Cernavoda Tritium Removal Facility Project

Laura Elena Moscu-Thijov, Cernavoda NPP
Andrei Cristian Cotoban, Cernavoda NPP

Technical Meeting on Tritium Breeding Blankets and Associated Neutronics

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Content

CTRF Short History

- 2005 – 2006: Early prefeasibility and feasibility studies, ICSI & AECL;
- 2007: Started conceptual design of CTRF;
- 2011: Major change into the project – including change of location and enhanced safety requirements following recommendations post Fukushima;
- 2015: End of conceptual design phase and associated safety documentation. Design considered the R&D works performed by ICSI Rm. Valcea (specialized in isotopic separation and cryogenic technologies) and other Romanian design organizations and extensively used the OPEX from DTRF and WTRF;
- 2015: CNCAN issue the Letter of Comfort for CTRF Project – the project is licensable;
- 2018: Updating the feasibility study and final project Investment approved by SNN shareholders;
- 2020: Prequalification Document issued for potential Participants to the EPC contract award procedure;
- 2021: Invitation to Tender for Design and Build CTRF issued for Participants;
- 2023: EPC Contract Signed

Project Strategy

- The project is part of Nuclearelectrica's portfolio of initiatives, aimed at the consistent implementation of the Company's general policy, vison and mission, namely for maintaining nuclear safety at the highest standards;
- Using a Romanian innovative technology, developed by the Romanian National and Development Institute for Cryogenic and Isotopic Technologies (ICSI), Cernavoda Tritium Removal Facility (CTRF) will be the world's third and Europe's first Tritium Removal Facility;
- The purpose of CTRF is to extract the tritium from heavy water used in the moderator and in the primary heat transport system resulting in a significant reduction of the radioactive emissions to the environment and of the internal dose exposure of the operation personnel;
- Project Implementation strategy includes an Owner's Engineer contract to supplement SNN's resources involved in the CTRF Project management and an EPC contract for providing the detailed design, procurement, construction and installation works, commissioning and support for a 6 months trial run.

Project Major Milestones

The contracted project EPC execution has the following main milestones:

- Contract commencement date (EPC) – July 2023
- Obtaining permits and starting the construction-assembly works – May 2024
- Commissioning works finalized and start of Trial Run – September 2027;

