International Atomic Energy Agency

REPORT

IAEA-KINS Workshop on Safety Evaluation of Research Reactor

Daejeon, Korea

15 - 19 July 2019

1. Introduction

The Code of Conduct on the Safety of Research Reactors recommends member countries to establish and maintain a legislative framework to govern the safety of research reactors. A regulatory body is responsible for regulatory control of research reactors, including authorization, review and assessment, inspection and enforcement, and establishment of regulations and guides. The basic objective of review and assessment is to determine whether the operator's submissions demonstrate that the facility complies throughout its lifetime with the safety objectives stipulated or approved by the regulatory body. This review and assessment of information shall be performed prior to authorization and throughout the lifetime of the facility or the duration of the activity, as specified in regulations promulgated by the regulatory body or in the authorization. The regulatory body should have sufficient full-time staff capable of either performing regulatory reviews and assessments, or evaluating assessments performed for it by consultants.

Feedback from recent IAEA's activities on the safety of research reactors shows the need in many Member States to continue to enhance regulatory effectiveness, including strengthening the regulatory body capacity in performing review and assessment of safety submittals in the framework of the licensing process.

Regional safety networks are an effective mechanism for safety enhancement through knowledge sharing and information exchange on safety topics of common interest. In support of strengthening the regional networks of the Arab Network of Nuclear Regulators (ANNuR), Asian Nuclear Safety Network (ANSN) and Forum of Nuclear Regulatory Bodies in Africa (FNRBA), the IAEA, in cooperation with the INSS (International Nuclear Safety School) of Korea Institute of Nuclear Safety (KINS), organised this workshop to share their practical knowledge and experience of safety evaluation for research reactors.

2. Objectives

The objective of the meeting was to provide the participating Member States with practical knowledge and information on regulatory review and assessment of safety submittals in the frame of the licensing process of research reactors. The meeting also ensured a forum for the participants to exchange their national practices and experience related to the subject and to discuss actions to strength the regional cooperation.

3. Work done

The technical meeting was attended by 18 participants from 11 Member States, including 9 participants from regulatory bodies and TSOs, and 9 from operating organizations for research reactors. The list of participants is given in Annex I.

The meeting was opened by Mr Oleksii Dybach, IAEA's Division of Nuclear Installation Safety, Research Reactors Safety Section. He welcomed all participants and emphasised that safety assessment competence is the key for making the right and justified decisions in design, operation and licensing. He also pointed out that safety assessment is a comprehensive and systematic process to justify the research reactor's safety against established acceptance criteria. Mr. Dybach mentioned that this WS was organized in support of strengthening three regional networks: ANSN, ANNuR and FNRBA. The opening address was followed by adoption of the meeting agenda (see Annex II). Mr. Hokee Kim, KINS Course Director, welcomed the participants and presented KINS regulatory practices for research reactors.

After the opening remarks, the workshop started with the presentations from the IAEA, KINS and invited lecturers:

- "IAEA activities on research reactor safety and feedback from activities of ANNuR, ANSN and FRNBA", "IAEA Safety Standards on safety assessment of research reactors" (Mr. Oleksii Dybach, RRSS/NSNI);
- "Licensing experience of research reactors", "Review of safety analysis", "Review of reactor core analysis", "Review of I&C and human engineering" (Lecturers from KINS);
- "NRC's regulatory framework and practices for research reactors", "Regulatory requirements and guidelines for safety review and assessment", "Licensing experience, focusing on safety issues in the US" (Mr. Rich Holm, AdSTM, USNRC);
- "Canadian experience in safety evaluation for research reactors", "Application of the graded approach to safety evaluation of research reactors" (Mr. Sang Shim, CNL).

The workshop continued with the country presentations on national practices and experience in review and assessment. The template for country presentations was sent to participants well in advance. National presentations covered three main topics:

- regulatory framework for review and assessment (national regulations applied to the research reactors, review and assessment process, role in the licensing, resources and capabilities of the regulatory body);
- review and assessment practices (contents of the safety submittals, safety analysis report and periodic safety review, acceptance criteria, practical examples on the completed review);
- experience and feedback resulting from application of the IAEA Safety Standards.

The summary of country presentations is given in Annex III.

The workshop also included working group exercises consisting of two activities:

- practical exercise on review and assessment of the Chapter "Safety analysis" of the SAR for research reactor (documentation for review has been developed and provided to the participants by the IAEA);
- elaboration of the ways to enhance regional cooperation.

