Management of Large Waste Volumes of Solid Waste in Ukraine

Tetiana Kilochytska

State Nuclear Regulatory Inspectorate of Ukraine

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accident at Chernobyl NPP **Unit # 4**

- reactor core totally destroyed,
- system related to safety of Unit # 4 totally destroyed,
- huge activity spread up,
- surround area contaminated,
- high levels of exposure doses,
- fragments of nuclear fuel and graphite around the destroyed unit

Mitigation of the Accident Consequences –

Organizational and Technical Issues

Organizational issues

Special Governmental Commission

- brain-storming and decision-making process
- full powers
- clear responsibility
- money
- scientific support
- immediate involvement of different specialists if needed

Technical Issues (1)

- **Overall Decontamination** of the industrial site, surround (residential) areas and roads.
- The main goals:

  - to decrease the exposure doses

  - to allow workers to provide measures related to the mitigation of accident subsequences

  - to provide activity at the Units # 1,2,3

  - *to allow people re-evacuation (this purpose was not reached – the 30-km "Exclusion Zone" was estalbished)*

Technical Issues (2)

- arrangement of facilities of decontamination, special treatment of trucks and personnel involved in the accident mitigation;
- collection and removal of RAW;
- organization of temporary RAW “points”, designing and construction of RAW “facilities”;
- concreting of territories (Chernobyl NPP site);
- ……..

Large amount of “Chernobyl” Waste – variety, characteristics, problems

“Chernobyl Waste”: variety

- **Fragments of reactor core and fragments of reactor structures thrown out by the explosion;**
- **The upper soil layer removal from the large in size area;**
- **Wood (“The Red Forest”);**
- **Fragments of civil engineering structures, debris generated as a result of demolishing the buildings in villages located around ChNPP;**
- **Contaminated equipment;**
- **Fragments of metal structures, concrete and various debris;**
- **Miscellaneous**

“Chernobyl Waste” – Characteristics

- **very different in they radionuclide composition and specific activity**
- **mostly located in Exclusion Zone (ChNPP site, Shelter Object, “disposal points” and “points of temporary localization of RW” organized after accident in 1986**
- **contain long-lived radionuclides (Th, Am, U…)**

