ДСП «Чорнобильська АЕС»

Overview of decommissioning and RAW management technologies applied and planning at Chornobyl NPP

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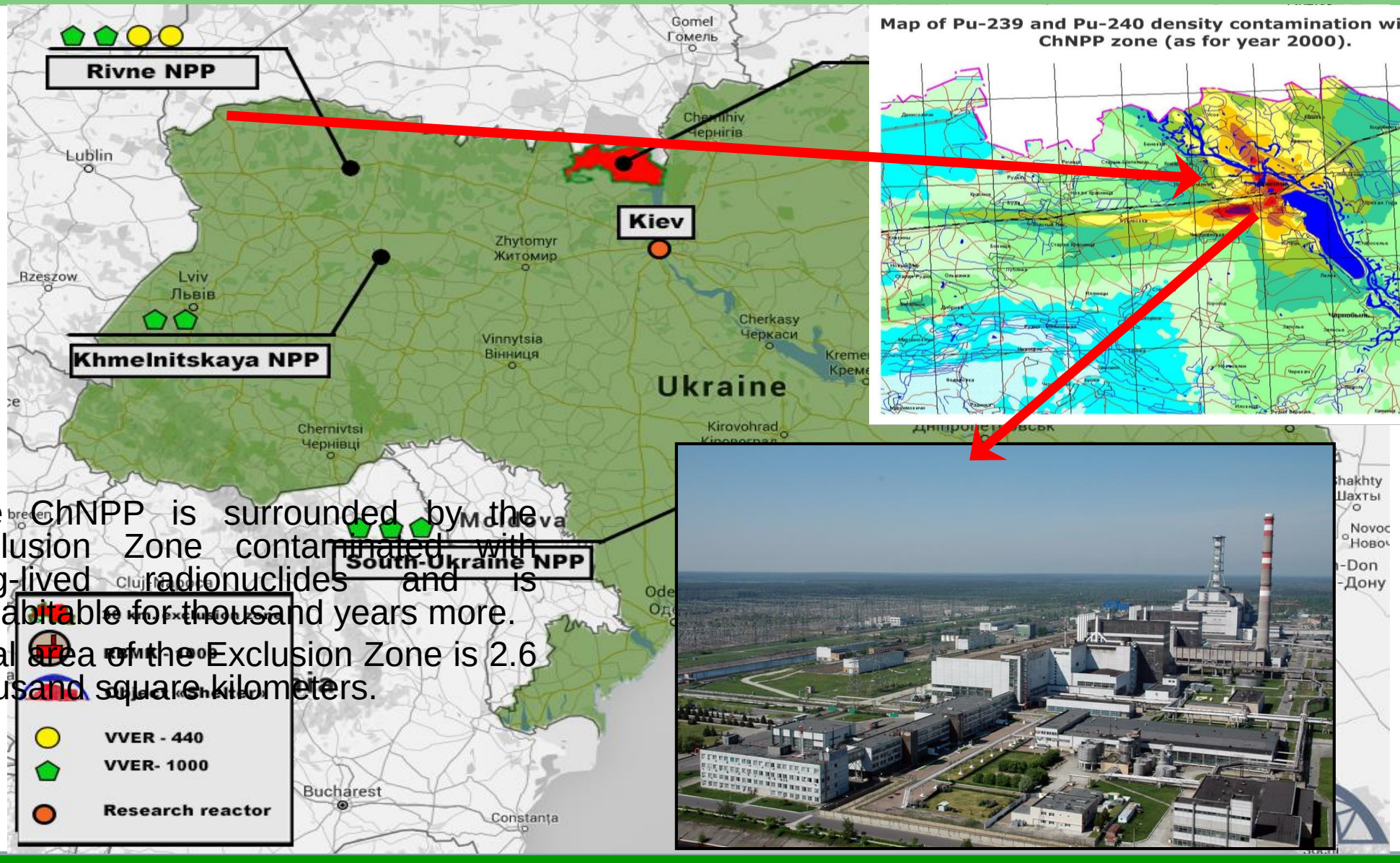
The Korea Atomic Energy Research Institute, Daejeon, South Korea, 29-30 August 2019

Chornobyl NPP



The ChNPP is surrounded by the Exclusion Zone contaminated with long-lived radionuclides and is unhabitable for thousand years more.

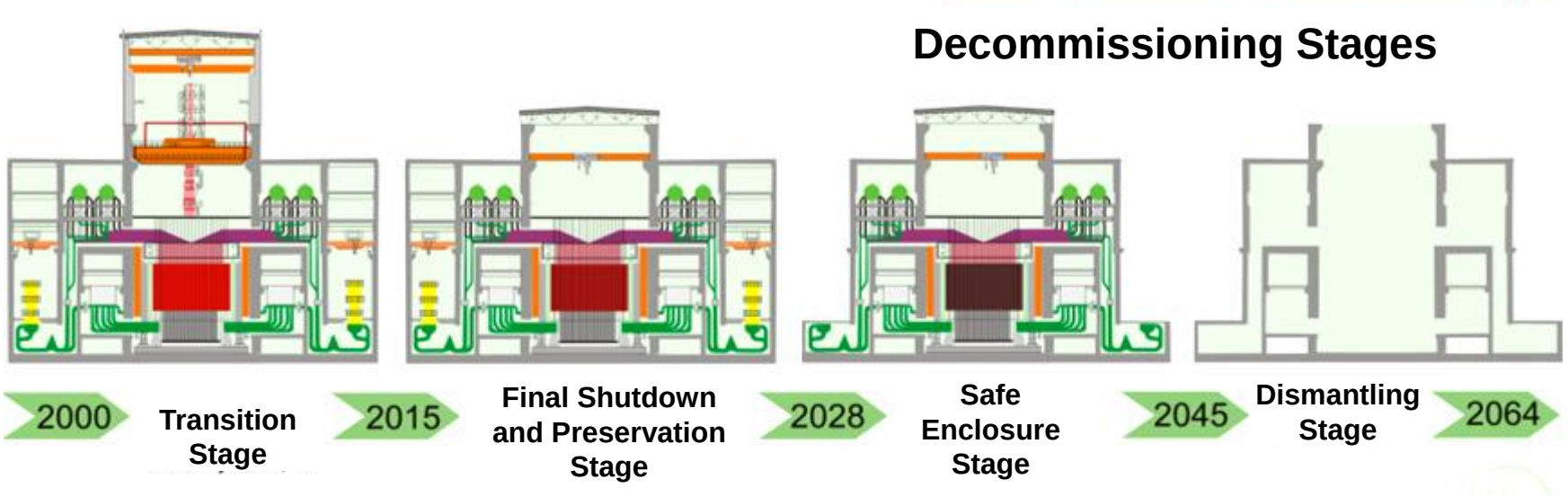
Total area of the Exclusion Zone is 2.6 thousand square kilometers.