Working group representatives made presentations on results of their discussions. A detailed description of the working group activities and the output from the each working group are given in Annex IV.

KINS organised the technical visit to HANARO research reactor in KAERI. The participants visited the reactor hall and familiarized with the main design features of the HANARO research reactor.

The meeting conclusions and recommendations are presented below.

5. Conclusions and recommendations

The workshop achieved its objectives providing the participating Member States with practical knowledge and information on regulatory review and assessment of safety submittals in the framework of the licensing process of research reactors. The meeting also provided a good platform for the participants to exchange their national practices and experience related to the subject and to discuss actions to strengthen the regional cooperation. The participants were actively engaged in discussion of the presentations and the working group exercises, and shared their national practices and lessons learned in an open manner.

The meeting participants concluded that:

- The issues and challenges for research reactors in ANNuR/ANSN/FNRBA countries are the same as for research reactors worldwide: regulatory effectiveness, ageing of facilities and continued safe operation, ability to perform safety analysis and periodic safety review, infrastructure for establishment of the first research reactor, capacity building.
- Technical expertise and experience are needed for conducting review and assessment of research reactor safety, and application of the IAEA safety standards is highly important.
- Well-established regulatory standards and guidelines for a prospective research reactor help to avoid unpredictable variables that may cause delays during the licensing process.
- Theoretical training on review and assessment should be supported with practical safety cases, including using the computer codes and ensuring their availability. For several participating Member States, availability of calculations tools and models for independent evaluations are challenges.
- Probabilistic approach is considered as a promising tool to complement the deterministic safety analysis. Several Member States have initiated national projects on PSA for research reactors. The technical guideline on PSA for research reactor and relevant components reliability data are needed to support the national activities.

The meeting participants recommended that the IAEA:

- Organize regular meetings to share experience and knowledge in review and assessment of research reactor safety, and to address in detail the specific aspects as deterministic analysis, probabilistic assessment, periodic safety review, application of the graded approach in the review and assessment process, and using the results of the safety analysis for the regulatory oversight and inspection activities.
- Consider the topical meeting to exchange experience and lessons learnt from implementation of new concepts introduced by SSR-3 to existing research reactors.
- Continue efforts on development of the Safety Report "Application of Probabilistic Assessment Methodology to Safety and Reliable Operation of Research Reactors" and publishing the TECDOC "Reliability Data for Research Reactor Probabilistic Safety Assessment".

Annex I: List of Meeting Participants

No.	Authority	Personal Details
1	Bangladesh	Mr Ashraful HAQUE Center for Research Reactor (CRR), Atomic Energy Research Establishment (AERE) Ganakbari, Ashulia, Savar, 1349 DHAKA BANGLADESH Tel:+880 (2)0088027789989, Email:ahaque_90@yahoo.com
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4	Indonesia	Ms Diah Hidayanti SUKARNO Nuclear Energy Regulatory Agency (BAPETEN) Jl. Gajah Mada No. 8, JAKARTA, INDONESIA Email:d.hidayanti@bapeten.go.id
5	Jordan	Ms Rahaf ABABNEH Energy and Mineral Regulatory Commission PO Box 1865, AMMAN, JORDAN Tel:+962 (580)5000, Email:rereab11@yahoo.com
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11	Malaysia	Ms Mazleha MASKIN Malaysia Nuclear Agency, Ministry of Science, Technology & Innovation Blok 18 BANDAR BARU BANGI MALAYSIA Email:mazleha.maskin@gmail.com; mazleha@nm.gov.my
12	Nigeria	Mr Godpower Ledeebari GBENENEH Nigerian Nuclear Regulatory Authority (NNRA) P.M.B. 559, Garki, Plot 564/565, Airport Road Central Business District 234-09 ABUJA, FCT, NIGERIA Email:godpower.gbeneneh@nnra.gov.ng

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17	Viet Nam	Mr Thanh Trung DO Vietnam Agency for Radiation and Nuclear Safety (VARANS) 113 Tan Duy Hung, HANOI, VIET NAM Tel:+84 438220289, Email:trungdt@most.gov.vn
18	Viet Nam	Mr Quang Huy PHAM Nuclear Research Institute (NRI); Vietnam Atomic Energy Institute (VINATOM); Ministry of Science and Technology (MOST) 01 Nguyen Tu Luc, DALAT, VIET NAM Email:huypq.re@dnri.vn

