CEPSTRA GR(O)UP *www.cepstra.ro*	**SC CEPSTRA GRUP SRL** *15 Prof.dr. Anibal Teohari Street,* *Sector 5, Code 050674* Bucharest	
	CIF: RO 13878330 J40/4694/2001 ***Tel:*** *+40372902955* ***Fax****: +4021- 410.40 86* ***E-mail****: office@cepstra.ro*	Certification **TÜV***:* ***ENVIRONMENTAL ENGINEERING SERVICES***

TECHNICAL MEMORANDUM

CONSTRUCTION WORKS FOR CERNAVODA NPP TRITIUM REMOVAL FACILITY

Documentation for

the environmental regulatory&control authorities

Revision 0

JUNE 2013

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TECHNICAL MEMORANDUM

I. PROJECT NAME

"Construction Works for Cernavoda NPP Tritium Removal Facility"

II. OWNER

Company Name : Nuclearelectrica National Company SA (SNN-SA) – Cernavodă NPP Branch

Mailing Address:

- SNN-SA - head office: 65 Polonă Street, Sector 1, 010494 Bucharest
- Cernavodă NPP Branch: 2 Medgidiei Street, 905200 Cernavodă, Constanța County

a) **Phone, fax, e-mail and website address**:

- phone +40 21 2038200; fax: 021 3169400 email: office@nuclearelectrica.ro; http://www.nuclearelectrica.ro
- phone 0241 801001; fax: 0241 239266; email: mciorciog@cne.ro ; http://www.cne.ro;

b) **Legal representatives/mandataries, identification data**: Mrs. Daniela Lulache - General Manager SNN-SA, email: office@nuclearelectrica.ro; phone: +4021 2038200; fax: +4021 3169400 and Mr. Ionel BUCUR, PhD – Cernavoda NPP Manager; email: mciorciog@cne.ro ; phone: +40241 801001; fax: +40241 239266

c) **Responsible for environmental protection**: Cernavoda NPP Environment Management Group Coordinator - Irina Florența MARIN; email: fmarin@cne.ro; phone: +40241 801505; fax: +40241 239266.

III. Project Description

III.1. Project Summary

Cernavoda NPP Tritium Removal Facility (briefed within the document as CTRF) will be built in order to reduce the concentration of tritium in heavy water used in Cernavoda NPP Unit 1 and Unit2. Detritiation Method Principle of the Project consists in removing tritium from heavy water (DTO) by using a combination of a liquid catalytic isotopic exchange (LPCE-Liquid Phase Catalytic Exchange) and cryogenic distillation.

Schematically, the main processes that occur within CTRF facility, in order to reduce the tritium content in heavy water and to separate tritium (T_2) for storage, are:

- Gaseous flow of Tritiated Deuterium (TD), resulted from the catalytic isotopic exchange between tritiated heavy water and deuterium in LPCE system, is passed through a Purification- Drying system, where traces of heavy water vapours (DTO) and foreign gases are retained, and then the purified flow is transferred to the first column of the Cryogenic Distillation System.

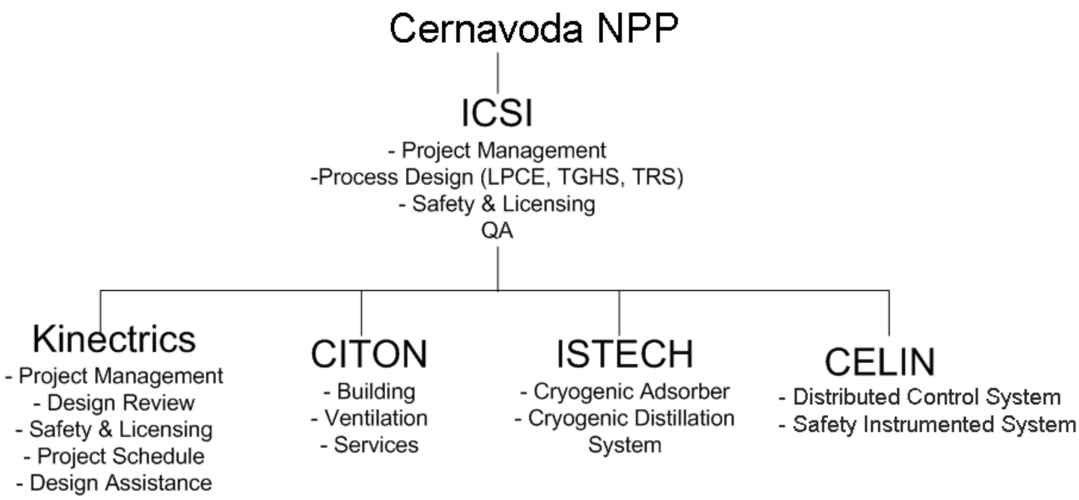
- Deuterium gas (D2) and tritium gas (T_2) are separated by passing through the columns of the Cryogenic Distillation System, which are placed in a cold chamber (cold-box) which provides thermal insulation required to maintain cryogenic temperatures of the process (~ 25 K). T_2 is extracted at the basis of the last column of cryogenic distillation and transferred to the Tritium Storage System placed in a Box, where tritium is immobilized on a bed of spongy Titanium. Detriatiated deuterium gas (D_2) resulting from the first cryogenic distillation column is recirculated to LPCE.

The Project consists of building up the entire Tritium removal facility and other auxiliaries required for handling and storage of process products, as well as special instrumentation and control systems used for plant operation purpose as well as effluents monitoring and control, facilities for preventing and extinguishing fires and other utilities as water supply, sewer system and electricity.

Project implementation mainly consists of: construction phase, installation of equipment, technological tests, commissioning and operation. Project implementation requires first obtaining all agreements, licenses, approvals and/or authorizations required by applicable laws.

To manage the project design phase, the owner, SNN-SA Cernavoda NPP is going to name a Consortium of specialized companies (referred to as MT-Management Team) able to provide the required experience gained in previous construction and operation of similar facilities **(OPEX-Operating Experience)**. It is expected that the MT will cover all fields and specialities required for the technical design and project implementation in order to enable CTRF safe operation according to up to date standards and legal requirements of the National Commission for Nuclear Activities Control (CNCAN), Ministry of Environment and Climate Change (MMSC), European Union (EU), and the International Atomic Energy Agency in Vienna (IAEA).

Fig. III.1-1 Project Consortium (design phase)



For Project implementation, the following are taken into account:

- ICSI operates a heavy water tritium removal facility at pilot experimental level which has been approved for the commissioning phase and is due to be reassessed according to the latest safety requirements;
- AECL owns a research facility at Chalk River where it demonstrates heavy water tritium removal technology at experimental pilot level;
- Heavy water tritium removal facilities are currently under operation at Darlington NPP-Canada (DTRF) and Wolsong NPP- Korea (WTRF);
- Kinectrics Canada has the expertise to manage design phase of the Project at Cernavoda NPP based on the authorization, design, construction and commissioning phases expertise on similar installations at DTRF and WTRF;
- CITON Bucharest- design company, which has expertise as general designer of the facility from ICSI and as designer of most systems in Cernavoda NPP U1 and U2.

For the construction phase of the facility, the selection of companies with expertise in the field will be considered.

III.2. Justification for the need to have the project

S.N. Nuclearelectrica Cernavoda NPP currently has two units- CANDU type, Unit 1 being under commercial operation since December, 2nd 1996 and Unit 2 since October 2007, each unit with 2061.4 MWt thermal power, generating about 706.5 MWe

The project **"*Construction works for Cernavoda NPP Tritium Removal Facility*"** represent the materialisation of long-term concerns of Cernavoda NPP to reduce occupational exposure to tritium of own staff and contractors, and also to reduce tritium discharges by effluents, with a positive impact on population and environment.

Therefore, implementation of the CTRF Project has a positive environmental impact due to its role of significantly reducing total tritium inventory from the CANDU type NPP.

The entire quantity of tritium in a CANDU reactor is formed in heavy water by deuterium neutron capture (D_2), resulting in the tritiated heavy water (DTO). Under normal operation of a CANDU reactor, the concentration of tritium formed in heavy water (used in nuclear systems as moderator and cooling agent) increases up to a steady state, where the formation of tritium is balanced by its radioactive disintegration.

For typical CANDU reactor-6, the steady state level of tritium is reached after two thirds of the reactor cycle life. With CTRF operation the value of tritium concentration would be reduced from 80-90 Ci/kg to about 10 Ci/kg for the Moderator System and from about 2-2.5 Ci/kg, below this value for the Primary Heat Transport System (PHTS).

The CTRF facility will alternatively ensure tritium removal from heavy water used in nuclear systems of U1 and U2.

Another issue is also the fact that CTRF will be used for the life time extension phase of NPP Cernavoda and during the decommissioning of Unit 1 and Unit 2 of NPP Cernavoda.

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

In the drawing below the location of CTRF within Cernavoda NPP general site is shown.

Fig. III.3-1 Positioning of CTRF inside Cernavoda NPP site

Attached to this document are the Cernavoda NPP site and CTRF site, flowsheets.

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

Cernavoda NPP site is owned by National Company Nuclearelectrica SA (SNN-SA) stated by ownership Certificate M03 Series, no. 5415/25.04.2000 issued by the Ministry of Industry and Resources.

The area balance estimated for the site in which the project will be located is presented in the following table:

Tab. III.4-1 Area balance estimated for CTRF site:

Category	Area (sq m)	Percentage of occupancy (%)
CTRF Gross Area	1350	100
CTRF Built Area	591	44

Outside the CTRF building, within the Project site, will be also located installations required for the operation of the facility, of which the main systems are:

- nitrogen tank platform
- helium tank (2x3.5m)

- inergen cylinders warehouse
- oxygen cylinders warehouse
- helium cylinders warehouse
- demineralized water tank
- ventilation stack (with a height of approx. 50m)
- instrumental air tank platform
- medium voltage transformers.

The carriageway/foundation of the site will be a concrete platform throughout. The concrete platform will be made by ballast, crushed stone, sand, Kraft paper and cement concrete.

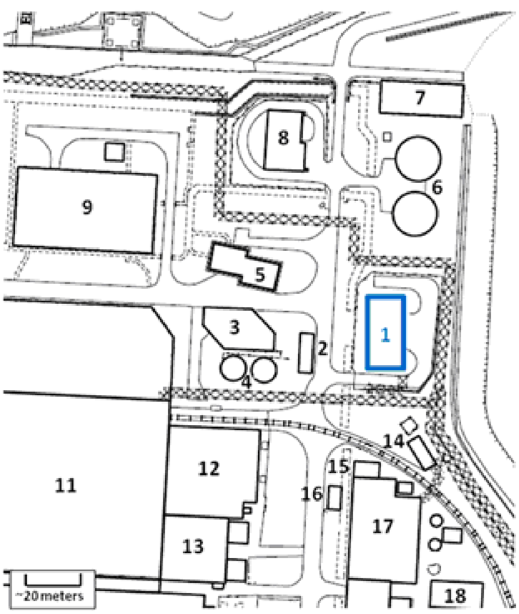
According to NTP P100-1/2006, table 4.2, page 88, CTRF building is classified as class-I importance and in accordance with Law no 10/1995 and Government Decision no 766/1997 is classified as class A – exceptional importance. According to STAS 10100/0-75, the structure belongs to importance class-I.

CTRF building construction with a height of about 25 m, falls into the category of production and storage buildings, seismically qualified DBE. The building will have a concrete slab foundation type C16/20, and the basement will be a rigid structure with resistance elements (walls, pillars, beams and floor) of class C25/30 concrete.

The building will be on layered metal structure developed on levels, the resistance elements being of welded thick steel sheet floors and floors will be of concrete class C25/30. Exterior closures will be executed according to the class of importance, the degree of protection from fire and explosion, either of brick, ROMPAN type panels or explosion panels.

In the drawing below, the division into zones of the construction is presented schematically.

Fig. III.4-1 Construction zoning. Connections



1. Planned CTRF Site / Amplasamentul Instalatiei de Detritiere
2. Diesel Oil Pump House / Statia de Pompare Motorină
3. Diesel Oil Storage Tank / Rezervor de motorină
4. Demineralized Water Storage Tanks / Rezervoare Apă Demineralizată
5. Filter Station - Drinking Water / Staţia de Pompare Apă Potabilă
6. Drinking Water Storage Tanks / Rezervoare de Apă Potabilă
7. High Voltage Terminal Station / Staţie Eletrică
8. Technical Gases Storage / Depozit Gaze Tehnice
9. 400 KV Switchyard Area Structure
10. Station Power Supply and Station Power Supply Evacuation Area
11. Unit 1 Turbine Building / Sala Maşinilor U1
12. Class 3 Station Power Supply Building (Diesel units) / Grup Diesel Electric (U1)
13. Chilled Water System Room / Corp Răcitori U1
14. Valve Room
15. Pump House
16. Filter House
17. Steam Production Plant / Centrala Termică de Pornire
18. Diesel Power Supply

III.5. Specific elements characteristic to the proposed project:

III.5.1. Production type and capacities

Purpose of the project – design, construction-installation, commissioning and operation of a Tritium Removal Facility.

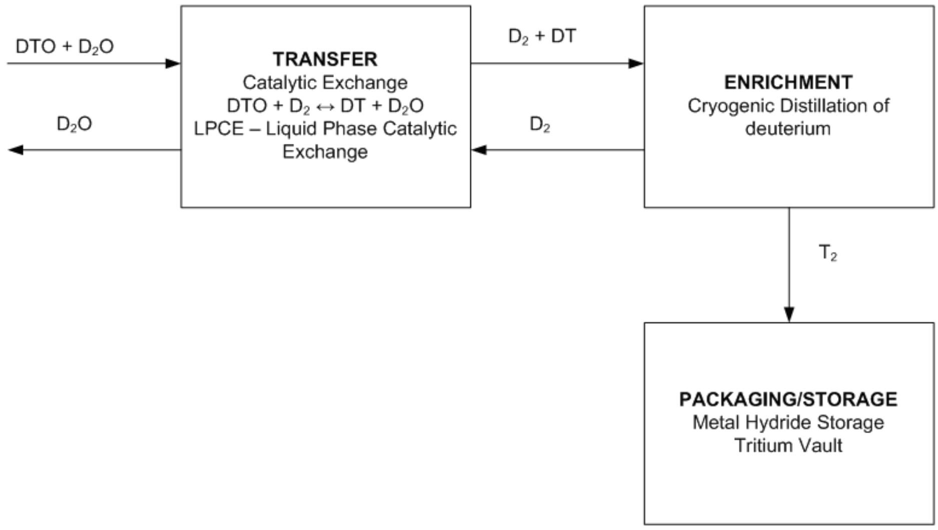
By the implementation of the project, the important contribution of tritium doses received by NPP staff will be limited by reducing tritium concentration in heavy water circuits of Unit 1 and Unit 2 at a low level, namely to 10 Ci/kg in the Moderator System and bellow 2.5 Ci/kg in the Primary Heat Transport (PHTS).

The technical solution adopted in the project is based on the catalytic isotopic exchange process in liquid phase and cryogenic distillation (known generically as LPCE CD/liquid phase catalytic exchange and cryogenic distillation). Basically, the process has three stages:

- Transfer of tritium from heavy water in gaseous phase,
- Final concentration of tritium by cryogenic distillation,
- Storing the separated tritium in a safe state, as a metal hydride.

The simplified process flowchart is shown below:

Fig. III.5-1 Simplified scheme of the process



The main characteristics of the process and capacities are:

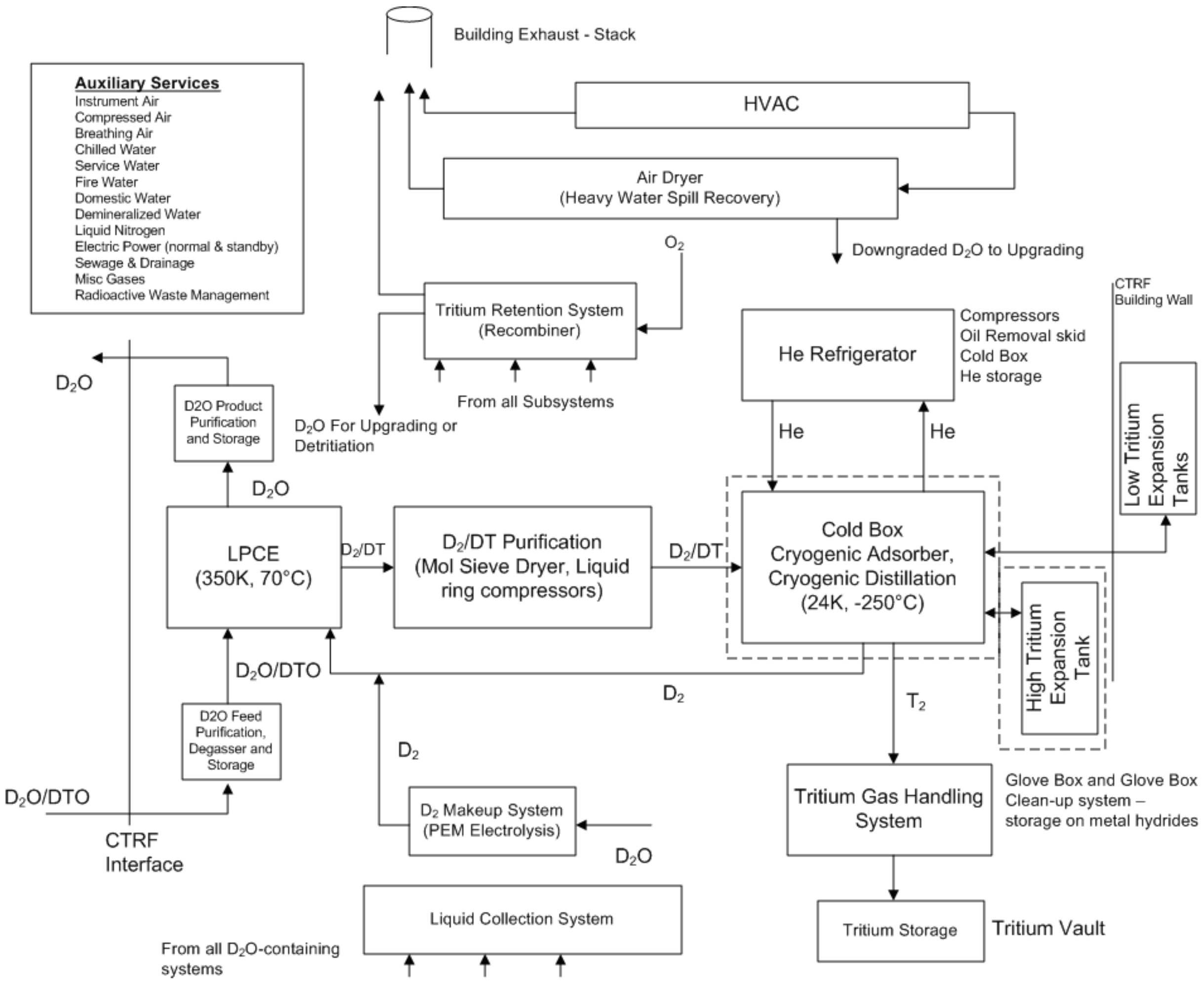
- Feed rate = 40 kg/h tritiated heavy water
- Tritium concentration in the feed = 54Ci/kg (initial feed) for the heavy water from the Moderator System, and 2.5 Ci/kg for the heavy water from the Primary Heat Transport System (PHTS)
- Detritiation factor = 100
- D_2 flow in cryogenic loop = 72 Nm^3/h
- D_2 inventory in the plant = 34 kg (approx. 203 Nm^3)
- Tritium inventory in the process = 2.83 x 10^4 TBq (approx. 34.9 g tritium)

- Tritium is drawn off in batches for storage on an ITC (Immobilized Tritium Container)
- Design service life = 40 years
- Design availability target = 80%
- The process uses high vacuum and low temperatures (< 10^{-8} torr, 25 K)
- High integrity systems with leak rates < 10^{-8} atm cc/sec helium.

