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Safety Management of Research Reactor Maria with Special Emphasis on Safety Culture Enhancement Process

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SCOPE

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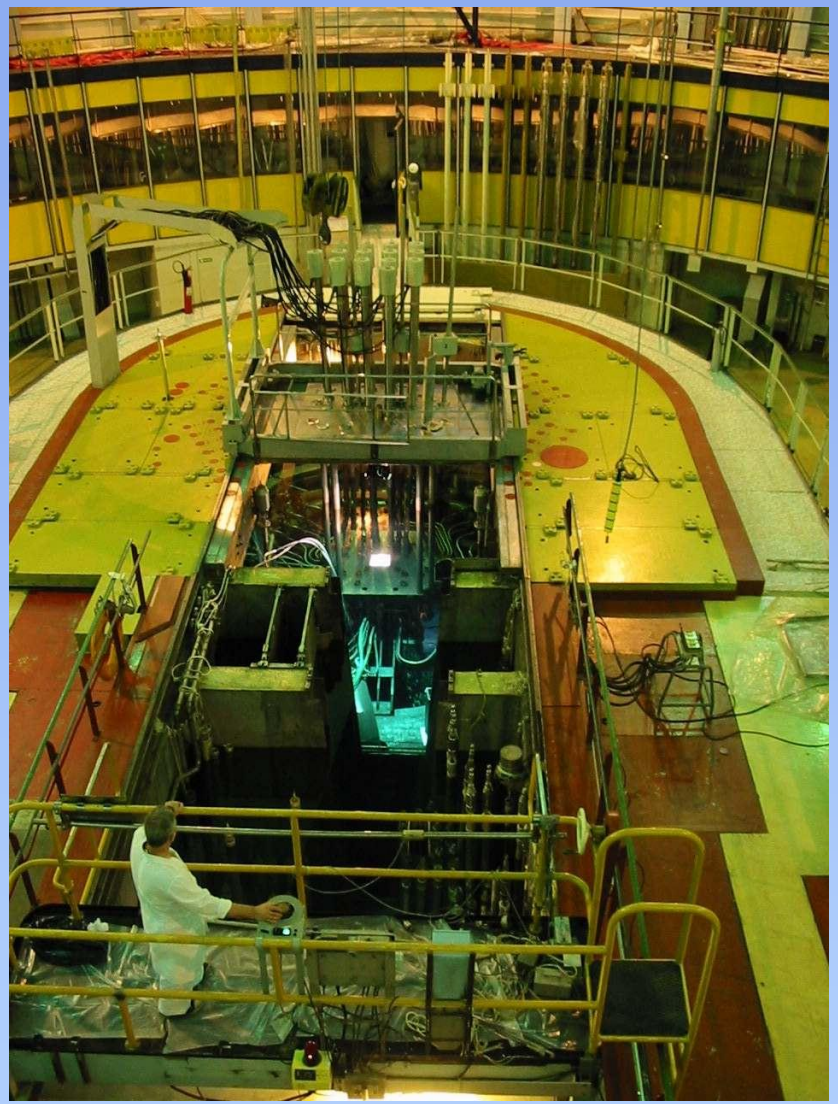
1. INTRODUCTION

1.1. Short presentation of High Flux Research Reactor MARIA

- Designed and constructed by Polish industry
- First criticality was reached in December 1974
- 1985 ÷ 1991 – modernization period:
  - removal of graphite blocks from the proximity of fuel channels
  - upgrading of heat exchangers
  - upgrading of ventilation system
  - replacement of closing valves in primary cooling system (the old valves didn’t meet the safety principles)
  - upgrading of protection system
- Put again into operation in 1992

