

# *The use of Robotics and Remote Equipment in International Projects implemented at Chornobyl NPP*

Norbert Molitor, Valeriy Seyda, Sergiy Kondratenko, Cécile Javelle  
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Contacts:

SSE "Chornobyl NPP", P.O.Box 11, Slavutych, Kyiv Region, 07101 Ukraine

PLEJADES GmbH - Independent Experts, Feldstr. 5, D 64347 Griesheim, Germany



# Chornobyl NPP Unit 4

## Chronology of International Projects

- 1986: Accident followed by immediate liquidation measures
- 1986-1991: Former Soviet-Union liquidation measures
- 1992: Kyiv Competition
- 1995: Completion of “Alliance – Study”
- 1995: Memorandum of Understanding (Ukraine, G7 and EU)
- 1996: Study “ChNPP Unit 4: Short and Long Term Measures”
- 1997: Initiation/ Start of „Shelter Implementation Plan (SIP)”

Major SIP projects:

- 2008: Completion of Stabilization works
- 2017: Completion of New Safe Confinement (NSC) works
- 2020: New Safe Confinement commissioned
- Next years: Deconstruction of upper unstable parts
- Followed by (not yet determined): Inventory retrieval

# Motivation for the Use of Robotics and Remote Equipment at ChNPP

## Extreme working environment:

- High radiation fields + Radioactive dust  
→ radiation protection
- Heavy duty work (dismantling) in dangerous areas  
→ use remote equipment
- Productivity  
→ less exposure time limitations, increased speed and precision implementation

## Effective robotic systems needed since the accident (1986):

- ChNPP has applied / used available technologies as available (e.g. accident response, removal of “pioneer wall”, configuration of NSC, configuration of NSC and deconstruction of upper unstable parts of “Sarcophagus”, waste retrieval, sorting and processing)
  - IT and robotics technologies now more mature and evolving further (e.g. machine learning, IT supported expert systems)  
⇒ more efficient solutions for most challenging situations (e.g. FCM retrieval)
- Remote technology, robotics, enhanced digital processing and operation support systems are key success factors for **safe, effective and efficient** project implementation

# Exhibition of Historical Equipment used during Accident Liquidation Period at Chornobyl

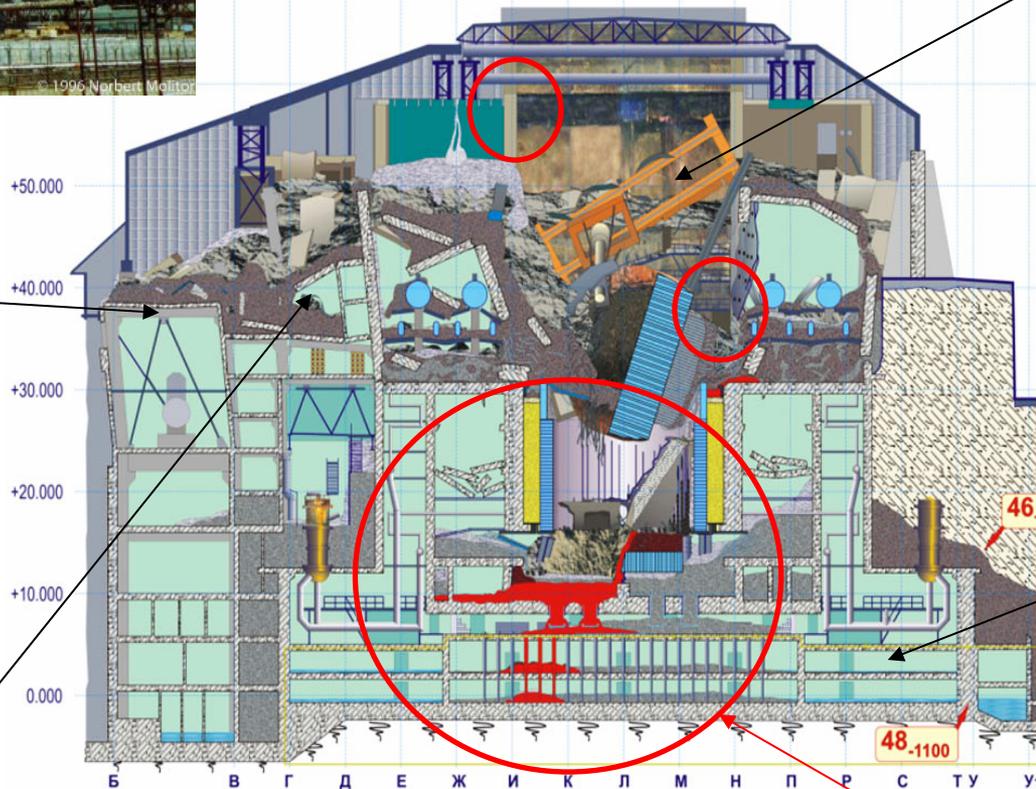
Equipment applied 35 years ago!