Annex II: Meeting agenda

Monday, 15 July 2019		
09:30-10:00	Opening session: welcome address, group photo, meeting objectives and expected results, adaption of the agenda, introduction by participants	KINS/IAEA
10:00-11:00	KINS regulatory practices for research reactors	KINS
11:00-11:30	Coffee break	
11:30-12:30	IAEA activities on research reactor safety and feedback from activities of ANNuR, ANSN and FRNBA	IAEA
12:30-13:30	Lunch break	
13:30-15:00	NRC's regulatory framework and practices for research reactors	AdSTM, NRC
15:00-16:00	IAEA Safety Standards on safety assessment of research reactors	IAEA
16:00-16:30	Coffee break	
16:30-17:30	Licensing experience of research reactors	KINS
17:30-18:00	Questions and Answers	All
Tuesday, 16 July 2019		
09:30-10:30	Canadian experience in safety evaluation for research reactors	IAEA (external expert)
10:30-12:30	Review of safety analysis	KINS
12:30-13:30	Lunch break	
13:30-15:30	Review of reactor core analysis	KINS
15:30-15:45	Coffee break	
15:45-16:15	Country presentation: Bangladesh	TBD
16:15-16:45	Country presentation: Egypt	TBD
16:45-17:15	Country presentation: Indonesia	TBD
17:15-17:45	Country presentation: Jordan	TBD
17:45-18:15	Questions and Answers	All
Wednesday, 17 July 2019		
09:30-11:30	Review of I&C and human engineering	KINS
11:30-12:30	Regulatory requirements and guidelines for safety review and assessment	AdSTM, NRC
12:30-13:30	Lunch break	
13:30-14:30	Licensing experience, focusing on safety issues in the US	AdSTM, NRC
14:30-15:30	Application of the graded approach to safety evaluation of research reactors	IAEA (external expert)
15:30-15:45	Coffee break	
15:45-16:15	Country presentation: Kazakhstan	TBD
16:15-16:45	Country presentation: Malaysia	TBD
16:45-17:15	Country presentation: Nigeria	TBD
17:15-17:45	Questions and Answers	All
Thursday, 18 July 2019		
09:30-10:00	Country presentation: Thailand	TBD
10:00-10:30	Country presentation: Vietnam	TBD

10:30-11:00	Introduction to working groups session	IAEA/KINS
11:00-12:30	Working groups activities	Facilitated by IAEA/KINS
12:30-13:30	Lunch break	
13:30-17:00	Working groups activities (cont.)	Facilitated by IAEA/KINS
17:00-18:00	Presentations of working groups activities results	All
18:00-18:30	Closing remarks	All
Friday, 19 July		
09:30-13:30	Technical visit to HANARO research reactor	KINS/KAERI

Annex III: Summary of Country Presentations

Bangladesh

It was mentioned in the presentation that Bangladesh Atomic Energy Commission (BAEC) has been operating 3 MW TRIGA Mark-II Research Reactor since 1986. The Safety Analysis Report was updated in 2006 following the IAEA guide SG-35-G1. Full-fledged facility license was issued in 2008. Currently, the reactor is using for NAA, NR, Neutron Scattering Experiments, Human Resource Development for NPP, Education and Training. During this period, several modification and upgradation work were carried out. Major modification includes, renovation of cooling system, installation of new decay tank, modification of ECCS and replacement of analogue console by digital console.

The reactor facility has been reviewed several times by international organizations. Peer review on Safety management System of Research Reactor was conducted in 2014 by FNCA. IAEA INSARR mission and subsequent follow-up mission was conducted several times. Pre-OMARR and main OMARR mission was performed by IAEA in 2018. Based on their recommendations and suggestions, the facility improves a lot.

It was also mentioned that Bangladesh Government has been approved an Annual Development Project (ADP) for the BMRE (Balancing, Modernization, Refurbishment and Extension) of safety systems of the 3 MW TRIGA Mk-II Research Reactor. Through this ADP, the ageing management of different systems/components of the reactor will be performed and it is expected that the operating life of the reactor will be increased for about 15 to 20 years. The safety and security of this reactor will also increase. It will also fulfil several recommendations and suggestions from the previous review missions by international organizations. A spent fuel storage facility will also be introduced through this project.

The presentation also covers legal and regulatory frameworks of the country for the regulation of nuclear and radiological installations in the country.

