2 in Figure III.10 and Figure III.11, respectively.

The entire tritium removed heavy water transport systems from CTRF to U1 / U2 units is provided with a heat tracing system and is monitored to sense possible accidental leakage along the way.



Fig. III.10 Heavy Water Product System (tritium removed heavy water) HWPS - Unit 1

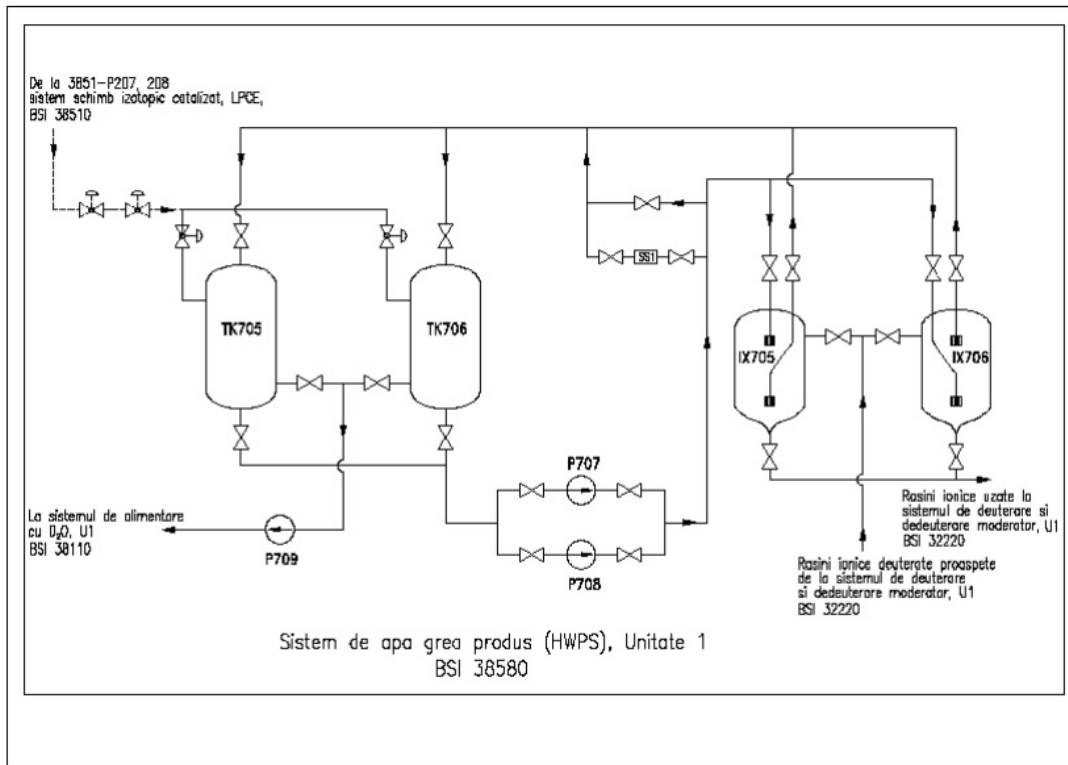
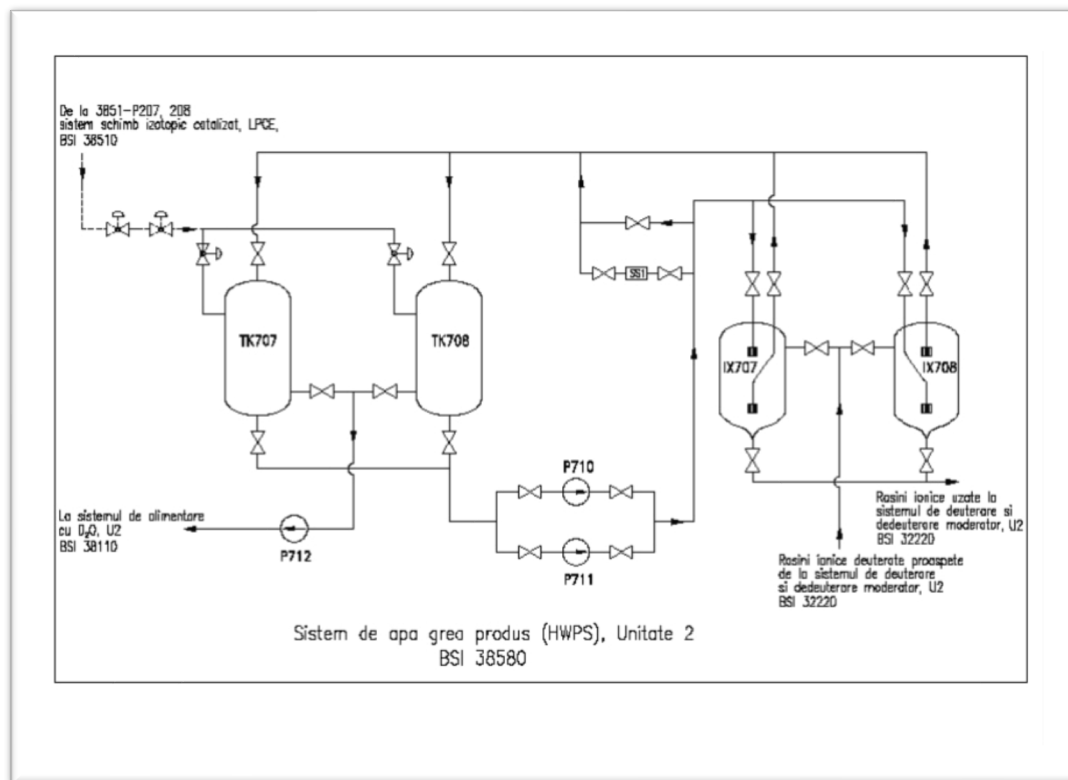


Fig. III.11 Heavy Water Product System (tritium removed heavy water) HWPS - Unit 2

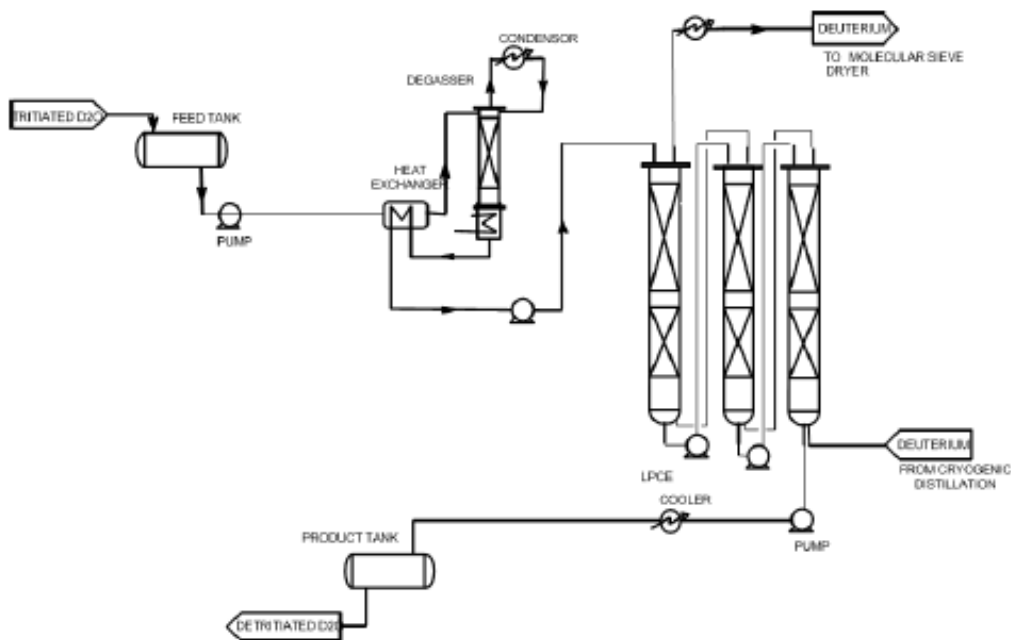


The technological systems within CTRF that ensure the reduction of the tritium concentration in the heavy water, its separation and storage (T2) are structured as follows: **main technological systems** and **operational support systems**, and are presented below

#### A. Three main technological systems:

1. **Liquid Phase Catalytic Exchange – LPCE** (the schematic-flow principle is presented in Figure III.12 and represents the "front-end" area of the installation and has as main elements:
  - c) the purification-drying module of the process gas containing tritiated deuterium in order to supply the cryogenic distillation system (CD);
  - d) process compressors, which ensure the transport of process gas in the closed loop between LPCE and CD;
  - e) Process pumps that ensure heavy water circulation in the LPCE system and return to U1, U2 after detritiation.
  - a) Isotopic exchange columns (equipped with mixed catalytic filler);
  - b) a temporary storage tank for both the (supply) tritiated heavy water, respectively for tritium removed heavy water;
  - c) the purification-drying module of the process gas that contains tritiated deuterium in order to supply the cryogenic distillation system (CD);
  - d) process compressors, which ensure the transport of process gas in the closed loop between LPCE and CD;
  - e) Process pumps that ensure heavy water circulation in the LPCE system and its return to U1, U2 after tritium removal process.

Fig. III.12 1. Liquid Phase Catalytic Exchange Scheme – LPCE





Entries into the LPCE system:

- tritiated heavy water (batches of 3000 kg at every 3 days, 40 kg / h process heavy water flow rate, tritium concentration of 54 Ci / kg for moderator heavy water or maximum 2,5 Ci / kg, in the case of heavy water from the main heat transport system – heavy water coming from the Heavy Water Feed System (HWFS) from U1 or U2)
- D2 process gas - provided by cryogenic distillation system (CDS). The initial D2 inventory, as well as further additions, are obtained by electrolysis of virgin heavy water<sup>1</sup> (without tritium) in the gas deuterium feed system.

Note <sup>1</sup> : heavy water of nuclear quality, wich was not exposed to the radiation field

Outputs from the LPCE system:

- tritium removed heavy water (tritium concentration - 0,5 Ci / kg) collected from the base of the last isotopic catalytic exchange column in a temporary heavy water product storage tank with a maximum storage capacity of 3500 kg is transferred to HWPS heavy water purification system, and afterwards returned to heavy water management systems from U1 or U2;
- the tritium-enriched gas stream (D2 / DT / HD) collected at the top of the first isotopic exchange column and which, after a purification step (retention of humidity and eventual traces of oxygen and nitrogen), is transferred to the cryogenic distillation.

2. **The cryogenic distillation system - CDS** (the flow diagram is presented in Figure III.13) constitutes the tritium concentration back-end zone of the installation and has the main elements:

- a) four columns of cryogenic distillation in cascade, where separation and tritium concentration from the gaseous phase occurs, and
- b) a helium refrigeration unit to cool the condensers of the distillation columns.

Inputs to CDS:

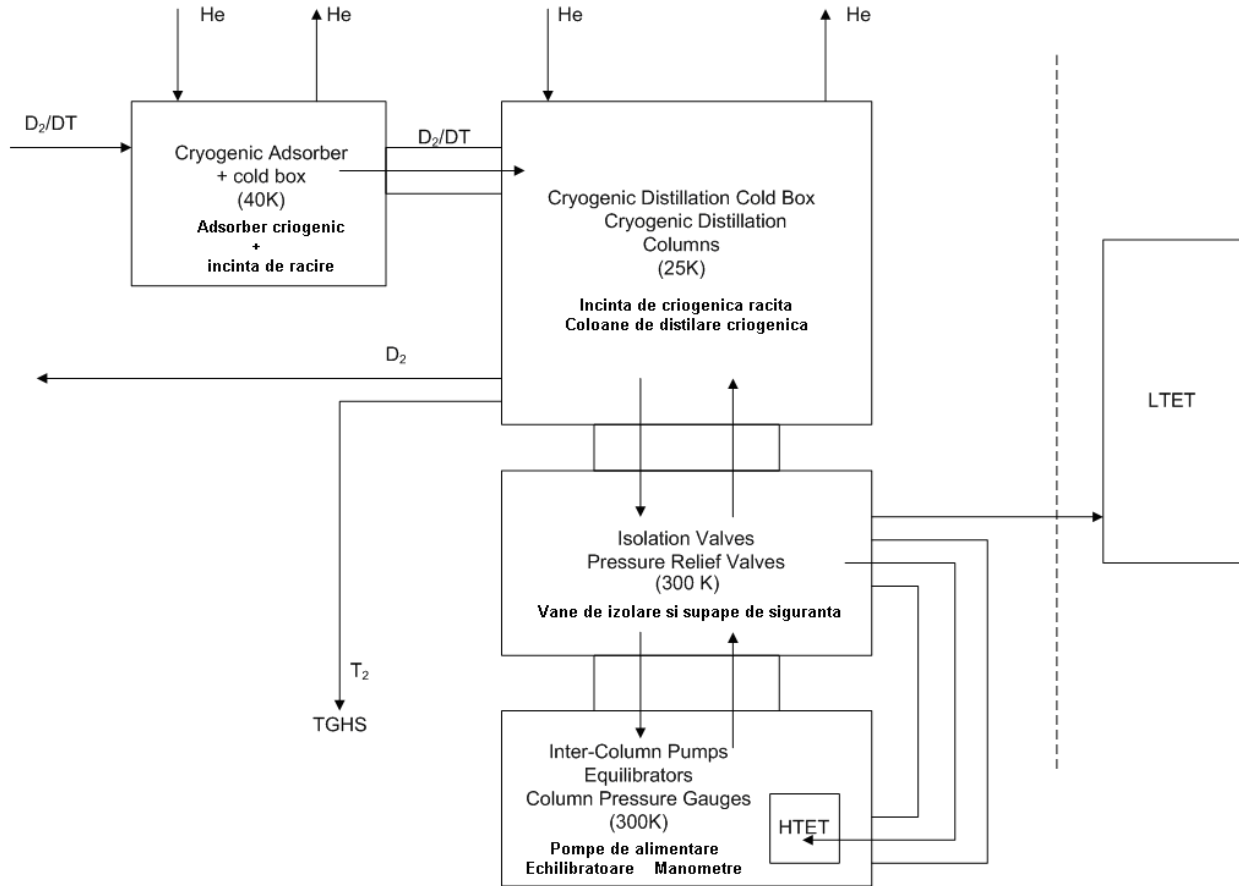
- D2 / DT / HD gaseous flow

CDS system outputs:

- gaseous tritium, which is transferred to the handling and storage system
- gaseous deuterium, which is returned to the LPCE

If controlled drainage of the distillation system is required following an incident / accident occurred during the operation, expansion vessels have been foreseen for the entire gas inventory in the cryogenic distillation columns.

Fig. III.13 Schematic diagram of the cryogenic distillation system - CDS



**3. Tritium gas handling and storage system - TGHSS, is located into a Glove box with stainless steel frame with removable windows of polycarbonate containing the location for gloves and including the main elements::**

- a) The tank to measure the specific activity of tritium from CDS;
- b) Immobilization Tritium Container (ITC) – active and spare – to store the tritium on titanium spongy;
- c) Uranium storage container used to clean the gas by absorption of any gas (deuterium și protium) generated as a result of an abnormal operation. Abnormal Operation refers to a quantitative presence of deuterium and protium (hydrogen atom, with nucleus from a single proton) in the flux of gaseous tritium gas transferred to TGHSS, which may be the result of an inefficient process of tritium separation in LCPE, respectively of tritium concentration in CDS;
- d) Transfer port for the storage containers.

Fig. III.14 Tritium gas handling and storage system from WTRF- Korea



Tritium inventory analysis in TGHS should have an accuracy of  $\pm 3\%$ .

The tritium containers' storage room is a reinforced concrete wall room located in the basement of the CTRF building, providing storage of ITCs resulting from heavy water processing in CTRF. The storage of tritium containers is an integrated part of the building and is designed with a wall thickness and a ceiling of approx. 1000 mm and floor thickness of approx. 1200 mm. The storage capacity is dimensioned to store all the resulting ITCs throughout the CTRF lifetime.

The storage is designed with a life span of 100 years as to ensure the safe storage of ITCs even after CTRF's partial decommissioning. The area is provided with a single access point with a secured door.

B. **Operational support systems** designed to ensure both operational safety and safety during maintenance works, as well as in the event of unplanned outages or power failures.

- **The ventilation system – HVAC** - aims to reduce the probability of explosion in the CTRF's building, to ensure air circulation between the CTRF radiological areas and to provide a suitable environment (ventilation and air conditioning) for personnel's protection and the operation of the equipment. The ventilation system includes 6 separate mechanical ventilation systems for: hydrogen installations' area, CTRF control room area, the battery chamber area, the compressor (helium and air) compartment, and the hydrogen-free installations' area. The detailed presentation of HVAC and its role is provided in Chapter VI (A) b). Sources of pollutants and installations for the containment and dispersion of pollutants in the environment - Air protection ".

- **Air detritiation system - ADS** is designed to reduce the tritium concentration in the CTRF rooms' atmosphere, in the tritiated heavy water transport and processing area, when the tritium concentration in the air exceeds the set thresholds, situations that may occur in case of accidental leakages or emergency.  
ADS uses a blower to create a depressurization in these rooms and ensures, through a catalytic recombinator, a tritium vapor recovery, in order to maintain the tritium concentration below the allowed limit of the exhaust air to the facility's stack. The role of ADS is presented in Chapter VI. (A) b).
- **Tritium Retention System - TRS** is a stand-by system, which operates during maintenance works, commissioning and unplanned outages  
TRS has the basic function of recovering tritium and deuterium from the systems that process these gases and is equipped with 2 x 100% dynamic equipment (pumps and blowers) and mechanical filters. Presentation of the role of TRS is provided in Chapter VI. (A) b).
- **Liquid collection system - LCS** is in charge of heavy water management, heavy water resulting from emptying the CTRF installation during decommissioning and maintenance works, in order to re-use it in the process or to return it to NPP's systems, as appropriate. The LCS consists of a network of leakage pipelines coming from equipment containing process heavy water (LPCE, TRS and ADS). This network is connected to a heavy water collector that supplies a 0.8 m<sup>3</sup> tank located in the drainage basin of CTRF technological zone.  
The tank is equipped with a water sampling point for the analysis of tritium and deuterium concentration before returning the heavy water to supply or product storage tanks in the LPCE system or to the active liquid collection system of the facility. The venting of the Liquid collection system is carried out in the tritium retention system – TRS's feed collector.

### III.f)-d) The raw materials, energy and fuels used in the process, and their supply

The operation of the CTRF facility requires the use of raw materials and products such as:

- virgin heavy water, oxygen gas, liquid nitrogen, helium gas, hydrophobic catalyst, recombinor catalyst, active charcoal, ion exchange resins, 13x molecular sieves, mineral oil, other technical gases; these are ensured through the acquisition system at Cernavoda NPP Unit 1 and Unit 2 and at SNN level.
- Instrumentation air, potable water, firewater, electricity, demineralised water; these are supplied from Cernavoda NPP Unit 1 and Unit 2 facilities.

The CTRF facility will not be connected directly to the national electricity grid.

Power supply of the facility is made through Cernavoda NPP own service transformers 5135-TC01 and 5135-TC02.

The installed electrical power of loads in the CTRF is approximately 4500 kW. The total power required at the level of 6 kV electric station, class IV, within CTRF is approximately of 3500 kVA.

The supply of vital 0.4 kV class III loads, in the case of power supply loss at 6 kV class IV, is ensured by internal power sources consisting of 600 kW Standby Diesel-Generators and the Uninterrupted Power Supply (UPS) sources, for a short period of time, until the nominal capacity

of the Standby Diesel-Generator or the safe shutdown of facility has been reached. UPSs will be enough to keep ventilation, tritium and hydrogen monitors and to ensure safe shutdown of the facility, lasting for one hour.

### **III.f)-e) Connection to existing utility networks in the area**

#### **A. Water supply**

##### ***Current situation***

At present, the water supply and wastewater discharge for U1 and U2 Cernavoda NPP is regulated by the Water Permit no.118 / 20.04.2018 that modifies the permit no.131 / 01.06.2016, issued by the Romanian Waters National Administration.

The potable water supply of Units 1 and 2 is coming from underground through three deep drillings, two located in NPP's enclosure and one located in the NPP's Campus area:

Fj1 H= 700 m;  $N_{hs}=4m$ ;  $N_{hd}=10m$ ; Q= 16 l/s;

Fj2 H= 700 m;  $N_{hs}=3,1m$ ;  $N_{hd}= 5m$ ; Q= 28,5 l/s;

Fj3 H= 700 m;  $N_{hs}=5,17m$ ;  $N_{hd}=5,92m$ ; Q= 21,2 l/s

Cernavoda's town potable water supply system is operated by RAJA SA Constanta – and represents a reserve of water supply.

Technological (industrial) water supply - the source is represented by the Danube River - the 1st Forebay of the Black Sea Danube Canal through the bypass channel. The water supply coverage degree is of 97%.

Fire Water Supply System- the water source for fire fighting is represented by the water from the Danube, taken either from the bypass channel, after the water passes through a 5 mm mesh filter or after it passes through the rotating sites associated to the technical service water system and Brassert filters for the fire water system.

For the CTRF project the Romanian Waters National Administration issued the Water Permit No.109 / 12.12.2018.

#### **A1. Water supply for hygienic - sanitary purposes of the CTRF**

The provision of water for sanitary and hygienic purposes for the personnel carrying out the CTRF activities, approximately 15 users (within 24 hours), will be done by connecting to the internal potable water supply network of Cernavoda U1 NPP, existing in the vicinity of the CTRF site.

The potable water is supplied to the CTRF facility by pumping it from the water supply system corresponding to U1's system. The connection from the water distribution network for U1 to the CTRF facility pipeline, measures approx. 30 m and will be a PEHD pipe with a nominal diameter of 50 mm.

Hot water is warmed up locally using electric boilers.

During the construction works, potable water is used, this being ensured by the existing facilities near CTRF project's site.

**A2. CTRF Technological water supply of the CTRF facility**

Technological water is required starting with the technological testing phase and commissioning phase.

The necessary water flow for technological consumption that ensures the operation of the chilled water system and the cooling water system consists of demineralised water produced by the Water Treatment Station (WTS) and comprises:

- **The necessary demineralized water flow 1** – needed for initial filling of the chilled water system; the necessary demineralized water flow 1 ensures the set into operation of the two redundant chillers (one active and one in stand-by state) located on the concrete platform on the roof of the CTRF building.

The system runs continuously, in a closed circuit; the necessary demineralized water flow represents 99% of the recirculated water flow.

$$Q_{n \text{ tehn } 1 \text{ day avg}} = 2,7 \text{ m}^3 / \text{day} = Q_{\text{rec } 1}$$

- **The necessary demineralized water flow 2** – needed for the initial filling of the cooling water system; ensures the cooling of various equipment from other CTRF systems (eg cooling the electrolyser from the deuterium make-up system, cooling the helium compressors in the refrigeration unit of the cryogenic distillation system, cooling the process compressors CP301 and CP302, cooling the gas in the HX 501 cooler , cooling the tritium removed heavy water from the LPCE).

The system runs continuously, in closed circuit, the necessary demineralized water flow representing 99% of the recirculated water flow.

$$Q_{n \text{ tehn } 2 \text{ day avg}} = 6,2 \text{ m}^3 / \text{day} = Q_{\text{rec } 2}$$

- **The necessary demineralized water flow 3** - for various subsequent additions of demineralized water to the consumers in chilled water and cooling water systems.

$$Q_{n \text{ day tehn } 3 \text{ avg}} = 0,025 \text{ m}^3 / \text{day} = 9,125 \text{ m}^3 / \text{year}$$

- **The necessary demineralized water flow 4** – for washing and decontamination of equipment and components related to LPCE.

The demineralized water distribution network will be made of stainless steel pipes.

For abnormal situations, the designer has foreseen an additional maximum flow rate of 0.5 m<sup>3</sup> / h. Also, in case of emergency situations, it was foreseen a volume of water for washing / decontamination of about 6 m<sup>3</sup>.

No technological water is used during construction-assembly works.

**A3. CTRF's Fire-fighting water supply**

Fire fighting water supply of the CTRF building is ensured by means of a connection to the fire-fighting water supply system of the Cernavoda NPP.

The fire-fighting water distribution network of the CTRF facility will provide external fire hydrants with a nominal diameter of 110 mm (PEHD pipe) which will provide a flow rate  $Q_{ie}$  of 15



l / s as well as internal fire hydrants with a nominal diameter of 100 mm which will ensure a flow rate  $Q_{ij} = 2.5 \text{ l / s}$ .

An H-CTRF fire hydrant with nominal diameter of 100 mm will be placed on the outside pipe. In case of fire outburst from outside, it will be intervened with fire-extinguishing water from this new hydrant and those existing on the fire-fighting water supply system.

## **B. Domestic and pluvial sewage circuit, active drainage**

### ***Current situation***

The non-radioactive domestic waste water from Cernavoda NPP U1 and U 2 is discharged into the sewage network of Cernavoda town, based on the Water Permit No. 118 / 20.04.2018 that modifies the Water Management Permit no.131 / 01.06.2016, issued by Romanian Waters National Administration.

Wastewater from the Cernavoda NPP is transferred to Cernavoda Waste Water Treatment Plant, which evacuates the treated wastewater through the Seimeni discharge channel into the Danube (the cooling water channel at Cernavoda NPP), the discharge point being before the cooling water discharge into the Danube.

Pluvial water discharge is done into Cernavoda NPP distribution basin, including the underground drainage, inactive drainage from the turbine building, U1 and U2 reactor buildings, U1 and U2 SDG (Stand-by Diesel Generator), siphoning basin 1 (2), Thermal Startup Station (TSS), waste water coming from washing (Water Treatment Plant) WTP's mechanical filters, wastewater from the oil separator, from overflow of the demineralized water tank, from the overflow of the filtered water tank.

### ***CTRF associated circuits***

CTRF's sewage system will be connected to the U1 domestic and pluvial sewage systems, while the active drainage will be connected to the Radioactive Waste Management System, whose dimensions / capacity can take over CTRF's sewage/drainage discharge.

#### **B1. CTRF's sewage system**

Waste water from the CTRF building consists of waste water coming from the sanitary groups of the building.

The sewage system ensures the collection, transportation and disposal of domestic waste water through an external connection in U1 domestic sewage network on Cernavoda NPP platform in the vicinity of the CTRF site.

#### **B2. CTRF's active drains**

Potentially contaminated fluids in the CTRF technological area (potentially radioactive liquid waste, including fire-fighting water and the water resulted from equipment decontamination) will be drained gravitationally and collected in a sealed sump (having a volume of 6 m<sup>3</sup>) located in the basement of the CTRF, from where they will be pumped to U1 Radioactive Liquid Waste Management System.

The Active Drainage System consists of a network of floors syphons located in each enclosure as well as discharge pipes connected to the active drainage system of CTRF building. The project also envisages collection trays for any potential process waters leakages.

The maximum waste water flow to be taken over by the active sewage system and collected in the sump is of 3.7 l / s. From the sealed sump, potentially radioactive liquid wastes are transferred by pumping into the Active Drainage System of the U1 Service Building, where they are then emptied into the Radioactive Liquid Waste Management System. The volume of the sump and transfer system have been designed so that they can take up the maximum volume of water that could accumulate and avoid flooding of the CTRF's first basement.

### **B3. CTRF pluvial drainage**

The pluvial water coming from CTRF and from the access roads to CTRF building area will be collected, transported and discharged through an external connection, made in a separated system, into the pluvial sewage network existent on the Cernavoda NPP site in the immediate vicinity of the newly built CTRF building and finally in the distribution basin/pool of the Cernavoda NPP.

The pluvial flow from CTRF is estimated at  $Q_p = 24.85 \text{ l / s}$ .

The collection, transport and evacuation of pluvial waters will be done through a collecting header with a length of approx. 50 m, made of polyvinylchloride PVC tubes, class SN4, with  $D_n$  of 315 mm.

### **C. Ensuring the thermal heating**

CTRIF building heating will be ensured by the heating ventilation and air conditioning system.