General characteristics of MARIA reactor

Nominal power	30MW
Maximum thermal neutron flux: in fuel in beryllium	 $2.5 \cdot 10^{18}$ n/m^{2}s $4.0 \cdot 10^{18}$ n/m^{2}s
Moderator	water and beryllium
Reflector	graphite (blocks in Al cans) and water
Fuel element: material enrichment shape overall dimensions	 U-Al alloy clad in Al. 36% U-235 Six concentric tubes 100 cm length
Primary fuel cooling system: type of fuel channel pressure range temperature, core inlet (outlet) water flow rate: through channel total	 field tube 0.8 ÷ 1.8 Mpa 50 (100) °C 30 m^3/h 600 ÷ 700 m^3/h
Primary pool cooling system: pressure temperature: at core matrix inlet at core matrix outlet Water flow rate	 Atmospheric 40 °C 50 °C 1400 m^3/h



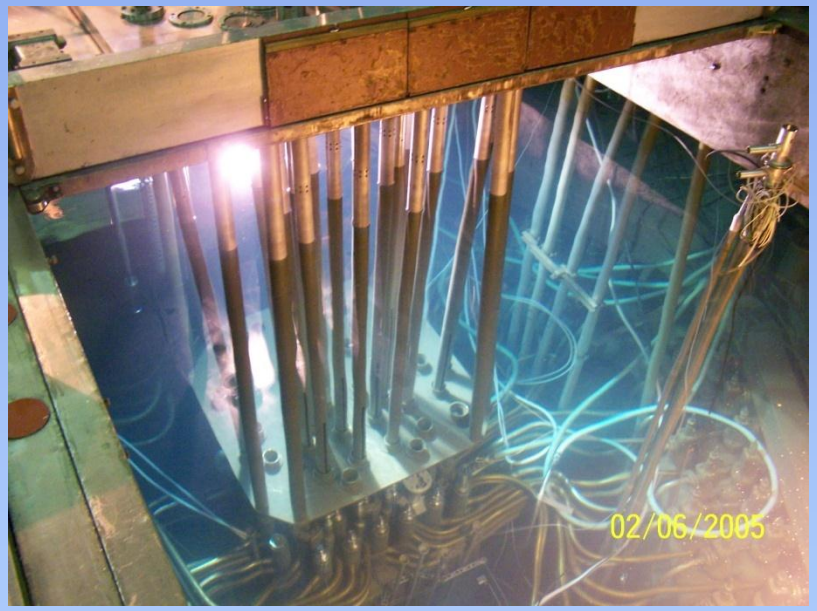
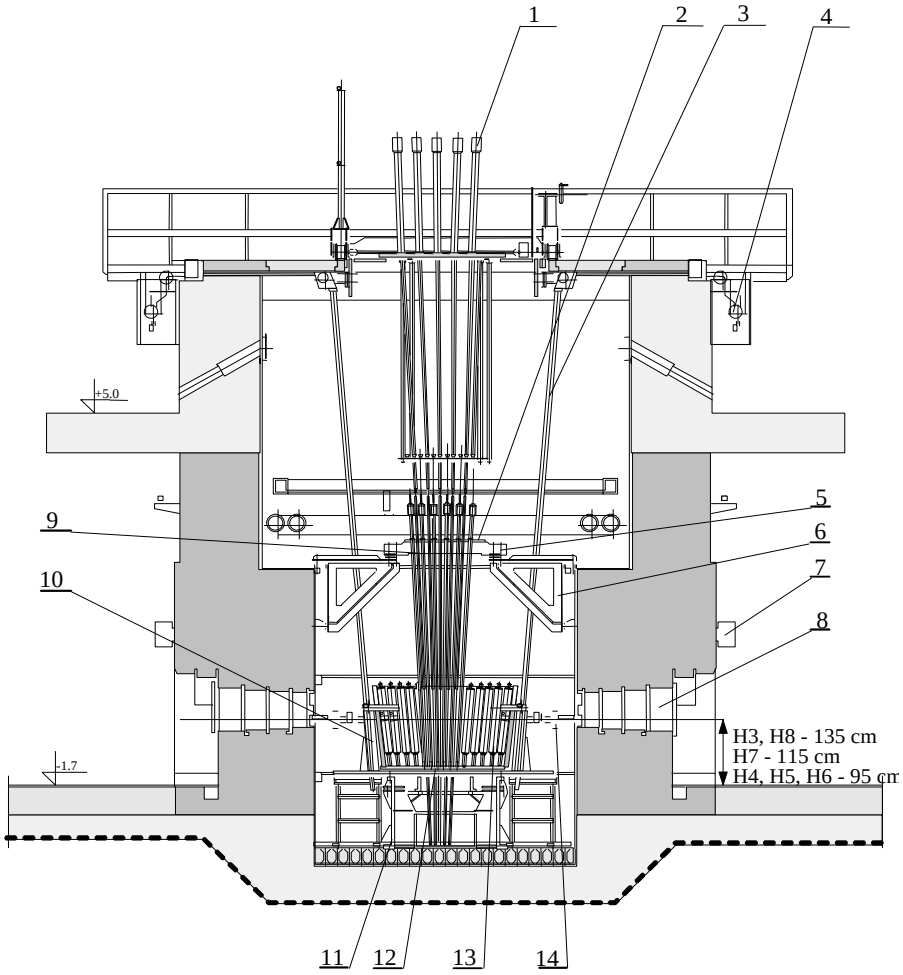