Indonesia

Review and assessment process plays an important role in ensuring safety at the entire lifetime of nuclear reactors, including research reactors. For the purpose of practical knowledge sharing on regulatory review and assessment, national practises of regulatory review and assessment for research reactors in Indonesia have been reported. The regulatory review and assessment process performed in BAPETEN aims to determine whether all legal and regulatory requirements have been met. Its process also involves independent safety calculations which is conducted by BAPETEN itself and/or external technical supports (universities, professional experts). Due to the wide range of research reactor characteristics, the regulatory review and assessment is carried out commensurate with the magnitude of possible risks arising from the reactors (a graded approach). Acceptance criteria for each aspect of review and assessment are mainly derived from BAPETEN regulations and IAEA standards. Currently, BAPETEN is conducting the regulatory review and assessment for several authorization processes, such as the operation license renewal of Kartini Reactor 100 kW and RSG-GAS Reactor 30 MW and the utilization approval for subcritical assembly for Mo-99 production (SAMOP testing facility) using Kartini Reactor's beamport. The major challenges in the regulatory review and assessment process are found in the areas of ageing management, periodic safety review, and implementation of Fukushima accident's lesson learnt. For safety improvement, BAPETEN starts to adopt several new concepts in IAEA SSR-3 into applicable requirements to be fulfilled in safety review and assessment.

Jordan

EMRC is responsible for preparing laws, regulations and instructions for the safe use of nuclear energy based on the basic principles and requirements of nuclear safety, nuclear security, emergency and nuclear safeguards published by the International Atomic Energy Agency(IAEA) and the best international practices, to ensure that the activities and facilities are under EMRC regulations through the issuance of licenses or permits necessary for Installations/ Facilities or individuals.

The current enforced law for Radiation and Nuclear Materials, Facilities and Activities; Radiation Protection, and Nuclear Safety and Security Law no. (43) for the year 2007 was revised.

EMRC review and evaluate the documents submitted from the licensee for the purpose of issuing: permits, licenses or evaluation to verify that the licensee follows the highest standards of safety in the design, construction, assembly, analysis, operation ... etc. of nuclear facilities. And so this is done through several stages covering the lifetime of the nuclear facility from the stage of site selection, construction, and commissioning, operation and decommissioning.

According to the licensing policy signed in 2011 , the basis for drafting the SAR's was NUREG-1537 part1 : " Preparing and Reviewing Applications for the Licensing of Non-Power Reactors".

As an acceptance criteria we used NUREG 1537, Part 2: Reviewing Applications for the Licensing of Non-Power Reactors: Standard Review Plan and Acceptance Criteria. By using the NUREG 1537, Part 2 in addition to the IAEA GS-G-1.2 , we can say that we followed a graded approach on review and assessment of the facility.

MRC granted Operation License (OL) for JRTR on November 15th, 2017. This OL was given as a result of a two years of authorization process of JRTR application, including:

- Receiving OL application: FSAR, EIA, QA program and other supplementary documents.
- Conducting 1st, 2nd and follow-up rounds of Request of Additional Information (RAIs) between EMRC's technical team and applicant.
- Missions with IAEA to get advices on some critical issues.
- Several meetings between EMRC, applicant, and its contractors.
- Meetings with Korean regulator, TSO (AdSTM) for consultations.
- Conducting several Inspections and Witness activities.
- Missions with European Union experts to get third party independent opinion.
- Commissioning Stages

Kazakhstan, Republic of

The country presentation provided a main information about the country legislation applied in the field of the use of atomic energy. Particularly the laws, rules, technical regulations, standards and etc. Also, the structure of the State regulations in the field of the atomic energy use was provided.

The country presentation included the information about the periodical and unscheduled review and safety assessment of nuclear and radiation safety of research reactor appointed by a regulatory body and the grounds for unscheduled review were considered. Also, operating organization appoints review and safety assessment of nuclear and radiation safety of research reactor.

The information about the expertise of nuclear, radiation safety and nuclear security, as well as the list of organizations accredited to implement the expertise were given. Also the process of licensing was described.

At the end of the presentation requirements for construction, commissioning, operation and decommissioning of nuclear installations were given.