#### **III.f-f) Description of the site restoration works in the affected area by the the project's construction works**

The execution of the project does not require environmental reconstruction works, the site being placed in an industrial area, within the Cernavoda NPP site. During the construction works there will be patches of soil affected around the construction. After completion of construction works, the land will be rehabilitated by scarification, laying soil and planting vegetation.

The land on which the CTRF will be built is construction-free, and no demolition is required.

The area related to CTRF facility is approx. 1350 sqm.

The CTRF building has a foot print area of approx. 600 sq m (30.00 m x 20.00 m).

#### **III.f-g) New access roads or changes to the existing ones**

The existing access roads on Cernavoda NPP site will be used. The roadside part within CTRF facility area will consist of a concrete platform on the entire surface. The road structure will consist of ballast, broken stone, sand, kraft paper and concrete

#### **III.f-h) Resursele naturale folosite în construcție și functionare The natural resources used during construction works and operation of the facility**



Project implementation is done in the spirit of sustainable development in the sense that neither the construction nor the operation of the CTRF does not involve the use of materials from the exhaustible natural resources category.

The renewable natural resources used are: river stone, sand, soil (the land on which the building will be located), water.

### III.f)-i) **Methods used during construction works/ decommissioning phase**

The construction works will be carried out in compliance with the Law no. 111/1996 regarding the safe conduct, regulation, authorization and control of nuclear activities, with subsequent modifications and completions, republished and in compliance with CNCAN Order no. 72 / 30.05.2003 that approves CNCAN's Norms regarding the specific requirements regarding the quality management systems applied to the construction and assembly works for nuclear installations (NMC-08).

Each of the structures, systems and components for the CTRF nuclear safety related will be classified into specific safety class based on their fulfilled safety functions as per CNCAN Order no. 66/30.05.2003 (NMC 02).

For the assessment of the ground foundation for the Tritium Removal Facility, drillings were performed and the results are presented in the Geotechnical Study that confirms the acceptance of the land on which the facility will be constructed.

Foundation will be done on base rock, by laying the facility's basement or by fixing it with rigid pilots.

For the infrastructure execution, taking into account the need to protect existing constructions, estacades, cable channels, etc., the excavation will be carried out in a closed berth-like enclosure.

### III.f)-j) **Implementation plan including construction works, commissioning, operation, reconditioning and subsequent use**

Project implementation involves:

#### **Implementation period**

CTRF project implementation includes the following phases:

- Site organization and construction works
- Technological tests and si commissioning phase

#### **Operation**

- The design lifetime of the CTRF facility is of 40 years, ensuring tritium removal from the heavy water over the life of U1 and U2.
- CTRF's operating time per year is 8000 hours.
- Planned outages for maintainance works will be less than 10 days / year

**Decommissioning** – the CTRF Decommissioning Plan represents CTRF's main decommissioning documentation. The plan will be prepared in its initial form in order to obtain the CNCAN's construction license and will be revised every 5 years according to the CNCAN's applicable requirements (CNCAN Norms regarding safety requirements for the decommissioning of the Nuclear and Radiological facilities - NDR-07, Article 59 paragraph 1 and Article 60).

**Subsequent land restoration** – represents an activity to be foreseen in the Final Decommissioning Plan, which will be drafted prior to end of lifetime and the permanent shutdown of Cernavoda NPP's nuclear reactors, in compliance with the applicable legislative and regulatory requirements issued by CNCAN.

In accordance with CNCAN's basic authorization requirements for the CTRF facility, CTRF's decommissioning plan will be correlated with the decommissioning plan of Cernavoda NPP Units 1 and 2. The closure and decommissioning activities of Cernavoda NPP will be started and carried out strictly after obtaining the legal permits/authorizations.

The decommissioning phase of the Cernavoda NPP will be subject to the environmental impact assessment procedure in order to obtain the Environmental Permit in accordance with the provisions of the Law no.292 / 2018 regarding the environmental impact assessment of certain public and private projects - Appendix 1- point 2b.

### **III.f-k) Relationship with other existing or planned projects**

#### **A. Similar projects**

The CTRF facility is the result of the research activity carried out within several projects developed and implemented by the National Research and Development Institute for Cryogenic and Isotopic Technologies Rm. Vâlcea (ICSI Rm. Vâlcea). The research data led to the implementation, within the Institute's enclosure, of an experimental tritium removal facility with the purpose to confirm the technical data and the functional characteristics of the specific materials and equipment used in the design of a tritium removal facility for CANDU type reactors.

Thus, starting with 1996, ICSI Rm. Valcea, through funding from the national research, development and innovation programs, developed the tritium removal technology of the heavy water used as moderator in a CANDU reactor. At first, the research focused on the use of hydrogen isotopes similitude, the technology being verified for hydrogen and deuterium isotopic species by carrying out an experimental Pilot Facility

Subsequently, the Pilot Facility was turned into a radiological installation with the purpose to verify and improve tritium removal technology for the tritiated heavy water. In 2002, extension works of the Pilot Facility were started in order to develop the tritium removal technology to be approached, the works being performed based on the Environmental Permit no. 2 / 15.01.2002 issued by the Ministry of Waters and Environmental Protection.

In between 2002-2008, the facility was developed taking into account the standards in force at that time and in accordance with the requirements stipulated into the Location and Construction License no. ICSI- 1/2002. Along with legislative changes, project changes (equipment replacements) were made to comply with PT ISCIR N SCP 1: 2008.

After the completion of the extension works, the Environmental Protection Agency Valcea issued the Environmental Permit no. 32 / 29.01.2008 for the Experimental Pilot Facility for Separation of Tritium and Deuterium (PESTD) in order to carry out the necessary activities for the development of tritium removal technology.

In 2004, by Government Decision no. 1428 regarding the approval of the Installations and Special Projects of National Interest financed by the Ministry of Education and Research, Rm. Vâlcea Pilot Facility was included in Appendix 1 - List of Facilities and Special Projects of national Interest: "the Experimental Pilot Facility for Tritium Separation and deuterium ".

In between 2011-2012, through the CRYO-HY project financed by the Operational Sectorial Programme - Increase of Economic Competitiveness 2007-2013, ICSI proceeded with the refurbishment of PESTD in order to increase the technological performances of the facility.

The refurbishment of the pilot facility focused on cryogenic cooling and consisted of:

- Replacement of the cryogenic distillation column with a cascade of four cryogenic distillation columns
- Replacement of the hydrogen and nitrogen based refrigeration system with a more efficient helium-based system
- assembly works of the replacing equipment
- Tests and commissioning.

The PESTD Pilot Facility is currently associated with the EURATOM / JET (Joint European Torus) programs as a facility for tritium removal studies and specific experiments related to fusion reactors, as well as taking part in the development of nuclear projects for the ITER reactor in Cadarache, France.

The activities related to PESTD are authorized by CNCAN.

Also, PESTD is nominated on the nuclear facilities list monitored by the International Atomic Energy Agency - IAEA, Vienna, being included in the nuclear safeguards reporting and control system.

## B. Existing or future relevant projects at Cernavoda NPP site

Several projects are being carried out on Cernavoda NPP site, which are meant to ensure the smooth and safe execution of the ongoing activities related to U1 and U2, respectively the implementation of future projects that aim the development of the activities in nuclear safety conditions, ensuring NPP's personnel, population and environmental protection.

In Table III.2 are presented the current or future projects considered relevant for the Project, from the point of view of the cumulative environmental impact assessment.

**Tab. III.2 Current or future relevant projects on Cernavoda NPP site**

Project's name	Project type	Distance to CTRF site	Development stage/ project's aim
Intermediate Dry Spent Fuel Storage Facility (IDSFS) base on the gradual construction of MACSTOR 200 modules  <i>IDSFS area: 24.000 sqm</i>	Ongoing project on U1 and U2 Cernavoda NPP site	Approx. 800 m	IDSFS was commissioned in 2003. The technological solution of the ongoing IDSFS project consists in the storage of spent nuclear fuel in MACSTOR 200 concrete modules. The environmental permit of Cernavoda NPP approved by GD no.84 / 2019 covers IDSFS project.
<sup>1</sup> IDSFS extension and continuation of	-	approx. 800 m	The Project was notified to Ministry of Environment by the Urban Planning Certificate no. 347 of 21.10.2015

<p>construction works MACSTOR 400 modules</p> <p><i>IDSFS total area + extension: 31.000 sqm</i></p>			<p>issued by the Town Hall of Constanta;</p> <p>-the environmental impact assessment procedure was completed; Ministry of Environment issued the Decision of the initial evaluation stage no.14.316 / 17.08.2016;</p> <p>- following the establishment of the area evaluation phase, the guideline no.15.608 / LAN from 17.08.2016 was issued</p> <p>This project requires changes due to additional requirements presented in the review of the IDSFS Long-Term Development Strategy.</p>
<p><sup>2</sup> IDSFS extention and construction of MACSTOR 400 modules</p> <p><i>IDSFS total area +extension: 40.000 sqm</i></p>	Future project		<p>Future project that will be notified to Ministry of Environment after the information necessary for the environmental impact assessment procedure will be available following the implementation of the revised IDSFS Long-Term Development Strategy.</p>
<p>Continuation of construction works and completion of Units 3 and 4 at Cernavoda NPP</p>	PFuture Project	Approx.400 m, respectively 500m	<p>On the Cernavoda NPP site will be built U3 and U4 Units, for which the Environmental Permit was issued by GD no.737 / 2013.</p>
<p>Cernavoda NPP Unit 1 refurbishment</p>	Future project	Approx. 200m	<p>Future project that will be notified to Ministry of Environment after the information necessary for the environmental impact assessment procedure will be available.</p> <p>By the Decision of SNN's Extraordinary General Meeting of Shareholders no.9 / 2017, it was approved the start of Phase 1 of the Strategy for the refurbishment project of Unit 1 at Cernavoda NPP. The refurbishment project is intended to extend the lifetime of Unit 1 Cernavoda NPP for another 30 years of operation.</p>

<sup>1</sup> The Environmental Impact Assessment Procedure for the "IDSFS Extension and construction of MACSTOR 400 Modules" project was launched as a result of IDSFS's Long-Term Development Strategy, which envisaged the transition to the construction of MACSTOR 400 modules. The main technical changes in relation to the technical documentation that was at the basis of the

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Environmental Permit no. 2058 / 22.02.2002 issue by the Environmental Protection Inspectorate Constanta were determined by:

- increase of the number of MACSTOR modules from 27 to 30 modules, out of which 9 are MACSTOR 200 modules and 21 are MACSTOR 400 modules;
- extension of the IDSFS' site extension, respectively the increase of the surface to approx. 31,000 sqm
- MACSTOR modules' lifespan: 50 years

<sup>2</sup> Currently, as a result of additional requirements, has been drafted and is currently under approval the review of IDSFS's Long-Term Development Strategy, which brings significant changes to the IDSFS Extension and MACSTOR 400 Module Design project, for the following reasons:

- the establishment of the conceptual solutions for the intermediate dry spent fuel storage for 2 nuclear units, respectively 4 nuclear units considering the commissioning of the National Geological Repository in 2055, deadline estimated in August 2015, by the Nuclear and Radioactive Waste Agency in relation to National Notification Program in relation to Directive 2011/70 / Euratom on the responsible and safe management of spent nuclear fuel and radioactive waste;
- CNCAN issued in January 2019 the requirement that the MACSTOR 400 modules be designed with a lifetime of 100 years;
- the need to take into account an intermediate fuel storage solution for four U1-U4 nuclear units for two life cycles

Significant changes to the technical documentation on which the Environmental Permit no. 2058 / 22.02.2002 was issued, respectively the notification of the project to the Ministry of Environment in 2016 will include:

- increase of MACSTOR modules number, out of which 17 modules will be MACSTOR 200 and up to 22 MACSTOR 400 modules;
- extension of the IDSFS site, respectively the increase of the surface to about 40.000 sqm;
- The lifetime of the MACSTOR 400 modules will be 100 years (Note: It is worth mentioning that the analysis to be made for the MACSTOR 400 module design will be extended to the MACSTOR 200 modules as well.)

The information included in new revision of the IDSFS Long-Term Development Strategy, as well as the information from the analysis and studies required to ensure compliance with the lifetime requirements of the MACCOR 400 Module, will allow the development of the necessary documentation for the environmental impact assessment of the future IDSFS extension project with MACSTOR 400 modules.

For the Cernavoda NPP Unit 1 Refurbishment project there will be information necessary to assess the environmental impact at a later date

**III.f)-I) Details regarding the alternatives to CTRF that have been taken into account****A. Alternative technological systems to Cernavoda Tritium Removal Facility (CTRF)**

Out of the studies/ analysis carried out on the available technologies to Cernavoda Tritium Removal Facility, the following solutions were identified in the Prefeasibility Study prepared for the Project:

- **Solution 1 - CECE – CD (Combined Electrolysis and Catalytic Exchange – Cryogenic Distillation)**

The CECE-CD solution is based on the tritium transfer from water to the gaseous phase by a combined electrolysis process - isotopic catalyzed exchange (thereby increasing the concentration of tritium in heavy water) followed by a final tritium concentration through cryogenic distillation and its safe storage (metal hydride).

- **Solution 2 - DE – CD (Direct Electrolysis – Cryogenic Distillation)**

The DE-CD solution consists of tritium transfer to the gaseous phase by the electrolytic dissociation of the tritiated heavy water followed by a final tritium concentration through cryogenic distillation and its safe storage (metal hydride).

- **Solution 3 - LPCE - CD (Liquid Phase Catalytic Exchange – Cryogenic Distillation)**

The LPCE-CD solution is based on the tritium transfer of from water to liquid phase through a catalyzed isotope exchange process followed by a final tritium concentration through cryogenic distillation and its safe storage (metal hydride).

Based on criteria that have taken into account:

- Minimal risk for personnel and environment, associated with tritium extraction technology,
- the optimal dimensions of the main components relative to the facility area,
- the necessary process subsystems and the appropriate size in terms of complexity, operability and maintenance,
- minimal D<sub>2</sub>O and tritium inventories and storage of tritium, operation and maintenance specific safety issues,
- utilities and optimal operating costs,
- authorization requirements for the technological solution
- the estimated cost of the investment,
- potential contractors for services and materials availability in Romania and operational requirements,

it was taken the decision to implement the LPCE-CD based technology (Solution 3) developed at ICSI Rm. Vâlcea in the pilot facility and for which there is operational experience (OPEX) at the Wolsong Tritium Removal Facility (WTRF) in Korea. This solution is presented in Chapter III.

**B. Options regarding the location selection where the detritiation process will occur**

For CTRF the following options were considered:

- **Option "0"** consisting in the operation of the nuclear units at Cernavoda NPP site without CTRF

Tritium removal process on Cernavoda NPP site (on-site):

- **Option "1"** – implementation of the Cernavoda Tritium Removal Facility project in the vicinity of both nuclear units U1 and U2, specifically between the Units.
- **Option "2"** - implementation of the Cernavoda Tritium Removal Facility project in the fixed front of the NPP, in the vicinity of the common facilities (water treatment plant, thermal startup power station).

### ***Option zero: Continue U1 and U2 operation without CTRF***

Given that Cernavoda NPP, which has U1 in service since 1996 and U2 since 2007, will not intend to apply tritium removal process of the tritiated heavy water, the tritium concentration in the heavy water contained in the nuclear system will reach peak rates of 80-90 Ci / kg, with effect upon the radiation fields and the collective dose for plant's personnel and population.

Thus, in the absence of tritium removal process, the process fluid (heavy water) in the nuclear systems will have high levels of tritium, which will make immediate access to preventative and predictive maintenance difficult, leading to extended intervention time and ultimately increased production costs of the electric and thermal energy through the nuclear process.

In addition, tritium effluents and tritium concentrations in the solid radioactive waste, although well below the regulated limits, will be higher as a result of reaching the stationary regime in the reactor U1 and U2 systems.

### ***Tritium Removal facility on Cernavoda NPP site (on-site)***

The Tritium Removal Facility (CTRF) implementation tritium significant contribution to the doses received by Cernavoda NPP staff and population will be limited by removing tritium from the reactor U1 and U2 systems and maintaining a low level steady-state concentration, respectively 10 Ci / kg in the moderator and less than 2.5 Ci / kg in the primary heat transfer system.

The proposed technology for the project implementation is based on the principle of liquid phase catalyzed isotope exchange and cryogenic distillation (LPCE - CD), followed by the immobilisation of the separated tritium as a metal hydride - technology developed at ICSI Rm. Vâlcea within the pilot facility and for which there is experience (OPEX) at the Wolsong Tritium Removal Facility (WTRF) in South Korea.

The choice of the optimal site alternative was based on the analysis of the advantages and disadvantages of the two alternatives, resulting in the following conclusions:

#### **Advantages:**

- Uses the existing facilities for U1 and U2 related to utilities (electrical, thermal, water supply, sewage, pluvial water, fire-fighting system), physical protection system, short-distance connection to Water Treatment Station for cooling water supply,
- Uses disposal facilities of potentially contaminated radioactive waters in the existing systems,



- Provides continuous tritiated water supply and prevents additional storage
- Uses the existing waste management system at Cernavoda NPP, reducing the implementation and operation costs for both CTRF and U1 and U2.

**Disadvantages:**

The disadvantage of the on-site option lies in the need to adopt special measures for the CTRF's site organization (construction works) in the vicinity of the U1 / U2 nuclear facilities.

Two options for CTRF location on the Cernavoda NPP site were taken into consideration:

- Option "1" - in the area between units U1 and U2 - the area between the physical protection fence and the road in the vicinity of the D<sub>2</sub>O Reconcentration Tower and the High Pressure Building for the cooling of the U 1 active zone (Appendix no. 2);
- Option "2" - on the land located at approx. 200 m East of the U1 reactor - limited by the slope to Saligny hill and the main road in on the NPP site that allows access from the PCA1 gateway to the Water Treatment Station (WTS), the Thermal Startup Power Station (TSPS) and leads to the Intermediate Radioactive Waste Storage Facility (IRWSF). On two sides, it is partially bordered by a concrete wall that has the role of anti-explosion protection (Appendix no. 3).

It was decided to adopt Cernavoda NPP Tritium Removal Facility project implementation choosing the 2<sup>nd</sup> option for site location " - the location of the tritium removal facility shall be on the land located at 200 m East of the U1 reactor, as a consequence, this location ensures risks reduction to nuclear safety systems, equipment and components of the U1 and U2 by increasing the distance from the nuclear units.

The Project implementation will be carried out in compliance with the requirements of the Construction License and the Operating and Environmental Permits issued for Cernavoda NPP.

**III.f)-m) Other activities that may occur as a result of project implementation**

Project's Feasibility Study mentioned the possibility of trading tritium, as an economic option, which in the future could contribute to increase the economic efficiency of the facility. At this point, the international tritium market has peaceful purposes, the uses being multiple: from the watch mechanisms (considered in Switzerland as environmentally friendly and risk free for the population), airport lighting and signaling systems and up to advanced fusion reactors.

**III.f)-n) Other permits required for the project**

In order to obtain the construction license for the Project, authorization that has to be obtained under the provisions of Law no. 111/1996 on the safety development, regulation, authorization and control of nuclear activities with amendments and completions, republished and according to the specific legislation of the related fields to the project, it is necessary to obtain permits, agreements, which include:

- Water Permit, if the case
- Environmental Permit
- Sanitary Permit
- Autorization for the operation of the equipment in explosive áreas, issued by INSEMEX
- The Authorization/Oppinion of ANANP (National Agency for Protected Natural Areas), if the case, pending on requests of the competent Authority for Environment Protection



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- CNCAN construction license

The authorities involved in project authorization are as follows: CNCAN, ISCIR, INSEMEX, Ministry of Environment, Romanian Waters National Administration, and General Inspectorate for Emergency Situations and Sanitary Authorities (DSP, INSP). The project being classified as a nuclear installation is authorized in accordance with Law no. 111/1996, with the subsequent amendments, republished, the regulatory authority in the nuclear field, CNCAN having to issue the specific permits for construction in order to start construction works.

Construction authorization process, commissioning, operation (decommissioning) and decommissioning of the tritium removal facility requires also other specific agreements, approvals and authorizations.

According to the provisions of art. 37 paragraph (3) of the Law no. 111/1996 regarding the safe conduct, regulation, authorization and control of nuclear activities, with the subsequent amendments and completions, republished, and according to the provisions of art. 46 of Law no. 265/2006 regarding the environmental protection, with the subsequent modifications and completions, one of the prerequisites for CNCAN to issue the construction license is to obtain the environmental agreement.

For the CTRF project, the Water Management Permit No.109 / 12.12.2018 was issued by the Romanian Waters National Administration and shall be analyzed under the Environmental Impact Assessment procedure, in accordance with the provisions of Article 4 align. (3) and (4) of Law no.292 / 2018.

#### **IV. Description of required demolition works**

The CTRF project does not involve demolition works.

The land on which the facility is located is free of construction.

#### **V. Description of the project location**

The CTRF project will be developed on the current site of Cernavoda NPP, in Constanta County, at approx. 2 km south-east of the town of Cernavoda, at approx. 1.5 km north-east of the first lock of the Danube-Black Sea Canal, on the land area of the platform resulting from excavations from the former limestone quarry Ilie Barza.

The NPP site is bordered to the north of Cismelei Valley and to the south-west by DJ 223.

The land from Cernavoda NPP premises, on which the CTRF project will be carried out, is located in the stationary front of the power plant and is limited by the slope towards Saligny hill and the main road within NPP site– that allows access from the PCA1 gate to the Water Treatment Plant (WTP), Start-up Thermal Power Plant (STPP) and goes to the Intermediate Radioactive Waste Storage Facility (IRWSF). On two sides it is partially bordered by a concrete wall that has the role of anti-explosion protection (Appendix no. 1 - Situation plan).

## V.a) Distance to borders for projects covered by the Convention on Environmental Impact

Assessment in a Transboundary Context, adopted at Espoo on 25 February 1991, ratified by Law no. 22/2001, with subsequent completions.

In the figure below it is shown the distance from the Cernavoda NPP site to the borders of the nearest states in the vicinity of Romania:

- approx. 36 km to Bulgaria
- approx. 110 km to Ukraine
- approx. 127 km to the Republic of Moldova

**Fig. V.1 Distances from Cernavoda NPP to the nearest borders**



## V.b) Monuments List, updated, approved by the Order of the Minister of Culture and Religious Affairs no.2314 / 2004, with the subsequent modifications and the National Archaeological Repertory stipulated by the Government Ordinance no.43 / 2000 on the protection of the archaeological heritage and the declaration of some archaeological sites as areas of national interest, republished, with subsequent modifications and completions

From consulting the General Urbanist Plan of Cernavoda town, of the Cartographic Server for National Cultural Heritage - administered by the National Heritage Institute - Directorate for Investigation, Evidence of Mobile Cultural Heritage, Intangible and Digital Bucharest, as well as from Law no. 5/2000 regarding the approval of the National Territory Planning Plan - Section III - Protected Areas it was found that the Cernavoda NPP platform is located in an area with a

concentration in the territory of the heritage built with cultural value of national interest – Cernavoda town, the Mircea Voda and Topalu communes.

### **V.c) Maps, site photos that can provide information on the physical features of the environment, both natural and artificial, and other information on:**

#### **Actual and planned land use both on the site and adjacent areas**

The site of the Cernavoda Nuclear Power Plant, in which the project is located, is placed on the platform resulting from the excavations of the former limestone quarry Ilie Barza, at approx. 2 km southe-ast of Cernavoda town of and approx. 1.5 km north-east of the first lock of the Danube-Black Sea Canal, being bordered to the north by Cismelei Valley and to the southwest by the DJ223C.

The overall physical characteristics of the Cernavoda NPP platform and the positioning of the CTRF project within the platform can be seen in the Location Plan in the area of Appendix 1.

#### **Zoning and land use policies**

According to the legislation in force in the nuclear field, the lands belonging to the Cernavoda NPP site will be used only with the approval of the National Commission for Nuclear Activities and Cernavoda NPP, only constructions related to the operation of the Nuclear Power Plant being admitted.

The legal situation regarding the land on which the CTRF project is located was established by the Decree of the State Council no. 31 / 27.01.1986 (for the realization of Cernavoda NPP Units 1-5), the land being expropriated.

The land occupied is the property of SNN S.A. according to the Certificate of Land Ownership, M03 series no.5415 issued by the Ministry of Industries and Resources, on 25.04.2000.

According to Urbanism Certificate no. 97 from 16.05.2018 the land on which the CTRF project is located:

- is placed urban in Cernavoda town, Constanta County, according to P.U.G. approved by H.C.L. no. 242/2014,
- is found in U.T.R. A3 - sub-area for production units of C.N.E.

#### **Sensitive areas**

The Project site does not overlap with protected natural areas of community interest. In this context, biodiversity in the protected natural areas of community interest was analyzed in the vicinity of the Cernavoda NPP platform.

The sensitive areas in the vicinity of the Cernavoda NPP site are presented in Chapter XIII of the Presentation Memoir.

#### **The geographic coordinates of the project site, which will be presented as a vector, in digital format with geographic reference, in the National Projection System Stereo 1970.**

The Stereo 70 Coordinates for CTRF are attached to this documentation (Appendix 4).

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**Details of any site option that was considered**

The options of site alternatives studied for CTRF are found in Appendix no. 2 and Appendix no. 3.

**VI. Description of all possible significant environmental effects of the project, within the limits of the possible information:**

Description of all possible significant environmental effects of the project, within the limits of the possible information:

In this chapter there are presented sources of pollutants and installations for the containment, evacuation and dispersion of pollutants in the environment during the operation (exploitation) stage.

Sources of pollutants and measures / equipment for controlling the emissions of pollutants in the construction / site construction stage, respectively the stage of technological and commissioning tests are presented in Chapter. X from the Presentation Memoir.

**VI.a) Sources of pollutants and installations for the containment, evacuation and dispersion of pollutants in the environment****VI.a)-a) Protection of water quality**

- **Sources of water pollutants, evacuation site or emissary**

**Domestic sewage**

The household sewage resulting from the CTRF building comes from the sanitary groups in the building.

The sewage system ensures the collection, transportation and evacuation of domestic waste water through an external connection made in separating system, in the domestic sewage network of Unit 1 existing on the Cernavoda NPP platform in the immediate vicinity of the CTRF site.

Household sewage – non-radioactive - generated from the U1 related activities, are directed gravitationally to the SP1 Pump Station, located in Unit 1, from where they are pumped at the Sewage Pump Station SP2, located between the locations of Units 3 and 4 and guided further to pumping station - SP "Valea Cismeiei" of Cernavoda town, for the final evacuation into the sewage network of Cernavoda Town

The pipes that ensure the evacuation of the water from the Cernavoda NPP from SP 1 and SP 2 to SP "Valea Cismeiei" are made of steel and have a diameter Dn 250 mm.

The capacity of pumping stations and pipelines existing on the NPP platform can assure the collection, transportation and discharge of household sewage, from the point of interconnection with the CTRF facility.

**Liquid collection system**

The system consists of a pipeline network to take over leaks from the following systems: Catalyzed isotope exchange system - LPCE; Tritium retention system - TRS; Atmospheric Detrition System - ADS and Gas Deuterium Supplementation System - DMS.

The leakage pipeline network is connected to a collector that supplies a tank made of stainless steel, with a storage volume of 0.8 m<sup>3</sup>, located in the heavy water drainage basement of the CTRF.

The storage tank is provided with a water sampling point for isotopic analysis of tritium and deuterium content before returning to the HWPS system or other NPP systems.

In case that it is found from the laboratory tests that the isotopic of the water collected in the reservoir is more than 0.2%, the water will be reintroduced into the technological detritiation process.

If, as a result of analyzes made that the isotopic of the water collected in the reservoir is less than 0.2%, the water will be transferred to the active drainage basement, mentioned below.

