THE AGENCY'S 1ST TECHNICAL MEETING ON THE RESEARCH REACTOR DECOMMISSIONING DEMONSTRATION PROJECT

26-30 JUNE 2006 - MANILA, PHILIPPINES

Status and Future Decommissiong Plan of Dalat Nuclear Research Reactor

Pham Van Lam and Le Vinh Vinh
Nuclear Research Institute
Dalat, Vietnam

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1. General Information

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NUCLEAR SECTOR IN VIETNAM

- In Hanoi Capital in the North: Headquarter (VAEC); Institute for Nuclear Science and Techniques (INST); Institute for Technology & Radioactive and Rare Elements (ITRRE)
- In HoChiMinh City in the South: Center for Nuclear Techniques (CNT); Center for Radiation Technology (VINAGAMMA).
- In Dalat City, 300 km North-East of HoChiMinh City: Nuclear Research Institute (NRI).

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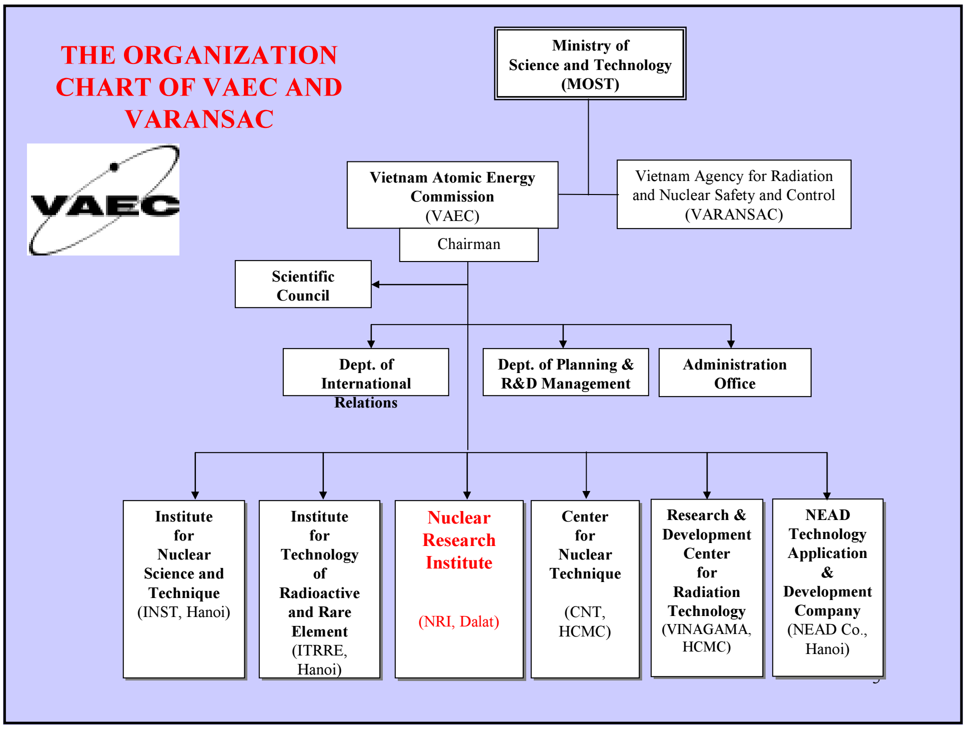
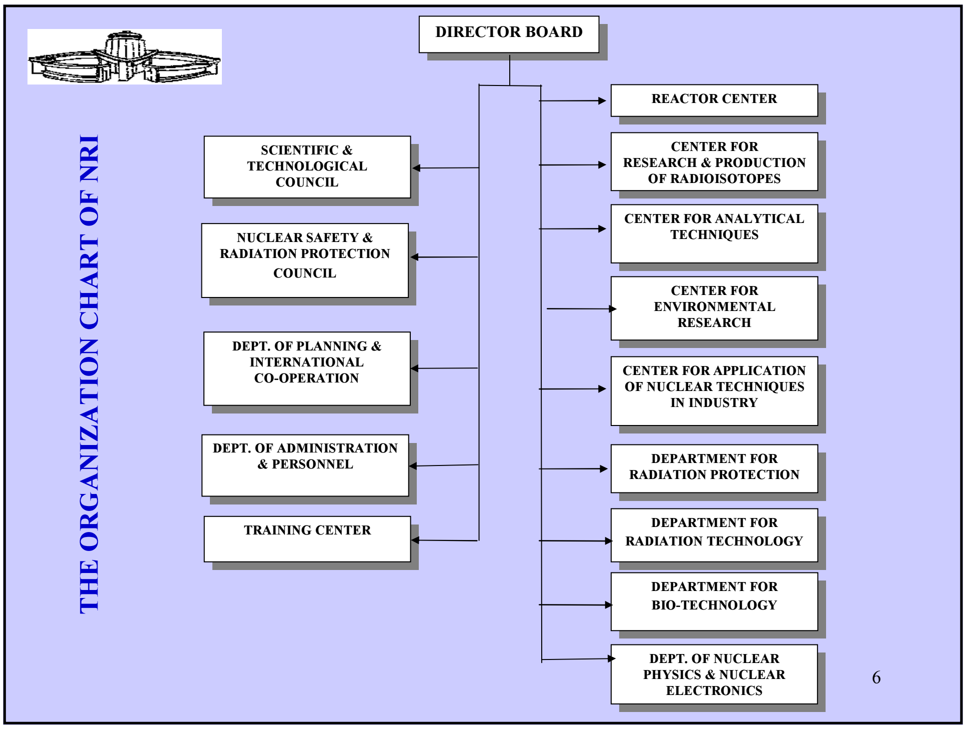

