Decommissioning Efforts on Chornobyl NPP site – Past, Present

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Mitigation of Chernobyl NPP accident

The worst world accident in the nuclear power history occurred at Unit 4 of Chernobyl NPP on April 26, 1986.

- The 7th level of the INES scale was assigned to the accident
- About 50 MCi of radioactivity was released within 10 days
- 200,000 square kilometers were contaminated

In the first days after the accident, all activities were aimed on three major hazards preventing.

Nuclear hazard is occurrence of a self-sustaining chain reaction

Thermal hazard is possibility of formation of high-temperature (2000 ° C) melt of core materials. This melt can burn a unit structure and reach the ground waters.

Radiation hazard is a release of radioactivity into the environment and high radiation background.

Early stage actions for Chernobyl accident elimination

Measures performed at early stage of the accident:

- Evacuation of general public from Pripyat and surrounding area (April 27-29)
- Plugging of the reactor from helicopters - until May 10,
- Construction of the under foundation plate (May-June)
- Organization of the 30 km Exclusion Zone
- Decontamination of the area close to emergency unit (May-July)
- Decontamination of the Unit 3 roof and the others facilities (August - December)
- Designing, construction and commissioning of the Shelter (June- November)

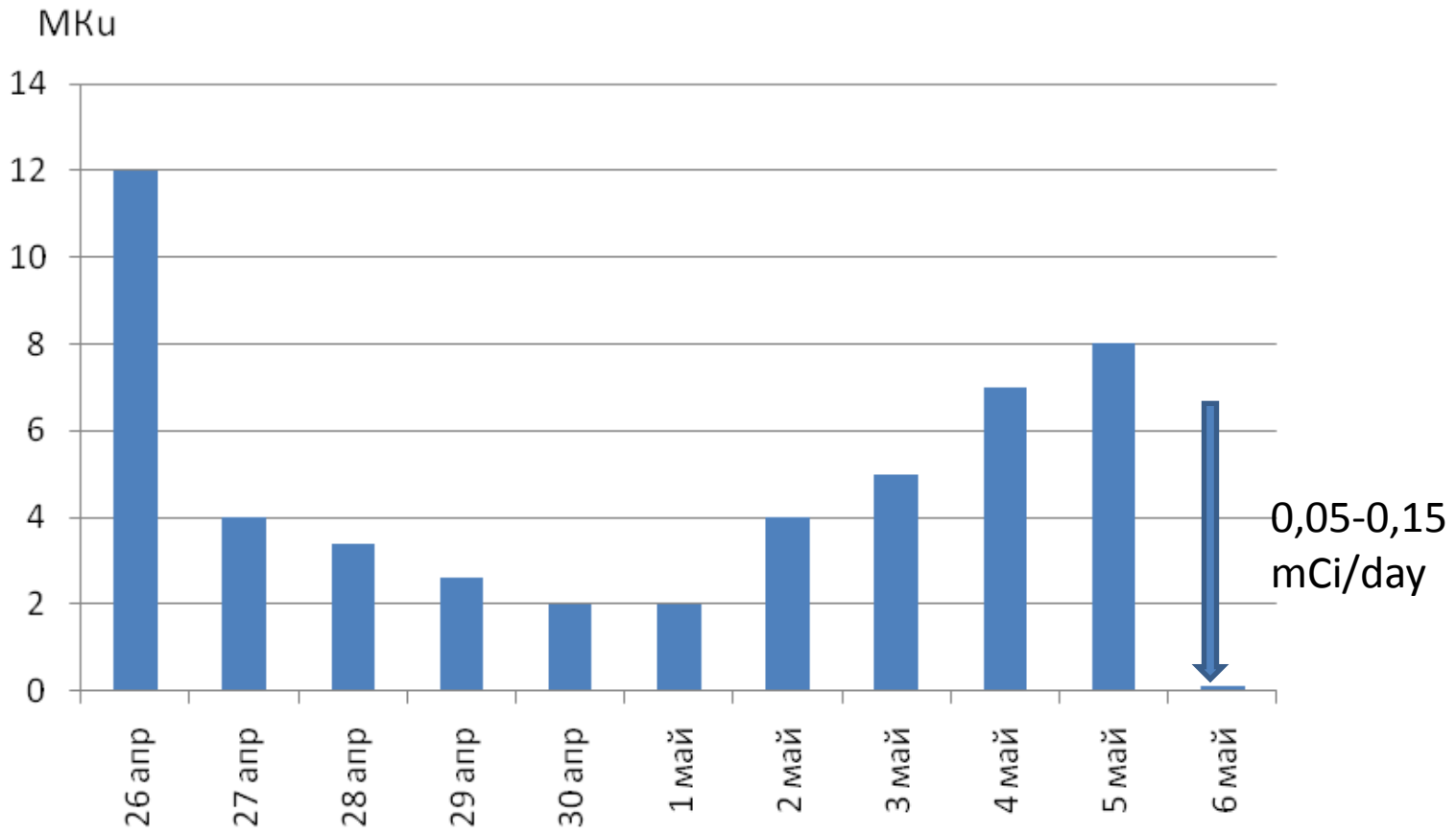
Top filling (plugging) of the reactor

To reduce releases from the destroyed reactor to the environment Governmental Commission decided to drop materials from helicopters into the reactor shaft.

Name of the material	Chemical formula	weight (t)
Boron carbide	B_4C	40
Dolomite	$MgCa(C0_3)_2$	1200
Crushed marble, clay, sand, etc.	-	3500
Lead (fractions + “bars" and others)	Pb	6700
Trisodium phosphate (solution)	Na_3P0_4	2500
Other dust suppression compositions (solutions).	Latex type СКС-65 gp, bard, liquid glass, silicon rubber, etc.	2700
Total		16600

Dynamics of releases

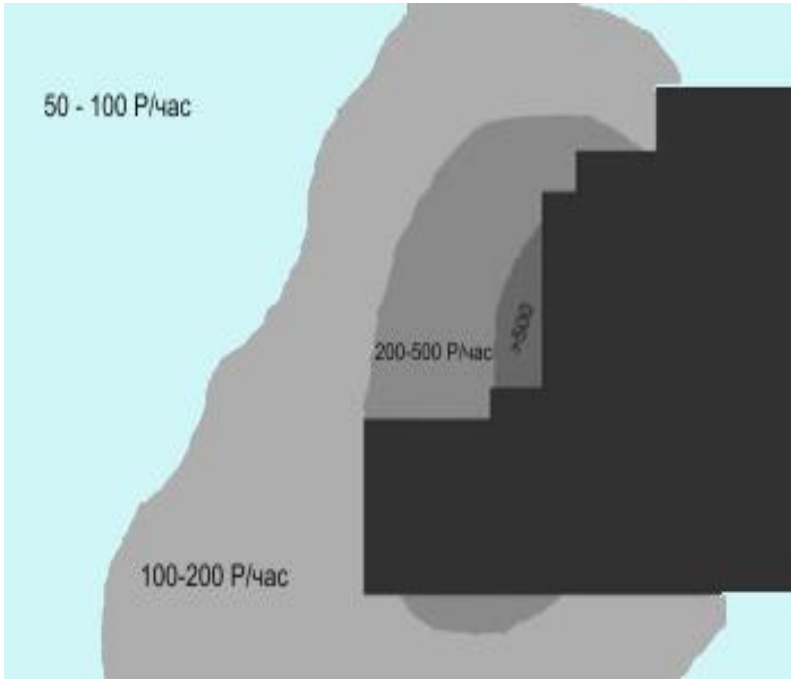
After the first powerful release of radioactivity caused by the reactor explosion, release of radioactivity has not stopped.