Decommissioning technologies

ChNPP Decommissioning Strategy

A Deferred Dismantling Strategy is accepted for ChNPP:

- Preservation and long-term (up to 50 years) safe enclosure under supervision of the most contaminated equipment (primary circuit and reactor)
- Step-by-step dismantling of equipment – from the most “clean” to “contaminated”
- End state is “Brown spot”

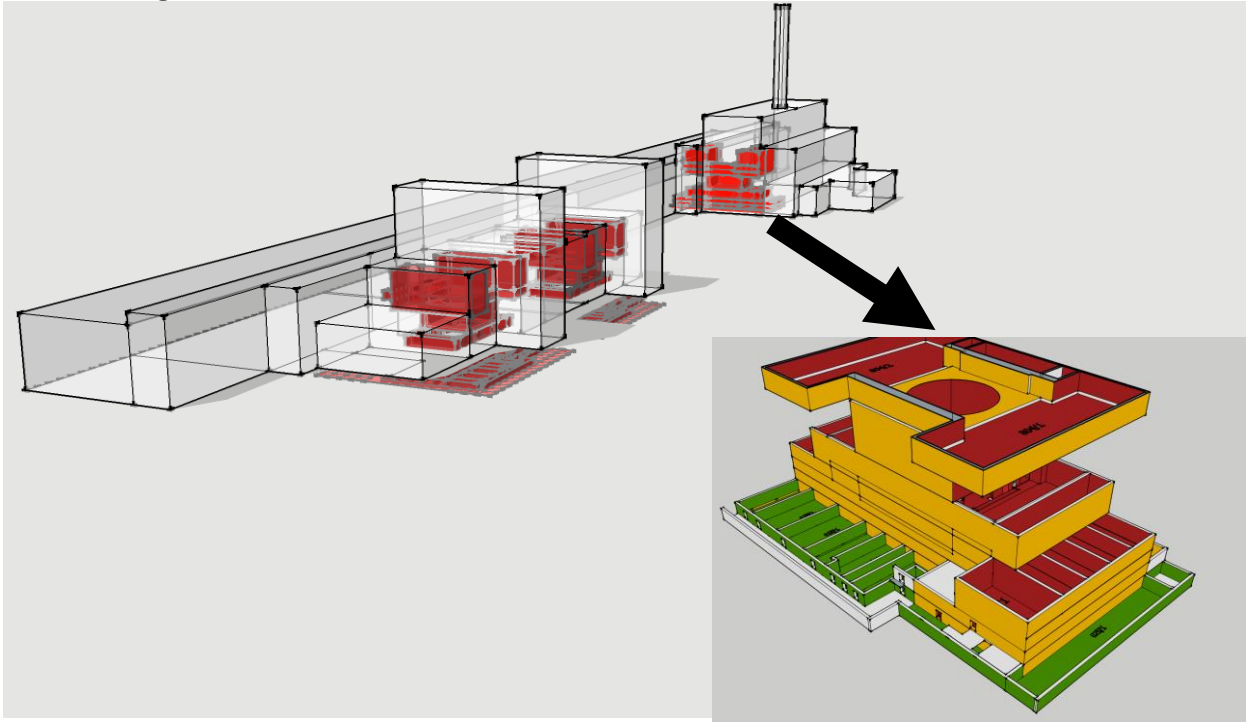


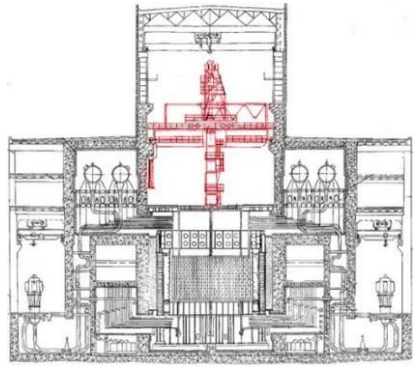
Implementation of FS&P Stage is to bring ChNPP Units 1, 2, 3 to the state which could provide long-term safe enclosure under supervision, with minimum resource consumption.

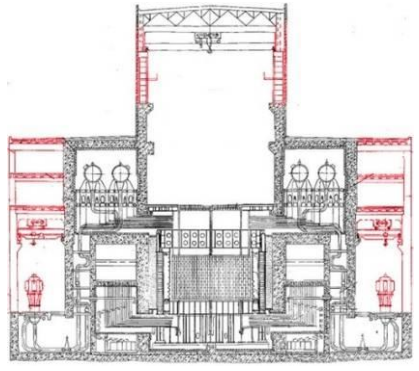
Final Shutdown and Preservation stage

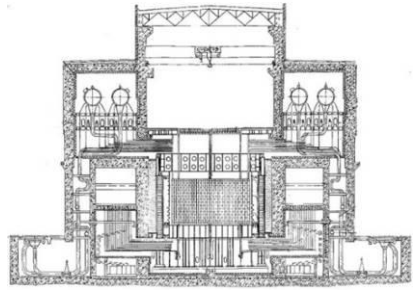
Preservation of reactor facility structures:

- ✓ Reconstruction of ChNPP fire fighting system;
- ✓ Dismantling and processing of fuel channels and control channels of Units No.1, 2 and 3;
- ✓ Preservation of reactors and localization of Units' preservation zone;
- ✓ Reconstruction of Central Halls' hipped roofs and dismantling of Units' handling machines.



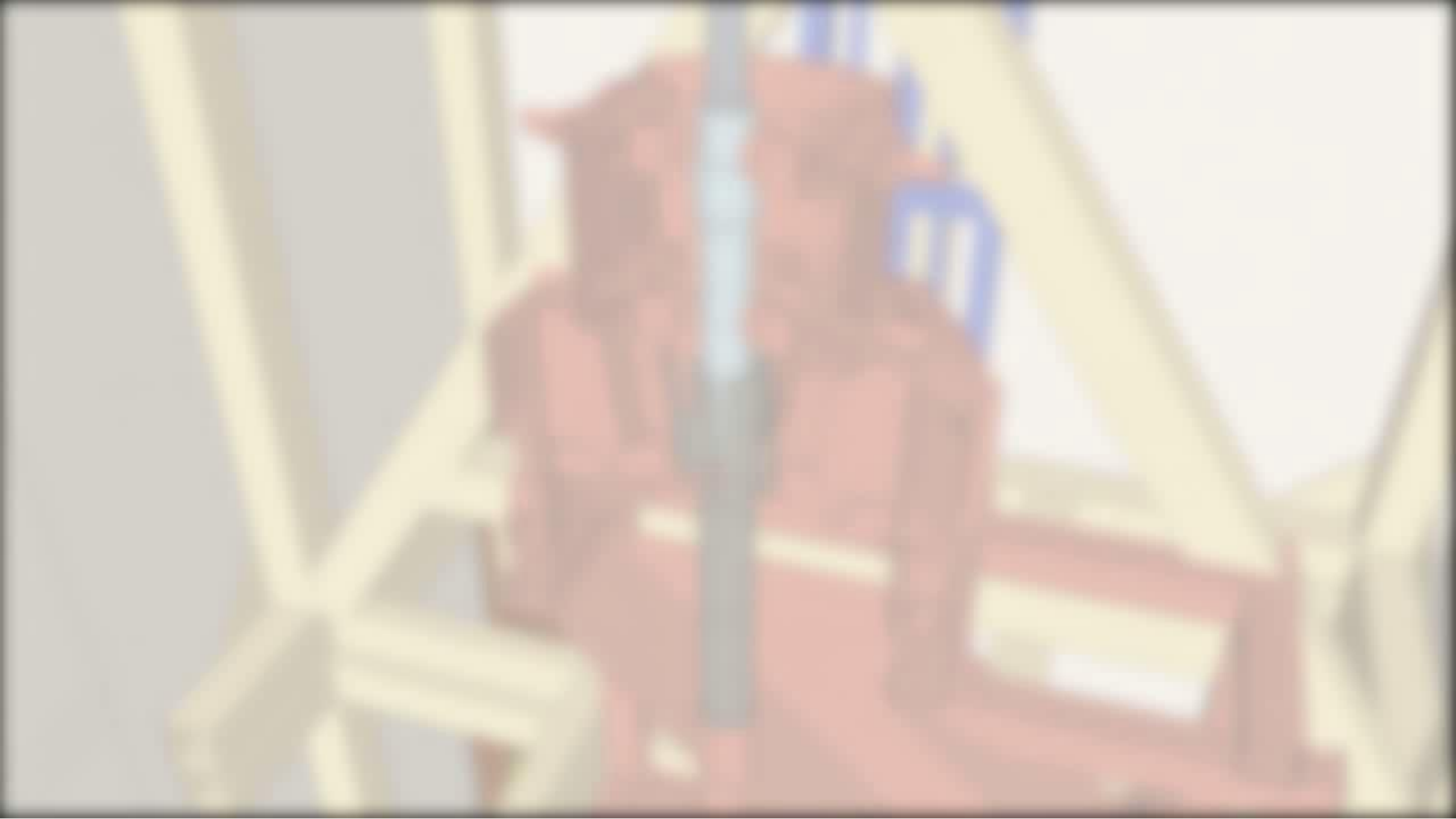






2015

2028



Dismantling technologies

Total amount of equipment to be dismantled at ChNPP is approximately 150,000 tons.