III.5.2. Description of facility and on site technological flows; production processes of the proposed project, obtained products and by-products, size, capacity

The block diagram of the tritium removal facility is shown in figure below:

Fig. III.5-2 CTRF block diagram



Within CTRF, the tritium removal process flow consists of the following:

- *Storage and purification of heavy water from reactor systems,* prior to feed CTRF circuits

The tritiated heavy water from reactor systems contains mechanical impurities and dissolved chemicals (including beta-gamma active impurities, mainly from activation of corrosion products), and their removal is necessary for the operation of catalytic columns.

This purification is planned to be done in two stages:

- first in the existing system *for purification of heavy water from moderator and primary heat transport system/circuit*, and then in the *heavy water treatment system* in the nuclear plant,
- in the *system supplying the facility with tritiated heavy water (HWFS – Heavy Water Feed System)* which contains a purification unit equipped with filters and ion exchangers, and also 2 tanks of 3 m^3 each.

For continuous operation and for the separate management of heavy water inventory from NPP U1 and U2, two similar HWFSs will be constructed - one for each nuclear unit - that will be located in the Services Building of U1 and respective U2.

The CTRF supply with tritiated heavy water from the HWFS tanks is via a stainless steel pipe system, pipe-in-pipe type, under the following conditions:

- 3000 kg in campaigns
- each campaign is divided into batches of 1,000 kg of tritiated heavy water
- Tritium concentration of heavy water from Moderator System, when enter CTRF – not exceeding 54 Ci/kg.

- *Catalytic isotopic exchange*, provides tritium transfer from the liquid phase (DTO) in the gaseous phase (D_2/DT)

Hydrophobic catalytic packings allow direct contact between water and deuterium gas at the surface of the catalyst, tritium transfer taking place under controlled conditions of temperature:

$$(DTO)_l + (D_2O)_v = (DTO)_v + (D_2O)_l$$
$$(DTO)_v + (D_2)_g = (DT)_g + (D_2O)_v$$

Chemical requirements for the two process fluids are:

- Deuterium gas concentration must be not less than the deuterium concentration in the tritiated heavy water and must not contain elements that may poison the catalyst;
- The heavy water moderator must have a minimum isotopic content of 99.75% D_2O and heavy water in the primary heat transport system (PHTS) of 99% D_2; maximum heavy water conductivity is 2 μS/cm.

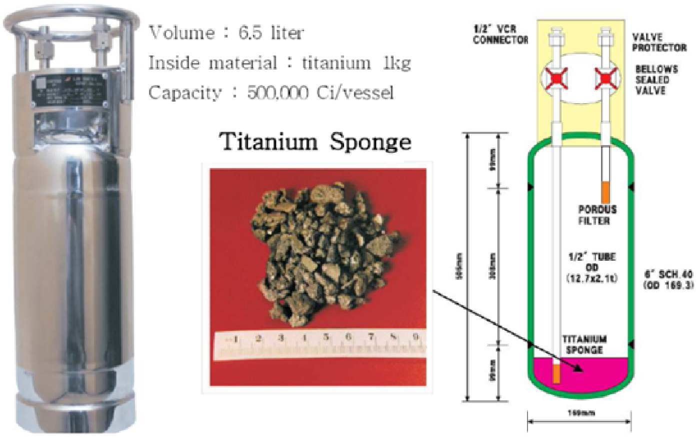
- *The purification of the gaseous flow of D_2/DT/HD*, is achieved by:
  - retention of humidity in the systems with molecular sieves (13X type), at room temperature.

- *Cryogenic distillation*, provides separation and concentration of tritium from the purified gas flow coming from LPCE, by using a cascade of cryogenic distillation columns and two types of chemical equilibrators designed to balance the deuterium-tritium mixture and to produce tritium (≥ 99.2% T_2). Also, at this stage, nitrogen and oxygen traces are removed by adsorption at low temperature, in 2 cryo-adsorbers with activated charcoal, before feeding the first column of cryogenic distillation.

- *Tritium gas storage* results in tritium (T_2) absorption on a titanium storage bed, the getter consisting in a vessel with a capacity of approximately 6.5 liters, filled with sponge titanium capable of storing 52 g of tritium containing 1 % DT in T_2 (total activity being about 500 kCi).

  To immobilize tritium, metallic sponge titanium is used, due to the low equilibrium pressure of gaseous tritium in titanium at normal storage temperature (<1 Pa at 25 °C), due to the ease of reaction between titanium and tritium at room temperature, and due to the safety in storing tritium as its release requires heating of metal tritide at high temperatures (> 400 °C).

Fig. III.5-3 Container for tritium storage on titanium bed, at WTRF-Korea



The entire amount of tritium absorbed in titanium bed totally disintegrates generating ^3He. As tritium retained on tritide disintegrates, ^3He partial pressure increases to about 6.0 MPa. The storage container can hold a total quantity of ^3He generated from tritium disintegration, and is designed to withstand a pressure of 7.4 MPa at 38 °C

- *Purification of heavy water product* (detritiated heavy water) resulting from the catalytic isotopic exchange (LPCE) aims to provide nuclear grade heavy water before it is reintroduced into the D_2O supply systems of Cernavoda NPP.

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

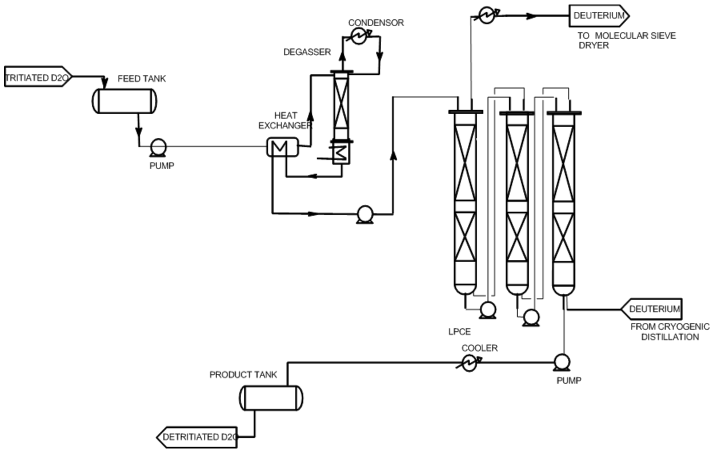
  For the separate management of detritiated heavy water inventory at units U1 and U2, there were provided two similar HWFSs - one for each nuclear unit - that will be located in the Services Building of the respective unit.

The process systems of CTRF, are structured as follows:

A) ***Three main process modules***:

- ***LPCE liquid catalytic isotopic exchange system*** is the front-end area of the installation, and has as main components:

Fig. III.5-4 Schematic diagram of isotopic exchange system - LPCE



a) Module of isotopic exchange columns (which are equipped with mix packings)
b) Module for the purification of the process gas (D_2) to supply the cryogenic distillation system (CDS)
c) module of process compressors, which provides the transfer of the process gas from LPCE to CDS
d) module of process pumps that provides heavy water circulation in the LPCE system and its return to U1, U2, after tritium removal.

LPCE inputs:

- *Tritiated heavy water* (3,000 kg in campaigns, with a maximum interval of 3 days; tritiated heavy water feed rate: 40 kg/h, tritium content - 54 Ci/Kg in heavy water moderator or maximum 5 Ci/kg in the heavy water PHT agent) – coming from the Heavy Water Purification System (HWFS) of U1 or U2

- *D_2 process gas* (72 m^3/h, t=70^{o}C) – provided by the cryogenic distillation system (CDS) by a compression system.

LPCE outputs:

- *Detritiated heavy water* (0.5 Ci / kg) - is collected at the bottom of the last column of LPCE system and passed to the heavy water product purification system HWPS, and then returns to the heavy water management systems of Unit 1 or Unit 2;

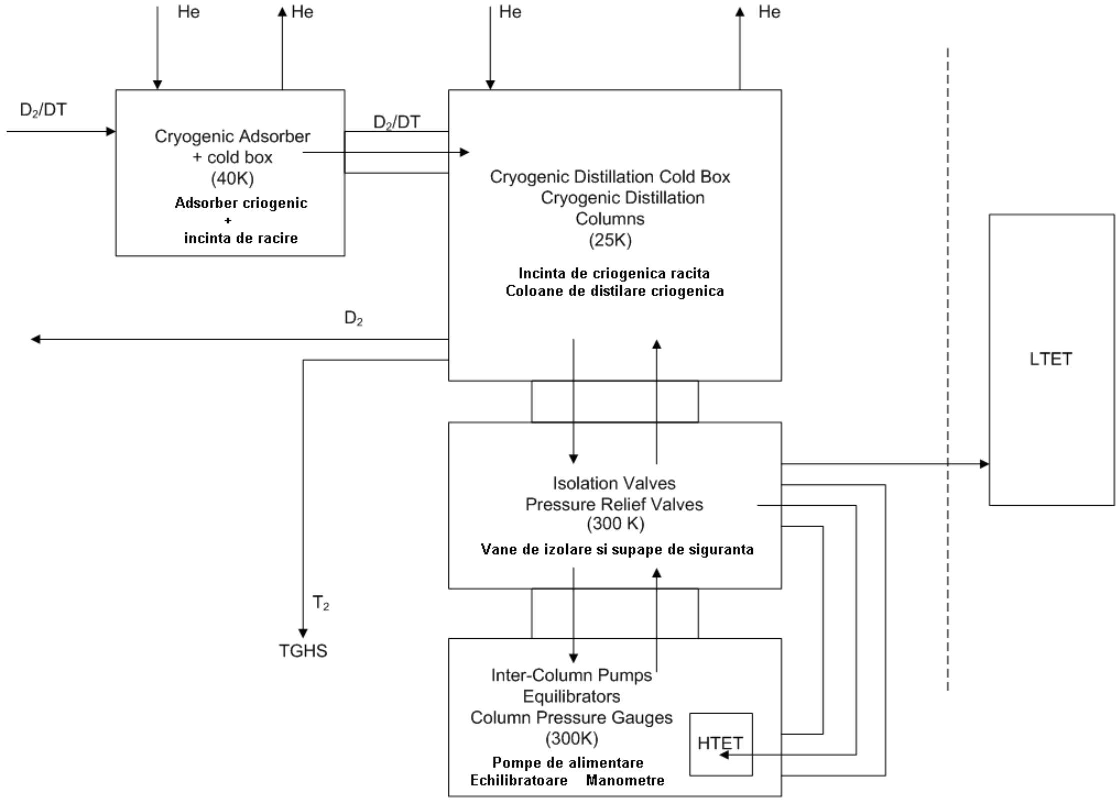
- *Tritium-enriched gas flow* (D_2/DT/HD) - is collected at the top of the first isotopic exchange column, and after a purification step (retaining humidity and any trace amounts of oxygen and nitrogen) is transferred to the cryogenic distillation system.

- ***CDS cryogenic distillation system*** is the "back-end" of the installation and consists of a cascade of cryogenic distillation columns, and a helium refrigeration unit to cool the cryogenic distillation column condensers.

CDS inputs:
- *Gas flow D_2/DT/HD*

CDS outputs:
- *tritium gas,* transferred to the tritium handling and storage system (TGHSS)
- *deuterium gas*, recirculated to LPCE.

Fig. III.5-5 Schematic diagram of cryogenic distillation system - CDS



- ***Tritium gas handling and storage system – TGHSS***, is placed in a glove-box and consists of:
- measuring tank for the specific activity of the tritium from CDS;
- containers for tritium immobilization on titanium bed (in use and in stand-by);
- container for tritium immobilization on uranium bed, used both for temporary storage of tritium or any other gas (deuterium and hydrogen) coming from any abnormal operation;
- container transfer port.

Fig. III.5-6 Tritium gas handling and storage system at WTRF-Korea

B) ***Operational support systems*** - designed to ensure the safe operation and maintenance, as well as in event of unscheduled shutdowns or failures.

- *Heating ventilation and air conditioning system* – ***HVAC*** is designed to reduce the probability of explosion in CTRF, to ensure the correct airflow between the radiological areas of CTRF and to provide an appropriate environment (ventilation and air conditioning) for the protection of personnel and equipment operation. The ventilation system comprises 5 separate mechanical ventilation systems, respectively for the areas of technological installations (hydrogen), CTRF control room, batteries room, compressors room and the areas occupied by equipment or operating personnel other than the technological areas. HVAC detailed presentation is in Chapter IV.2.2 ”*Equipment/Systems for retention and dispersion of pollutants in the atmosphere*”.

- *Atmosphere Detritiation System* - ***ADS*** - has the function to ensure minimization of tritium concentrations in the atmosphere of the rooms in CTRF building, in the area of tritiated heavy water circulation and processing. ADS is equipped with a blower to create a depression in these rooms, and by means of a catalytic recombinator, it ensures tritium vapours recovery to maintain tritium concentrations below the permitted limit at the ventilation stack. ADS detailed presentation is in Chapter IV.2.2 *”Equipment/Systems for retention and dispersion of pollutants in the atmosphere”.*

- *Tritium Retention System* – ***TRS*** - is usually in stand-by mode, entering in operation mode during maintenance, commissioning or unplanned shutdowns. The basic function of the TRS is to recover the tritium and deuterium from the deuterium and tritium processing systems; it consists of equipment, dynamic (pumps, blowers) and mechanical filters, 100% redundant. TRS detailed presentation is in Chapter IV.2.2 ”*Equipment/Systems for retention and dispersion of pollutants in the atmosphere”.*

- *Liquid Collection System* – ***LCS*** - is designed to manage the heavy water resulting from draining the installation during shutdown and maintenance intervals, either for its reuse in the process or return to the systems of U1 or U2, as appropriate. LCS consists of a system of drainage pipes (coming from the equipment containing process water - LPCE, TRS and ADS), which is connected to a collector that feeds a tank of 0.6 m^3, placed in a sump.

III.5.3. Connection to existing utility networks in the area

i) Connection to the national electricity network

CTRF will not be directly connected to the national electricity network.

CTRF electric power supply will be provided by the service transformers 5135-5135-TC01 and TC02 of Cernavoda NPP.

The installed power (Pi) of CTRF consumers is about 4789 kW.
The total power required at 6 kV class IV station of CTRF is about 3860 kVA, out of which:

- 1500 kVA for class IV Medium Voltage consumers
- 2170 kVA for class IV Low Voltage consumers
- 190 kVA for class III Low Voltage consumers

For some 0.4 kV class III essential consumers supply, when the 6 kV class IV power supply is lost, internal power supplies are provided such as Standby Diesel Generators (SDGs) and respectively Uninterruptible Power Supplies (UPS) - for a short period until the SDGs reach the nominal capacities or the installation is safely stopped. The UPSs will be enough to allow safe shutdown of the facility and maintain ventilation, hydrogen and tritium monitors, for 1 hour.

ii) Water supply/Sewerage

Water supply

Present situation

Water supply and wastewater discharge for Cernavoda NPP Units U1 and U2 are licensed by the Water Management Authorisation No. 277/30.11.2011 amended by Authorisation No. 160/07.08.2012, issued by the "Romanian Waters" National Administration (ANAR).

Drinking water for Units U1 and U2 is supplied from ground sources, through 3 deep wells - two located on site and one located in the NPP Campus.

Fj1 H= 700 m; N_{hs}=4m; N_{hd}=10m; Q= 16l/s;
Fj2 H= 700 m; N_{hs}=3.1m; N_{hd}= 5m; Q= 28.5l/s;
Fj3 H= 700 m; N_{hs}=5.17m; N_{hd}=5.92m; Q= 21.2l/s;

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

Water Supply for technological purposes
The water source for Cernavoda NPP is the Danube River – Race I of the Danube-Black Sea (DBS) Channel, through the derivation canal, providing 97% of the water required for Cernavoda NPP Units U1 and U2.

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

CTRF

a) Water supply for hygienic - sanitary purposes at CTRF

The water requirements for hygienic and sanitary purposes for staff serving CTRF (about 15 users per day) will be provided by connection to the Unit 1 water supply internal network, existing in the vicinity of CTRF.

Water will be pumped to CTRF from the system serving the Unit 1 (U1). The connection between the water supply networks of U1 and CTRF, with length of approx. 30 m and DN 50 mm will be made of HDPE pipes [1, 12].

Hot water will be prepared using local electric boilers.

During construction and installation, domestic water will be provided by existing facilities near the project site, not being necessary a new source.

b) Water supply for technological purposes

Water for technological purposes is required starting with the phase of systems technological tests and commissioning phase.

Water requirements for technological consumption – that ensures running of the **Chilled Water System** and **Cooling Water System** – refers to demineralized water produced in the existing Water Treatment Plant on site (WTP/STA - that currently serves Units U1 and U2 in operation), is as follows:

- **Demineralized water requirements 1** – for initial filling of Chilled Water System; demineralized water requirements ensures commissioning of the two redundant chillers (one active and one in reserve), located on the concrete pad on CTRF roof. The system operates continuously, in closed circuit, with 99% recirculated water flow [1, 12].

  $Q_{n\ techn\ 1\ day\ avg} = 2.7\ m^3/day = Q_{rec\ 1}$

- **Demineralized water requirements 2** – for initial filling of Cooling Water System; provides cooling of different equipments in other CTRF systems (eg. cooling the electrolyzer EL01, the helium compressors of the refrigeration unit of the Distillation System, the process compressors CP301 and CP302, the gas in cooler HX 501, the detritiated heavy water in LPCE. The system operates continuously, in closed circuit, with 99% recirculated water flow [1, 12].

  $Q_{n\ techn\ 2\ day\ avg} = 6.2\ m^3/day = Q_{rec\ 2}$

- **Demineralized water requirements 3** – for various subsequent make-ups to the consumers in the Chilled Water System BSI 71950 and in the Cooling Water System BSI 71360.

  $Q_{n\ day\ tech\ 3\ avg} = 0.025\ m^3/day = 9.125\ m^3/year$

- **Demineralized water requirements 4** – for flushing, and decontamination of equipments and components related to the Catalytic Exchange System BSI 38510, located in CTRF building.

For abnormal situations or unplanned events, the designer established a maximum flow of addition of 0.5 m^3/h. In such cases, an amount of about 6 m^3 of water has been estimated for washing/decontamination.

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

The water for technological purposes is not used during the construction and installation stage. **The water for technological purposes** will be used for technological tests and commissioning phases.

c) Firefighting Water Supply - CTRF

The CTRF firefighting water supply of will be provided via a connection to the existing firefighting water supply system of Cernavoda NPP site.

On the CTRF firefighting water distribution network, there will be installed outdoor hydrants with nominal diameter of 110 mm (HDPE pipe) - ensuring a flow of 15 l / s, and also indoor hydrants with nominal diameter of 100 mm - delivering 2.5 l/s [1, 12].

A fire hydrant H-CTRF with nominal diameter of 100 mm will be placed on the outdoor supply pipe. In case of fire from outside, firefighting water is taken from the new hydrant and also from the existing ones on the firefighting water network [1, 12].

