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The Role of a Research Reactor in the National Nuclear Energy Programme in Vietnam: Present and Future

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Current status of the DNRR

Geography:

- Located between the North latitude of 8^{o}30’ and 23^{o}23’, and between the East longitude of 102^{o}12’ and 108^{o}50’;
- Covering an area of 333,688 km$^{2;}$
- 3,700 km of frontier and 3,260 km of sea coast;
- Bounded by China, Cambodia, Laos, South China Sea, and Gulf of Thailand;
- Capital: Hanoi in the North;
- Big City: HoChiMinh City in the South;
- Dalat City: 300 km North-East of HoChiMinh City.

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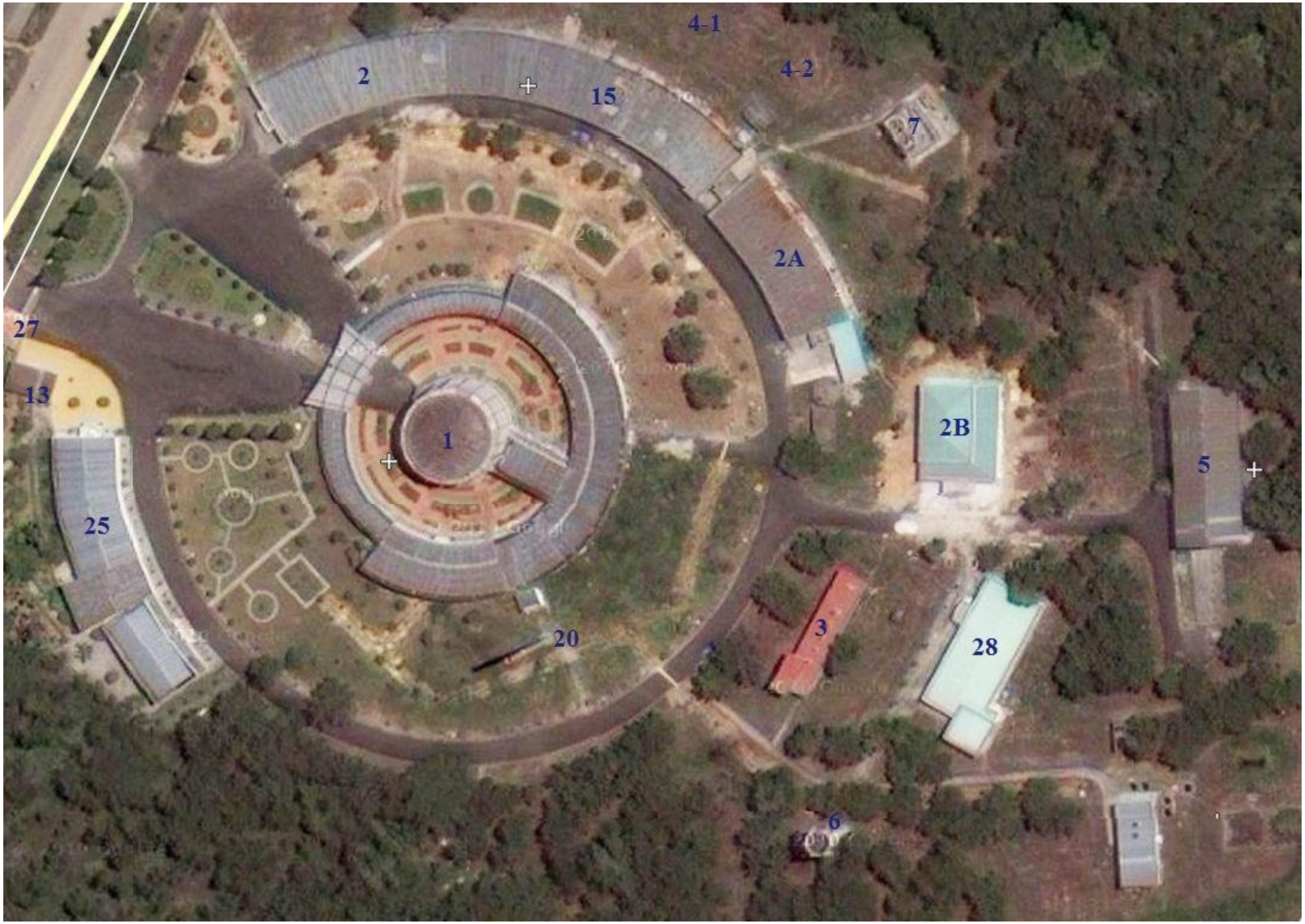
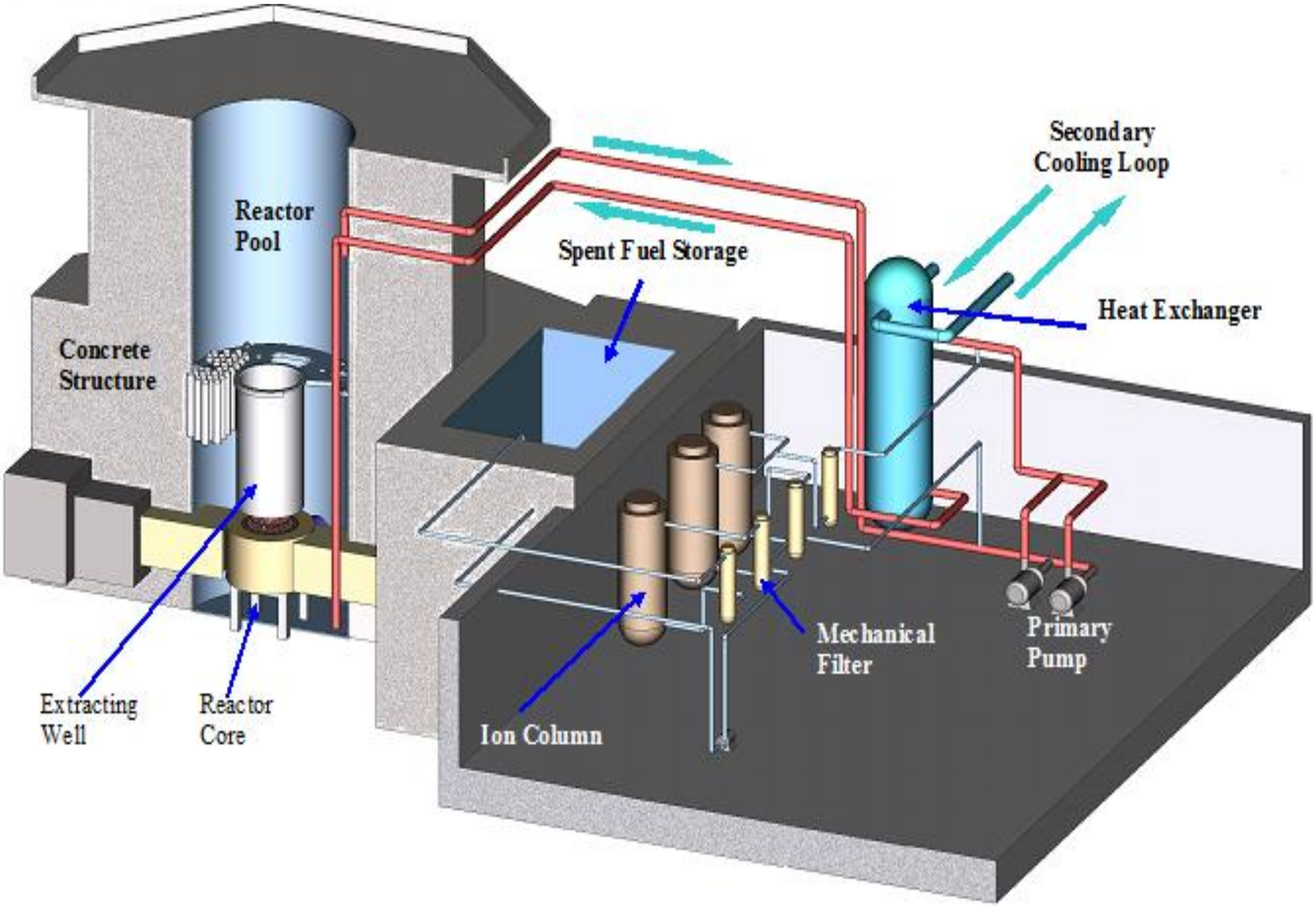
Current status of the DNRR

