ПРЕДПРИЯТИЕ ГОСКОРПОРАЦИИ «РОСАТОМ»

FSUE «RosRAO»

Economic impediments to tritium separation technologies

Sergei Floria, Dr.
Head of project management office

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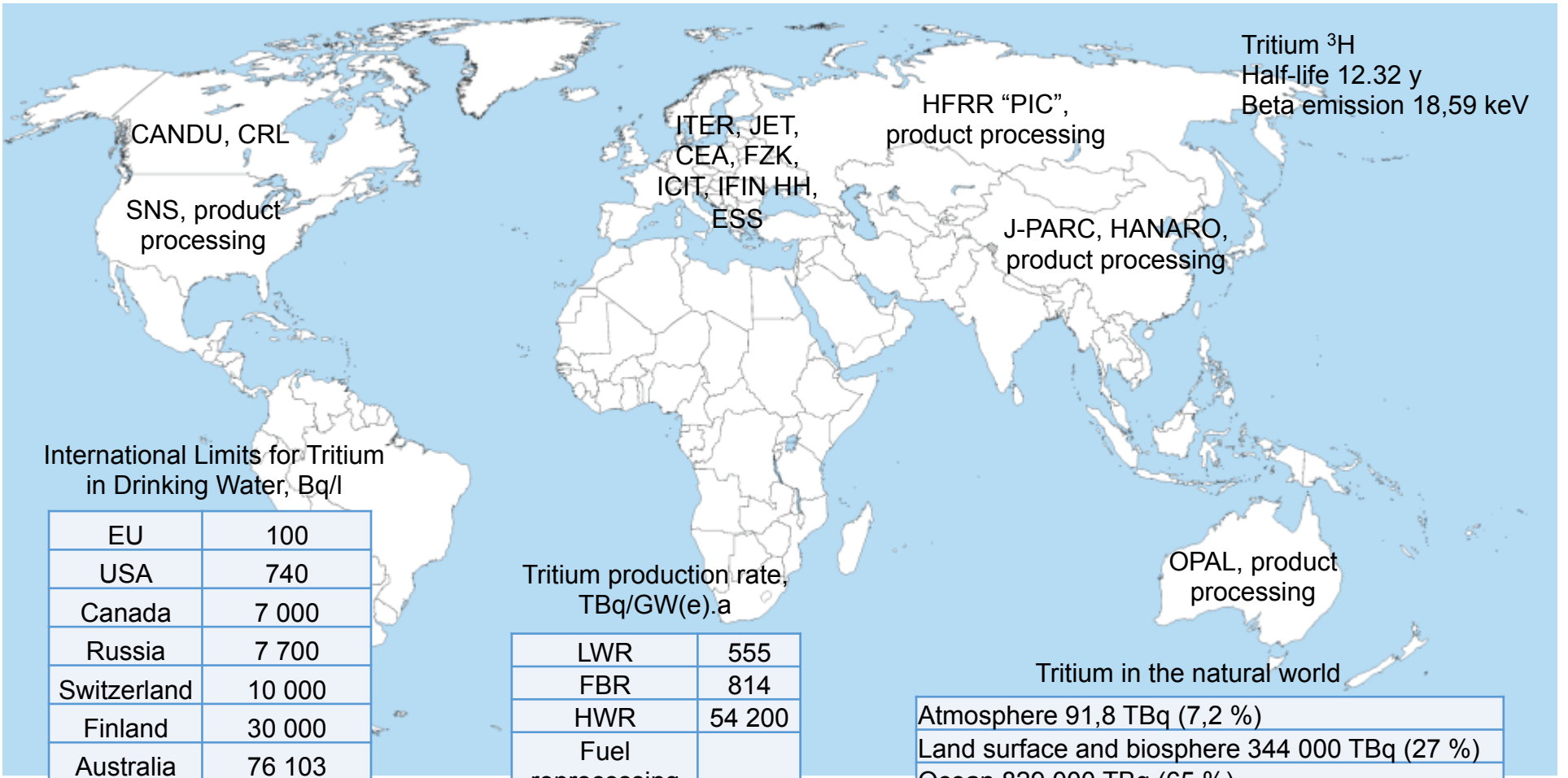
Sources of tritium and regulations



International Limits for Tritium in Drinking Water, Bq/l

EU	100
USA	740
Canada	7 000
Russia	7 700
Switzerland	10 000
Finland	30 000
Australia	76 103
WHO	10 000