Sewerage

Current situaţion

Currently, the non-radioactive domestic wastewater from Units U1 and U2 are discharged into the sewerage system of Cernavoda town, according to the Water Management Authorisation No. 277/30.11.2011 amended by Authorisation No. 160/07.08.2012, issued by the "Romanian Waters" National Administration.

The rainwater, including the ones, non-radioactive, coming from underground drainage, the inactive drainage from the turbine building, U1 and U2 reactors buildings, U1 and U2 SDG buildings, siphon pool 1 (2), the Start-Up Plant (CTP), the waters from flushing the mechanical filters of the Water Treatment Plant (STA), the wastewater from the oil separator, the meteoric waters washing the surface of the actual hydrogen cylinders platform, and the waters from the spraying the actual unused hydrogen tanks are discharged into the distribution basin of Cernavoda NPP.

CTRF

a) Domestic sewerage

Domestic wastewater from CTRF comes from the lavatories in the building.

The domestic sewerage system provides collection, transportation and disposal of the domestic wastewater through a connection, in separate sewerage system, into the domestic sewerage system of Unit 1, existing in the immediate vicinity of CTRF.

b) Active drainage system

The wastewater from CTRF technological area (potentially radioactive liquid wastes, including water from the firefighting system with hydrants, and water resulting from equipment decontamination) will be collected by gravity into a sealed sump in the basement of CTRF, from where these waters are pumped to the Radioactive Liquid Waste Management System of Unit 1.

The Active Drainage System of CTRF consists of a network of floor traps located in each room and of discharge ducts to the Active sewerage of CTRF. Placement of trays for inside collection of eventually indoors heavy water leaks is also taken into account.

From the sealed sump, the potentially radioactive liquid wastes are transferred in a controlled manner, by pumping into the Active Drainage System of U1 Services Building, from where they are discharged into the Liquid Waste Management System of Unit 1.
Maximum flow of wastewater that can be drawn off by CTRF Active Drains and collected into the sump is of 3.7 l / s. The sump with a capacity of 2.0 m^3 is made of reinforced concrete, protected inside with ALOREX MSN 3 and with 3 layers of epoxy enamel.

c) Pluvial sewerage
The precipitation water from CTRF and from the driveways of CTRF building will be collected, transported and discharged by an exterior connection made as a separate system, first into the pluvial drainage system of Cernavoda NPP site, which exists near to CTRF, and finally into the Cernavoda NPP distribution basin.

The precipitation water flow from CTRF is estimated at Qp = 24.85 l/s [12].

Precipitation water collection, transportation and discharge will be through a sewer with a length of approx. 50 m and a nominal diameter of 315 mm, made of tubes of polyvinyl chloride - PVC, class SN4.

iii) Providing the heating

The heating of CRTF building will be provided through the ventilation and air conditioning system and/or by using Cernavoda NPP heating system.

III.5.4. Description of the rehabilitation works of the site in the area affected by the implementation of the Project

The implementation of the project requires no ecological reconstruction works, the site being in the industrial area, within Cernavoda NPP. During the execution of construction and construction-installation works small portion of soil around the building will be affected. After completing these works, the land will be rehabilitated by ripping, topsoil and grassing over.

III.5.5. New access roads or changes of the exiting ones

Existing access roads are used. The carriageway inside CTRF will be provided as a concrete platform, throughout. The road structure of the carriageway will consist of ballast, crushed stone, sand, Kraft paper and concrete cement.

III.5.6. Natural resources used during construction and operation

The implementation of the project is done for sustainable development, in the sense that neither construction nor operation of the CTRF facility involves the use of materials from the depleting natural resources category.
The renewable natural resources used are: river stone, sand, soil (land on which the building is placed), water, air.

III.5.7. Construction methods

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

The framing of constructions, systems and components of the tritium removal facility important to safety is in security classes based on safety functions they fulfil in accordance with CNCAN Order no. 66/30.05.2003 (NMC 02) [1, ch. 2.2.2.6].

For the assessment of the foundation soil for the CTRF drillings were conducted and the results are presented in the Geotechnical Study ("CTRF-Cernavoda NPP's Location" Document code: 79-28000-SG-1199-11, April 2011) that confirms the acceptability of the installation location on this field [1, ch. 2.3.4].

III.5.8. The execution plan including the construction phase, commissioning, operation, rehabilitation and subsequent use

The implementation of the project implies:

a. Period of Implementation:
The implementation works of the CTRF project include the following phases:
- Preparing the field
- Construction/installation
- Technological test
- Commissioning.

The estimated deadline is 2018.

b. Period of operation:
- Designed operating time of CTRF is 40 years, thus providing heavy water tritium removal for the lifetime of U1 and U2.
- The operating time/year is 8000 hours.
- The outages for maintenance purposes will be less than 10 days/year for a CTRF lifetime of 40 years.

c. Decommissioning – the CTRF decommissioning documentation is prepared as required in order to obtain the construction permit from CNCAN (nuclear regulatory body) and will be revised every 5 years according to the applicable requirements for nuclear facilities (Decommissioning norms of nuclear facilities and plants – NSN 15 art.11); the decommissioning activity shall be subject to the environment assessment procedure for obtaining the Environment Agreement according to GD no.445/2009 Annex 1- List of projects subjected to the assessment of impact upon the environment item 22.

d. The subsequent reconstruction of the area – represents an activity part of decommissioning documentation and shall follow the legal provisions in force applicable to nuclear facilities/plants.

III.5.9. The relation with other existing or planned projects

CTRF facility is the result of the activity carried out within several projects that have been developed and implemented by the National Research and Development Institute for Cryogenic and Isotopic Technologies Rm. Valcea (ICSI), and culminating in the achievement within ICSI of an pilot plant for tritium removal for confirming technology data and functional characteristics of specific equipment for their use for the design of heavy water tritium removal facility used in CANDU reactors.

Thus, starting with 1996, through funding from national research, development and innovation programs, ICSI has developed tritium removal technology for heavy water used as moderator in a CANDU reactor. In the first phase, the research focused on the use of hydrogen isotopes similarity, the technology being tested for isotopic species of hydrogen and deuterium, by achieving an experimental pilot plant.

Subsequently, the Pilot Plant was converted into a Nuclear Facility, in order to verify and improve the tritium removal technology for tritiated heavy water. In 2002 works started to extend the pilot plant to enable the establishment the technology of tritium removal from heavy water. The work has been done under the Environmental Approval no. 2/15.01.2002 issued by the Ministry of Waters and Environmental Protection.

During 2002-2008, the extended Pilot Plant has been constructed based on the standards in force at the time and in accordance with the requirements of Location and Construction Authorisation no. ICSI-1/2002. Once changes in legislation were made, design changes (replacement of equipment) for compliance with PT ISCIR N SCP 1:2008 were carried out.

After the changes, the Local Environmental Protection Agency issued the Environmental Authorisation no. 32/29.01.2008 for the Experimental Pilot Plan (PESTD) in order to carry out the necessary activities for separation of tritium and deuterium (PESTD) and to establish the technology of extracting tritium from heavy water.

In 2004, by Government Decision no. 1428 on the approval of the list of special plants and facilities of national interest funded by the Ministry of Education and Research, the Pilot Plant from Rm. Valcea is included in Annex 1 - List of special plants and facilities of national interest: "Experimental Pilot Plant for Tritium and Deuterium Separation".

In the period of 2011-2012, by CRYO-HY project, funded by the Sectoral Operational Program - Increase of Economic Competitiveness 2007-2013, ICSI undertook the PESTD upgrading technology to increase technological performance; the investment was of 2.5 million Euros. Refurbishment aimed cryogenic cooling mode and consisted of:

- Replacing the cryogenic distillation column with a cascade consisting in 4 cryogenic distillation columns
- Replacement of the refrigeration system based on hydrogen and nitrogen with a more efficient system based on helium
- Installation of new equipment
- Testing and commissioning.

Currently, the Pilot Plant - PESTD is associated to EURATOM/JET (Joint European Torus programs) as a facility for studies and experiments specific for tritium removal facilities for fusion reactors, also participating in the development of projects for ITER reactor in Cadarache, France.

PESTD related activities are regulated by permits issued by CNCAN such as:

- Authorisation for location and building no. ICSI-1/2002/23.12.2002
- Authorisation for commissioning no. 10-055/21.12.2012
- Authorisation for quality management system no. 12-012/24.03.2012
- Authorisation for holding nuclear material PD/241/30.10.2012
- Authorisation – Notified Laboratory for testing LI01/18.01.2010

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

Description of the Experimental Pilot Plant for separation of tritium and deuterium at ICSI, Ramnicu Valcea

From the operational point of view, PESTD uses tritiated heavy water coming from the Cernavoda NPP that, before being transported to PESTD, is purified in the D_2O purification system of Cernavoda NPP reactor and then brought to a maximum concentration of 30 Ci/kg, in a process of dilution. Dilution is performed on Cernavoda NPP site.

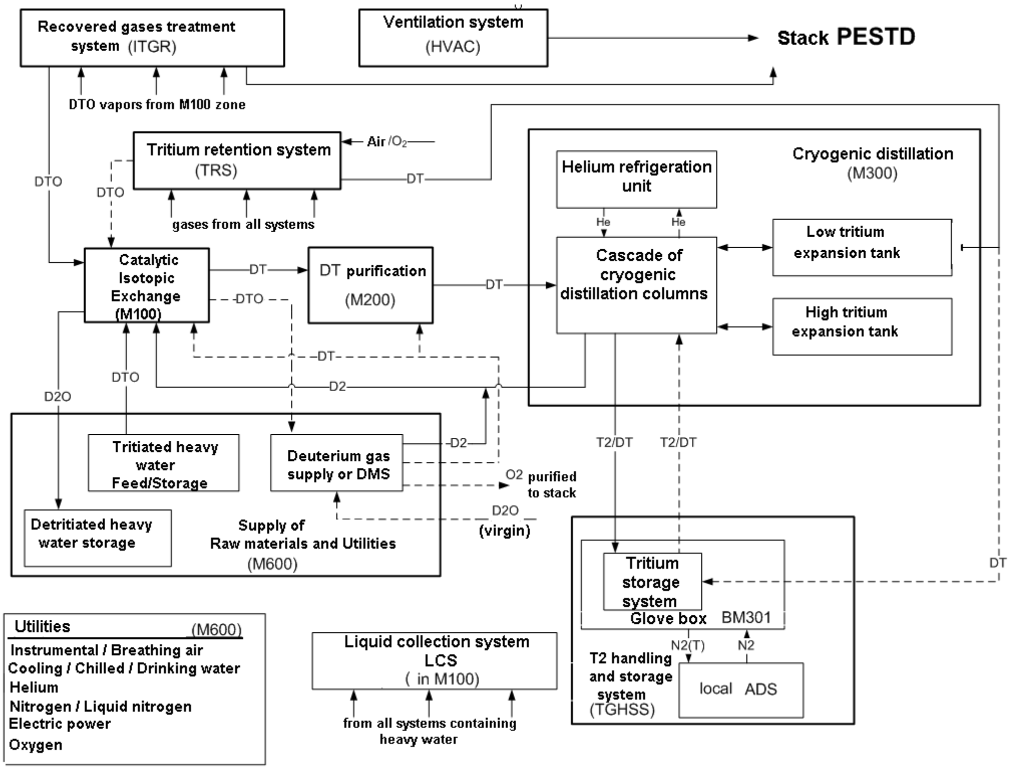
PESTD plant is designed to process a quantity of 2000 kg/year of tritiated heavy water and to hold an inventory of max. 200,000 Ci of tritium on the site.

The main characteristics of the PESTD are:

Heavy water flow	5 kg/h
Detritiation factor	3
Catalytic isotopic exchange (M100)	1 LPCE column: Ø100 mm
Cryogenic Distillation (M300)	Helium refrigerator, 1000W 4 columns cascade
Tritium storage system (TGHSS)	1 titanium storage bin 1 depleted uranium storage bin
T_2 Inventory in operation (in water and gas)	Approx. 7 g (does not include the stored tritium)
H_2 Inventory (its isotopes) in operation	Approx. 15 m^3 (gas equivalent)
Heavy water inventory [kg]	Aprox. 200 kg (max. 30 Ci/kg)
Vapour treatment system (ITGR)	Processed flow min. 100 m^3/h
Purged gas recovery system (TRS)	Processed flow min. 10 m^3/h
Deuterium production subsystem (DMS)	Produced flow min. 2 m^3/h
Ventilation system (HVAC)	10 exchanges/h

Technological process at PESTD level is shown in the schematic below:

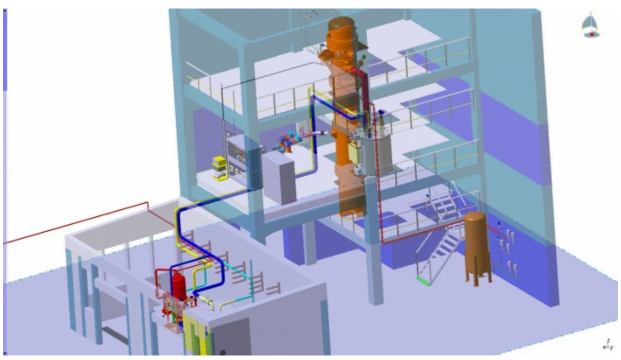
Fig. III.5-7 Flow diagram of heavy water tritium removal in the experimental pilot plant (PESTD) from ICSI – Rm. Vâlcea



Systems (referred to as modules as well), directly involved in the technological process are:

- ✓ **Catalytic Isotopic Exchange** where tritium in liquid phase is transferred (tritiated heavy water) in gaseous phase (deuterium flow). This phase takes places in **Module 100 (M100)**;
- ✓ **Purification** during which impurities from water, oxygen and nitrogen present in the deuterium flow at the output from M100 are removed. This phase takes place in **Module 200 (M200)**;

Fig. III.5-8 Cryogenic distillation module



- ✓ **Cryogenic distillation** during which separation of molecular forms of hydrogen isotopes (D_2, T_2) by cryogenic distillation takes place, obtaining concentrated gaseous tritium and deuterium. Tritium obtained after distillation, with a concentration of minimum 99% is extracted and stored as metallic deutero-tritides and deuterium is reintroduced in the circuit at M100. This process takes place in **Module 300 (M300)**;

- ✓ **Supplying raw and auxiliary materials** - This phase includes operations of storing gas deuterium recipients (full or empty), nitrogen and oxygen cylinders, tritiated and processed water containers and transport of all primary and auxiliary process fluids. In this system, there is also the subsystem for producing deuterium by heavy water electrolysis. This subsystem is an alternative for the use of deuterium containers for supplying the plant in different stages of operation. These activities take place in **Module 600 (M600).**
- ✓ **Extracting and storing tritium** on metallic hydrides (deutro-tritides) is performed in TGHSS module (system).

III.5.10. Details on the alternatives taken into consideration

A. Process options for Cernavoda NPP tritium removal facility (CTRF)

From the analyses made on the processes applicable to implement the tritium removal facility at Cernavoda NPP, the following solutions have been identified:

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

CECE-CD solution is based on the transfer of tritium from water in the gaseous phase trough a combined process of electrolysis – catalytic isotopic exchange with a tritium final concentration by cryogenic distillation and its storage under a safe state (metallic hydride).

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

DE-CD solution consists in the transfer of tritium in gaseous phase by electrolytic dissociation of tritiated heavy water, followed by a final concentration of tritium by cryogenic distillation and its storage in a safe state (metallic hydride).

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

LPCE-CD solution is based on the transfer of tritium from water in gaseous phase through a process of catalytic isotopic exchange followed by a final concentration of tritium by cryogenic distillation and its storage in a safe stare (metallic hydride).

Based on certain criteria considering:

- The minimum risk for the personnel and environment, associated with the tritium extraction technology,
- The appropriate dimensions of the main components in relation with the available area for CTRF site at Cernavoda NPP
- The necessary process sub-systems and the appropriate dimension in terms of complexity, operability and maintainability,
- Minimum inventories and storing space of tritium and D_2O, specific problems of safety under operation and maintenance,
- The availability of utilities nearby to minimize costs
- Project licensing options,
- Estimated cost of the investment,

- Availability in Romania of specialised contractors for services, equipment manufacturing and other operational requirements,

it was decided to **implement the technology based on LPCE-CD, developed at ICSI Rm. Valcea in the pilot plant and to take benefit of operational experience (OPEX) in the tritium removal facility from Wolsong NPP (WTRF) in Korea, which uses the same technology**.

B. Options on the selection of the location where the tritium removal process will take place

For CTRF the following alternatives were taken into consideration:

- **Alternative zero: continue the operation of U1 and U2 without CTRF**

During the first decade of operation of a CANDU type NPP, this alternative does not present impact, as the requirement to reach 50 Ci/Kg of tritium to start CTRF is not achieved.

If Cernavoda NPP, having U1 under operation since 1996 and U2 since 2007, does not apply the tritium removal process of tritiated heavy water, the tritium dose rates in the nuclear systems will increase up to 90 Ci/kg for moderator heavy water, with significant effects on the reactors' indoors environment and on operation and maintenance staff.

However in the absence of tritium removal, the environment in the nuclear systems may have high levels of tritium, which will make difficult the immediate access for preventive and predictive maintenance, which may lead to the extension of the intervention and ultimately to the increase of the cost of production of electricity and heat by the nuclear process.

Although emissions of tritium will remain below the regulated limits, they will continue to grow up until reaching the values corresponding to a stationary regime in the systems of U1 and U2 reactors.

- **Tritium removal in a location different from CANDU nuclear plant (off-site)**

It involves extracting large amounts (hundreds of tons) of tritiated heavy water from the reactor systems (moderator and PHT) and transporting it to an existing unit for tritium removal. Heavy water extracted will be replaced, in the first stage, by virgin heavy water, following that, in the next stages, to be replaced by heavy water detritiated in the off-site tritium removal unit.

Advantages:

- The decrease of tritium inventory on Cernavoda NPP site.

Other related advantages:

- Avoiding the contribution which individual radiological dose of CTRF personnel would bring to the collective dose of the NPP personnel
- Avoiding the production of supplementary radioactive waste quantities beyond the ones generated by NPP units.

Disadvantages:

- Potential significant adverse environmental impact due to the movement of large amounts of radioactive material (hundreds of tons of tritiated heavy water with activity of tritium that can exceed 50 Ci/kg) both in terms of environmental, personal and population impact and the safety of that transport.
- Replacement of a large amount of tritiated heavy water to be transported to the off-site tritium removal unit involves great financial efforts associated with an equivalent amount of

virgin heavy water, therefore the considerable increase in heavy water requirement up to the fluidisation of the tritium removal process.
- Project costs would increase significantly due to the necessity of building water, sewage, fire fighting, electrical systems, etc., providing demineralised water requirements and ensuring a system for physical protection, etc, features which, in the current location, are provided from the existing facilities on Cernavoda NPP site.

Conclusion: This alternative has a potential significant negative environmental impact as shown above, with potential effects on population and environment. Additionally, as Cernavoda NPP is the only beneficiary of such a facility, the option is not financially advantageous leading to the increase of the project value with serious consequences on the operating costs and finally affecting the production price of nuclear energy.