More than 10,000 tons of equipment are dismantled

Methods of dismantling :

- abrasive cutting tool,
- metal arc cutting,
- gas cutting

ChNPP decontamination technologies

Chemical techniques

- steam-jetting
- blasting
- immersion (bath)
- hydromechanical
- ultrasound

Physical techniques

- abrasive blasting

Electrochemical techniques

- immersion (bath)
- out of bath, with an outer electrode

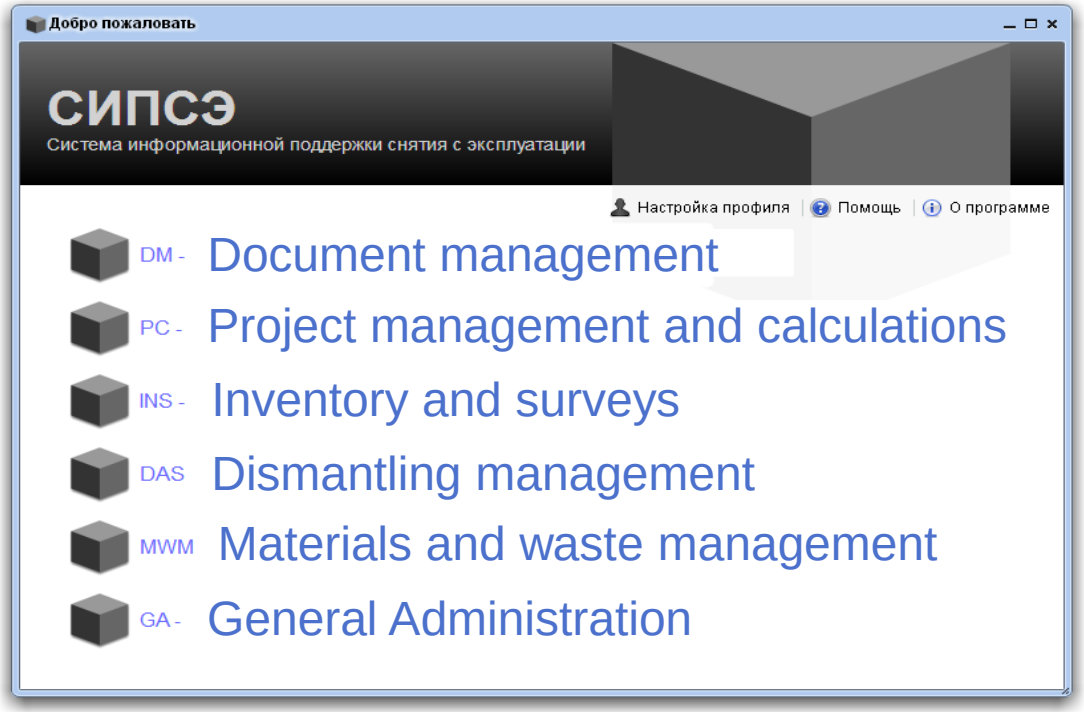
Performing the Comprehensive Engineering and Radiation Survey

CERS consists of four independent parts:

- engineering survey of equipment and systems of the unit;
- engineering survey of buildings, structures and premises;
- calculations of induced activity of reactor structures;
- radiation survey of the unit.

The CERS enabled to obtain the initial data for development of the ChNPP Decommissioning Program and the Design of Final Shutdown and Preservation of ChNPP Units.

Decommissioning Information Support System



- Storing data;
- Keeping track of the current state;
- Accounting of the dismantled equipment;
- Storing technical documentation;
- Coordination of materials and waste production and movement;
- Waste flow control and management of containers;
- Management of decommissioning projects;

Simulation of the processes of dismantling the roof elements of the "Shelter" and personnel doses assessment with the help of modern software tools

ChNPP Cooling Pond

- Length	11.4 km
- Average width	2.2 km
- Average depth	6.6 m
- Inmost depth	21 m
- Area	22.9 km^2
- Water level	111 mBS
- Water surface height over Prypiat River level	6-7 m

Decommissioning completion criteria are achieved regarding:

1. Water level
2. Equivalent dose rate
3. Radiation level in its surrounding areas
4. Formation of vegetation cover
5. Ecosystem transformation

Decommissioning technologies used at Chornobyl NPP

Performed

- Performing the Comprehensive Engineering and Radiation Survey
- Selection of the decommissioning strategy
- Design of Final Shutdown and Preservation of Chornobyl NPP Units 1, 2, 3
- Chornobyl NPP Cooling Pond decommissioning

Under development

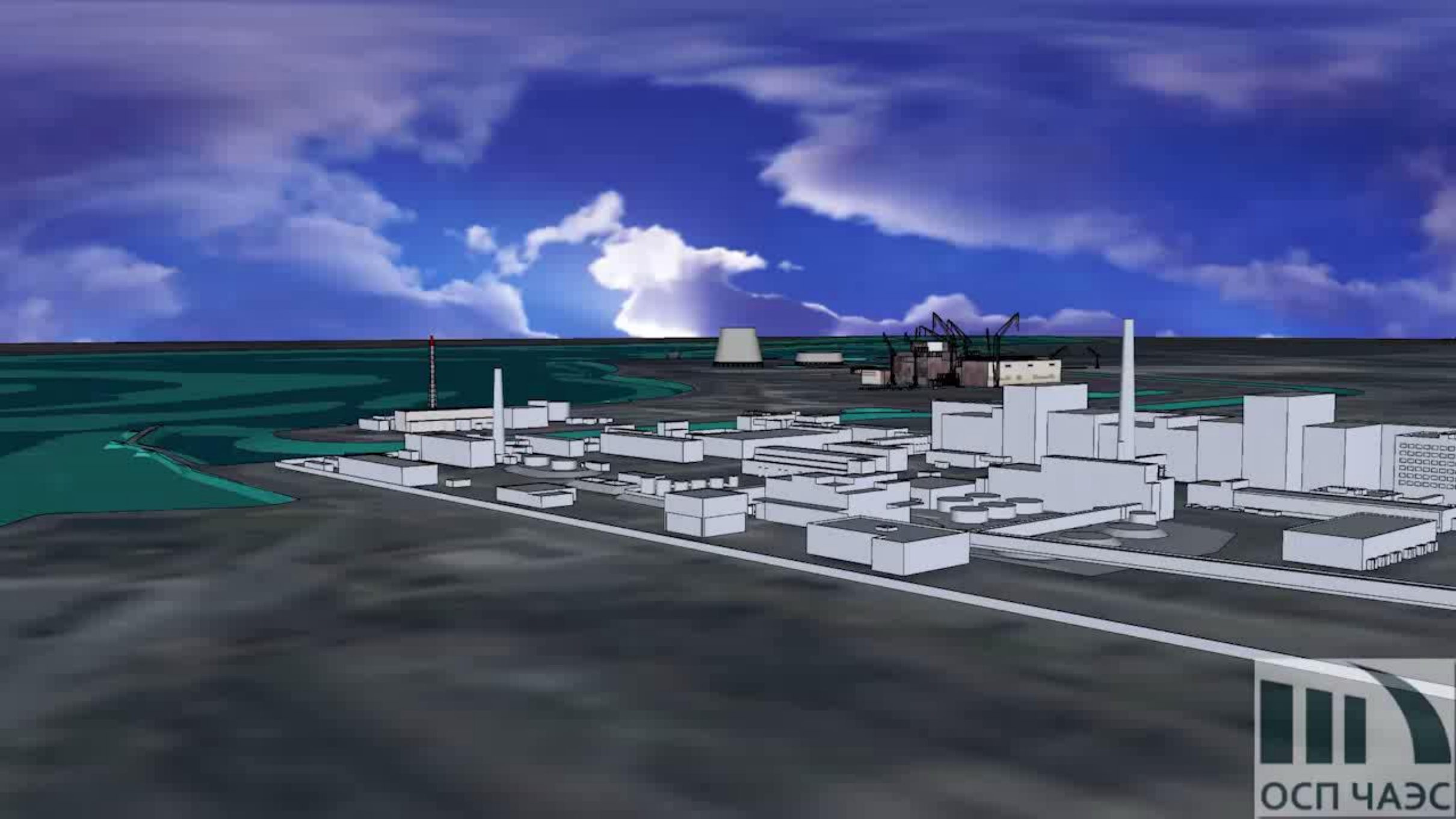
- Preparing the power units for long-term safe enclosure under the supervision
- Creation of Long-Length Item Cutting Facility
- Dismantling and decontamination
- Experimental laser decontamination
- Management of reactor graphite
- 3D-Modeling, Visualization, Virtual Reality for Decommissioning
- Creation of the facility for material release from regulatory control at ChNPP
- Decommissioning Information Support System (DISS)