* hold most countries of the world

Tritium production rate, TBq/GW(e).a

LWR	555
FBR	814
HWR	54 200
Fuel reprocessing plant (1400 t/a)	30 000

Tritium in the natural world

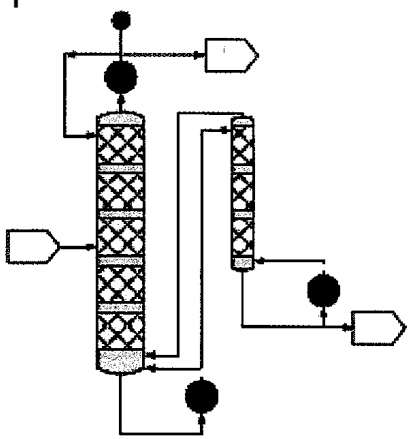
Atmosphere 91,8 TBq (7,2 %)
Land surface and biosphere 344 000 TBq (27 %)
Ocean 829 000 TBq (65 %)
Generated by cosmic ray 72 000 TBq/year

World practice (core technology)

Water rectification (WD)

Proven technology in the production of heavy water. Water purification from tritium is based on the difference between the volatility of HTO and H_2O. At 60^{0}C, the pressure of H_2O in the 1.056 more than HTO.

The downside of technology is the large amounts of energy to maintain a constant temperature and a large amount of equipment required.

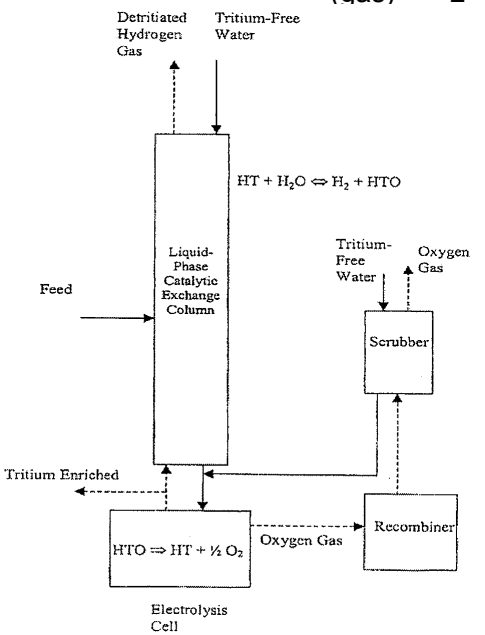


Two stage water purification by rectification.

Monotermal isotopic exchange in the system hydrogen-water (CECE)

Technology is based on the process of isotope exchange between the hydrogen atoms of water molecules and the hydrogen gas in which a heavy isotope (tritium) condenses in the liquid phase.

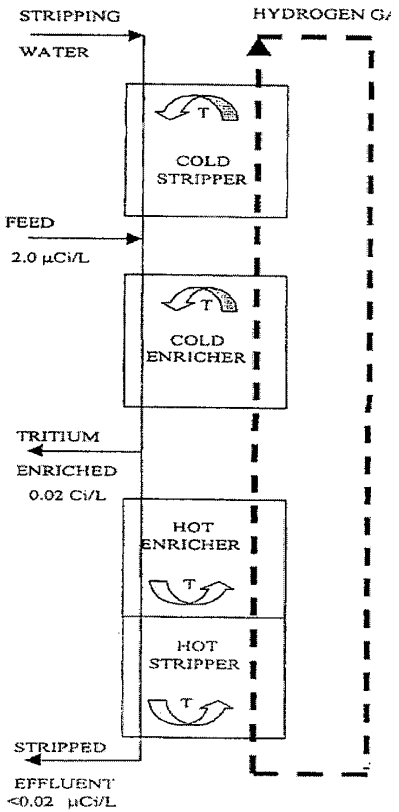
$$HT_{(gas)}+H_20=HTO+H_2 \qquad (1)$$



The downside of technology is the high consumption of electricity due electrolysis of the total incoming liquid radioactive waste, which also entails additional security requirements.

World practice (core technology)

Bitermal isotopic exchange in the system hydrogen-water (BHW)



The technology is also based on the reaction of (1), but does not require the electrolytic water supplied for processing. Thereby achieving a reduction in energy costs.
The downside of technology is the high operating pressure of the column ~ 50 atm. and a large volume of hydrogen gas.
Basically applicable when low purity.