“Chernobyl Waste” – LARGE volumes

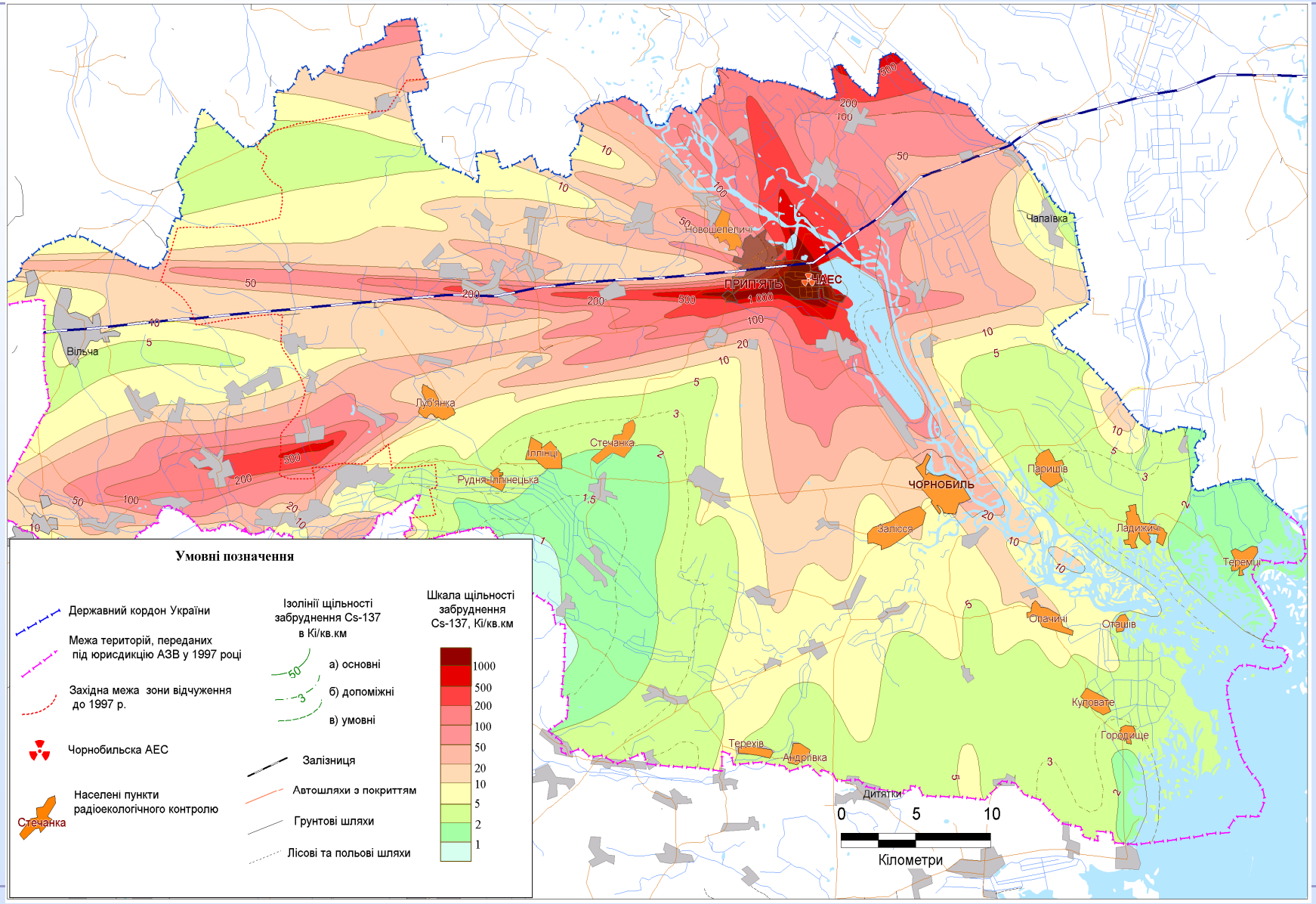
- **90% of all RW amount in Ukraine**
- **Inside Shelter and at its site is located 400 000…1 740 000 m^3 RW, total activity $4,1 \cdot 10^{17}$ Bq**
- **total amount estimated at 2.8 million m^3**