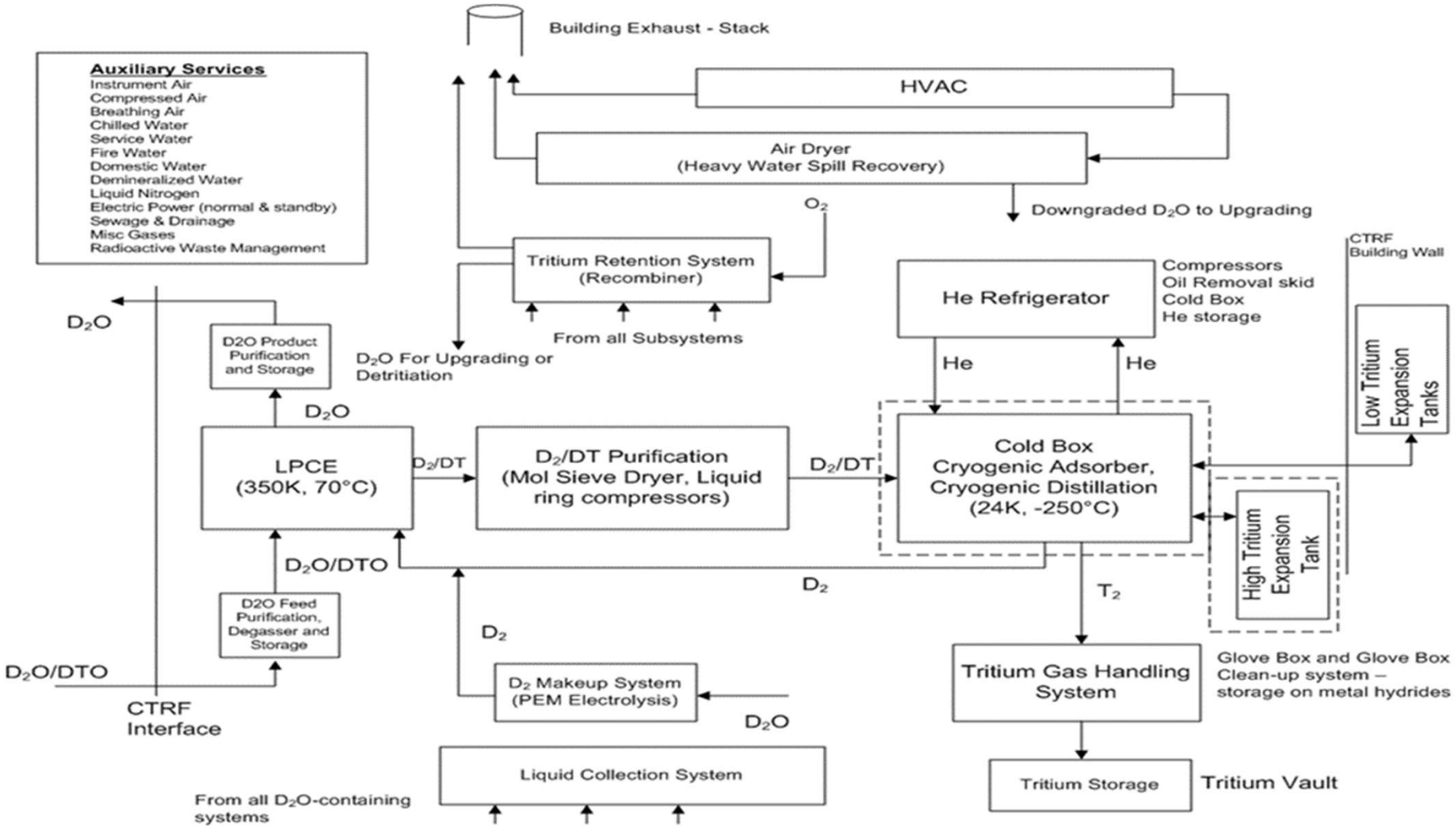
Up to date, Contract has been signed, all the permits for contraction were obtained and activities for design, procurement and construction are ongoing.

Project Participants

- OE contract RUEC # 679/04.06.2020 signed with KINECTRICS, who is nominated as the Engineer in the EPC contract;
- Plant and Design-Build (FIDIC Yellow) EPC contract RUEC # 961/28.06.2023 awarded to KHNP as the Main Contractor, and
  - Design services subcontracted to KEPCO E&C overall designer and A/E, supported by Sargent & Lundy - USA and CITON - Romania as designer subcontractor;
  - Construction and installation works subcontracted to Hyundai and Samsung Joint Venture. Local contractors are involved for specific works, as required;
  - Supply of LPCE columns and catalyst contracted to ICSI Rm. Valcea.

Background presentation

- A processing facility for CNE-Cernavoda, Units 1 & 2, which will separate tritium contained in moderator and PHT heavy water;
- Process involves feeding the tritiated heavy water to a LPCE system where the tritium content is transferred from liquid into a gas phase, to a deuterium gas flow;
- This is followed by a Cryogenic Distillation (CD) process which separates tritium gas from deuterium gas.
- Tritium gas handling and storage system receives tritium gas and absorbs it onto titanium storage beds within specialised storage containers. These are stored onsite in a dedicated vault.