Bitermal isotopic exchange in the system hydrogen sulfide-water

Just as in the process in the BHW - GS uses hot and cold column and the circulating gas system. However, GS as hydrogen sulfide gas is used. This technology is used for a long time for the production of heavy water.

The downside of technology is the use of highly toxic hydrogen sulfide under high pressure of about 20 atmospheres.

World experience (facilities in operation)

South Korea. Wolsong tritium removal facility, 100 kg/h

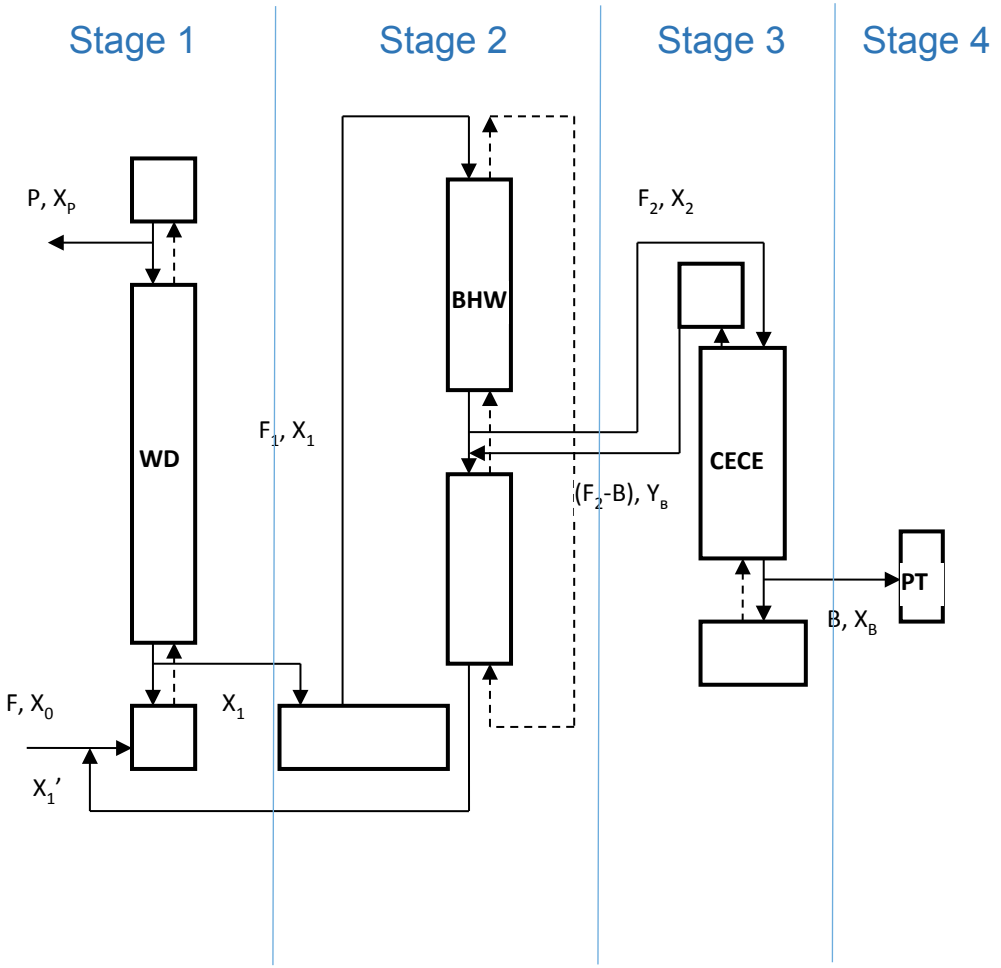
Canada. Prototype CIRCE, 300-500 kg/h

Romania, ICSI - TRF, 4-8 kg/h

Russia. TRW-test, 2 kg/h

Selection of the technology

Technological scheme



On the set input is fed tritium condensate .

Further processing is carried out on three consecutive units.

Rectifier unit (WD) provides distillate purification from impurities and salts of organic impurities and performs preliminary concentration of tritium in 10 times .