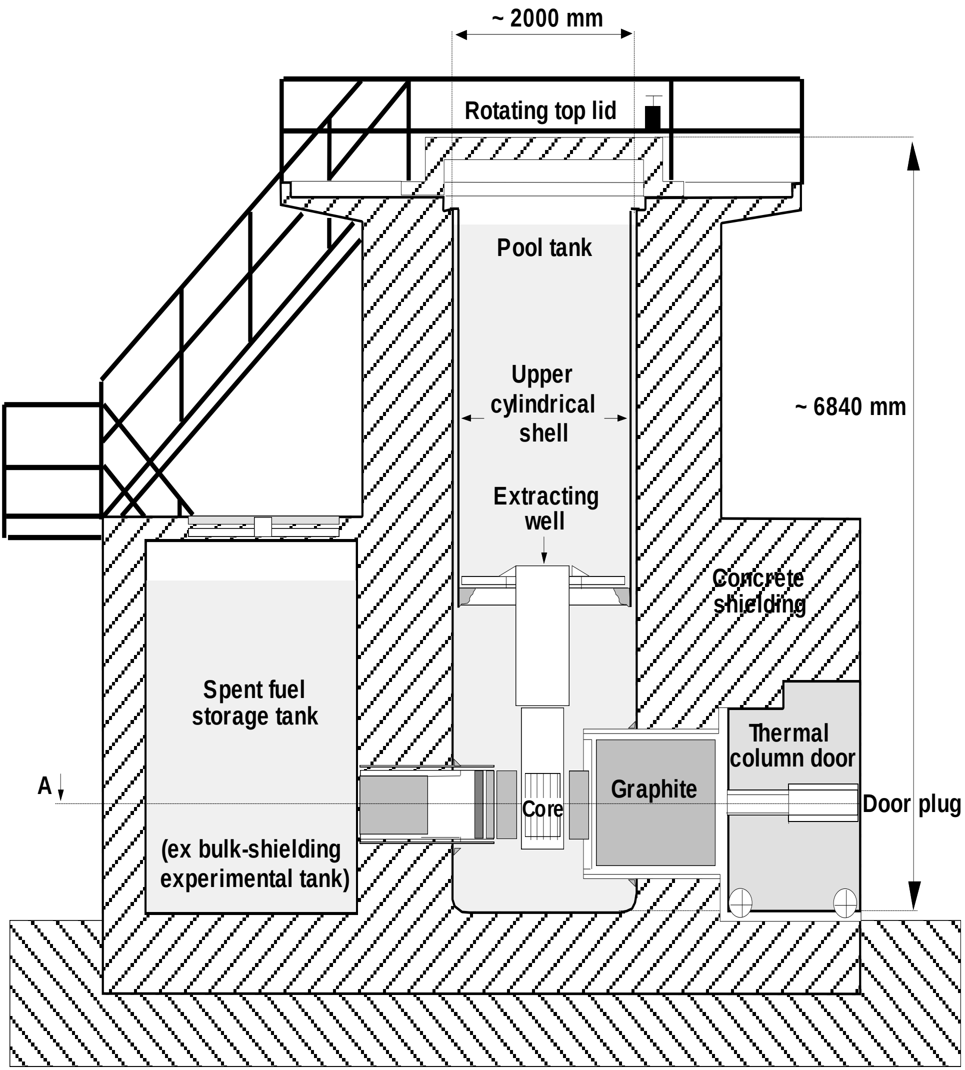


Current status of the DNRR



Vertical section view of the DNRR

Current status of the DNRR (Cont.)



- Combination between TRIGA MARK II (USA) and IVV (RF)
- Power: 500 kW
- Coolant and moderator: Light water
- Core configuration: Cylindrical core 44.2cm Di x 60cm H.
- Natural convection
- 7 control rods: 2 safety rods (B_4C), 4 shim rods (B_4C) and one automatic regulating rod (SS)
- 6 nuclear channels: 3 in Source range and Intermediate range with CFC, and 3 in Power range with CIC
- Reflector: Beryllium and graphite.