### **Active drains**

Potentially contaminated fluids from the CTRF technology area (potentially radioactive liquid waste including fire-fighting water and decontamination water) will be gravitationally collected in a 6 m<sup>3</sup> volume Sump located in the basement of the CTRF, from where they will be pumped into the U1 Radioactive Waste Management System, as described below.

The Active Drainage System consists of a network of floor syphons located in each enclosure and discharge pipes to the active drainage Sump in the CTRF building basement. The project also includes trays for the collection of eventual leaks of process waters.

The capacity of Radioactive Waste Management System from Unit 1 can also manage the radioactive contaminated water taken from the point of interconnection with the CTRF.

The radioactive waste management system of Unit 1 (consisting of 5 x 50 m<sup>3</sup> tanks, filter unit / ion exchanger - for purification, if any, and bringing up to lower values than the discharge limit - and pumps) discharges water from the reservoirs, in the capacitor cooling water channel of Units 1 and 2 of Cernavoda NPP. Discharging the contents of a reservoir in the condenser cooling water channel is done in a controlled manner, as shown in chapter VII.d) of the Presentation Memoir.

The evacuation of the cooling water from Units 1 and 2 in the Danube (in normal operation) is done by a circuit made of cassettes, a concrete channel tunnel and a canal which crosses Cismelei Valley with discharge, at km 296+000 in the Danube river.

In normal operation, the cooling water can also be evacuated in the second channel of the Black Sea Danube Canal with the approval of the Romanian Water Administration and of the Dobrogea - Litoral Water Basin Administration as well as with the approval of the other authorities according to the legal provisions (Administration of the Navigable Canals SA, authorities within the Ministry of Health, etc.).

The water management licence for "Water supply and wastewater discharge for units U1 and U2 from the Cernavoda Nuclear Power Plant" issued by ANAR foresee for technological wastewater evacuation the following sections:

- in the Danube River - normal situations  
XIV-1.000.00.00.00.0 (Danube)  
hectometer 779 (Danube)
- in the CDMN - normal situations  
XV 1.010B.00.00.00.0. (Seaside)  
hectometer 594 (the 2nd Danube - the Black Sea Canal reach)
- in the CDMN - emergency situations (through the Cişmelei valley)  
XV - 1.010B.00.00.00.0 (Seaside)  
hectometer 611 (1st Danube - Black Sea Canal reach).



### **Pluvial drainage (meteoric)**

The pluvial waters from the CTRF and those from the access roads in the new CTRF building area will be collected, transported and discharged through an external connection, executed in a separating system, into the pluvial drainage network (stormsewer) existing on the Cernavoda NPP platform, in the immediate vicinity of the new CTRF building and finally the Cernavoda NPP distribution basin.

The collecting, transporting and evacuation of pluvial waters will be done through a collecting channel.

The pluvial drainage system of Cernavoda NPP is designed for evacuation of pluvial waters collected on the Cernavoda NPP platform and, as a consequence, it can also ensure the take-off and evacuation of rainwater at the point of connection with the CTRF facility.

### **Wastewater treatment or pre-treatment plants**

Waste water (uncontaminated) from the CTRF facility is discharged through the U1 Water Supply Network into the sewage network of Cernavoda, which is also provided with the Cernavoda Wastewater Treatment Plant. The Cernavoda wastewater treatment plant discharges the treated wastewater into the cooling water discharge channel of Units 1 and 2 of Cernavoda NPP, with approx. 500 m before the final discharge into the Danube.

## **VI.a)-b) Air Protection**

### **Sources of pollutants for air, pollutants, including odor sources**

During CTRF operation there will be available both stationary sources related to tritium removal facility i.e. two Standby Diesel-generators sets as well as temporary mobile Diesel generators sources (unit supply trucks).

Following the tritium removal technology will result also radioactive tritium emissions (discharged to the CTRF facility stack).

Subsidiary activities and support may also result in emissions of particulate matter, volatile organic compounds (VOC) and combustion gases of diesel fuel used as fuel for Diesel groups, respectively fuel combustion and particle re-suspension as a result of transport and traffic activities .

#### **➤ Point sources - directed radioactive emissions**

Under normal CTRF operating conditions, there are two situations:

- a) **Operation**, heavy water detritiation process from Units 1 and 2 is carried out at nominal parameters and all system components of the facility are operational. For this situation, the entire tritium inventory is in a closed system in the CTRF circuits, managing it by controlling process temperatures and pressures (the spaces with nuclear systems are maintained at a lower pressure than the normal one, thus preventing any potential accidental release of radioactivity outside). The maximum tritium inventory in CTRF systems and components estimated for normal operation of the facility is  $9.2E + 15$  DT (Bq) and  $7.8E + 15$  DTO (Bq)

- b) **Outage**, the frequency of which is 1 / year, when the CTRF facility will be fully shutdown for maintenance and repair work. This implies that all process systems will be disconnected, except for the two tritium retention sub-components from tritium retention system TRS, which are designed to take over and manage the tritium inventory from the cryogenic distillation unit, so that works on the premises of the facility can be carried out in optimal conditions:
- Low Tritium Expansion Tank (LTET) ensures that the tritium inventory from cryogenic distillation columns 1, 2 and 3 of the CDS is taken over and maintained during the revision. The project is planned to be equipped with 3 LTETs superposed and positioned outside the CTRF building.
  - High Tritium Expansion Tank (HTET) ensures that the tritium inventory from Column 4 of CDS is taken over and managed during the revision. The project is provided with a single HTET, positioned in the gloves box which also houses the cryogenic distillation unit pumps.

According to the legal provisions (Article 51 of the Fundamental Radiological Safety Norms, CNCAN), Tritium Derivative Emission Limits (DEL) for CTRF will be approved by the National Regulatory Authority in the nuclear field, CNCAN, in the licensing process. The related documentation will be developed in order to obtain the Construction Licence from CNCAN and the subsequent testing and commissioning/ CTRF operation licences

➤ **Other directed sources**

In situations of interruption of power supply of systems that allow short interruptions up to 180 seconds, Standby Diesel –generators sets will be used. These will be emission sources for Diesel and Diesel fuel - mainly CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub> and hydrocarbons. Estimation of the quantities of pollutants is done by calculation because the operating mode (stand-by equipment) does not economically justify the installation of measuring devices to the discharge stack.

These sources will be characterized by short-term emissions, usually due to periodic tests, which will be regulated by operating routines agreed with CNCAN. Euro 5 Diesel with low sulfur content will be used and, based on the experience of the other on-site combustion installations, it is estimated that the impact of these equipment on the atmosphere will be insignificant. According to the legal requirements, these equipment will be subject to the revision of the GES authorization of Cernavoda NPP.

Loading of Diesel fuel in the two new tanks with capacities of approx. 1500 l is a category of short-term emissions of volatile organic compounds (VOC), which will take place at a reduced frequency, and the storage of Diesel fuel in these tanks is also a source of VOC emissions. Taking into account the safety requirements for designing the tanks, due to the specificity of the Cernavoda NPP objective, the reduced tank sizes, lower Diesel fuel volatility compared to other fuels, as well as the decrease in volatility due to the inclusion of the tanks in the enclosures - with protection from solar radiation, it is estimated that VOC emissions from these categories of activities will be insignificant.



➤ **Mobile sources**

During the operating period, the mobile sources of air pollutants will be from the transport of auxiliary materials (eg nitrogen, helium bottles, oxygen bottles, Diesel fuel for Standby Diesel-generators), materials such as those for fire extinguishers (inergen bottles, eco foam - friendly, portable fire extinguishers), as well as those from devices / machines / spare parts, etc.

Emissions of pollutants from the material transport activity are powders and combustion gases of fuels.

It is estimated that by supplying quantities and consequently the possibility of merging with the supply to other Cernavoda NPP facilities, this category of sources will generate insignificant emissions of pollutants (powders and fuel gas) compared to the situation existing in the absence of the CTRF.

There are no odor sources as a result of operating or supplying various auxiliary materials or fuel to Standby Diesel-generators.

### **Installations for the containment and dispersion of pollutants in the atmosphere**

The HVAC ventilation system has a safety and comfort role, consisting of 6 mechanical ventilation systems in the CTRF building, organized as follows:

- A S1 ventilation system, in the area of technological installations (potential contamination and / or explosion potential - hydrogen zone):
  - ensure the evacuation of possible hydrogen accumulations in the technological area, by sucking the air from the rooms in the respective area
  - In order to ensure a safe system, the hydrogen-containing areas within the facility have 10 air exchanges per hour (approximately 55,000 m<sup>3</sup> / h)
  - The air is ventilated (directed) to the evacuation stack of approx. 50 m attached to CTRF
  - The hydrogen ventilation system is independent and is powered also from batteries and from the Dstandby Diesel-generators
  - Hydrogen and tritium monitors are distributed inside the CTRF building as well as the ventilation air flow rate monitoring from the exhaust stack
  - manual shutdown of the ventilation facility and manual isolation of it for certain rooms, in case of accidental tritiated water vapors in a CTRF room, followed by manual starting of the Atmospheric Detritiation System (ADS)
  - ensures temperature of 15-20°C in the technological area
  - the ventilation supply units to the technological areas with hydrogen, have a 100% redundancy;
- a S2 ventilation system for the auxiliary systems area (hydrogen free area, approximately 45,000 m<sup>3</sup> / h);
- a S3 ventilation system for the electric battery room (approximately 3,000 m<sup>3</sup> / h);
- A S4 ventilation system, for the area occupied by operating personnel (about 1500 m<sup>3</sup> / h):
  - min. 6 air / h air exchanges (area where there is no explosion hazard)
  - it must provide temperatures of 20-26°C

- air circulation will be made from the area occupied by operating personnel to areas with potential for contamination (technological area) by increasing depressions. Thus the largest depression will be provided in the tritiated water processing area, a risk contamination area.
- A S5 ventilation system in the helium compressor room (approximately 15,000 m<sup>3</sup> / h);
- A S6 ventilation system in the air compressor compartment (about 2,000 m<sup>3</sup> / h).

Dispersion system - the effluent discharge from the S1, S2 and S3 ventilation systems into the atmosphere is achieved through the CTRF own stack, having the following features:

Stack height: 50 m

Inner Stack diameter: approx. 1.7 m

Stack cross-section: approx. 2,3 m<sup>2</sup>

Exhaust flow: 103,000 m<sup>3</sup> / h = 28.6 m<sup>3</sup> / s

Exhaust speed: approx. 12.4 m / s

Exhaust flows are designed to ensure efficient hydrogen evacuation from the building, in order to prevent hydrogen accumulation in the enclosure, therefore, to prevent the potential hazard of explosive conditions.

The ventilation systems S4, S5 and S6 provide fresh air without any risk of contamination, evacuating air them directly outside the building.

#### **Other systems with tritium retention or recovery (in closed circuit)**

ADS - atmospheric detritiation system – with role of decontamination (detritiation) of air through vapor recovery in the area where tritiated heavy water processing / storage equipment is located, when the tritium concentration in the air exceeds the predetermined thresholds, situations that may occur in accidental leakage or in case of emergency.

The operating principle of the atmospheric detritiation system consists in evacuating the air from the technological area through an equipment in which D<sub>2</sub>O / DTO / H<sub>2</sub>O vapors are adsorbed to a desiccant mass. Tritium and hydrogen in the gaseous form are catalytically oxidized to tritiated water, followed by condensation of tritiated water vapors and drying of the gaseous effluent on molecular sieves. In the catalytic recombinor, 99.9% of hydrogen isotopes are catalytically oxidized to tritiated water. Less than 0.1% of the tritium gas will not be oxidized.

The air thus treated is recirculated to the rooms where the increase in tritium concentration has been detected. A hydrogen detector is located on the supply lines to ADS to avoid an explosion during system operation, by the accumulation of hydrogen in these lines.

The TRS tritium retention system is designed to ensure the recovery of tritium and deuterium from all processes involving waste gas streams and purge gases generated during normal operation, maintenance activities (purging and evacuation from equipment) and / or starting/shutdown of process systems.

The operation mode of the TRS is of the stand-by type, which enters in the normal operation mode when performing maintenance, commissioning, planned outages or in case of emergency.

The tritium retention system TRS has the ability to simultaneously and independently process tritiated deuterium from the technological systems and contaminated air sucked from different locations where maintenance operations are carried out.

#### **VI.a)-c) Protection against noise and vibration**

##### **Sources of noise and vibration**

The main sources of noise are associated with activities carried out on the NPP platform and on-site road transport.

The tritium removal facility will be built in an area located in the East of the nuclear power plant site (see Figure VII.2).

Noise sources include Ventilation and Conditioning (HVAC) equipment, pumps and compressors.

##### **Arrangement and equipment for protection against noise and vibration**

The nuclear power plant is located in the industrial area, and by ensuring the exclusion zone, the existence of the dwellings is not allowed to less than 1000 m from the nuclear units.

For a company located in the industrial area, according to STAS 10009-88, the continuous equivalent A-weighted sound pressure levels shall be below the admissible limit of 65 dB (A).

The noise sources on the site are, for the most part, at a distance of at least 20 m inward from the boundary of the enclosure (fence that borders the territory of the NPP). Predicted noise levels shall be at least 3 dB (A) lower than the 65 dB (A) limit imposed by law. The location of the CTRF is placed in an area where the noise level at the enclosure boundary is about 55 dB (A) - the initial state corresponding to the absence of the CTRF facility. The CTRF equipment is not expected to have a contribution greater than 60 dB (A) at the enclosure boundary (point A in Figure VII.2), which implies a resulting level of about 62 dB (A).

#### **VI.a)-d) Radiation protection**

##### **Radiation sources**

In the CTRF project, the radiological risk is due to the presence of tritium, given that the other radionuclides will be retained in the purification systems located in Units 1 and 2 before the tritiated water is transferred to the CTRF building.

All tritium-containing equipment is located inside the CTRF building, with the exception of the Low Tritium Expansion Tanks (LTET) located outside the CTRF building.

Potential tritium release sources are: heavy water transfer pipes, CTRF building ventilation, LPCE, CDS, TGHSS systems, active drains from TRS, ADS, LCS systems (CTRF building systems are presented in the Presentation Memoir at Chapter III.f) -c).

##### **Radiation protection arrangements and equipment**

Radiation protection is ensured by minimizing tritium leakages. The Project endowment and arrangement ensure the isolation of the danger of leakages and the control of effective contamination in case that leakages have occurred and include the following:

- a secondary enclosure for equipment such as: double walls for tritiated heavy water transfer pipes from Unit 1/2 to the CTRF building; the use of glove-box for tritium leakage control and second enclosure (the cold box) for the cryogenic distillation columns;
- Atmospheric detritiation system (ADS) that recovers tritiated heavy water vapors from leakages
- Installation of deep drain trays that are positioned to collect and retain tritium leakages;
- Contamination control, eg. by maintaining tritium concentrations in air in accessible areas below 0.4 MBq / m<sup>3</sup>;
- Radiological zoning of the CTRF building: the spaces on the premises and on the CTRF site will be classified in controlled areas and monitored areas according to the specific criteria established by CNCAN (Articles 93-99 of the Fundamental Radiological Safety Norms, CNCAN);
- endowments for the radiological protection of personnel.

Radiation protection is also ensured through specific administrative measures, including: training the staff on technical and safety issues in the CTRF Project related to tritium use, and establishing the individual dosimetry system for staff.

The CTRF project beneficiary, Cernavoda NPP, already has a Radiation Protection Regulation and subsequent procedures applicable to production activities, which foresee actions and measures to ensure radiation protection. The regulation is reviewed periodically, with actions and procedures being tested through simulation exercises. The procedural system will be reviewed and supplemented with CTRF specific aspects and will be applied to safe operation of the facility for personnel and the environment

#### **VI.a)-e) Soil and subsoil protection**

##### **Sources of pollutants for soil, subsoil and groundwater and deep water**

The potential sources of soil, subsoil, ground and depth water pollution are represented by:

- errors in waste management
- Accidental leakage of fuel from the Diesel Fuel Tanks
- Accidental leakages of radioactive contaminated fluids from the transfer technological pipelines from Units 1 and 2 to and from the CTRF facility.

##### **Works and endowment for soil, subsoil and groundwater protection**

The location of the project being within Cernavoda NPP enclosure, the realization and functioning of the CTRF are carried out in the context of the site destination, being considered an integrated support system of Units 1 and 2. Also, through the profile and character of activities during the operation period of the project, potential interactions on the soil would be due to abnormal situations with consequences in the soil pollution, but this variant is unlikely because facilities and landscaping works are provided, namely:

- concrete platforms for soil and underground protection in the site area;
- Diesel fuel tanks shall be designed and installed with leakage prevention and collection means;
- risk reduction systems associated with fluid leakages in circuits:

- **The water-heavy leakage detection system** detects accidental tritiated and detritiated heavy water leakage from the transfer technology pipelines from Units 1 and 2 to and from the CTRF. The transfer piping systems is designed in the "pipe-in-pipe" configuration, thus providing protection in the case of cracking of the pipeline with the heavy water . The leakage will be signaled at the main control room of Unit 1 and Unit 2 and the control panels that will be installed in the S015 rooms of the U1 / U2 Units. **The heavy water drainage and collection system** - LCS has the role of managing the heavy water resulting from emptying the facility during interruption and maintenance periods, for re-use in the process or return to the Cernavoda NPP Units 1 and 2 as appropriate. The LCS consists of a leakage pipeline network that takes over eventual leaks from equipment containing process water (LPCE, TRS, ADS and DMS) which is connected to a collector that supplies a 0.8 m<sup>3</sup> tank in basement.

#### **VI.a)-f) Protection of terrestrial and aquatic ecosystems**

##### **Identification of sensitive areas that may be affected by the project**

CTRF is located on Cernavoda NPP platform at a distance of more than 1.8 km from nature monuments, protected natural areas, species or habitats of community interest.

Within 15 km of Cernavoda NPP, the following natural areas are protected by community and national interest:

- **ROSPA0039 Danube - Ostrova** (about 1.8 km to NPP)
- **ROSCI0022 Danube Canaralele** (Canaries) (about 2,2 km to NPP)
- **IUCN Fossil Cernavoda place** (about 2.6 km to NPP)
- **IUCN Fossilized Seimenii Mari** (about 8.8 km to NPP)
- **ROSPA0012 Borcea Branch** (about 10.06 km to NPP)
- **ROSPA0002 Allah Bair - Capidava** (about 10.3 km by NPP)
- **ROSPA0001 Aliman - Adamclisi** (about 11.5 km by NPP)
- **ROSCI0353 Pestera - Deleni** (about 13.4 km to NPP)
- **ROSCI 0412 Ivrinezu** (about 9.5 km by NPP)
- **RASMSAR RORMS0014 - Borcea Branch** (about 10 km to NPP)
- **RAMSAR RORMS0017 - The islands of the Danube-Bugeac-Iortmac**

The Chapter. XIII presents the impact assessment on protected natural areas of Community interest susceptible to be affected by the CTRF project.

## **Works, endowments and measures for the protection of biodiversity, nature monuments and protected areas**

The location of the project being within the Cernavoda NPP enclosure, the implementation and functioning of the CTRF is carried out in the context of destination and activities developed on site, being considered a support system of Units 1 and 2.

Taking into account that for a similar tritium removal facility project implemented at the Wolsong NPP - South Korea, the reduction in total tritium atmospheric emissions of the nuclear power plants after the WTRF was put into operation, as well as the fact that the potentially contaminated wastewater from the CTRF technological area will not be discharged directly into the environment, it can be appreciated that the normal operation of CTRF, integrated in the normal operation of Units 1 and 2 at Cernavoda NPP, provides a measure to improve the protection of aquatic and terrestrial ecosystems following the operation of the Cernavoda NPP platform.

### **VI.a)-g) Protection of human settlements and other public interest objectives**

#### **Identification of public interest objectives, distance from human settlements, historic and architectural monuments, other areas on which a restriction regime is in place, areas of traditional interest, etc.**

Around each nuclear unit are set up:

- *Exclusion area with a radius of 1 km* - where activities other than those of the NPP are not allowed; measures are taken to exclude the location of permanent residences for the population and the conduct of social economic activities that are not directly related to the functioning of the nuclear facilities of Cernavoda NPP.
- *the low population area* - with a range from 1 to 2 km from the nuclear reactor - where measures are taken to restrict the location of permanent residences for the population and the conduct of social economic practices.

The nearest localities in the area of influence of Cernavoda NPP as a whole are:

- Cernavoda town with 19,401 persons dwelt on 1 January 2016 - located at approx. 1.6 km NV to the Cernavoda NPP platform
- Ștefan cel Mare village with a population of approx. 573 inhabitants at the level of 2002 - located at approx. 2 km SE from Cernavoda NPP.

Downstream of cooling water overflow from Cernavoda NPP into the Danube, there are located Seimeni (about 2.4 km), Dunarea (about 8.5 km), Capidava (about 15 km) and Topalu (about 22 km).

The Cernavoda NPP platform is located in an area with a concentration of the heritage built with cultural value of national interest - Cernavoda, Mircea Voda and Topalu.

The nearest are the archaeological sites of Axiopolis - about 2,6 km VSV, the medieval settlement Dealu Viforului - about 3,6 km VSV and the Cernavoda stone valley - approx. 2.7 km VSV, respectively " Carol I Bridge" - approx. 3,8 km VNV to the CTRF.

Among the closest historical monuments in the Cernavoda city is Geamia ~ 3 km, "Sf. Imparati Constantin and Elena" Church ~ 3.5 Km and « Carol I » Bridge with the statues "Dorobantii" ~ 4 km. At a distance of up to 30 km from the NPP platform there are the following historical

monuments: Capidava Fortress ~ 20 km (place.Capidava), Sacidava Fortress ~ 25 km (place Dunareni).

### **Work, endowment and measures for the protection of human settlements and of protected and / or publicly protected objectives**

The systems and measures for the prevention and control of emissions into the atmosphere and into the aquatic environment, respectively the waste and hazardous waste management systems foreseen for the CTRF facility, will be integrated into the Cernavod NPP's environmental management system, thus ensuring the conditions and requirements legally authorized for the protection of human settlements and other protected and / or publicly protected objectives in the area.

Cernavoda NPP will complete the set of emergency procedures with provisions specific to the activity carried out in the CTRF facility.

### **VI.a)-h) Prevention and management of waste generated on site during project realization / during operation, including disposal**

#### **List of wastes (classified and coded in accordance with European and national legislation on waste), quantities of waste generated**

##### ***During project realization:***

The non-radioactive waste generated during the project execution period is mainly the following:

<b>Type of non-radioactive waste</b>	<b>Coding / classification</b>
<b>a.Waste from building materials</b>	
concrete	17 01 01
mixtures of concrete, bricks, tiles and ceramics, other than those specified in 17 01 06	17 01 07
iron and steel	17 04 05
metallic wastes	17 04 07
wood waste	17 02 01
plastics	17 02 03
soil contaminated by Diesel fuel spills, oils etc.	17 05 03*
earth and stones, other than those specified in 17 05 03*	17 05 04
fertile soil and rocks resulting from excavations for foundations	17 05 05
insulating materials other than those specified under 17 06 01 (asbestos-containing) and 17 06 03 (consisting of, or containing dangerous substances)	17 06 04
absorbents, filtering materials (polishing materials, contaminated protective clothing with dangerous substances)	15 02 02*)
polishing materials and protective clothing, other than those mentioned in 15 02 02	15 02 03
<b>b. Packaging waste</b>	
paper and cardboard packaging	15 01 01
packaging wastes of plastics	15 01 02
wood packaging	15 01 03
packaging of composite materials	15 01 05
packaging containing or contaminated with dangerous substances	15 01 10*)



<b>c. Other types of waste</b>	
<b>c.1 Reusable / recyclable waste</b>	
waste paper and paperboard (from administrative, office)	20 01 01
glass waste	20 01 02
plastics	20 01 39
metals	20 01 40
<b>c.2 domestic waste (mixed municipal waste) generated by the work of the staff</b>	20 03 01

Note: 1. The above-mentioned codes for waste are estimated, the classification being made at their generation in accordance with the applicable legal requirements.

Note: 2. The amount of waste resulting from the project execution period can not be estimated.

The flow-management scheme for non-radioactive waste generated during the construction of the CTRF facility is presented in Appendix no.5.

#### **During operation:**

The non-radioactive waste (municipal waste and industrial waste assimilation type) and radioactive waste result from CTRF activity.

**Non-radioactive wastes** are:

Type of non-radioactive waste	Coding / classification
<b><i>Reusable / recyclable waste for which separate collection and storage is recommended in suitable containers specifically intended to be handed over to authorized companies for recovery:</i></b>	
waste paper and paperboard (from administrative, office)	20 01 01
glass waste	20 01 02
plastics	20 01 39
metals	20 01 40
<b><i>Packaging waste</i></b>	
paper and cardboard packaging	15 01 01
packaging waste of plastics	15 01 02
wood packaging	15 01 03
packaging of composite materials	15 01 05
packaging containing or contaminated with dangerous substances	15 01 10*
<b><i>Domestic wastes (mixed municipal waste) generated by the work of the staff</i></b>	20 03 01

During the period of operation, the management of municipal and industrial waste will be carried out according to the regulations in force, the beneficiary, the Cernavoda NPP, having implemented rigorous waste management procedures.

The non-radioactive waste management scheme generated during the operation of the CTRF facility is presented in Appendix no.6.

**The radioactive waste** resulting from CTRF operation will be low and medium active. According to the procedures in force within the NPP, they are to be treated and classified according to their physical and radiological characteristics in order to optimize their processing and intermediate storage.

The following types of radioactive waste are estimated:

- Organic liquids: pumps and compressor oils
- Solids: catalyst from the catalytic isotopic exchange columns; molecular sieves from process gas dryers; ion exchange resins from tritiated heavy water purification systems and product water (detrirated water); metallic wastes and solid materials from the CTRF building (material and equipment, maintenance / cleaning material, etc.)

The table below shows the estimate of the main quantities of radioactive waste:

<b>Radioactive waste category</b>	<b>Estimated generated quantity</b>
catalyst and filling from LPCE	2700 kg / every 5 years
metal waste and solids	500 kg / year
molecular sieves from LPCE dryers	300 kg / every 5 years
molecular sieves ADS and TRS	200 kg / every 5 years
molecular sieves from TGHSS dryers	50 kg / year
ion exchange resins	400 kg / year
oils	220 kg / year

The flow-management scheme for radioactive waste generated from the CTRF facility is presented in Appendix no.7.

## **Waste Prevention and Reduction Program**

### ***During project realization:***

In Construction phase will not result radioactive waste.

During the development of the construction works a series of measures will be taken aiming to prevent and reduce / minimize the quantities of generated wastes, such as:

- judicious planning / optimization of the quantities of raw materials / materials needed to be used in the project, so as to avoid the formation of unnecessary stocks (especially for raw materials / materials that have an expiration period or that could suffer degradation over time)
- Reuse of materials / raw materials / packaging where possible
- Temporary storage of materials / materials under appropriate conditions so as to avoid possible degradation
- the use of prefabricated, sub-assemblies, with finishes at their place of production (eg prefabricated metal panels for building walls, concrete mixers instead of concrete preparation at Cernavoda NPP site)
- Proper handling of raw materials / materials / equipment so as to avoid losses, accidental spillage
- awareness of the personnel regarding the compliance with the provisions of the environmental legislation in force, of the importance of preventing the generation of wastes for the health of the population and the environment.

There will be complied with the provisions of the environmental legislation in force, the measures and conditions imposed by the approvals / agreements / authorizations issued by the regulatory authorities, the procedures and measures for the prevention and / or reduction of the accidental leakages, the waste management procedures resulting during the construction,

periodic maintenance of equipment and vehicles, as well as of proper handling and storage of fuels and materials.