(Picture source: Robotics expert visit at Chornobyl, Plejades 2015)

⇒ Robots in accident response: considerable experience acquired

# Chornobyl NPP Unit 4 Situation in 1996



Fuel Containing Material (FCM)

(Picture source: diagram - ISP NPP of NASU, photos ChNPP, Plejades)

# The Fuel Containing Material (FCM) Challenge



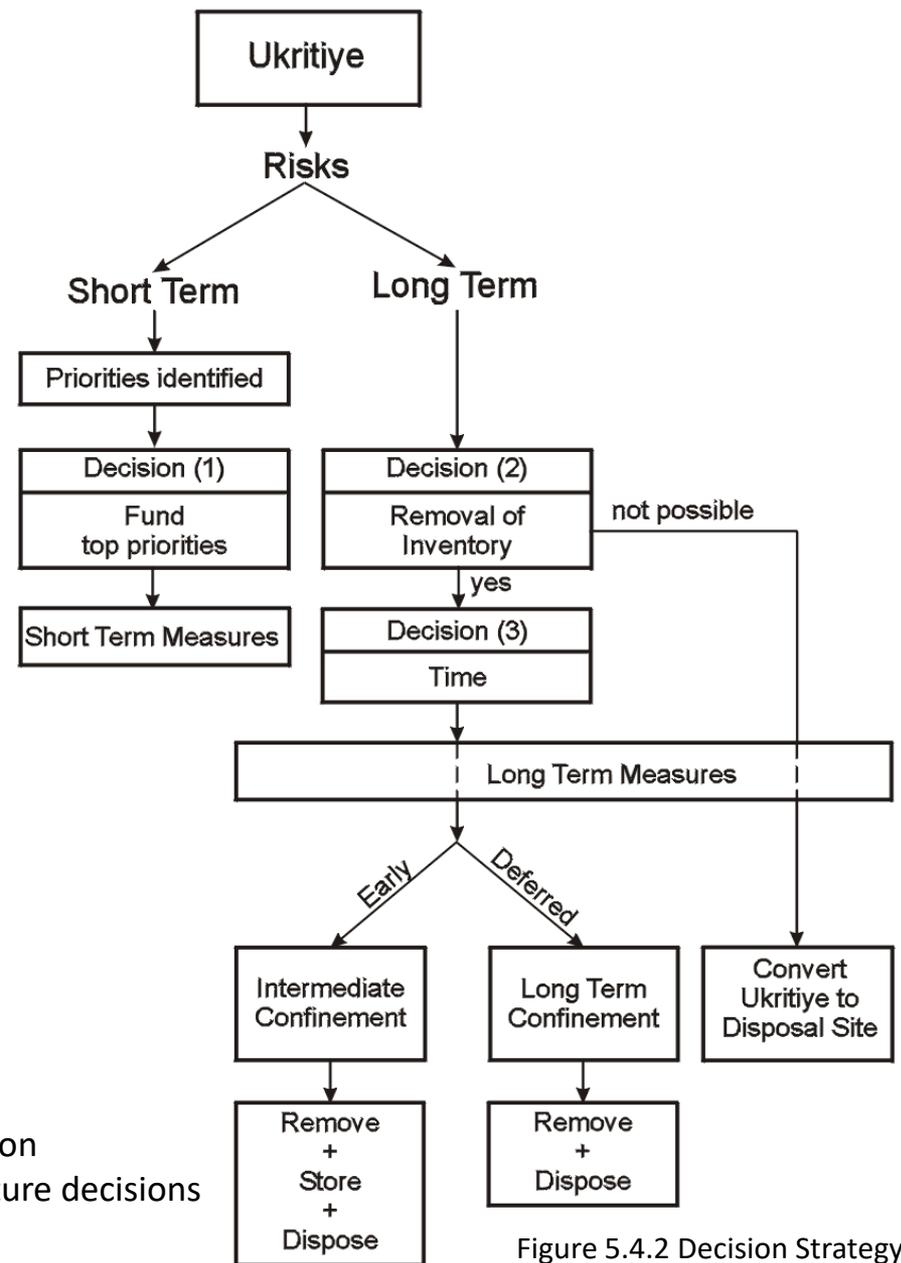
Need for a program for management of fuel containing materials (FCM), e.g.:

- Fissile material in non-normative conditions (unconfined, spread)
- In degrading conditions (ongoing processes, e.g. weathering, dust formation)
- Limited control
- Nuclear safety concerns
- Nuclear security concerns

(Picture Source: SIP Pledging Conference Brochure 1997)

# Development of the Recommended Course of Actions

- Phase 1  
Stabilisation and other 'Short Term Measures'
- Phase 2  
Preparation for conversion into an environmentally safe site
- Phase 3  
Conversion into an environmentally safe site



With decisions: optimisation along decision  
Without decisions: remain flexible for future decisions

Figure 5.4.2 Decision Strategy

Source: ChNPP + International Expert Team 1996

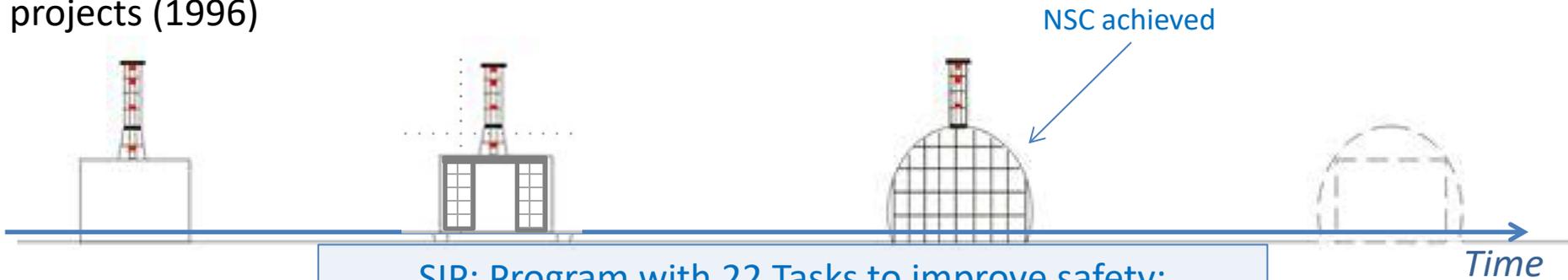
# Shelter Implementation Plan (SIP)

At start of int'l projects (1996)

Short-term Measures

Long-term Measures

End-state



SIP: Program with 22 Tasks to improve safety:

Object  
'Ukritiye'

Stabilized  
'Ukritiye'  
Monitoring &  
Safety improvement

New Safe Confinement  
Deconstruction of unstable parts  
Inventory Management  
& Removal Strategy

Inventory  
Removal

Various  
hazards  
& risks

Less  
hazards &  
risk

Acceptable  
situation:  
risks managed  
(eliminated or confined)

