Technical Meeting (TM) on the Research Reactor Decommissioning Demonstration Project (R2D2P)
Manila, Philippines, from 16 to 20 October 2006

PLANNING AND PROGRESS FOR DECOMMISSIONING OF HEAVY WATER RESEARCH REACTOR

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HWRR reactor building and cooling tower

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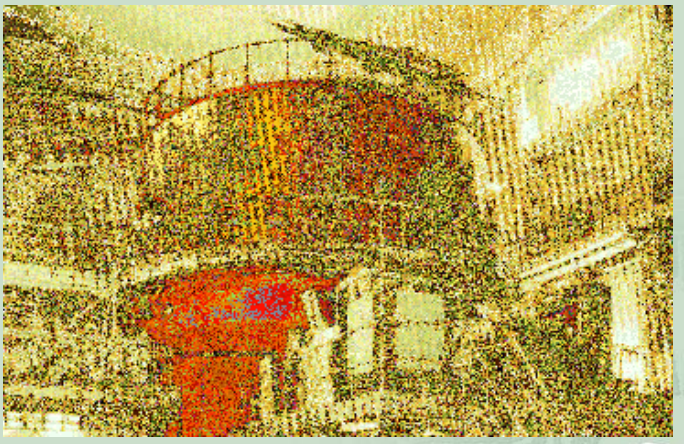

HWRR reactor body

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Introduction

- HWRR was constructed and put in operation in 1958,
- It is scheduled to be permanently shut down by the end of 2007,
- Immediate dismantling of HWRR after final shutdown will be carried out.

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HWRR Overview(1)

- HWRR was established and put in operation in 1958 at CIAE, and is located in suburb of Beijing, the Capital of China,
- It is the first nuclear reactor in China,
- It is a 10 MW multi-purpose research reactor, and
- It has been operated for 48 years.

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HWRR Overview(2)

- Core: a tank-type structure
- Moderator and Coolant: Heavy Water
- Reflector: Graphite
- Fuel: UO_2 with U235 enrichment 3%
- Largest thermal neutron flux: $2.6 \times 10^{14}/cm^2.s$
- Rated thermal power: 10MW
- Strengthened power: 15MW

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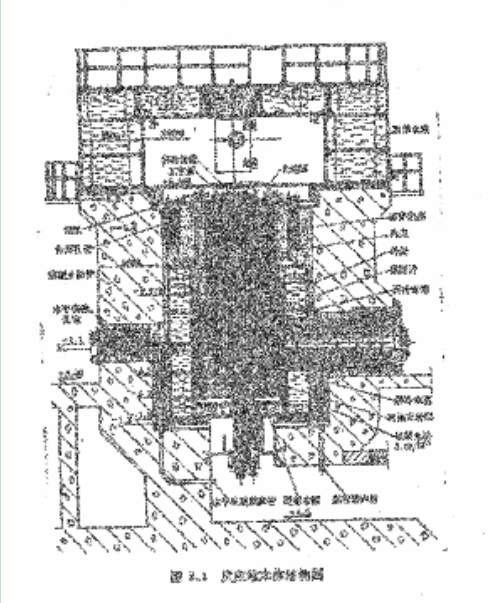

Fig.1 HWRR Structure

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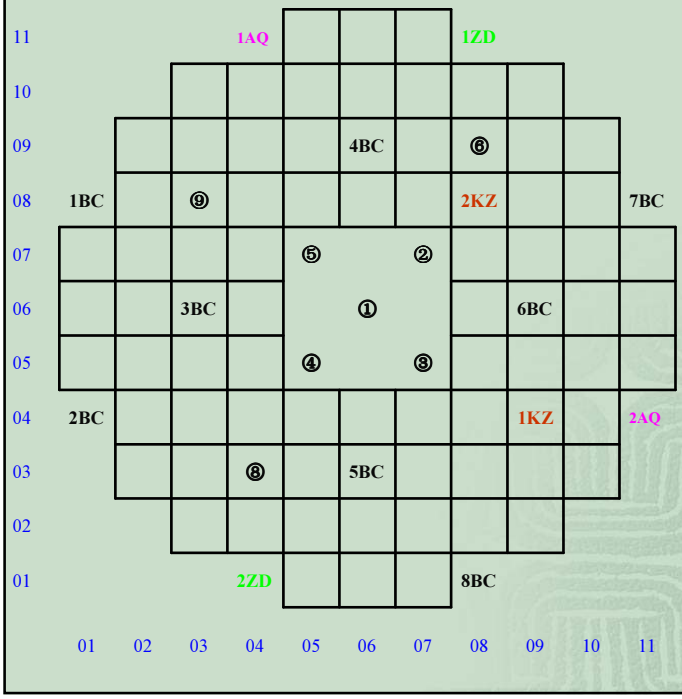