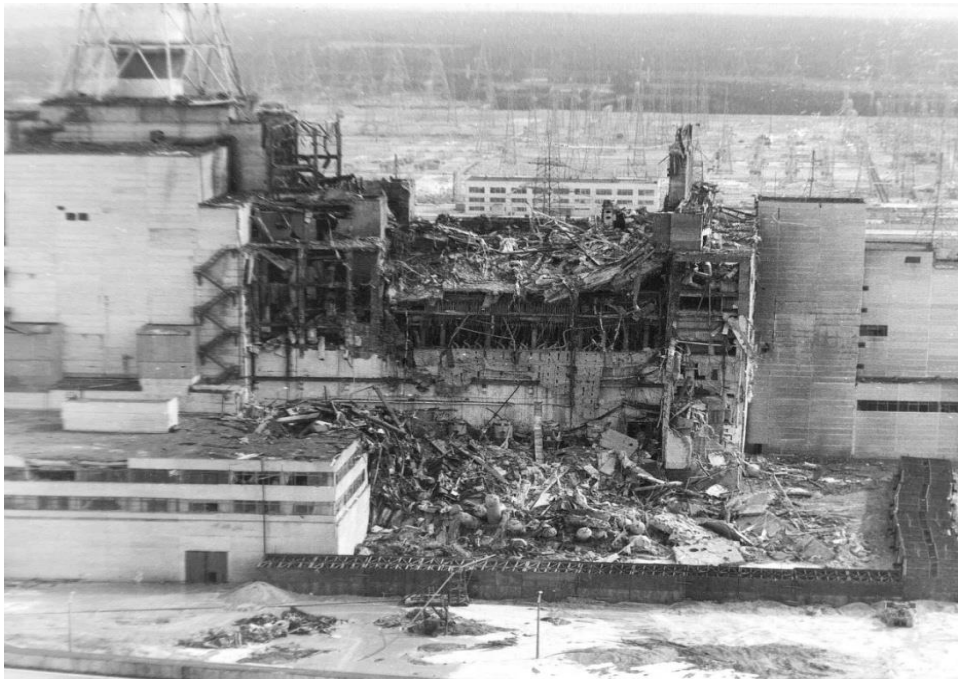


The intensity of the release, mCi/day. The limit of uncertainty for all releases was ± 50%.

Arrangement of sub-foundation slab

Reducing of the radioactivity level and cleaning of the territory adjacent to the accidental Unit





The dose rate around the reactor compartment walls was 2,000 R/h and along the perimeter of Unit - 200 R/h.

Removal of reactor core fragments, removal of the top soil layer and construction of the concrete "pioneer" walls along the perimeter of the accidental unit improved significantly radiological situation.
High-Level Waste collected from the surrounding area was placed behind the "pioneering" walls.

Cleaning of the territories adjacent to the accidental Unit

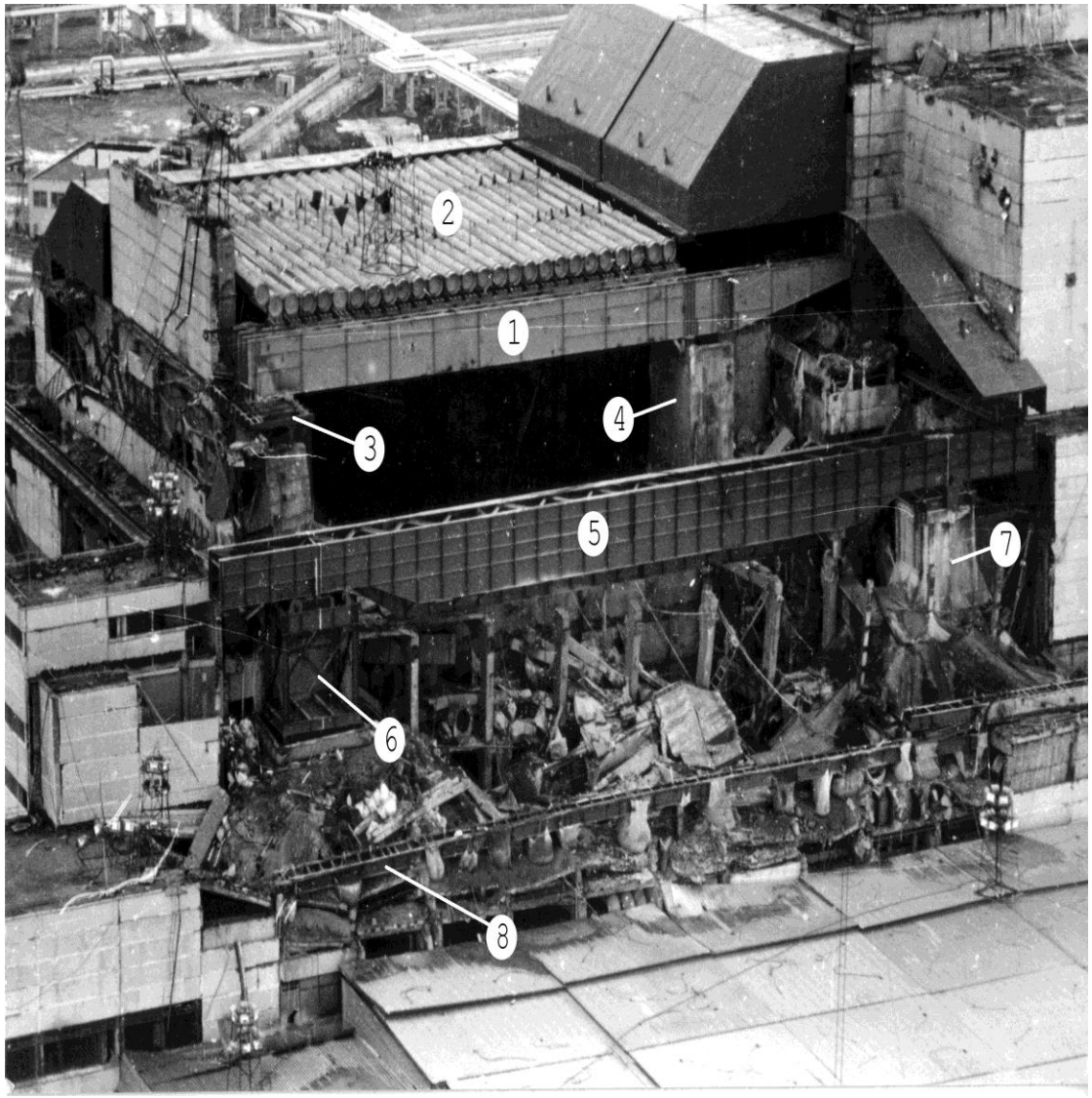
Trail-builder BAT-M was used for work on decontamination of the territory adjacent to the destroyed nuclear reactor. Basically BAT-M was used to remove the top layer of soil. Its weight is 27 tons.