“Chernobyl Waste” – PROBLEMS

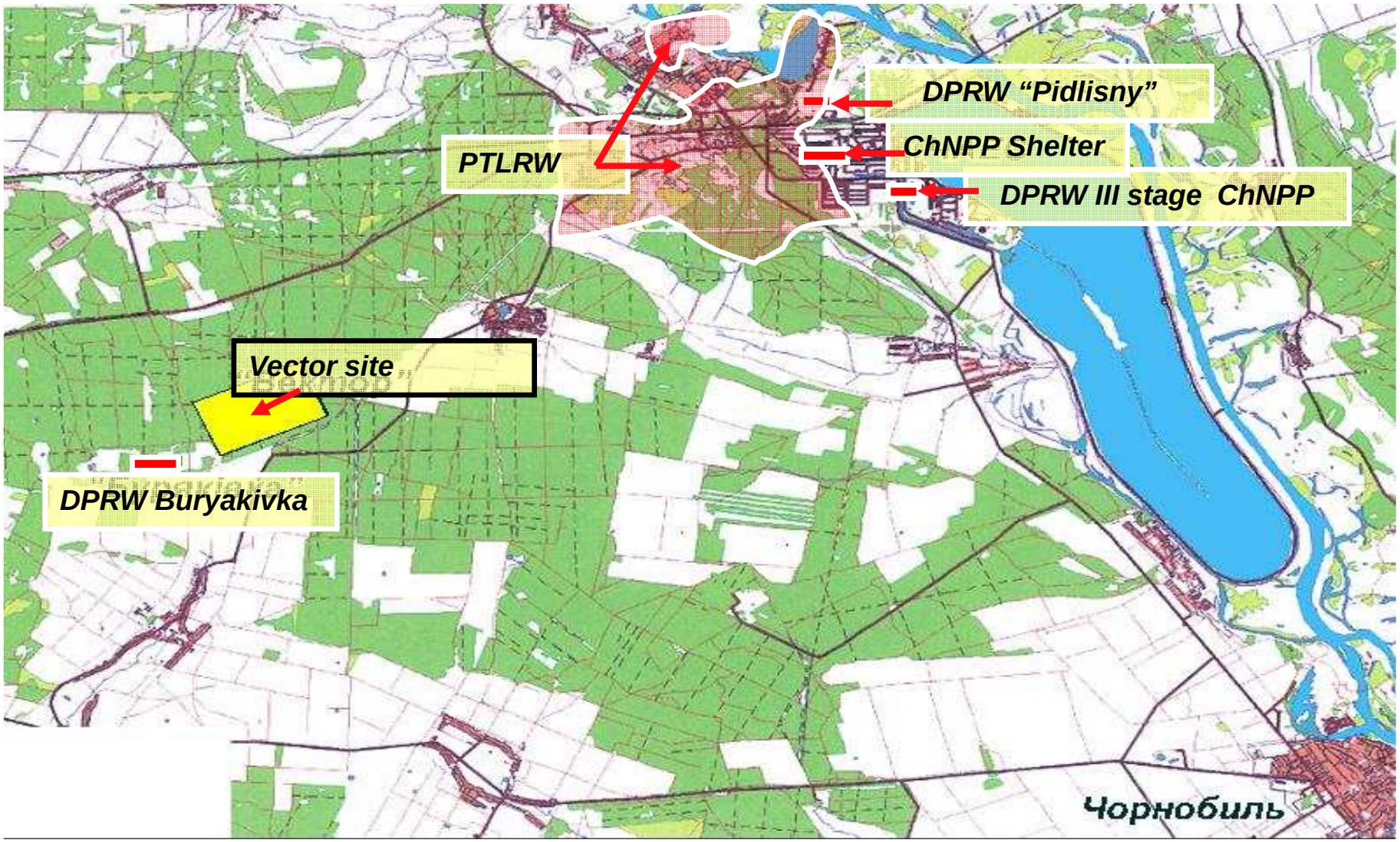
- **LARGE amount**
- **very different in they radionuclide composition and specific activity**
- **long-lived radionuclides in waste (Th, Am, U…)**
- **“stored”/”disposed” (excepting Disposal Facility “Burykivka) in conditions which do not comply with current radiation protection requirements**
- **required “re-disposal”**

”Chernobyl Waste” – The main places of localization (30-km “Exclusion Zone”)

30-km Exclusion Chernobyl Zone - 2600 km^2



Main places of waste location in Exclusion Zone



Shelter Object (1)

- Inside Shelter and at **its site is located**

400 000…1 740 000 m^3 RW,

total activity 4,1•10^{17} Bq

- **long lived 44 000 m^3**

- **“Not organized storage for not organized waste”**
- **underground layer of the local zone around Shelter 15 000 m^3 RW (contaminated soil, concrete pieces and slabs, metal structures, debris)**

RW inside Shelter Object (2)

- fragments of building structures, reactor core
- materials thrown inside during the accident

- İrradiated graphite
- fuel containing materials
- radioactive dust
- liquid RW

RW inside Shelter Object (3)

Fuel containing materials (app. 200t**)**

Chernobyl NPP site

at ChNPP site located near 500 000 m^3 of low- and medium level RW (soil, concrete and metal components, equipment**)**