Fig.2 Core Configuration of HWRR

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Activities Conducted

- Nuclear physics
- Reactor physics and thermal hydraulics
- Radiation protection and monitoring
- Irradiations of nuclear fuel rods
- Neutron activation analysis
- Production of radioactive isotopes
- Technical services for NPPs
- Reactor operation management
- Training of reactor operators

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Major Renovation & Improvement(1) (1979-1982)

- Change of inner vessel
- Change of two main heat exchangers
  Heat transfer area(m^2):58 → 102
- Chemical decontamination of primary coolant system
- Core: Fuel number: 84 → 72
  Lattice size (cm) : 13×13 → 9.2×9.2
  Fuel: Metal U(2%) → Ceramic UO_2(3%)
  Fuel height(cm):124.3 →100
  Cladding:S.S. → Zr-2
- Primary coolant flow rate(m^3/h):400 → 640
- Secondary coolant flow rate(m^3/h):1000 → 1800

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Major Renovation & Improvement(2) (1979-1982) con't

- Rated thermal power(MW): 7 → 10
  strengthened power (MW) : 10 → 15
- Largest thermal neutron flux(n/cm^2.s):
  $1.2\times10^{14} \rightarrow 2.6\times10^{14}$
- Irradiation tube number:9 → 33

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Major Renovation & Improvement(3) (1983 -1995)

- Construction and operation of irradiation system for PWR fuel rods of Qinshan Nuclear Power Station (phase 1)
- Construction and operation of Cold Neutron Source

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Major Renovation & Improvement(4) (1992-1997)

- Improving safety systems
  - ECCS
  - Spare Safety Rods System
  - Emergency Power Supply System
- Improving central control room
- Improving instrument monitoring systems
- Improving fire alarming system

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Necessity for Decommissioning

- Since long operation, all equipment are aged and outdated, not good for safety consideration
- As a replacement, a new 60 MW CARR(China Advanced Research Reactor) is under construction and will be operated before 2006 at CIAE
- Besides, CEFR(China Experimental Fast Reactor) is also under construction at CIAE
- HWRR will be shut down by the end of 2007
- Beijing will host the Olympic Games in 2008.

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Objectives of Decommissioning

- After shut down and 3 years transit period, then implementing decommissioning for final reuse of the facility as education base
- Minimizing waste volumes produced
- Minimizing personnel exposure and environment release
- Minimizing project costs
- Increasing reuse rate of equipment and site

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Significance of the Project

- HWRR is under IAEA Safeguard system. Its decommissioning is the first nuclear reactor to be decommissioned under the system in China.
- Safe decommissioning of HWRR with minimized environmental impacts from the wastes is an important and sensitive issue in Beijing region.
- Experience gained by HWRR decommissioning will be very valuable for decommissioning of other nuclear facilities and for further development of nuclear programme in China.

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HWRR Decommissioning Plan

- HWRR decommissioning has been included in the governmental plans for the period of 2001-2005, 2006 –2010 and 20-year long-term plan.
- A project on preparation for HWRR decommissioning has been submitted to the national authority.

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Decommissioning Work Plan Preparation Period (2005-2007)

- Complete preparation for history/event investigation and technical file compilation
- Estimation of radiation source
- Developing preliminary decommissioning plan
- Developing national project proposal
- Submitting documents and reports to authorities for project approval

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Decommissioning Work Plan
Transition Period (2008-2010)

- Reactor cooling and fuel discharging
- Transport of spent fuel & radioactive residuum
- Discharge of heavy water in reactor & systems
- Reconstruction of special decommissioning facilities (e.g., ventilation, radiation protection)
- Development of software & documents
- Implementation of special research projects

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Decommissioning Work Plan
Implementation Period I (2011-2015)

- Disposal of water in spent fuel pool & low-level waste water containing tritium
- Cutting of pipes, dismantlement of components, disassembly/packaging/transporting of big equipment
- Cleaning & surface decontamination of radioactive structures