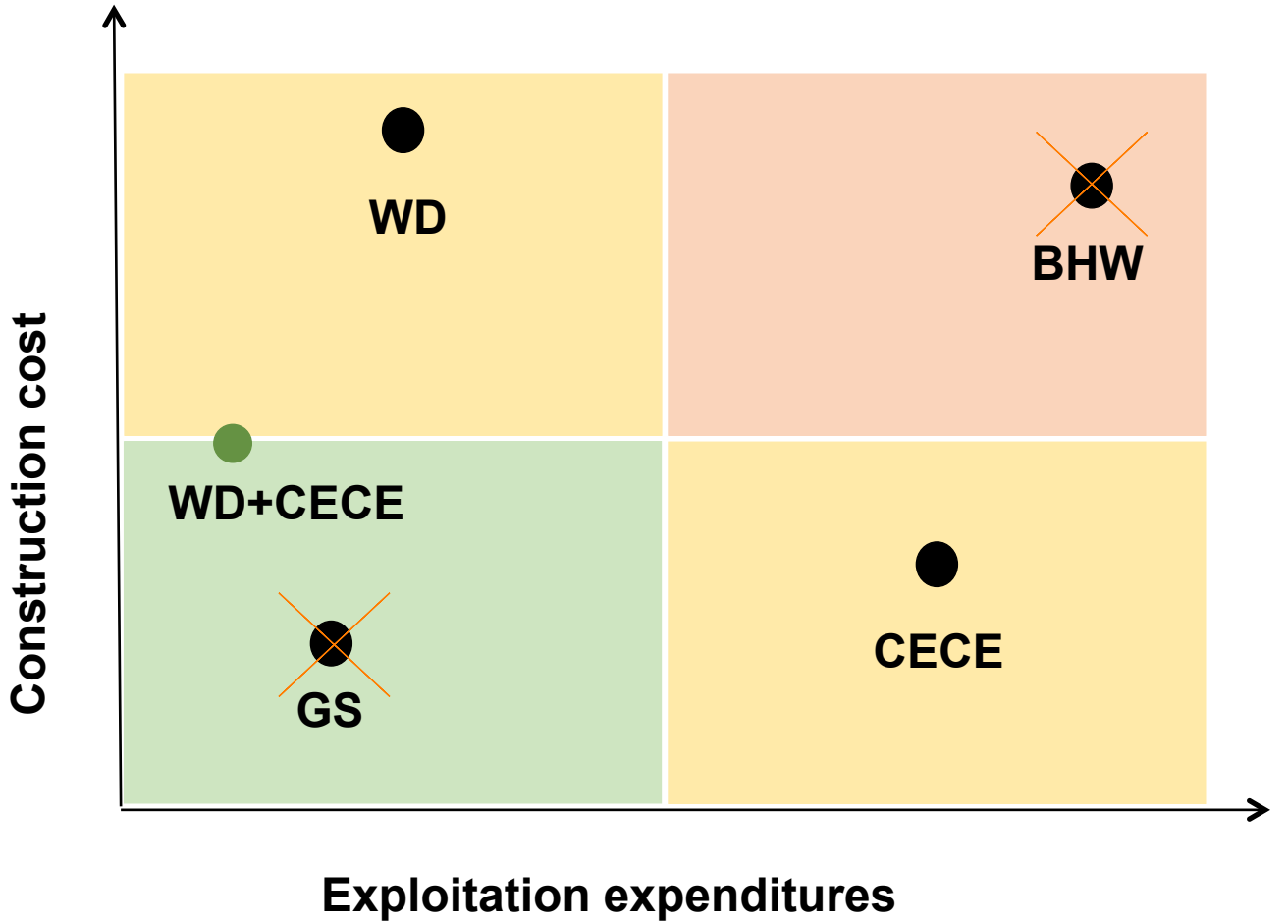
Two-temperature unit (BHW) provides a tritium concentration of 10.

Unit of the final concentration (CECE) provides tritium concentration in 200 times, and its subsequent fixation (PT) as a solid, air stable product - tritide titanium.

As a result, the concentration of tritium in the original LRW decrease of 20,000 times.