Fig.1. Views on the reactor pools



1. control rod drive mechanism
2. mounting plate
3. ionization chamber channel
4. ionization chamber drive mechanism
5. fuel and loop channels support plate
6. plate support console
7. horizontal beam tube shutter drive mechanism
8. beam tube shutter
9. fuel channel
10. ionization chambers shield
11. core and support structure
12. core and reflector support plate
13. reflector blocks
14. beam tube compensator joint

Fig.2. Vertical cross section of the MARIA reactor

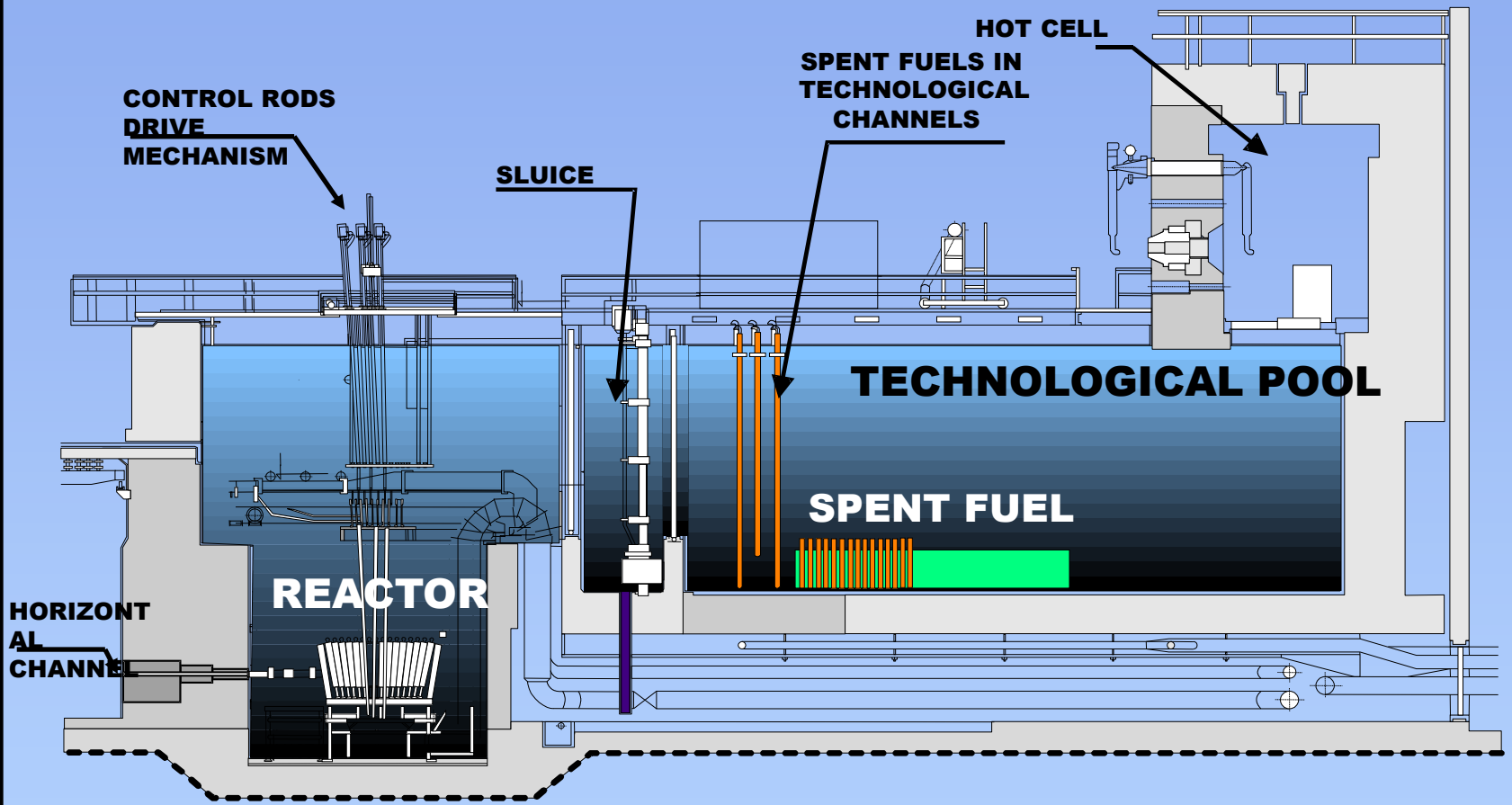


Fig.3. Cross section of the reactor pools

The main areas of reactor application are:

- production of radioisotopes