- **Tritium removal on the site of the CANDU nuclear plant (on-site)**

Advantages:
- It uses the existing facilities for U1 and U2 related to utilities (electricity, heating, water supply, sewerage, storm water, fire fighting system) system of physical protection, short-range connection to water treatment plant, facilities for discharging radioactive contaminated wastewater, continuous supply with tritiated heavy water from NPP Units thus avoiding additional storage, the use of existing waste management system in Cernavoda NPP.
- Reduced project implementation, operation and maintenance costs both for CTRF and beneficiary – U1 and U2.

Disadvantages:
- Site organisation near U1 under operation requires special measures for avoiding any impact with the normal operation of NPP units.
- The project must be carried out so that during all phases of construction-installation, testing, commissioning and operation not to influence the activity of U1/U2.
- The project implementation shall be done according with the provisions of Construction Licence without affecting the other authorizations and licenses of Cernavoda NPP.

By analyzing the advantages / disadvantages of each option in terms of efficiency for Cernavoda NPP, through the feasibility study completed for CTRF, this solution was adopted.

Therefore, it was decided to locate the tritium removal plant on-site at Cernavoda NPP.

III.5.11. Other activities that occur as a result of the project

The feasibility study for the project mentioned tritium trading as an economic option which in future could contribute to increasing economic efficiency of the plant. At the moment, the international market for tritium has requirement for peaceful purposes, the uses being multiple: from watch/clock mechanisms (regarded in Switzerland as Environmental-friendly and safe for the population), to lighting and signalling systems on airports, and up to the advanced technologies of power production in fusion reactors. However, at this time, the decision on this issue, is not a priority for Cernavoda NPP.

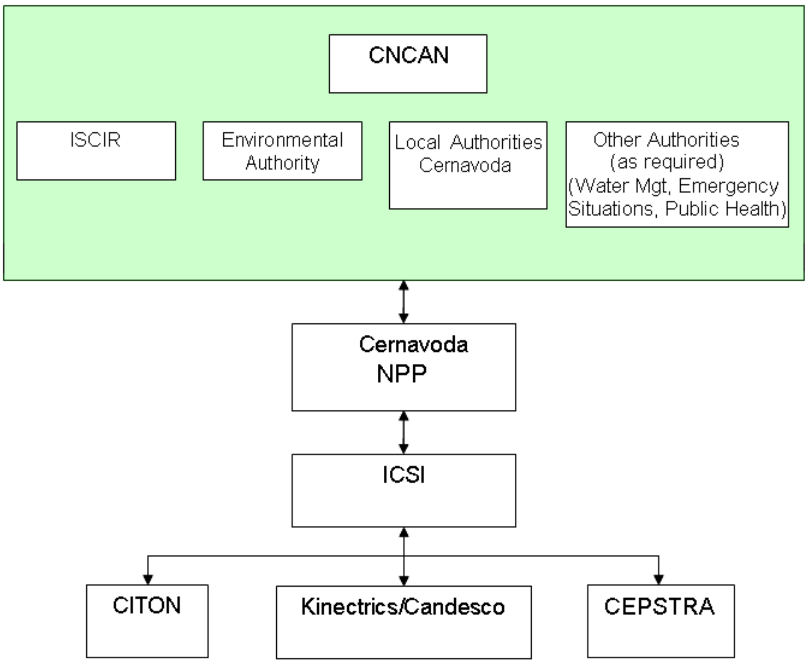
III.5.12. Other permits required for the project

As required by law, in order to obtain the License for construction for the project ***"Construction works for Cernavoda NPP Tritium Removal Facility"*** under the provisions of Law No. 111/1996 on nuclear activities (with subsequent additions and republishing), it is necessary to obtain permits, approvals, authorizations from the competent authorities, such as:

- Water Management Permit
- Natura 2000 Permit
- Sanitary Permit
- Permit issued by SC RAJA SA Constanta – county administrator of public water supply and sewarage networks
- Permit issued by the Inspectorate for Emergency Situations

The Authorities and the project consortium involved in the CTRF project authorization are presented in the following figure:

Fig. III.5-9 Authorities and the project consortium involved in the CTRF project authorization



Being classified as a nuclear installation, the project shall be authorized in accordance with Law no. 111/1996 regarding nuclear activities, the nuclear regulatory authority (CNCAN) following to issue the specific Location and Construction Authorisation to allow the construction and installation works.

Authorisation of the tritium removal plant operation and decommissioning involves other approvals, permits and specific authorizations.

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

- Emergency Ordinance no. 195/2005 on environmental protection, amended and approved by Law no. 265/2006 with subsequent amendments and completions
- Water Law No. 107/1996 with amendments and additions in force and subsequent legislation applicable
- Law no. 111/1996 with amendments and additions in force, the Norms for Radiological Safety and the Norms for Quality Management at Nuclear Objectives applicable to the design and implementation phases of the Project
- Order No. 135/76/84/1284 of 10 February 2010 approving the methodology for applying of environmental impact assessment for public and private projects
- Directive 2011/92/EU (Directive EIA) transposed by the Governmental Decision No. 445/2009 on environmental impact assessment for certain public and private projects as amended
- Governmental Emergency Ordinance No. 57/2007 on the status of natural protected areas, conservation of natural habitats, wild flora and fauna, as amended and supplemented (including Order No. 19/2010 for the approval of methodological guidelines for appropriate assessment of the potential effects of plans or projects on protected natural areas of community interest)
- Other subsequent legislation, specific to environmental protection.

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

III.6. Project location

III.6.1. Current and projected land-uses, both on site and on adjacent areas

Cernavoda Nuclear Power Plant is located in Constanta County, approx. 2 km southeast of the town of Cernavoda, approx. 1.5 km northeast of the Race 1 of the Danube-Black Sea Channel, on the land of the platform from the excavations of the former limestone quarry Ilie Barza, 44°20' north latitude and 28°01' east longitude.

The site of Cernavoda NPP is bordered on the north by Cismelei Valley, and on the South-west by the county road DJ 223.

The land inside the Cernavoda NPP, where the project will be located, is in the vicinity of Unit 1 (U1) and is limited by the slope toward the Saligny hill and by the main road in the perimeter of the NPP, which allows the access from the gate PCA1 to the Water Treatment Plant (WTP/STA), to the Start-up Plant (CTP) and continues towards the Solid Radioactive Waste Temporary Storage Facility (DIDR).Two sides of CTRF are partially bordered by an explosion proof concrete wall.

III.6.2. Zoning and land-use policies

The lands that are part of the Cernavoda NPP site shall only be used with the assent of the National Commission for Nuclear Activities Control (CNCAN) and of Cernavoda NPP.

Only constructions associated to NPP operation are allowed.

The legal status of the Cernavoda NPP site where is going to place also "Heavy water tritium removal facility" – has been established by the State Council Decree No. 31/27.01.1986 (for building Cernavoda NPP Units 1 - 5), the land being expropriated at that time.

Thus, the land is owned by SNN-SA Cernavoda NPP according to the certificate of land ownership, Series M03, No. 5415 issued by the Ministry of Industry and Resources, on 25.04.2000.

According to the Town Planning Certificate no. 221 of 11.09.2012 the land situation is as follows:

- is located within the incorporated area of Cernavoda town, according to the General Urban Plan approved by the Local Council Decision No. 25/2012;
- is in Reference Territorial Unit UTR A3 – Sub-area Production Units associated to Cernavoda NPP.

III.6.3. Sensitive areas

CTRF building and its support systems are located within Cernavoda NPP site, in the protected perimeter of U1 and U2.

Coordinates in projection Stereo 70 for installation CTRF are attached to this documentation, as requested by the Ministry of Environment in the Decision of Initial Screening Stage No. 10963/TLC/19.12.2012.

The site of the project is not located in zones, sites or areas protected by the environmental legislation in force, namely:

- MO No. 1964/2007 regarding the establishment of the protected natural area regime for the sites of Community interest, as integral part of European ecological network Natura 2000 – amended by MO No. 2387/2011
- GD No. 1284/2007 regarding the declaring of SPAs as integrated parts of Natura 2000 network in Romania - amended by GD No. 971/2011
- GEO No. 57/2007 on the status of natural protected areas, conservation of natural habitats, wild flora and fauna, as amended and supplemented, approved by Law No. 49/2011.

Some of the activities to be performed in CTRF operation are already provided by activities required for running the Units U1 and U2 (e.g. *activity of demineralised water production in the Water Treatment Plant – WTP/STA, activity of liquid effluents management and monitoring by LEM and the Radioactive Liquid Waste Management System from U1, activities of treatment, classification and intermediate storage of low and medium radioactive waste by DIDR and the Radioactive Waste Classification Laboratory*), and consequently, the potential influence area of CTRF is the same as of the Cernavoda NPP site as a whole.

After verifying the site of the project in relation to the protected areas, the project "Construction works for Cernavoda Tritium Removal Facility" falls under GD. 445/2009 on environmental impact assessment for certain public and private projects, being included in Annex. 2 point "13a) Any changes or extensions other than those listed in Annex. 1 or in this Annex, already authorized, executed or in the process of being executed, which may have significant environmental effects".

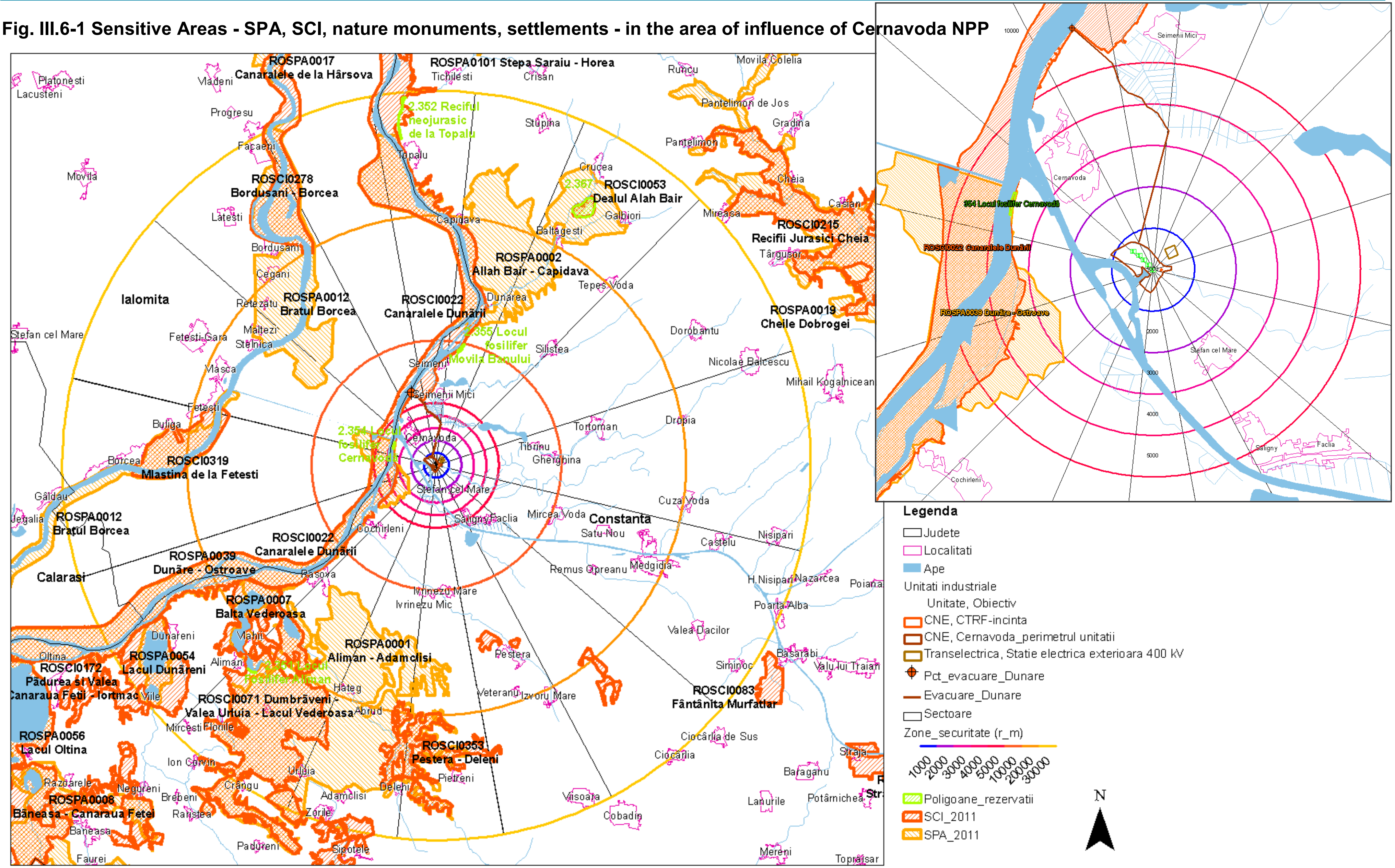
As specified by the Ministry of Environment in the Decision of Initial Screening Stage No. 10963/TLC/19.12.2012, the proposed project is subject of Art. 28 of GEO 57/2007 on the status of natural protected areas, conservation of natural habitats, wild flora and fauna - as amended and supplemented, the site being located in the vicinity of Natura 2000 sites [21, 24, 25] to be analyzed in terms of environmental impact:

- ROSCI0022 "Canaralele Dunării" – evacuation of cooling water from Cernavoda NPP in the Danube is made through a circuit made up of boxes, tunnels, an open concrete type canal and an earthen canal, with outlet/opening in Danube. The northern extremity of the protected area is at about 52 km downstream the outlet of cooling water into the Danube.

  Junction point coordinates under Stereo70 projection are: X (North) 323843 m ; Y (Est) 742188 m
- ROSPA0002 "Allah Bair – Capidava" – the southern limit of the protected area is about 6.5 km downstream the outlet of cooling water into the Danube.
- ROSPA0017 "Canaralele de la Hârşova" – the southern limit of the protected area is over 33 km downstream the outlet of cooling water into the Danube.

The figure below illustrates the location of protected areas and localities in the area of influence with a radius of 30 km of Cernavoda NPP, the sectors and security zones, offering the possibility of assessing the relative orientation and distances from the Cernavoda NPP site.

Fig. III.6-1 Sensitive Areas - SPA, SCI, nature monuments, settlements - in the area of influence of Cernavoda NPP



III.7. Aspects of the potential impact

III.7.1. Impact on population, human health

From the socio-economical point of view, project implementation has a positive impact on local development and quality of life. Outsourced effect on the environment, the Project will bring economic opportunities in the region where it is located, both during construction and during operation.

The obvious economic benefits are:

- The Project presents obvious economic and financial benefits to the population both on short and long term and also a guarantee of the continuity of the activity for SNN – SA Cernavoda NPP as : it is funded by the beneficiary, has long-term beneficial effects resulting from heavy water lowering costs and shortens the time required for maintenance access in the reactors rooms with tritium in air rate doses;
- For the design period, specialised companies with expertise in the field are required;
- During the project construction period, an average number of 400 employees from construction-installation companies will work, for approx. 5 years;
- Business growth in the area will be felt particularly in the construction sector, at the local level, for both builders and manufacturers of building materials;
- There will be twenty-six new job openings directly related to the activity during the operation period.

Regarding human health, it is stated that CTRF plant will lead to the reduction of tritium intake to doses received by the staff and the contractor, as well as tritium emissions from Cernavoda NPP units, with a positive impact on people and the environment.

Thus, it is estimated that, by CTRF commissioning and operation, the dose received by a person professionally exposed, working in U1 and U2 in areas with significant exposure to radiation is reduced by approx. 350 person * mSv/year, and respectively approx. 60 person * mSv/year.

The dose for an individual of the population due to emissions of DT or DTO (vapours) in CTRF normal operation is estimated at 2.05 µSv/year (of which 5.54 E-02 µSv/year from DT and 1.99 E +00 µSv/year from DTO), well below the dose constraint of 10 µSv/year established for CTRF by CNCAN.

However, emissions from Units U1 and U2 of Cernavoda NPP will be significantly reduced and, depending on the detritiation fraction, doses will decrease proportionately as demonstrated by existing data from a similar installation at the Nuclear Plant at Wolsong - Korea [16]. Thus calculations for emissions from Unit 1 in the year 2012, based on information from Wolsong show that if CTRF existed in 2012, according detritiation fraction of 50% or 75% dose personally of the population (4.0 µSv/year 2012) would be reduced below 1 µSv/year 2012.

III.7.2. Fauna and flora

As the project is located on Cernavoda NPP site, flora and fauna in the area will not be affected by either making or operation of the tritium removal facility.

In support of this claim are used both the expertise of the speciality national studies [23] and information obtained from practice at similar facilities from Darlington, Canada and Wolsung-core or exchange of experience (best practices) and international organizations (ex.COG - CANDU Owners Group).

Thus, considering that for Units U1 and U2 of the nuclear power plant in Wolsong - Korea was reported the reduction of total air emissions of tritium after the start of the tritium removal facility - WTRF [16], and given that potentially contaminated wastewater from CTRF technological area will not be discharged directly into the environment, it can be estimated that the normal operation of CTRF will not have a direct or indirect, short or long-term impact on flora and fauna, or a cumulative one with the potential impact of activities other than those conducted by the Cernavoda NPP.

Measurements and evaluations carried out in the Study on the impact of the operation of the nuclear power plant in Cernavoda (U1 and U2) on aquatic and terrestrial organisms from the zone of influence [23] , clearly conclude that, even in the case of relatively high values of tritium (which were highlighted in samples from a single location of all sites surveyed within a radius of 35 km around the NPP Cernavoda site, i.e. Cismelei Valley) they are well below the reference values, for which there are no environmental effects.

> *„If water, air and soil are some of the indicators of environment sensitive to the presence of nuclear target in the area of 30 km, the vegetation receives the total influence of the environment in which it grows. The average of tritium concentration in water extracted from vegetation in the area of 30 km (without the exclusion area of 1 km) was set at 7.08 +/- 0.48 Bq/kg fw for all species of vegetation analyzed, the maximum recorded in the Cismelei Valley (average of 606.62 +/- 1.89 Bq/kg fw)".* [23, ch. 4.2 Average exposure].

