Safety of Research Reactors: Views of the NEA Committee on the Safety of Nuclear Installations

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Missions of the CSNI

- International committee made of senior scientists and engineers with broad responsibilities for safety technology and research programs, also representatives from regulatory authorities and industry
- Main activities:
  - To exchange technical information and to promote collaboration between research, development, engineering, technical support and regulatory organizations
  - To review operating experience and the state of knowledge on selected topics of nuclear safety technology and safety assessment
  - To initiate and conduct programs to overcome discrepancies, develop improvements and research consensus on technical issues
  - To promote the co-ordination of work that serves to maintain competence in nuclear safety matters
  - To facilitate the establishment of joint research projects

Committee on the Safety of Nuclear Installations (CSNI)

Chair: J. Repussard
Secretary: J. Reig
Bureau: K. Soda (V-C), B. Sheron (V-C), F. Weiss, J.M. Cavedon, A. White

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CSNI Programme Review Group (PRG)

Chair: M. Hirano,
Secretary: G. Lamarre

Working groups

Fuel Cycle Safety (WGFCS)
Chair: P. Nocture
Secretary: R. Rehacek

Risk Assessment (WGRISK)
Chair: N. Siu
Secretary: A. Amri

Working Group on Analysis and Management of Accidents (WGAMA)
Chair: T. Nitheanandan
Secretary: A. Amri

Working Group on Integrity of Components and Structures (WGIAGE)
Chair: A. Blahoianu
Secretary: A. Huerta

- **Concrete Structures Ageing**
  Chair: L. De Marneffe
- **Seismic Behaviour of Structures**
  Chair: A. Murphy
- **Integrity of Metal Components and Structures**
  Chair: C. Faidy

Working Group on Human and Organisational Factors (WGHOF)
Chair: D. Tasset
Secretary: G. Lamarre

Working Group on Fuel Safety (WGFS)
Chair: T. Fuketa
Secretary: R. Rehacek

OECD-NEA Joint Research Projects

- **DIDELSYS2 Group**
  Chair: J. Bickel
  Secretary: A. Huerta
- **Sump Clogging Group**
  Chair: D. Guzonas
  Secretary: A. Amri

Background (1)

- More than 660 research reactors (research, radio-isotope production, material testing, prototypes) ranging from 1W to 250MW have been constructed and 248 of them (124 in OECD countries) are operational or in shutdown state
- CSNI has not differentiated research reactor safety issues from those of power reactors and not discussed the safety issues specific to research reactors safety so far
- On the other hand, NEA and CSNI have a long history of coordinating collaborative research activities at research reactors: *DRAGON*, *HALDEN*, *LOFT*, *NSRR*, *PHEBUS*, *CABRI*, *HTTR*…
- NEA has created a High-Level Group on Security of Supply of Medical Radioisotopes (HLG-MR)

Background (2)

- Drivers for consideration of safety of research reactor initiatives within CSNI:
  - **Recent unplanned shut-downs of research reactors:** NRU in Canada, HFR Petten in the Netherlands have resulted in major impacts world-wide on the supply of medical radio-isotopes
  - **Many research reactors are in operation for a long time:** 10 % are more than 50 years old and nearly 50% are more than 40 years old; ageing is a key issue; periodic safety reassessments are not systematic
  - **Emerging specific technical matters:** Specific technical matters, e.g. severe accident management, have emerged and will remain relevant as current research reactors continue to operate with or in some cases, without a planned shut-down date

Position paper on research reactors

- In close connection with the NEA Committee for Nuclear Regulatory Activities (CNRA), the CSNI decided at this December 2009 meeting to:
  - Identify safety issues where knowledge gaps specific to research reactors may exist
  - Examine how its working groups could contribute to address these gaps
- Based on discussions and consultation with CSNI members, a position paper was produced, discussed with IAEA staff and transmitted at the end of 2010 to CNRA, who established a senior task group on research reactor safety
- The proposed work should not duplicate but rather should complement the extensive work already carried out over the past number of years by the IAEA on the safety of research reactors

