CURRENT STATUS OF RESEARCH REACTOR DECOMMISSIONING ACTIVITIES IN ROMANIA

Marin DINCA

ROMANIA

Ministry of Economy and Finance

National Agency for Radioactive Waste - ANDRAD

Responsible for Decommissioning of Nuclear Facilities

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National Authorities

In Romania there are the next authorities with competences in nuclear field (as it is stated in the law 57/2006 for peaceful utilization of nuclear energy) :

- **Nuclear Agency – AN** - that provide technical assistance to the Romanian Government in wording politics in the nuclear area as well as to promote and monitor nuclear activities in Romania. The actual organization of AN was established by the law 57/2006. From April 2007 the AN is subordinate to Ministry of Economy and Finance (MEF),. All nuclear activities in Romania deploy based on "Nuclear National Programme "(NNP) elaborated on the provisions of "National Strategy for Development of the Nuclear Field" (NSDNF). AN coordinates the elaboration of NNP and NSDNF.

- **National Commission for Nuclear Activities Control – CNCAN** - the regulatory body that offers regulation, authorization and control for nuclear activities. CNCAN was established on January 8, 1990 through reorganization of the former regulatory body. CNCAN elaborates "National Strategy for Nuclear Safety" that it is included in NSDNF. CNCAN is coordinated by Prime Minister's Cabinet.

- **National Agency for Radioactive Waste – ANDRAD** – the competent authority for disposal administration of spent nuclear fuel and radioactive wastes and coordination of the **decommissioning** of nuclear facilities and of the management of spent nuclear fuel and radioactive wastes. Government Ordinance (GO) No. 11/January 30, 2003 and Government Decision (GD) no. 1601/ December 23, 2003 established the ANDRAD's foundation and organization. ANDRAD elaborates "**National Strategy** on medium and long term regarding the management of the nuclear spent fuel and radioactive waste, including disposal and the **decommissioning** of the radiological and nuclear facilities**"** that is a component of the NSDNF. The actual "National strategy on medium….." approved in August 2004 by AN will be revised soon and will be approved by MEF. ANDRAD is subordinate to MEF from April 2007.

The state authorities collaborate to fulfill their specific responsibilities. The regulatory body is independent of the organizations which are related to the nuclear activities.

National Policy

- **National policy** of radioactive waste management comply fully with the international requirements, established by "Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management", adopted in 5 September, 1997 in Vienna, and also with the directives and policy of radioactive waste management promoted at European Union level (EURATOM treaty for example). By ratifying, by the Law nr. 105/June 16, 1999, the "Joint Convention….." Romania has shown its willingness to undertake all the necessary steps for achieving the required level in the safe managing of the spent fuel and radioactive waste.
- Romania has decided to use the **open fuel cycle**, considering spent fuel as radioactive waste, so that the policy for spent fuel management is included in the policy for radioactive waste.
- **The Romanian radioactive waste management policy is to ensure safe management of radioactive waste, including spent fuel, according to the principles stated in IAEA Safety Fundamentals SF-1 "Fundamental Safety Principles" and specific principles presented in** Safety Series No. 111-F, "The principles of Radioactive Waste Management".
- **The import for disposal of radioactive waste is prohibited.**
- The **principal objective of the national policy** of radioactive waste management is to ensure a zero negative impact of the radioactive waste management activities on the population and the environment.