***During operation:***

In order to minimize the amount of non-radioactive waste generated during the operation of the CTRF facility, there will be complied with the provisions of the applicable environmental legislation, the provisions of the applicable licences, the NPP procedures for accidental leakage prevention and / or reduction measures, waste management, periodic maintenance of the equipment / equipment, as well as for proper handling and storage of fuels and materials.

In order to minimize the generation of radioactive waste, Cernavoda NPP has already implemented a system for the handling, classification, treatment and monitoring of waste in the radiological areas, as well as procedures for optimizing the quantities of potentially generating waste materials. The system will also be properly implemented in CTRF activities.

The radioactive waste management program of Cernavoda NPP is carried out in a procedure and is approved by CNCAN. The minimization of radioactive waste volumes through preventive measures and treatment / conditioning methods is one of the main objectives of the radioactive waste management program. The volumes of radioactive waste produced are reported to CNCAN and environmental authorities.

**Waste Management Plan*****During project realization:***

The waste management plan is intended to comply with legal provisions, procedures and measures to prevent and / or reduce accidental leakages, waste management procedures resulting from construction and assembly activities, periodic maintenance of equipment and vehicles, as well as handling and storage of fuels and materials.

The Waste Management Plan includes the necessary measures for the collection and proper storage of non-radioactive industrial waste generated during the project period and to ensure that the operations for collection, transport, disposal or recovery are carried out by authorized economic operators.

No construction materials containing asbestos will be used and consequently will not be generated construction waste - insulating materials and construction materials containing asbestos code 1706 according to GD no. 856/2002 on the waste management records and for the approval of the list of wastes, including hazardous wastes, with subsequent amendments and completions.

The machinery and equipment used for the construction and assembly stages will be provided by service contract, their maintenance and repair being exclusively contractor's duty and will be performed at the specialized units used by the contractor.

Construction waste will be managed in accordance with specific legal requirements, avoiding temporary storage in the site of the site organization.

The temporary storage of the waste generated at the construction stage and their disposal will be done according to the environmental legislation in force, the applicable agreements / approvals / licences and the internal procedures of Cernavoda NPP.

In construction phase will not result radioactive waste. The construction works that are performed in the interconnection areas of the Units 1 and 2 systems are performed under the maintenance or planned shutdown works performed at these units. Any radioactive waste generated in maintenance and shutdown works shall be managed in accordance with the existing radioactive waste management program at Cernavoda NPP.

***During operation:***

The management of non-radioactive industrial waste (collection, segregation and temporary storage) will be carried out according to the approved procedures, the Environmental Licence of Cernavoda NPP and the normative acts in force, complying with Law no. 211/2011 on the waste regime, republished, GD no. 1061/2008 on the transport of waste on the territory of Romania, with modifications and completions, GD no. 856/2002 on the waste management records and the approval of the list of wastes, including hazardous wastes, with modifications and completions, the specific legislation for certain categories of waste (GD No 235/2007 on waste oil management, GEO no.5 / 2015 on electrical and electronic equipment waste, with modifications and completions, etc).

At Cernavoda NPP the traceability of the non-radioactive waste management process from the place of generation to the final disposal or recovery operations is ensured. The same system will apply to non-radioactive waste from CTRF.

The management of radioactive waste generated by the project activities will be similar and integrated with those generated from the U1 and U2 activities.

At CTRF will be foreseen temporary collecting and storage facilities for radioactive waste destined to the short-term storage of packaged organic or solid liquid wastes and radioactive waste barrels resulting from the operation and periodic maintenance of CTRF to be transferred to U1 or U2 for characterization and processing, release from the CNCAN authorization regime, if applicable, or transferred to the Intermediate Radioactive Waste Storage Facility (IRWSF).

The waste ion exchange resins result from the equipment of the heavy-water tritiated water supply system (HWFS - Heavy Water Feed System located at Cernavoda NPP, Unit 1 and Unit 2); they are managed in the same way as those in the nuclear power plant, and they are transported to spent storage tanks of used ionic resins (3 concrete vessels with a capacity of 200 m<sup>3</sup> each) located in the Service Building in each unit.

The transfer of radioactive waste from CTRF will be done according to the specific procedures existing at Cernavoda NPP.

***The elimination:***

Currently, the on-site Intermediate Radioactive Waste Storage Facility (IRWSF) provides intermediate storage of radioactive waste barrels in solid form generated by Cernavoda NPP Units 1 and 2. According to the Medium- and Long-Term National Strategy for the Management of Waste and Radioactive Waste, a Final Low and Medium Waste Storage Facility (FLMWSF) will be commissioned by the Nuclear and Radioactive Waste Agency. The commissioning of FLMWSF will allow the transfer of radioactive processed waste from IRWSF in order to comply with acceptance criteria at final disposal and consequently redistribute space in IRWSF.

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## VI.a)-i) Managing hazardous chemicals and compounds

### Dangerous substances and compounds used and / or produced

In the implementation of the project as well as subsequently in the current activity of CTRF, it is estimated that chemical substances and compounds classified as hazardous will be used, such as those in the following categories:

- lubricants (oils and grease)
- oxygen
- biocides (for cleaning, washing equipment etc.)
- refrigerants (freon environment friendly)
- glycol
- fire extinguishing substances
- fossil fuel (Diesel fuel)
- equipment cleaning products (Avesta paste)
- degreasing solvents
- coating mixtures (primer, paint).

Biocidal products will be accompanied by the Permits given by the Ministry of Health in accordance with the provisions of GD no.617 / 2014 establishing the institutional framework and some measures for the implementation of Regulation (EU) No 528/2012 of the European Parliament and of the Council of 22 May 2012 on the making available on the market and use of biocidal products, with subsequent amendments and completions.

Managing hazardous chemical substances and solutions and ensuring the protection of the environmental and health factors of the population

Only chemicals complying with the classification, packaging and labeling requirements will be accepted for use in accordance with EC Regulation 1272/2008 (CLP) with subsequent amendments and completions.

The management of dangerous chemical substances and solutions will only be carried out in accordance with their Safety Data Sheets prepared in accordance with Regulation (EC) 1907/2006 (REACH) with subsequent amendments and completions, according to the environmental legislation in force, of the requirements of the approvals, agreements, applicable licences and according to the requirements of the Cernavoda NPP procedures regarding the inclusion in the list of chemical substances approved for use in the Cernavoda NPP.

According to Cernavoda NPP procedures, chemical products are stored in the manufacturer's packaging, existing procedural requirements to ensure both, the order as well as reception and periodic inspections of the integrity and tightness of the packaging, correct labeling with information on the correct product name, the manufacturer's name, date of manufacture, warranty period, data strictly necessary to avoid chemical hazards, first aid, removal of waste products and, where applicable, restrictions on the use of the product.

The use of chemical substances, especially toxic and dangerous, is carried out with equipment and endowments for work safety according to the norms in force. The personnel who handles,

stores, transports and uses chemical substances is trained for these activities in accordance with the legislation in force and the specific tasks described in the Job Sheet.

For CTRF needs, chemicals substances and compounds will be supplied in quantities necessary to carry out the production process, respectively for interventions / repairs, avoiding to create unjustified stocks.

Minimizing the use of chemical substances and compounds in the construction / assembly phase will be achieved by using prefabricated subassemblies of equipment with finishes at their place of production (eg prefabricated metal panels for building walls, supplying concrete mixtures instead of concrete preparation on the Cernavoda NPP site). Chemical products used in the various phases will be held in temporary facilities approved under the internal procedure for allocating these facilities to contractors (Operations Manuals: Handling and Storage of Chemicals, Code 03410-OM-SM-1-22; management of chemicals code OM94000). Diversity and quantity approved for these products will be within the time limits and reduced in time.

The chemical management program procedures will also integrate the CTRF chemicals management aspect.

## **VI.b) Use of natural resources, in particular soil, land, water and biodiversity**

The realization of the project is in the spirit of sustainable development in the sense that neither the construction nor the operation of the CTRF does not involve the use of materials from the exhaustible natural resources category.

The renewable natural resources used are: river stone, sand, soil (the land on which the construction is located), water.

For CTRF project are not used resources from the protected natural areas adjacent to the Cernavoda NPP.

## **VII. Description of the environmental aspects likely to be significantly affected by the project**

### **VII.a) The impact on public and human health**

Regarding the human health, the CTRF facility will reduce the contribution of tritium to the doses received by its own and contractor's staff, as well as the tritium emissions from Cernavoda NPP, having a positive impact on public and the environment.

The operating experience of the tritium removal facility located on Wolsong NPP site - South Korea showed that by commissioning the facility, the average internal tritium dose due to the tritium oxide recorded for the exposed professional staff working in Wolsong Unit 1 was reduced by about 7 times. It is estimated that a significant reduction will also be made for the annual internal doses collected by the professionals working at Cernavoda U1 and U2 in the areas with significant radiation exposure.

The dose for a person due to DT or DTO (steam) emissions during the CTRF normal operation is estimated at 2.05  $\mu\text{Sv}/\text{year}$  (of which 5.54E-02  $\mu\text{Sv}/\text{year}$  from DT and 1.99E+00  $\mu\text{Sv}/\text{year}$  from DTO).

By removing the tritium, the emission of tritium in the atmosphere from Units 1 and 2 of Cernavoda NPP will be significantly reduced. Estimated emission reduction is by approx. 20% from the very first year of the CTRF operation, which will lead to a proportional reduction in the dose received by the population.

At the same time, given the dynamics of the tritium concentrations in the nuclear power plant systems and the tritium emissions in the atmosphere, with the detritiation of the U1 moderator with factors ranging from 50 at the NPP's start up, 70 after the first year, and more than 80 after the second year, it is estimated that there will be a decrease of the specific activity in the moderator by approximately 37% and total U1 emission reduction by ~ 22% during the first year. After 2 years, the activity of tritium in the moderator will decrease to 30% of the initial value, and after 3 years to 14% of the initial value - reaching less than 10 Ci/kg. Under these circumstances, it is estimated that the dose for the public will decrease to ~42% after 3 years (without detritiation of the cooling agent in the primary heat transport system - PHT).

It is estimated that:

- the radiological impact of the tritium discharges into the environment generated by the implementation of the project is not significant;
- the cumulative radiological impact of the tritium discharges into the environment generated by the implementation of the Project and integrated on the Cernavoda NPP site, on short, medium and long term is positive.

In order to estimate the impact on the health of the population in the Cernavoda NPP area of influence of the detritiation facility during normal operation, the National Institute for Public Health elaborated in March 2015 the "Radiological Impact Assessment Study on the Health Status of the Population Cernavoda in relation to the normal operation of the Cernavoda NPP detritiation facility (CTRF)" using the latest data for the population under surveillance around the Cernavoda NPP in 2012.

The conclusions of the study on the impact of CTRF on human health are as follows:

- On Cernavoda NPP site, the normal operation of the tritium removal facility will lead to a reduction of the potential tritium-related diseases and will bring a benefit to the health of the population residing in the area of influence of Cernavoda NPP;
- Subject to the technical measures for the operation of the objective, the impact on the health of the population associated with the operation of the objective can be considered as insignificant.

In conclusion, the CTRF project together with future projects, will lead to:

- an insignificant impact on population health in the Cernavoda NPP area of influence.
- Positive, medium and long-term impact on human health and public



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**VII.b) Impact on fauna, flora, biodiversity, conservation of natural habitats, wild flora & fauna and on land**

The flora and fauna in the Cernavoda NPP's area of influence will not be affected neither by the construction of the tritium removal facility nor by its operation.

This statement is supported by the information on the biodiversity impact assessment presented in the chapter XIII of the Presentation Memoir.

Thus, the statement is supported by:

- radioactivity monitoring programs carried out in the pre-operational and operational phase of the Cernavoda NPP;
- Studies on the impact of the Cernavoda NPP operation (U1 and U2) on the aquatic and terrestrial organisms in its area of influence during 2008-2012 and 2013-2016;
- the appropriate assessment study elaborated in 2015 by INCDM "Grigore Antipa" Constanta, in which the impact of the construction and exploitation of the project was determined;
- independent environmental studies conducted in order to reauthorize the Cernavoda NPP Unit 1 and 2 (see Chapter XIII).

The environment radioactivity monitoring, as a result of the implementation of the Project, will be integrated within the regular environment radioactivity monitoring program at Cernavoda NPP.

For the correct estimation of the environmental impact of nuclear power plant operation during 1984-1994 the pre-operational environmental monitoring program was carried out in the Cernavoda NPP area. This program represented the "zero status" for the regular radioactivity monitoring program at Cernavoda NPP, which was implemented starting with March 1996 (commissioning of Cernavoda NPP Unit 1).

The types of samples analyzed under the radioactivity monitoring program of Cernavoda NPP are made on the environmental factors and their components: air, water, soil, sediment, atmospheric deposition, spontaneous vegetation, food samples, and cereals according to the program monitoring approved by CNCAN.

It should be mentioned that the results of the measurements of the radioactivity monitoring program at Cernavoda NPP during 1996-2017 did not reveal the presence of specific CANDU radionuclides within the 30 km area around the Cernavoda NPP, except tritium.

The presence of tritium in the environment due to the operation of Cernavoda NPP has been detected in locations in the immediate vicinity of the plant since 2001.

Annual tritium concentrations were at very low levels, a claim supported by very low annual effective doses for the exposed population, tritium being an important contributor to these doses, as shown above in chapter VII.j).

By implementing the Project it is estimated that no increase in annual tritium concentrations in the environment will be recorded, and the concentrations will be comparable to those in the previous years.

The conclusions of the assessment and of the independent environmental studies conducted for Cernavoda NPP (see Chapter XIII) have taken into account that nuclear units have begun operation since 1996 and that until the date of the studies, the biota in the area did not suffer any obvious reductions in number of species or in effective number.

It is estimated that the implementation of the project will have an insignificant negative impact, indirectly on flora and fauna.

The impact on the land on which CTRF is being built is insignificant, being the land on the Cernavoda NPP site located near Unit 1.

### **VII.c) Impact on soil, property rights of land use, material assets**

The location of the project being within the Cernavoda NPP premises, the construction and operation of the CTRF is carried out in the context of the destination of the site and can be considered an auxiliary system (support) of Units 1 and 2.

In order to identify the lithology, stratification and determination of the geotechnical characteristics of the foundation ground, the Geotechnical Study elaborated by SC GEOTEHNICA DESIGN SRL in 2011 for the CTRF site analyzed the layout of the foundation ground through the geotechnical drilling - F1 executed in the perimeter under analysis (Appendix no.8 ).

From the field conditions point of view and according to NP 074/2007, the foundation ground falls within the category of good lands. The building's foundation slab will be embedded into the base rock (Bareman limestone), which will further improve the characteristics of the foundation ground.

The project provides for the protection of the soil and subsoil at the site, as shown in the chapter. VI.a) -e) of the Presentation Memoir.

A series of literature data indicates that operating a detritiation facility would have even beneficial effects on the soil as a result of lowering tritium emissions from the nuclear power plant. Thus, the simulations made for the Wolsong nuclear power plant in South Korea have shown that by operating a tritium removal facility, the tritium concentration in the interstitial water in the upper layer of the soil is reduced rapidly, even if tritium is reduced with one-tenth.

During the operation period, it is estimated that the activities within the CTRF will have an insignificant impact on soil and subsoil geology. The access ways in the CTRF area are concreted and the access of the personnel to the CTRF facility will be limited and subject to the procedures of the Cernavoda NPP site.

The supply of materials and source materials needed for the maintenance of the facility will be done in a controlled fashion.

Also, in case of CTRF operating at the designed parameters, due to the reduction of tritium emissions in the atmosphere, a reduction of deposits is also expected.

It is estimated that CTRF operating within the designed parameters will lead to a reduction of the radiological impact on soil compared with to the operation the nuclear units in the absence of detritiation.

In view of the above, it is estimated that the implementation of the Project will have an insignificant impact on the soil environmental factor, both directly and cumulatively, with the other activities on the Cernavoda NPP site.

There are no data to allow an estimation of the impact on the property rights of land use.

There is no impact on material assets.

## VII.d) Impact on the quality and quantity of water

The water supply and waste water discharge of the CTRF facility presented in Chapter. III.f) - e) of the Presentation Memoir shall be carried out in connection to the existing supply and discharge facilities of the Cernavoda NPP Unit 1 and 2.

At the date of elaboration of the Presentation Memoir, the water supply and the waste water discharge at Cernavoda NPP are regulated by the Authorization no.118/20.04.2018 that modifies the Water Management Authorization no. 131/01.06.2016 issued by the Romanian Waters National Administration.

According to the CANDU reactor literature, during the operation period, the tritium emissions from Cernavoda NPP are considered to be mostly under the oxidized form (DTO).

Both, the literature and CANDU reactors operating experience - including the results of the emission monitoring at Cernavoda NPP nuclear units - show that tritiated water and air emissions are in the same order of magnitude - 1011 Bq/MW(e).

The literature shows levels of losses from detritiation facilities as follows: <0.03% losses from complex detritiation facilities, or 0.004% losses from the similar facility in Wolsung-South Korea. For detritiation facilities, tritium emissions are predominantly in air, while liquid effluent emission is approx. 10% of emissions into the atmosphere.

The radioactivity of effluents discharged into the emissary is monitored and the monitoring results are compared to the derived emission limits which are calculated in accordance with the requirements of the CNCAN Limit Norms that were approved in the process of construction authorization or later in the commissioning phase of the facility.

The tritium radioactivity evacuated in the emissary after the implementation of the Project will be lower than the permitted dose constraint established by CNCAN for the Project.

At the same time, the tritium radioactivity discharged to the emissary at Cernavoda NPP, following the implementation of the Project and taking into account the radioactivity of the tritium discharged to the emissary through the operation of the existing and future projects mentioned in the chapter. III.f) -k) Point B of the Presentation Memoir, will be lower than the dose limitations established by CNCAN for all these activities on the Cernavoda NPP site.

### Impact preventing measures

The liquid effluents from the tritium removal facility will be directed to the radioactive wastewater collection and treatment system of the nuclear Unit. The Radioactive Liquid Waste Management at Unit 1 will also allow for the liquid evacuation of the CTRF.

This waste will be processed in accordance with the Unit's liquid effluent monitoring program. Waste water is collected into 5 tanks, each with a capacity of 50 m<sup>3</sup>, located in the basement of the service building. Liquid waste processing begins when the volume of liquid radioactive waste reaches a maximum of 25 m<sup>3</sup>.

Before releasing the content of a tank into the condenser cooling water channel, the content is recirculated to ensure good homogenization and a representative sample is taken. The sample is then collected and transferred to the Chemistry Laboratory to determine the pH, gamma and tritium activity. An estimate of % of the annual LDE for this release is made and the results of the analyses are sent to the Dispatch Shift Supervisor for verification. The Shift Dispatch Supervisor may authorize a discharge if a specific tank contains less than 0.05% of the annual LDE - gamma

activity and 0.5% of the LDE annual tritium, and the estimated total discharge for that month (including previous discharges) is lower of 3% of the annual LDE. In case of higher activity values, the approval of the Radioprotection Chief Engineer is required.

If the measured values are greater than the thresholds for the discharge, the content of the tank is decontaminated by filtration with ion exchange columns equipped with ECODERX resins that retain gamma radionuclides and the process is resumed.

During the discharge, the LEM (Liquid Effluent Monitoring) continuously collects a sample. The collected sample is analyzed in the dosimetry lab and the values are reported.

The used resin is sent to the waste resin collection and storage system.

### **VII.e) Impact on air and climate quality**

The calculations made during the initial technical design for the normal CTRF operating period considered the chimney emission, ground emission, or a combination of the two, depending on the type of event. For estimations, the Gaussian diffusion model recommended by CSA Standard N288.2 was used.

The positive environmental impact of a tritium removal facility on air quality in the NPP area was practically demonstrated by the decrease in specific tritium activity in the Wolsong - Korea Nuclear Power Plant, recorded after commissioning of a facility similar to CTRF.

The normal operation of CTRF does not generate greenhouse gas emissions (CO<sub>2</sub>, CH<sub>4</sub>, HFC, PFC, N<sub>2</sub>O, SF<sub>6</sub>). Greenhouse gases may result only during the power supply interruption when standby Diesel-generators become operational (or during their periodic testing period).

Pollutants such as ozone and ozone precursors or suspended particles (SO<sub>2</sub>, NO<sub>x</sub>, CO, O<sub>3</sub>, heavy metals, polycyclic aromatic hydrocarbons - PAHs, volatile organic compounds - VOCs, suspended particles - fractions PM<sub>10</sub>, PM<sub>2,5</sub>) are not emitted into the atmosphere during normal operation of the CTRF.

It is estimated that the normal operation of the CTRF will have an insignificant impact on the air quality on and outside the Cernavoda NPP perimeter, as support activities, such as the operation for periodic testing of Standby Dieselgenerators and local traffic, are characterized by discontinuous, short and reduced in value emissions.

It is estimated that, under normal operating conditions, the CTRF facility will have no influence on the meteorological parameters, so there will be no effects on the microclimate in the Cernavoda NPP area.

The radioactivity of tritium discharged into the air from the Project will be lower than the allowed dose constraints established by CNCAN for the Project.

Thus, it is estimated that in the short, medium and long term, the radiological impact on the environment due to tritium from effluents discharged into the air through the implementation of the Project will be insignificant.

### **VII.f) Impact caused by noise and vibration**

Cernavoda NPP is located in an industrial area and due to the existence of the 1000 m exclusion zone for U1 and U2, the existence of people homes is not allowed

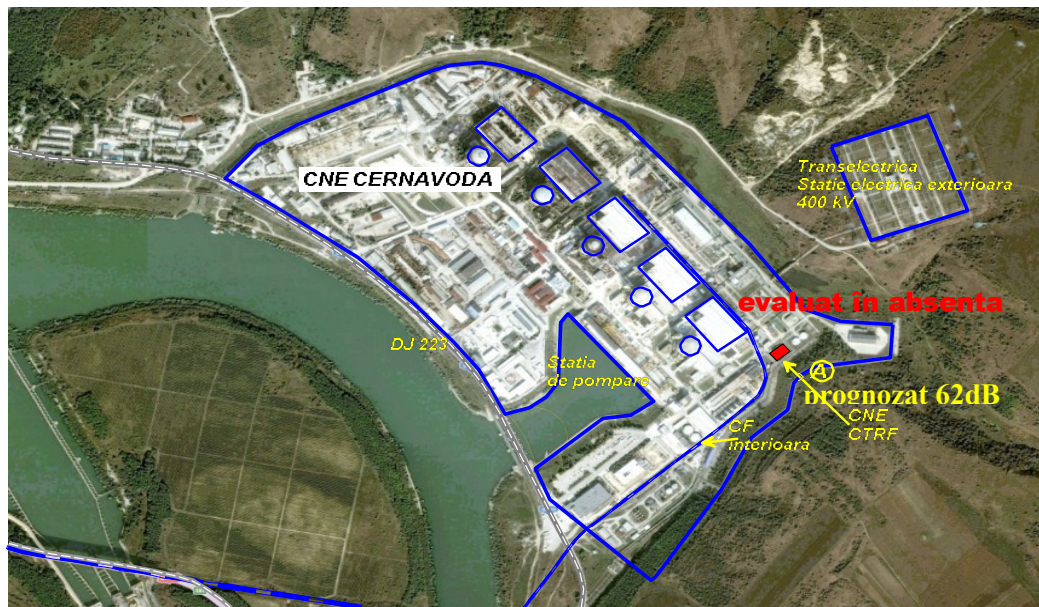
For an company located in the industrial area, according to STAS 10009-88, the continuous equivalent sound pressure levels, weighted A, will be below the 65 dB(A) allowable limit.

The CTRF is located in an area where the noise level at the enclosure boundary is about 55 dB(A) - the initial condition corresponding to the absence of the CTRF. No contribution greater than 60 dB(A) at the boundary of the enclosure (point A in Figure VII.1), which implies a level of about 62 dB(A), is projected for the equipment of the CTRF.

In these circumstances, it is considered that the acoustic impact of the CTRF operation will not exceed 65 dB(A) limit imposed by law.

It is estimated that the impact of the Project construction and operation, from the point of view of noise and vibrations generated, will be insignificant.

**Fig. VII.1 Estimated noise levels for the initial state (without CTRF) and for the final state (with CTRF)**



### VII.g) Visual and landscape impact

In the area of the Project site, the landscape has industrial characteristics, with the presence of dispersing stacks, production halls and social offices of Cernavoda NPP (office buildings, workshops, and laboratories).

The project envisages the application of external quality finishes, in harmonized colors, to the parts built as well as site landscaping.

It is estimated that through these efforts, the project will have a direct and positive impact contributing to the improvement of the landscape in the area.

There is no direct negative visual impact on the landscape.



### **VII.h) Impact on historical and cultural heritage**

The CTRF project is located within the Cernavoda NPP site, has the role of reducing the tritium emissions from the Cernavoda NPP and under operating conditions at the design parameters, it is estimated that it will not have a negative impact on the historical and cultural heritage in the area of interest.

### **VII.i) Indirect, secondary, cumulative impact, short, medium and long term, permanent and temporary, positive and negative; the impact determined by the interaction of the elements mentioned in items a) to h)**

The positive impact of the CTRF project is represented by the environmental benefits of reducing the tritium emissions in air and indirectly into the soil as well as by the economic benefits to the owner.

We further highlight the categories of the environmental factors / elements identified at the level of the Presentation Memoir:

- Given the role of CTRF in reducing tritium emissions from Units 1 and 2 Cernavoda NPP, the impact of CTRF on the medium and long-term environmental factor, cumulated with the effects of existing and future activities mentioned in Chapter VII, are estimated to be positive.
- The radiological impact on the environment due to the tritium in the liquid effluents discharged from the project will be insignificant, and from the point of view of the cumulative impact, in the short, medium and long term, the realization of the project will have a positive impact considering the role of the project in reducing the tritium emissions from Units 1 and 2 of Cernavoda NPP.
- The cumulative radiological impact due to tritium discharge into the environment generated by the implementation of the Project and integrated with the Cernavoda NPP site in the short, medium and long term is positive.
- The cumulative radiological impact in the short, medium and long term, determined by the operation of the facility will be positive for the soil compared to the situation of the operation of nuclear units without the project.
- The medium and long-term impact on human health and the population is positive.
- Medium and long-term impact due to the interaction between water and air environmental factors and human health is positive.

The economic benefits are:

- The realization of the investment from own funds, combined with the long-term beneficial effects resulting from the decrease of the tritiated water costs and from shortening the time required for access to the maintenance in the rooms with containing tritium in the air, have economic and financial advantages in the both short and long run, but also a guarantee of continuity for the activity of SNN SA;
- During the construction of the project, an average number of 400 contractor's employees will be mobilized for approx. 5 years to carry out the workS;
- The growth of business in the nearby area will be particularly in the construction sector at the local level, both at the level of manufacturers and building materials suppliers;

- 
- A number of 26 new jobs directly linked to the activity of operation will be created. From a socio-economic point of view, the realization of the CTRF project has a net positive impact on the development of the region and quality of life. Aside from the effect on the environment, the realization of the project will bring economic opportunities to the region in which it is located, both during the construction and operation period.