Comparison of technologies

Equal treatment rate and capacity



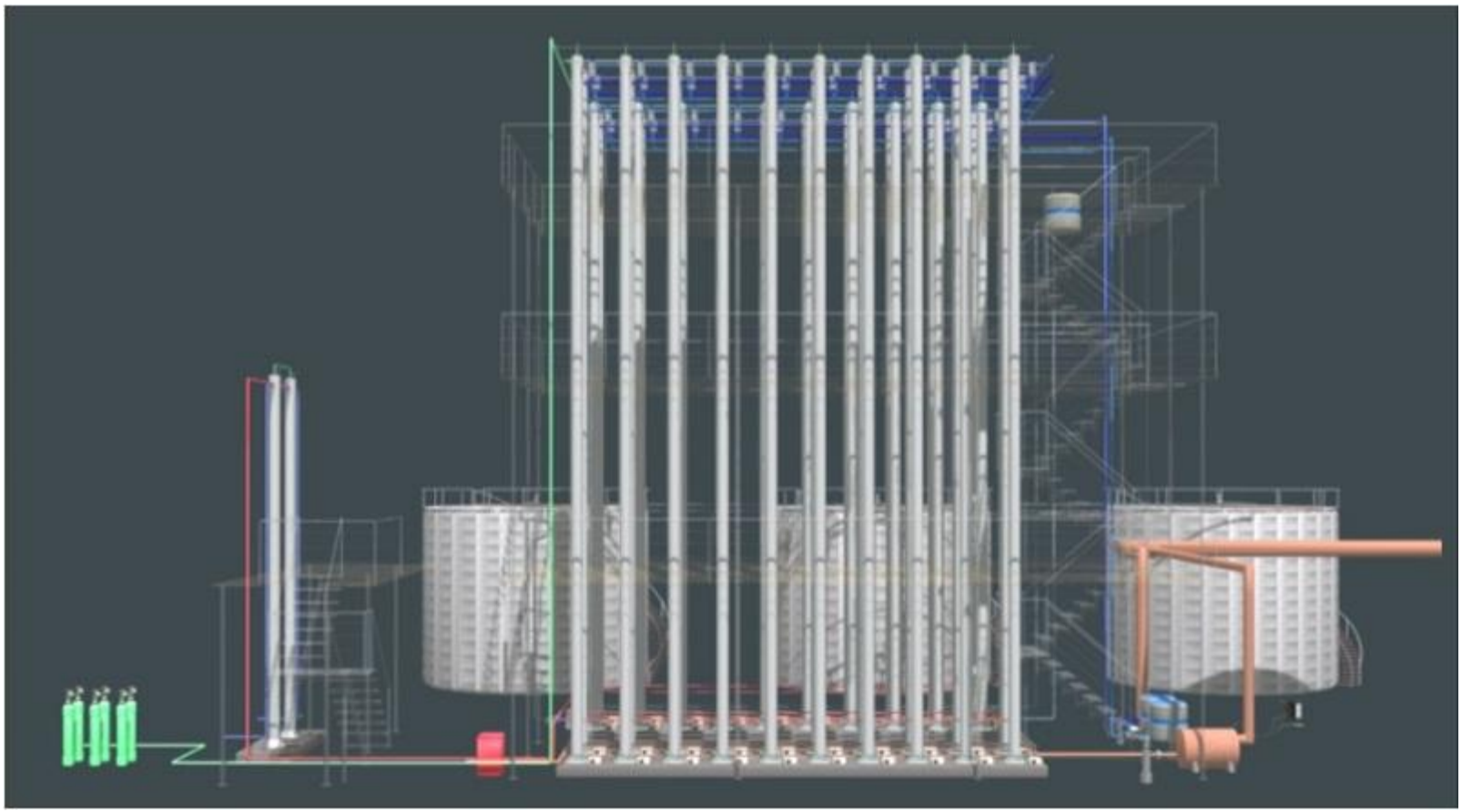
Tritium removal plant

Technical characteristics of the proposed plant:

Productivity – 0.1 м^3/ч
Degree of removal tritium – non less than 2 000
Degree of tritium concentration– non less than 20 000