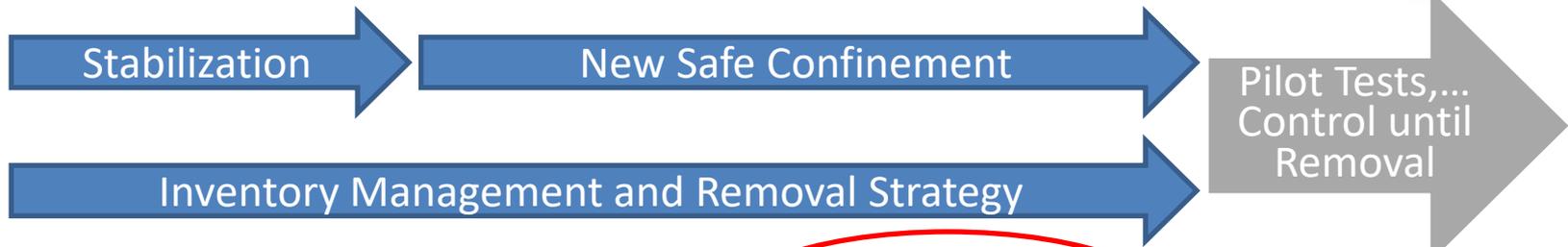
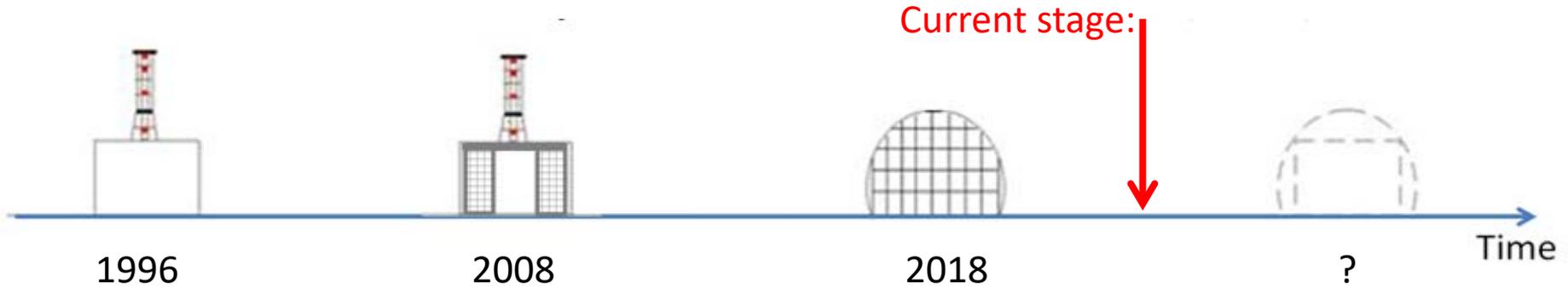
All nuclear  
and radiological  
risks removed

Implementation: 2008-2018/2020 (NSC Commissioned)

→ Next years – Deconstruction of unstable upper parts!

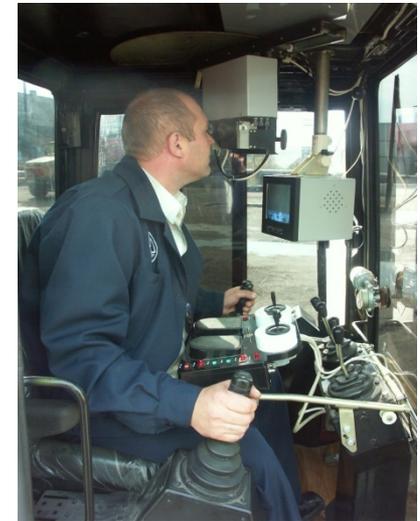
Source: ChNPP + International Expert Team 1996, update 2020

# Shelter Implementation Plan (SIP) and Follow-Up Steps (Long Term Measures)



Phase 1 Stabilization      Phase 2 NSC + Deconstruction      Phase 2 Pilot Tests      Phase 2 Safe Control      Phase 3 End State