We mention the important tritium radioactivity considerations that support the environmental impact assessment:

- Tritium radioactivity discharged into the air at Cernavoda NPP following the implementation of the Project and taking into account the radioactivity of the tritium discharged into the emissary through the operation of the existing and future projects mentioned in the chapter. III.f) -k). point B of the Presentation Memoir will be lower than the permitted dose limits established by CNCAN for all these activities on the Cernavoda NPP site.
- From the point of view of estimating the cumulative radiological impact of the CTRF Project with the relevant projects presented in chapter. III.f) -k). point B of the Presentation Memoir are mentioned the following aspects:
  - The legal dose limit for one person 1 mSv / year.
  - CNCAN has established dose constraints for existing and future projects at the Cernavoda NPP site, as follows:
    - CTRF facility: 0.010 mSv / year;
    - Cernavoda NPP Units 1 and 2 (with Intermediate Radioactive Waste Storage Facility (IRWSF) implemented): 0.1 mSv / year for each unit;
    - Cernavoda NPP Units 3 and 4 (future project): 0.060 mSv/year for each unit;
    - Intermediate Dry Spent Fuel Storage Facility (IDSFS): 0.050 mSv/year (it is estimated that this dose constraint is maintained for the future repository extended with MACSTOR 400 modules);
    - In the case of CTRF, the only contributor to the dose is the tritium radionuclide. Dose contributors for the nuclear units are radionuclides resulting from fission and activation processes specific to CANDU-6 nuclear technology, tritium being a major contributor to the dose for the population.
- Annual effective population exposure due to the radioactive effluent discharges in the Cernavoda NPP environment Units 1 and 2 are much lower than the dose limits set by CNCAN, respectively 0.1 mSv / year for each unit and 0.05 mSv/year for existing IDSFS. In 2017, this dose was 0.005717 mSv/year for the a person within the population of interest.
- At the same time, the tritium radioactivity evacuated in the emissary and in the air at Cernavoda NPP following the implementation of the Project and considering the radioactivity of the tritium discharged to the emissary through the operation of the existing and future projects mentioned in chapter III.f) -k) in the Presentation Memoir will be less than that allowed dose constraints established by CNCAN for all these activities at the Cernavoda NPP site.
- On medium and long-term, It is estimated that there is a positive impact due to the interactions between the water, air, soil, as well as positive effects on the conservation of



natural habitats, flora and wildlife in the protected natural areas in the neighborhood of Cernavoda NPP.

It is estimated that the implementation of the Project will have an insignificant environmental impact, using a state-of-the-art technology and integrating international experience gained in building and operating similar facilities.

## **CONCLUSION CONCERNING THE CURRENT IMPACT OF THE PROJECT**

*From the perspective of the cumulative impact, with the two nuclear units in operation and with the future projects (DICA extension, U1 refurbishment, Units 3 and 4) prospects and taken into account:*

- *Impact reduction measures taken during the construction of CTRF, as well as for the future extension of IDSFS and the future refurbishment of Unit 1, as well as the distance between CTRF and these projects*
- *The fact that the main buildings related to U3-U4 are to a great extent constructed, expected to be finalized and equipments installed*
- *The role of CTRF to reduce tritium emissions resulting from the operation of the two units currently in operation,*

*it is estimated that, both, the construction and operation of the CTRF will have insignificant negative impact, that could be even a positive impact on medium and long term.*

## **VII.j) Measures to avoid, reduce or mitigate the significant impact on the environment**

No significant negative impact on the environment resulting from the operation of the CTRF project has been identified.

However, the Project provides facilities and arrangements for streamlining and control of technological processes, emission control and reduction, noise and vibration, soil and subsoil protection, waste management, fire protection and prevention. The detailed presentation of these measures was made in Chapter VI.a). Sources of pollutants and systems for the containment, evacuation and dispersion of pollutants into the environment.

## **VII.k) Transboundary nature of impact**

The project is located within the premises of the nuclear power plant that it serves. Constructing and operating the CTRF within its design limits does not produce a significant negative impact within a transboundary context.

From the point of view of the cumulative impact in normal operation, based on the information of the tritium radioactivity supporting the environmental impact results presented in Chapter VII.i) above, with Units 1 and 2, the future Unit 3 and 4 project there will be no transboundary negative impact. It should be mentioned that the existing and future IDSFS project have an insignificant radiological impact on the environment during normal operation.

Consequently, it is estimated that the Project will not produce significant negative effects in a transboundary context (for accident situations, see the information in Chapter XI of the Presentation Memoir).

### **VIII. Provisions for environmental monitoring - facilities and measures to control emissions of pollutants to the environment**

For the construction period of the CTRF facility, considering the work to be carried out and the measures for reducing the impact on the environment, no specific facilities for the monitoring of the pollutant emissions in the environment are required.

From the design phase, the CTRF has all the facilities necessary to control and reduce the possible tritium-negative effects over the entire operating period.

#### ***Workspace monitoring***

The air within the facility premises may be contaminated due to accidental technological fluid leakage. Due to the double purification of heavy tritiated process water, tritium remains the main contaminant in the form of vapors of tritiated water or gas. However, as a precautionary measure, the possibility of beta-gamma contamination will also be considered when tritiated water leakage occur.

Minor contributors will be monitored with portable equipment (beta-gamma contaminants and aerosol sampling pumps) whenever leakage of heavy water occur.

Tritium monitoring of the workspace will employ both, the fixed tritium monitoring system in the air and portable tritium monitors.

For each room in which tritium vapors or gas are susceptible to leakage, air will be taken from strategically chosen locations (e.g., in the vicinity of valves, pumps or flanges). Air sampling locations are provided for the radiological Zone 1 (Zone 1 is the area with the highest radiological hazard where potential sources of radioactive contamination are present), in order to continuously or sequential monitor the total tritium concentration (HTO and HT) in the air. Monitoring is done using tritium air monitors equipped with a flow-through ionisation chamber (with air flow through the active volume of the detector).

Tritium monitors will be provided with alarms and recording features when default threshold values are exceeded. Measured values and alarms will be available both locally and in the control room of the facility.

Each monitor will provide real-time information on tritium concentrations in the air and to alert any exceedance of the preset threshold of tritium concentration in the air.

The information on the tritium concentration in air given by these monitors is useful both for estimating the level of radiological hazards for personnel entering the radiological areas and for assessing the operating status of the facility. Also, based on the measurements made by these monitors, it is possible to decide whether it is appropriate to start the atmospheric detritiation system (ADS) in order to decontaminate the air.

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## Zoning

The rooms of the CTRF and the CTRF site will be classified in controlled areas and areas monitored according to the specific criteria established by CNCAN regulations. (Articles 93-99 in the Norms on Basic Radiological Safety Requirements, CNCAN). Controlled areas and supervised areas will be delineated and measures will be taken to ensure a controlled access, depending on the nature of the systems and sources and the associated radiological risks.

Also, the spaces within the CTRF enclosure will be delimited as radiological areas, with similar restrictions to those applicable in U1 and U2. The personnel will be monitored dosimetrically and will receive appropriate protection and/or radioprotection equipment as appropriate.

## Transfer and monitoring between radiological areas

All people transferring from Zone 1 to Zone 2 will be monitored for beta-gamma contamination of the hands and feet. In the case of CTRF, this measure is preventive and constitutes a barrier against the spread of beta-gamma contamination from Zone 1 to Zone 2.

Operating personnel will be provided with two stationary workstations to facilitate the decontamination, as follows: a fixed inter-zone screen for verifying beta-gamma contamination for hands and feet; a fixed inter-zone monitor for beta-gamma contamination testing for the whole body.

Inter-zone monitors will be located near the demarcation line, inside the area that has higher contamination potential. These will also be provided with the possibility of measuring the object contamination.

A portable beta-gamma contamination monitor will be used for monitoring the contamination of all equipment to be removed from Zone 1 through the equipment airlock.

## ***Monitoring of liquid and gaseous radioactive discharges***

The U1 and U2 radioactive effluent monitoring program will be extended to include CTRF discharges.

The dose on the population will be estimated based on tritium emissions of CTRF using the same calculation models that are applied to Units 1 and 2 of Cernavoda NPP and approved by CNCAN.

Verification of compliance with the Derivative Emission Limits will be done by monitoring the gaseous emissions to the ventilation stack. According to the regulatory requirements, the Derivative Emission Limits will be established by the applicant for authorization in consultation with an expert accredited by CNCAN in the field of radioprotection and approved by CNCAN in the authorization process.

Measurement of the tritium concentration in the discharged air will be done both in real time and by additional measurement. Thus, for emission control and limiting the emissions the following will be installed:

- An air tritium monitor with ionization chamber or proportional counter to provide real-time information on tritium discharges to the ventilation stack;
- Two tritium collectors from the air provided with the possibility of collecting tritium in both the form of vapor (HTO) and gas (HT). The samples will be analyzed in the chemical

laboratory of the nuclear power plant to determine the concentration of tritium from the gaseous effluents to be released into the environment;

- A flowmeter for measuring ambient air flow to the ventilation stack. The flowmeter will be equipped with an electronic integrator to determine the volume of air released during different time intervals.

Continuous representative samples of air from the ventilation basket will be continuously taken to determine the tritium concentration in the air, both global and discriminatory for the water vapor form (HTO) and the gas form (HT).

The effluent samples will be collected by the CTRF operating staff and analyzed by the chemical laboratory of the Cernavoda NPP. The monitoring and reporting of radioactive effluents related to the operation of the NPP will also include data from the CTRF.

All equipment to be used in the monitoring the radioactive discharges at CTRF will be certified according to the legal provisions, while the procedures for calibration, testing, maintenance and metrological verification will be rigorously documented and approved by the responsible authorities, including the competent authorities.

The results of monitoring the radioactivity of effluents discharged into the air are compared to the derived emission limits, which are calculated according to the requirements of the CNCAN Norms, limits which are approved by CNCAN in the process of construction authorization or later in the commissioning phase of the facility.

The monitoring of radioactive liquid effluents is presented in chapter VII.d).

### **Environmental Radioactivity Monitoring**

The environmental radioactivity monitoring program of the NPP is dimensioned to ensure the monitoring of the environmental integrated impact generated by CTRF operation and of the on-site facilities at the Cernavoda NPP site. This program is carried out according to procedures approved by CNCAN.

## **IX. The link to other normatives and/or plans/programmes/strategies planning documents**

### **(A) Justification of classifying the Project, as appropriate, in the provisions of other national legislation that are transposing the Community legislation (IED, SEVESO, Water Framework Directive, Air Framework Directive, Waste Directive, etc.)**

The Cernavoda NPP activity is included in the provisions of Law 59/2016, being classified to have a major risk, the substances notified to the competent authorities being the hydrazine (maximum storage capacity 9 tonnes) and petroleum products (Diesel Fuel and CLU with a total storage capacity of 2479 tonnes).

For CTRF, it is estimated that substances with potential for oxidation, explosion or oxygen, (16 cylinders per site in the amount of 0.1369 tonnes), hydrogen (up to 230 Nm<sup>3</sup> within the facility - about 0.01934 tonnes) will be located on the site of the CTRF in quantities less than 2% of the

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relevant quantities - the minimum threshold provided by Law no. 59/2016 Appendix 1 Part 1 and Part 2.

The CTRF project also envisages the construction of two Diesel fuel tanks with a maximum capacity of 3 tonnes, capacity well below the minimum threshold provided by Law no. 59/2016 Appendix 1 Part 1 and Part 2. Consequently, there are no requirements for the future CTRF facility under the incidence of SEVESO III.

From the point of view of the provisions of Law no. 104/2011 on ambient air quality, as amended and supplemented, transposing Directive 2008/50/EC on ambient air quality and for a cleaner air in Europe and Directive 2004/107/EC on arsenic, cadmium, mercury, nickel, hydrocarbons polycyclic aromatic compounds in the ambient air, it is appreciated that the implementation and operation of the CTRF facility will not affect the air quality in the area with respect to the pollutants regulated by this Directive.

It is estimated that the Project will comply with the provisions of Water Law no. 107/1996 with subsequent amendments and supplemented transposing Directive 2000/60/EC establishing a framework for Community action in the field of water policy and pursuing sustainable development - harmonizing the development of the socio-economic system with the capacity to support the aquatic environment. Currently, the water management for the U1 and U2 Units is regulated by the Water Management Authorization no. 118/20.04.2018 that modifies the Authorization no. 131/01.06.2016 issued by the Romanian Waters National Administration.

Construction of the CTRF facility will be done under the permit issued by CNCAN after the the environmental permit being issued by the Ministry of Environment. According to the provisions of Law no.292/2018 on the assessment of the impact of certain public and private projects on the environment art. (3), the environmental impact assessment procedure for the CTRF project is carried out in coordination with the procedure for issuing the water management opinion including the impact assessment on water bodies. Further information on the impact of the CTRF project on surface water and groundwater can be found in Chapter XIV of this Presentation Memoir.

The management of the industrial non-radioactive waste shall be carried out in accordance with the approved procedures, the U1 and U2 Environmental Authorization of Cernavoda NPP issued by GD no.84 / 2019 and the normative acts in force, observing the Law no. 211/2011 on the waste regime, republished - transposing Directive 2008/98/EC on waste, GD no. 856/2002 on the waste management record and for the approval of the list of wastes, including hazardous wastes, with modifications as well as the specific legislation for certain categories of waste (GD no. 235/2007 on waste oil management, GEO no.5 / 2015 on waste electrical and electronic equipment, with modifications and completions, etc.), respectively GD no. 1061/2008 on the transport of dangerous and non-hazardous waste on the territory of Romania, with amendments and completions, normative acts transposing also European directives.

Cernavoda Tritium Removal Facility does not fall under the provisions of the Industrial Emissions Act No.278/2013, with subsequent amendments and completions transposing Directive 2010/75/EU on Industrial Emissions (Integrated Pollution Prevention and Control).

The CTRF is a project in the nuclear field and for its regulation the provisions of the Law no. 111/1996 on the safe conduct, regulation, authorization and control of the activities, with the subsequent modifications and completions, republished, are applied.

The CTRF project is subject to the provisions of the nuclear directives that have been transposed into packages of transposing legislation (laws, government decisions, norms) by CNCAN, namely the Nuclear and Radioactive Waste Agency.

- Euratom Directive 2013/59 laying down basic safety standards for the protection against the dangers of exposure to ionizing radiation and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom (the main document transposing this Directive is "Rules on Basic Radiological Safety Requirements", approved by the Order of the Minister of Health, the Minister of National Education and the President of the National Commission for Nuclear Activities Control no. 752/3.978 /136/2018.
- Council Directive 2014/87/Euratom of 8 July 2014 amending Directive 2009/71/Euratom establishing a Community framework for the nuclear safety of nuclear installations.
- Directive 2011/70/Euratom transposed by Law no.378/2013 amending and supplementing Government Ordinance No. 11/2003 on the safe management of radioactive waste, as well as Law no. 111/1996 on the safe conduct, regulation, authorization and control of nuclear activities, with subsequent modifications and completions, republished.

### **(B) The plan/program/strategy/document for the planning to which the project belongs, indicating the normative under which it was approved**

Further, strategic documents at SNN S.A. level and at national level, related to the CTRF project are mentioned.

**SNN Development Strategy S.A. for 2015-2025 period**, published on the company's web page, at <http://www.nuclearelectrica.ro/wp-content/uploads/2015/11/SNN-Strategy-Development2015-2025.pdf> which has 7 long-term strategic objectives, including "Operation of the Nuclear Station with respecting the nuclear safety and security for the personnel, population, environment and production assets." The strategic investment plan includes the CTRF project that will reduce the release of tritium to the environment (for consultation at [http://www.nuclearelectrica.ro/wp-content/uploads/2015/11/Anexa\\_1\\_Plan-strategic\\_investment-of-the-CNE\\_Cernavoda-on-period-2015-2...pdf](http://www.nuclearelectrica.ro/wp-content/uploads/2015/11/Anexa_1_Plan-strategic_investment-of-the-CNE_Cernavoda-on-period-2015-2...pdf) )

The following are the national strategies under which the CTRF project has been evaluated and included in the development of the implementation plan.

**The National Strategy for Nuclear Safety and Security** approved by GD no. 600/2014 develops the concept of nuclear safety and security in an integrated manner and aims at controlling and maintaining at the lowest reasonable achievable level the specific risks associated with nuclear installations, materials and activities. The Strategy also mentions the "... protection of the individuals, society and environment against exposure to ionizing radiation or radioactive contamination beyond the limits allowed by the legislation in force". Thus, according to art. 10 letter h) the strategy also applies to the detritiation facility, being a depollution facility, but at the same time a facility that contributes to the improvement of the environmental performance indicators.



The National Strategy for Development in the Nuclear Field approved by GD no. 1259/2002 presents the national objectives in the nuclear field, on the medium and long term and the strategies for their realization. One of the derived objectives is "Ensure and continuously increase the level of nuclear safety in line with the evolution of the requirements of international standards". The strategy for implementing this objective is to support nuclear research and development activities, including activities/actions to develop technologies to improve tritium control at Cernavoda NPP and to develop technologies for manufacturing, concentration and detritiation heavy water.

## X. Necessary site organization for construction

### Description and location of works required to organize the site

The site organization will be established in the vicinity of CTRF.

Existing concrete platforms will be used and, if necessary, any additional areas will be temporarily covered with a 20 cm ballast layer and another 10 cm of broken stone to allow truck access for carrying work.

Where necessary, the sewers inspection pits will be covered with wooden beams or metal plates embedded in the gravel layer.

The area of the sewers inspection pits will be properly indicated by adjacent panels.

Excavated earth will be temporarily stored inside the NPP's premises to check for potential radioactive contamination. After verification, the intention is to reuse the earth for backfill.

Drainage of the rainwater from the area of the site organization is carried out by portable drainage pumps located at the low elevations of the excavation and connected with flexible hoses to the pluvial drainage network of the Cernavoda NPP site, in the immediate vicinity.

The site organization will include:

- Access routes - approved access routes
- Changing/locker rooms
- Provision for drinking water, sanitary equipment - according to the Cernavoda NPP procedures applicable to contractors (either existing sanitary facilities or ecological toilets will be used).
- Specific measures on occupational safety and security - which require signing and implementation of a Labor Safety Convention as an integral part of service contracts to be signed with the future contractors.

*There will be no space for the temporary storage of fuel or chemicals on the site organization. The fuel supply for the machinery and the means of transport will be made in specialized units.*

**Tools, devices, equipment and means** estimated to be required:

- trucks for supplying of raw materials and materials, respectively for the evacuation of construction waste, the movement of machinery and equipment
- concrete mixers trucks
- 1-2 bulldozers, 1-2 excavators, 2-3 mobile cranes; pneumatic hammers, welding machines (electric and oxyacetylene arc), shovels, metal scaffolding, etc.



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**Energy sources:** electricity will be provided from the Cernavoda NPP on-site grid  
**Sources of pollutants and means for the confinement, discharge and dispersion of pollutants in the environment during the site organization; the description of the environmental impact of the site organization and the measures envisaged for the control of the emissions of pollutants into the environment**

### **Construction phase - land preparation, construction-assembly works**

Work required for site organization is reduced in size, so it is estimated that the impact on the environment will be insignificant.

Throughout the organization of the site and the construction/assembly works, the contractor will take all necessary measures to prevent any negative impact to the environment.

### **Sources of pollutants during site organization/construction-assembly works**

#### **Water**

The personnel involved in the construction-equipment install stage, for hygienic-sanitary consumption, commercially available bottled drinking water will be distributed or from another drinking source according to the specific procedures of Cernavoda NPP. For washing, domestic use water will be used and will be provided by the existing facilities near the project site.

Waste water generated from the sanitary use of the personnel serving the construction of the CTRF facility generated within the Unit 1 premises, together with the domestic water generated by the staff serving the existing activities of Unit 1, are discharged to the sewage network of the Cernavoda Town.

Operation staff will use either the existing on-site sanitary groups or ecological toilets.

The water required to limit dust emissions will be ensured from the water supply network. Moisturing will be carried out only if necessary (during windy periods) avoiding excessive consumption. Conditions will be provided for washing the wheels of vehicles in case of sludge/ground entrainment, when leaving the site organization. The resulting waste water will be discharged into the existing on-site rainwater network. Work under high humidity or precipitation, as well as the use of truck/concrete mixer on unpaved surfaces will be limited.

The main sources of pollutants in the construction phase are:

- household waste water from the contractor's staff;
- accidental leakage of lubricants or fuels from the machines/vehicles used due to possible technical failures or repairs in undefined places;
- Inappropriate temporary waste storage can be a source of accidental pollution in case of rainwater inflow;
- washing wheels in undefined areas.

#### **Air**

The construction phase contains the categories of atmospheric pollution sources listed in Table X.1, classified according to the EMEP/EEA 2009 methodology.

**Tab. X.1 Categories of atmospheric pollution sources related to the land preparation and construction-assembly works according to the EMEP/EEA 2009 methodology**

Description of the source / activity category	Framing according to EMEP/EEA 2009 methodology	The main pollutants emitted into the atmosphere
<p>Land preparation</p> <ul style="list-style-type: none"> <li>- digging (excavation, excavation) for the surfaces on which access routes, foundations, structures, platforms and constructions</li> <li>- Making fillings, leveling, compacting, etc.</li> <li>- Temporary transfer and storage of the soil, respectively of waste resulted from the demolition works</li> </ul> <p>Performing construction and assembly activities</p> <ul style="list-style-type: none"> <li>- supply and temporary storage of construction materials and equipment/machinery</li> <li>- realization of foundations and the upper structures - concrete pooring, prefabricated mounting, metal plates, filling and compacting, assembly - drilling, welding joints, screwing, etc. of machinery, equipment, pipelines, tubing - both for the CTRF building and its Appendixes and for making the connections with U1 and U2.</li> <li>- Temporary storage and loading of construction and assembly works related waste.</li> </ul> <p>Land rehabilitation of the potentially affected areas</p> <ul style="list-style-type: none"> <li>- land back-fillings from the excavation,</li> <li>- compaction and vegetation coatings, if needed</li> </ul>	<p><b>cod NFR 2.A.7.b</b> Construction, demolition</p>	<p>TSP Particulate Particulates in suspension PM<sub>10</sub></p>
<p>Fuel combustion in vehicles engines (trucks, concrete mixers) - transport of materials within the Cernavoda NPP's premises.</p>	<p><b>cod NFR 1.A.3.b</b> Transportation - for the categories NFR 1.A.3.b.iii - Heavy vehicles</p>	<p>Combustion gases - NO<sub>2</sub>, SO<sub>2</sub>, CO, COVnm Polycyclic aromatic hydrocarbons (PAH) Particles</p>

Description of the source / activity category	Framing according to EMEP/EEA 2009 methodology	The main pollutants emitted into the atmosphere
<p>Land preparation</p> <ul style="list-style-type: none"> <li>- digging (excavation, excavation) for the surfaces on which access routes, foundations, structures, platforms and constructions</li> <li>- Making fillings, leveling, compacting, etc.</li> <li>- Temporary transfer and storage of the soil, respectively of waste resulted from the demolition works</li> </ul> <p>Performing construction and assembly activities</p> <ul style="list-style-type: none"> <li>- supply and temporary storage of construction materials and equipment/machinery</li> <li>- realization of foundations and the upper structures - concrete pooring, prefabricated mounting, metal plates, filling and compacting, assembly - drilling, welding joints, screwing, etc. of machinery, equipment, pipelines, tubing - both for the CTRF building and its Appendixes and for making the connections with U1 and U2.</li> <li>- Temporary storage and loading of construction and assembly works related waste.</li> </ul> <p>Land rehabilitation of the potentially affected areas</p> <ul style="list-style-type: none"> <li>- land back-fillings from the excavation,</li> <li>- compaction and vegetation coatings, if needed</li> </ul>	<p><b>cod NFR 2.A.7.b</b> Construction, demolition</p>	<p>TSP Particulate Particulates in suspension PM<sub>10</sub></p>
<p>Combustion of fuels in non-road mobile machinery (machinery operation and mobile equipment – for site)</p>	<p><b>cod NFR 1.A.4</b> - Other mobile sources, source category 1.A.2.f.ii - Machinery and equipment in manufacturing industry and construction</p>	<p>Combustion gases Particles containing metals (Cd, Cu, Cr, Ni, Se, Zn) VOC</p>
<p>Wind erosion from disturbed land areas and from piles of earth</p>	<p><b>cod NFR 7.A</b> – Other sources</p>	<p>TSP Total Suspended Particles and Fractions</p>

Description of the source / activity category	Framing according to EMEP/EEA 2009 methodology	The main pollutants emitted into the atmosphere
<p>Land preparation</p> <ul style="list-style-type: none"> <li>- digging (excavation, excavation) for the surfaces on which access routes, foundations, structures, platforms and constructions</li> <li>- Making fillings, leveling, compacting, etc.</li> <li>- Temporary transfer and storage of the soil, respectively of waste resulted from the demolition works</li> </ul> <p>Performing construction and assembly activities</p> <ul style="list-style-type: none"> <li>- supply and temporary storage of construction materials and equipment/machinery</li> <li>- realization of foundations and the upper structures - concrete pouring, prefabricated mounting, metal plates, filling and compacting, assembly - drilling, welding joints, screwing, etc. of machinery, equipment, pipelines, tubing - both for the CTRF building and its Appendixes and for making the connections with U1 and U2.</li> <li>- Temporary storage and loading of construction and assembly works related waste.</li> </ul> <p>Land rehabilitation of the potentially affected areas</p> <ul style="list-style-type: none"> <li>- land back-fillings from the excavation,</li> <li>- compaction and vegetation coatings, if needed</li> </ul>	<p><b>cod NFR 2.A.7.b</b> Construction, demolition</p>	<p>TSP Particulate Particulates in suspension PM<sub>10</sub></p>
<p>Resuspension of particles by entrainment on surfaces as a result of vehicle movement</p>	<p><b>cod NFR 7.A</b> – Other sources</p>	<p>TSP Total Suspended Particles and Fractions</p>

The main pollutant to be released into the atmosphere over the construction period will be represented by total suspended particulates - especially TSP and PM<sub>10</sub> fraction.

All the categories of sources associated with the construction phase will be undirected, surface and linear, with a strictly local, temporary and low-impact impact.

Particle resuspension by entrainment on surfaces as a result of vehicle movement will be reduced as a result of the preponderant circulation of heavy vehicles and site machinery on landscaped surfaces and less on unpaved surfaces.

Particle emissions will be reduced by washing the concrete/paved surfaces, respectively by spraying unpaved or disrupted surfaces.

Emissions from fuels combustion for the operation of road and non-road machinery will fall within the limits approved by the machinery technical book, any malfunctions or abnormalities will result in shutting down the machinery until the problems are addressed.

An important aspect is that all construction materials will be produced off-site and will be delivered in the construction area in strictly necessary quantities and at the planned stages. Also, given the need to protect the buildings within the vicinity of the site, the excavation will be carried out in a closed, temporary retaining wall (berlin-type wall).

Considering the above, as well as the fact that all the activities related to the construction phase will be carried out:

- on a relatively small surface and for a limited time,
- mainly at ground level or at low heights,
- In a screened area from other industrial buildings,

it is appreciated that in the inhabited areas closest to the Cernavoda NPP perimeter, the values of atmospheric pollutant concentrations regulated by Law no. 104/2011 regarding the ambient air quality, with subsequent modifications and completions, will not be affected as a result of the construction and assembly activities for the CTRF.

### **Ground/Underground**

The possible sources of pollution can be:

- potential accidental leakages of oils and/or fuels/lubricants that may result from the operation of the equipment/means of transport used during the construction work; repairs to these machines/means of transport in undefined areas;
- washing the wheels for the means of transport in undefined areas;
- Inappropriate storage of waste generated during the period of conducting the work

### **Noise**

In the construction phase the noise sources are given by:

- Traffic of the heavy vehicles: dumpers, concrete mixers, trailers for the transport of heavy equipment, aggregates, various components. Noise generated by heavy traffic will include both engine noise and the noise produced by running the machines on the site access roads.
- Machinery operation: bulldozers, excavators, compactors necessary for the preparation of the land - equipment according to the norms and procedures for the construction of the nuclear constructions. The noise generated by these machines will also include the noise generated by the engines of these machines, the noise generated during excavation work and the safety alarms of these machines.
- On-site machinery handling, soil loading and unloading operations - all these will be accompanied by specific noise emissions.

### **Systems and measures to control emissions of pollutants into the environment**

Due to the fact that there are no significant sources of pollutants during the site organization, there is no need for specific equipment to control the emission of pollutants into the environment.

Throughout the duration of site organization and the construction/installation work, the contractor will take all the necessary measures to prevent any negative impact to the environment.

The work area will be delineated and marked.