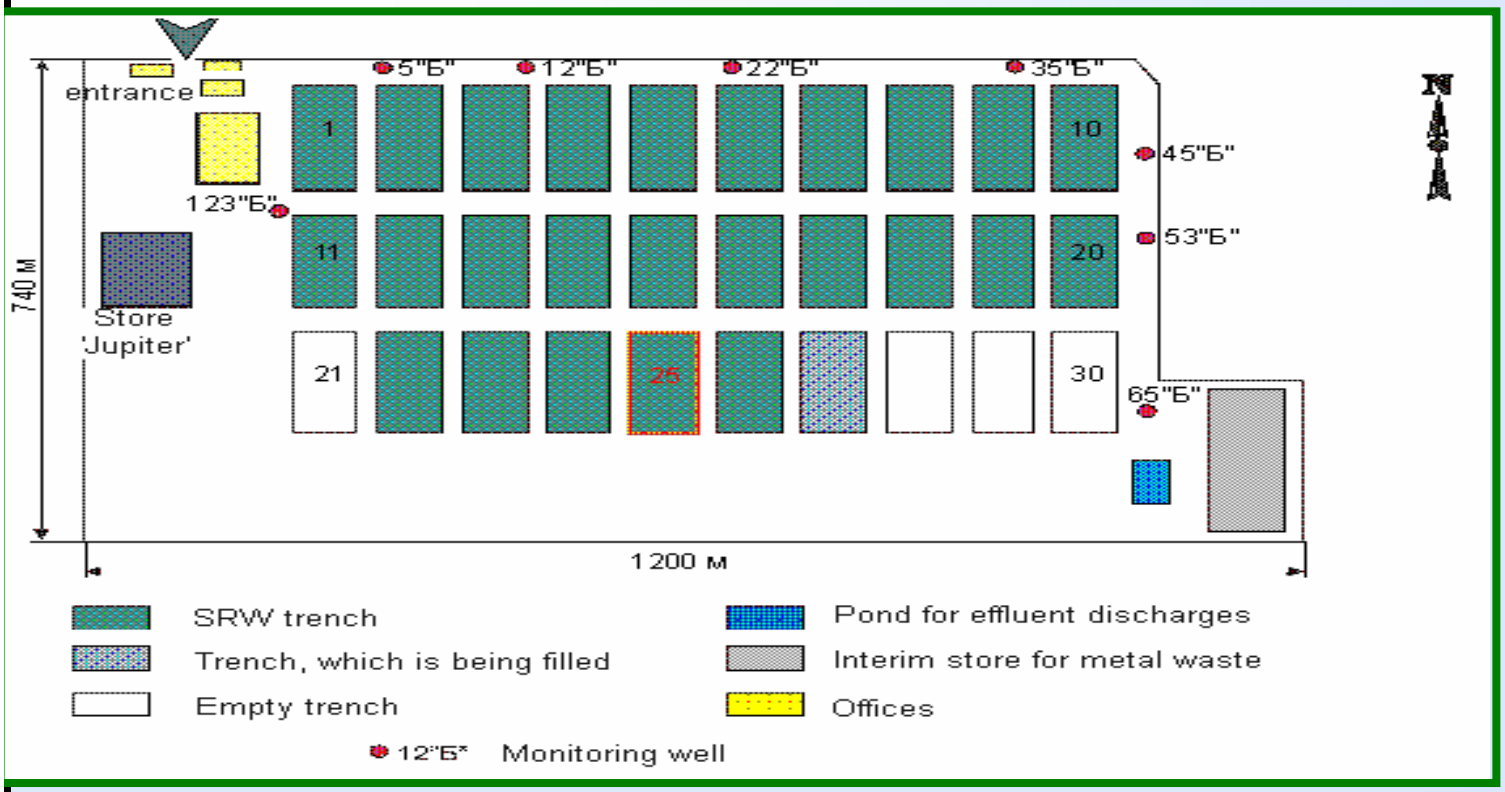
ChNPP Cooling Pond major activity in bottom silt - 0,2•10^{15} Bq