Legislation

- **The Romanian law No. 111/1996** on safe deployment of nuclear activities with subsequent modifications and completions (lows No. 193/2003 and 63/2006) applies to research, designing, holding, sitting, construction, installation, commissioning, operation, modification, preservation, **decommissioning**, import-export of nuclear facilities.
- **The GO 11/2003** with subsequent modifications and completions (GO No. 31/2006, law No. 26/2007) on the safety management of the radioactive waste. The law establishes duties and responsibilities of ANDRAD in the management of the radioactive waste area, duties and responsibilities of the nuclear licence holders and established the relationships between these, also, in their quality of unique coordinator at national level of radioactive waste management activities and of radioactive waste producers, respectively.
- The holders of nuclear licence have the obligation to register themselves to ANDRAD if they produce radioactive waste by operation or **decommissioning** as it is provided in GO No. 1080/September 5, 2007, that establishes formation and management of financial resources for management of radioactive waste (including that from decommissioning) and decommissioning activities. For the future it is considered a tight collaboration with CNCAN to have a data base with al holders of licence that produce radioactive waste.
- The **decommissioning of research reactors** is approved by GD, as it is provided in the Romanian regulations and laws (57/2006 on peaceful utilization of nuclear energy).

Regulations and Recommendations

Norms emitted by CNCAN:

- **NSN-15**, "Norms on Decommissioning of Nuclear Installations" approved by Order No. 1815.09.2002 of the CNCAN President, published in the Official Bulletin No. 867/2.12.2002, in force from January 1st, 2003, are applicable for decommissioning of the following nuclear installations: **research reactors;** subcritical assemblies, radioactive waste treatment plant, intermediary storage of spent nuclear fuels; intermediary storage of radioactive waste. These norms establish the conditions and steps necessary for decommissioning of nuclear installations with the purpose of release from licensing regime.
- **NDR-01**, "Fundamentals norms for safety management of the radioactive wastes" elaborated by CNCAN with the Order no. 56/March 25, 2004. The norms represent the adaptation of the IAEA SS No. 111-F: "The principles of radioactive waste management"
- **NDR-02**, "Norms for Free Release of Materials Resulting from Authorized Practices" that establish the clearance levels for materials. For the future decommissioning activities of nuclear facilities there are requested specifically norms for materials, buildings and soil.

IAEA documents:

- **SRS -26, "Safe Enclosure of Nuclear Facilities Durind Deferred Dismantling"**
- **SRS-36, "Safety Considerations in the Transition from Operation to Decommissioning of Nuclear Facilities"**
- **SRS-45**, "Standard Format and Content for Safety Related Decommissioning Documents"
- **IAEA-TECDOC-1476, "**Financial aspects of decommissioning"
- **Safety Requirements No. WS-R-5, "Decommissioning of Facilities Using Radioactive Material"**

ANDRAD's Responsibilities (for decommissioning)

- **Prepares the National Strategy** for safe management of radioactive waste and **decommissioning** and monitor its implementation.
- **ANDRAD is responsible** by law for disposal of radioactive waste.
- **Gives an expert opinion** for the plan for the decommissioning of the nuclear and radiological facilities.
- **Coordinates** the waste management predisposal activities and the activities for **decommissioning** of the nuclear facilities.
- **Administrates the decommissioning activities** if the financial resources are deficient after a financial liquidation of a nuclear licence holder.
- **Proposes specific objectives** for the National Plan for research and development regarding the **decommissioning** of nuclear and radiological facilities.
- **Administrates** the financial resources earmarked for the safe management of SNF and RW, disposal and decommissioning of nuclear facilities.
- **Promote** through the MEF the necessary GO, GD or laws related to decommissioning activities.

Licence Holder's Responsibilities

- **Elaborates decommissioning plan (DP)** and supporting documents that are submitted for an expert opinion to ANDRAD and for approval to CNCAN.
- The **DP** is an imperative component of the documents requested by CNCAN to issue the authorization for operation for a new nuclear facility specified in NSN-15. **DP** is revised by authorization holder after 5 years.
- **Obtains** from CNCAN the **authorization for decommissioning** (valid 5 years) based on a proper documentation that contains **DP** and other documents**.**
- **Performs decommissioning activities** itself or with authorized organizations. Personal has proper permits from CNCAN.
- **Requires** from CNCAN **the certificate** for free release of the site.
- The **waste producers are responsible** for predisposal activities related to their waste and for the decommissioning of their facilities. They shall bear the expenses related the collection, handling, transport, treatment, conditioning, storage and disposal of the waste they had produced, and shall pay the legal contribution to the funds earmarked for management of radioactive waste and decommissioning.
- By conditions set in the **license for decommissioning**, and by regulatory standards and norms, the licensee is requested to send the radioactive waste for treatment and disposal or long term storage at dedicated facilities.
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Financing