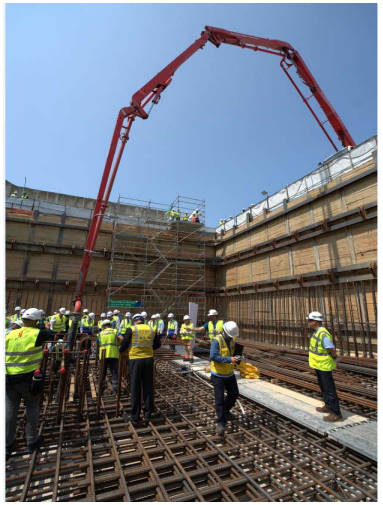

Building Exhaust - Stack
Auxiliary Services
Instrument Air
Compressed Air
Breathing Air
Chilled Water
Service Water
Fire Water
Domestic Water
Demineralized Water
Liquid Nitrogen
Electric Power (normal & standby)
Sewage & Drainage
Misc Gases
Radioactive Waste Management
HVAC
Air Dryer
(Heavy Water Spill Recovery)
Downgraded D2O to Upgrading
O2
Tritium Retention System
(Recombiner)
From all Subsystems
D2O For Upgrading or
Detritiation
He Refrigerator
Compressors
Oil Removal skid
Cold Box
He storage
CTRF
Building Wall
Low Tritium
Expansion
Tanks
He
He
D2O
D2O Product
Purification
and Storage
D2O
LPCE
(350K, 70°C)
D2/DT
D2/DT Purification
(Mol Sieve Dryer, Liquid
ring compressors)
D2/DT
Cold Box
Cryogenic Adsorber,
Cryogenic Distillation
(24K, -250°C)
High Tritium
Expansion
Tank
D2O/DTO
D2
T2
D2O Feed
Purification,
Degasser and
Storage
D2
D2O/DTO
D2 Makeup System
(PEM Electrolysis)
D2O
Tritium Gas Handling
System
Glove Box and Glove Box
Clean-up system –
storage on metal hydrides
CTRF
Interface
Liquid Collection System
Tritium Storage
Tritium Vault
From all D2O-containing
systems

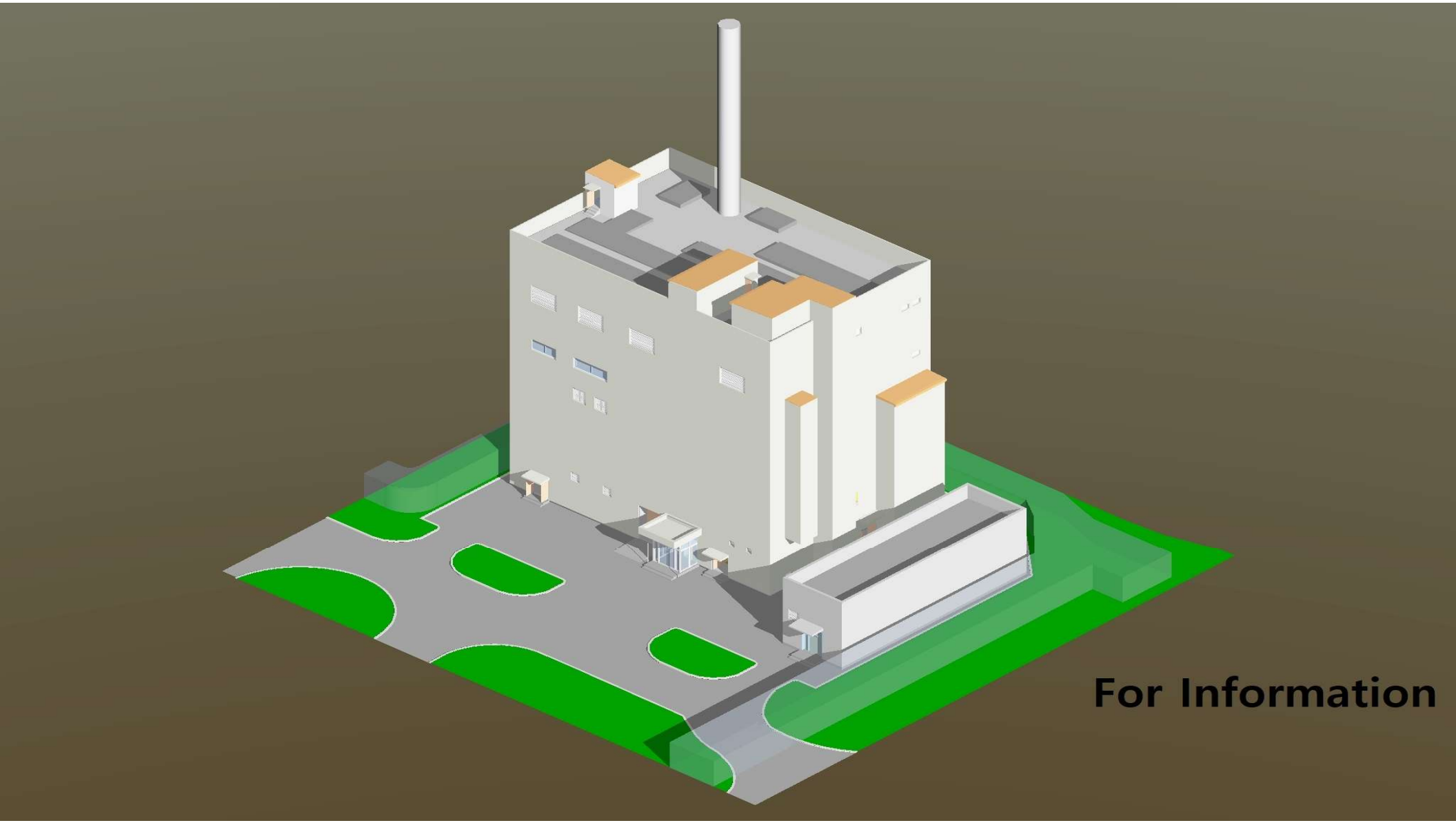
Main CTRF Process Specifications and Key Features