Armoured engineering vehicle AEV played a decisive role in radioactive debris handling around the Unit 4. They are also used to cover the territory with a layer of sand, gravel, and others materials, loading and unloading of containers with radioactive waste. The vehicle was constructed on the basis of the tank T-72A and serially manufactured by IA "Uralvagonzavod" in Nizhniy Tagil.

Its weight is 60 tons.

The radiation dose reduction factor was ~ 100.

Shelter object construction and commissioning



•Construction of supports and load-bearing elements of the Shelter object covering:

1 - Beam B1 (Beam B2 is behind it);

2 – Pipe covering;

3 - Upper part of the wall along the axis 50, reinforced with a "corset";

4 - Exhausting shaft;

5 - "Mammoth" Beam;

6 - Western support of the "Mammoth" Beam;

7 - Eastern support of the "Mammoth" Beam;

8 - "Octopus" Beam.

Shelter object construction and commissioning

Construction and installation works were carried out using the unique machines and tools:

- crawler cranes «Demag» with a loading capacity on main arm up to 650 tons;
- truck cranes «Liebherr»;
- pumps for concrete mortar supplying, produced by «Schwing», «Putzmeister», «Worthington» companies;
- other machinery and equipment, refitted with remote control and protection equipment.

Structural integrity of the Shelter object

Building constructions of the Shelter object perform the function of the primary physical barrier on the way of radioactivity release in the environment.

Shelter object wasn't created in accordance with the rules and norms of designing and construction.

Shelter object's building constructions do not meet the requirements of normative and technical documentation on safety in parts of the structural integrity and reliability and have an undefined life time.

A complex of 8 measures (stabilization) improving durability and reliability of steel structures and building constructions was performed within the period from 1998 to 2008 to reduce the risk of the Shelter object critical structures collapse.

Implementation of stabilization measures improved the SO safety level till 2023.

Structural integrity of the Shelter object

Monitoring of building constructions condition

VISUAL INSPECTION.

The main objective is to identify cracks, shifts, distortions, damage, elements deformation, denudation of reinforcement, metal corrosion leading to reduction in strength or stability of the Shelter object supporting structures.

Subject to visual inspection:

- 17 structures erected within 1986-88. Beginning of survey -1986-88, frequency at least 1 time per year.
- 8 constructions of stabilization built within 2006-08.
- Beginning of survey -2008, frequency at least 1 time per year established by general designer
- *Performed by ChNPP personnel*.