### **Water**

Measures to control emissions of pollutants during the construction period:

- 
- periodic checking of the transport vehicles/machineries, in order to avoid the possibility of accidental leakages as a result of their defects;
  - avoiding/eliminating discharges to the soil, waste water resulted during the development of works in surface waters;
  - adequate storage of materials within the site organization premises for avoiding accidental loss and pollution;
  - washing the wheels for the transportation means at the exit from the site organization will be done in the designated area;
  - the staff use of the existing sanitary groups of the Cernavoda NPP and/or the ecological toilets.

For the period of conducting the work, considering both the possible pollution sources described and the measures to prevent the impact, it is estimated that the impact on the water environment factor will be insignificant from the perspective of the work for the CTRF project, as well as with the work for the others projects on the Cernavoda NPP site.

### **Air**

Measures to control pollutant emissions in the construction phase:

- Powdery materials will be stored in specially arranged places, as protected against unfavorable weather conditions (wind); during storage, they will be splashed with water if becomes necessary to prevent air pollution from sedimentary dusts;
- In order to avoid dust creation, the transport of the powdery materials will be accomplished using covered means of transportation;
- Loading/unloading in the transporter and handling of the powder-generating materials will be avoided during adverse weather conditions;
- Periodic checks of the equipment/transportation means used in the construction work will be carried out so that they are in good technical condition to prevent emissions of pollutants beyond the limits allowed by the legal provisions in force.

For the work execution period, considering the potential pollution sources mentioned and the measures to prevent the impact, it is estimated that the impact on the air factor will be insignificant, both in terms of CTRF project work and cumulated with the other site organizations at Cernavoda NPP site.

### **Soil/subsoil**

Measures to control and reduce emissions of pollutants in the construction phase:

- Regular checks of the transport equipment/vehicles for avoiding accidental leakage as a result of their failures (provision of absorbent materials for intervention in the case of accidental pollution will be ensured within the site organization);
- Avoiding/eliminating discharges to the soil, waste water resulted during the construction of the building ;
- The appropriate temporary storage of the resulting waste;
- Washing the wheels of the transportation vehicles will be done in the specially arranged area;
- Repairs of the equipment/transportation vehicle shall be made with authorized economic operators.



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During the construction of the CTRF, the impact will be reduced local. The impact may come mainly from the foundation works, construction and assembly works. Trough applying specific measures to prevent emissions of pollutants (dust, accidental fuel leakage) It can be estimated that the impact on the upground/underground will be insignificant.

### **Noise**

Measures to control pollutant emissions in the construction phase:

- Work will be carried out in stages to avoid the accumulation of multiple sources of noise/vibration.
- Existing traffic rules on site and approved access ways will be respected.

### **IMPACT ASSESSMENT**

*Given their limited size, limited time, pollution sources and environmental impact prevention measures, it is estimated that the environmental impact of construction works will be insignificant,*

The CTRF project will be located away from the future U3 and U4 projects; it is mentioned that the main buildings related to these projects are already being completed, and are pending to be finalised and equipped with the related equipments and installations, the construction works for these projects being located at a distance of approx. 400 m and approx. 500 m from the CTRF site.

*It is estimated that the environmental impact o the works during the construction phase of the Project will not lead to a significant cumulative impact with the other projects on the Cernavoda NPP site, because in the vicinity of the Project site there will be no construction works of a certain magnitude to lead to an increase in environmental impact.*

### **Technological and Commissioning Tests**

*It is estimated that the environmental impact during the technical testing and commissioning phase is similar to the one at the CTRF operating stage, as presented in the chapter. VII of this Presentation Memoir.*

At the technological tests and commissioning phases, construction work has ended, the sources of pollution at this stage becoming practically reduced to a minimum to nonexistent. Sources of pollutants presented in chapter VI.a) of the Presentation Memoir become active and the installations for the containment, evacuation and dispersion of environmental pollutants, also presented in chapter VI.a), work at process parameters. The operating procedures covering the incidents, respectively the Emergency Plan at the Cernavoda NPP site, mentioned below in chapter XI of the Presentation Memoir become operational for the CTRF at this phase.

It is mentioned that the estimation of the level of the impact at the technological tests phase and operation startup is conservatively estimated to be at the operation level of the impact because the testing program and subsequent commissioning is done in phases and the sources of pollutants may reach the level of potential pollution from operation, only in the final commissioning phases, as shown below.

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The commissioning of the CTRF will be carried out on the basis of a program demonstrating that the CTRF design requirements are met as foreseen in the Preliminary Safety Analysis Report.

The planned tests will pursue the following objectives:

- Ensuring that the equipment has been designed and installed according to the project
- Ensuring that the CTRF meets the system performance requirements and that the safety assumptions are validated.
- Familiarizing of the CTRF personnel with operating the facility (training and certification of operating and maintenance personnel in accordance with current regulations)
- Approval of facility operating procedures.

The CTRF commissioning plan will reflect the relevant industrial practices and will use the OPEX operating experience from the Wolsong Tritiation Removal Facility(WTRF Korea).

The commissioning plan for the CTRF will be correlated with the importance of the structures, systems, equipment, components, that are classified as important for nuclear safety, according to the CNCAN Norms (Quality Management Norms, Radiological Safety Norms, Nuclear Safety Standards). Policy documents, program documents describing the objectives and policy of the commissioning organization will be submitted and subject to the approval of the national regulatory authority in the field, CNCAN, upon which the Cernavoda NPP Integrated Management Manual will be revised.

A summary of the commissioning program and its outcomes will be included in the Final Safety Analysis Report (FSAR), which will be developed to obtain the CNCAN authorization for commissioning.

The CTRF commissioning program will identify five specific steps for to the verification/ inspection phases of facility in a logical sequence as follows:

- Step 1: Pre-Hydrogen - includes the activities necessary for the general verification of the construction and the safety requirements before the introduction of the deuterium inventory into the installation.
- Step 2: Deuterium testing - involves filling the deuterium process systems in order to confirm the operation of all hydrogen safety equipment according to the design specifications.
- Step 3: D2O tests - involves the introduction of heavy water (D2O) into detritiation equipment to confirm the operation of major CTRF systems according to design specifications.
- Step 4: Low concentration tritium trials - involves the introduction of tritiated water (DTO) in order to process a low concentration of tritium in the facility and is aimed to demonstrate the effectiveness of the tritium removal process at low concentrations.
- Step 5: High concentration tritium trials - gradually add heavy water with high concentration of tritium. The higher concentration of tritium will allow to demonstrate the reaching the detritisation factors and the processing rates provided in the detail design. It will also demonstrate compliance with the limits and operating conditions as well as compliance with the CTRF facility safety objectives.

At the end one step, the next step will be taken only after the successful completion of the previous sequence and only after obtaining the CNCAN authorization issued for each step. Before CTRF operation starts, a performance test will be performed to ensure the following:

- The commissioning of the equipment has been carried out in accordance with the documented procedures, with qualified and trained personnel;
- All operating parameters meet the specified criteria;
- All deficiencies have been identified and resolved;
- The analysis of the completion of commissioning steps has been carried out in accordance with the pre-established requirements.

The performance test will be carried out as part of Step 5. Thus, the relevant provisions of the Quality Requirements for the Quality Management System applied to commissioning, as assimilated to the Cernavoda NPP quality assurance policy, will apply. All tests will be performed in accordance with the test procedures and the documentation prepared for commissioning. The results of the performance test will be included in the commissioning report.

All the procedures that will be developed for the commissioning of the CTRF facility will be integrated into the specific processes described in the Cernavoda NPP Management Manual, approved by CNCAN.

As part of the commissioning program, the organization responsible for commissioning will inform CNCAN on the planning of the commissioning activities and the state of their fulfillment.

The organization responsible for construction activities and the organization responsible for the support activities in commissioning will establish and document the interface procedures for the transfer of responsibilities to the organization responsible for the operation of the facility (Cernavoda NPP branch).

## **XI. Site restoration work upon completion of the investment in the event of accidents and / or cessation of work**

### **Suggested work for site restoration at completion of investment, and /or cessation of activity**

For the completion of the investment is not necessary to make special restoring site work. Once the construction and assembly work has been completed, the green area remaining in the perimeter of the unit will be covered with grass.

The proposed activities are those stipulated in the decommissioning plan, approved by CNCAN as presented in Chapter III.f)-j), for ceasing the activity of the Nuclear Units on the NPP Cernavoda platform.

### **Issues regarding the prevention and how to respond in case of accidental pollution**

#### **Safety analysis in case of accidents**

The protection of the population, the staff and the environment, both in the condition of normal operation and in the event of an accident, is the primary safety objective that has been considered since the design of a nuclear installation, maintaining it as well in the operational and decommissioning stages.

Starting from this major objective, CTRF's safety strategy is based on an in-depth protection approach both during designing and operating, taking into account the potential hazards to the facility.

Hazards are dangers associated with internal events (eg facility malfunctions, fires) and external events (floods, earthquakes, extreme weather phenomena, human activities in the area of influence of the Project, which could lead to accidents) which could occur during the operation of the facility.

Since the design phase, a rigorous assessment of potential hazard (PHA - Preliminary Hazards Assessment) has been carried out by considering each system individually in the CTRF facility. Additionally, events leading to potential representative accidents, have been identified/ established on the basis of existing documentation from other similar facilities, such as Wolsong Tritium Removal Facility (WTRF) Preliminary Safety Analysis Report (PSAR) and in the authorization documentation such as: CTRF Hydrogen Detonation Frequency Assessment and CTRF Licensing Basis Document (LBD).

The two main hazards defined in the authorization documentation for CTRF are:

- Radiological hazard due to potential releases of tritium in the gaseous state DT and T2 and /or tritiated water vapor (DTO)
- Danger of explosion due to potential hydrogen releases (including all isotopes: protium, deuterium and / or tritium in gaseous state).

All PHA conclusions and recommendations have been duly taken into account by the designer, so that the facility can pass through these events under safe operating conditions.

The identification of postulated initiation events has been systematically performed on the basis of the conceptual design assessment, taking into account all plausible failures or malfunctions of components and systems, including those due to human errors, as well as internal initiation events of common cause, as well as external events, both natural and human-induced.

With regard to the danger of explosion / deflagration due to potential hydrogen releases, the results of the analysis performed demonstrate that for all initiation events considered (including combinations thereof) the probability of explosion is low.

Concerning the impact on the neighboring nuclear units, the analysis shows that CTRF's contribution to the risk of failure of the active area at any of the units is negligible (less than 10<sup>-6</sup> events / year).

Regarding the radiological hazard, in accordance with the requirements of CTRF Licensing Basis Document (LBD) similar initiation events or similar consequences have been grouped and classified according to the frequency of occurrence, and for the events (including their combinations) with the most severe potential consequences for the fulfillment of the nuclear safety functions, an accident analysis was carried out demonstrating the fulfillment of the population dose criteria set by CNCAN in the LBD for the design of the security protection systems.

The results of the accident analysis carried out during the design phase demonstrate:

- for event classes with an annual frequency of above 10<sup>-4</sup> (event or sequence of events) the most severe possible consequences of the Project are below the dose limits set by

CNCAN for the design of safety-related systems and even below the legal dose limit for the population for normal operation;

- for severe event classes with an annual frequency of occurrence between  $10^{-4}$  and  $10^{-6}$ , and in the case of a very severe accident with an annual occurrence frequency of  $10^{-6}$  and  $10^{-7}$ , the most severe consequences of the Project are well below the criteria by the dose set by CNCAN for the design of safety protection systems. The dose for the population drops significantly at distances of over 5000 m from the site, respectively over 4000 m from the exclusion zone limit, approaching the legal limit for the population for normal operation.

It is estimated that potential accidents with radiological consequences will have an insignificant impact both on the safe operation of the nuclear units and on the safe operation of the relevant objectives in the vicinity, in terms of impact analysis (presented in chapter III.f) -k), point B).

It is estimated that in case of accidental tritium releases, the Project will have a low impact on the population outside the site exclusion area and will not have a significant negative impact in a transboundary context.

### **Aspects regarding the measures to prevent and limit accidental pollution during the design phase**

The following two major objectives, derived from the CTRF security strategy, were considered during the design of the facility:

- Radiation: maintenance of tritium discharges and exposure of personnel and the population within the authorized limits, in normal operating conditions while respecting the ALARA principle and in acceptable limits in the event of an accident;
- Hydrogen: control and reduction of the risk of leakage and accumulation of hydrogen to prevent explosions.

Safety functions that ensure the protection of the population and the operating personnel in both normal and accidental situations are implemented in three major directions:

- Limiting tritium discharges by creating and maintaining adequate barrier systems to prevent and control emissions.
- Monitoring of operational parameters throughout the technological flow and the existence of automatic shutdown systems in the event of eventual damage detection and maintenance.
- Minimize the risk of explosion within the facility by maintaining an adequate ventilation system and separate CTRF components which use DT from those with DTO.

The main measures provided in the Project for the prevention and limitation of incidents and accidents have been introduced since the conceptual project phase.

The analysis made in the conceptual design phase of the facility, demonstrate that the technical project of CTRF facility has implemented important measures which ensure a level of protection of the staff, the population and the environment.

Regarding the problem with the explosion due to hydrogen accumulations, major measures have been implemented within the project in order to implement a safety function consisting of preventing the explosion caused by hydrogen accumulations, integrating:

- 
- Establishing a safe shutdown state of the CTRF for which the danger of explosion of hydrogen does not affect the location and facility systems ("Safe Shutdown State");
  - Reducing the inventory of hydrogen inside CTRF by placing an inventory outside the building (about 60 m<sup>3</sup> of hydrogen) while reducing the number of equipment located in the hydrogen zones and providing redundant monitoring and safety features.

In terms of ensuring nuclear safety, respectively avoiding and limiting the consequences of some radiological events, it has been identified:

- important measures that ensure the avoidance and limitation of incidents through the operation of the Project that were presented in chapter VI.a)-d) of the Presentation Memoir;
- measures to limit the total tritium inventory that may exist in the facility;
- introducing a secondary isolation system to prevent DT from entering the operational area in the event of a breach in primary isolation. Secondary isolation/enclosure is commonly used in detritiation or tritium handling facilities, especially for systems that contain Tritium-specific activity in elemental form;
- the technical and nuclear safety measures implemented in the conceptual design that ensure the prevention and limitation of the consequences for potential accidents, are taking into account the capacity of the Project to cope with severe external events in accordance with the authorization requirements and the international recommendations as a result of Fukushima accident in Japan.

### Planning and preparation for emergencies

Emergency situations for CTRF may result from radiological, chemical events, fires, internal events, external events, etc. and will be integrated in the Planning and Preparedness Process at Cernavoda NPP, which ensures:

- organizing the planning and preparation process for emergencies;
- the plan and the emergency procedures on site
- providing material basis and logistic support in emergency situations
- training and emergency exercises
- interfacing with public authorities and informing the public.

**The Cernavoda NPP activity enters the provisions of the Law 59/2016**, being classified as a high risk objective, the substances notified to the competent authorities being hydrazine and petroleum products (diesel and CLU).

In the Cernavoda NPP Security Report and in the Emergency Plans, there is a risk analysis of accidental scenarios and accident response mode, respectively, in which the substance involved could be Diesel fuel / liquid light fuel for boilers (CLU).

Both the Cernavoda NPP staff and the contractor staff working on the Cernavoda NPP site are trained on how to respond and behave in the event of incidents or accidents, including conventional ones.



Fire and explosion barriers are provided for the CTRF through preventive measures such as optimizing facility's capacity - limiting as much as possible the volume of hydrogen within the facility installing detection and alarm equipment, providing ventilation in areas with hydrogen storage potential, using seismically qualified equipment, reducing equipment in hydrogen areas, the use of waterproofing materials, respectively by means of mitigation measures, such as a protective wall outside the facility, the installation of expansion vessels, the disposal of intervention means and the development of specific procedures.

On the Cernavoda NPP site there is a Fire Fighting Brigade with equipment and machinery suitable for rapid fire intervention, with a permanent shift program, which serves all the buildings and systems on site. Periodically, emergency drills are organized under the conditions set out in the internal procedures and regulations, including emergency response sequences.

**The Emergency Plan at the Cernavoda NPP** site ensures the response to accident occurrences at the Cernavoda NPP site which may have the following negative effects on: the health of the population in the vicinity of the site; short or long-term to the environment; the health of the on-site staff; the equipment and the plant assets.

In order to prepare the personnel, test the procedures and the emergency plan, test the response capacity of the Public Authorities and the Cernavoda NPP, the following types of emergency exercises (drills) are performed on the NPP Cernavoda platform: Partial Exercise, Annual Exercise and General Exercise.

The assessment of the state of the facility / systems / personnel and the hazards generated by the event, respectively the classification of the emergency situations according to the event, shall be made according to the procedure and immediately after the occurrence of the event.

Incident situations (any unintended events, including equipment failures, initiation events or accident precursors) that do not have radiological consequences, consequences on staff health or do not lead to fires or spills of hazardous chemicals will be solved by accomplishing (such measures are presented in Chapter VI.a) and above in Chapter XI of the Presentation Memorandum) and / or operating procedures, without activating the on-site emergency plan.

In this situation, prompt action is taken to reduce the consequences of the event, to protect the on-site staff and notify the competent authority and the public authorities of the off-site Emergency Plans and prepare off-site protection measures if necessary.

The Emergency Plan at the Cernavoda NPP site provides that an Emergency Situation statement on the Site will be held in the case of an event involving a major reduction in the level of protection of the personnel on the site and the population in the immediate vicinity of the plant.

### **Aspects related to the closure / decommissioning / demolition of the facility**

Decommissioning is the final stage of the Project, as it was presented in the chapter. III.f) -j) of the Presentation Memoir.

The initial decommissioning plan that is being carried out during the building permit phase is being developed / updated during the Project's operating phase. During the final period of the exploitation period, a final decommissioning plan will be prepared, according to the provisions of the normative acts in force at that time. The decommissioning of the CTRF facility is regulated by the provisions of Law no. 111/1996 on the safe conduct, regulation, authorization and control of

nuclear activities, republished, with the modifications and completions in force and by the "CNCAN NSN-15 - Norms on Decommissioning of Nuclear Installations".

The final decommissioning plan will be submitted for approval to the authority after notification of the CTRF's final closure intention, will be in line with the proposed decommissioning strategy for the facility and will describe decommissioning activities (including the preparation stage of the decommissioning of facility itself) and the installations, systems, equipment needed to carry out the decommissioning activities.

Taking into consideration the specificity of the tritium removal facility on the Cernavoda NPP platform, a decommissioning strategy is proposed in the conceptual design phase, to be carried out in two stages:

- I. stage of cleaning and preparation of the facility for decommissioning;
- II. the actual decommissioning phase going to the release of the site under the CNCAN authorization requirements, which includes decontamination, dismantling, treatment, conditioning and storage of waste and restoration and greening of the land.

In accordance with the criteria established by the regulations, the final decommissioning plan will define the final status of the facility after the decommissioning including the environmental impact assessment of the decommissioning activity, and upon completion of the decommissioning, a final decommissioning report will show that the final status of the facility or site, was made in accordance with the final decommissioning plan, ensuring the protection of the population and the environment.

The final decommissioning plan will be supported by the environmental impact estimation /assessment and will include a synthesized presentation demonstrating compliance with the environmental legislation requirements / limits. The environmental impact assessment will be subject to the approval of the authorities with responsibilities in the field, according to the requirements of the regulatory procedures existing at the date of the facility final closure.

Final shutdown / closure and decommissioning activities will be initiated and performed strictly after obtaining the permits / authorizations provided for by law.

Taking into account the existing environmental legislation existing at EU and national level, the decommissioning project will be subject to the environmental assessment procedure for the issuance of the environmental agreement in accordance with the provisions of Law No 292/2018, Appendix 1, point 1b.

The environmental conditions required to be met when closing / decommissioning nuclear targets and those needed to restore the initial state of the land will be established in the environmental impact assessment procedure for this type of project, following the analysis of environmental documentation that will meet the requirements of the law and will be specified in the environmental agreement issued for this type of project.

Environmental Impact Assessment, both in normal operation and in accidental pollution situations, will take into account the magnitude of the inventory of radioactive and non-radioactive materials existing in the decommissioning process.

The environmental decommissioning agreement will also include requirements for monitoring environmental components.

### **Ways of restoring the initial state / rehabilitation for subsequent use of the land**

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The initial restoration / rehabilitation modalities are set out in the CNCAN approved decommissioning plan, as mentioned in Chapter III. f) - j).

## **XII. Appendix - Drawings**

Appendix no.1

- Development Site Plan
- Lay-out Plan
- General Lay-out and utilities Plan

Appendix no.2 - Alternative no. 1 for site

Appendix no.3 - Alternative no. 2 for site

Appendix no.4 - STEREO 70 coordinates

Appendix no.5 - Nonradioactive waste generated during construction works of the tritium removal facility (CTRF) - management flow chart

Appendix no.6 - Nonradioactive waste generated during tritium removal facility's operation period - management flow chart

Appendix no.7 - Flow chart of radioactive waste management generated during CTRF exploitation (within the radioactive waste management system on the Cernavoda NPP platform)

Appendix no.8 - Situation plan with the positioning of the F1 drilling

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**XIII. For projects falling under the provisions of Art. 28 of Government Emergency Ordinance no. 57/2007 on the regime of natural protected areas, conservation of natural habitats, wild flora and fauna, approved with amendments and completions by Law no. 49/2011, as amended and supplemented, the memo shall be completed with the following:**

**XIII.a) The short description of the project and the distance from the protected natural area of community interest, as well as the geographic coordinates (Stereo 70) of the project site. These coordinates will be presented as a vector in digital format with geographic reference in the National Stereo 1970 projection system, or an electronic chart containing the contour coordinates (X, Y) in the Stereo 1970 national projection system**

The description of the CTRF Project is presented in the Presentation Memoir chapter III.f).

In Appendix no.4 there are presented the Stereo 70 coordinates for the CTRF Project.

The Cernavoda NPP platform that integrates the Project site is not located on protected areas, sites or areas, but is located in the vicinity of such areas, as per the information below.

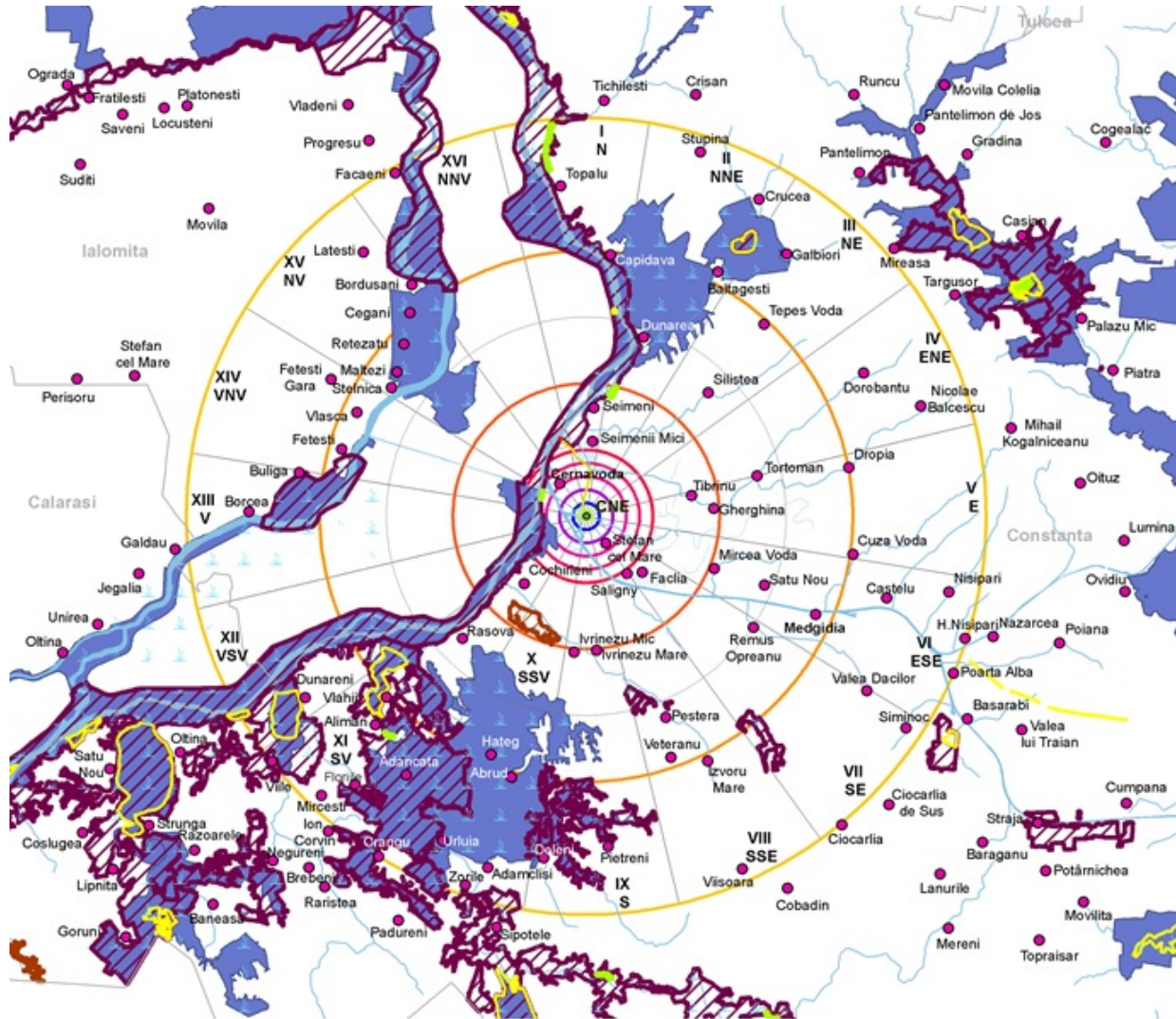
Figure XIII.1 below illustrates the location of sensitive areas - areas of interest for nature preservation, settlements - in the Cernavoda NPP 30 km area, as well as the security zones and boundaries of the areas, to allow the assessment of the orientation and the distances in relation to Cernavoda NPP platform.

The distances of Cernavda NPP site in relation with the CTRF project, compared to the nearest natural protected areas, are presented in the Presentation Memorandum under b) point.

Most of the areas located in the 30 km area around the power plant, the Danube banks and Balta Ialomița are covered by anthropogenic ecosystems.

Biodiversity before the extension of agriculture to the reference area is replaced by large areas, the original flora and fauna being kept on small "islands" surrounded by cereal crops.

Fig. XIII.1 Sensitive areas - settlements, protected areas - from Cernavoda NPP area of influence



**Legenda**

- Judete
- Localitati
- Cursuri de apa
- CNE**
- CNE\_U1, U2
- CNE\_Canal pt evacuare in Dunare
- Pct\_evacuare\_Dunare
- Raze de securitate\_m**
- 10000
- 20000
- 30000
- 40000
- 50000
- 100000
- 200000
- 300000
- Sectoare

**Arii protejate**

- IUCN**
- Monument al naturii
- Arie de gestionare a habitatelor/speciilor
- Ramsar**
- Zone umede de importanta internationala
- Natura2000**
- SPA
- SCI
- SCI\_propunere



Thematic Layers on Protected Areas, published on the website of the Ministry of Environment in August 2017

### XIII.b) the name and code of the protected natural area of Community interest

Table XIII.1 lists the names and codes of protected natural areas of Community and national interest that are within 15 km in relation to Cernavoda NPP.