THE ORGANIZATION CHART OF VAEC AND VARANSAC
VAEC
Ministry of Science and Technology (MOST)
Vietnam Atomic Energy Commission (VAEC)
Vietnam Agency for Radiation and Nuclear Safety and Control (VARANSAC)
Chairman
Scientific Council
Dept. of International Relations
Dept. of Planning & R&D Management
Administration Office
Institute for Nuclear Science and Technique (INST, Hanoi)
Institute for Technology of Radioactive and Rare Element (ITRRE, Hanoi)
Nuclear Research Institute (NRI, Dalat)
Center for Nuclear Technique (CNT, HCMC)
Research & Development Center for Radiation Technology (VINAGAMA, HCMC)
NEAD Technology Application & Development Company (NEAD Co., Hanoi)


THE ORGANIZATION CHART OF NRI
DIRECTOR BOARD
SCIENTIFIC & TECHNOLOGICAL COUNCIL
NUCLEAR SAFETY & RADIATION PROTECTION COUNCIL
DEPT. OF PLANNING & INTERNATIONAL CO-OPERATION
DEPT. OF ADMINISTRATION & PERSONNEL
TRAINING CENTER
REACTOR CENTER
CENTER FOR RESEARCH & PRODUCTION OF RADIOISOTOPES
CENTER FOR ANALYTICAL TECHNIQUES
CENTER FOR ENVIRONMENTAL RESEARCH
CENTER FOR APPLICATION OF NUCLEAR TECHNIQUES IN INDUSTRY
DEPARTMENT FOR RADIATION PROTECTION
DEPARTMENT FOR RADIATION TECHNOLOGY
DEPARTMENT FOR BIO-TECHNOLOGY
DEPT. OF NUCLEAR PHYSICS & NUCLEAR ELECTRONICS
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NRI's INFRASTRUCTURE AND MANPOWER

- *500-kW Research Reactor*
- *16.5-kCi Co-60 Irradiator source for research purpose*
- *Facilities for Radioisotope & Radiopharmaceutical Production*
- *Laboratory with beta, gamma, X-RAY Spectrometers and other equipment for element analysis and low-background radiation measurements*
- *Laboratory for calibration of radiation measurement equipment*
- *Laboratory for internal and personal dosimetry*
- *Environmental monitoring stations in Dalat and HoChiMinh Cities*
- *Facilities for liquid and solid radioactive waste treatment*
- *Electronics and mechanical workshops*
- *Laboratory for plant cell and tissue cultures*
- *Training and education facilities*
- *Occupied two campuses: No.1 (reactor area) with 110,000 M^2 and No. 2 (training center area) with 80,000 M^2*
- *195 staffs including 15 Ph.D. and equiv., 35 masters, 85 engineers, and others (technicians, workers).*