INSTRUMENTAL MEASUREMENTS

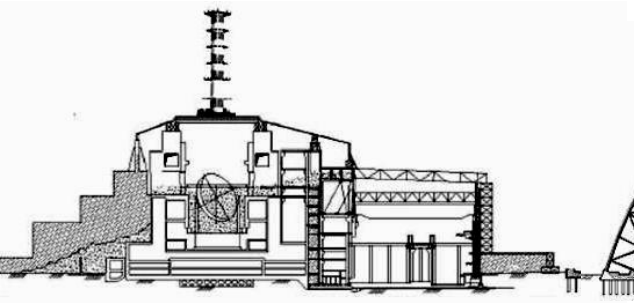
The main objective is to monitor SO and its individual elements deformations and drawdown, identification of the horizontal and vertical movement of the control marks.

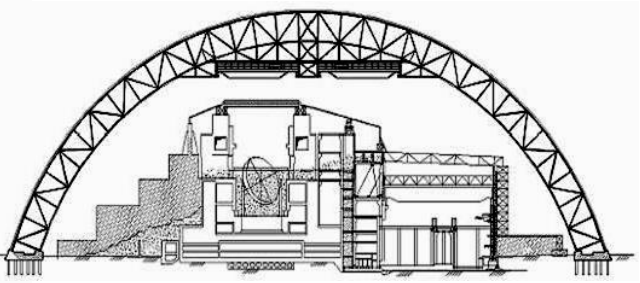
- Surveillance on the Shelter object drawdown and deformation is performed on 64 geodetic marks. Beginning of survey - 1986., frequency 1 time every quarter
- Engineering and geodesic works on the instrumental survey of reinforced concrete frame of SO deaerator stake is performed on 26 geodetic marks. Beginning of survey - 1987, frequency once per six months. GPS-technology and tools are used to ensure high accuracy.