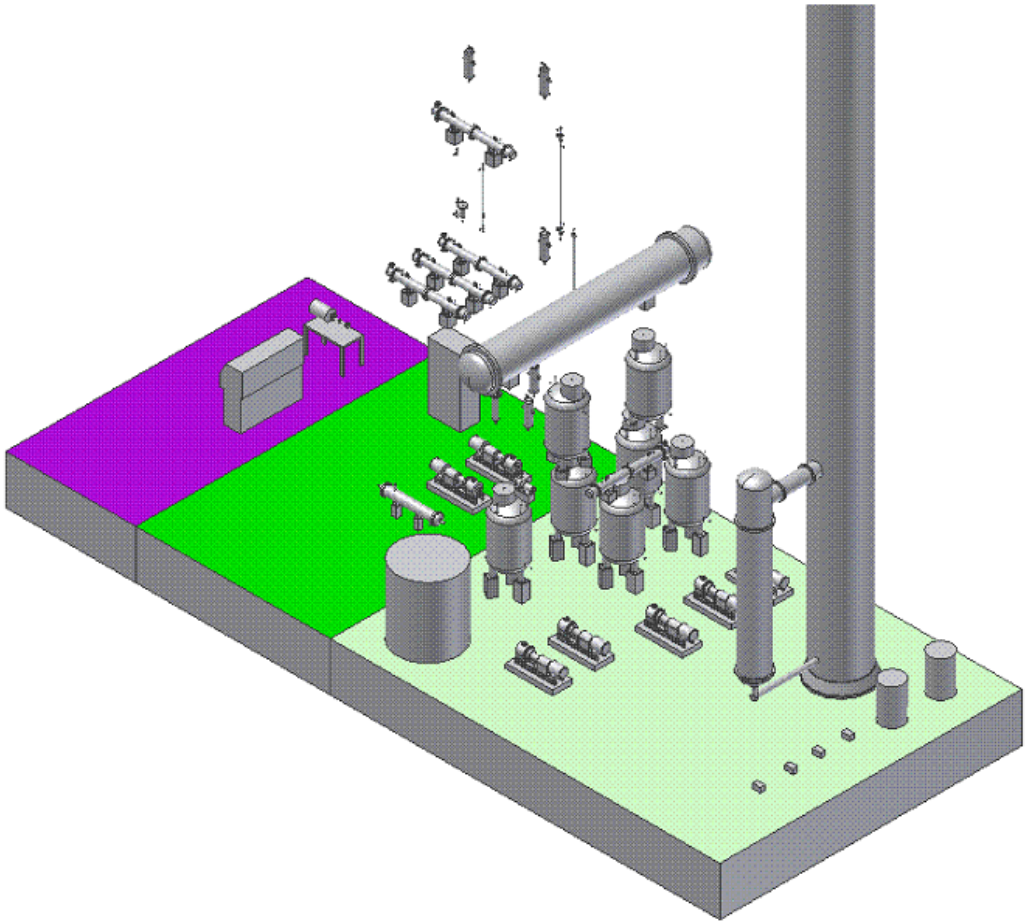
Energetic capacity:
Electricity– 100 kW/h
Steam, 2.5 MPa – 2800 kg/h

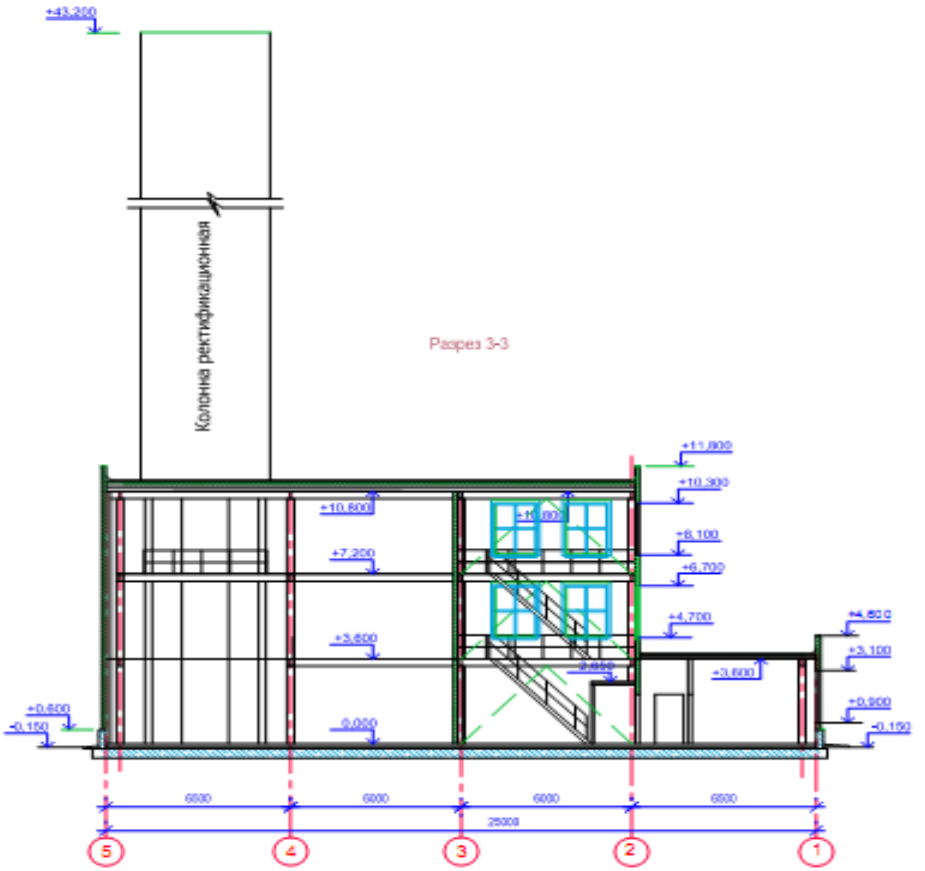
Dimensions 40 × 20 × 27 m
The construction time – 1 year