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MISSIONS AND ROLES OF NRI

- *TO MANAGE AND EXPLOIT THE RESEARCH REACTOR AND OTHER SCIENTIFIC INSTRUMENTS AT NRI*
- *TO CARRY OUT RESEARCH AND DEVELOPMENT IN NUCLEAR AND RELATED FIELDS*
- *TO PREPARE MATERIAL & TECHNICAL BASES AND MANPOWER FOR THE INSTITUTE AND FOR NUCLEAR ENERGY PROGRAM IN VIETNAM*
- *TO ENSURE NUCLEAR AND RADIATION SAFETY FOR THE INSTITUTE AND TO HELP OTHER ORGANIZATIONS ON RADIATION PROTECTION*
- *TO CARRY OUT ACTIVITIES ON INTERNATIONAL COLLABORATION IN RESEARCH AND TRAINING*

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SCIENTIFIC RESEARCH ACTIVITIES

1. REACTOR PHYSICS, REACTOR THERMO- HYDRAULICS AND REACTOR TECHNOLOGY
2. NEUTRON BEAMS RESEARCHES AND APPLICATIONS
3. RADIOISOTOPE AND RADIOPHARMACEUTICAL PRODUCTION
4. ANALYTICAL TECHNIQUES BASED ON NEUTRON ACTIVATION AND RELATED METHODS
5. ENVIRONMENT RADIOACTIVITY AND POLLUTION STUDIES
6. SEDIMENTOLOGY AND EROSION STUDIES
7. APPLICATIONS OF NUCLEAR TECHNIQUES AND RADIOISOTOPES IN INDUSTRY
8. RADIO-BIOLOGY AND BIOLOGICAL TECHNOLOGY STUDIES
9. RADIATION SCIENCE AND TECHNOLOGY
10. RADIATION DOSE MEASUREMENT TECHNIQUES
11. RADIOACTIVE WASTE MANAGEMENT
12. DESIGN AND CONSTRUCTION OF NUCLEAR EQUIPMENT

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2. Status of DNRR Operation and Utilization

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BRIEF HISTORY OF DNRR (1)

- ☞ Early 1960 - Construction of the TRIGA Mark II reactor started
- ☞ 26/2/1963 - First criticality of the TRIGA reactor
- ☞ 4/3/1963 - Official inauguration of TRIGA reactor with the nominal power of 250 kW
- ☞ 1963-1968 - Reactor operated with the 3 main purposes: Training, Research and Isotope Production
- ☞ 1968-1975 - Extended shutdown
- ☞ 1975 - Fuels were unloaded and shipped back to USA

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BRIEF HISTORY OF DNRR (2)

- 9/10/1979: Contract for reconstruction and upgrading signed. Reactor name was changed to DNRR
- 15/3/1982 - Start-up the reconstruction and upgrading work of the DNRR.
- 01/11/1983 - First criticality of the DNRR
- 20/3/1984 - Official inauguration of the DNRR with the nominal power of 500 kW.
- 3/1984 to present - DNRR has been operating for
  - Radioisotopes production;
  - Neutron activation analysis;
  - Basic and applied research in nuclear physics;
  - Research on reactor physics and thermo-hydraulics;
  - Personnel training and education.

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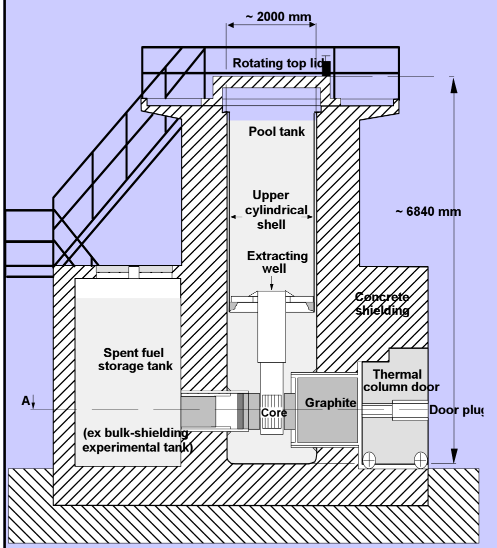
Reactor Description (1)



MAIN CHARACTERISTICS

- Thermal power: 500 kWt, steady
- Coolant and moderator: Light water
- Core configuration: Cylindrical core of about 44.2cm diameter and 60cm height.
- Core cooling mechanism: Natural convection
- Number of fuel assemblies in the core: 89 (1984-1994), 100 (1994-2002), 104 from 25 March 2002
- 7 control rods: 2 safety rods (B_4C), 4 shim rods (B_4C) and one automatic regulating rod (SS)
- 9 nuclear channels: 3 in Source range and 3 in Intermediate range with CFC, and 3 in Power range with CIC
- Neutron reflector: Beryllium and graphite.