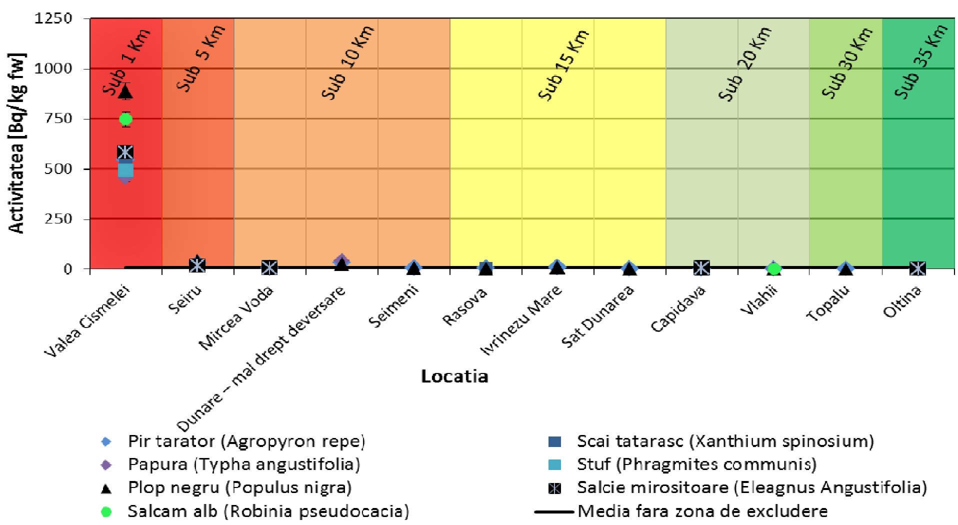


Fig. III.7-1 Mean concentrations of tritium in vegetation sampling points in correlation with the distance from Cernavoda NPP, during 2009-2011 [23, ch. 4.2, Fig. 4]

„In conclusion, in what regards the behaviour of tritium emitted through liquid and gaseous effluents by the NPP Cernavoda, the only location of those monitored in the radius of 35 km around the plant that showed a higher value compared to the usual level met in the environment is Cismelei Valley. ***The values found, however, are far from the values calculated (COG, 2006 Chouhan et al.) in a very conservative manner, in which no changes are found in the environment. A meaningful comparison is shown in Table ...*** *".*

Tab. III.7-1 Comparison between the mean concentrations measured for Cismelei Valley and the generic concentrations below which no radiation effects are expected on the environment [23, ch. 4.2, Table 1]

	Tritium Air concentration [Bq/m^3]	Tritium Soil concentration [Bq/kg fw]	Tritium Fresh Water concentration [Bq/l]	Tritium freshwater Sediment concentration [Bq/kg fw]
COG-05-3068	8.84 x 10^3	-	1.26 x 10^7	1.26 x 10^7
Cişmelei Valley	7.56 +/- 0.39 (min. 4.14 +/- 0.38 June 2011) (max. 11.23 +/- 0.54 September 2011)	22.44 +/- 0.29 (min. 16.07 +/- 0.23 August 2010) (max. 39.95 +/- 0.37 May 2010)	38.71 +/- 0.85 (min. 6.55 +/- 0.59 June 2011) (max. 93.12 +/-1.27 May 2010)	29.76 +/- 0.41 (min. 5.99 +/- 0.24 June 2011) (max. 76.90 +/- 0.72 November 2010)

III.7.3. Soil, uses and material assets

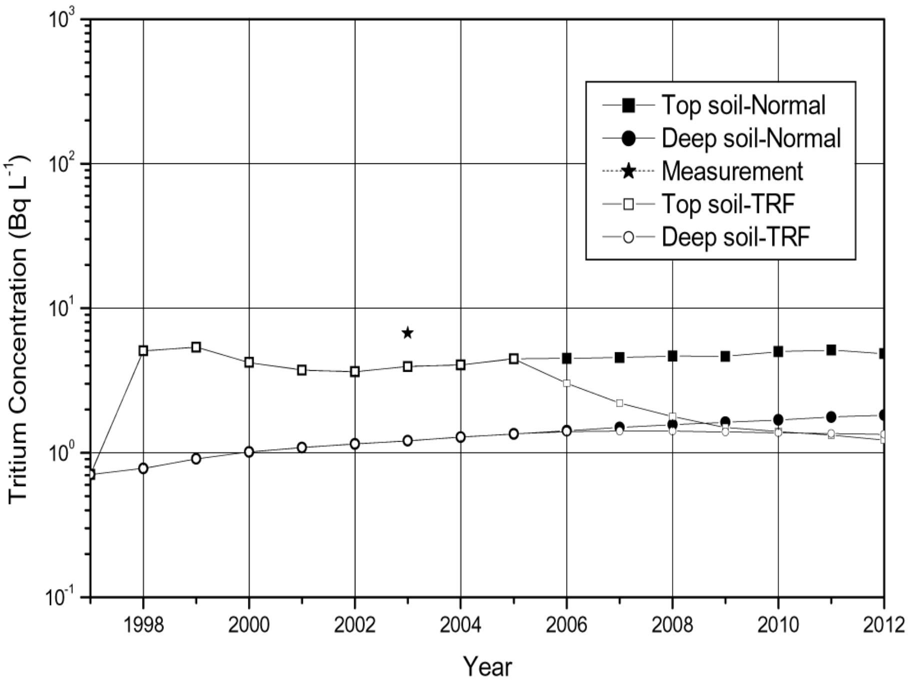
Since the project site is inside NPP Cernavoda, CTRF completion and operation is performed in the context of the site destination, which can be considered auxiliary system (support) of Unit 1 and Unit 2. Also, by the profile and nature of activities during the project operation period, the potential interactions on the soil would be due to abnormal situations with consequences on local pollution of the soil, but this option is less likely for the following reasons:

- The project provides for the protection of soil and subsoil of the site by concrete platforms.
- During the operation, the management of household and technological waste will be done according to regulations, the beneficiary, NPP Cernavoda having implemented approved procedures for handling, treatment, containment and storage of waste.
- From a constructive point of view, the facility is provided with systems to minimize any risk of leakages of fluids from circuits (sealed sumps, pipe system in the pipe, rapid intervention procedures for collecting leakage).

Compared to the above, it may be estimated that the impact of the project on the soil is insignificant.

A set of data from the literature indicates that operating a tritium removal facility would even have beneficial effects on soil due to the decrease of tritium emissions from the nuclear plant. Thus simulations for the nuclear plant in Wolsong - Korea [18] showed that by operating a tritium removal facility, the tritium concentration in interstitial water from the superior soil layer decreases rapidly, even when reducing emissions by a tenth.

Fig. III.7-2 Simulation of changes in concentrations of tritium in the top-soil and deep soil at approx. 6 km from the nuclear plant in Wolsong - Korea [18]



III.7.4. Quality and quantitative regime of water

Water supply and wastewater discharge for CTRF will be connected to the existing facilities of Cernavoda NPP Units U1 and U2, authorised, at present, by the Water Management Authorisation No. 277/30.11.2011 amended by Authorisation No. 160/07.08.2012, issued by the "Romanian Waters" National Administration (ANAR).

CTRF operation involves insignificant consumption of water for technological purposes compared to the site consumption, for CTRF being provided also, 99% recirculation of demineralized water, thus ensuring protection of water resources.

III.7.5. Air quality and climate

During construction & installation phase, the environmental factors may be influenced by the use of equipment and machinery consuming fuels (diesel, gasoline), the dust from the works performed, etc.

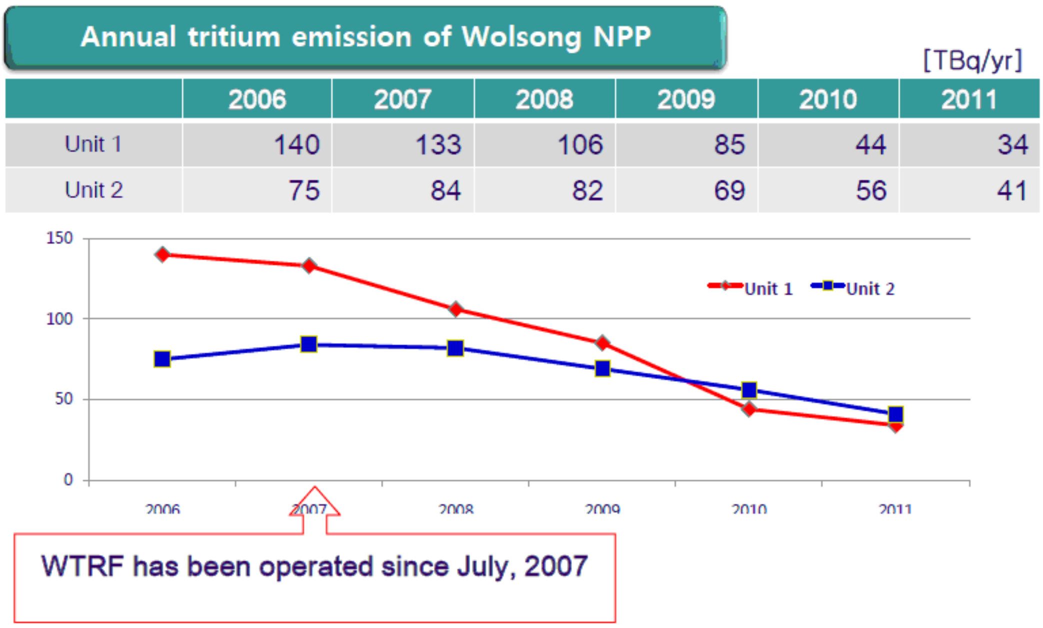
The calculations for the period of CTRF normal operation took into account stack emissions, ground level emissions or a combination of both, depending on the type of event. For estimation, the Gaussian diffusion model recommended by the CSA Standard N288.2 [69] was used.

Source terms for these calculations are presented in Chapter IV.2.1 "*Air pollution sources, pollutants*".

CTRF positive environmental impact on air quality is practically demonstrated by decreases in the specific tritium activity in the releases from the Nuclear Plant in Wolsong - Korea, which were recorded after a tritium removal plant similar to CTRF [16] was commissioned.

Thus, with a total running time of the tritium removal facility of approximately 130 hours between 2008 to 2011 a decrease of approx. 75% in the emissions from Unit 1 and 50% in emissions from Unit 2 of the nuclear Power Plant in Wolsong was recorded.

Fig. III.7-3 Reduction of total annual emissions of tritium from nuclear power units in Wolsong - Korea as a result of the commissioning of the tritium removal plant [16]



Similarly, it can be estimated that if Cernavoda NPP had a tritium removal facility, even in the conditions of ensuring just a fraction of detritiation of only 50%, tritium emissions (and thus doses to the population) would have been much lower, as shown in the following table

Tab. III.7-2 Annual emissions of tritium from Cernavoda NPP Unit 1 - actual vs. estimate

[TBq/an]

U1	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Actual emissions	**50.8**	**85.3**	**208**	**180**	**286**	**171**	**198**	**246**	**350**	**250**	**274**	**451**	**249**	**140**	**301**
Estimated emissions (50% fraction of detritiation)	**25.4**	**42.7**	**104**	**89.8**	**143**	**85.5**	**99.1**	**123**	**175**	**125**	**137**	**226**	**125**	**69.9**	**150**

Normal operation of CTRF does not generate greenhouse gas emissions (CO_2, CH_4, HFC, PFC, N_2O, SF_6).

The normal operation of CTRF will not generate acidifying air pollutants, tropospheric ozone and ozone precursors or particulate matter (SO_2, NOx, CO, O_3, heavy metals, polycyclic aromatic hydrocarbons - PAH, volatile organic compounds - VOCs, particulate matter – fractions PM10, PM2.5).

The bellow shows the classification in terms of air quality, of the localities Cernavoda and Saligny, according to MO No. 1269/2008 for the approval of Region 2 localities classification lists. The concentration levels of regulated pollutants on ambient air quality were below the limit values.

Tab. III.7-3 Classification in terms of air quality of localities Cernavoda and Saligny, according to MO No. 1269/2008

Pollutant	Averaging Interval	Lower Assessment Threshold	Upper Assessment Threshold	Limit Value	Classification according to MO 1269/2008 (**)
		ug/m^3			
NO_2	1 hour	100	140	**200**	List 3 Sub-list 3.1
	year	26	32	**40**	
PM_{10}	day	20 (25 *)	30 (35*)	**50**	List 3 Sub-list 3.1
	year	10 (20 *)	14 (28*)	**40**	
SO_2	1 hour	-	-	**350**	List 3 Sub-list 3.3
	day	50	75	**125**	
CO	max. of daily 8h running avg	5 000	7 000	**10 000**	List 3 Sub-list 3.3
Pb	year	0.25	0.35	**0.5**	List 3 Sub-list 3.3
C_6H_6	year	2	3.5	**5**	List 3 Sub-list 3.3

Note
(*) In 2008, the thresholds and limit values were established by MO No. 592/2002. Currently, for these regulated pollutants, Law No. 104/2011 amended only the upper and lower assessment thresholds for PM10 indicator.
(**) List 3 Sub-list 3.1 - Zones in which the levels of one or more pollutants are lower than the limit values, ranging between this and the upper assessment threshold
List 3 Sub-list 3.3 - in which the levels of one or more pollutants are lower than the limit values, not exceeding the lower assessment threshold

For the project, since support activities such as the periodically running the Standby Diesel Groups for testing purposes, and respectively the on-site traffic, are characterized by low value, short-term and discontinuous emissions, it is considered that the CTRF normal operation will have an insignificant impact on air quality outside the perimeter of Cernavoda NPP.

It is estimated that under normal operating conditions, CTRF will not influence the meteorological parameters, so there will be no effect on the microclimate in the area of Cernavoda NPP.

III.7.6. Noise and vibrations

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

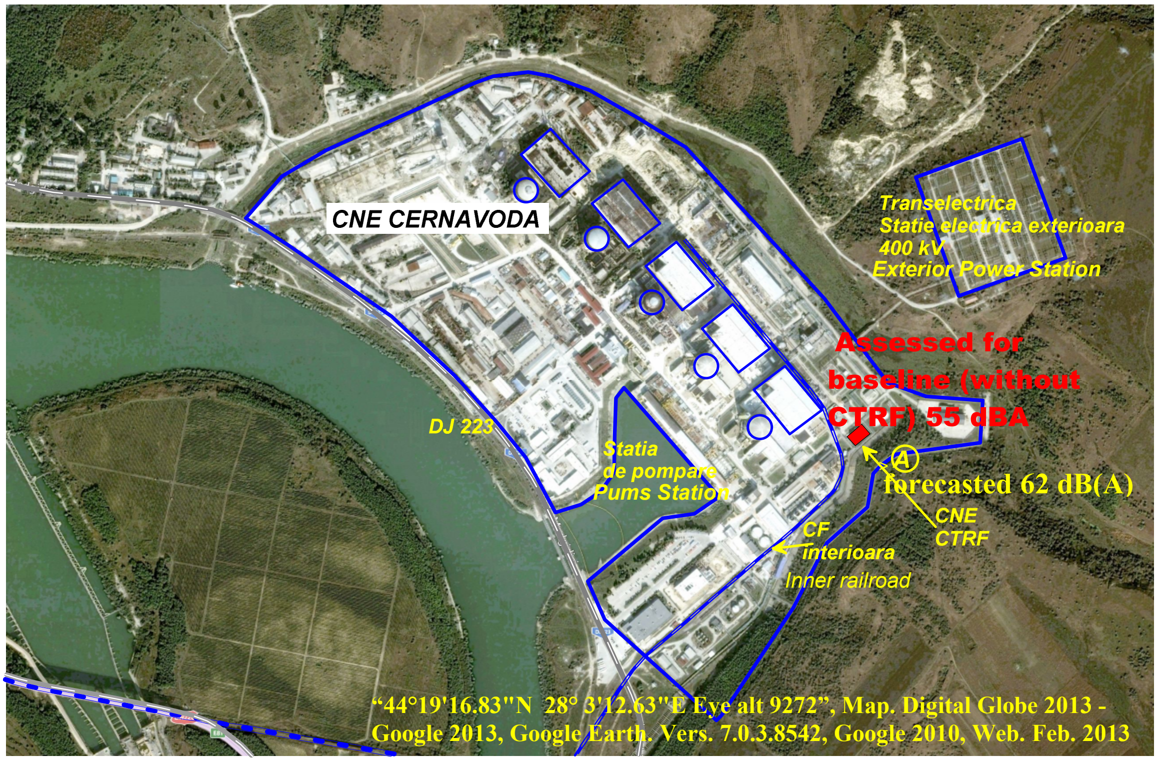
In accordance with STAS 10009-88, for the an enterprise located in an industrial area, the equivalent continuous A-weighted sound pressure levels, must be lower than the permitted limit of 65 dB (A).

Most noise sources within Cernavoda NPP site are located at more than 20 m inward from the site boundary (fence that borders the territory of the plant). The forecasted noise levels are at least 3 dB (A) lower than the limit of 65 dB (A) settled by legislation.

The zone designated for CTRF location is an area where the noise level at the enclosure limit is of about 55 dB (A) - corresponding to the absence of CTRF (baseline). By the planned endowment, CTRF will not contribute with more than 60 dB (A) at the boundary of the enclosure (point A in Fig. III.7-4), which implies a resultant level of about 62 dB (A).

Under these circumstances, it is considered that the acoustic impact of CTRF implementation will not generate an exceedance of the limit settled by the law.

Fig. III.7-4 Noise levels estimated for the baseline (without CTRF) and for the final stage (with CTRF)



III.7.7. Landscape and visual environment

Around the site, the landscape and visual environment are those characteristic to industrial platforms, having dispersion stacks, production related buildings and headquarters of NPP Cernavoda (offices, workshops and laboratories), etc.

The project envisages implementation of quality exterior finishes, in harmonized colours, to the existing buildings. Through these works the project will have a direct and positive contribution to improving the landscape and visual environment in the area.

III.7.8. Historical and cultural heritage

Given the location of the project in Cernavoda NPP site and through the role of reducing tritium emissions from NPP Cernavoda, under operating conditions to the designed parameters, CTRF facility will not have an impact on the historical and cultural heritage of the area.

III.7.9. Measures to prevent, reduce or improve the significant impact on environment

Using the latest technology and incorporating international experience in the development and operation of similar facilities, the implementation of the project will produce an insignificant negative impact on the environment.

The project provides endowments and facilities for: increasing the efficiency and control of technological processes, controlling and reducing emissions, noise and vibration, soil and subsoil protection, waste management, fire protection and prevention. Details on these measures and endowments are presented in the next chapter *(IV. "Pollutions sources. Controls, discharges and dispersion of pollutants in the environment").*

III.7.10. Transboundary nature of the impact

Implementation and operation of CTRF facility does not produce any transboundary effects, the Project being located just inside the nuclear facilities it serves: Cernavoda NPP Unit 1 and Unit 2.

The systems and measures for prevention and control of emissions into the atmosphere and water, and the systems for waste and hazardous substances management, planned for CTRF, will ensure protection of the human settlements and the other objectives - protected and/or of public interest in the area.

Specific provisions related to CTRF activities shall be added to Cernavoda NPP emergency procedures.

IV. Pollutions sources. Controls, discharges and dispersion of pollutants in the environment

IV.1. Protection of water quality

IV.1.1. Water pollution sources and receivers

a) Domestic sewerage

Domestic wastewater from CTRF comes from the lavatories in the building.

The domestic sewerage system provides collection, transportation and disposal of the domestic wastewater through a connection, as separate sewerage system, into the domestic sewerage system of Unit 1, existing in the immediate vicinity of CTRF.

b) Active Drainage System

The potentially contaminated fluids from the process area of CTRF (potentially radioactive liquid wastes, including water from the firefighting system and water resulting from equipment decontamination) will be gravitationally collected into a sealed sump in the basement of CTRF, from where they are pumped out to the Radioactive Liquid Waste Management System of Unit 1.

The Active Drainage System consists of a network of floor drains located in each CTRF room and of discharge ducts to the Active sewerage of CTRF. Placement of trays for process water leakage collection is also taken into account.

c) Pluvial sewerage

The meteoric water from CTRF and from the driveways of CTRF building will be collected, transported and discharged by an exterior connection made as separate system, first into the pluvial drainage system on the Cernavoda NPP site, existing near CTRF, and finally into the Cernavoda NPP distribution basin.

Meteoric water collection, transportation and discharge will be through a sewer.

IV.1.2. Wastewater treatment/pre-treatment plants and equipment

Domestic wastewater (non-radioactive) resulting from CTRF is discharged through the sewage system of Unit 1 into the municipal sewerage system of Cernavoda, being treated in the municipal WWTP of Cernavoda before its discharge into the Danube.

IV.2. Air protection

CTRF facility is designed as a closed system, all the technological losses being collected inside it. The intake, collection and exhaust system is designed as to ensure the reduction of radiological hazard (tritium in air) both in the air from the technological areas and in the area occupied by the operating personnel (clean area) inside CTRF. ALARA principle applies to this facility (As Low as Reasonably Achievable - The lowest level reasonably practicable [33, Art. 16]) similar to the one implemented in nuclear facilities.