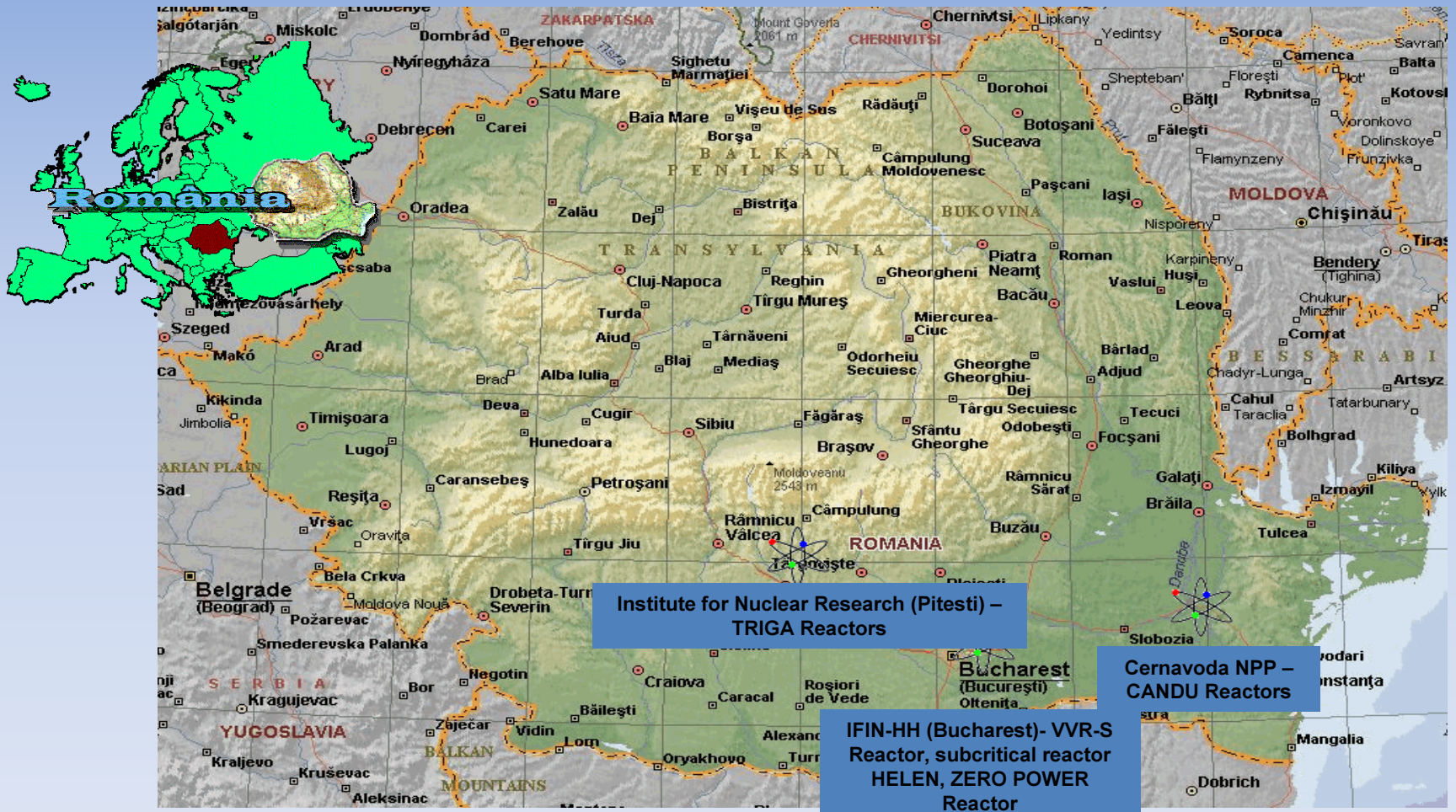
•The financial resources for decommissioning activities of nuclear facilities are separated from those for disposal of radioactive waste from operation and decommissioning activities.