Malaysia

The national legal framework of Malaysia comprises of its Atomic Energy Licensing Act 1984 (Act 304), subsidiary regulations was informed. The safety review and assessment process was explained where the activities are done whenever there is an application of license renewal together with submission of documents related to the research reactor (e.g. Safety Analysis Report). There will be an issuance of RAI to the applicant and Safety Evaluation Report will be issued provided the RAIs are closed, in order to support the decision of the Board whether the license is granted or declined. The practices of review and assessment in Malaysia is based on the acceptance criteria which has been set by the Act 304 and its regulations (e.g. Dose limit of worker is 20mSv/yr and fuel temperature limit). Other than that, the methodology of safety review and assessment in Malaysia is not stated in the regulations or guidelines. In 2012, Malaysia (Malaysian Nuclear Agency) has cooperated with KAERI for their upgrade of Reactor Digital Instrumentation and Control System (ReDICS) due to system ageing. There are also role of AELB as regulatory body in order to monitor the activity of modification are parallel with the Act 304 and its subsidiary regulations together with involvement of Korean Institute of Nuclear Safety (RB). There are several cooperation between Malaysia and other organisation (USDoE, IAEA and etc.) in order to sustain the expertise (AELB) in the field of safety review and assessment. In conclusion, this can help to strengthen the legal and regulatory infrastructure and look forward for the establishment of independent and sufficient single authority to oversee safety, security and safeguards (3S).

The framework and structure of safety review and assessment for the operator (Malaysian Nuclear Agency, MNA) of reactor TRIGA PUSPATI (RTP) was informed. Followed with review and assessment framework by the IAEA such as: INSARR, ORPAS, IPPAS and ETReS. Experiences in the application of IAEA Safety Standards were intensively used in the development of Safety Analysis Report, operation and maintenance of RTP, and RTP strategic planning. It was mentioned that, IAEA Safety Standards for NPP were also used in the development of Level-I PSA internal initiating event and internal hazard for fire such as: SSG-3 and 50-P-4 . A brief presentation on the result of the PSA were revealed. As concluding remark, Malaysia (Mazleha) request: (1) an update of IAEA-TECDOC-930 especially on certain unavailable component reliability and (2) guideline or procedure on developing Level-I internal hazard (fire) for research reactor.

Thailand

The currently status of the role of the Atomic Energy Regulatory Agency of Thailand, the Office of Atoms for Peace, OAP was informed. The enforcement of nuclear laws, in 2016, based on IAEA Nuclear Law Handbooks and regulatory laws of Thailand and other countries, currently effective legal which cover and have more details on the topics of safety, security, and safeguard. The Organizational structure processes related to the review and evaluation of research reactor safety was informed. The existing operation of Thai Research Reactor (TRR-1/M1), TRIGA Mark III power 1.3 MW was review and assessment for upgraded and modified I&C System in 2013 – 2017. To convert the I&C analog system to digital system due to the problem of ageing and unavailable spare parts for maintenance. The new MNSR research reactor was under site licensing process. The application IAEA safety standards were described; (1) IAEA SSR-3 was considered for all review and assessment processes, (2) preparation, for and content of Safety analysis report which adopted from IAEA SSG20, (3) the screening form to categorized the modification program which adopted from IAEA SSG24.

Vietnam

Mr Thanh Trung Do, VARANS presented the status of the Dalat RR, current activities related to establishing a new 10-15 MWt RR from both RB side and applicant side. Roles and resources of VARANS and its TSC for safety assessment of the RR were presented. International cooperation of VARANS with international organizations was showed. The key nuclear regulations for new RR were informed. Safety requirements and acceptance criteria for the RR site, design, construction, commissioning, operation and decommissioning were specified in the regulations. Safety requirements for the content of SAR for each phase and relevant documents were also specified in the regulations. Numeric criteria, list of PIEs and list of DEC extracted from the regulations are showed. It is intended that the regulations and standards of original country and IAEA safety standards will be adopted and applied directly. It is identified that the development of regulatory framework and the enhancement of technical capability are top priorities of VARANS and the assistants of IAEA, Rostechnadzor and other RBs are very important and necessary with VARANS. The challenges relating to the RR are not being fully independent RB, insufficient national regulations, lack of experience specialists, review activities for RR long time ago, unfamiliar of RB personnel with the RR, not carried out the safety analysis by RB personnel, etc.