# ChNPP Unit 4 -SIP: Use of Remote Equipment during Dismantling of the “Pioneer Wall”

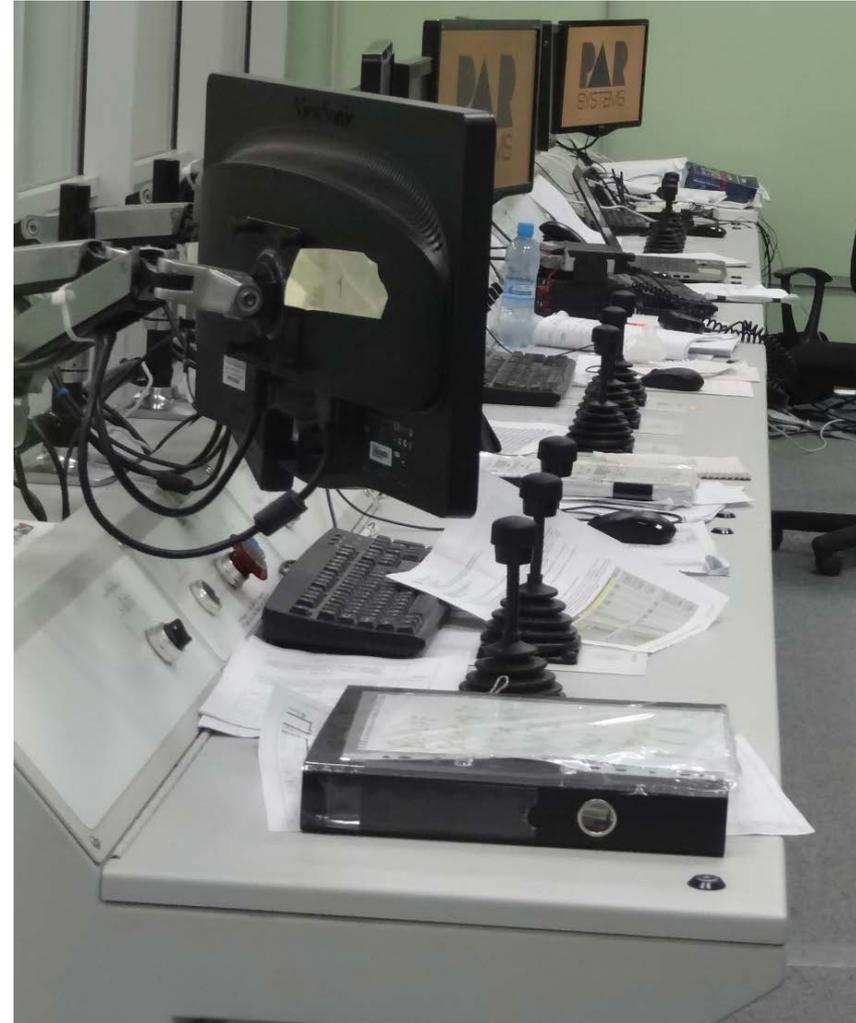


Picture source: ChNPP



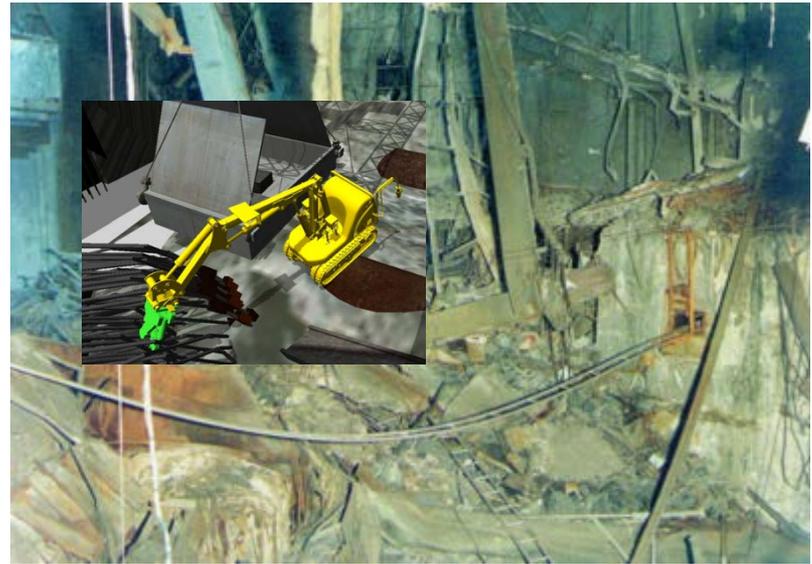
Example: Remote operated equipment for removal of highly contaminated wastes during removal of the “pioneer wall” from the accident liquidation time to prepare NSC erection.