•GO No. 1080/September 5, 2007, establishes formation and management of financial resources for management of radioactive waste (including that from decommissioning) and decommissioning activities. This GO is the base for calculations for nuclear power plant owners. For all other holders of authorization, named small radioactive waste producers (including nuclear research reactors) in the GO 1080 it is specified that are applied the provisions of the GO No. 11/2003, republished.

• As the state is the owner of the research reactors , the decommissioning activity is financed from State Budget or legal resources by contributions in an account of the holder of licence. The funds are used only for the future decommissioning activity. In practice, for current decommissioning activities of the research reactors are emitted GD, as the specific legislation entered into force recently and were not gathered necessary funds for decommissioning.

•The estimated contributions are revised periodically by ANDRAD, farthest at 5 years, and are approved by Government Decision (as it is provided in GO Nr. 1080) .

Nuclear Reactors in Romania



TRIGA Reactor

The TRIGA reactor of the Institute for Nuclear Research (INR), located near Pitesti town, 120 Km N-E from Bucharest, is in operation from 1979.

TRIGA Reactor is a pool type reactor with 2 cores:

- SSR Core operates at P_{max} = 14 MW ;
- ACPR Core can be operated as steady state at P_{max} = 500 kW and can give a pulse of 20.000 MW (th). ACPR .

SSR Fuel:

- Fuel Assembly: 25 Fuel Rods;
- The fuel originally used for SSR: HEU type (93% enrichment);
- Full conversion of the core to use LEU (20 % enrichment): accomplished (May 2006), with support from IAEA TC project ROM/4/024, “Full Conversion of TRIGA 14-MW”.

ACPR fuel: LEU type fuel pins (20 % enrichment).

The ACPR Core will be operated longer than SSR Core.

TRIGA Reactor (cont.)

- In 2005 was elaborated by INR the first conceptual decommissioning plan that was approved by CNCAN with observations in September 11, 2005. The observations must be accomplished at next revision in 2010.
- As regarding the decommissioning strategy for the TRIGA reactors, the safe enclosure with deferred dismantling is preferred. The main argument for this option is the presence of more facilities on the site, whence may have different live time. The final objective of the decommissioning is the green field status of the site, but also the possibilities to use the building for nuclear or non-nuclear activities are not excluded.
- **Till 2025 all aspects for decommissioning will be well reflected in DP.**
- **The license for decommissioning is scheduled for 2025.**
- **INR must achieve the decommissioning activities.**
- **The stages of decommissioning are estimated:**
  - **Stage 1: 2035;**
  - **Stage 2: 2045;**
  - **Stage 3: 2055.**

TRIGA Reactor (cont.)

- The main radioactive wastes associated to the decommissioning phase are:
  - Spent nuclear fuel (high-level waste) – requires disposal in a geological repository
  - Low and Intermediate-Level Liquid and Solid Wastes arising from the core internals, irradiation devices, experimental devices – that will be processed at the radioactive waste facility on the INR site. The main solid radioactive wastes expected are: aluminum, graphite, beryllium and steel (small quantities).
- It is to mention that the presence of aluminum, graphite and beryllium wastes requires further researches to establish optimal solutions for disposal.
- **TRIGA – LEU Fuel Strategies: all TRIGA-LEU fuel is loaded now in SSR reactor. The spent fuel discharged from reactor till May 2016 may be send in USA till 2019, after wet storage in the storage pool. If this strategy is not possible, after wet storage in the spent fuel storage pool for 20 to 30 years, is considered a dry storage that it is under development and, finally deep geological disposal in a future National Repository that will be commissioned by ANDRAD around 2055.**
- **The last 612 spent fuel TRIGA-HEU elements will be sent back in USA in 2008.**

TRIGA Reactor (cont.)

