Polish Regulatory Authority's experience from implementation of the outcomes from INSARR mission to the Maria research reactor

J.Adamczyk[1],

[1]National Atomic Energy Agency (PAA), Warsaw, Poland

E-mail contact of main author:Justyna.Adamczyk@paa.gov.pl

Abstract. The National Atomic Energy Agency (PAA) in Poland undergone the IAEA Integrated Safety Assessment of Research Reactors mission (INSARR) dedicated for the Maria research reactor during the period from 31 March to 4 April 2014.

Maria reactor is located in the city of Swierk, 30 km from the city of Warsaw. It is a pool-type, multipurpose, cooled and moderated by light water and beryllium with graphite reflector, with a maximum power of 30 MW. Currently, the reactor is operating at a power level between 18 and 23 MW. The reactor has been designed and manufactured by the Polish Industry and went critical for the first time in 1974. The reactor is currently operated with fuel elements with enrichment of 19,75%. The programme of core fuel conversion to low enriched uranium was completed in September 2014.

The reactor is expected to play an important role in the development of the national safety and technical infrastructures for embarking on a nuclear power programme.

This paper demonstrates the current status of the implementation of the INSARR outcomes during the License Renewal Process for Maria RR, and evaluation of the Safety Analysis Report in 2015 performed by PAA.

Key Words: Maria research reactor, INSARR mission

1. Introduction

The Maria research reactor is the major nuclear facility in Poland operated by the National Centre for Nuclear Research (NCBJ) and supervised by the Polish Nuclear Regulatory Authority (PAA).

The Maria reactor was designed as a high neutron flux, multi-purpose materials testing, isotope production and research reactor to serve the public interest in Poland in academic, medical, nuclear power and industrial applications. The current utilization programme of the reactor consists primarily of commercial production of radioisotopes and provision of services for medical and industrial applications. The main products in this category are ^{99}Mo and ^{131}I. The reactor is also used for neutron transmutation doping of silicon. The reactor also includes experimental facilities for fast neutron irradiation and six horizontal channels for neutron beam research. Other utilization activities include neutron activation analysis, education and training.

Following the request from NCBJ and PAA the IAEA conducted during the period from 31 March to 4 April 2014 an Integrated Safety Assessment of Research Reactors (INSARR) mission.

The objective of the mission was to review the operational safety of the Maria reactor according to the procedures of the IAEA Safety Review Service INSARR.

The scope of the mission was agreed, during the Pre-INSARR mission conducted at the site in March 2013, to cover the following safety review areas [1]:

- Regulatory Supervision (RSV)
- Operating organization and reactor management (RMG)
- Management system/quality assurance programme for operation phase (IMS)

- Safety Committee (SC)
- Training and qualification of operating personnel (TRQ)
- Safety Analysis Report (SAR)
- Safety Analysis (SA)
- Operational Limits and Conditions (OLCs)
- Conduct of operations (COP)
- Maintenance programme, including ageing management, (MPT)
- Safety of utilization programme (EXP)
- Safety of major modifications (MOD)
- Operational radiation protection programme (ORP)
- Radioactive waste management programme (RWM)
- Emergency planning (EMR)
- Decommissioning plan (DP)

2. Main issues and recommendations

During the INSARR mission there were several issues identified, the IAEA team made recommendations and suggestions to further enhance the safety of the reactor which covered mainly the organizational aspects, safety analysis and safety documents, and technical modifications to the facility.

2.1. Reactor licensing, Safety review and assessment

Maria RR undergone the License Renewal process in 2015. In view of the preparation for the licensing process, regulatory body requested revised documentation in accordance with updated Polish regulations and the IAEA safety standards (eg. NS-R-4) to provide adequate information to demonstrate the reactor safety – (IAEA team recommendation).

PAA made every effort to ensure that the Safety Analysis Report (SAR) for Maria research reactor will meet these criteria. Main issues noted during regulatory safety review were as follows: significant inconsistencies among the different chapters of the SAR, and SAR was not reflecting the actual status of the reactor facility. The recent core conversion to LEU followed with technical improvements of the cooling system of the facility lead to these problems. As the SAR is the main document used for the training and qualification of reactor operating personnel and regulatory inspectors, the clarity and technical validity is a key element in order to ensure nuclear safety [2,3].