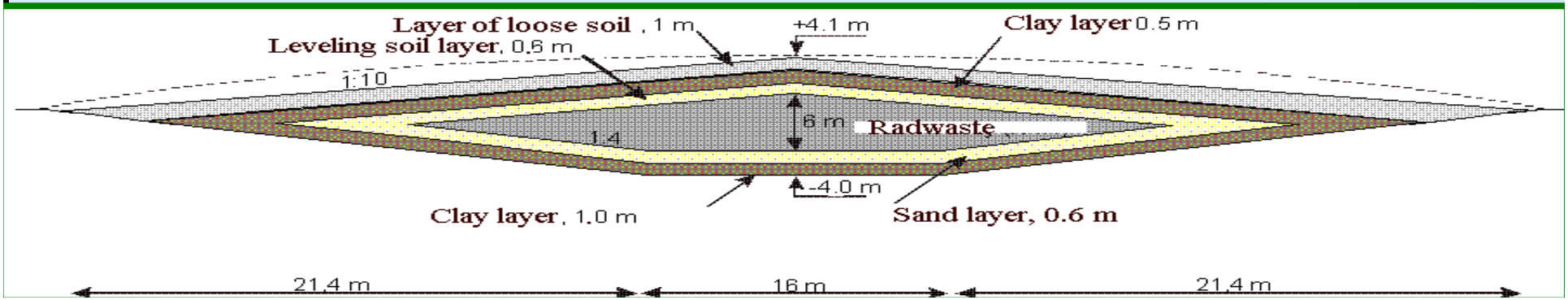
- **In existing storages accumulated RW from operation of Units and accident liquidation**
  - **solid RW – 2500 m^3**
  - **liquid RW – 19800 m^3**

RW Near-surface Disposal Facility "Buryakivka" (1)

- Trench-type (30 trenches) disposal facility located in the Exclusion Zone which accepts low- and medium-level RW for disposal
- Operated since February 1987 until now
- Design to dispose RW with dose rate 1R/h, however, during the accidental time real RW dose rate was up to 5 R/h
- Overall capacity is about 690 000 m^3
- Activity about $2.45 \cdot 10^{15}$ Bq
- Currently the designed capacity has been practically exhausted (606 000 m^3)

Radioactive Waste Disposal Facility – “Buryakivka” (2)

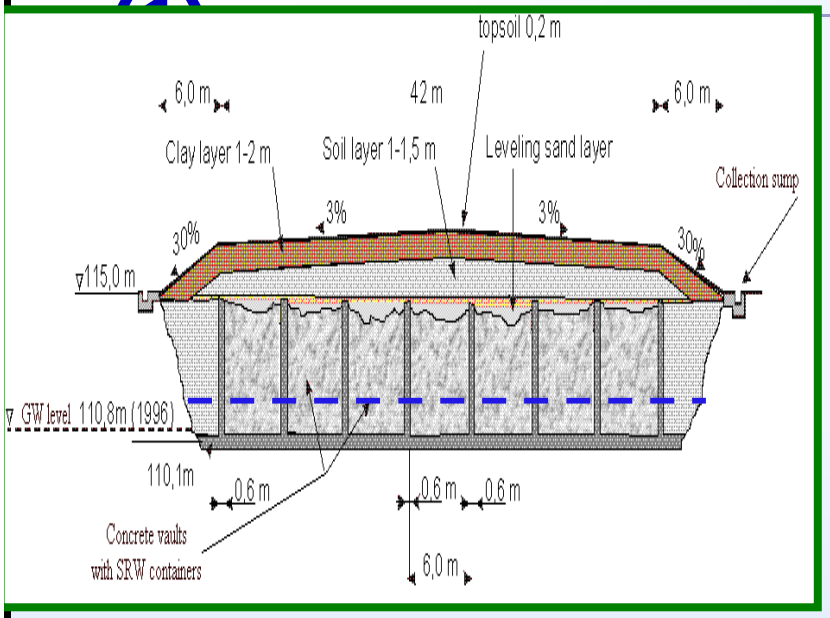




”Disposal Point N 1”: “Pidlisny”

- In operation from XII 1986 to XI 1988
- Concrete Modules contain 11 000m^3 RW without containers
- Total activity according to different investigations is app. $2.6 \cdot 10^{15}$ Bq
- It was planned for RW with dose rate up to 50 R/h however, in reality dose rate was up to 250 R/h
- Practically all RW is long-lived waste
- There are numerous cracks in the concrete foundation and walls of the facility.