The main building, ventilation tower, cooling towers of the TRIGA Reactor from Institute for Nuclear Research (Pitesti), Romania

Zero Power Multi-Core Reactor

- The Zero Power Multi-Core Reactor (RMZ) has been designed and constructed in the years ’80 to be used for reactivity tests on the Romanian CANDU fuel. Due to strategies change and financial reasons, the commissioning has been stopped before the fuel loading. The RMZ has been placed in the storage pool of TRIGA reactors and hot cell laboratories. As consequence the core structures have been not activated do to irradiation, but the contamination of structures do to other activities on the site was not excluded.
- In 2004 the decision of dismantling the installation has been done in order to release the pool for storage activities. A short decommissioning plan has been prepared and approved by CNCAN in 2004, taking account to the installation status. The decommissioning license and free release of materials has been issued by the regulatory body for the period 09/20/2005-09/19/2010.
- The radiological characterization of the site showed that only 137Cs and 60Co contaminations are present on the external surfaces of some of the installation compounds.

Zero Power Multi-Core Reactor (cont.)

- Based on this assumption the main steps of the facility dismantling have been established as follows:
  - Removal of dust using vacuum cleaner and wet cloths in order to avoid the spreading of non fixed contamination;
  - Dismantling of equipments and systems;
  - Radiological characterization of each resulting pieces in order to separate contaminated and non-contaminated parts.
- The free release procedure has been also simplified, based on the above mentioned assumptions and well conservative criteria for the threshold establishment.
- Starting from the free release limits (norm NDR-02), the activity due for such contamination has been estimated. The presence of 3 Bq/cm2 60Co (free release limit) leads to dose rates at 10 cm from the surface, comparable with the natural background (0.1 – 0.15 μSv/h).

Zero Power Multi-Core Reactor (cont.)

- As consequence, the measurement procedure has stated that the measurements will be performed as near possible to the object surface and the threshold value is around 1.7 times higher to the background. It is to mention that the measurement area has been rigorously selected, in order to not overtake 0.1 – 0.15 µSv/h for the background value.
- At the end of radiological characterization of pieces resulting from the installation dismantling, about 10 – 15 contaminated pieces have been fund. Only manually abrasive methods (sand paper) have been applied for contamination removal.
- As regarding the radiation protection of the workers involved, the usual regulations for works with open radioactive sources have been applied: protective coats and monitoring of external exposure and internal contamination. No internal contamination and overtaking of normal external exposure values have been recorded during the installation dismantling.
- Some relevant pictures from the dismantling phases and radiological characterization are presented on the next slide.

Zero Power Multi-Core Reactor (cont.)

RMZ installation before dismantling

Free release measurements

Contaminated pieces

The storage pool after installation dismantling

VVR-S Reactor

- The Institute for Physics and Nuclear Engineering –Horia Hulubei (IFIN-HH), from Bucharest-Magurele, performs research activities in the nuclear field and on radioactive waste treatment and is the owner of the research reactor pool type VVR-S (for the moment the national LL and IL radwaste repository).
- Type of VVR-S Russian research nuclear reactor - Thermal neutrons research reactor, moderately, cooled and reflected with distilled water, fuelled with (**10%** enriched) uranium **dioxide - magnesium alloy in aluminium cladding** in the beginning (designated EK-10) and (**36%** enriched) **uranium dioxide - aluminium matrix (designated as S-36),** subsequently from 1984. **An assembly consisted of 16 rods of EK-10 and 15 rods of S-36 in an aluminium casing. From 1993 to December 1997 was used exclusively S-36 nuclear fuel.**
- **All the EK-10 and S-36 spent nuclear fuel as complete assemblies are stored underwater in Spent Fuel Cooling Pool in the reactor building and in Spent Fuel Storage Pools (4 identical ponds, each of them having the storing capacity of 60 fuel assemblies). Now are stored 223 assemblies.**
- **The reactor was operated at a power of max. 2 MW, from 1957 until December 1997.**
- In July 2001 the Board of Administration of IFIN-HH decided the permanent shutdown and starting of the decommissioning preparation actions.
- By Governmental Decision on April 2002, VVR-S reactor was permanently shutdown for decommissioning.
- The first three revisions of DP were developed during November 2002 to April 2003 in SAFE ENCLOSURE strategy.
- Revision four and five of DP were developed during May 2003 –December 2003 in IMMEDIATE DISMANTLING strategy. The immediate dismantling strategy was chosen based on the Decommissioning Plan and the Project Management (brown field).