Spent Nuclear Fuel Management

Interim Storage Facility for Spent Nuclear Fuel (ISF-2)

- Construction and installation works are coming to an end;
- Integrated tests are being performed;
- “Cold” testing have been started, following which “hot” testing is scheduled;
- Commissioning of ISF-2 is scheduled for 2020

New railcar of Skoda company for SNF transportation from ISF-1 to ISF-2 is commissioned.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SNF management technologies used at Chornobyl NPP

Performed

- Safety improving of the Interim Spent Fuel Storage Facility “wet type” (ISF-1)
- Improvement of the Interim Spent Fuel Storage Facility “wet type” operational characteristics
- Transportation and temporary storage of the damaged fuel

Under development

- Construction of the Interim Spent Fuel Storage Facility “dry type” for RBMK fuel (ISF-2)
- Ensuring long-term safe storage of spent fuel

Radioactive Waste Management

Creation of Chornobyl NPP decommissioning infrastructure

Industrial Complex for Solid Radioactive Waste Management – activities on preparation for commissioning are in progress (3rd stage).

Liquid Radioactive Waste Treatment Plant – the facility was commissioned in 2018.

Complex on Manufacturing Steel Drums and Reinforced Concrete Containers for RAW Storage/Disposal – the facility was commissioned in 2012.

Radioactive water and Liquid RAW Management at ChNPP

Main Building

Radioactive water

Radioactive water

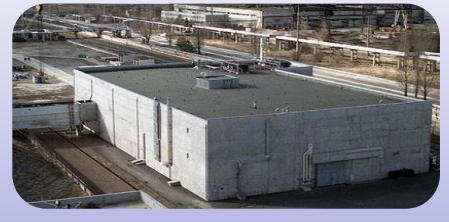
ISF-1

LRAW

LRAW

LWSF (coop.83)

LRAW



LRWTP

LRAW

LSWSF

0,2 m³ drums
(cemented LRAW)

Radioactive oil

Incinerator at SRWPP

Ash after incineration with other processed SRAW

ENSDS (Lot-3)