Annex IV: Summary of Working Group Discussions

WGs' Activities:

Activity 1: Practical exercise on review and assessment of the safety analysis of Hypothetical Research Reactor (HRR) – 4 hours

Activity 2: Elaboration of the ways to enhance regional cooperation in the area of review and assessment – 1 hour

Activity 1 Practical exercise on review and assessment of the safety analysis of Hypothetical Research Reactor (HRR)

List of the aspects for discussion within the Activity 1:

1) Discuss on what basis the Chapter "Safety analysis" will be reviewed and what constitutes the acceptance of the submission
2) Discuss what process will be used between the applicant and the regulatory body with respect to communication of issue resolution
3) Perform a cursory review and assessment of the sufficiency of the Chapter "Safety analysis" against SSR-3, SSG-20 and SRS-55 (use the document "Design features" to familiarize with the HRR design specifics)
4) Does this Chapter "Safety analysis" contain information sufficient enough to undertake a detailed technical review and make a licensing recommendation?
5) Does the Chapter "Safety analysis" sufficient to establish OLCs and others purposes (e.g. emergency preparedness)?
6) Does the list of IEs complete and sufficient?
7) Generate any other questions and recommendations from this cursory review to make the submission more complete

Activity 2 Elaboration of the ways to enhance regional cooperation in the area of review and assessment

List of the aspects for discussion within the Activity 2:

1) Considering your national experience and challenges you are faced, elaborate the group's opinion(s) on the ways to enhance regional cooperation in the area of review and assessment
2) Specific needs of the IAEA's support

Compositions of the Working Groups

WG-1	**WG-2**
Chairperson - Mr. Haque (Bangladesh) Rapporteur - Mr. Dridi (Tunisia)	Chairperson - Mr. Yussef (Egypt) Rapporteur - Ms. Maskin (Malaysia)
Members: Mr. Omar (Egypt) Ms. Sukarno (Indonesia) Ms. Ababneh (Jordan) Mr. Almagambetov (Kaz…) Ms. Azidin (Malaysia) Mr. Gbeneneh (Nigeria) Mr. Pham (Viet Nam)	Members: Mr. Bani Yasin (Jordan) Mr. Orazgaliyev (Kaz…) Ms. Sani (Nigeria) Mr. Waer (Libya) Mr. Harzli (Tunisia) Mr. Do (Viet Nam) Mr. Sangkaew (Thailand)

Summary of Working Group Discussions

1. WG1:

Activity 1:

1) Discuss on what basis the Chapter "Safety analysis" will be reviewed and what constitutes the acceptance of the submission
    i. SSG-20, chapter 4. INFORMATION TO BE SUBMITTED FOR THE REVIEW AND ASSESSMENT PROCESS
    ii. SSR-3 Safety of Research Reactor
    iii. Regulation on the contents of safety analysis report
    iv. Safety review guide for RRs (NEUREG-1537)
2) Discuss what process will be used between the applicant and the regulatory body with respect to communication of issue resolution.
    i. Issuance of RAIs (request additional information) and supplement/supporting document
    ii. Conduct meetings between the applicant and the regulatory body
    iii. Applicant shall submit the RAI feedback to regulator (until the RAIs resolved)

3) Perform a cursory review and assessment of the sufficiency of the Chapter "Safety analysis" against SSR-3, SSG-20 and SRS-55 (use the document "Design features" to familiarize with the HRR design specifics)

- The applicant shall provide information as follows (A.16.3, SSG-20)
  i. Methods of identification, selection and justification of IEs;
  ii. Methods of analysis [Ref. : AA16.4.(2)];
  iii. Acceptance Criteria
  iv. Reactor Characteristics (A.16.5 – A.16.9, SSG-20)
  v. Evaluation of individual events shall include transient analysis, radiological consequences, relevant computational models used for the analysis, completeness of input parameters and initial conditions, complete results of the analysis including uncertainties. (Ref. A.16.13 – A.16.46)
  vi. Determine maximum hypothetical accidents as a bases to analyse the consequences
  vii. Summary of safety analysis (A.16.47 – A.16.48)

4) Does this Chapter "Safety analysis" contain information sufficient enough to undertake a detailed technical review and make a licensing recommendation?

INITIATED EVENT 6: INSERTION OF EXCESS REACTIVITY

- Insertion rate and maximum reactivity insertion are not mentioned
- There is no information on computational codes used
- The data of fission product released in the primary coolant is not mentioned.
- Dose rate calculation need to be provided in case of fission product release

INITIATED EVENT 7: LOSS OF COOLANT FLOW

- OLC : time needed for shutdown, how much 'few seconds' ?

Initiated event 8 : LOSS OF THE HEAT SINK

- Loss of heat sink
- This initiating event is not included in list of PIEs in chapter 3
- The applicant does not specify simulation code used for calculation the heating rate for RR pool.

INITIATED EVENT 9: COOLANT FLOW BLOCKAGE

- Which computer code is used for analysis?
- Correlations used in calculation? (force convection and natural convection etc..)
- What is safety parameters like DNBR ratio, fuel cladding temperature...
- Max. percentage of fuel failure.
- Max. fission products release.
- Dose rate calculation for workers and public?