- Feed rate = 40 kg/h, with a Tritium concentration in the feed = 54 Ci/kg (lower for PHT)
- Design service life = 40 years, with a design availability target = 80%
- Detritiation factor = minimum 50, design performed for 100
- D_2 inventory in the plant = 34 kg (approx. 203 Nm^3)
- Tritium inventory in the process = 2.83 x 10^4 TBq
- Process uses high vacuum and low temperatures (< 10^{-8} torr, 20 K)
- High integrity systems with leak rates < 10^{-8} atm cc/sec helium
- Heavy water feed and product systems are located in the station Service Buildings, with the role to remove LPCE catalytic poisons and radionuclides, other than tritium, from heavy water to be fed to the CTRF. Water transportation from station to CTRF is exclusively by pipeline;
- CTRF – independent from the station, utilities. Cooling and chilled water, instrument and breathing air, and support gases (nitrogen, oxygen, helium) are produced or available on the CTRF site (not supplied by the station);
- Provisions taken for electrical ventilation intake air heating, to avoid HW systems freezing in case of loss of class IV power;

CTRF Project Status

- Environmental Permit obtained form Environmental Ministry in January 2023;
- EPC Contract Signed in June 2023;
- Sitting and Construction Authorizations obtained from CNCAN in March 2024;
- Detailed design development in progress;
- Procurement of LLI Ongoing;
- Construction works started in May 2024;
- Deep excavation finalised;
- Reinforcement for first level ongoing.





For Information

Expected Benefits from CTFR Operation

- Reinforcing the ALARA principle;
- 5-6 x personnel dose reduction;
- 4-5 x reduction in emissions to environment (Wolsung OPEX shows a 20% reduction after the first year of operation);
- Operational cost savings in terms of radioprotection materials and radioactive wastes;
- Reduced cost of maintenance materials;
- Significant waste storage and decommissioning costs savings;
- Potential for tritium as marketable product for future fusion energy generation;
- Potential for He3 sales;

Conclusions

- CTRF project is the newest TRF project at industrial scale and includes previous experience gained at research level and from DTRF and WTRF;
- The CTRF project is an evolution in the industrial-sized TRF market and can be considered as a reference project for the construction of a new TRF that meets current technical and safety requirements;
- Project is now active: Design, Procurement and Construction underway;
- Operation of CTRF will have a great benefit by reducing the concentration of tritium in heavy water minimizes the radiological dangers associated with possible escapes from the technological circuits of reactors containing this fluid. It is estimated that the operation of the detritiation installation will reduce the radiological effects of possible heavy water escapes by about 5 times;
- Operation of CTRF will conduct to have a significant benefit for:
  - waste storage and decommissioning costs savings;
  - Tritium as marketable product for future fusion energy generation.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Thank you!
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VIZIUNESNN
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SIGURANȚĂ ȘI SUSTENABILITATE
EXCELENȚĂ PROFESIONALĂ
GRIJĂ FAȚĂ DE ANGAJAȚI
EMPATIE ȘI RESPONSABILITATE
DEZVOLTARE DURABILĂ
Questions
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