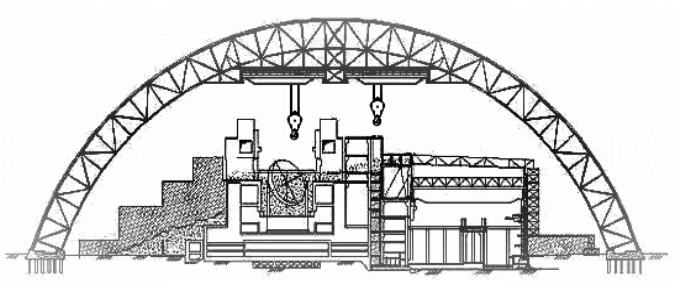
Performed by specialized organization

Sliding of the NSC in design position

Shelter Transformation Strategy





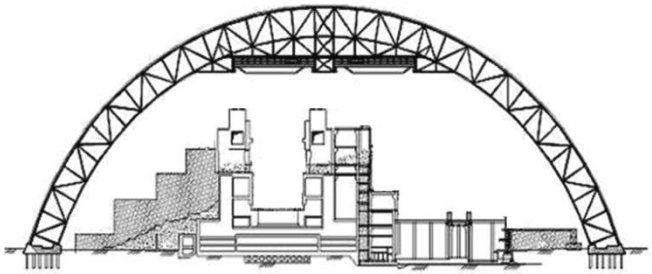


1998 → **2008** → **2017**

Phase 1: stabilization of existing object status

Phase 2: creation of the additional protective barriers

Phase 3: Fuel Containing Materials and Long Lived RAW retrieval from SO