Solid Radioactive Waste Management at ChNPP

Main Building

SRWPP

Solid Waste Retrieval Facility

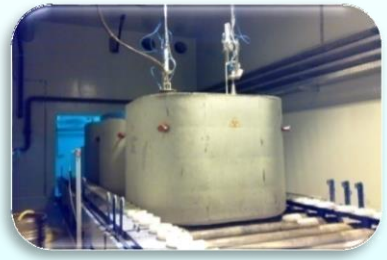
Processing

LSWSF

HLW & LLW

Sorting and characterization

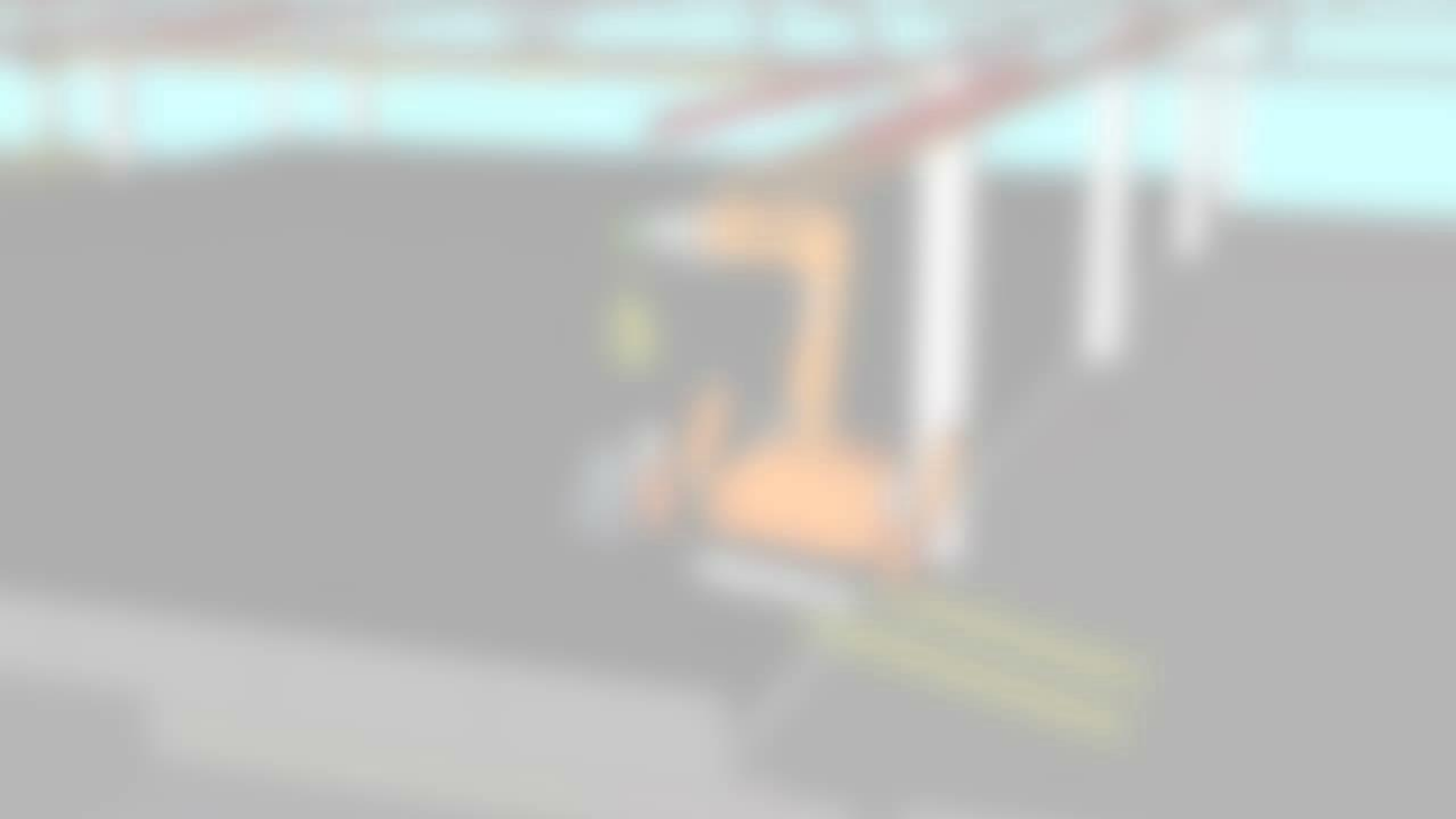
Cementing

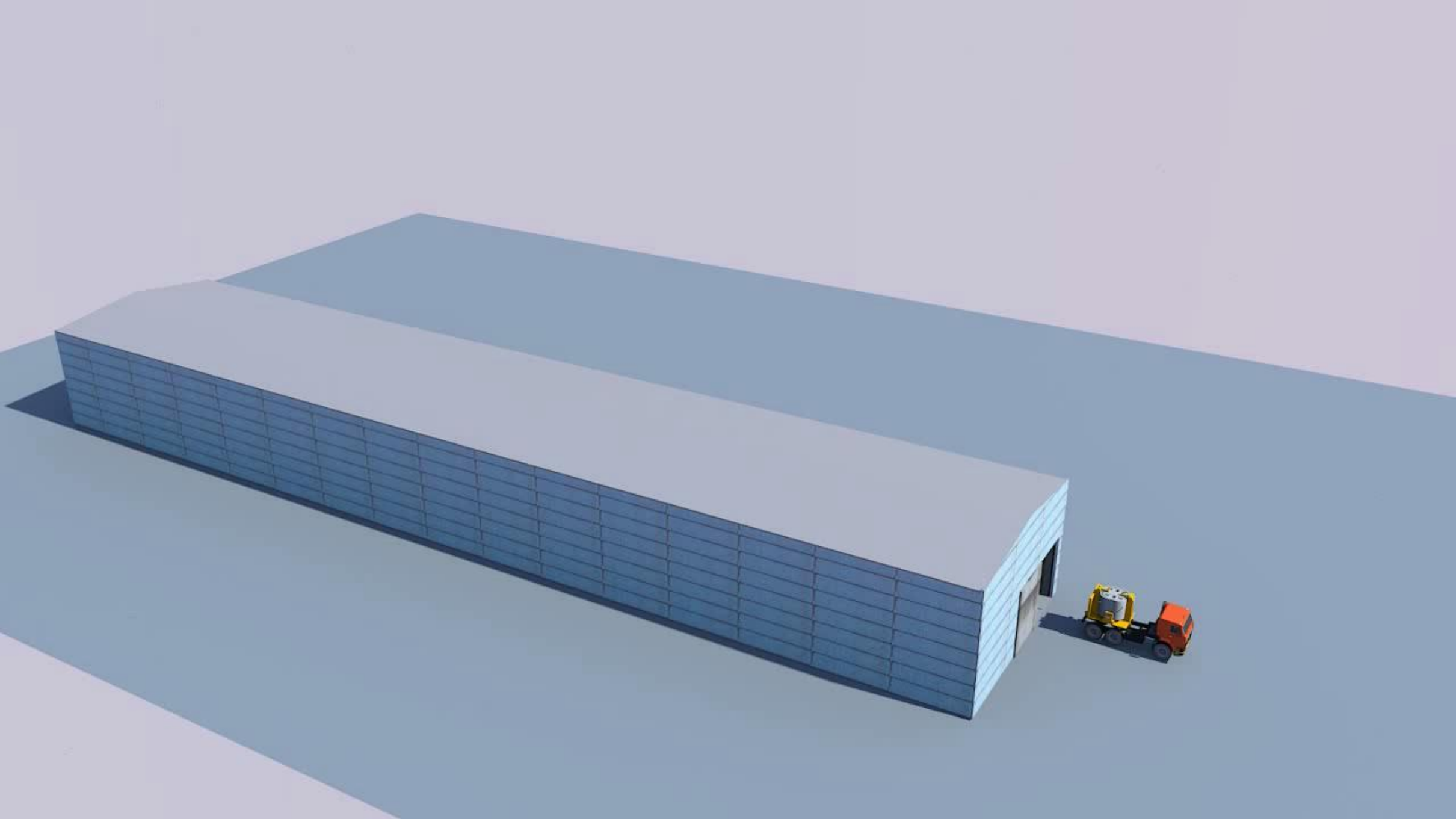


Passport for the package

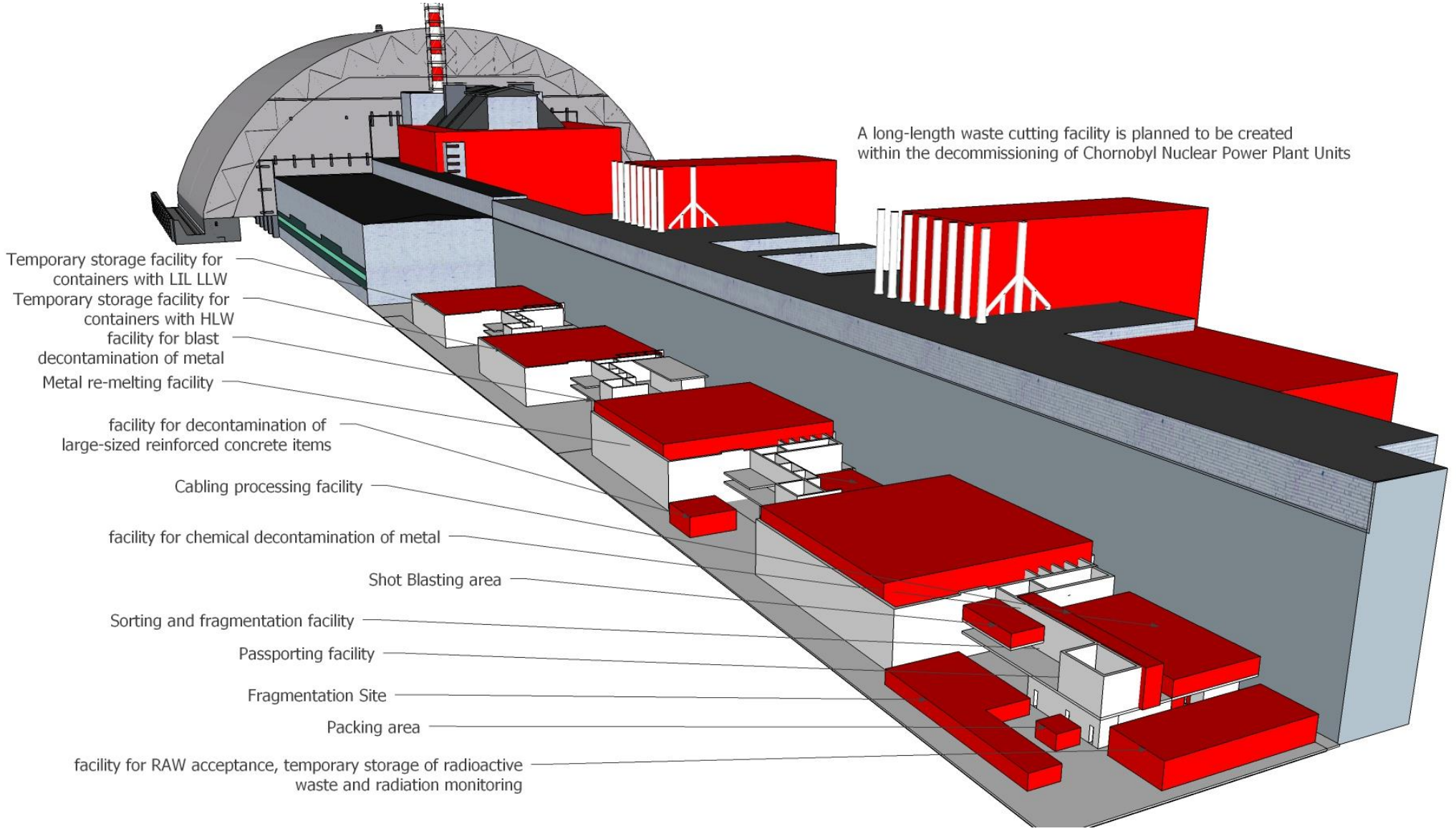
ENSDS

LIL-SLW in containers





Establishment of new facilities for RAW management



Sampling device for LRW

Sampling device for solids of spent ion-exchange resin and filter perlite pulp

Allows sampling of the solid phase of LRW from tanks with LRW at given heights. In-house design of ChNPP specialists .

Pilot Facility for Purification of Liquid RAW from Transuranium Elements and Organics

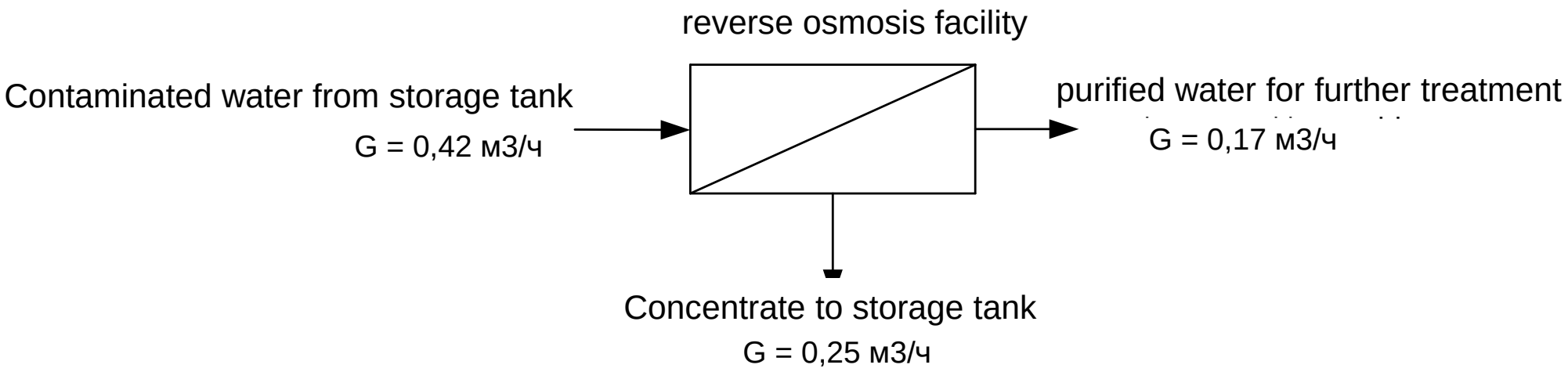
The use of dust suppressing composition at the Shelter object makes it impossible to process radioactively contaminated water in existing evaporators due to organic emulsion polymerization

The pilot facility has been created and successfully tested

The Design of an industrial facility including the Safety Analysis Report has been developed

Treatment of radioactive contaminated water at a reverse osmosis facility