2.2. Safety analysis

According to INSARR recommendations, safety analyses demonstrated in the SAR was reviewed against the IAEA safety standards NS-R4. Regulatory body required from the NCBJ to perform additional calculations with the integrated safety analysis covering entirely each accident situation, starting from the initiating events and ending by the evaluation of the accident consequences also in terms of doses to the personnel and the public, impact of the releases to the environment, with a comparison of the calculated doses to the acceptance criteria, and detailed procedures of emergency actions. Additionally the Safety Analysis Section in the PAA performed the same calculations simultaneously in order to check any inconsistencies.

Adequate analysis was performed also to determine the maximum allowable neutron fluence of the beryllium and graphite blocks. Finally, the developed calculations and verification lead to significant changes in Operational Limits and Conditions (OLCs) Chapter 17 of the SAR [2,3,5].

2.3. Operational Limits and Conditions

Mentioned process result in full revision and reorganization of chapter 17 of the SAR Operational Limits and Conditions (OLCs). Presented chapter was evaluated against regulatory requirements and the IAEA safety standards to reflect actual status of the reactor facility, including core fuel conversion to LEU, refurbishment and modification of the reactor systems structures and components (SSCs) with changes in the utilization programe and to provide for correction of technical inconsistencies existing between different documents. In addition, following the IAEA recommendation the revised chapter includes the section on administrative requirements.

Regarding safety operational limits INSARR mission team recommended verification of the coolant flow limit.

Maria reactor core has a complex structure of separate fuel channels - reactor fuel is loaded in individual channel pressure tube which is placed in beryllium metal matrix and cooled with water. Regulatory body required updated safety analysis for the critical coolant flow of the individual fuel assembly. Applicant applied calculations with two values of critical parameter ONBR (onset nucleate boiling ratio): =1 (for safety limits) and =1.2 for the reactor protection signal limits. This action result in changes in the OLCs chapter, the nominal flow remained constant while acceptable coolant flow limits increased so that the acceptable safety margin increased, proving that the reactor is maintained in a safety manner .

2.4. Integrated Management System

Regulatory body required from the operator plan for transition from the existing Quality Assurance programme (QA) to the Integrated Management System (IMS) following the IAEA safety standards as recommended during the INSARR mission. Former QA programme covered all the activities important to the reactor safe operation including operation, maintenance, radiation protection, modification and refurbishment projects, however its basis relayed on the national standards and outdated IAEA safety standards. Development of IMS was finalized in 2015 before the license renewal process completion.

2.5. Ageing management

The NCBJ representatives agreed with the INSARR team opinion that a systematic ageing management should be established and should cover all the SSCs important to the reactor safety. Internal procedure was established to cover all SSCs important to reactor safety and integrate the operating programme and activities interfacing with the ageing management such as maintenance, periodic testing and inspection, refurbishment and modernization activities, and revision of safety analysis. The procedure and related documents have been evaluated by PAA to meet the requirements of legislation and IAEA safety standards. New license conditions required from the operator to perform verification of reactor SSC’s from the ageing perspective and update internal procedures following the IAEA safety standard SSG-10 *Ageing Management for Research Reactors* [2,6].

2.6. Maintenance programme

The counterparts agreed the mission observation and recommendations indicating that a more systematic preventive maintenance programme will be established. In view of the preparation

for application for the reactor operating license renewal , regulatory body required development of the maintenance, periodic testing and inspection programme in accordance with the IAEA safety standards NS-R-4 and NS-G-4.2,. Instructions and additional documents provided by the operator were consistent and sufficient for the nuclear regulatory body [1,2,4].