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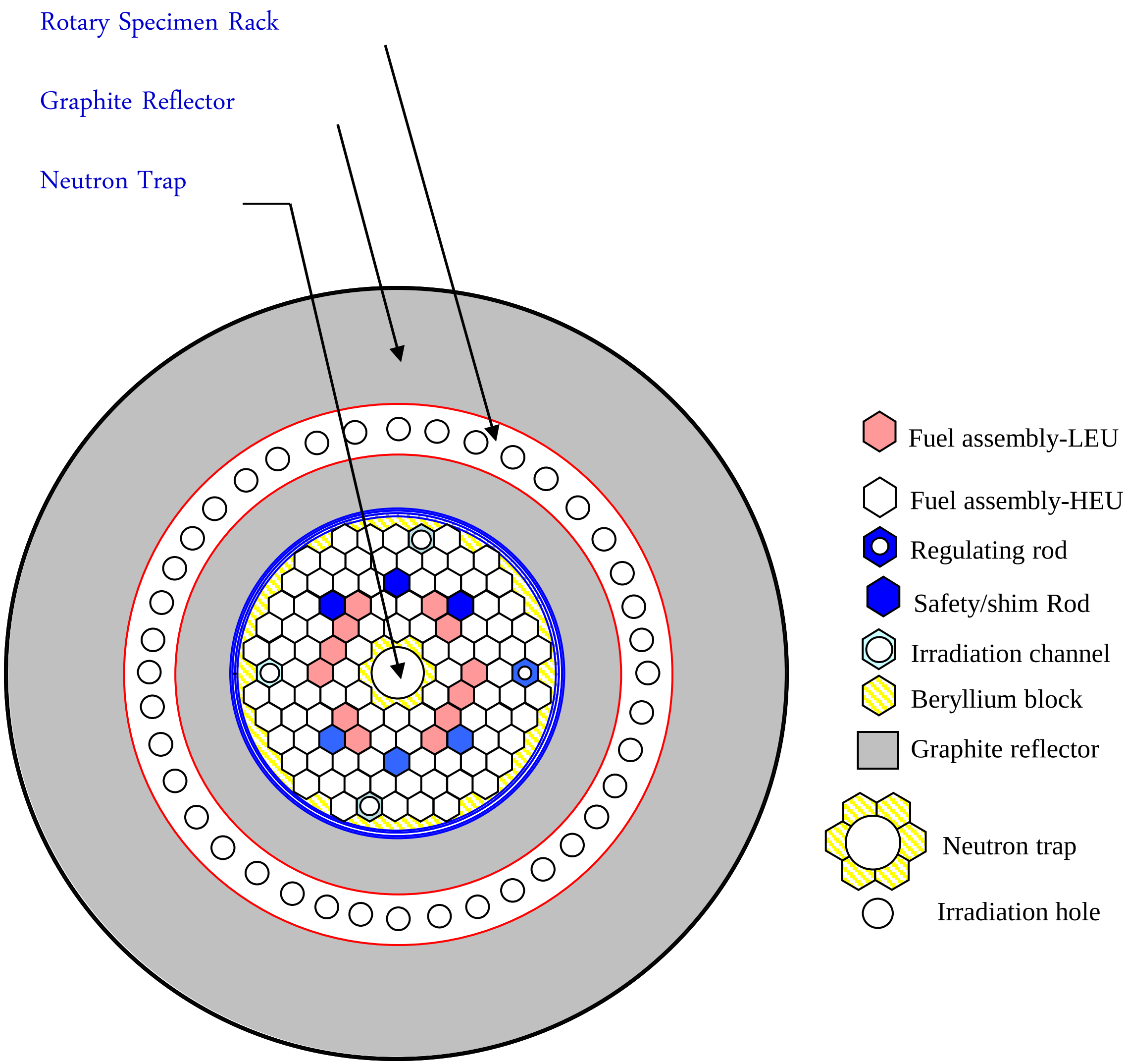
Current status of the DNRR (Cont.)