Technical Issues (1)

- **Risk Categorization**
  - Lower risk than power reactors, but could be located in areas with high population density
  - Categorization largely based today on power level
  - For medium and high power research reactors, the risk involved is dependant upon the type and the characteristics of the reactors (fission product inventory, criticality…)
  - Strong interest of IAEA in defining proper generic criteria for risk categorization
  - Basis for using an appropriate graded approach in the application of safety requirements for research reactors

Technical issues (2)

- **Ageing Management and Long Term Operation**
  - Key issue for research reactors, already addressed by IAEA in terms of ageing management programs
  - CSNI could focus first on the identification of materials and degradation phenomena specific to research reactors
  - Emphasis on operating experience - IAEA ready to share its data base containing 280 reports on experience with ageing of research reactors
  - Extension of existing WGIAGE activities on Long Term Operation of power plants to these materials (e.g., aluminum) and phenomena could be then considered, leading to:
    - ✓ Best practices for ageing management programs
    - ✓ Areas where further research is required to address knowledge gaps

Technical Issues (3)

- **Accident Analysis Code Review and Validation**
  - Existing research reactors designed using simple and conservative approaches. Increasing use of more sophisticated analytical tools in the framework of PSR or LTO and for new projects. Tendency to use less enriched fuel
  - Analytical tools (thermal-hydraulic and neutronic codes) developed and qualified for power reactors. Less data available to qualify their application to research reactors
  - Ongoing IAEA Coordinated Research Project on "Innovative Methods in RR Analysis" – Discrepancies between code results showing lack of data or knowledge
  - NEA countries have developed data bases and methodologies which could be used to achieve a better adaptation and qualification of analytical tools applied to research reactor analysis

Technical Issues (4)

- **Severe Accident Analysis and Source Term Assessment**
  - Ongoing IAEA Coordinated Research Project on "Modeling and Analysis of Radio-nuclides Transport and Source Term Evaluation" to produce facility-specific calculations based on IAEA methodology (SS n°53)
  - Feedback of IAEA activities:
    - ✓ Need for more consistent approaches in safety demonstration
    - ✓ Significant discrepancies in data used for source term evaluations
    - ✓ Use of PSA not as mature as for power reactors
  - To complement IAEA activities, the CSNI could:
    - ✓ Define best practices for the selection of bounding scenarios
    - ✓ Share relevant data for the modeling of severe accident propagation and source term
    - ✓ Perform benchmarks on the qualification of analytical tools

Technical Issues (5)

- **Human and Organizational Performance**
  - Research reactor operating organizations not always involved in improvements undertaken to support the safe operation of power reactors in last decades
  - CSNI could consider a review of good organizational practices (management, training and qualification, safety culture…) for their application to research reactor operating organizations
  - In particular, the knowledge management issue appears extremely important for safe operation and ageing management of research reactors

Lessons learned from the Fukushima accident

- Some lessons learned from the Fukushima accident are also relevant to research reactors:
  - Approach to select maximum credible external events in the design basis
  - Consideration of beyond design basis events and improvement of the general robustness of the installation regarding the main safety functions
  - Management of situations with severely damaged fuel, explosions, use of mobile means
  - Human and organizational factors in extreme situations
- In some countries (such as France), targeted safety assessments ("stress tests") have been undertaken also on important research reactors in order to address these issues and improve the safety level of theses facilities if needed

Conclusions

- The CSNI review showed that there are no major safety issues where the lack of scientific data could be considered as an important source of weakness in the regulation and safe operation of research reactors in the OECD-NEA countries
- Some technical areas of potential interest exist where the CSNI could undertake specific reviews or assessments of interest to the nuclear safety community
- Any technical work activity would need to be closely coordinated with the IAEA
- These conclusions have been provided to the CNRA who established a Senior Task Group on research reactor safety
- After the Fukushima accident, attention and priority are largely focused on power reactors, but concerns regarding some research reactors should also be addressed with due consideration to the actual risk involved

Thank you for your attention!