**Table XIII.1 Natural protected areas of community and national interest placed within 15 km radius from Cernavoda NPP**

Site Type		Site Code	Name of site	Comments
Natura 2000	Site of Community Importance	ROSCI0022	Canaralele Dunării	<p>– Approximately 2.2 km in a straight line to the Cernavoda NPP</p> <p>– The cooling water from Cernavoda NPP is evacuated through a circuit, consisting of cassettes, tunnels, open concrete channel and earth channel, discharging into the Danube at a distance of 6.3 km from the Cernavoda NPP. The northern edge of the protected area is about 52 km downstream of the discharging of the cooling water in the Danube. The Stereo 70 coordinates of the point of confluence are: X (North) 323843 m; Y (Est) 742188 m</p>
Natura2000	Site of Community Importance	ROSCI0353	Peștera Deleni	Approximately 13.4 km SSE to Cernavoda NPP
Natura2000	Site of Community Importance	ROSCI0412	Ivrinezu	Approximately 9.5 km distance in a straight line Cernavoda NPP - Ivrinezu Mare
Natura2000	Special Avifaunistic Protection Area	ROSPA0001	Aliman Adamclisi	Approximately 11.5 km S-SV to Cernavoda NPP
Natura2000	Special Avifaunistic Protection Area	ROSPA0002	Allah Bair Capidava	<p>Approximately 10.3 km to Cernavoda NPP</p> <p>The southern edge of the protected area is about 6,5 km downstream of the</p>



Site Type		Site Code	Name of site	Comments
				discharging of the cooling water in the Danube.  Aria declared by the Romanian Ornithological Society as Avifaunistic Importance Area (AIA) – code RO107 Allah Bair-Capidava
Natura2000	Special Avifaunistic Protection Area	ROSPA0012	Brațul Borcea	Approximately 10.06 km to the Cernavoda NPP
RAMSAR	Wetlands of International Importance	RORMS0014		Confluence of the Bratul Borcea and Danube is approximately 52 km downstream of the discharging of the cooling water in the Danube.
Natura2000	Special Avifaunistic Protection Area	ROSPA0039	Dunăre Ostroave	SV-V of NPP, the nearest point is located approximately 1.8 km from the NPP  Upstream of intake the cooling water for NPP and their restitution in the Danube.
IUCN	Natural monument	RONPA0371	Cernavoda fossil site	Approximately 2.6 km VNV to the Cernavoda NPP
IUCN	Natural monument	RONPA0372	Seimenii Mari fossil site	Approximately 8.8 km N to the Cernavoda NPP
RAMSAR	Wetlands of International Importance	RORMS0017	Ostroavele Dunării Bugeac Iortmac	Includes the following Natura 2000 sites:  ROSCI0022 Canaralele Dunării,  ROSPA0001 Aliman – Adamclisi  ROSPA0002 Allah Bair – Capidava.

### **XIII.c) presence and estimates / areas covered by species and habitats of community interest in the Project area**

As mentioned above, the site of the Project does not overlap with protected natural areas of Community interest. In this context, the biodiversity in the protected natural areas of Community interest in the neighborhood of Cernavoda NPP was analyzed.

The presence and estimates / areas covered by species and habitats of Community interest in the protected natural areas of interest for the Cernavoda NPP site are mentioned in the appropriate assessment studies elaborated in various stages, for the projects on site.

Among the protected areas mentioned above at chapter XIII. b), ROSCI0022 area “Canaralele Dunării” and ROSPA0002 area “Allah Bair – Capidava” were considered the most susceptible to

the impact on biodiversity, due to the proximity to the Cernavoda NPP and the downstream location of the cooling water discharging in the Danube.

The impact on biodiversity in these protected areas has been assessed since the first appropriate environmental impact assessment study, the impact on biodiversity achieved for the Cernavoda NPP in 2010-2011. The study was conducted during the procedure for obtaining an environmental agreement for the project of Units 3 and 4 Cernavoda NPP, by the National Research and Development Institute "Danube Delta" (2012).

The impact assessment of the Project on biodiversity was carried out through an appropriate assessment study of the impacts of the construction and operation of the CTRF, developed by INCDM "Grigore Antipa" in Constanta in 2015.

In the environmental impact assessment report has been assessed the impact on biodiversity for sites ROSCI0022 "Canaralele Dunării", ROSPA0002 "Allah Bair – Capidava" and ROSPA0017 "Canaralele de la Hârșova", in accordance with the requirements of the environmental authority and on the basis that the location of these sites indicates that they are most likely to have a potential impact on the activities of this industrial objective.

**XIII.d) There shall be specified whether the proposed project has no direct or unnecessary link to the management of the conservation of the protected natural area of Communitary interest.**

The proposed project is not connected (or not necessary) with the conservation management of the protected natural area of Communitary interest.

**XIII.e) There will be estimated the potential impact of the project on species and habitats from protected natural area of Communitary Interest**

- **during construction phase**

According to the Environmental Impact Assessment report developed for the CTRF project, it is estimated that the impact of biodiversity due to construction-assembly works is insignificant, mentioning the following:

- ✓ construction and assembly activities can be carried out throughout the year, but the wintering period from November to January is the time when the area of interest is of the greatest importance from the point of view of biodiversity because it is a place where birds species are present and adapted to aquatic ecosystems - some of Communitary interest - who shelter themselves during adverse periods in the vicinity of protection structures due to the shelter provided by them.
- ✓ It is not necessary to limit specific activities the project during migration because these activities have the opportunity to interact directly with specific biodiversity of these stages. The construction and fitting-out and biodiversity activities specific to the Natura 2000 site do not intersect directly, so that the residual impact level is insignificant, with a minimum value.

- **during operation**

For the CTRF project, when assessing the impact of normal CTRF operation on biodiversity in the appropriate assessment study, there were considered:

- ✓ the effect of reducing tritium emissions as a result of the operation of the assembly: CTRF and nuclear units (U1 and U2)
- ✓ low individual contribution of CTRF to tritium in water,
- ✓ local characteristics from the perspective of ecosystems, habitats and species
- ✓ the results of monitoring environmental factors and biota in terms of tritium accumulation in the biota of the area of interest

It is also estimated that by CTRF operation, the flow, temperature and intake of nutrients discharged into the emissary (after treatment) will not change with the discharges from units U1 and U2. Under these conditions it is estimated that the normal operation of the CTRF will have an insignificant impact on aquatic fauna and flora (from the thermal aspect of the nutrient intake), as well as the mechanical effects of drawing - hit at the point of evacuation.

In the Environmental Impact Assessment Study of the impact of the construction and operation of this facility, elaborated in 2015 by INCDM "Grigore Antipa" Constanta, extensive conclusions were made, which are presented below.

It is worth mentioning that the estimation of the cumulative impacts of CTRF on biodiversity from the appropriate assessment study was made under the conditions of operation at the Cernavoda NPP Units 1 and 2, which integrates the existing IDSFS project.

**Plants** Based on the results of the investigations carried out during 2010-2011, it was concluded that the operation of Units 1 and 2 of Cernavoda NPP does not have a significant radiological impact directly or indirectly on the species of plants of Community interest, either in the short or long term.

Operating on the Cernavoda NPP site during the lifetime of nuclear units 1 and 2 and having the role of reducing tritium emissions in effluents, the appropriate assessment study estimates that neither the implementation of the Project will have a negative impact on the species of plants of Community interest significantly, directly or indirectly, nor in the short term or in the long term, neither in the construction phase, nor in the operation or in the decommissioning phase.

Regarding the cumulative impact, a positive impact on Cernavoda NPP activity U1 and U2 was estimated, lower in the short term (one year) and higher in the medium and long term, due to the reduction of tritium emissions. In the case of plant species of Community interest, no measures are proposed to reduce or eliminate any type of activity or infrastructure element, as a result of which there is no residual impact either.

**Invertebrates** - Based on the results of the investigations carried out during 2010-2011, it was concluded that the operation of Units 1 and 2 of Cernavoda NPP does not have a direct or indirect impact on the species of invertebrates of Community interest (from ROSCI0022 Canaralele Dunării), either in the short or the long term.

CTRF operating on the Cernavoda NPP site during the lifetime of nuclear units 1 and 2 and having the role of reducing tritium emissions in effluents, the Environmental Impact Assessment Study estimates that neither the implementation of the Project will have an impact on the

invertebrate species of Community interest directly or indirectly, negatively or in the short term, nor in the long run, in the construction phase, neither in the operation, nor in the decommissioning phase.

Concerning the species of invertebrates of Community interest, there is no cumulative radiological impact and no measures are proposed to reduce or eliminate any type of activity or element of infrastructure, as a result of which there is no residual impact either.

**Fish species** - Based on the results of the investigations carried out during 2010-2011, it was concluded that the operation of Units 1 and 2 of Cernavoda NPP does not have a direct or indirect radiological impact on fish species of Community interest, either in the short or long term.

Operating on the Cernavoda NPP site during the lifetime of nuclear units 1 and 2 and having the role of reducing tritium emissions in effluents, the Environmental Impact Assessment Study estimates that neither the implementation of the Project will have an impact on the fish species of Community interest directly or indirectly, negatively or in the short term, nor in the long run, in the construction phase, neither in the operation, nor in the decommissioning phase.

For fish species of Community interest, there is no cumulative radiological impact and no measures are proposed to reduce or eliminate any type of activity or infrastructure element, as a result of which there is no residual impact either.

**Amphibians** - Based on the results of the investigations carried out during 2010-2011, it was concluded that the operation of Units 1 and 2 of Cernavoda NPP does not have a radiologic impact directly or indirectly on both amphibian species of Community interest, in the short or long term.

Operating on the Cernavoda NPP site during the lifetime of nuclear units 1 and 2 and having the role of reducing tritium emissions in effluents, the Environmental Impact Assessment Study estimates that neither the implementation of the Project will have an impact on the amphibians species of Community interest directly or indirectly, negatively or in the short term, nor in the long run, in the construction phase, neither in the operation, nor in the decommissioning phase.

Regarding the cumulative impact, a positive impact on the U1 and U2 activity of the Cernavoda NPP was estimated, lower in the short term (one year) and higher over the medium and long term due to the reduction of tritium emissions.

In the case of amphibian species of Community interest, no measures are proposed to reduce or eliminate any type of activity or infrastructure element, as a result of which there is no residual impact either.

**Reptiles** - Based on the results of the investigations carried out during the period 2010-2011, it was concluded that the operation of Units 1 and 2 of Cernavoda NPP does not have a direct or indirect radiological impact on reptile species of Community interest, neither in the short or long term.

Operating on the Cernavoda NPP site during the lifetime of nuclear units 1 and 2 and having the role of reducing tritium emissions in effluents, the Environmental Impact Assessment Study estimates that neither the implementation of the Project will have an impact on the reptiles species of Community interest directly or indirectly, negatively or in the short term, nor in the long run, in the construction phase, neither in the operation, nor in the decommissioning phase.

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Regarding the cumulative impact, a positive impact on the U1 and U2 activity of the Cernavoda NPP was estimated, lower in the short term (one year) and higher in the medium and long term due to the reduction of tritium emissions.

In the case of reptile species of Community interest, no measures are proposed to reduce or eliminate any type of activity or infrastructure element, as a result of which there is no residual impact either.

**Mammals** - Based on the results of the investigations carried out during 2010-2011, it was concluded that the operation of Units 1 and 2 of Cernavoda NPP does not have a direct or indirect impact on the species of plants of Community interest, either in the short or long term (INCDDD, 2012).

Operating on the Cernavoda NPP site during the lifetime of nuclear units 1 and 2 and having the role of reducing tritium emissions in effluents, the Environmental Impact Assessment Study estimates that neither the implementation of the Project will have an impact on the mammals species of Community interest directly or indirectly, negatively or in the short term, nor in the long run, in the construction phase, neither in the operation, nor in the decommissioning phase.

Regarding the cumulative impact, a positive impact with the U1 and U2 activity of the Cernavoda NPP was estimated, lower in the short term (one year) and higher in the medium and long term due to the reduction of tritium emissions.

In the case of mammalian species of Community interest, no measures are proposed to reduce or eliminate any type of activity or infrastructure element, as a result of which there is no residual impact either.

**Birds** - The location where the CTRF project will be implemented is located in the NPP site, a very anthropic area being an industrial site.

Within the NPP there are no natural habitats, which is why only the species of anthropophilic birds can live here - common species, widespread in all the localities of Dobrogea and even in Romania. These species are sedentary (most of them, such as sparrows and starling) or summer guests (such as swallows and martin birds). These are the only species nesting in the NPP. Is not present endangered or vulnerable species.

Aquatic bird species can not be found in the Cernavoda NPP but many of them can be seen in passage or winter in the Seimeni water basin or Seimeni cooling water drain. They find temporary shelter here. They do not nest in the area. These species prefer the Danube, Balata lalomiței, Balta Brăilei, the Danube islands or the lakes of south-western Dobrogea.

Daybreeding birds do not have favorable places in the Cernavoda NPP. They can only be seen in migration, possibly passing high above the Cernavoda NPP. The winter, the bird's eagle or the winter hawk can come in search of food (sparrows or domestic pigeons) and in the Cernavoda NPP. They do not nest here.

The species characteristic of the steppe, bushes or agroecosystems do not penetrate the NPP because they prefer open habitats of the plain.

Species living in the Danube's meadows and meadows rarely enter the Cernavoda NPP because they lack their specific habitats.

In the appropriate assessment study it was estimated that the temporary presence of some bird species on the distribution basin and along the discharge channel is possibly due to the water

temperature characteristic favoring the creation of a favorable habitat (waters are warm even in Winter, so no freezing).

In formulating the conclusions, the authors of the appropriate assessment study took into account that Cernavoda nuclear reactors started operating in 1996 and that until the date of the study (2015) the avifauna in the area did not suffer significant reductions in a number of species or effective.

The Environmental Impact Assessment report concludes that the construction and operation of the CTRF will have an insignificant impact on avifauna, and from the point of view of the cumulative impact with the activities carried out at the Cernavoda NPP site, a positive environmental impact on avifauna is estimated; no countermeasures will be required to reduce environmental impact or additional monitoring programs.

***The final consideration for the radiological impact assessment based on the biodiversity assessments made up to the date of the Presentation Memoir presented above shows that:***

- Since the two units of the Cernavoda NPP were in operation, no radiological risk was found for the habitats and species of conservation interest in the protected natural areas.
- As a result of the implementation of all measures for the correct operation of Cernavoda NPP (U1 and U2) and environmental monitoring, no radiological effects on biota have been observed so far.
- It is estimated that the implementation of the CTRF Project will have a medium and long-term positive impact on the conserved species and habitats of the adjacent protected natural areas. Achieving this investment can be considered as a measure to reduce the risk of exposure due to the capture of tritium from the heavy water and the reduction of the risk of this reaching the environment.

It is worth mentioning that the estimation of the cumulative impact of CTRF on biodiversity in the assessment study was made in the conditions of Cernavoda NPP Unit 1 and 2 being operational, which also integrates the existing IDSFS project.

The results and conclusions of the appropriate assessment study carried out for the CTRF Project are supported by the measurements and results of the study "Impact of the Cernavoda Nuclear Power Plant on Aquatic and Terrestrial Bodies in its Influence Area" (BIOTA Study), which was conducted by the INCDTCI-ICSI Rm. Vâlcea laboratories in the period 2008-2012 and continued during the period 2013-2016 as part of the program for monitoring the impact of the operation of the Cernavoda nuclear power plant on the aquatic and terrestrial organisms in the area of influence. This monitoring program aims at assessing the thermal, mechanical, chemical and radiological impact on aquatic and terrestrial organisms as a result of the operation of the nuclear power plant, the scope being extended over a radius of 30 km.

**The BIOTA study did not reveal a significant impact of Cernavoda NPP operation in the area.**

Thus, the Report drawn up as a result of the campaigns conducted in 2016 presented the following conclusions:

*"There were no atypical changes in the structure of the vegetal associations in the influence zone of the NPP Cernavoda NPP. From an artificial association - lolium and trifolium - the grass*



*that was part of the original landscape architecture - a "new ecosystem" with a larger number of new plant species was born, the seeds of which were naturally brought by birds or wind, widening their variability.*

*The evolution of plant associations from "simple" (several) to "complex" (several species with specific spatial layout) indicates favorable conditions (unaltered by plant activity) of growth in the NPP's ecosystem and amplification of genetic fund diversity.*

*We believe there is no need to intervene in the evolution of the ecosystem, the signs of amplification and diversification of vegetation support this statement.*

*The use of snails, fish, birds, insects, etc. for ecosystems can be used to justify the existence of a clean environment for the biosensors in the ecosystem. "*

At the same time, the results and conclusions of the assessment Study carried out for the Project are supported by the environmental studies carried out for the renewal of the environmental permit for SNN-Cernavoda NPP Branch, namely the "Report on the Environmental Level II Balance Sheet for Cernavoda NPP" 2017. The report was drawn up on the basis of the investigation plan and the information provided by the Level II environmental balance for the reauthorization of Cernavoda NPP Units 1 and 2, which consisted of investigations on the Cernavoda NPP site and the influence of the power plant in order to determine the pollution intensity by sampling and physico-chemical and radiological analysis. The determination of interest indicators - sampling, sample preparation, analyzes and analysis reports - were carried out by specialized laboratories.

Thus, according to the mentioned report, radioactivity determinations on samples taken for environmental factors; water, air, soil, spontaneous vegetation and food (cultivated crops - cereals, vegetables, fruits - eggs, milk, meat, fish) show that the results fall within the intervals determined by the BIOTA Study, respectively confirming the results of the monitoring programs The Radioactivity Monitoring Program, according to which the operation of Cernavoda NPP did not lead to the propagation of radioactive pollution to the analyzed environmental factors.

### **XIII.f) other information provided by the applicable law**

It is estimated that there is no other information at the level of this document which could change the conclusions on the potential impact of the project presented above.

## **XIV. For water or water related projects, the presentation memoir will be completed with the following information, taken from the updated Basin Management Plans:**

### **1. Location of the project:**

- hydrographic basin: the Danube River

- watercourse in the area of Cernavoda NPP platform: name and cadastral code;

- Danube: XIV 1.000.00.00.0
- Danube-Black Sea Canal: XV 010b.00.00.0

- water body in the area of Cernavoda NPP (surface and/or underground): name and code.

---

Surface water:

- Chiciu-Isaccea - RORW14.1\_B4
- CDMN1 - RORW15.1.10b\_B1

Underground water:

- RODL06 - Platform Wave (Deep Sea Water Body)

**2. Indication of the ecological status/ecological potential and the chemical status of the body of surface water; for the body of groundwater, the quantitative status and the chemical status of the body of water will be indicated**

*The status of surface water bodies near the Cernavoda NPP site*

Surface water:

- Chiciu-Isaccea - RORW14.1\_B4: Moderate ecological potential, good chemical status
- CDMN1 - RORW15.1.10b\_B1: good ecological potential, good chemical status

*Information on the current state of groundwater bodies*

Underground water:

- RODL06 – Valahian platform (deepwater body) platform: good quantitative state, good chemical status

**3. Indication of the environmental objective (s) for each identified water body, specifying the exceptions applied and the related deadlines, as appropriate**

ENVIRONMENTAL OBJECTIVE for Chiciu-Isaccea surface water: good ecological potential, good chemical status

**XV. The criteria set out in Appendix 3 to Law No ... regarding the assessment of the impact of certain public and private projects on the environment shall be taken into account, when appropriate, when compiling the information in accordance with points III to XIV**

- Not applicable

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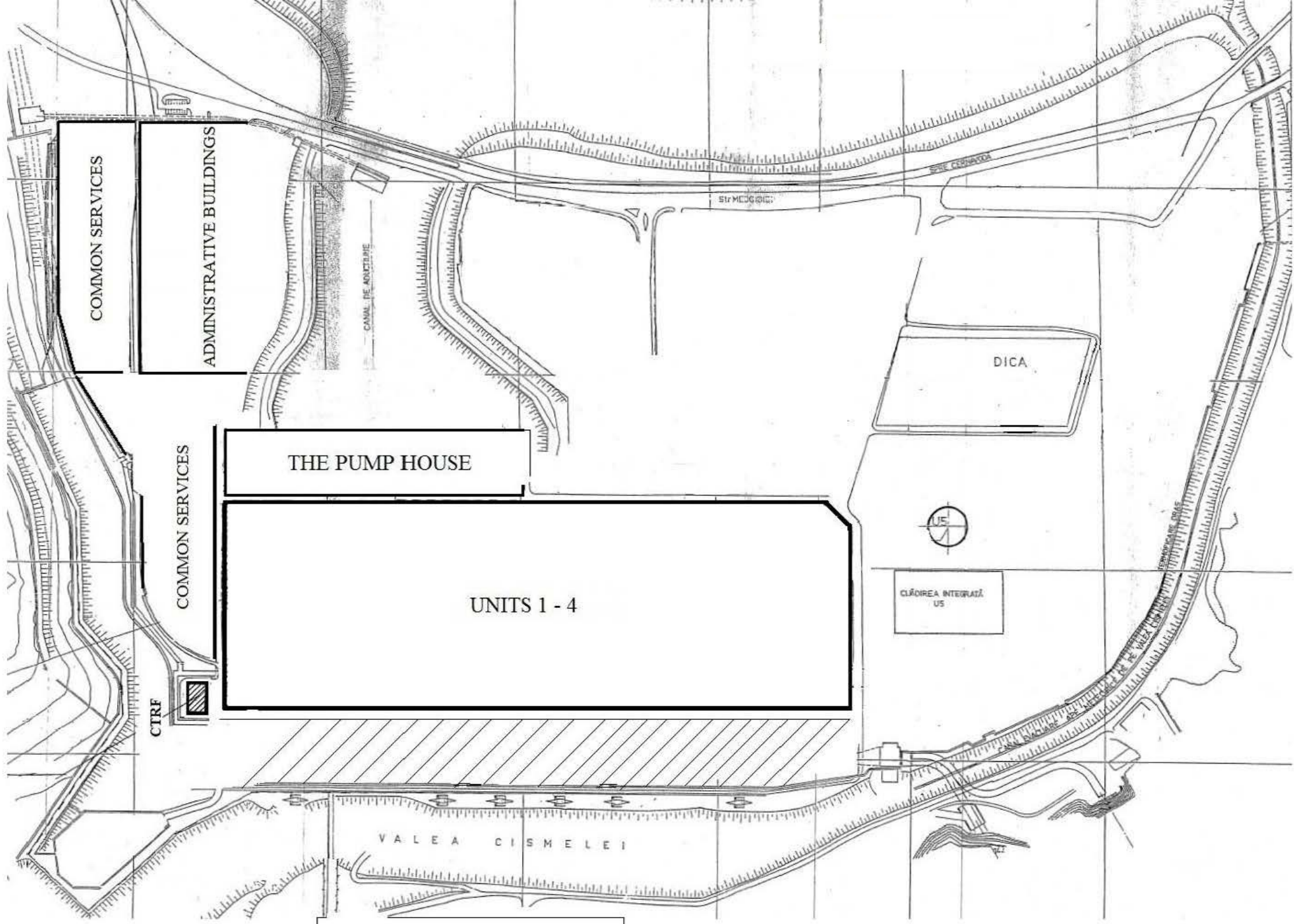


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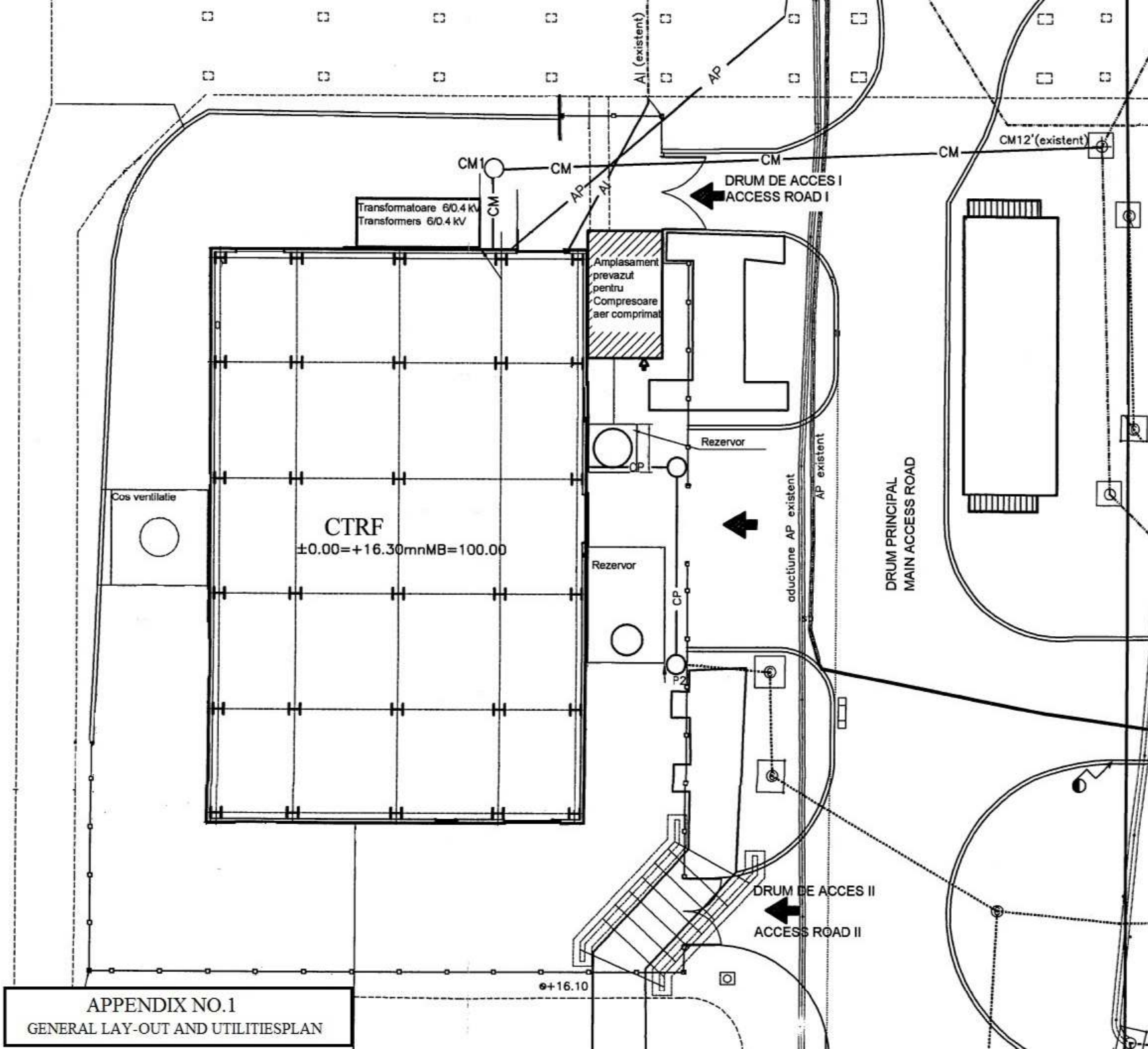