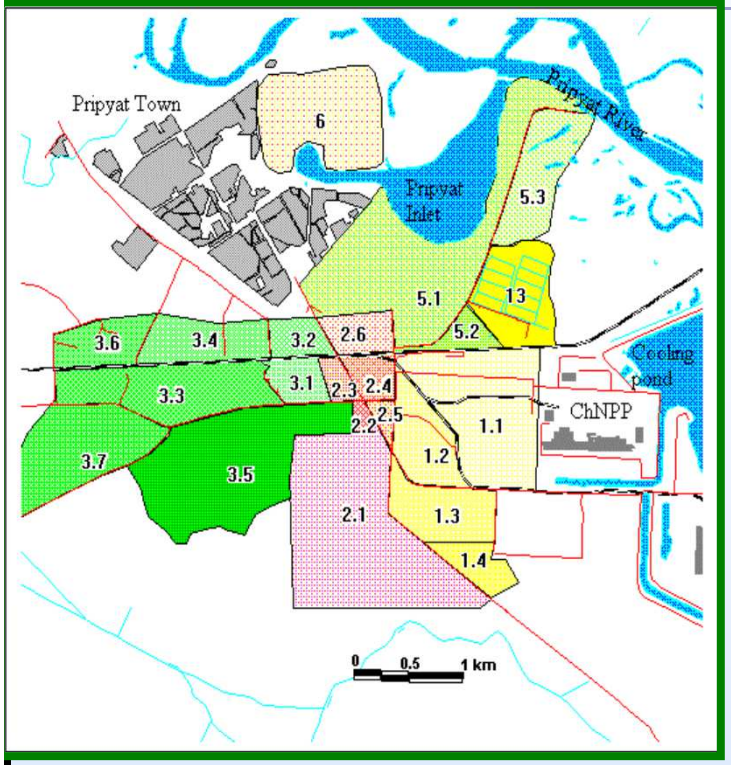
”Disposal Point N 2”: “III stage of ChNPP”



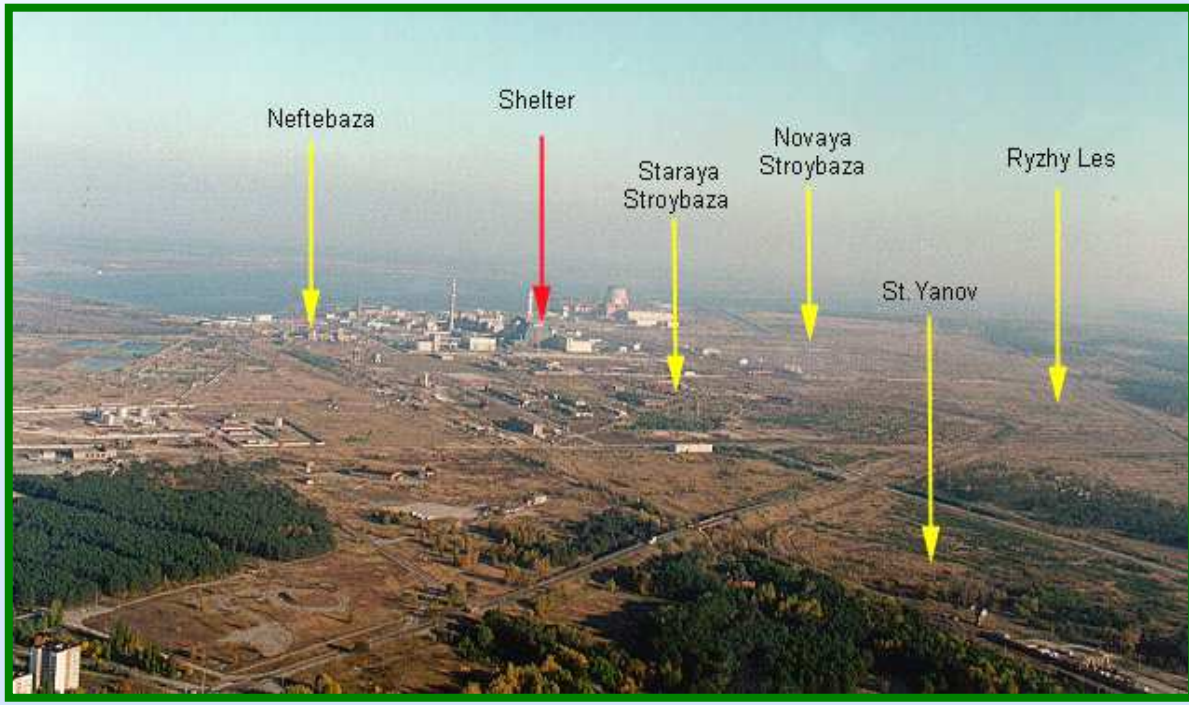
- in operation from X 1986 to XII 1988
- Used concrete building of unfinished RW storage of the 5th and 6th units (III stage of ChNPP)
- Without containers 13 400 m^3 RW
- In containers 12 800 m^3 RW
- low- and medium-active, including long-lived
- RW in total activity $3{,}43 \cdot 10^{14}$ Bq