# SIP-NSC: Control Room for Command of Remote Equipment installed at the NSC



Picture Source : Commissioning of NSC operation control centre, Plejades 2018

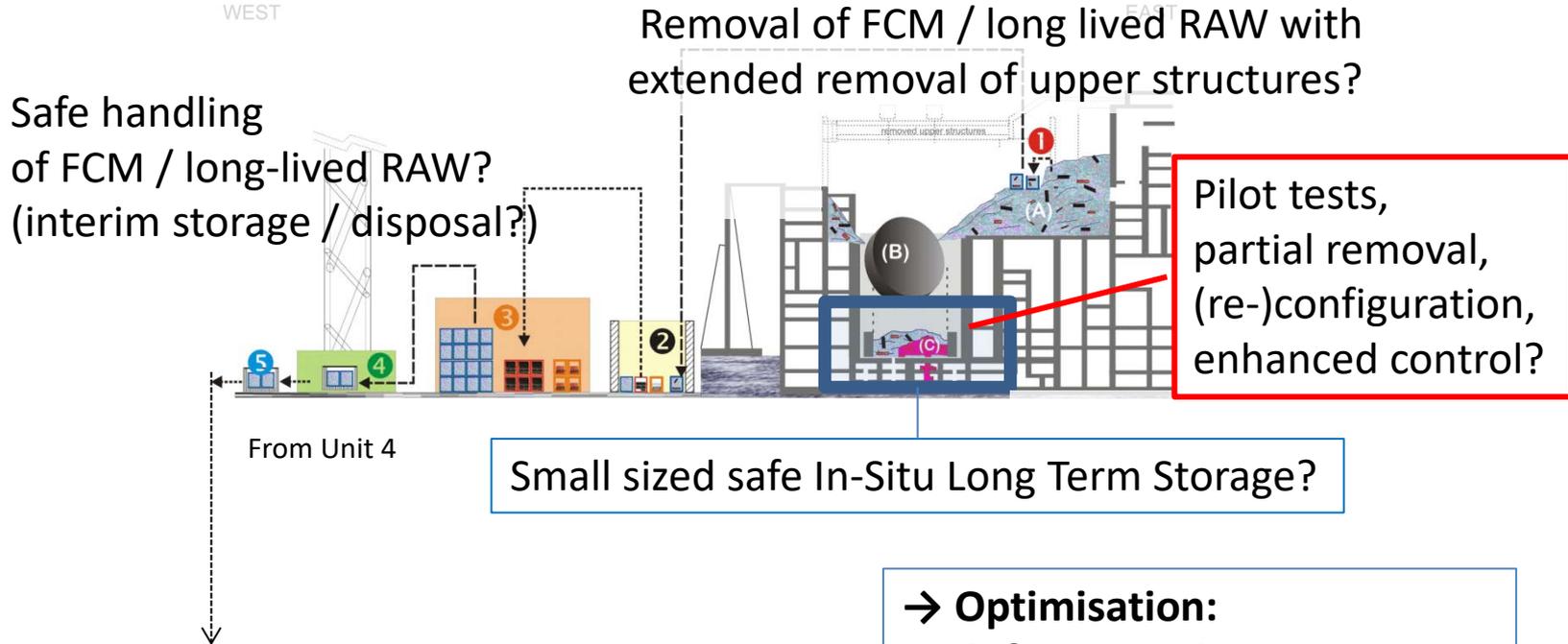
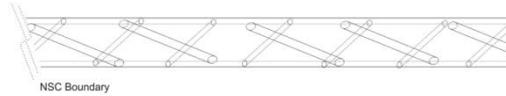
# Plan: Remote Deconstruction of Upper Parts, Vision: Remote Retrieval of Inventory



Picture Source: ChNPP, ISP-NPP

# Further Steps: FCM Strategy Options

Within available technical and time boundaries different options needs to be analysed, such as:



Disposal in DGR (in or near ChEZ)?  
(also for FCM and long lived RAW)

## → Optimisation:

- Safety, security
- Dose uptake, wastes
- Timing
- Costs
- Budget needs

# Experience for RAW Retrieval and Sorting at ChNPP



Picture source: Plejades 2007-2015

Example: Remote equipment used at Industrial Complex for Solid Radwaste Management (ICSRM)

# Recently Commissioned Remote High-tech Equipment at ChNPP

Example: Dry Interim Spent Fuel Storage (ISF 2)



Picture source: Plejades 2016-2018

Hot Cell for dividing RBMK-Fuel assemblies with high precision remote equipment

# Benefits of Remote Technology and Robotics

- Remote equipment and robotics contribute to safe, effective and efficient solutions
- Advantages of remote equipment
  - Dose reduction
  - Performance of heavy duty work
- Automated equipment contribute to:
  - Speed/productivity in repetitive work
  - High precision work
  - Immediate use of multi-sensor data
- Specific modern information technology options:
  - Real time simulation
  - Digital twins/ shadows
  - Machine learning
  - Artificial intelligence

# Chornobyl NPP Offer

- Its site as a unique platform to test and improve new technologies under real conditions
- Openness to cooperation, sharing experiences and joint projects
- Professional experts experienced in implementation of unique international projects for joint research activities
- Possibility to take part in addressing the important problem for all mankind – elimination of the Chornobyl catastrophe consequences



Thank you