VVR-S Reactor(cont.)

- The IAEA has been assisting the operator (IFIN-HH) in the preparation for decommissioning and development of a final decommissioning plan since 1995 through two Technical Cooperation (TC) projects ROM/9/017 (1994-1998) and ROM/4/029 (2003-2007).
- The current TC project ROM/4/029 **"Strengthening the Infrastructure for the Decommissioning of the Research Reactor at Magurele-Bucharest"** has the objective to complete a detailed decommissioning plan and the entire infrastructure required for decommissioning, including completion of pre-decommissioning activities to support the decommissioning programme of VVR-S research reactor. This technical assistance covered expert advice, delivery of equipment and training of the IFIN-HH staff. Revision 6 of DP in IMMEDIATE DISMANTLING strategy under technical assistance of IAEA began in May 2004.
- The Decommissioning Plan of the VVR-S Research Reactor is elaborated by IFIN-HH taken into consideration the documents of the IAEA - Safety Reports Series No 45 for standard format, and the content of Romanian Regulations for the nuclear facilities decommissioning –NSN -15.
- At present the operator (IFIN-HH) has a license for preservation of the reactor and storage of SNF in the pools (one in the reactor hall and four in a special building).

VVR-S Reactor(cont.)

- The revision 8 of the draft decommissioning plan (DDP) and was submitted to CNCAN and ANDRAD in July 2007 for review and approval.
- CNCAN asked the IAEA for an expert mission (10 to 14 September 2007) for "Review of the Draft Decommissioning Plan for the VVR-S Research Reactor in Romania" in accordance with the relevant IAEA safety standards and good practice in decommissioning.
- The report from IAEA was received to CNCAN in October 16, 2007. CNCAN sent the report to IFIN-HH and ANDRAD at the end of October 2007.
- All chapters were analysed and recommendations must be implemented in the revision 9, that it is desirable to be the last one.
- The current version 8 of the DDP reflects the substantial work that has been incorporated by IFIN-HH which has resulted in substantial improvement in the document.
- Expert mission had general observations and specific recommendations that must be implemented.

VVR-S Reactor(cont.)

- In addition, a support from EC through Phare 2006 project related to the infrastructure needed for decommissioning will be implemented. Through this project is made a refurbishment of the Radioactive Waste Treatment Plant (STDR) Magurele, for treatment and conditioning of radioactive waste from decommissioning (the liquid processing is not operational for the moment).
- Regarding the management of spent fuel from VVR-S Research Reactor, the main issue is related to the corrosion in time of the old Aluminum EK-10 spent fuel of VVR-S reactor Magurele.
- As Romania get international technical assistance through Russian Research Reactor Fuel Return Program, USDOE – IAEA – Russian Federation – Romania, dedicated to return of S-36 spent fuel to Russia, the implementation of this arrangement is underway and it is expected that the shipment can be completed in 2009-2010.
- The future of spent fuel EK-10 is not defined yet and this is a milestone for the DP approval.
- To date it is not clear whether the high level waste from SNF reprocessing will be returned to Romania for storage or disposal.

VVR-S Reactor(cont.)