Vertical irradiation channels and thermal neutron flux($n.cm^{-2}.s^{-1}$):

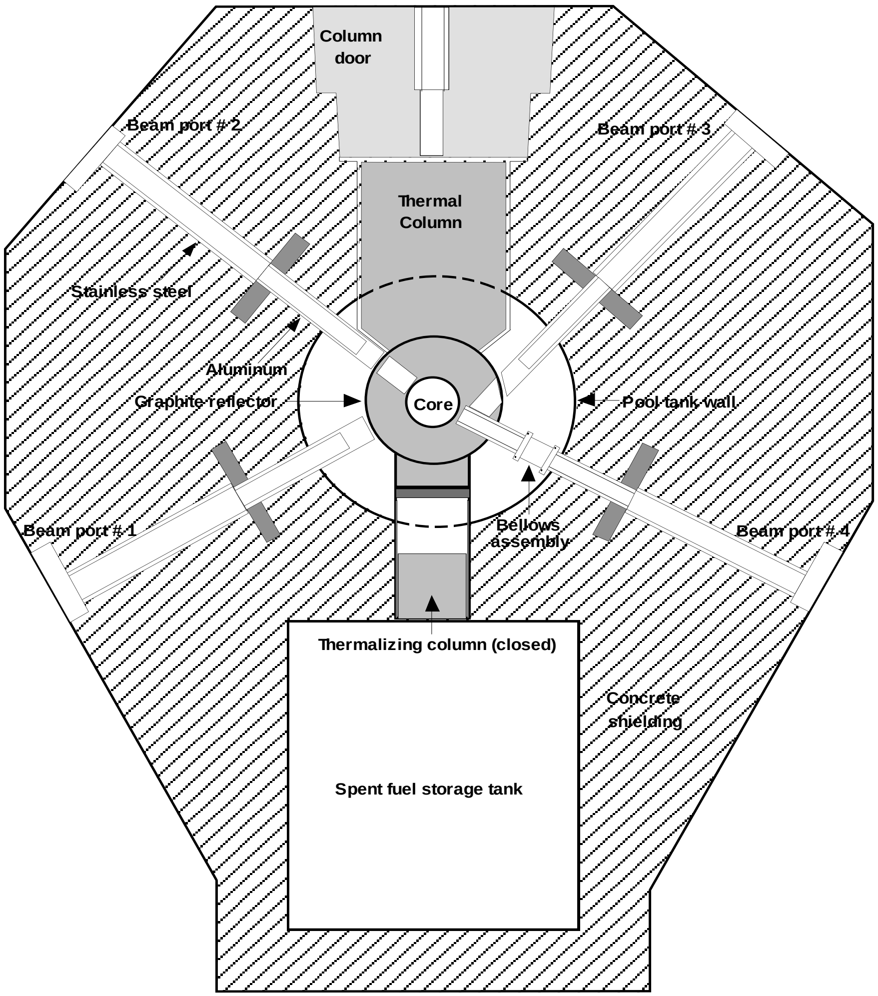
+ Wet channels:

- Neutron trap at the core center: 2.21×10^{13}
- Irradiation hole at cell 1-4: 1.28×10^{13}
- 40 holes at rotary specimen rack: 4.3×10^{12}

+ Dry channels:

- Pneumatic transfer tube at cell 7-1: 4.5×10^{12}
- Pneumatic transfer tube at 13-2: 4.6×10^{12}

Current status of the DNRR (Cont.)



Horizontal irradiation channels and thermal neutron flux(n.cm^{-2}.s^{-1}):

+ Tangential beam port No. 3:
  1.4x10^6 (n, 2gamma)
+ Radial beam port No. 4:
  1.8x10^7 (PGNAA, ND, …)
+ Radial beam ports No. 1 :
  not used
+ Radial beam ports No. 1 :
  will be used in next year

• Thermal column :

+ 5.8x10^9 n.cm^{-2}.s^{-1}

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Current status of the DNRR (Cont.)

- Vietnam has only one RR – main purpose: training, radioisotope production, neutron activation analysis and basic research.
- During operation, DNRR played a very important role in the development of the nuclear infrastructure and provided numerous products and services.
- Limitation of neutron flux level, the out-of-date design of the experimental facilities and the ageing of the reactor facilities (~ 50 Ys), DNRR can not meet the increasing user's demands.
- Building a new multipurpose research reactor of high power (10 to 20MW) to increase nuclear potential of the country, to meet the requirements of energy and non-energy related applications, to create staff for nuclear industry.
- The main role of a new RR:
    - To serve the nuclear power development program,
    - To promote the application of nuclear science and technology,
    - To train scientific and operational staff for the future nuclear facilities.