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Reactor Description (2)

MAIN CHARACTERISTICS

☞ Cooling system:

+ Flow rate of primary loop: 50 m^3/hr
+ Water temperature of primary loop:
- At the inlet of the heat exchanger: 34-37 ^{o}C
- At the outlet of the heat exchanger: 25-28 ^{o}C
+ Flow rate of 2nd loop: 90 m^3/hr
+ Water temperature of secondary loop:
- At inlet of heat the exchanger: 17-20 ^{o}C
- At outlet of the heat exchanger: 22-25 ^{o}C

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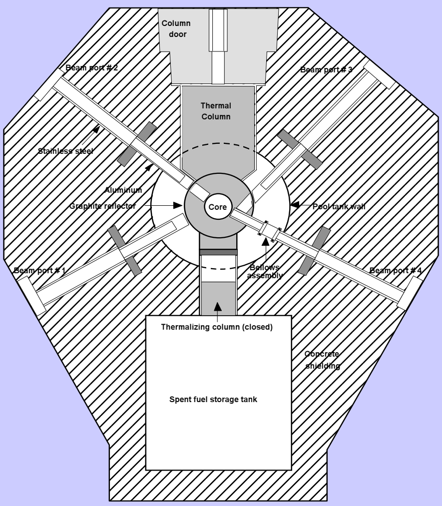
Reactor Description (3)

MAIN CHARACTERISTICS *(Cont'd)*



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

+ Tangential beam port No. 3: 2.3x10^6
+ Radial beam port No. 4: 1.8x10^7
+ Radial beam ports No. 1 & 2: not used yet

☞ Thermal column and thermal neutron flux:

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

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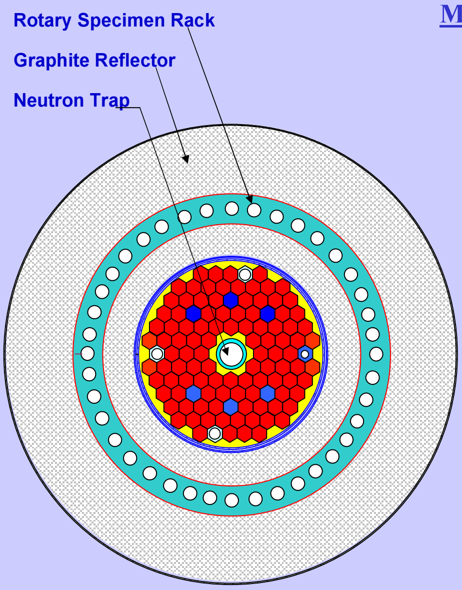
Reactor Description(4)



MAIN CHARACTERISTICS *(Cont'd)*

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

+ Wet channels:
- Neutron trap at the core center: $2.21x10^{13}$
- Irradiation hole at cell 1-4: $1.28x10^{13}$
- 40 holes at rotary specimen rack: $4.3x10^{12}$

+ Dry channels:
- Pneumatic transfer tube at cell 7-1: $4.5x10^{12}$
- Pneumatic transfer tube at 13-2: $4.6x10^{12}$

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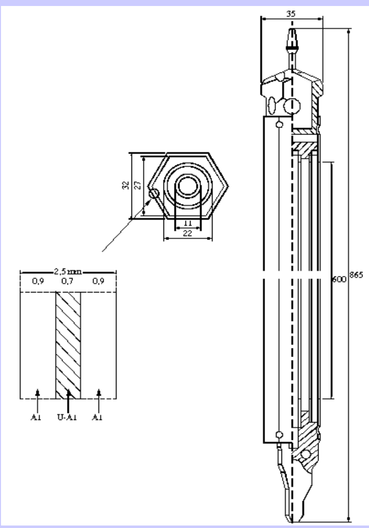
Reactor Description (5)



☞ Fuel assembly WWR-M2 type:

+ Al-U alloy, 36% enriched U-235
+ Total long: 865 mm
+ Fuel meat part long: 600 mm
+ 3 layers (2 round tubes inside, 1 hexagonal outside)
+ Fuel meat thickness: 0.7 mm
+ Cladding thickness: 0.9 mm

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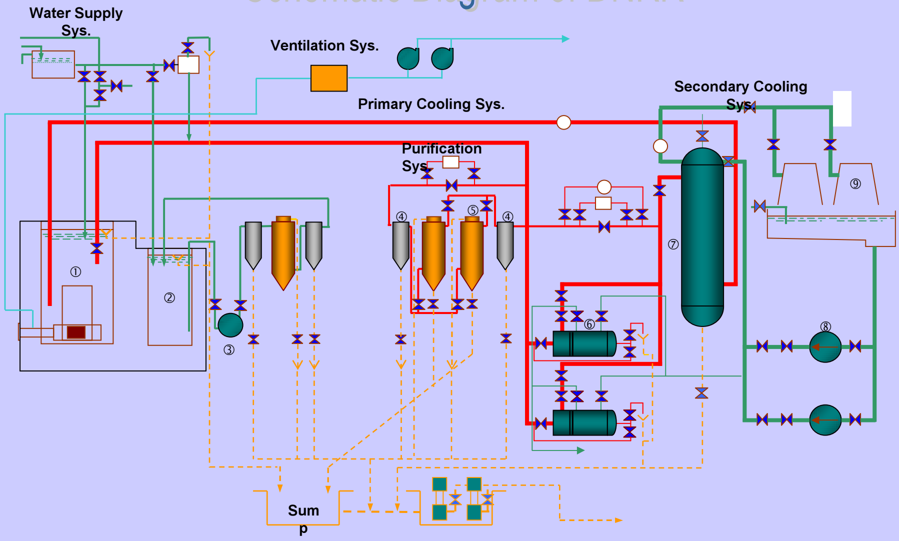
Reactor Description (6)

Schematic Diagram of DNRR



FACILITY DESCRIPTION (in summary)

Reactor type	TRIGA Mark II, modified to DNRR
Nominal thermal power	500 kW, steady state
Coolant and moderator	Light water
Core cooling mechanism	Natural convection
Reflector	Beryllium and Graphite
Fuel type	VVR-M2, U-Al alloy, 36% enrichment
Number of control rods	7 (2 safety rods, 4 shim rods, 1 regulating rod)
Control rod material	B_4C for safety and shim rods, Stainless steel for automatic regulating rod
Neutron measuring channels	9 (6 CFC, 3 CIC)
Vertical irradiation channels	4 (neutron trap, 1 wet channel, 2 dry channels) and 40 holes at the rotary rack
Horizontal beam-ports	4 (1 tangential, 3 radial)
Thermal column	1
Spent fuel storage (temporary)	inside reactor building, next to the reactor shielding
Maximum thermal neutron flux in the core	$2.1x10^{13}$ $n.cm^{-2}.s^{-1}$
Utilization	RI, NAA, PGNAA, NR, basic and applied researches, manpower training

REACTOR OPERATION (1)

- Operation regimes:
  + continuously at 500 kW:
  108 hrs/cycle, 1 cycle/month,
  ➔ 1250 hrs/year
  + short run for experiments and training
- Total operation time from March 1984 to May 2006:
  ➔ about 29,000 hrs
  ➔ the total energy released was about 580 MWd.

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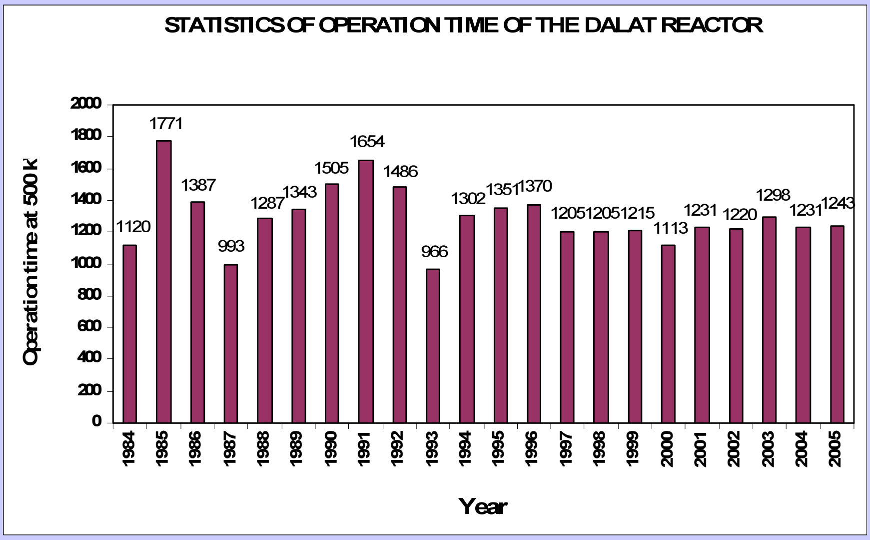
REACTOR OPERATION (2)