IV.2.1. Air pollution sources, pollutants

CTRF operation involves both stationary sources - associated to the tritium removal facility itself and to the Standby Diesel Groups, and also short-term mobile sources - supply vehicles.

The tritium removal process technology is a potential source of radioactive effluents (point source - the stack of CTRF).

Auxiliary and support activities can also generate emissions of particulate matter, volatile organic compounds (VOCs) and exhaust gases from diesel combustion in the Standby Diesel Groups, respectively from fuel combustion and resuspension of particles due to transport activities and onsite traffic.

Point sources - radioactive emissions ducted

Under normal conditions, two situations appear for CTRF:

a) **Normal Operation**, the tritium removal process of tritiated heavy water from Units U1 and U2 is carried out at nominal parameters and all CTRF systems are operational. For this situation, **the entire inventory of tritium is in a closed system, in CTRF circuits, its management being performed by controlling the temperature and pressure process (spaces with nuclear systems are maintained at a pressure lower than normal, thus preventing any potential accidental releases of radioactivity to the outside).** Tritium inventory of CTRF under normal operation is shown in the table below:

Tab. IV.2-1 Tritium inventory in CTRF systems/components in operation

Location zone	Type/form	Estimated tritium inventories	
		DT (Bq)	DTO (Bq)
Chamber for containers with tritiated or detritiated heavy water	Tritiated heavy water	-	7,992E+15
	Detritiated heavy water	-	7.40E+13
„Hydrogen” zone	Deuterium - gas, vapours	2.96E+15	
TOTAL CTRF (equivalent of 34.9 g tritium): 1,103E+16 Bq out of which:		2.96E+15	8,066E+15

B) Planned shutdown, whose frequency is 1/year, when CTRF is turned off for maintenance and repairs. This means that all process systems will be disconnected, except for the two sub-components in the Tritium Retention System - **TRS**, which are designed to retrieve and manage the tritium inventory from the cryogenic distillation unit, so that the work can be carried out under optimum conditions:

- *Low concentration tritium expansion tanks (LTET - Low Tritium Expansion Tank)* ensure handling and management of tritium inventory from the cryogenic distillation columns 1, 2 and 3 during maintenance work. The system is equipped with three superimposed LTET and positioned outside CTRF building.
- *High Concentration Tritium Expansion Tank (*HTET – High Tritium Expansion Tank), ensures handling and management of the tritium inventory from column 4 during maintenance. The system is equipped with a single HTET, located in the box with gloves hosting also the pumps of the cryogenic distillation unit.

According to the legal provisions, the derived emission limits (DEL) will be established by the national regulatory authority in the nuclear field, CNCAN. Related documentation will be developed in order to obtain the Construction Authorisation from CNCAN and/or subsequent licensing for tests, commissioning/operation of CTRF.

Calculations made by Candesco based on existing data from the nuclear plant and the tritium removal facility at Darlington - Canada [4, KI-CTRF-00335-0/2012], show that the following estimates can be made for LDE for Cernavoda NPP (U1 + U2 + CTRF):

- LDE for DTO (vapours) will be of 3.95E+12 kBq (3.95E+15 Bq), which is in fact LDE for Cernavoda NPP;
- LDE for DT will be of 7.44E+13 KBq (7.44E+16 Bq).

Other point (ducted) sources

If in cases of interruption of the power supply systems which admit short breaks up to 180 sec (Class III systems) Standby Diesel Groups (SDG) will be used being thus sources of particulate matter and diesel exhaust gases - mainly CO_2, SO_2, NOx and hydrocarbons.

According to the EMEP/EEA 2009 and to the IPCC methodologies, these sources of emissions are classified in the source category code NFR 1.A.4 Small combustion (stationary engines).

These sources will be characterized by short-term emissions, during the operating periods or during the periodical tests of SDG. Under these circumstances, and by using diesel with low sulphur content and performance equipment, the impact on the atmosphere generated by the operation of this category of sources will be insignificant.

Loading the two diesel tanks with capacities of about 1500 l represents a category of activities with short-term emission of volatile organic compounds (VOCs), occurring with reduced frequency. Diesel oil storage in tanks is also a source of VOC emissions. Considering the security requirements when designing the tanks, due to the specific of Cernavoda NPP, it is estimated that VOC emissions from these types of activities will be insignificant due to: the small size of the tanks, the low volatility of diesel fuel compared to other fuels, and due to the volatility decrease by including the tanks in enclosures with protection against solar radiation.

Emission inventories shall be carried out according to the EMEP/EEA 2009 methodology transposed by MO. No. 3299/2012 on emission inventories, respectively according to the 2006 IPCC guidelines on greenhouse gas (GHG) emission inventories. The new combustion sources shall be considered as new entrants in the GHG authorization held by Cernavoda NPP.

Mobile Sources

During operation, the mobile sources of air pollutants will be represented by transportation of auxiliary materials (e.g. nitrogen, helium cylinders, oxygen cylinders, diesel fuel), of materials such as fire-fighting materials (INERGEN cylinders, eco-friendly foam, portable fire extinguishers) and devices/equipment/spare parts, etc.

It is estimated that by the supplied quantities and due to the possibility of merging with the supply for other facilities of Cernavoda NPP, this category of sources will generate insignificant emissions of pollutants (particles and exhaust gases) compared to the situation in absence of CTRF.

IV.2.2. Equipment/Systems for retention and dispersion of pollutants in the atmosphere

- **MITIGATE SYSTEMS:**
  - ***HVAC Ventilation System*** – plays a safety and comfort role, consisting of 5 mechanical air ventilation systems in CTRF building, organised as follows:

- a ventilation system in the area of process systems (area with contamination and/or explosion potential):
  - Provides the exhaust of potential hydrogen accumulations by exhausting air
  - To ensure a safe environment, the areas containing hydrogen have ten exchanges per hour (approximately 55 000 m^3/h)
  - Air is ventilated (ducted/routed) to the exhaust stack of approx. 50m height, attached to CTRF
  - The hydrogen ventilation system is independent, with normal power supply and additional electric supply by batteries and Diesel generator
  - hydrogen and tritium monitors are distributed inside CTRF building; there is also provided the monitoring of stack air effluent;
  - the manual shutdown of the ventilation system and its manual isolation in certain rooms is provided, in case of accidental occurrence of tritiated water vapours in a CTRF room, followed by manual turning on of ADS (Atmosphere Detritiation (tritium removal) System)
  - ensures a range of 15-20 ˚C room temperature in process areas

- a ventilation system in the area occupied by the operation personnel:
  - min. 6 air exchanges/h for the area where there is no explosion hazard
  - it must ensure temperatures of 20-26˚C in the clean area
  - Air circulation will be from the area occupied by operating personnel to potential areas of contamination (process area) by pressure difference between zones. Thus, the greatest depression will be provided in the tritiated water processing area, area with contamination hazard.

- **ADS Atmosphere Detritiation (tritium removal) System** – having the role to decontaminate (detritiate) air through recovering vapours in the area where the tritiated heavy water processing/storing equipment is located; it operates when the concentration of tritium in the air exceeds the preset thresholds, situations which may arise in the case of accidental spills or damage.

The operating principle of ADS consists in the exhaust of air from the process area through a facility where D_2O/DTO/H_2O vapours are adsorbed into a desiccant mass, followed by the catalytic oxidation of tritium to tritiated water and vapour condensation of tritiated water and drying of the gaseous effluent on molecular sieves. In the catalytic recombiner, 99.9% of hydrogen isotopes are oxidized catalytically to tritiated water. Less than 0.1% of tritium gas will not react to water phase.

Air treated in this way is recirculated to the rooms where the increase of tritium concentration was detected. On the supply circuit of ADS it is provided the location of a hydrogen detector to avoid an explosion hazard when operating the system, by the accumulation of hydrogen in the system supply duct.

- **Tritium Retention System TRS** – provides 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 turning on of the process systems.

The operation mode of TRS system is stand-by, entering into normal operation when executing maintenance, during commissioning and controlled shutdown or in case of emergency.

TRS tritium retention system is able to process simultaneously and independently tritiated deuterium from process systems and contaminated air drawn from different locations where maintenance operations are performed.

- **DISPERSION SYSTEMS**

Effluents discharge into the atmosphere is done through CTRF's own stack under the following circumstances:

Stack height	50 m
Inner diameter of the stack	1.95 m
Stack section	~ 3.0 m^2
Discharge flow	55,000 m^3/hr = 15.28 m^3/s
Discharge speed	~ 5.1 m/s

Exhaust flows are designed as to ensure efficient evacuation of hydrogen from the building, to prevent the accumulation of hydrogen inside, namely the potential hazard related to the formation of the explosive concentration.

IV.3. Protection against noise and vibrations

IV.3.1. Sources of noise and vibrations

The main sources of noise are associated to the activities carried out and road transport within Cernavoda NPP site.

Noise sources associated with CTRF

The tritium removal facility will be built in an area in the eastern part of Cernavoda NPP site (see Fig. III.7-4).
The noise sources are the components of ventilation and air-conditioning (HVAC), pumps and compressors.

IV.3.2. Design and endowments for protection against noise and vibration

Cernavoda NPP is located in an industrial area, and by ensuring the exclusion area, dwellings are not permitted closer than 1000 m from the nuclear units.

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

Most noise sources within Cernavoda NPP site are located at more than 20 m inward from the enclosure boundary (fence that borders the territory of the plant). The forecasted noise levels are at least 3 dB (A) lower than the limit of 65 dB (A) settled by legislation.
The zone planned for CTRF location is an area where the noise level at the enclosure limit is of about 55 dB (A) - corresponding to the absence of CTRF (baseline). By the planned endowment, CTRF will not contribute with more than 60 dB (A) at the boundary of the enclosure (point A in Fig. III.7-4), which implies a resultant level of about 62 dB (A).

IV.4. Protection against radiation

The beneficiary of CTRF project, Cernavoda NPP, already has Radiation Protection Regulations and subsequent procedures which provide actions and measures to ensure protection from radiation. The procedures are reviewed periodically, the actions and procedures being tested through simulation exercises. The NPP procedures will be reviewed and completed, if required, with CTRF specific aspects in order to provide the safe and sound operation of CTRF both for personnel, population and environment.

Zoning

Spaces inside and from CTRF site will be divided on **controlled zones** and **supervised zones** (Zone 1 and Zone 2) according to the specific criteria established by CNCAN. Controlled and supervised areas will be defined and measures will be taken to provide access control, according to Radiological Safety Fundamental Norms, depending on the nature of the facilities and sources and on the associated radiological risks.

Also, spaces inside CTRF will be defined as **radiological zones,** with similar restrictions applicable as for U1 and U2. The personnel will be dosimetrically monitored and will benefit from appropriate protection and/or radioprotection equipment, as applicable.

Monitoring of the work spaces

The plant's atmosphere may become contaminated as a result of accidental leakage of process fluid. Because of double purification of process tritiated heavy water, the main contaminant remains only tritium as vapour or gas. However, as a preventive measure, the possibility of beta-gamma contamination when tritiated heavy water leaks occur, will be taken into account.

Monitoring of minor contributors will be done whenever heavy water leaks are likely to happen, with portable equipment (beta-gamma monitors and aerosol sampling pumps).

Fixed monitoring system of tritium in the air and portable tritium monitors will be used to monitor tritium in work area.

For each room where tritium leakage under the form of vapours or gas is likely to happen, air sampling will be provided in strategically chosen locations (e.g. from the neighbourhood of valves, pumps and flange connections). The minimum number of sampling points air in Zone 1 classified rooms from a radiological point of view will be 12, taking into account the continuous or sequential monitoring of global tritium concentration (HTO and HT) in the air sampled by means of air tritium monitors equipped with flow-through type ionization chamber detector (with air flow through the active volume of the detector).

Tritium monitors will be equipped with alarms for detecting the exceeding of some predetermined threshold values and recording the values. The measured values and alarms will be available both locally and in the control room of the facility.

Each monitor will be designed to provide real time information on the concentrations of tritium in air and to signal any exceeding of the preset threshold of tritium concentration in air. Information on the values of tritium concentration in air provided by these monitors are useful both for estimating the radiological hazards level to the personnel entering radiological areas and to assess the status of the plant. Also, based on measurements made by these monitors, the decision whether it is appropriate to turn on the ADS to decontaminate air can be made.

Moving and monitoring in radiological areas

All persons walking from Zone 1 to Zone 2 will be monitored in terms of beta-gamma contamination of hands and feet. In the case of CTRF, this measure is preventive and represents a barrier against the spread of beta-gamma contamination from Zone 1 to Zone 2.

For the contamination control of operating personnel, two fixed locations will be provided as follows: an interzonal fixed monitor to test beta-gamma contamination of hands and feet; an interzonal fixed monitor to check beta-gamma contamination of the entire body.

Interzonal monitors will be placed next to dividing line of areas, in the higher contamination area. They will be provided with the means to measure the contamination of objects.

To monitor contamination of all equipment to be removed from Zone 1 through equipment airlock, a portable monitor to monitor beta-gamma contamination of surfaces will be used.

Facilities for radiological protection of personnel

CTRF building is provided with spaces for clothes change and decontamination of operating personnel, separate for both genders.

Personal protective equipment such as underwear, socks, cotton jumpsuit for radiation protection and radiation protection footwear with steel toecap shoes will be available inside the spaces for clothes change. The required quantity of equipment will be dimensioned in accordance with the number of operators.

Equipment necessary for working with tritiated heavy water or for working in contaminated areas and portable instruments for monitoring radiological hazards will be located and available in special places near the access airlock of personnel in Zone 1.

Personal dosimetric monitoring of CTRF personnel

Individual dosimetric monitoring of CTRF personnel consists in the external dosimetry (performed using the thermoluminescence dosimeters) and internal dosimetry of tritium (performed by collecting urine samples and their analysis in the dosimetry laboratory of NPP).

Dosimetric monitoring of the personnel will be done by the extension of the dosimetry program of NPP.

Monitoring of liquid and gaseous radioactive exhausts

The monitoring program of radioactive effluents of U1 and U2 will be extended in order to cover exhausts from CTRF.

The doses received by the population will be estimated on the basis of tritium emissions of CTRF, by the same calculation models which are applied for Units U1 and U2 of Cernavoda NPP.

Monitoring gaseous effluents will be done only for tritium (because process heavy water is purified before transferring to CTRF, to remove traces of activation products, beta-gamma emitters, which would poison the LPCE catalyst and the observance of Derivated Exhaust Limits which will be set for tritium in gaseous effluents will be followed. Derivated Exhaust Limits will be established by the applicant for authorization after consulting a CNCAN expert in the field of radiation protection accredited and approved by CNCAN in the authorization process.

Measurement of tritium concentration in the exhaust air will be done both in real-time (online monitoring systems of emissions is detailed under chapter V) and by the additional measurement, in the laboratory, of samples to be collected by a tritium collector. Representative air samples from the recirculated air ventilation will be collected continuously to determine the concentration of tritium in air, both globally and discriminatorily for water vapours (HTO) and gas (HT).

Liquid effluent samples will be collected by CTRF operating personnel and analyzed by Cernavoda NPP labs, in order to determine the quantities of radioactive materials discharged into the active drainage systems related to Unit 1.

All equipment and machinery to be used in the monitoring of radioactive discharges at CTRF will be certified under the law, and the work, calibration, testing, maintenance and metrological procedures will be fully documented and approved by those in charge - including the competent authorities.

Monitoring environmental radioactivity

Environmental radioactivity monitoring program of the plant will be extended only for the assessment analysis of the additional environmental impact caused by the operation of CTRF, according to the procedures validated by CNCAN and referenced in operating license of CTRF.

IV.5. Soil and sub-soil protection

IV.5.1. Sources of pollution for soil, subsoil and groundwater

Potential pollutant sources for soil, subsoil and groundwater are:

- errors in waste management
- accidental leakages of radioactively contaminated fluids from the technological pipelines that ensure the transfer between the Units U1 and U2, and CTRF.

IV.5.2. Works and endowment for soil, subsoil and groundwater protection

Because the project site is inside the NPP Cernavoda, CTRF completion and operation is performed in the context of the site destination, and can be considered support system of Unit 1 and Unit 2. Also, through the profile and nature of activities during the operation period of the project, the potential interactions on the soil would be due to abnormal situations with consequences for soil pollution, but this possibility is unlikely for the following reasons:

- The project provides for the protection of soil and subsoil of the site, through concrete platforms.
- During the operation, the management of waste which can be assimilated to municipal and of industrial waste, will be done according to the regulations in force, the beneficiary, NPP Cernavoda, having implemented rigorous management procedures for industrial waste.
- From a constructive point of view, the facility is provided with reduction systems of the risk associated to the fluid leakage from circuits:
    - *Heavy water leak detection system* - provides detection of accidental leakages of tritiated and detritiated heavy water from the technological pipes that ensure the transfer between the Unit 1 or Unit 2, and CTRF. The transfer pipelines are designed as "pipe in pipe", thus providing protection in case of the inner transfer

pipes damage. The potential leakages will be signalised in the main control room of Unit 1 or Unit 2 and on the control panels in rooms S015 of U1/U2 units.

- *Heavy water drainage and collection system – LCS* is designed to handle heavy water resulting from the draining of the plant systems during the interruption of operation and maintenance outage periods, in order to reuse it in the process or return it to the NPP systems as appropriate. LCS is formed by a network of the discharge (drainage) pipes (coming from the equipment containing process water, LPCE, TRS and ADS) which is connected to a collector that supplies a tank of 0.6 m^3, placed in a sump [13] within CTRF.

IV.6. Protection of terrestrial and aquatic ecosystems

According MO No. 19/2010 for the approval of the Methodological Guide for proper assessment of the potential effects of plans or projects on protected natural areas of community interest, regarding the content of this technical memorandum, it is stated that the project ***"Construction works for Cernavoda NPP Tritium Removal Facility"*** is located on the industrial site of Cernavoda NPP, and on the site and the nearby area - up to a minimum of 2.6 km around CTRF – there are not natural monuments, protected natural areas, species or habitats of community interest

Stereo 70 coordinates for CTRF plant are attached to this documentation, as requested by the Ministry of Environment in the Decision of stage classification

As the project site is within Cernavoda NPP site, CTRF implementation and operation are performed in the context of destination and activities performed on the site, being considered as a support system for Unit 1 and Unit 2.

Since for Wolsong NPP- Korea the reduction of total air emissions of tritium after the start of the operation of WTRF [16], was reported and the fact that potentially contaminated wastewater from CTRF technological area will not be discharged directly into the environment, it can be appreciated that CTRF normal operation will have an low/insignificant impact on the aquatic and terrestrial ecosystems.

This conclusion is also supported by speciality literature - latest adequate assessment studies carried out for Cernavoda NPP supporting this conclusion by experimental measurements and specialized expertise [23, Final Report. Study on the impact of the operation of the nuclear plant in Cernavoda (U1 and U2) on aquatic and terrestrial organisms in its area of influence].

IV.7. Protection of human settlements and other public interest objectives

IV.7.1. Identifying public interest objectives, the distance from human settlements and from historical and architectural monuments, and other areas over which a system of restriction is established, the traditional focus areas etc.

Around each nuclear unit there is *an exclusion area* with a radius of 1 km – in which no other activities than those carried out in the NPP are allowed, circled by a ring area with *low population* – with a radius starting from 1 up to 2 km from the nuclear unit.