- uranium plates irradiation for Mo-99 production
- testing of fuel and structural materials for nuclear power engineering
- neutron radiography
- neutron activation analysis
- neutron transmutation doping
- research in neutron and condensed matter physics
- training

1.2. General information

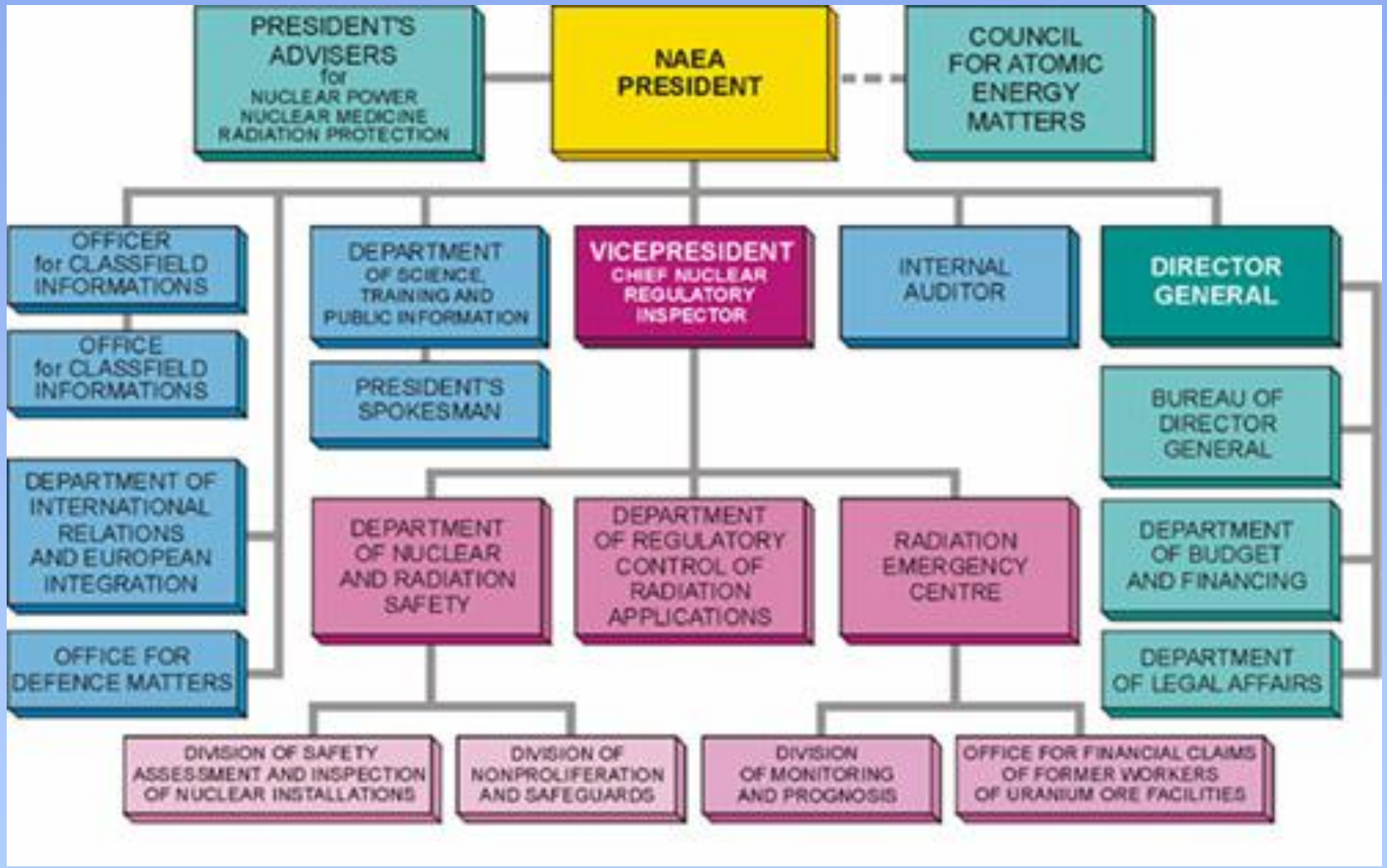
- Assurance of research reactor MARIA safety is provided by three organizations:
  - National Atomic Energy Agency
  - Regulatory Body
  - Operating Organization (National Centre for Nuclear Research
- Management of safety is performed on the basis of the following IAEA documents:
  - Code of Conduct
  - Safety Fundamentals
  - Safety Requirements
  - Safety Guides