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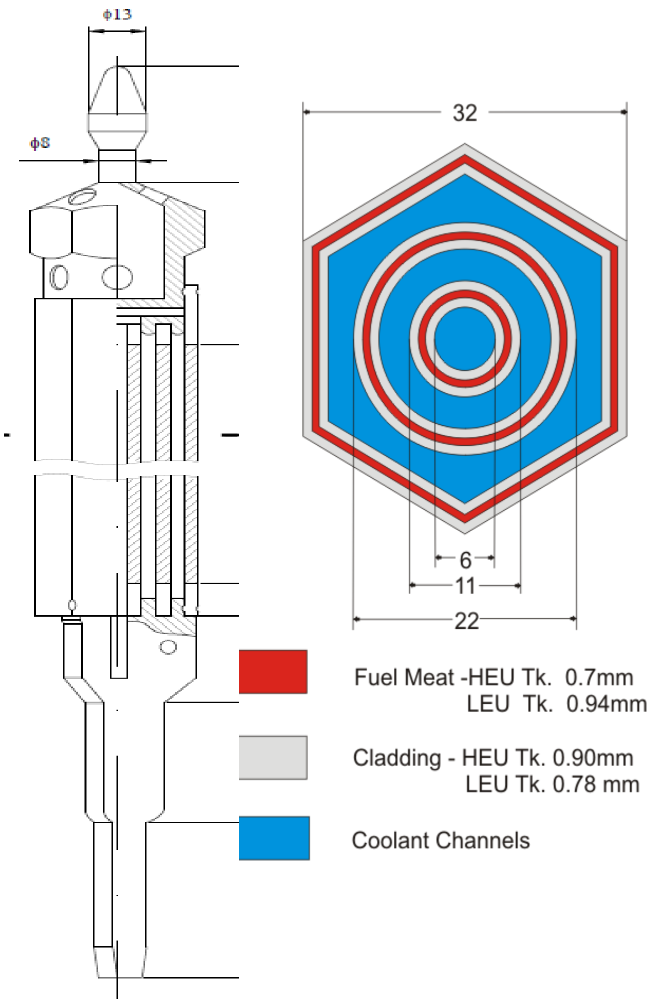
Current status of the DNRR (Cont.)

Parameter	WWR-M2 HEU	WWR-M2 LEU
Enrichment, %	36	19.75
Average Mass of ^{235}U in FA, g	40.20	49.70
Fuel Meat Composition	U-Al Alloy	UO_2+Al
Uranium Density of Fuel Meat, g/cm^3	1.40	2.50
Cladding Material	Al alloy (SAV1)	Al alloy (SAV1)
Fuel Element Thickness (Fuel Meat and Cladding), mm	2.50	2.50
Fuel Meat Thickness, mm	0.70	0.94
Cladding Thickness, mm	0.90	0.78