- Storage facilities located outside of STDR building (5 separate rooms) are currently being cleaned up from legacy waste to provide storage space for decommissioning waste from the VVR-S reactor.
- The decommissioning process is envisaged to last 12 years.
- There is not formally established long term funding mechanism, but from 1997 funding has been provided on a yearly basis.
- For 2005-2006 IFIN-HH received about 2 million Euros for VVR-S decommissioning project.
- IFIN-HH prepares a feasibility study which will provide the basis to request the estimated costs of 19 million Euro from Government as an investment objectiv. These funds is expected to be approved in 2008.
- For the period 2007-2009 there are additional funds from three PHARE projects:

  - Safe decommissioning of VVR-S, technical assistance and procurement for Phase 2

  - Upgrading the STDR- technical assistance and procurement

  - Upgrading the national disposal facility for radioactive waste, Baita -Bihor

VVR-S Reactor(cont.)

Activated waste:

- concrete: 35 500 kg
- Aluminum alloy: 650 kg
- Graphite: 4 700 kg

Contaminated waste:

-Aluminum alloy: 2 865 kg
-Cast iron: 131 700 kg
-Stainless steel: 6 620 kg
-Concrete: 5 000 kg
-Water : 500 000 liters
-Resins: 1 100 kg
-Textile and plastics: 5 000 kg

VVR-S Reactor(cont.)

Wastes resulted from decommissioning:

- Activated waste:
- concrete: 35 500 kg
- Aluminum alloy: 650 kg
- Graphite: 4 700 kg

Contaminated waste:

-Aluminum alloy: 2 865 kg
-Cast iron: 131 700 kg
-Stainless steel: 6 620 kg
-Concrete: 5 000 kg
-Water : 500 000 liters
-Resins: 1 100 kg
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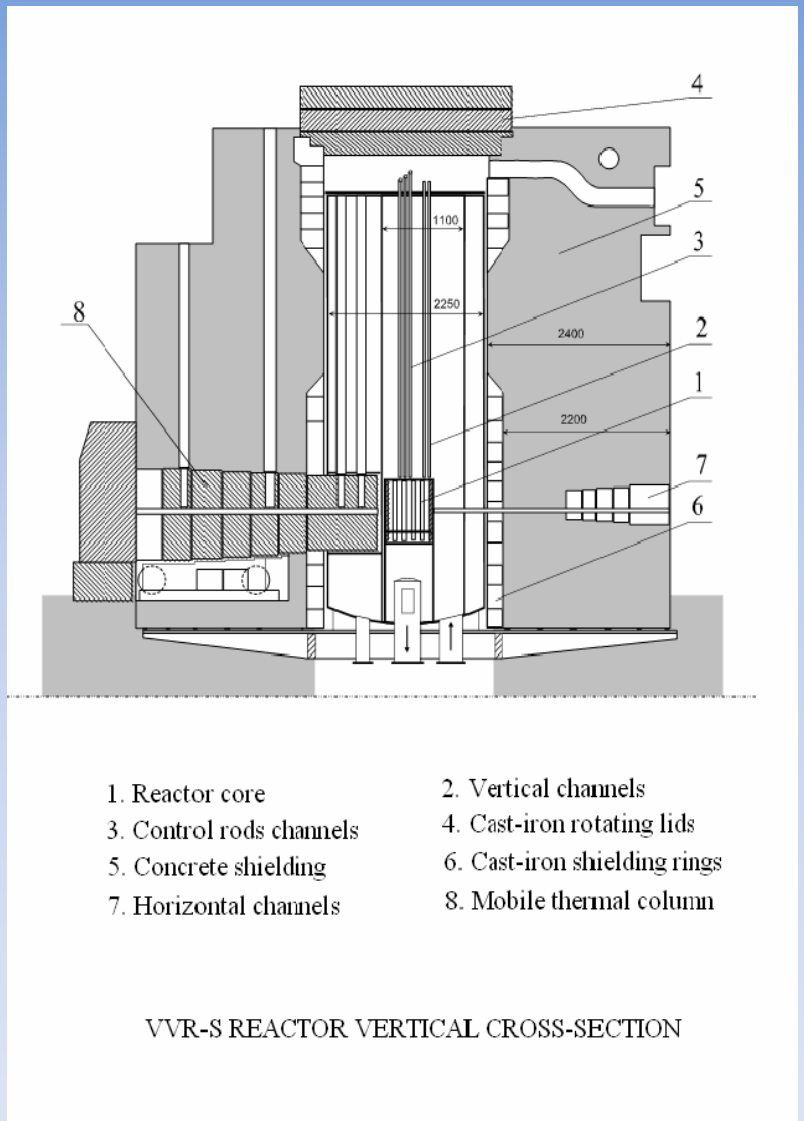
VVR-S Reactor(cont.)