Since the evaporation plants were stopped at the Chernobyl nuclear power plant radioactively contaminated water accumulates. To reduce it volume the possibility of using reverse osmosis facility is being investigated.



Radioactively contaminated water is supplied to the reverse osmosis facility from a storage tank. From the facility purified water is sent for further treatment and is used for technical needs. And the concentrate is returned back to the storage tank.

This let us significantly reduce the accumulation of radioactive water.

More than 400 m3 have been treated in such a way already.

RAW management technologies used at Chornobyl NPP

Performed

- Liquid Radioactive Waste Treatment Plant (LRTP)
- Industrial Complex for Solid Radioactive Waste Management
- Sampling device for solids of spent ion-exchange resin and filter perlite pulp
- Pilot Facility for Purification of Process Water and Liquid RAW of ChNPP from Transuranium Elements (TUE)

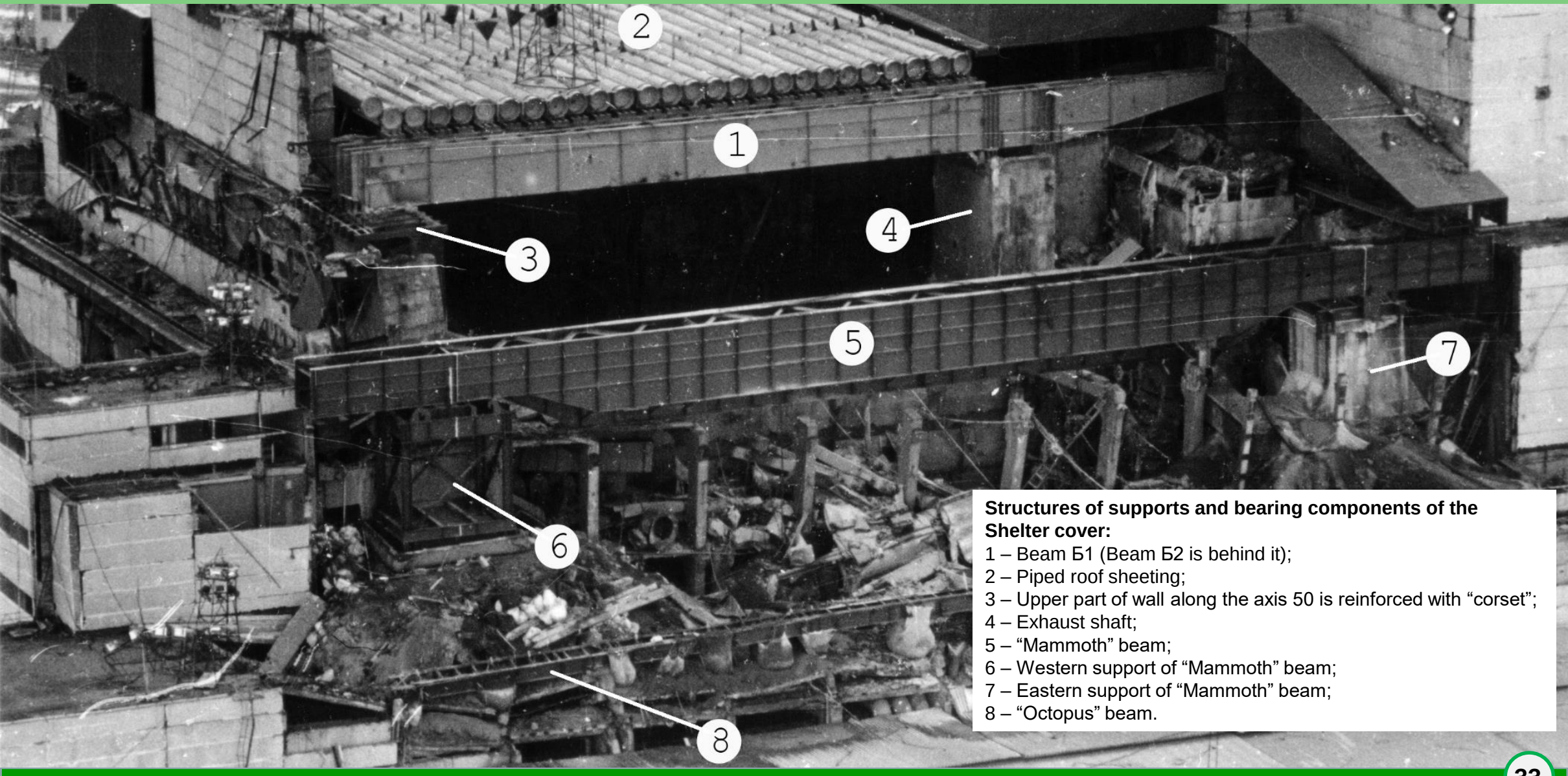
Under development

- Creation of the Industrial Facility for Purification of Process Water and Liquid RAW of ChNPP from Transuranium Elements (TUE) and Organics
- Processing of bituminous compound – preparation for disposal
- Creation of the new RAW management facilities
- The concrete composite material reinforced by basalt-boron fiber for nuclear waste management applications