- Max. capacity of filter system in case gas fission release.
- They mentioned that they use qualified fuel or control quality of primary coolant but it's nothing without showing the qualified calculation.

INITIATED EVENT 10: LOSS OF COOLANT IN THE PRIMARY COOLING SYSTEM

- The design and operation of the primary cooling system should be described in detail. The design and performance characteristics of the main components (pumps, valves, heat exchanges, piping) should be tabulated.
- A flow and instrumentation diagram should be included, as well as drawings of the main components. The materials the components are made of and the effects of irradiation on these materials should be specified. The reactor vessel, together with in-service environmental factors such as corrosion, fatigue, thermal stress cycling and ageing effects, should be described.
- Methods utilized for leak detection and measures to minimize the loss of the primary coolant should be described. The potential consequences of a loss of primary coolant should be discussed.
- The chemistry data for the primary coolant should be presented, including the effects of irradiation of the primary coolant.

INITIATED EVENT 11: BREAKAGE IN PRIMARY PIPING OUTSIDE THE RR POOL

- Regulatory Guides:
    - Leak detection : Early detection of leakage in components of the reactor coolant pressure boundary is necessary to identify deteriorating or failed components and minimize the release of fission. Products.
    - At least three different detection methods should be employed in the reactor : Methods used for detection.
- Technical specification:
    - Technical specifications limit both unidentified and identified leakage from the reactor cooling system
- Simulation of Accident: tools used, extreme conditions
    - Sequence of Events after Guillotine Break: Time (s) / Event /

The probability of a large break (LB), including a double-ended guillotine break (GB), is extremely low. For smaller breaks where the operator has time to take action, procedures are in place to a) mitigate a loss of water by tripping pumps and closing control valves after the falling water level in the vessel is detected by instrumentation, and b) assure that emergency cooling water continues to flow for as long as needed.

INITIATED EVENT 12: BREAKAGE OF AN IRRADIATION BEAM TUBE

- The computational simulation used to calculate accident scenario of irradiation beam tube breakage is not clearly mentioned, method, assumption, and validation.
- The worst accident scenario has been used, but the radiological consequences due to the core exposure are not explained quantitatively.

- Information of chapter 4 (Building & Structure) is not available to confirm on the design specification of irradiation beam tube.

INITIATED EVENT 13 : INADVERTENT SWITCH-ON OF PRIMARY COOLANT

- Sequences of events are explained.
    - transient analysis shall be explained comprehensively including computational codes used.

INITIATED EVENT 14 : INADVERTENT SWITCH-ON OF A PRIMARY COOLANT PUMP

- To prevent fires and explosions
- To detect and extinguish quickly those fires that do start, thus limiting the damage caused
- To prevent the spread of those fires that are not extinguished

INITIATED EVENT 15: EXTERNAL EVENTS (SSR-3):

- A research reactor facility located in a seismically active region shall be equipped with a seismic detection system that actuates the automatic reactor shutdown systems if a specified threshold value is exceeded.
- Features shall be provided to minimize any interactions between buildings containing items important to safety (including power cabling and instrumentation and control cabling) and any other structure as a result of external events considered in the design.
- The design shall be such as to ensure that all items important to safety are capable of withstanding the effects of external events considered in the design, and if not, other features such as passive barriers shall be provided to protect the reactor facility and to ensure that the main safety functions will be achieved.
- The design shall provide for an adequate margin to protect items important to safety against levels of external hazards more severe than those selected for the design basis, derived from the site hazard evaluation.
- Emergency pumps must be located in a waterproof room and room has to have waterproof door

INITIATED EVENT 16 : HUMAN ERRORS

- Warning signal and sign to remind human

INITIATED EVENT 17: MALFUNCTION OF EXPERIMENTS

- The explanation is insufficient (2 lines)
- Detailed information should be provided as per A.16.13, SSG-20

5) Does the Chapter "Safety analysis" sufficient to establish OLCs and others purposes (e.g. emergency preparedness)?

Not sufficient to establish OLCs

6) Does the list of IEs complete and sufficient?

The list of IEs are not sufficient. Following IEs need to include (Ref. Appendix I, SSG-20):

Sl.	IEs
3.2	Control Rod Drive System Failure
	Unbalanced Rod Positions
3.3	Deviation of System Pressure
3.5	Malfunction of Reactor Power Control
3.6	Drop of Heavy Load
	Exothermic Chemical Reaction
3.7	Electromagnetic Interference
	Lightning Strikes
	Power or Voltage Surges on the External Supply Line

7) Generate any other questions and recommendations from this cursory review to make the submission more complete.