**APPENDIX NO.1**  
DEVELOPMENT SITE PLAN

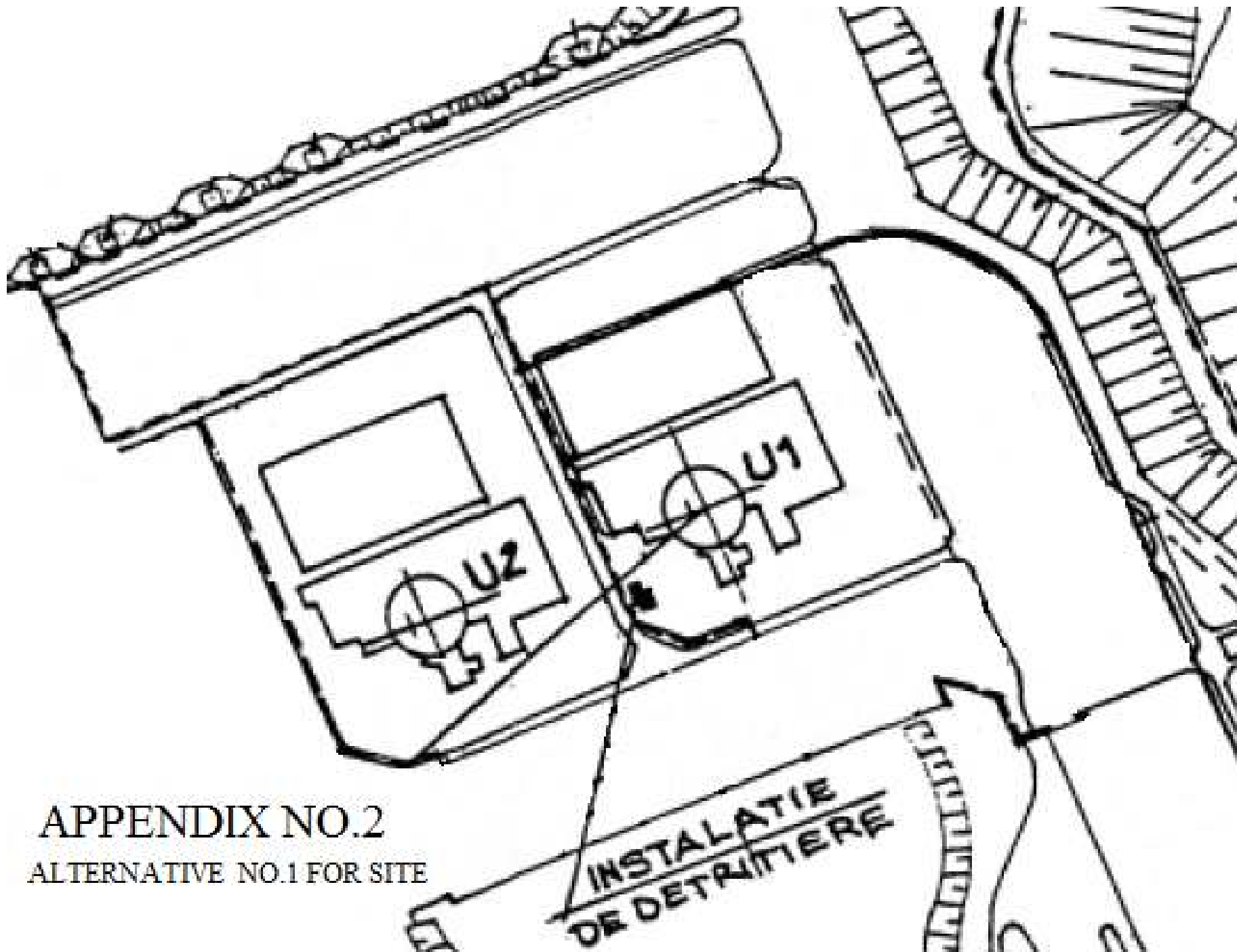




THE EXTERNAL ELECTRIC STATION  
400KV



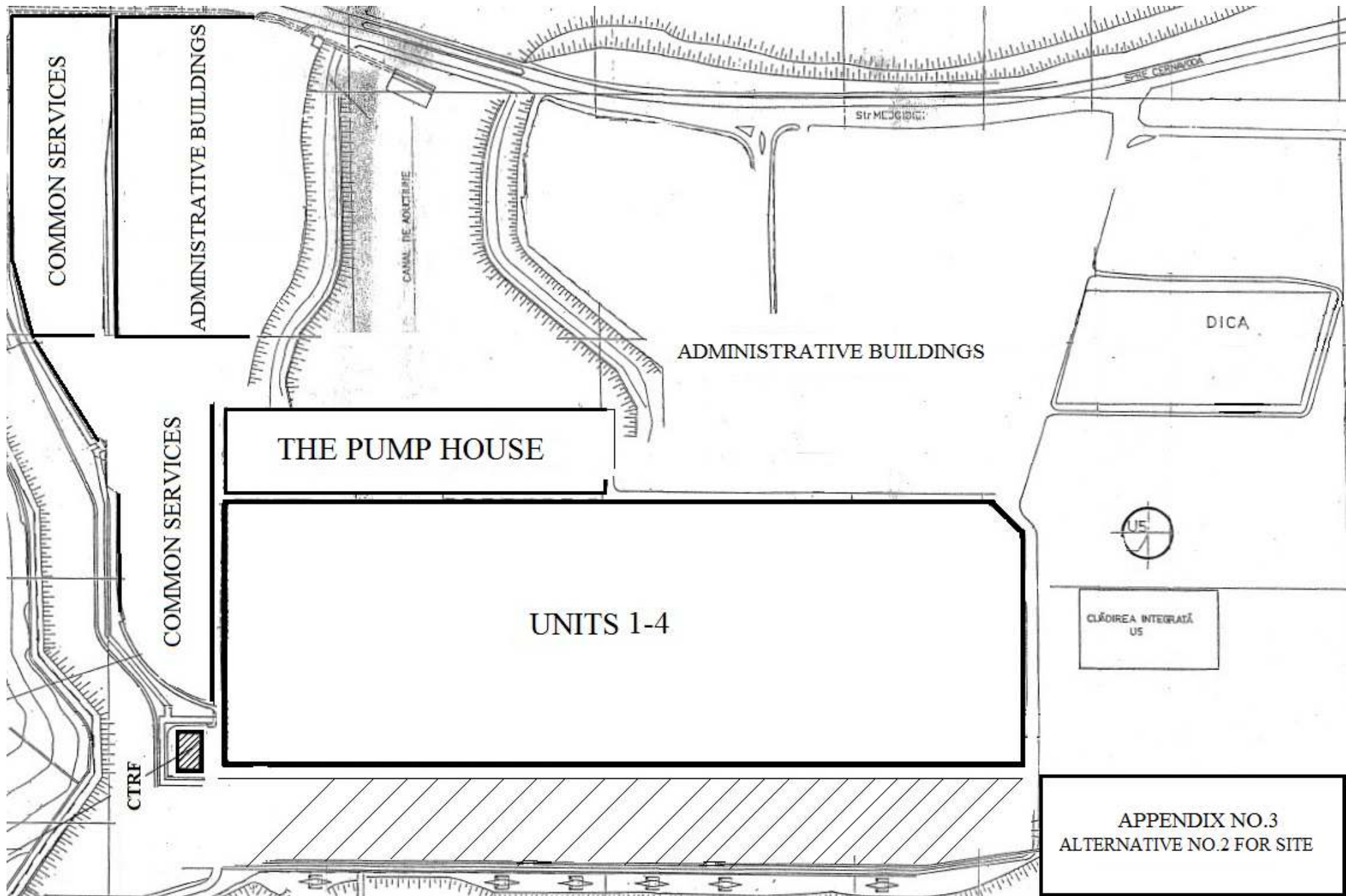
APPENDIX NO.1  
GENERAL LAY-OUT AND UTILITIES PLAN



APPENDIX NO.2

ALTERNATIVE NO.1 FOR SITE







## Appendix no. 4

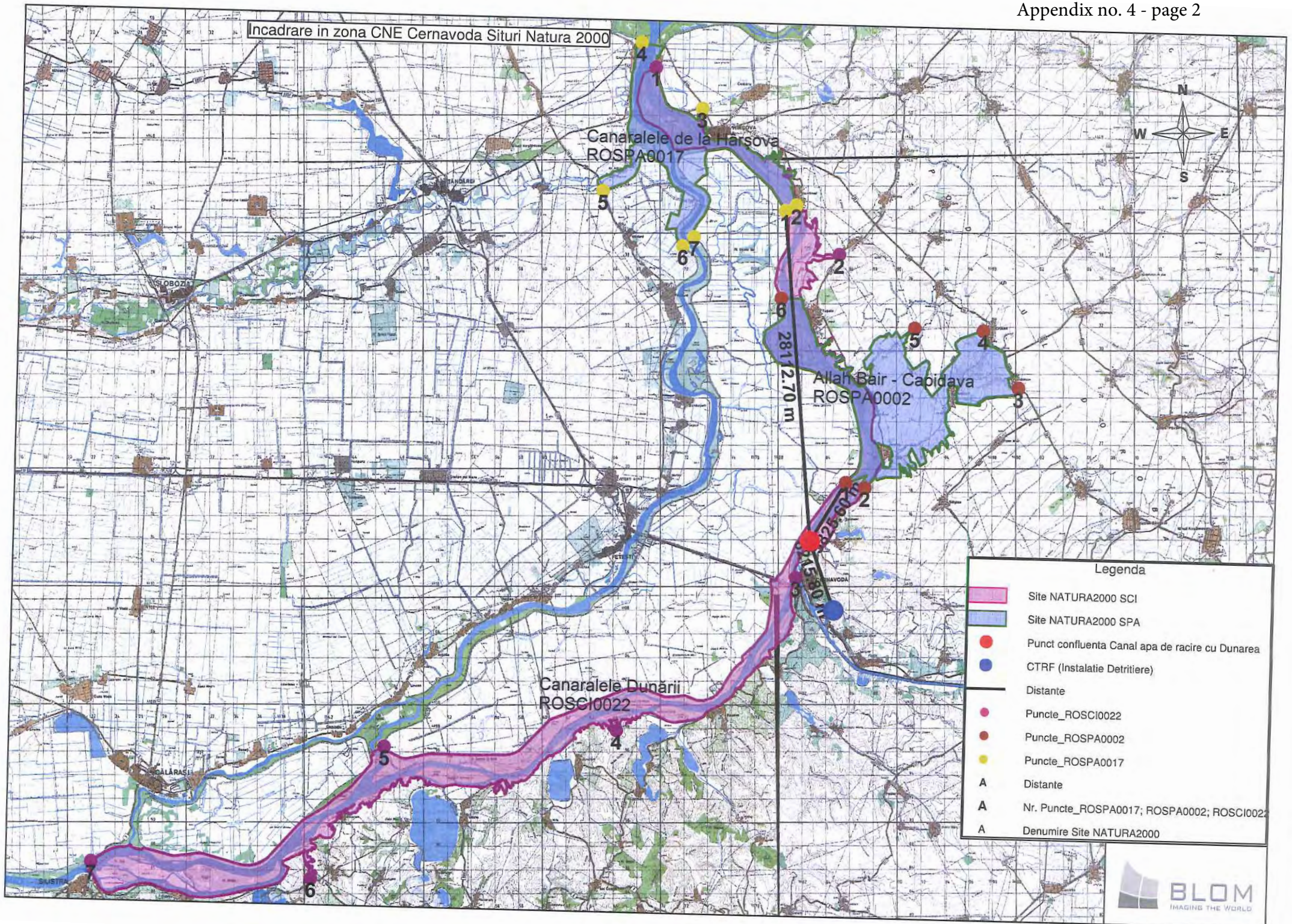
Table containing the geographical coordinates and distances between the confluence point of the cooling channel and the Danube river and the marked points on the site layout plan:

Name of the point	Name of the Site	COORDONINATES		Distance (m)
		East	North	
Confluence point of the cooling channel with the Danube river	ROSCI0022	742188.06	323842.68	
CTRF (Cernavoda Tritium Removal Facility )		744312.79	318001.31	6216
1	ROSPA0017	739452.41	351821.99	28113
2	ROSPA0017	740376.73	352318.81	28534
3	ROSPA0017	732237.94	360324.56	37815
4	ROSPA0017	726988.50	365799.00	44625
5	ROSPA0017	723991.69	353137.44	34486
6	ROSPA0017	730846.43	348625.82	27255
7	ROSPA0017	731782.73	349419.64	27613
1	ROSPA0002	745101.19	328887.66	5826
2	ROSPA0002	746721.80	328484.69	6489
3	ROSPA0002	759467.25	337228.16	21857
4	ROSPA0002	756397.06	342053.56	23098
5	ROSPA0002	750609.06	342127.09	20130
6	ROSPA0002	739291.06	344408.82	20769
1	ROSCI0022	728252.37	363729.70	42251
2	ROSCI0022	744093.07	348227.98	24460
3	ROSCI0022	741068.42	320705.24	3331
4	ROSCI0022	726222.42	307358.17	22949
5	ROSCI0022	706641.04	305511.47	39995
6	ROSCI0022	700682.67	294186.17	51012
7	ROSCI0022	682175.33	295213.10	66492

Endorsed by:  
S.C. BLOM ROMANIA SRL

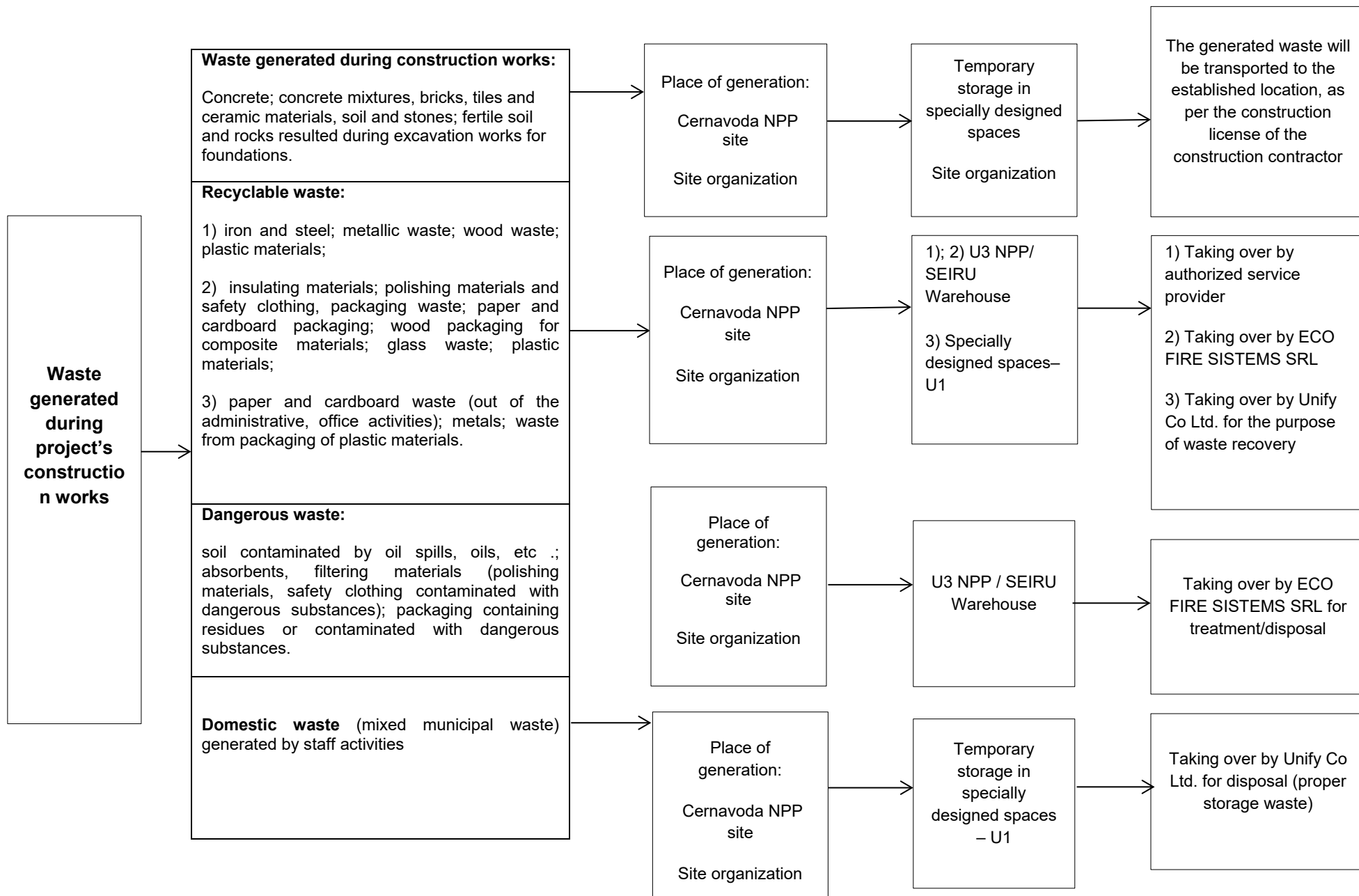




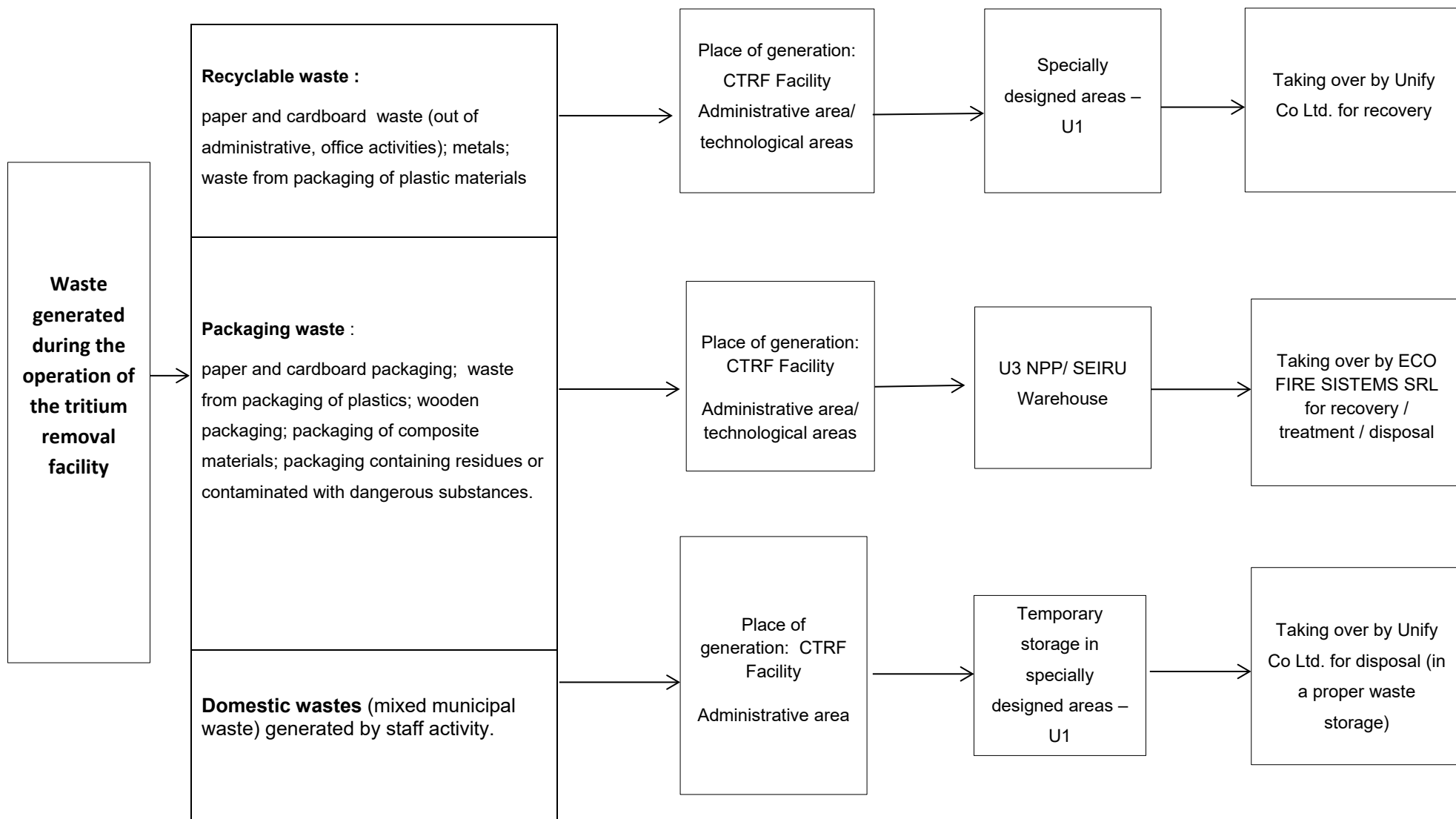




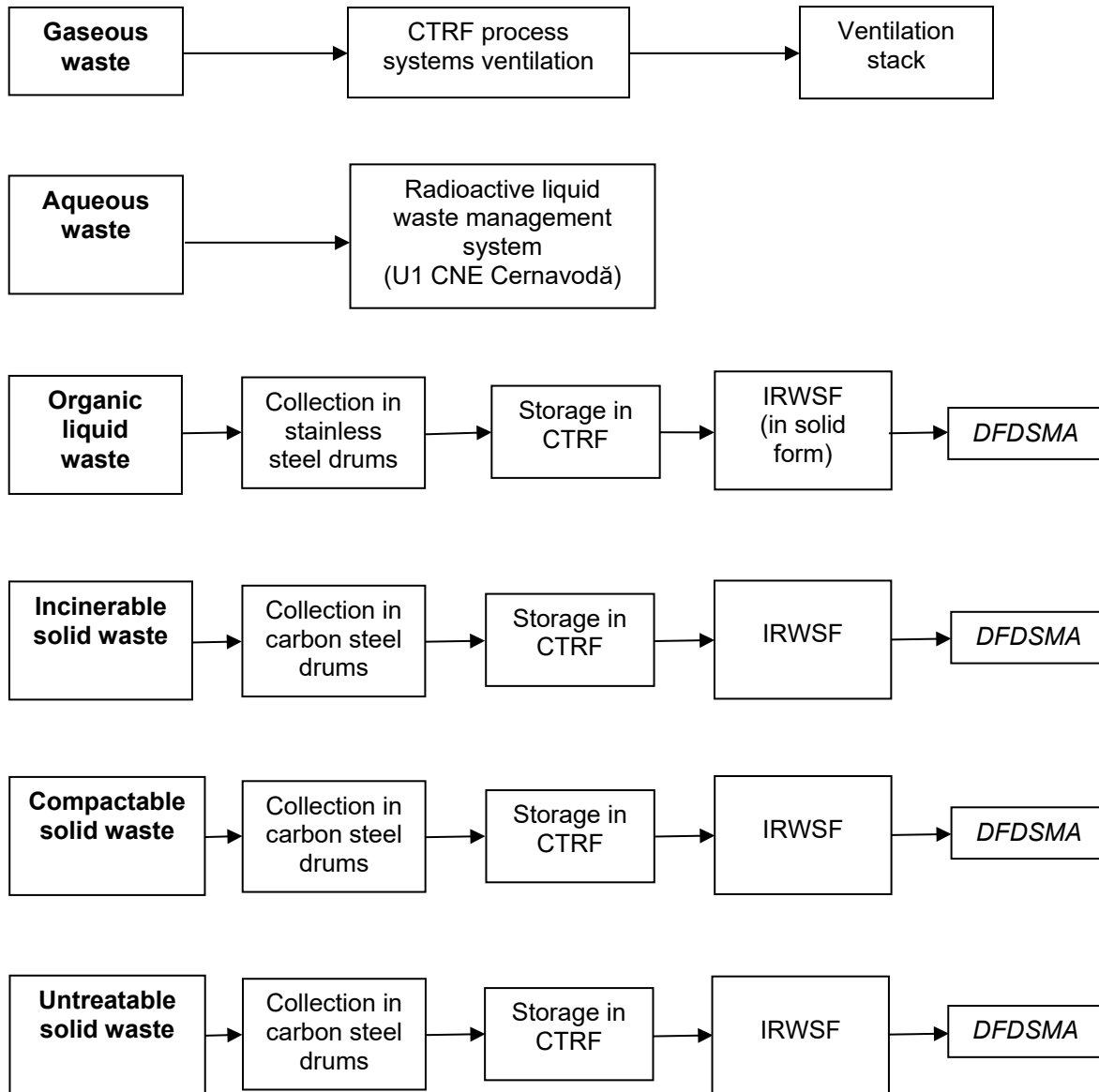
Nonradioactive waste generated during construction works of the tritium removal facility (CTRF) - management flow chart



Nonradioactive waste generated during tritium removal facility's operation period - management flow chart



**Management of radioactive waste generated during CTRF operation Flow chart  
(part of the radioactive waste management system on the  
Cernavoda NPP platform)**



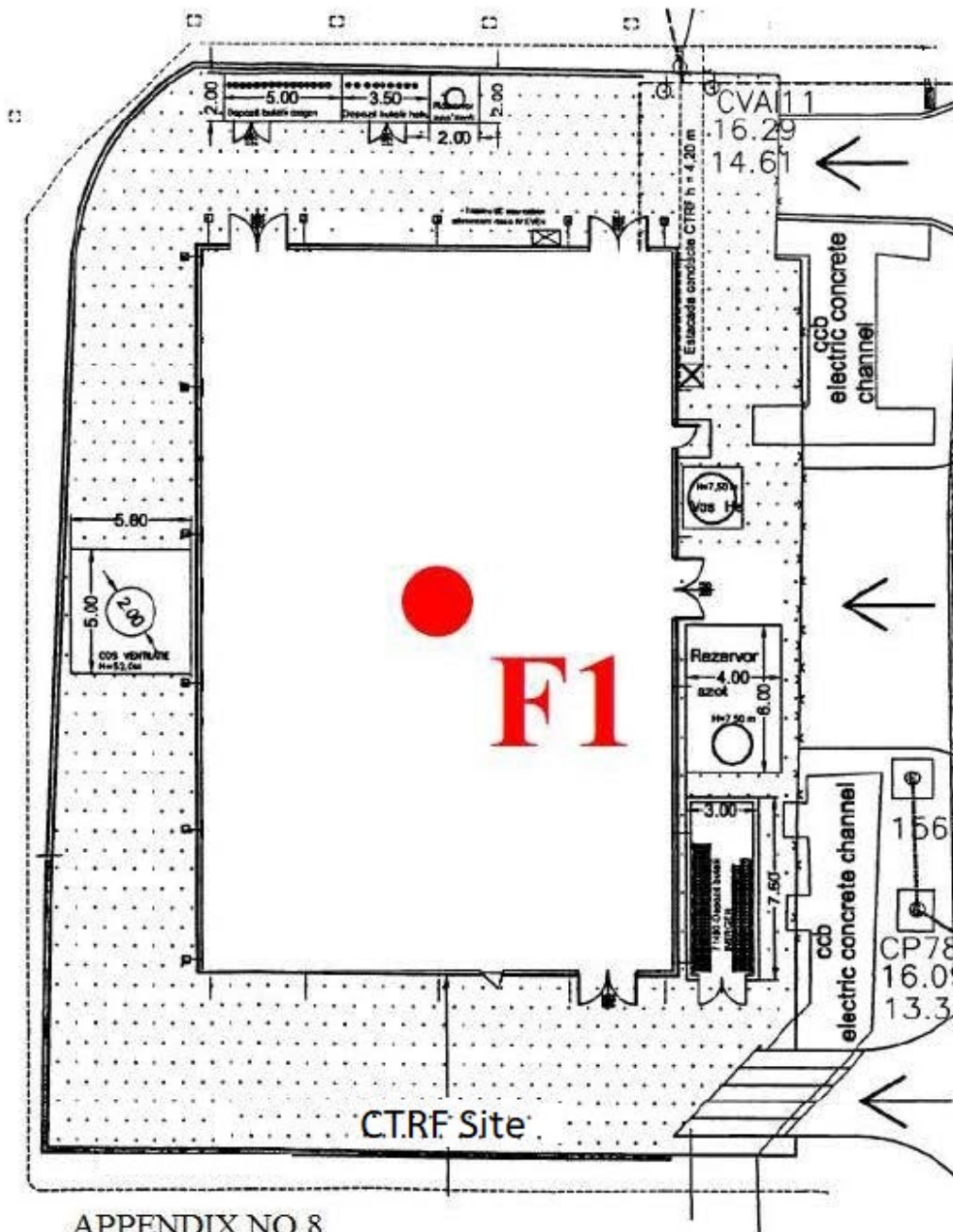
**LEGENDĂ:**

DFDSMA = Low and Intermediate level waste Repository

IRWSF - CNE Cernavoda- Intermediate Radioactive Waste Storage Facility

CTRF = Cernavoda Tritium Removal Facility

*Nota\*: DFDSMA is a future project in the National Strategy for spent fuel and radioactive waste management – Nuclear Agency and for Radioactive Waste (ANDR)*



APPENDIX NO.8  
 SITUATION PLAN WITH THE  
 POSITIONING OF THE F1 DRILLING