The nearest localities in the influence area of Cernavoda NPP site, are:

- Cernavoda town with a population of 16143 inhabitants accounted in 2011 – situated at approx.1.6 km NW from Cernavoda NPP site
- Stefan cel Mare village with a population of approx.573 inhabitants in 2002 – situated at approx.2km SE from Cernavoda NPP.

The localities Seimeni (approx. 2.4 km), Dunarea (approx. 8.5 km), Capidava (approx. 15 km) and Topalu (approx. 22 km) are downstream of the discharge of cooling water from Cernavoda NPP into the Danube.

After consulting the General Urban Plan of Cernavoda, the Mapserver for national cultural heritage - managed by National Heritage Institute – Department of Research, Record of Mobile Cultural Heritage, Intangible and Digital Bucharest, as well as Law No. 5/2000 on the approval of the National Spatial Plan - Section III - protected areas, it was found that Cernavoda NPP site is located in an area with concentration in the territory of built heritage of national cultural value – the municipality of Cernavoda, Mircea Voda and Topalu communes.
The closest are the archeologic sites from Axiopolis – approx. 2.6 WSW, Dealu Viforului medieval settlement – approx. 3.6 km WSW and Valul de piatra from Cernavoda – approx. 2.7 km WSW, and "Engineer Anghel Saligny" Bridge – approx. 3.8 km WNW from CTRF plant.

Given the location of the Project within Cernavoda NPP site, as well as its role in reducing emissions of tritium from Cernavoda NPP, when running to the designed parameters, it can be estimated that CTRF facility will not have an impact on the localities and on the historical and cultural heritage of the area.

IV.7.2. Works, equipment and measures for the protection of human settlements and protected and/or public interest objectives public

Systems and measures for the prevention and control of emissions into the atmosphere and aquatic systems, respectively waste and hazardous substances management planned for CTRF, will be integrated into the environmental management system of Cernavoda NPP, thus ensuring conditions and requirements duly authorized for the protection of human settlements and other protected and/or public interest objectives in the area.

Cernavoda NPP will complete all emergency procedures with specific provisions for the activity carried out at CTRF.

IV.8. Management of waste generated on the site

IV.8.1. Types and quantities of any kind of generated waste

CTRF operation will generate non-radioactive waste (which can be assimilated to municipal and industrial waste) and radioactive waste.

Radioactive waste resulting from CTRF operation will be low and medium active. According to the procedures in force at NPP, they will be treated and classified depending on their physical and radiological characteristics in order to optimize the processing and the storage thereof.

The following types of radioactive waste are expected:

- Organic liquids: oil from pumps and compressors, non-chlorinated solvents
- Solids: catalyst from catalytic isotope exchange column; molecular sieves from process gas dryers; ion-exchange resins.

Also, the generation of low active solid waste from CTRF operation and maintenance is estimated, namely:

1. Cellulosic materials
2. Maintenance materials (cloths, gaskets, etc.)
3. Materials and equipment.

The estimated quantities of radioactive solid waste are:

- hydrophobic catalyst from isotopic separation columns	495 kg / 2 years
- molecular sieves from dryers	664 kg / 2 years
- ion-exchange resins	1500 kg / 1 year

To reduce to the minimum the generation of radioactive waste, Cernavoda NPP has already implemented a treatment, segregation and monitoring process of waste from radiological areas, as well as procedures to optimise the quantities of potentially generating waste materials. This process will be implemented properly in CTRF activities as well.

IV.8.2. Waste management

Non-radioactive industrial waste management will be in accordance with the approved procedures of Cernavoda NPP, the Environmental Authorisation of Cernavoda NPP and the norms in force, complying with Law No. 211/2011 on waste regime, GD No. 1061/2008 on the transportation of hazardous and non-hazardous waste on the territory of Romania, GD No. 856/2002 regarding waste management classification and for approval of waste list, including hazardous waste (GD No. 235/2007 on waste oils, GD No. 1037/2010 on WEEE, etc.).

The management of the radioactive waste resulting from CTRF will be similar with the management of the ones generated from the activities at U1 and U2.

Waste management activities are adequately documented, and reported on a monthly basis to the environmental authorities and to CNCAN, as applicable.

At CTRF there will be temporary storage spaces of radioactive waste. Thus there will be a **Buffer Storage Space**, in transit, at the elevation of 95.50 m, with an estimated surface of S = 24m^2 intended for short-term storage of radioactive waste barrels resulting from the operation and regular maintenance of CTRF, which are to be transferred to the nuclear plant for segregation, treatment and subsequent processing or transferred to the Solid Radioactive Waste Intermediate Storage (DIDR).

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

IV.9. Management of dangerous substances and chemical mixtures

During Project implementation and subsequently in CTRF normal operation is expected to be used chemical substances and mixtures classified as dangerous, such as those in the following categories:

- Lubricants (oils and greases)
- Biocides (for cleaning, equipment washing, etc)
- Cooling fluids (environmental friendly freons)
- Glycol
- Fire extinguishing substances
- Fossil fuel (diesel fuel)
- Products for cleaning the equipment (Avesta paste)
- Solvents (non-chlorinated) for degreasing
- Mixtures for coating (primer, paint).

Dangerous chemical substances and mixtures used at CTRF will meet the requirements of the CLP European Regulation (1272/2008), which amends Regulation 1907/2006 transposed by GD 1408/2008. At the moment of the purchase at the latest, suppliers of chemical products will submit the Safety Data Sheet, Data Sheets and REACH registration numbers (for hazardous substances that require these authorizations or registrations).

The other legal requirements on certain categories of substances and chemicals (biocides - GD no. 937/2010, drug precursor substances, etc.) will meet the requirements for notification, authorization, registration according to the legal provisions and the requirements of the Cernavoda NPP procedures on entry on the list of chemicals approved for use in Cernavoda NPP.

The procedures of the chemicals management program shall also integrate the management aspect of chemicals from CTRF.

V. Provisions for environmental monitoring

V.1. Equipment and measures provided for the control of pollutant emissions in the environment

Since the design phase, CTRF will be provided with all necessary facilities to control and reduce the potentially negative effects for the entire period of operation. Thus, for the control and limitation of emissions, the following items will be installed:

- A monitor for tritium in air, with ionisation chamber or proportional counter in order to have real time information on tritium discharges through the stack;
- Two collectors of tritium from air, provided with the possibility to collect tritium discriminatorily both under vapour (HTO) and gaseous (HT) forms. The samples thus collected will be analyzed in the chemical laboratory of the nuclear plant to determine the tritium concentration in gaseous effluents released to the environment;
- A flowmeter for measuring the flow of air discharged into the environment through the ventilation stack of the facility. The flowmeter is equipped with electronic integrator for determining the volume of air released in different periods of time.

Radioactive effluent monitoring program of the plant will be expanded to include the radioactive effluents released by CTRF.

Effluent samples will be collected by CTRF operating personnel and analysed by the chemical laboratory of Cernavoda NPP. Monitoring and reporting of the radioactive effluents resulting from Cernavoda NPP operation will also include CTRF data.

VI. Justification of project framing under the provisions of other regulations transposing Community legislation (IPPC, Seveso, VOC, LCP, Water Framework Directive, Air Framework Directive, Waste Framework Directive, etc.), as appropriate

The project "Construction Works for Cernavoda Tritium Removal Facility" is not subject of the following regulations:

- GD No. 699/2003 establishing certain measures on the limitation of volatile organic compounds emissions due to the use of organic solvents in certain activities and installations, as amended, transposing the Directive 1999/13/EC on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations (VOC) as amended. It is estimated that CTRF operation will not involve activities with usage of solvents containing volatile organic compounds over the regulated consumption thresholds. If during the project implementation, the use of organic solvents containing volatile organic compounds will exceed the regulated consumption thresholds, Cernavoda NPP will report in accordance with respective regulations in force.
- GD No. 440/2010 concerning the establishment of measures to limit air emissions of certain pollutants from large combustion plants, transposing the Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants (LCP Directive) as subsequently amended. No power plant over 50 MW is associated to CTRF implementation and operation.
- EGO No 152/2005 concerning integrated pollution prevention and control, as amended, that transposes Directive 2008/1/EC concerning integrated pollution prevention and control (IPPC Directive) as amended. The activity carried out at CTRF is not included in the categories of industrial activities listed in Annex 1 of the Directive.

These directives are integrated and recast by Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) (Recast) - (IED Directive).

Regarding the control of major-accident hazards involving dangerous substances, the following clarifications are made. GD No. 804/2007 on the control of major accident hazards involving dangerous substances, modified by GD No. 79/2009, transposes the Directive 96/82/EC on the control of major-accident hazards involving dangerous substances (Directive SEVESO II). The Directive does not apply to harzards induced by ionizing radiations.

It is estimated that potentially oxidizing, explosive and flammable substances, namely oxygen, hydrogen (up to 300 Nm^3 isomers in the facility) and diesel fuel will be on the CTRF site in quantities of less than 2% of the relevant qualifying quantities for lower level establishments.

The sum of the ratios between the quantities of hydrogen, oxygen and diesel fuel namely (q_x) and the relevant qualifying quantity for lower level establishments for each of them (Q_{LX}) is less than 1 ($\sum q_x / Q_{Lx} < 1$).

For the CTRF facility are set out protection barriers against fire and explosion, by *preventive measures* such as optimizing the facility capacity (limiting as much as possible the volume of hydrogen in the facility, installation of detection and alarm equipment, providing ventilation in areas with potential for hydrogen accumulation, the use of qualified seismic equipment, reducing equipment in areas with hydrogen, use of materials impermeable to hydrogen), respectively by *measures to limit the effects* (as protection wall outside the facility, installation of expansion vessels, provision of means of intervention and the development of specific procedures). Relevant training operational intervention staff is also considered.

It is noted that on site is a fire station endowed with adequate equipment for rapid intervention in case of fire, with permanent program organized on shifts, which serves all buildings and systems from Cernavoda NPP site. Emergency intervention exercises that include sequences of intervention in case of fire are periodically organized, as provided by internal procedures and regulations.

From the point of view of Law No. 104/2011 on ambient air quality, transposing Directive 2008/50/EC on ambient air quality and cleaner air for Europe, it is estimated that the implementation and operation of CTRF will not affect air quality in the area in terms of pollutants regulated by the Directive .

Water Law No. 107/2006 with subsequent amendments transposes the Water Framework Directive 2000/60/EC which aims sustainable development – ie the harmonization of socio-economic development in relation to the supportability of the aquatic environment. Currently, water management for Units U1 and U2 is licensed by the Water Management Authorisation No. 160/07.08.2012 amending the Authorisation no. 277/30.11.2011, issued by the "Romanian Waters" National Administration. Construction of CTRF will be under a regulatory act issued by the "Romanian Waters" National Administration. For the operation phase, water management for CTRF will impose modification of the Authorisation for water management at Cernavoda NPP and its appendix - the Regulation on operation, by including the new facility. Similar to the specificity found and approved by the Water Management Authorisation for Cernavoda NPP - including Solid Radioactive Waste Storage Facility (DIDR), Interim Nuclear Spent Fuel Storage (DICA) - CTRF has not constructive and technological characteristics potentially affecting surface and ground waters.

Non-radioactive industrial waste management will be in accordance with the approved procedures of Cernavoda NPP, the Environmental Authorisation of Cernavoda NPP and the norms in force, complying with Law No. 211/2011 on waste regime - which transposes Directive 2008/98/EC on waste, GD No. 856/2002 regarding waste management classification and for approval of waste list, including hazardous waste (GD No. 235/2007 on waste oils, GD No. 1037/2010 on WEEE, etc.) and GD No. 1061/2008 on the transportation of hazardous and non-hazardous waste on the territory of Romania.
Periodical reports on non-radioactive industrial waste management for CTRF will be included in the regular reports submitted by the Environmental Management Group of Cernavoda NPP for the entire branch, even since the initial stages of the project.

The management of the radioactive waste resulting from CTRF will be similar with the management of the ones generated from the activities at U1 and U2. Management activities are adequately documented and reported on monthly basis to the environmental authorities and to CNCAN. During construction and installation, neither radioactive nor potential radiological contaminating waste is generated.

VII. Site organization works

VII.1. Description and location of construction works

Site organization will be conducted on project location, following the Cenavoda NPP requirements on access control of persons and vehicles and will include:

- **Access ways - approved access routes**
- **Tools, devices, equipment, machinery and means estimated to be needed:**
  - Trucks for raw materials and materials supply, for construction waste disposal or for moving machinery and equipment
  - Mixer Trucks
  - 1-2 bulldozer(s), 1-2 excavator(s), 2-3 mobile cranes, pneumatic hammers, welding equipment (electric arc and oxyacetylene), shovels, metal scaffolds etc.
- **Power sources:** Electricity will be supplied by existing utilities in Cernavoda NPP
- **Locker rooms, drinking water, lavatories** - according to Cernavoda NPP procedures applicable to contractors
- **Works schedule**
  - Temporary works for site organization (including connections) - approx. 1 month
  - Preparing the ground for construction (digging and leveling) - approx. 2 months
  - Making outdoor platforms for external equipment and machinery - approx. 2 months
  - Excavations and foundation preparation for building - approx. 4 months
  - Preparation of the metallic structure and building assembly - approx. 6 months
  - Contracting, execution and delivery of equipment - approx. 30 months
  - Common installations works - approx. 3 months
  - Installation of process equipment - approx. 12 months
- **Organizing spaces for temporary storage of materials, specific measures for preservation and to avoid degradation during storage** - it will comply with Cernavoda NPP procedures for the approval of temporary storage spaces for equipment and materials, depending on the quantity, hazards, etc.
- **Specific measures for protection and safety** - involving signing and implementation of a Convention on occupational safety, as part of service contracts commitments with prospective contractors

VII.2. Pollution sources; description of environmental impacts and measures to control the pollutant emissions into the environment

VII.2.1. Construction phase – field preparation, construction/installation

Water

The personnel involved in the stage of construction/ installation will be supplied with commercially bottled drinking water or in accordance with the specific procedures of Cernavoda NPP.

This stage does not require sewerage, being used ecological toilets or lavatories of Cernavoda NPP.

The water for spraying to reduce particulate emissions generated by wind erosion on unpaved or disturbed surfaces or on earth piles, or by the resuspension of particles due to vehicle traffic will be provided from the drinking water supply network of Cernavoda NPP. Wetting will be made only when needed, (e.g. dry earth piles in weather conditions that favours particles suspension - high temperatures and wind) and only in sufficient quantities to avoid excessive consumption of water and puddles.

The same source of water will be used for washing the vehicles wheels of mud/soil. As far as possible, work will be limited in conditions of high humidity or precipitations, as well as the traffic of trucks/mixers on unpaved surfaces.

Air

During construction and installation will occur the following categories of air pollution sources, as classified by the methodology EMEP/EEA 2009:

Tab. VII.2-1 Categories of air pollution sources related to the stage of preparing the land and construction/installation, as classified by the methodology EMEP/EEA 2009

Description of categories of sources/activities	Classification acc. methodology EMEP/EEA 2009	Main pollutants emitted into atmosphere
Preparing the field - diggings (scraping, excavation) on the surfaces where access roads, foundations, structures, platforms and buildings will be constructed - fillings, levelling, and compacting works etc. - transfer and temporary storage of soil or waste from demolition Activities of construction& installation - supply and temporary storage of construction materials and equipment/ machinery - laying the foundation and the superstructure - casting concrete, cladding, installation of prefabricated pieces, metal plates, fillings and compaction, respectively assembling - holing, welding joints, fittings etc. for machineries, equipment, pipes, ducts - for CTRF building and annexes, and for its connections with units U1 and U2. - Temporary storage and loading of construction and installation wastes Rehabilitation of potentially affected land - fillings with soil from excavations - eventually compaction and topsoil coatings	***code NFR 2.A.7.b*** Construction and demolition	Total suspended particles TSP Suspended particles – fraction PM_{10}
Combustion of fuels in vehicle engines (trucks, concrete mixers) - transportation of materials inside the Cernavoda NPP site	***code NFR 1.A.3.b*** – Road transport – source category code *NFR 1.A.3.b.iii – Heavy-duty vehicles*	Exhaust gases – NO_2, SO_2, CO, NMVOC Polycyclic aromatic hydrocarbons (PAHs) Particles
Fuel combustion engines that equip non-road mobile sources (on-site operation of mobile machines and equipment)	***code NFR 1.A.4*** – Other mobile, source category code *1.A.2.f.ii –Mobile combustion in manufacturing industries and construction land-based mobile machinery*	Exhaust gases Particles containing metals (Cd, Cu, Cr, Ni, Se, Zn) VOCs
Wind erosion from disturbed land surfaces and earth piles	***code NFR 7.A*** – Other sources	Total suspended particles (TSP) and fractions
Resuspension of particles due to vehicle traffic	***code NFR 7.A*** – Other sources	Total suspended particles (TSP) and fractions

Dust will be the main pollutant emitted into the atmosphere during construction and installation, particularly TSP and PM10 fraction.
All sources associated with the construction and installation phase are ***unducted - area and linear sources***, with a strictly local, temporary, low impact.

Resuspension of the particles by entrainment from surfaces, as a result of vehicles movement will be reduced due to preponderance of on-site traffic of heavy-vehicles and of machineries on paved surfaces and less on unpaved ones.

Particulate emissions will be reduced by washing the concrete/paved surfaces or by spraying the unpaved or disturbed surfaces.

Emissions from the combustion of fuels for road and non-road machinery operation will be within the limits specified by the technical manuals, any malfunction or abnormalities leading to stopping machine until repairs are performed.

An important aspect is that all materials for construction will be manufactured off-site and will be delivered on-site, in the strictly necessary quantities and in the planned stages. Also, given the need to protect the construction in the immediate vicinity of the site, the excavation will be done in closed enclosure, Berliner support type.

In view of the above as well as the fact that all activities associated with the construction stage will be carried out:

- in a relatively small area and short period of time,
- mostly at ground level or at low heights,
- in an area shielded by other objectives and industrial buildings,

it can be appreciated that in the inhabited area closest to Cernavoda NPP the concentrations of air pollutants regulated by Law no. 104/2011 on ambient air quality will not be affected as a result of construction and installation activities for CTRF.

Noise

During the construction phase the source of noise are:

- Traffic of heavy vehicles: dump trucks, concrete truck mixers, trailers to transport heavy-machinery, aggregates and different components on-site. The noise generated by heavy traffic will include both engine noise and noise from machinery movement on the access roads to sites.
- Operation of machinery: bulldozers, excavators, compactors for the preparing the field - equipment complying with the applicable norms and procedures for such constructions. The noise from this source will also include the noise generated by running the engines and also the noise produced by the alarms of these machines.
- Handling the equipment on-site, loading and unloading operations the excess soil - all these accompanied by specific noise emissions.

It is estimated that during construction and installation, the noise levels starting from 30 m far from the construction site will fall within the maximum permitted limit of 65 dB (A) specified by STAS 10009-88 for industrial area.

Waste management

The waste resulted during the execution of the project are mainly the following: construction waste (earth waste, concrete waste), wastes of water-proofing materials, bituminous asphalt waste, sludge from manholes (possibly contaminated with oil residues), wastes of packaging and textile waste (personal protective equipment worn or damaged, etc..), iron and steel, plastics, paint, paper, paperboard and oil leaks.