Transformation of the Object Shelter into an Environmentally Safe System

Chornobyl NPP Unit 4 destroyed by beyond design basis accident

Basic critical building structures of Shelter Object



Structures of supports and bearing components of the Shelter cover:

1 – Beam Б1 (Beam Б2 is behind it);
2 – Piped roof sheeting;
3 – Upper part of wall along the axis 50 is reinforced with “corset”;
4 – Exhaust shaft;
5 – “Mammoth” beam;
6 – Western support of “Mammoth” beam;
7 – Eastern support of “Mammoth” beam;
8 – “Octopus” beam.

Shelter Object before and after stabilization measures

SO stabilization measures

Implementation period – 2004-2008
Total cost – about EUR 60 mln

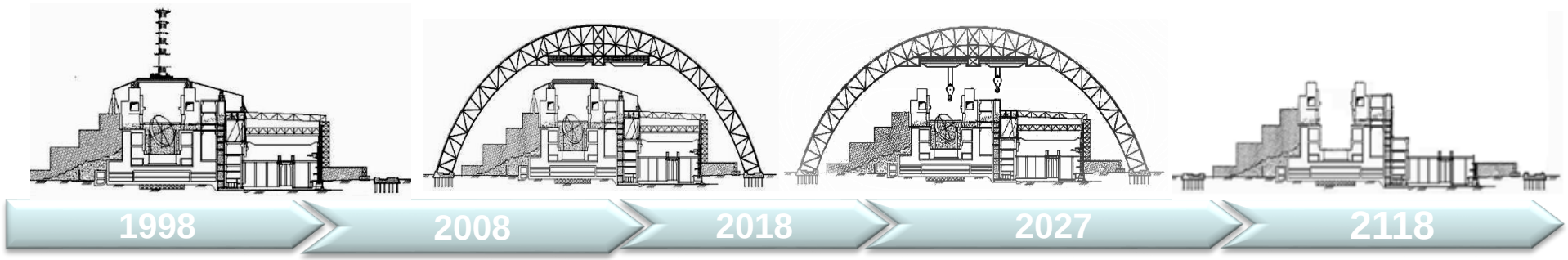
Ensuring the acceptable safety level of SO till the end of 2023 (based on 15-year period of stabilization structures operation)

Creation of New Safe Confinement

NSC CS-1 – “A protective structure having technological life-support systems and necessary infrastructure”

NSC CS-2 – “Infrastructure for dismantling of unstable structures of the Shelter”

Shelter transformation into an environmentally safe system



Stage 1
Stabilization

Stage 2
Creation of additional safety barrier

Stage 3
SO transformation into an environmentally safe system

Main tasks of Stage 3

- **Dismantling of unstable structures of SO**
- **Transition of fuel-containing materials into a controlled condition**
- **SO transformation into a long-term safe structure**

SO Technologies used at Chornobyl NPP

Performed

- Experience in mitigating the beyond design basis accident
- Construction of the New Safe Confinement (NSC)
- Use of dust-suppression solutions and making water curtains when performing works with intense dust generation
- Drilling operations in the building structures of Object Shelter and RAW storage facilities to install sensors, sampling, and condition studies

Under development

- Operation of the integrated New Safe Confinement and Shelter Object facility
- Dismantling of the Unstable Object Shelter Structures
- Use of the advanced computer modeling techniques
- Getting the fuel containing materials under controlled state

Long-Term Plan
of actions to perform scientific and technical assistance (support) of activities regarding decommissioning of Chornobyl NPP Units and Shelter transformation into environmentally safe system
for 2019–2029

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of actions to perform scientific and technical assistance (support) of activities regarding decommissioning of Chornobyl NPP Units and Shelter transformation into environmentally safe system
for 2019–2029

1. Geodetic observation over structural state under conditions of integrated facilty NSC-SO
2. Development of the NSC-SO geodetic observation program
3. Study into the feasibility of reducing the number of annual cycles of geodetic observations over NSC-SO building structure state and their replacement with mathematical forecasts
4. Development of procedural (operational) documentation for monitoring of NSC-SO building structure state, in general
5. Investigation of the impact of FCM state change on the nuclear safety level
6. Radio-hydro-ecological monitoring near NSC
7. Scientific and engineering support for implementation of the project on observation and investigation wells
8. Selection of effective decontamination methods for dismantled structures and contaminated surfaces inside NSC
9. Support of systematic (scheduled) monitoring of FCM accumulation behavior, revision of the FCM Monitoring Program

Long-Term Plan
of actions to perform scientific and technical assistance (support) of activities regarding decommissioning of Chornobyl NPP Units and Shelter transformation into environmentally safe system
for 2019–2029

10. Analysis of the applicability of the requirements of existing safety-related legislative acts, norms, regulations and standards for the purpose of Shelter transformation into environmentally safe system
11. Development of normative, regulatory and departmental documents relevant to activity regulation during all stages of NSC-SO facility life cycle
12. Revision (editing/amending) of the NSC-SO STS Program considering the results obtained during certain stages (actions) provided by the Program
13. Methodological support (development and metrological certification of measurement procedures) of measurements performed using the multi-channel system MDS-32 based on alpha, beta counters of MPC-9604 type
14. Inspection of LSWSF (Liquid and Solid Waste Storage Facility) capacities
15. Inspection of LWSF capacities to determine an ability to extend their life cycles
16. Inspection of KTZV-0.2 container condition
17. Identification of radionuclide vectors for SRW characterization being stored at SWSF compartments
18. Development of methodology and procedure for radioactive graphite characterization

Long-Term Plan

Long-Term Plan
of actions to perform scientific and technical assistance (support) of activities regarding decommissioning of Chornobyl NPP Units and Shelter transformation into environmentally safe system
for 2019–2029

19. Investigation of the processes of microbiological activity, corrosion and radiolysis of radioactive graphite packages during their temporary storage
20. Influence of decontamination methods on changing radioactive vectors during decontamination of radioactive materials
21. Improving efficiency of actions regarding decontamination of radioactively contaminated materials during decommissioning of ChNPP Units 1, 2, 3
22. Research developments of new, efficient facilities for decontamination and management of radioactively contaminated materials of different types being generated during stages of ChNPP Units 1, 2, 3 decommissioning
23. Identifying potential options of managing the graphite from ChNPP Units 1÷3 reactors, selection of the most advantageous and practicable ones for implementation. Study of prospective, potential for implementation, options for managing the graphite of ChNPP Units 1÷3 reactors. Specifying a technology and justifying the safety of an optimal option of ChNPP Units 1÷3 graphite management

Proposals for cooperation

Proposals for cooperation

The Chernobyl nuclear power plant may provide a basis for joint development and testing of decommissioning technologies