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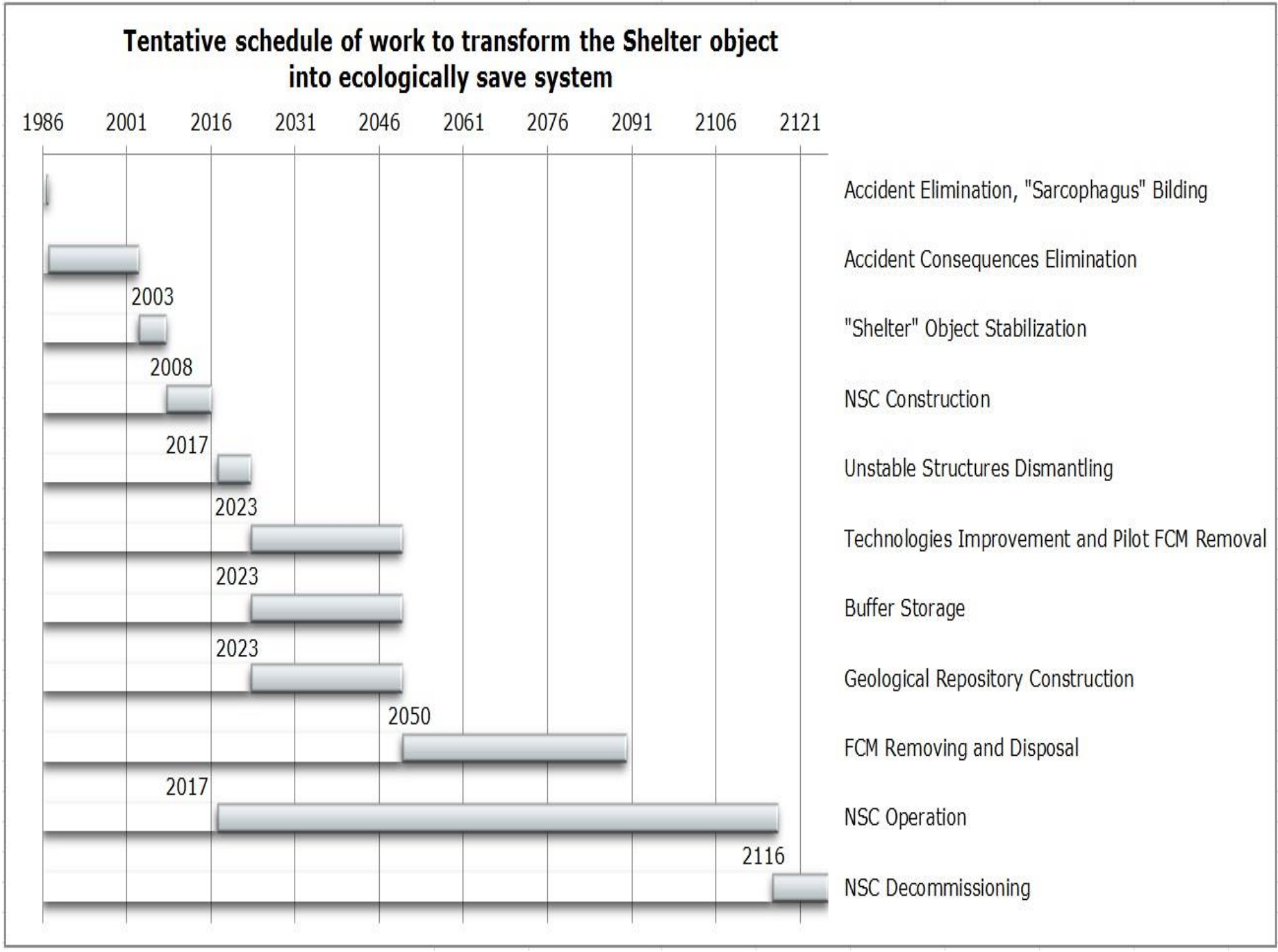
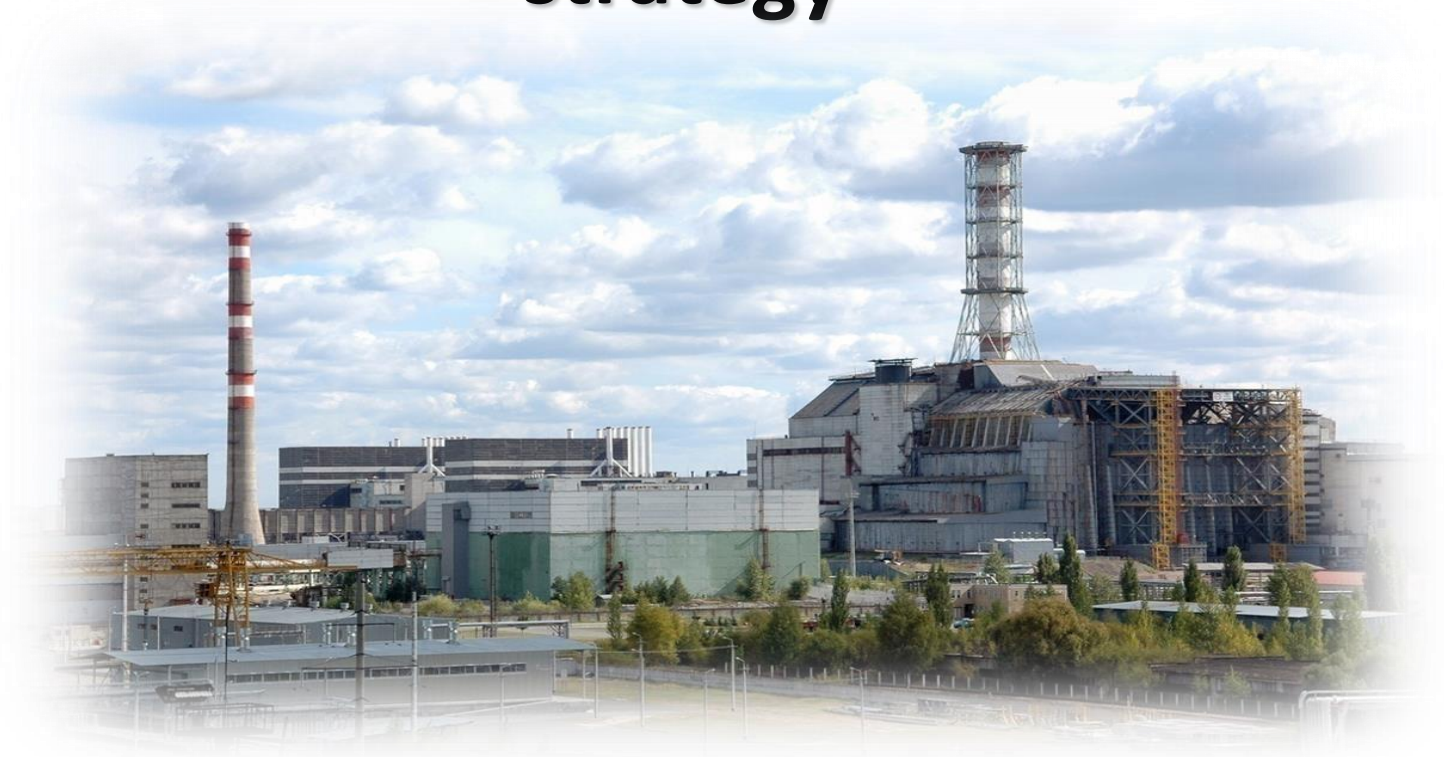
After full removal (retrieval) of Fuel Containing Materials and Long-Lived RAW **decommissioning of Shelter Object will be carried out** as the final phase of transformation into ecologically safe system.

