Lisbon, 26 February 2016

CONCLUSIONS AND RECOMMENDATIONS OF THE IAEA INSARR MISSION TO THE RPI RESEARCH REACTOR, INSTITUTO SUPERIOR TECNICO (IST), LISBON, PORTUGAL 22 -26 FEBRUARY 2016

INTRODUCTION

The RPI is an open pool type research reactor of 1 MW thermal power, owned and operated by the Instituto Superior Tecnico (IST), University of Lisbon. The reactor went critical in 1961 and since then has undergone several modifications and refurbishments, including conversion of the core fuel from highly enriched uranium to low enriched uranium. The reactor is mainly utilized for neutron activation analysis, education and research and development.

The operating license of the RPI is valid till the end of the service life of the existing fuel (estimated to be about ten years - based on the current operating schedule of about 30 MWD/year). In this regard, the Regulatory Commission for Safety of Nuclear Installations (COMRSIN) is initiating an assessment of long-term safety of the reactor. On the other hand, the IST original plan was to return back the fuel to the country of origin (USA). However, IST is currently considering the use of the reactor fuel beyond the year 2016, which does not meet the conditions for fuel return to USA (defined as May 2019).

COMRSIN raised concerns on the feasibility of the continued operation of the reactor in view of its age and the need for further development of the national infrastructure for management of spent fuel and radioactive waste. In this context, COMRSIN requested this INSARR mission. The Pre-INSARR mission was held in September 2015 at the COMRSIN headquarters. The follow-up actions from the Pre-INSARR, which included representatives from reactor management, led to the agreement on the objective and scope of the INSARR mission.

The objective of the INSARR mission was to review the operational safety of the reactor, covering reactor management, safety committee, management system, training and qualification, Safety Analysis Report (SAR), safety analysis, Operational Limits and Conditions (OLCs), conduct of operations, maintenance and ageing management, safety of the utilization programme and modifications, operational radiation protection and waste management, safety culture, emergency planning, and decommissioning plan.

The mission was conducted in accordance with the IAEA procedures for INSARR missions, which are based on the IAEA safety standards. The mission team was composed of two IAEA staff members: Mr A. M. Shokr (SH-RRSS - Team Leader) and Mr A.J. D'Arcy (RRSS - Deputy Team Leader), and four international experts: Mr H. Abou Yehia (France), Mr P. Boyle (USA), Mr G.J. Storr (Australia) and Mr P. Lundell (Sweden). The main counterpart of the mission was Mr A. Fonseca, President of COMRSIN.

CONDUCT OF THE MISSION

During the entry meeting, the IAEA Team Leader presented the objectives of the mission, scope of the review, expected results and summarized the general comments which resulted from the review of the documents provided to the IAEA by COMRSIN before the mission. The entry meeting was held with the participation of Mr A. Oliveira, President of IST and Mr J. G.

Marques, RPI Manager and Vice-President of IST. The RPI supervisor and senior technical staff also participated in the meeting.

In addition to the documents provided to the IAEA team before the mission, during the mission the counterparts made presentations which covered the reactor description, its safety status, and the agreed areas for safety review. These presentations provided an overview of the current status of the reactor facility and its associated documentation, and were followed by detailed discussions within the framework of the mission activities. For the actual conduct of the mission, the following procedures were used:

- Examination and assessment of technical documentation;
- A detailed walkthrough of the facility;
- Discussions with RPI management and operating, and COMRSIN;
- Discussions among IAEA team members;
- Preparation and review of the summary report by IAEA team members.

During the first day of the mission, the IAEA team and the counterparts conducted a detailed walkthrough of the reactor and associated facilities. During the walkthrough, the IAEA team discussed with the RPI management and operating personnel various aspects related to the reactor operational safety and made observations regarding housekeeping, water leakage detection, radiation protection and radioactive waste management, and control room operations.

Three and a half out of five days of the mission were dedicated to a series of technical meetings, and plenary and parallel sessions with the RPI management and operating personnel, including discussions about the main findings and recommendations of the mission.

On Friday 26 February 2016, the IAEA team briefed the IST president on the results of the mission. The conclusions and recommendations of the mission were discussed in detail with RPI management and personnel in the presence of COMRSIN President and Vice-President, Ms M. Roldao, during the exit meeting held on 26 February 2016. There was general agreement by the counterparts on the IAEA team recommendations.