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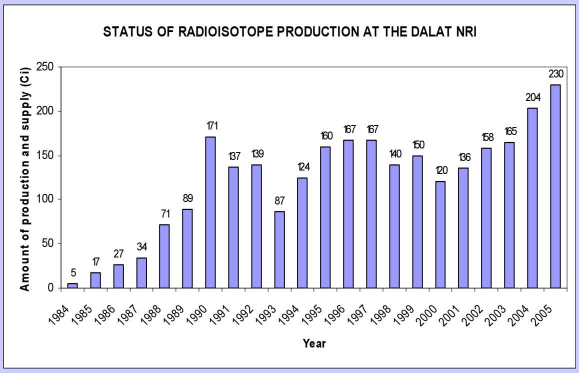
REACTOR UTILISATION (1)

1. RADIOISOTOPE PRODUCTION

- *Main radioisotopes & radiopharmaceuticals regularly produced for medical purposes are:*
  - *> ^{131}I solution and capsules*
  - *> ^{32}P applicator*
  - *> ^{32}P, ^{51}Cr, ^{153}Sm, etc. solution*
  - *> Tc^{99m} generators from Mo*
  - *> In-vivo labeled kits for Tc^{99m}*
  - *> In-vitro T_3, T_4 kits*
- *Other radioactive tracers for sedimentology study, oil field study, and industry application can also be produced:*
  - *^{46}Sc, ^{192}Ir, ^{198}Au, etc.*
- *Small sources:*
  - *^{60}Co, ^{192}Ir, etc.*

YEARLY RADIOISOTOPE PRODUCTION FOR MEDICAL USE (2)

Diagnosis and Treatment by I-131



Diagnosis of brain by ^{99m}Tc-HMPAO

REACTOR UTILISATION (3)

2. NEUTRON BEAMS UTILIZATION

- Set-up the neutron filters at horizontal channels to extract neutron beams from the reactor

  Neutrons with energy of 25keV, 55 keV, 144 keV, >1.2 MeV can be used for nuclear data measurements, irradiation of electronic components and research (n,γ; n,2γ; n,n' reactions)
- Improvement of PGNAA facility at channel No. 4 (collimation components, beam shutter, shielded sample room, beam catcher) in order to decrease background and increase neutron flux at sample position.
- Measurement of Ko-factors to use in PGNAA technique: Ko-factor of V, Sc, Mn, Fe, Cd, Sm, Ni, Ga were determined and used in PGNAA
- Design for setting up a measurement system at channel No. 3 for studying (n,2γ) reactions

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REACTOR UTILISATION (4)

3. NEUTRON ACTIVATION ANALYSIS

- Different methods are used for element analysis:
  - . Instrumental NAA
  - . Radiochemical NAA
  - . Prompt gamma NAA
- K-zero method has been developed to analyse airborne particulate samples for investigation of air pollution; crude oil samples and base rock samples for oil field study
- Under VIE/2/005 (2000-2001), an automatic 40-sample changing system (robot) has been set up and utilized
- QA/QC management for analytical laboratories is being set up and implemented in the framework of RCA project RAS/2/010 and national projects (following ISO 17025)
- Doing services for various purposes (geology exploration, oil prospecting, agriculture, biology, environmental studies, etc.).