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Decommissioning Work Plan Implementation Period II (2016-2020)

- Cutting/disassembly/packaging/transporting of reactor shield plug, inner components, experimental tubes, graphite reflector, sand layers, bio-shield water tank
- Decontamination of reactor concrete body

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Problems to Be Faced

- Lack of decommissioning experience and plan establishment
- Key techniques: as treatment of tritium in used heavy water and dismantling graphite reflector
- Calculation and analysis of radiation source
- Lack of advanced decommissioning equipment
- Knowledge of regulations, rules and standards
- Personnel training

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International Cooperation

- Since HWRR decommissioning will be the first nuclear reactor to be decommissioned in China, lack of decommissioning experience and knowledge of key techniques is major problem to be faced, international cooperation is necessary.
- So far, we have established several ways for international cooperation, and we will still look for further international cooperation on nuclear facilities decommissioning.

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IAEA TC Project

- Decommissioning Planning and Technology for Heavy Water Research Reactor (HWRR) at CIAE
- Project code: CPR/9/034
- Implementation period: 2005-2006
- Total budget: USD 319,190

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TC Project Counterparts

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IAEA TC Project Objectives

- **Overall:** To make good preparation for HWRR decommissioning, consequently successfully carry out HWRR decommissioning step by step with meeting the requirements of safety and environment.
- **Specific:** To develop HWRR decommissioning plan and to acquire know-how in state-of-the-art key decommissioning techniques.

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TC Project Components
Expert Services (4 Missions)

- Development of decommissioning plan (April 2005)
- Safety analysis, environmental assessment
- Project management (November 2005)
- Key techniques, as treatment of tritium in used heavy water, demounting graphite reflector, treatment of large-structure equipment (April 2006)
- Peer review of decommissioning plan documents (2007)

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TC Project Components
Scientific Visits
(1 group with 3 persons)

- Learn international decommissioning experience and lessons
- Establishment and implementation of decommissioning plan
- Project management, cost estimate
- Applications of regulations, rules and standards
- Learn key techniques and uses of equipment (postponed to February 2007)

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TC Project Components
Fellowships
(3 groups with 6 persons)

- Develop decommissioning plan and radiological characterization survey plan (October,2005)
- Learn key techniques, as treatment of tritium in used heavy water, demounting graphite reflector, treatment of large-structure equipment and radiation protection and waste management (October,2006)
- Calculation and analysis of radiation source and application of computer software and database and safety analysis and environmental impact assessment(2007)

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TC Project Components
Procurement of Equipment

- General radiation protection detectors (1 package)
- Sample collector
- Automatic low level α, β, γ smear counter (2005)
- Digital Gamma ray spectrometer with software (being evaluated)

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TC Project Progress
Workshops

Before the TC project, two workshops had been accomplished at CIAE.

- In April 2003, Workshop on Nuclear Facility Decommissioning Planning was held, Mr. Reisenweaver gave the lectures.
- In October 2004, Characterization Survey Workshop was held, Mr. Reisenweaver, Mr. Drape and Ms. Milijana attended and gave lectures.

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TC Project Progress
Expert Services

3 Expert Services have been accomplished.

- In April 2005, the first one
- In October 2005, the second one
- In April 2006, the third one

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TC Project Progress
Expert Services (1)

- In April 2005, the first expert mission was implemented. Topic is developing decommissioning plan, safety analysis report and environmental assessment report. Mr. Reisenweaver, Mr. Hansford and Mr. Ljubenov attended and gave lectures.

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Right: Mr. Reisenweaver is talking with Mr. XUE, Director of Department.

Left: Mr. HU is giving a presentation on HWRR decommissioning planning.

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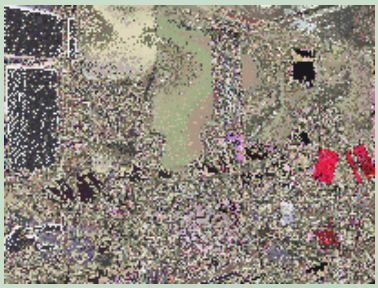
TC Project Progress Expert Services (2)

- In October 2005, the second expert mission was implemented. Topic is project management. Mr. Reisenweaver, Mr. Crabtree and Ms. Nikolic attended and gave lectures.