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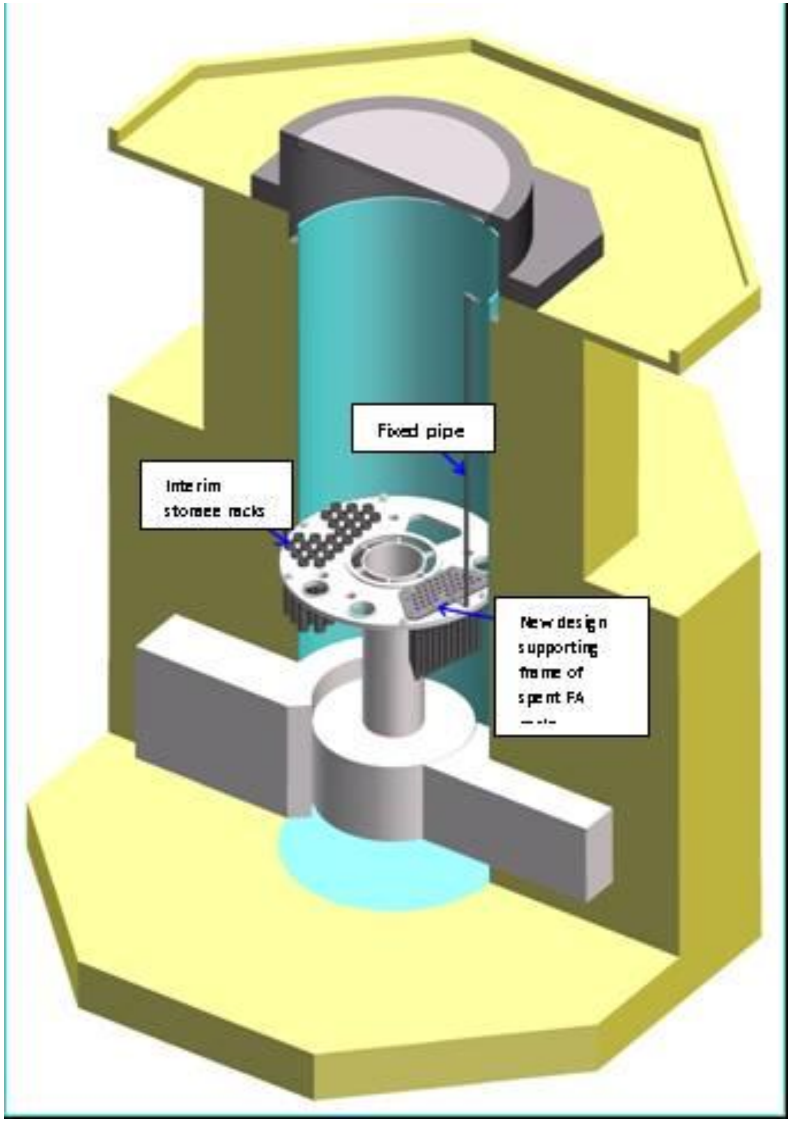
Current status of the DNRR (Cont.)

- Finishing theory calculation for full core conversion – up to date SAR (under RERTR program)
- Reactor shutting down from May, 2011 to prepare for re start up
- Upgrading crane in the reactor hall from 3.5 to 5.0 tons weight capacity
- Upgrading security system
- Unloading all FAs from the reactor core and loading Be rods Al chock rods
- Transferring all burnt HEU FAs (106) from interim storages in the reactor pool to spent fuel storage
- Preparing for re-startup reactor with fully LEU FAs: program, measure instruments and others



Main role of new high performance multipurpose RR

- To satisfy the increasing demands for the utilization of the research reactors;
- To support the national nuclear power development program;
- To enhance the development of the science and technology in Vietnam. The nuclear technologies provide essential tools and technical information for the advanced technologies;
- To improve the nuclear technologies and infrastructures including the human resources established through the DNRR;
- To have an opportunity for experiencing the localization of the nuclear power technology.

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Characteristics of new RR

- The maximum thermal neutron fluxes $2x10^{14}$ to $3x10^{14}$ $cm^{-2}s^{-1}$,
- Stable neutron flux in experiments. Variation of neutron flux due to samples in other irradiation sites less than 5%.
- Thermal neutron flux at the nose of the beam tube stable within a 5% variation;
- The axial neutron flux gradient at the irradiation site within ±20% over a length of 50 cm or more;
- Burn up of the discharged fuel more than 55% in the EOC;
- The reactor operating cycle longer than 30 days;
- A reasonable combination of sizes, types and orientations for the irradiation holes and beam tubes is required for various experiments;
- Inherent safety characteristics.

Characteristics of new RR (Cont.)

- Reactor type: Open tank. Water channel to spent fuel storage
- Power: 10 to 20MW
- Neutron flux max and average: 3-5E14 and 2-4E14 $n/cm^2.s$
- Power peaking factor: as low as possible (<5% axial)
- Core size: Optimize
- Core height: 70 – 80 cm
- Fuel: MTR
- Fuel burn up and cycle: 55% and 30 days or more
- Number of FAs: Under 100
- Control rod position: Upward
- Reflector: D_2O or $Be+H_2O+D_2O$
- Coolant and moderator: H_2O
- Flow direction: Upward
- Biological shielding: Heavy and light concrete

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Characteristics of new RR (Cont.)