1. Reactor core
2. Vertical channels
3. Control rods channels
4. Cast-iron rotating lids
5. Concrete shielding
6. Cast-iron shielding rings
7. Horizontal channels
8. Mobile thermal column

VVR-S REACTOR VERTICAL CROSS-SECTION

HELEN and ZPR reactors

- HELEN is a subcritical reactor. The owner is the Faculty of Physics from Bucuresti-Magurele and it is sited in the area of IFIN-HH.
- Zero Power Reactor (ZPR) is sited near VVR-S reactor and the owner is the Politechnical University from Bucharest.
- These two reactors, used in the past by students, have not DP and license for operation.
- Their situation must be clarified in the near future by collaboration between ANDRAD and CNCAN.

Baita-Bihor Repository

- Capacity: approx.5.000 m^3 conditioned waste in about 21.000 standard containers (220 litre carbon steel drums);
- First disposals were made in 1985 and the current estimate is that disposals might continue for the next 20 to 35 years;
- Accepts LILW from industry, medicine and research activities. The waste include sludge, evaporates and ashes, solid waste, activated materials, ion exchange resins, spent sealed sources and components from the decommissioning research reactors;
- Wastes are generally conditioned using an Ordinary Portland Cement based grout;
- Disposal galleries are former uranium exploration galleries that have been enlarged;
- Disposal galleries are situated in the unsaturated zone, several hundred meters above the water table;
- Refurbishment of Baita-Bihor repository through the PHARE 2006 project "Upgrading of the Baita-Bihor Repository for Institutional Waste in Romania" is under development.
- This year were revised the acceptance criteria for low and intermediate level waste, including the waste from VVR-S decommissioning.
- A project for Government Decision for transferring in 2007 the administration of Baita-Bihor repository from IFIN-HH to ANDRAD was issued.

Baita Bihor repository (cont.)

The upgrading of Baita-Bihor repository means:

- Improvement of the electrical, ventilation, drainage and transport systems;
- Waterproofing of the transport gallery;
- Construction of a new physical protection system;
- Upgrading the administration building;
- Construction of an asphalted access road.

Conclusions

- The regulatory body is independent from other authorities and operators from nuclear field.
- In Romania there are implemented the provisions of the “Joint Convention on management of spent fuel and on the management of radioactive waste”.
- There is a necessity to have a proper decommissioning plans for any nuclear facility.
- Regulatory framework, decommissioning plan with supporting documents and funds are considered the basics for a successful decommissioning activity.
- There are considered all necessary steps from regulation to disposal of radioactive waste for decommissioning of a nuclear facility.
- The decommissioning of the RMZ was a successful exercise for a decommissioning of a nuclear facility.
- The decommissioning of VVR-S is the most important activity in the next years in Romania. It is a challenge for IFIN-HH, CNCAN and ANDRAD. The help of IAEA is inestimable.

Acknowledgements

- To IAEA for the opportunity to participate to this important event
- To ANDRAD's colleagues for their observations
- To D&D staff from Institute for Nuclear Research, Pitesti
- To CNCAN for collaboration in the field of decommissioning of nuclear facilities
- To IFIN-HH for their responsibility to ANDRAD's requests about VVR'S decommissioning

THANK YOU FOR YOUR ATTENTION