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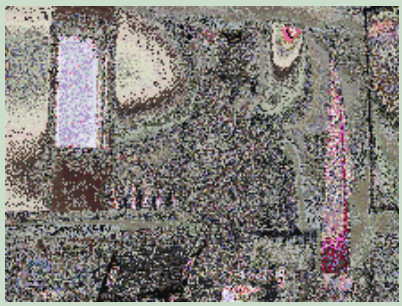

Mr. Crabtree

Ms. Nikolic

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Listening

Practicing

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TC Project Progress
Expert Services (3)

- In April 2006, the third expert mission was implemented. Topic is decommissioning techniques. Mr. Laraia, Mr. Noynaert and Mr. Thierfeldt attended and gave lectures.

Mr. Laria

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Mr. Noynaert

Mr. Thierfeldt

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I was introducing HWRR spent fuel management

Young participants from different departments at CIAE

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TC Project Progress
Fellowships

1 Fellowship has been accoplished.

- During September 26 and October 25, 2005, the first fellowship was implemented. Fellows are Ms. Yifei ZHANG and me. Topic is developing decommissioning plan and characterization survey.
- The host institute is VINCA Institute of Nuclear Sciences in Serbia and Montenegro, Mr. Ljubenov is our supervisor.
- RA research reactor is similar with HWRR, both were designed by former Soviet Union, so their experience is valuable for us.

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TC Project Progress
Fellowships

1 Fellowship is being implemented.

- Duration: from October 13 and November 10, 2006.
- Fellows: Mr. Yang CAO and Mr. Jinxin PANG.
- Topic: decommissioning technology and waste management.
- The host institute: SCK/CEN in Belgium.
- The supervisor: Mr. Noynaert, who came to CIAE for the third expert mission on decommissioning techniques in April 2006.

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TC Project Progress
Procurement of Equipment

4 packages of equipment have been delivered, and we have checked and fulfilled relevant personnel training.

- TRUMPF N1000-0 Nibbler
- Hollow Saw Kit K2000PE
- Diamond Hollow Drill
- PIC-WPC-9550 Ultra-low-background Alpha/Beta counting system
- E-600 Multipurpose data logging digital survey meter

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TC Project Progress
To Be Done

- 1 Scientific Visit (2007)
- 1 Expert Service (2007)
- 2 Fellowships (one is being implemented)

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TC Project Progress Outputs (1)

- HWRR decommissioning project promoted,
  - Organization established,
  - Decision made for final shut down by the end of 2007,
  - Domestic project proposal for preparation and transition phase (2006-2010) submitted,
  - Drawing decommissioning plan initiated.

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TC Project Progress Outputs (2)

- Personnel trained,
  - Workshops: decommissioning planning, characterization survey, project management, and techniques,
  - Fellowships: decommissioning planning and characterization survey.

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TC Project Progress Outputs (3)

- International cooperation established.
  - IAEA,
  - IAEA experts,
  - Institutes of some countries.

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DeSa Project

- I participated in the opening meeting of DeSa project in Vienna, from 1 to 5 November, 2004.
- Mr. HU participated in the second meeting of DeSa project in Vienna, from 17 to 21 October, 2005.
- Mr. HU will participate in the third meeting of DeSa project in Vienna, from 13 to 17 November, 2006.
- We choose Assessment Framework Working Group, Graded Approach Working Group and Research Reactor Test Case Working Group.

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Fig.1 The opening meeting of DeSa project

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Fig.2 the second DeSa project meeting

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R2D2P

- Mr. HU, who is the counterpart of the TC project CPR/9/034, is also the coordinator of R2D2P in China.
- We missed the first R2D2P workshop in Manila for its topic on Legal and Regulatory Aspects, so the governmental authority dispatched 2 regulators to participate.
- We would like to participate in all remaining activities of R2D2P.

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Decommissioning Progress Made

- Organization established
- Decision made for final shut down by the end of 2007
- Domestic project proposal for preparation and transition phase (2006-2010) submitted
- Drawing decommissioning plan initiated
- Collecting related documents
- Collecting information for establishing research projects
- Related project on waste disposal coordinated

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Organization

Decommissioning organization established

- Decommissioning planning lead group at the institute
- Decommissioning office at the department
- TC project counterparts

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Summary

- HWRR will be permanently shut down by the end of 2007
- Organization established
- Domestic project proposal for preparation and transition phase (2006-2010) submitted
- Drawing decommissioning plan initiated
- International cooperation needed and established.

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Thank you