Atmospheric and ground water easily penetrates inside the disposal point as it is not damp-proof

“Points of temporary localization of RW” – PTLRW (1)



Located on the territory close to ChNPP (for RW after decontamination activity, created in 1986-88



simple “facilities” - trenches or clamps type covered with layer of soil on top

“Points of temporary localization of RW” – PTLRW (2)

- created because of the lack of infrastructure for treatment of large amount of “emergency RAW”
- cover territory about 10 km^2 divided to nine “Points” with about 1000 trenches and clamps
- RW - contaminated soil, equipment, metal, concrete, construction materials, wood, debris, etc
- mainly RW was low activity however almost all contains long-lived radionuclide

Points of temporary localization of RW – PTLRW (3)

- neither engineering barriers nor damp-proof
- neither design documents nor precise location maps
- more than a half of the PTLRW area was not investigated
- accumulated about $1{,}3 \cdot 10^6$ m^3 RW with total activity near $1{,}8 \cdot 10^{15}$ Bq
- located at the territory characterized by high water table, about 100 trenches either permanently or periodically flooded and radionuclides easily penetrate into ground water

Options Considered for management of large amount of “Chernobyl Waste”

National Policy and Strategy

…take into account issues related to management of large amount of "Chernobyl waste":

- **National Ecological Program of Radioactive Waste Management** (approved by Low of Ukraine № 516-VI, 17Sept 2008)
- **Radioactive Waste Management Strategy in Ukraine** (approved by the Order of Government № 990, 19 August 2009)
- **National RW Management Fond**

Options Considered for RW management in Ukraine

- **Near-surface disposal** for low- and intermediate level short-lived RW

(the category of "VLLW" is not established)

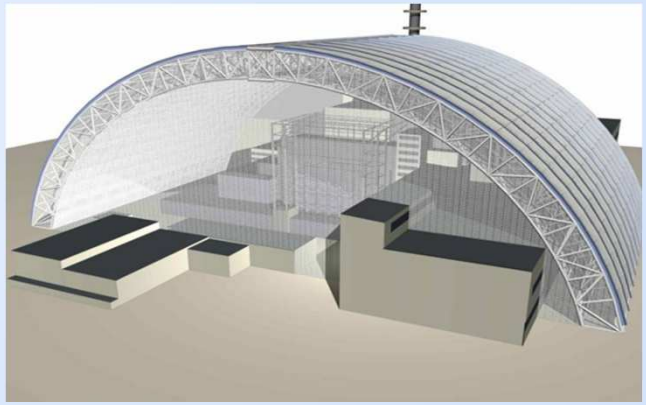
- **Geological disposal** for long-lived RW, high-level RAW, fuel containing materials from Shelter Object
- Option of **long-term storage** before Geological Repository is possible