2.7. Radiological protection programme improvement

PAA attention and effort has been dedicated for the radiation protection improvements. The IAEA mission observations included recommendations on radiological classification of working areas, labeling of controlled areas, and technical changes in the facility (flooring of controlled areas). All of these aspects were taken into account during regulatory licensing process. Operator established zones within the controlled areas in accordance with potential contamination and radiation hazards of these zones with proper access control. Locations and items with high radiation level or contamination has beenappropriately marked indicating the radiological risk. Operator is in the process of implementing the renovation of flooring in the controlled zone

The instruction about the *Control of worker exposure to ionizing radiation, control the work environment in the reactor Maria and monitoring of the area* was evaluated against the Polish atomic law, the secondary legislation to atomic law and additionally against the IAEA safety standards *RS–G-1.8, Safety Report Series no. 64 Programmes and Systems for Source and Environmental Radiation Monitoring, Commission recommendation on standardised information on radioactive airborne and liquid discharges into the environment, from nuclear power reactors and reprocessing plants in normal operation.*

Developed and implemented radiation programme was satisfactory for the regulatory body [1,2].

2.8. Emergency plan and preparedness improvement

The safety analysis and the SAR review resulted in changes of the emergency plan. The plan was broadened to the calculated dose rates inside the reactor building, the fission product releases to the environment, and the dose rates on-site and off-site. Furthermore, during the license renewal inspections the emergency equipment was examined. As a result of this inspections, the radiation protection instruments with their measurement ranges are compatible with the accident potential conditions, emergency plan includes a description of available communication and transportation means for evacuation of personnel in case of a general emergency on the site.

2.9. Inspections –Safety culture

Concerning the regulatory supervision of Maria reactor, the team noted the frequent interaction between the regulatory body and the operating organization and the comprehensive character of the regulatory inspection activities, which cover most of the safety areas. Moreover PAA fully agreed with the team suggestions and subsequently established:

- The quality assurance programme and the quality internal audits in the scope of the inspection
- Requirements that the operating organization reports on events having safety significance, covering analysis of the events and corrective actions taken to prevent their recurrence - requirement included during the issuance of the reactor license

- Regulatory inspections dedicated to follow-up the implementation of the recommendations provided by the INSARR mission – mainly fulfilled during the license renewal process, results are presented in this paper [1,2]

3. Conclusions & Lessons learned

INSARR mission gives an opportunity to exchange information between the team of experts, operator and regulator on safety matters. The assistance in solving safety problems bring a lot of incomes in terms of enhancing safety on research reactors [7].

Definitely the biggest improvements from PAA perspective are brought by follow-up detailed inspections, firstly the attention was paid on the technical issues pointed by an external experts, and secondly a clarification on existing reactor documentation was required during the license renewal process.

INSARR report was broadly used by PAA during the Maria RR license renewal process performed in 2015. Examination and assessment of safety documentation: SAR, OLCs, operating and maintenance documents and an emergency plan have discovered shortages and deficiencies and great amount of was done to fulfill them. Thanks to the work of external experts during INSARR mission, PAA had already identified issues and could clearly and carefully verify implementation of the INSARR mission outcomes during licensing process. This lead to the enhancement of reactor safety but also improve regulatory licensing process.

References

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, *Report of the Integrated Safety Assessment of the Research Reactors INSARR Mission to the Maria research reactor*, Co-operation Project RER/1/007 (2014)

[2] NATIONAL ATOMIC ENERGY AGENCY (PAA), *Regulatory Safety Evaluation Report on the Maria RR licence renewal process* (2015)

[3] NATIONAL CENTRE FOR NUCLEAR RESEARCH (NCBJ) – *Safety Analysis Report* (2015)

[4] INTERNATIONAL ATOMIC ENERGY AGENCY, Presentations on Safety of Research Reactors: H. Abou Yehia, *NS-R-4: Safety Requirements for Research Reactors*, Vienna, 2012

[5] INTERNATIONAL ATOMIC ENERGY AGENCY, Presentations on Safety of Research Reactors: H. Abou Yehia, *Safety Analysis for Research Reactors: Methods and Approaches*, Vienna, 2012

[6] INTERNATIONAL ATOMIC ENERGY AGENCY, Presentations on Safety of Research Reactors: A. M. Shokr, *Ageing Management for Research Reactors*, Vienna, 2012

[7] INTERNATIONAL ATOMIC ENERGY AGENCY, Presentations on Safety of Research Reactors: H. Abou Yehia, *INSARR: Integrated Safety Assessment for Research Reactors*, Vienna, 2012