Online picture and the current status of this project can be found at: www.chnpp.gov.ua


Tentative schedule of work to transform the Shelter object into ecologically save system
1986
2001
2016
2031
2046
2061
2076
2091
2106
2121
Accident Elimination, "Sarcophagus" Bilding
Accident Consequences Elimination
2003
"Shelter" Object Stabilization
2008
NSC Construction
2017
Unstable Structures Dismantling
2023
Technologies Improvement and Pilot FCM Removal
2023
Buffer Storage
2023
Geological Repository Construction
2050
FCM Removing and Disposal
2017
NSC Operation
2116
NSC Decommissioning

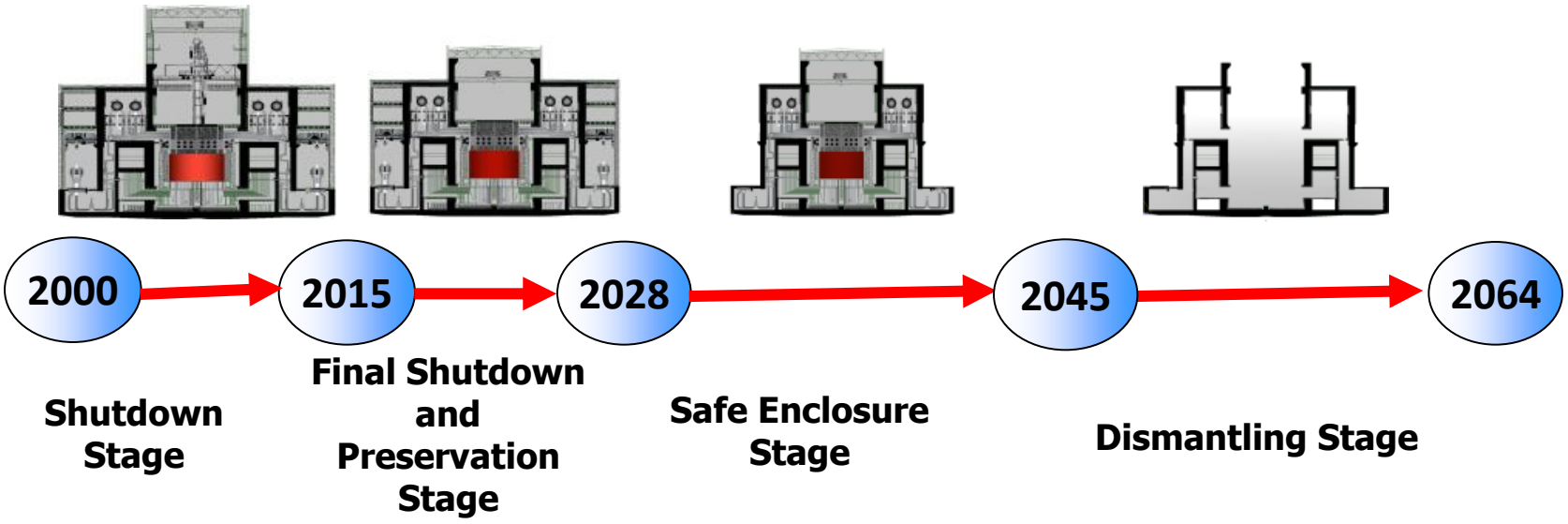
ChNPP Units 1, 2, 3 Decommissioning strategy



ChNPP Units 1, 2, 3 Decommissioning strategy

Deferred Dismantling Strategy (SAFSTOR) is accepted for ChNPP:

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



Decommissioning Infrastructure

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

Liquid Radioactive Waste Treatment Plant – commissioned in 2014. Processed first 3.4 m3 of liquid radioactive waste. Obtained the first 40 packages (drums) RW. 4 of them have already been transferred for disposal.

Industrial Complex for Solid Radioactive Waste Management – project is completed. Currently carried out the hot tests. Two of the three stages of the test was successful. The scheduled Complex commissioning – 2017

Interim Storage Facility for Spent Nuclear Fuel (ISF-2) - long-term interim dry storage of spent nuclear fuel from Chernobyl NPP RMBK-1000 reactors. Design service life - 100 years.
Contractor- Holtec International, USA
The scheduled ISF-2 commissioning – 2017.

Equipment and pipelines dismantling

Dismantling of the Unit 1 machine hall is scheduled from 2012 to 2017 .

Total quantity of the equipment is 13 900 tons of metal. Currently 5300 t are dismantled by contracting organizations.

Dismantling of the Unit 2 machine hall is scheduled from 2016 to 2018.

Tender procedures are undergoing now.

The premises of Unit 1 and 2 turbine hall are being planned to use for locating new RAW processing facilities and additional interim storages of RAW.

Cooling Pond Decommissioning

Main technical parameters:

- Water surface area – 22.9 km^2
- Water level is 7 m higher than the water level in Pripyat river
- Annual costs for maintaining the water level ~ UAH 5 mln.

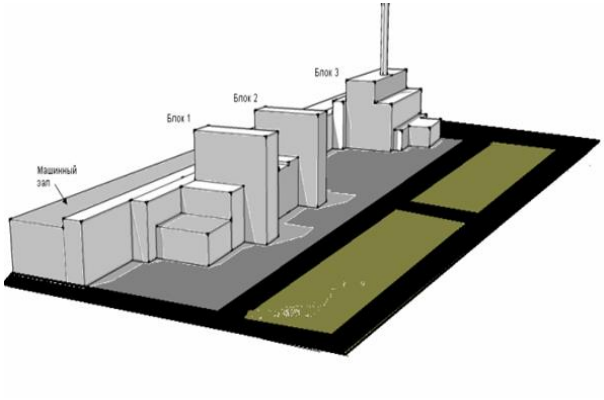
- A small cooling pond was created – that is a new source of technical water.
- Feasibility Study for the existing cooling pond decommissioning is under expert examination.

Development industrial site - final status of Chernobyl NPP

«Green field»
1992

«Brown spot»
2002

Industrially developed site
2008



Industrialy developed site is the best solution for the final status of Chernobyl NPP site decommissioning

Thank you for your attention!

Links:
www.chnpp.gov.ua