The applicant shall refer to the IAEA Safety Standard: Safety Assessment for Research Reactors and Preparation of the Safety Analysis Report, SSG-20, IAEA Safety : Safety of Research Reactor, SSR-3 and other related guidelines.

Activity 2:

Considering your national experience and challenges you are faced, provide the group's opinion(s) on the ways to enhance regional cooperation in the area of review and assessment

- Participation on Safety Review and Assessment workshop (target audience: Reviewer from Regulatory Body), share and exchange on Safety Review and Assessment experiences including major safety issues.

Please also indicate the needed IAEA support (be specific)

- More practical exercises (Review and assessment) on specific topics including issuance of RAI (justification, basis and etc.) and review strategy.

2. WG2:

Activity 1

1) Discuss on what basis the Chapter "Safety analysis" will be reviewed and what constitutes the acceptance of the submission: completeness base on the regulations,

    a. SSG-20 (3.17): A.3.17. This section should describe radiological aspects and, in particular, the biological aspects of transfers of radioactive material to people. Most of these details may not be required for low hazard, low power reactors. In this case, only a brief summary should be given under each heading. If no radiological impact section is provided, justification should be provided for omitting this section of the safety analysis report.

    b. SSR-3 (6.38): An analysis of the postulated initiating events shall be made to establish the preventive and protective measures that are necessary to ensure that the required safety functions will be performed.

    c. SSR-3 (6.61): The design basis accidents shall be analysed in a conservative manner. This approach involves the application of the single failure criterion (see Requirement 25) to safety systems, specifying design criteria and using conservative assumptions, models and input parameters in the analysis

    d. SSR-3 (6.64): An analysis of design extension conditions shall be performed24 to determine whether the potential radiological consequences would exceed those deemed acceptable by the relevant authority., … etc

2) Discuss what process will be used between the applicant and the regulatory body with respect to communication of issue resolution: Request for Additional Information (RAI), meeting/discussion.

3) Perform a cursory review and assessment of the sufficiency of the Chapter "Safety analysis" against SSR-3, SSG-20 and SRS-55 (use the document "Design features" to familiarize with the HRR design specifics)

4) Does this Chapter "Safety analysis" contain information sufficient enough to undertake a detailed technical review and make a licensing recommendation? Insufficient information, base on general comment

5) Does the Chapter "Safety analysis" sufficient to establish OLCs and others purposes (e.g. emergency preparedness)? Technical specification for reactor operation is not mentioned.

6) Does the list of IEs complete and sufficient? No. Please refer to document (Item 3)

7) Generate any other questions and recommendations from this cursory review to make the submission more complete. Insufficient information, base on general comment

Activity 2

I. Please provide " integrated training ".

- Theoretical training supported with practical by using computer code (simulation) and ensuring the availability of the codes

- Eg: NSNI, IAEA (on DSA and PSA funded by Norwegian Extra-Budgetary Programme)

II. Building capacity

- To ensure the staff is capable to do assessment and review

III. IAEA need:

- to provide more efficient workshops with long-term training
- ensure more participation from the regulatory body in training and workshops

IV. Scientific visit: to research reactor under construction

V. Challenges faced:

- Regulatory Body (RB) lack of experience specialists relating to RR
- Review activities for RR by RB personnel were long time ago
- RB personnel is not familiar with RR
- Activities of safety analysis are not carried out by RB personnel (or long time ago)

VI. Lack of computer codes

- Reactor Physics Codes:
  1) WIMS, CASMO, PARAGON, HELLIOUS, etc.
- Fuel Behaviour Codes
  1) Static: PAD, FATES, FRAPCON, CARO, etc.
  2) Transients : STRIKIN, FRAPTRAN, SCANAIR, etc.
- Thermal Hydraulics Codes
  1) System: RELAP5, TRACE, ATHLET, CATHAR, MAR
  2) Containment T/H codes: CONTAIN, COCOSYS, GOTHIC, WAPCO, CONTEMPT
- Radioactive Waste:
  1) Disposal facilities safety assessment
  2) Code: GoSim, AMBER, Hydrus
- Probabilistic Safety Assessment:
  1) Pipe reliability: Methodology and Analysis
  2) External Hazard: Seismic
  3) Internal Hazard: Fire and Flood
  4) Level 2: Confinement/Containment Integrity