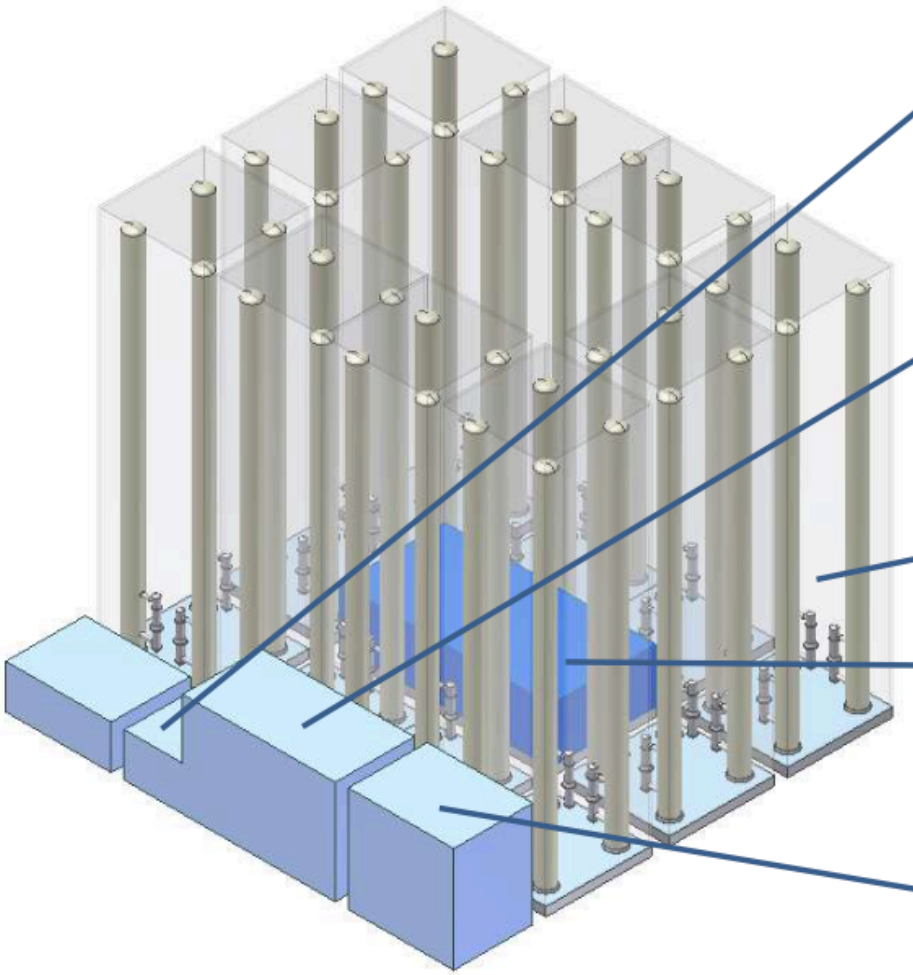
Tritium water accumulation problem at Fukushima NPP

Tritium separation demonstration system for Fukushima NPP





Example of layout of the system with the capacity 240 m^3/day



Hydration unit

Final concentration unit

Water distillation unit

Power unit

Utility spaces module

Thank you for your attention!

Dr. Sergei Floria
Project manager
+7-916-007-05-79
Florya.s@rosrao.ru

119017, Russia, Moscow,
Pyzhevsky lane., 6
Tel.: +7 (495) 710-76-48
Fax: +7 (495) 710-76-50
e-mail: info@rosrao.ru

www.rosrao.ru