The legal provisions will be applied, as well as the procedures and measures to prevent and/or reduce accidental spills, the procedures for the management of wastes resulting from construction and installation activities and from the regular maintenance activities of equipment and vehicles, and also the procedures for proper handling and storage of fuels and materials.

Construction materials containing asbestos will not be used and therefore will not be generated construction waste - Insulation materials and building materials containing asbestos coded 17 06 according to GD No. 856/2002.

The vehicles and machinery used for construction and installation phase will be provided through contract services. The contracted companies will be the solely in charge for the maintenance and repair activities performed through its specialized units.

The construction waste management will be according to the specific norms, avoiding temporary storage in spaces associated with the site organization.

The temporary storage of waste generated during construction and installation, and their disposal will be done according to the internal procedures of Cernavoda NPP.

VII.2.2. Technological tests. Commissioning tests (cold and hot)

Commissioning of CTRF facility will be performed based on a program that will demonstrate that CTRF design requirements are met, as provided in the Safety Analysis Report (SAR). This will be achieved through a planned testing program that meets the following objectives:

- To provide assurance that equipment construction and installation have been accomplished in accordance with the design;
- Ensure required CTRF system performance can be achieved and validate safety assumptions;
- Familiarize CTRF staff with the operation of the facility (training and certification of operating and maintenance personnel, according to the regulations in force); and
- Verify adequacy of and approving the operating procedures within CTRF.

CTRF Commissioning Plan will reflect relevant industrial practices and will incorporate the operating experience (OPEX) of tritium removal at Wolsong NPP - Korea (WTRF).

Commissioning Plan for CTRF will be correlated to the importance of structures, systems, equipment, components classified as important for nuclear safety, according to CNCAN norms (NMC, NSR). Policy documents, program documents that describe the organization's policy and objectives on the commissioning will be submitted and subject to approval of the national regulatory authority in the field, CNCAN, and will be addressed correspondingly, under the Integrated Management Manual of Cernavoda NPP.

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

Commissioning tests for CTRF have been arranged in phases in the following logical sequence:

Phase 1: *Pre-Hydrogen Commissioning* - includes the activities necessary for the general checking of the construction and ensuring the safety requirements, prior to large inventories of hydrogen in the facility

Phase 2: *Deuterium Tests* - involves the filling of process systems with deuteurim, in order to confirm the operating mode of all safety equipment for hydrogen, according to the project specifications

Phase 3: *D_2O Performance* - consists of adding Heavy Water (D2O) to the tritium removal equipment to confirm the operation according to design specifications for major CTRF systems.

Phase 4: *Low-Tritium Performance* - consists of adding Tritiated Heavy Water (DTO) to obtain a low tritium concentration in the facility and aims to demonstrate effective removal of tritium given a low concentration feed

Phase 5: *High-Tritium Performance* - tritium is added gradually to increase the total tritium inventory. The higher tritium concentration will enable CTRF to demonstrate detritiation factors and processing rates prescribed in the design details. Operating limits and conditions as well as safety objectives will also be demonstrated by CTRF.

Upon completion of a stage, the shift to the next stage will be done only after successful completion of previous sequence and only after obtaining CNCAN licences which will be issued for each stage separately. Before declaring CTRF is operational, a performance verification test will be done in accordance with the NMC 09 in order to ensure that:

- ✓ Commissioning of equipment was carried out in accordance with the documented procedures, with qualified and trained personnel;
- ✓ All operating parameters fulfil the specified criteria;
- ✓ All deficiencies were identified and solved;
- ✓ The analysis of the completion of the commissioning stages was carried out in accordance with the preset requirements.

The performance verification test will be carried out as part of Phase 5. As such, provisions of applicable Norms regarding the requirements for quality management system applied to commissioning compliant with the Cernavoda site quality assurance policy will apply. All testing will be performed in accordance with the testing procedures and commissioning documents developed. The results of the performance verification test will be included in the Commissioning Completion Assurance Report.

The organization responsible for commissioning will plan the commissioning activities, as described above. Planning the commissioning will include sourcing, identifying responsible personnel, verification activities, and documents concerning the criteria and key objectives of the commissioning for major processes and security systems.

Based on relevant industrial practices and successful commissioning of the tritium removal facility from Wolsong NPP - Korea, commissioning procedures for the Cernavoda tritium removal facility will include different levels of detail planning, developed through collaboration between system designers and facility operators. The accuracy of this approach was tested and demonstrated practically during the commissioning of WTRF - Korea.

All procedures to be developed for the commissioning of the CTRF will be in accordance to the integrated management system of Cernavoda NPP, including all general management methods, performance and evaluation of commissioning activities.

Verification activities will be planned and organized in conjunction with commissioning activities. As part of the commissioning program, the organization responsible for commissioning shall inform the National Commission for Nuclear Activities Control (CNCAN) on commissioning activities planning and their completion stage.

The organization responsible for construction and installation activities and the organization responsible for commissioning activities shall establish and document interface procedures for the transfer of responsibilities to the organization responsible for the operation of the facility (SNN-SA, Cernavoda NPP branch).

VIII. Works for the restoration of the site upon the completion of the investment, in case of accidents and/or when the activity stops

VIII.1. Works proposed for the restoration of the site upon the completion of the investment

Upon Project implementation, no special restoration works are required on the site. Once the construction-installation works are completed, the green area within the site will be covered with grass.

VIII.2. Aspects related to prevention and response in case of accidental pollution

Protection of population and of the operating personnel, both during normal operation and in case of incident/accident, represents the main safety objective which is envisaged even from the outset of the design of a nuclear facility.

Deriving from this major objective, CTRF safety and protection strategy is based on a protection approach in depth, both in design and operation, taking into account the potential hazard to the facility (internal and external). In depth protection at CTRF aims at both prevention and/or reduction, and addressing potential abnormal events and actions to be taken.

Even during the design phase, the project international consortium performed a rigorous assessment of potential hazards (PHA - Preliminary Hazards Assessment), by considering individually each system of CTRF componence. Additionally, initiating and representative events were identified based on available documentation from other similar facilities, such as: Wolsong Tritium Removal (WTRF) Preliminary Safety Analysis Report (PSAR) [19], CTRF Hydrogen Detonation Frequency Assessment [14] and CTRF Licensing Basis Document (LBD) [15].

The two main hazards defined by the documentation for CTRF authorisation are:

a) Radiological hazard, due to potential releases of tritium under gaseous forms DT or T_2 , and/or under the form of tritiated water vapours (DTO)
b) Explosion hazard due to potential hydrogen releases.

Design basis events include: process system failure, earthquake design basis, flood, fire, tornado, and the potential impact of a possible airborne object.

All Preliminary Hazard Assessment findings and recommendations were carefully considered by the designer so that the facility could pass through these events in safe operating condition, and without exceeding the authorized limits.

When designing the facility, the following two major objectives derived from CTRF safety strategy [9 , Safety Design Guide, cod 79-38500-SDG-613/ martie 2013] were taken into consideration:

- Radiation: maintaining releases of tritium and exposure to both operational personnel and the population within the authorised limits, in normal operating conditions and within acceptable limits in the event of an accident;
- Hydrogen: minimize the potential for accumulation of hydrogen to prevent explosions and implementation of all safety requirements to ensure that even in the event of an explosion at CTRF, it does not pose an unacceptable risk to the safety of NPP reactors, particularly for Unit 1.

Safety functions to ensure the protection of the population and of the operating personnel, both under normal operation and accident situations, are implemented in three major directions:

- Limiting tritium discharges, by achieving and maintaining appropriate barrier systems for the prevention and control of emissions;
- Monitoring of operational parameters values of all processes, and availability of systems dedicated to automatically shutdown the facility in case of detection of any failures and to maintain it safe;
- Minimizing the risk of explosion in the facility by maintaining an adequate system of ventilation and placing separately the facility’s components that convey DT, from those with DTO.

A key element in the implementation of the safety strategy is that CTRF was designed so that the total inventory of tritium in the facility, to be at any time managed in such way that even in the worst-case accident, exposure of both population and on-site personnel not to exceed the limits imposed by licences.

Also, the hydrogen inventory within CTRF was limited to 160 m^3, at the same time reducing the equipment located in hydrogen areas, and redundant elements being also provided for monitoring and safety.

However, a secondary containment system was included in CTRF design to prevent DT penetration in the operational area in event of breaches in the primary containment. Secondary containment is commonly used in tritium removal facilities or handling of tritium, especially for systems containing high Tritium specific activities under an elementary form.

Given that secondary containment is available 100% of the time, it is able to retain tritium inventory even under increased pressure resulted from system indoor emissions due to the failure.

Tab. VIII.2-1 CTRF Secondary Containments

Secondary containment	Description
Cryogenic Distilation System Cold Box	Contains the CD columns and sections of the process line pipes between these columns. Also contains sections of the relief line pipes between the CD columns and the LTET/HTET
HT Tank and Cryogenic Distillation System Pump Glove Box	Contains the HTET and CD System pumps
Tritium Gas Handling Storage System Glove Box	Contains the TGHS Tank and other TGHS System components. The glove box operates at a negative pressure compared to the room atmosphere and includes a closed loop tritium clean-up system capable of removing any leaked T_2 or DT
AIV/PRV Containment	Contains Automatic Isolation Valves (AIVs) and Pressure Relief Valves (PRVs).

In terms of preparation, planning and intervention in case of accidental pollution, Cernavoda NPP has a general plan Plant Emergency Plan, which is approved by the entitled authorities, and which will be revised to include CTRF as well.

VIII.3. Aspects related to the facility shutdown/decommissioning/demolition

Nuclear decommissioning has as main objectives the protection of personnel, population and environment against radiological and non-radiological hazards resulting from the decommissioning of the facility, and also limiting the potential impacts on future generations.

Considering the specificity of the tritium removal facility, a two-stage decommissioning strategy is proposed:

I. A cleaning stage (cleaning) and preparation of the facility for decommissioning;
II. An actual decommissioning stage going up to releasing the site from under CNCAN requirements, which include decontamination, dismantling, processing and waste disposal activities and land restoration and cleaning.

Once the project reaches the end of the operation period, a plan for shutdown and decommissioning will be prepared, according to the provisions of normative acts in force at the time. Decommissioning a nuclear facility is regulated by the provisions of Law No. 111/1996 on the safe deployment, regulation, authorization and control of nuclear activities, republished, as further amended and supplemented and by "The norms on specific requirements for quality management systems applied to nuclear facilities decommissioning" (NMC-11). Also, when planning a decommissioning, current applicable international standards are used.

Internal norms and international regulations specific for decommissioning recommend the preparation of a Decommissioning plan in three stages, as follows:

- *Initial decommissioning plan,* prepared since the design and construction phase of the nuclear objective.
- *Decommissioning plan in the process,* prepared when the nuclear objective is in operation.
- *The final decommissioning plan,* at the end of the operational period, necessary for the actual start of the decommissioning process.

This plan will include procedures to be followed for decommissioning, removal and storage of equipment and structures present on site and to restore the original state of the land for future use

The shutdown and decommissioning plan will also include actions to comply with the limits imposed by environmental legislation and will be subject to approval by the authorities with responsibilities in the field.

Shutdown and decommissioning activities will start and unfold strictly after obtaining the legal authorizations/licences.

The decommissioning project will be subject to environmental assessment procedure for issuing environmental permits in accordance with Directive 2011/92/EU on the assessment of effects of certain public and private projects on the environment, as further amended and supplemented, transposed in the national legislation.

The conditions required to be met when shutting down/decommissioning nuclear facilities as well as those necessary to restore the original state of the land will be determined in the procedure of environmental impact assessment for this kind of project, after analyzing a technical documentation that will meet the requirements of the norms, practices, national and international legislation, and will be included in the environmental approval issued for this type of project.
The technical documentation shall also include the monitoring plan of the environmental components.

IX. ABBREVIATIONS – SYMBOLS – DEFINITIONS

AECL	Societatea Canadiană pentru Energie Atomică	**AECL**	Atomic Energy of Canada Limited
AIEA	Agenției Internaționale pentru Energie Atomică din Viena	**IAEA**	International Atomic Energy Agency, Vienna, Austria
ALARA	***Cel mai scazut nivel rezonabil posibil***: reprezintă principiul de optimizare a radioprotecției, în sensul de a asigura că toate expunerile, inclusiv cele potențiale, din cadrul practicii desfăşurate să fie menținute la cel mai scăzut nivel rezonabil posibil, luând în considerare factorii economici şi sociali	**ALARA**	„As Low As Reasonably Achievable", a radiation safety principle for minimizing radiation doses and releases of radioactive materials as low as can be achieved, based on technologic and economic considerations
CAN/CSA-N288.2-M91 (R2008)	Ghid pentru calculul dozelor de radiații pentru public ca urmare a emisiei de material radioactiv în aer în condiții de accident ipotetic la reactoare nucleare – standard emis de Asociația de Standardizare din Canada	**CAN/CSA-N288.2-M91 (R2008)**	Guidelines for Calculating Radiation Doses to the Public From a Release of Airborne Radioactive Material Under Hypothetical Accident Conditions in Nuclear Reactors – standard issued by the Canadian Standards Association
CANDU	CANada Deuterium Uranium	**CANDU**	CANada Deuterium Uranium
CDS	Sistem de distilare criogenica	**CDS**	Cryogenic Distillation System
Ci	Curie (Unitate de măsură a radioactivității, egală cu activitatea unui material radioactiv în care se dezintegrează 3,7x 10^{10} nuclee pe secundă)	**Ci**	Curie - An unit of radioactivity equal to 3.1x10^{10} desintegrations per second
CITON	Sucursala de Inginerie Tehnologică Obiective Nucleare Bucureşti	**CITON**	Subsidiary of Technology and Engineering for Nuclear Projects
CLP	Regulamentul (CE) 1272/2008 privind clasificarea, etichetarea şi ambalarea substanțelor şi a amestecurilor, de modificare şi de abrogare a Directivelor 67/548/CEE şi 1999/45/CE, precum şi de modificare a Regulamentului (CE) nr. 1907/2006	**CLP**	Chemical Labeling and Packaging Regulation (EC) on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No. 1907/2006
CNCAN	Comisia Națională pentru Controlul Activităților Nucleare	**CNCAN**	The National Commission for Nuclear Activities Control in Romania
CNE	Centrala Nuclear-Electrică (Centrala Nuclear-Electrică de la Cernavodă)	**NPP**	Nuclear Power Plant
COG	Grupul deținătorilor de instalații de tip CANDU	**COG**	CANDU Owners Group
COV	Compuşi organici volatili	**VOC**	Volatile Organic Compunds
CTRF	Instalația de detritiere Cernavodă	**CTRF**	Cernavoda Tritium Removal Facility

D **^2_1H**	Deuteriu Izotop stabil al hidrogenului, cu 1 proton şi 1 neutron - abundența naturală 0,0156%	**D** **^2_1H**	Deuterium Stable isotope of hydrogen with 1 proton and 1 neutron - natural abundance of 0.0156%
D_2	Deuteriu molecular	**D_2**	Molecular Deuterium
D_2O	Apă grea	**D_2O**	Heavy Water
DT	Deuteriu tritiat	**DT**	Tritiated Deuterium
DTO	Apă grea tritiată	**DTO**	Tritiated heavy water
DTRF	Instalația de detritiere de la Darlington, Canada	**DTRF**	Darlington Tritium Removal Facility
H **^1_1H**	Protiu Izotop comun, stabil al hidrogenului, cu 1 proton şi 0 neutroni – abundența naturală 99,985 %	**H** **^1_1H**	Protium Common, stable isotope of hydrogen with 1 proton and 0 neutrons - natural abundance of 99.985%
HTET	Sistemul de expansiune a titiului de concentrație ridicată	**HTET**	High Tritium Expansion Tank
HWFS	Sistemul de apa grea de alimentare	**HWFS**	Heavy Water Feed System
ICSI	Institutul National de Cercetare-Dezvoltare pentru Tehnologii Criogenice şi Izotopice – Râmnicu Vâlcea	**ICSI**	The National R&D Institute of Cryogenics and Isotopic Technologies – Râmnicu Vâlcea
IED	Directiva 2010/75/UE privind emisiile industriale (prevenirea şi controlul integrat al poluării) (reformare)	**IED**	Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) (Recast)
IMA	Instalații mari de ardere	**LCP**	Large Combustion Plants
IPPC	Directiva 2008/1/CE privind prevenirea si controlul integrat al poluarii	**IPPC**	Directive 2008/1/EC concerning integrated pollution prevention and control
ITC	Stocator cu titaniu spongios	**ITC**	Immobilized Tritium Container
LCS	Sistem de drenaje şi colectare apă grea	**LCS**	Liquid Collection System
LPCE	(Sistem de) Schimb isotopic catalitic in fază lichidă	**LPCE**	Liquid Phase Catalitic Exchange (System)
LTET	Sistemul de Expansiune a Tritiului de Activitate Joasă	**LTET**	Low Tritium Expansion Tank
MEL	Sistem de monitorizare a efluentului lichid	**LEM**	Liquid Effluent Monitoring
OPEX	Experiență de operare	**OPEX**	OPerating EXperience
SCI	Situri de importanță comunitară	**SCI**	Sites of Community Importance
SEVESO	Directiva privind controlul asupra riscului de accidente majore care implică substanțe periculoase	**SEVESO**	Directive on the control of major-accident hazards involving dangerous substances
SNN-SA	Societatea Națională Nuclearelectrica SA	**SNN-SA**	Nuclearelectrica SA National Company
SPA	Arii de protecție specială avifaunistică	**SPA**	Special Protection Areas for Birds
SPTC	Sistem primar de transport al căldurii	**PHTS**	Primary Heat Transport System
T **^3_1H**	Tritiu Izotop instabil al hidrogenului, cu 1 proton şi 2 neutroni	**T** **^3_1H**	Tritium Unstable isotope of hydrogen with 1 proton and 2 neutrons
T_2	Tritiu molecular	**T_2**	Molecular Tritium

TGHS	Manipulare si stocare tritiu gazos	**TGHS**	Tritium Gas Handling and Storage
TGHSS	Sistemul de manipulare si stocare tritiu gaz	**TGHSS**	Tritium gas handling and storage system
TRS	Sistem de Reținere Tritiu	**TRS**	Tritium retention system
U1, U2	Unitatea nucleară 1, Unitatea nucleară 2 – ale CNE Cernavodă	**U1, U2**	Nuclear Unit 1 and 2 of NPP Cernavodă
UE	Uniunea Europeană	**EU**	The European Union
WTRF	Instalația de detritiere de la Wolsong, Coreea	**WTRF**	Wolsong Tritium Removal Facility

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XI. Annexes. Drawings

1. CTRF location in the area
2. CTRF layout
3. Other annexes – elaborator's competence

Prepared by:

Gyongyi RUZSA – expert SC Cepstra Grup SRL

Anca DRAGOMIR – expert SC Cepstra Grup SRL

Daniela ZISU – expert SC Cepstra Grup SRL

Verified by:

Sorina ILIUȚĂ – expert SC Cepstra Grup SRL

Approved by:

Mihai ZAPLAIC, PhD – expert SC Cepstra Grup SRL, director

Accepted by:

Liviu ŞTEFAN – INC DTCI ICSI Rm. Vâlcea
Project Coordinator

Irina Florența MARIN, PhD – NPP I Expert
External Interfaces and Environmental Group Coordinator

Nicolae TRANTEA – Project Management Superintendent

APPROVED

CERNAVODĂ NPP DIRECTOR

Ionel BUCUR, PhD.