- samples of radioactive contaminated materials (liquid and solid radioactive waste, various metal fragments, graphite, radioactive contaminated water and soil)
- access to territories contaminated with radionuclides
- equipment and buildings that can be dismantled
- test rooms
- radiological laboratories
- qualified staff

Proven technologies can be used in such ChNPP projects as

- creation of new facilities for radioactive waste management
- dismantling of unstable structures of the Shelter object
- extraction of fuel-containing masses from SO and bringing them into a controlled state

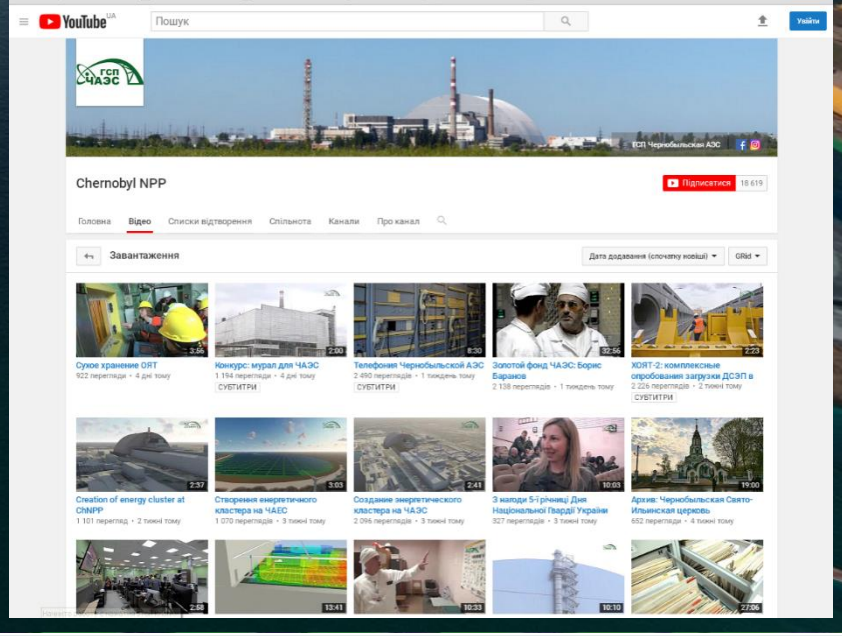
It is also possible to consider

- cooperation for decommissioning of other nuclear power plants in Ukraine. The first from fifteen Power Units planed to be decommissioned in 2030.
- entering the European decommissioning market.

Ukraine NOW ua

Look for us in Internet
www.chnpp.gov.ua

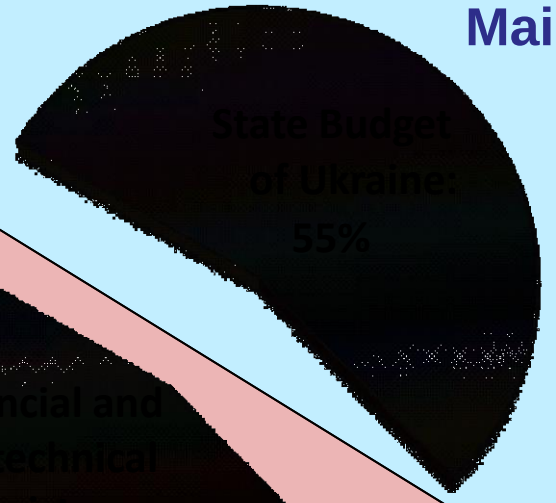
Thank you for attention!



And keep an eye on our YouTube channel

Transition stage

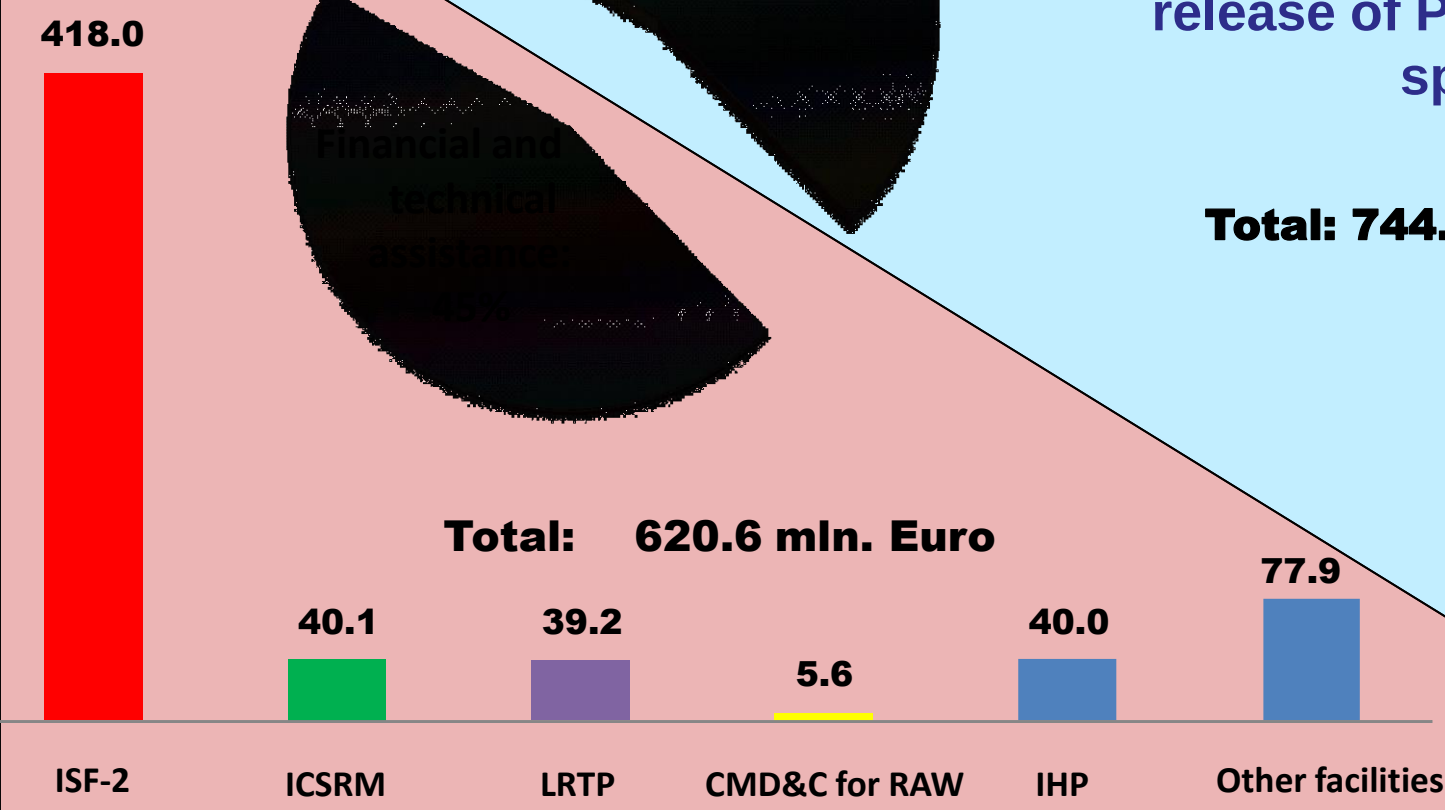
Maintenance of Chornobyl NPP facilities in safe conditions



Main expenditure item – release of Power Units from spent nuclear fuel

Total: 744.1 mln. Euro

Total: 620.6 mln. Euro



Creation of decommissioning infrastructure (capital expenditures)

In total, **1,364.7 mln. Euro** were spent from 2003 through 2018