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3 . Future Decommissioning Plan of DNRR

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Decommissiong plan for DNRR

- We follow international legal instruments
- Decommissioning plan for the DNRR is not yet carried out
- The decommissioning plan proposed for DNRR is under study
- However, from the early phases of facility design and construction and during operation, the aspects that facilitate decommissioning process have been considered

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Considerations during Design and Construction

- During the design and construction phases of DNRR, the aspects to facilitate the decommissioning process and reduce occupational exposures such as selection of material to reduce activation products, use of modular for easy dismantling, designing to avoid contamination or to allow easy decontamination have been considered.
- Besides, the liquid waste treatment station, the spent fuel storage, the flask for spent fuel transferring from the reactor pool to the spent fuel storage, and the solid radioactive disposal facility with a crane of 5 tons capacity were designed and constructed.

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Considerations during Design and Construction (Cont.)

- ***The main materials*** used in the reactor core components are aluminium alloy. The aluminium alloy used in the main structures kept from the former TRIGA Mark II reactor is the US 6061 alloy, which contains very low impurities
- The other structures and components such as control rod guiding tubes, wet irradiation channels, rotary specimen rack were made by SAV-1 alloy of the former USSR

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Considerations during Design and Construction (Cont.)

- ***The reactor core and the supporting structure*** were designed in such a way as to be easy dismantled remotely.
- ***To reduce contamination and to allow easy decontamination,*** the floors of the reactor hall, the corridor and laboratories for radio-isotope production are coated by plastic and that of the room 148 where placed the primary pumps, the heat exchanger and the demineralization system are coated by stainless steel

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Considerations during Design and Construction (Cont.)

- ***The liquid waste treatment station*** is designed for decontamination and treatment of about 5m3/day of liquid radioactive wastes using methods of coagulation, precipitation, mechanical filtration, and ion-exchange
- ***The disposal facility*** in Bldg. No.5, designed for disposal of low level solid radioactive waste, contains 8 pits of 94 m3 volume each for storing the metal drums of radioactive wastes

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Considerations during Design and Construction (Cont.)

- Besides, the old bulk-shielding tank is coated with stainless steel and filled with demineralized water for ***spent fuel storage***
- The 2.5 metric ton lead flask and the crane with 3.6-ton capacity in the reactor building are provided to transfer spent fuel assemblies from the reactor pool to the spent fuel storage
- The capacity of the spent fuel storage is 300 fuel assemblies. However, for returning the spent fuel to its country of origin (Russia) there are a lot of administrative and technical problems should be resolved.

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Considerations during Operation

- During the operational phase of the DNRR, the following measures to facilitate decommissioning and reduce resource requirements and radiological hazards associated decommissioning have been considered: keeping good records and flagging those relevant to decommissioning; periodic decontamination of contaminated systems

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Considerations during Operation (Cont.)

The relevant operational records of the DNRR include details of:

- the operating history of the facility, including changes in fuel core geometry;
- radiological surveys (radiation and contamination level);
- modifications to the facility;
- operating and maintenance records of systems and equipment;
- the design and location of experimental devices used during the operational lifetime of the facility

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Considerations during Operation (Cont.)

- During operations, consideration is given to minimizing the extent of contamination of structures and surfaces, segregation of different categories of wastes, avoidance and prompt cleanup of spillages and leaks, and selection of material for specimen irradiation and experiment.

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Considerations during Operation (Cont.)

- The Bldg. No.5 (which original designed for low level solid radioactive disposal) recently used as a temporary storage.
- With the help of IAEA under Project No. VIE/9/007, the liquid radioactive waste sludge are cemented in the metal drums of 200 litters;
- The solid waste are categorized, compressed for volume reduction, and immobilized in the metal drums of 200 litters;
- The radioactive waste drums are kept in the pits of Bldg. No.5

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Development of decommissioning plan for the DNRR

- An initial decommissioning plan for the DNRR should be established as early as possible

In the initial plan, the following matters should be included:

- Characterization of the facility
- Development of the regulatory infrastructure
- Decommissioning strategy alternatives
- Safety principles and criteria
- Preparation of estimated costs and determination of funding source.

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Areas of specific interest for Agency technical assisstance

- For management of radioactive liquid waste at and suport decommissiong plan for DNRR we need Agency's assistance in Project on renovation of control system of radioactive liquid waste treetment station here
- For DNRR decommissiong plan we need to exchange knowledge experience and lessions learned

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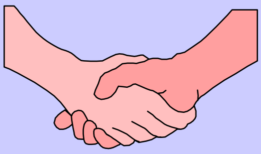
Thank you !



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