  and Polish Atomic Law

2. ROLE OF THE STATE IN REACTOR SAFETY ASSURANCE

NAEA assures reactor safety by following activities:

- Establishing and maintaining a legislative and regulatory framework
- Providing the Regulatory Body
- Licensing of research reactor operation and operational personnel
- Establishing a system of governmental emergency response
- Ensuring that the operating organization has adequate financing system for safe reactor operation


PRESIDENT'S ADVISERS for NUCLEAR POWER NUCLEAR MEDICINE RADIATION PROTECTION
NAEA PRESIDENT
COUNCIL FOR ATOMIC ENERGY MATTERS
OFFICER for CLASSFIELD INFORMATIONS
OFFICE for CLASSFIELD INFORMATIONS
DEPARTMENT OF INTERNATIONAL RELATIONS AND EUROPEAN INTEGRATION
OFFICE FOR DEFENCE MATTERS
DEPARTMENT OF SCIENCE, TRAINING AND PUBLIC INFORMATION
PRESIDENT'S SPOKESMAN
VICEPRESIDENT CHIEF NUCLEAR REGULATORY INSPECTOR
INTERNAL AUDITOR
DIRECTOR GENERAL
BUREAU OF DIRECTOR GENERAL
DEPARTMENT OF BUDGET AND FINANCING
DEPARTMENT OF LEGAL AFFAIRS
DEPARTMENT OF NUCLEAR AND RADIATION SAFETY
DEPARTMENT OF REGULATORY CONTROL OF RADIATION APPLICATIONS
RADIATION EMERGENCY CENTRE
DIVISION OF SAFETY ASSESSMENT AND INSPECTION OF NUCLEAR INSTALLATIONS
DIVISION OF NONPROLIFERATION AND SAFEGUARDS
DIVISION OF MONITORING AND PROGNOSIS
OFFICE FOR FINANCIAL CLAIMS OF FORMER WORKERS OF URANIUM ORE FACILITIES

3. ROLE OF THE REGULATORY BODY IN REACTOR SAFETY ASSURANCE

The regulatory body ensures assessment and verification of safety by following activities:

- Assessment of safety related documents such as: Safety Analysis Report, Quality Assurance Programme, Emergency Plan, and Reactor Personnel Training Program
- Assessment of quarterly reports on reactor operation
- Performing of inspections (at least 3 per year)
- Assessment and acceptance of the projects on reactor system upgrading and new devices to be installed in reactor

4. ROLE OF THE OPERATING ORGANIZATION IN THE REACTOR SAFETY ASSURANCE

NCNR assures reactor safety by following activieties:

- Establishing appropriate organizational chart, promoting high level of safety
- Ensuring the adequate reactor operation financing
- Ensuring sufficient numbers of qualified staff
- Performing systematic safety assessment (Elaboration of Quarterly Report on reactor operation)
- Elaboration of documents ensuring safe reactor operation such as: Safety Analysis Report, Quality Assurance Program, Emergency Plan, Reactor Personnel Training Program, Ageing Management Program, Operational Procedures
- Ensuring the continuous training
- Appointment of Safety Committee

Role of the Safety Committee

Very important role in ensuring reactor safety is played by the Safety Committee which was established to advise the Director of the NCNR on following items:

- Modifications of reactor systems and components which operation is important to safety
- Implementing new experiments, equipments, tests to be of significance for safety
- Evaluation of the proposed design for new type of the nuclear fuel elements and the control rods
- Proposed procedures that are of significance for safety, for example procedure of reactor core conversion and so on

5. SAFETY CULTURE AS AN IMPORTANT FACTOR OF REACTOR SAFETY ASSURANCE

5.1. Commitment of the top management to the improvement of the safety culture:

- Showing the personnel why the improvement of safety culture is important
- Underlining the significance of safety culture in the time of training, exams, organization work and so on
- Participation of senior manager in the commission for requalification of personnel

5.2. Involvement of the co-operating groups such as: project office, safety analyses and reactor measurement service, maintenance group, to enhancement safety culture by following actions:

- Organization of common training meetings
- Demonstration of the potential consequences of badly done even the small work

5.3. Involvement of operational personnel to improvement of safety culture by following ways:

- Promotion of openness attitudes
- Organization of the training meetings on topics requested by employees
- Performing the requalification process

5.4. Involvement of operational personnel to improvement of safety culture by following:

- Promotion of openness attitudes
- Organization the training meetings on themes requested by employees
- Performing the requalification process

5.5. Open and partnership co-operation with supervisory organizations which are:

- Regulatory Body
- Deputy Director for Nuclear Safety and Radiological Protection
- Inspector of Quality Assurance

5.6. Adequate training as an important factor improving safety

Frequent themes of training are:

- Accidents which happened in nuclear reactors and analysing the reasons of these accidents
- Unplanned shut-down in our reactor with detailed analyses
- Disturbances and defects in reactor Maria
- Presentation of new projects and modifications

5.7. Broad self-evaluation process

- Elaboration of quarterly reports on reactor operation which contain the following items:
  - general information on reactor operation (number of hours of reactor operation, power, reactivity distribution, safety and control rods reactivity)
  - reactor core configurations
  - performed irradiations
  - unplanned scrams
  - components and systems failures observed
  - maintenance tasks and reparation works performed
  - list of verifications and calibrations of systems and devices
  - measurements and scientific examinations

- chemical measurements and analysis
- utilization of horizontal beam tubes
- vibration measurements
- list of performed trainings and relicensed persons
- radiation protection activities
- estimation of radiation hazard of operation activities
- estimation of radiation hazard of operational personnel
- releases of radioactive products to the atmosphere
- eventual releases to the secondary cooling system
- volume of radioactive effluents and solid waste

- Internal and external inspections

5.8. Improvement of teamwork

- Preparation of individual Quality Assurance Plan for unusual tasks, containing detailed organization plan and description of responsibility for each employee
- Appointments of all employees involved in execution of the task and discussion unclaire issues specialy these related to safety

5. CONCLUSION

The high level of research reactor safety is assured by: clear and adequate administrative and legislative system, adequate reactor financing, sufficient number of well trained operational personnel, good reactor technical status, continuous reactor supervision and inspection by external and internal bodies. This measures have to be completed by high level of safety culture which have to be continuously developed.