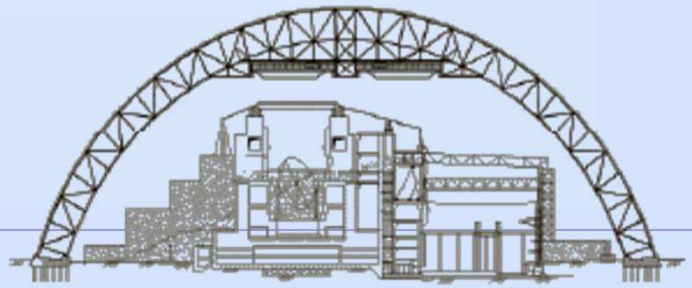
Options for Shelter Object safety

Implementation of National Strategy of Shelter Object Transformation into Ecologically Safe System:

- stabilization of unstable structures and components
- New Safe Confinement construction (ARCH)
- RW removal, sorting, conditioning of long-lived RAW, high-level RAW, fuel containing materials for disposal in geological repository.

Open Issue – criteria for "ecologically safe system"





Options considered for waste from Chernobyl NPP site

To develop infrastructure for RW management (treatment, storage, disposal):

- Liquid RW Treatment Plant
- **I**ndustrial **C**omplex for **S**olid **R**W **M**anagement**:**
  - Retrieval facility of solid RW from existing solid RW storage facility
  - Solid RW processing facility
  - Engineered near-surface disposal facility for low and intermediate level, short-lived conditioned RW (located on Vector Site)
- Temporary storage facility for LLW and HLW
- Complex on manufacturing of steel drums and reinforced concrete containers for RAW storage/disposal

Options Considered for waste from "interim storage facilities" with Chernobyl Waste – "Disposal Points"

- radiation monitoring
- comprehensive study incl. structural stability
- safety assessment
- stabilization measures if needed
- development and implementation of projects for RW retrieval, removal, treatment
- disposal in geological repository/storage in long-term storage facility

Options Considered for Chernobyl Waste from “interim storage facilities” – “points for temporary localization of RW”

- radiation monitoring
- Investigations of all “points” for the inventory clarification
- Safety assessment of the impact on the environment as the basis for making decision of their conservation or excavation (re-disposal)
- Retrieval RW from the “points” that mostly influence environment due to flooding and barriers fault
- Conditioning and preparation for near-surface disposal or geological disposal/long-term storage

Options Considered for Chernobyl Waste Disposal “Buriakovka”

Closure:

- **closure of disposal trenches**
- **closure of disposal**

Or

Reconstruction:

- **safety re-assessment**
- **reconstruction (additional trenches)**
- **possible future use for disposal of very low level short lived RW**

“Chernobyl Waste” – situation now (1)

Development in Exclusion Zone of the National Centre for RW conditioning, disposal of low- and medium level short-lived RW and temporary storages of long-lived and high-level RW – so called “Vector Site”

- investigations proved that there are territories suitable for repositories location
- 90% of all RW in Ukraine is located in the Exclusion Zone (reducing transport problems) and activity on RW infrastructure development is currently concentrated in the Exclusion Zone”
- no social problems (no population permanently living in the Exclusion Zone)

The “Vector Site”

“Chernobyl Waste” – situation now (2)

“Vector Site”

First stage

- Near-surface disposal facilities for low-level short-lived RW originated from Exclusion Zone, ChNPP and Shelter

Second stage

- Near-surface disposal facilities for low-level short-lived RW originated from Ukrainian NPPs, regional special enterprises “Radon”
- Long-term storages for:
- - long-lived RW,
- - high level RW,
- - vitrified high level waste to be returned from Russia after reprocessing of Ukrainian WWER-440 spent fuel
- Centralized storage facilities for disused ionized sources
- Technological complex for RW treatment

More than 20 years after the accident – *some conclusions and lessons learned*

- “Chernobyl waste” – large amount of RW stored/disposed under conditions that do not fully comply with safety requirements
- A lot of preoperational work should be done before their disposal – time- and costs consuming process
- “Re-disposal” option requires comprehensive safety assessment
- Improvement of RW classification and regulations are needed
- Development and operation of facilities on the Vector site
- Siting of “Geological Repository”

Thank you for your attention!