Experimental devices:

- Irradiation in the reactor core: 1-3 (loop test, …)
- Silicon doping (NTD): 4-6 (multi size, diversity product)
- Horizontal beam tube: 8-10 (CNS, other applications)
- Vertical irradiation channels: 25 (RI, NAA, …)

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Applications of new RR

- Neutron beam application
  - *Neutron scattering, neutron diffraction, prompt gamma neutron activation analysis, neutron capture therapy, ect*
- Irradiation application
  - *Fuel and material test and study by using various types of capsules and fuel test loops*
  - *Radio Isotopes production*: I-131, Mo-99, Tc-99m, P-32, Sm-153, Re-186, Ho-166, Lu-177, Cr-51, Fe-55, Ir-192, Co-60, C-14, S-35, etc.
  - *Neutron Activation Analysis*
  - *Neutron transmutation doping*
- Basic research
  - *Reactor physics – Nuclear Data – Nuclear structure*
  - *Experiments*
- Training and Education

Main results of national project on new RR

- A research project on a new RR for Vietnam 2002 –2004
- The requirements for RR utilization in Vietnam after the years of 2020
- Design characteristics of the 8 typical modern RRs in the world (OPAL, JRR-3M, HANARO, CRCN/RPM, ETRR-2, FRM-II, TRR-II, Russian offered reactor)
- Basic design calculation on neutronics and thermo-hydraulics.
- Establishment 5 reports in the project

Main results of national project on new RR (Cont.)

- **Report 1**: *Status of the world's research reactors with the orientation to nuclear power development program.*
- **Report 2**: *Effects of research reactor utilization for socio-economic development and nuclear power program in Vietnam*
- **Report 3**: *Necessity of a high power RR in Vietnam. Applications of research reactor are still being expanded together with the development of technology*
- **Report 4**: *Considerations on the selection of a new research reactor.*
- **Report 5**: *Sitting for a new research reactor (3 candidate positions).*

Status and plan for new RR

The key objectives of the long-term strategy for the nuclear power development program in Vietnam

- To develop a nuclear energy source into one of the main energy sources; striving for the first nuclear power plant to be put into operation by 2017~2020 and continuing the construction of other nuclear power plants in the coming years;
- To develop and promote a national nuclear industry step by step in order to localize the nuclear power plant and nuclear fuel technologies and to achieve self-reliance in nuclear technique applications;

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Status and plan for new RR

The key objectives of the long-term strategy for the nuclear power development program in Vietnam

- To research, develop and apply nuclear techniques to various fields: Industry, Agriculture, Medicine, Oil industry, Hydrology, Geology, Extractive industry, Transportation and Civil construction;
- To develop infrastructures of the techniques and regulations for nuclear safety and radiation protection in accordance with international standards;
- To develop and promote the national potential of nuclear technology to have an advanced level, the same as that of Asia’s developed countries for both infrastructures and human resources.

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Status and plan for new RR (Cont.)

- A new research reactor will be launched during 2015 to 2020 in Vietnam by cooperation with Russian Federation and the following activities should be included:
  - Identify a proposed multipurpose research reactor for Vietnam;
  - Assessment of the capability of the Vietnam industry, technology transfers and potential suppliers;
  - Establish a preliminary plan of designing and constructing a new multipurpose research reactor for Vietnam;
  - Assessment of the localization potential.

Status and plan for new RR (Cont.)

Manpower requirements for implementing:

- Technical personnel. They will participate in both the national project and the joint study with a foreign technical partner on the identification and evaluation of a proposed conceptual reactor.
- Engineering personnel. Joint study with a foreign technical partner, if possible, are needed. They will be involved in the assessment of the capability of the Vietnam industry, technology transfers and potential suppliers;
- Project management personnel are also required. They will join with a foreign partner in order to establish a preliminary plan for the work scope and a detailed implementation plan for a new research reactor project.

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Conclusions

-The DNRR continue to be played an important role to the development and delivery of benefits of nuclear science and technology in Vietnam.

-With many limited factors in neutron flux, experimental facilities, etc …application of the DNRR to few areas among the various research reactor application fields.

-The new multipurpose and high power RR should be put into operation before 2020 to support for the nuclear power development program and non-power utilizations in the future of the country.

- Many stages and problems : Assessment of the type of reactor, Abilities of localization potential, Establishment an implement plan and schedule, Manpower requirements and International cooperation.

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THANK YOU VERY MUCH FOR YOUR ATTENTION