CONCLUSIONS AND RECOMMENDATIONS

The IAEA team noted the efforts of RPI management to enhance reactor safety and good practices in the areas of reporting on reactor operating performance. The team also noted that maintenance activities and safety provisions of experiments are broadly in line with the IAEA safety standards. Based on the activities of the mission, the IAEA team made recommendations and suggestions to further enhance the safety of the reactor. These covered the organizational aspects, safety analysis and safety documents, and technical modifications to the facility. These are as follows:

Organizational aspects

- In accordance with the IAEA Code of Conduct on the Safety of Research Reactors, the IST (the operating organization of the RPI) should ensure that an adequate number of qualified human resources is available for the safe operation of the reactor. This is of particular importance in the case that a national decision is taken to continue the operation of the reactor.

- The organizational structure of the RPI should be reviewed and, if necessary, revised to ensure:

- Clarification of duties, responsibilities for safety, line of communications of different individuals and groups involved in the reactor operation, particularly for the positions of reactor manager and reactor supervisor;
- Avoidance of potential conflicts of interest that may result due to assigning more than one function (with duties important to safety requiring an adequate level of independence) to the same individual within the organization;
- Inclusion of the function of quality assurance.

- A management system for the RPI operation phase should be developed in a systematic manner in accordance with the IAEA safety standards. This covers structuring and developing, as needed, the reactor documentation in a "top-down" manner, including processes, operating procedures, and work instructions. A process should be developed and implemented, which deals with non-conformances important to safety and which incorporates the ability to provide feedback that can lead to continuous improvement. The processes important to safety should be designed to ensure the existence of independent review and verification, and that this is conducted in a way that assures quality.

- Safety culture should be enhanced through developing, documenting, and monitoring expectations on management and staff, including behaviours and attitudes, to ensure that the human contribution to safety is as high as possible. Continued efforts to develop and maintain a strong safety culture should include further development of programmes for self-assessments, operating experience feedback, and knowledge management.

- The procedures of the safety commission should be revised in accordance with the IAEA safety standards NS-R-4 to include nuclear safety in its scope of work, including review of proposed changes or modifications having safety implications. List of items to be reviewed by the commission should cover all those that are required by the NS-R-4. The OLCs should be updated to reflect these revisions.

- The training programmes should be expanded to cover all positions within the RPI organizational structure that have a bearing on safety (i.e. chief operator, reactor supervisor, and deputy reactor supervisor). The scope of training and retraining programmes should be broadened to cover in a systematic manner the SAR, OLCs, safety culture, and managerial aspects as appropriate. The retraining programme should be enhanced (in terms of duration and contents) so that staff are kept appropriately abreast of evolving aspects of the facility that have an impact on their duties.

Safety analysis and safety documents

- In accordance with the comments provided during the mission, a detailed review of the SAR (including the OLCs) should be performed with the objective to ensure its completeness (by inclusion of missing items), and to ensure technical consistency between its different chapters and other facility documents.

- In light of the relevant feedback from the accident at the Fukushima Daiichi nuclear power plant, a safety reassessment should be performed in accordance with the IAEA Safety Report Series No. 80, with application of a graded approach commensurate with

the potential hazard of the reactor. This includes assessment of extreme external events, analysis of combined and consequential events, assessment of design extension conditions, and emergency preparedness.

- In addition to the recommendations mentioned elsewhere in this report, the OLCs should be revised to include:
  - Testing (in situ) of the efficiency of the HEPA and charcoal filters of the emergency ventilation system (suggested annually);
  - Restrictions of moving heavy loads over the pool;
  - Instructions to stop the primary cooling pump in the case of fuel melting accidents;
  - Conditions (in terms of time limits and restrictions on handling of radioactive material) related to opening of the reactor hall equipment hatch.

- The operating procedures should be completed to cover all the operations important to safety, including facility walkthrough and operators' response to the anticipated operational occurrences and accident conditions (e.g. pipe break and seismic). The operating procedures should be revised in accordance with the IAEA safety standards NS-G-4.4 to include, in particular, acceptance criteria, check lists as needed, and provisions for formalizing the effective implementation of the specified actions.

- A decommissioning plan in accordance with the IAEA safety standards should be developed without further delay. Measures for facilitating ultimate decommissioning of the reactor facilities should be defined and implemented in the activities, including training of personnel, configuration management, operation, maintenance, and utilization.

Technical modifications

Ageing of the facility

- An ageing management programme should be established in accordance with the IAEA safety standards No. SSG-10. In this regard, the physical status of the reactor components important to safety (including fuel elements, pool liner, core structure, and coolant pipelines) should be assessed using appropriate in-service inspection methods. Accordingly, actions should be specified and implemented to ensure continued safe operation of the facility.

Water leakage from the reactor pool

- Actions should be taken to ensure adequate leak tightness of the reactor pool, including:
  - Better quantification of the existing water leakage rate;
  - Inspection of the liner in Section I of the pool with the objective to repair possible defects causing the existing water leakage;
  - In case of a decision taken to continue the reactor operation, restoration of the water leak tightness of Section II of the pool through repair of the existing tiles (e.g. by use of epoxy) or its replacement by a stainless-steel liner.

- Considering the possibility of primary coolant water leakage into the soil and ground water, periodic monitoring should be performed by sampling at appropriate locations around the reactor facility.

Water leakage detection

- Actions should be taken to ensure early detection of possible water leakage in the pump room. Generally, an assessment should be made throughout the facility to check, and if needed to ensure, that water leakage detectors are appropriately located to enable early detection of small quantities of water.

Seismic detection

- Seismic detectors with an automatic shutdown (scram) signal connected to the reactor protection system should be installed at appropriate locations within the reactor facility.

Experiments

- The use of double encapsulation should not be limited to irradiation of fissionable material but should be also used with dispersible material. It is also suggested to develop a list of materials allowed to be irradiated together with limits on their amounts and physical and chemical forms.

I&C system and its replacement project

- The frequency of measurement of the control rod drop time should be increased (suggested twice a year, after core configuration change, and after maintenance of the control rod drive mechanisms). Trend analysis should be performed to provide for early detection of degraded performance and, accordingly, to implement necessary actions. The OLCs should be revised accordingly.

- An analysis of the coverage of the reactor protection system for the relevant postulated initiating events should be performed, to determine if the safety channels for core pressure difference, coolant flow rate through the core, and status of the flapper valve provide for adequate protection against single failure.

- With respect to the installation of the new I&C system, it is recommended to perform the system installation acceptance and integrated functional tests with the fuel unloaded from the reactor core.

Operational radiation protection

- The radiological classification of working areas should be reviewed in accordance with the IAEA safety standards No. GSR – Part 3 and NS-G-4.6, and the relevant engineering and administrative measures should be established accordingly, including:
    - Analysis of the adequacy of the existing radiation fixed area monitors in terms of number, location, and measurement range, and take appropriate actions;
    - The access control procedures, and associated contamination control measures;
    - Installation of flooring material to provide for ease of decontamination;
    - Radiation and contamination control procedures, including areas to be controlled and frequency of monitoring.

- Access control to the primary pump room during the reactor operation should be improved through, for example, control of the door (open/close) from the control room;

- The operational aspects of radiation protection should be further improved by establishing procedures for decontamination of personnel, areas, and equipment; and for maintenance work permit consistent with the IAEA Safety Standards NS-G-4.2. Radiation protection procedures should cover all operational and maintenance activities involving radiation exposure.

Operational radioactive waste management

- IST should strengthen the capability for treatment of low and intermediate radioactive wastes considering future needs. The currently established practices on managing liquid radioactive waste should be revised to ensure minimization of generation of waste.

Emergency preparedness

- IST should establish formal agreements with external emergency support organizations (e.g. fire department, civil protection, hospitals) with definition of their roles responsibilities, and communication modalities.

Additionally, the IAEA team suggests that a study could be performed to support a national decision on the future of the reactor: whether to continue its operation or to proceed with decommissioning. Such a study could address, among others, the:

- Implementation of the recommendations of this mission, as applicable to the decision;
- Future needs of the facility and its utilization plan;
- Physical status of the reactor systems and components;
- Various aspects of the safety infrastructure, including management of spent fuel and radioactive waste and availability of adequate human and financial resources.

Further, the IAEA team recommends that COMRSIN plans and implements regulatory inspections dedicated to follow-up the implementation of the recommendations provided by this mission.

Finally, the implementation of the mission was done in excellent conditions; the openness and technical knowledge of the RPI staff and their excellent preparation for the mission should be highlighted. The team also recognized and appreciated the commitment of the RPI senior management and staff to enhance the operational safety of the reactor.

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