MAJOR UPDATE OF SAFETY ANALYSIS REPORT FOR THAI RESEARCH REACTOR-1/MODIFICATION1

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ABSTRACT

Thai Research Reactor-1/Modification 1 (TRR-1/M1) was converted from a Material Testing Reactor in 1975 and it had been operated by Office of Atom for Peace (OAP) since 1977 until 2007. During the period, Office of Atom for Peace had two duties for the reactor, that is, to operate and to regulate the reactor. However, in 2007, there was governmental office reformation which resulted in the separation of the reactor operating organization from the regulatory body in order to comply with international standard. The new organization is called Thailand Institute of Nuclear Technology (TINT) which has the mission to promote peaceful utilization of nuclear technology while OAP remains essentially the regulatory body. After the separation, a new ministerial regulation was enforced reflecting a new licensing scheme in which TINT had to apply for a license to operate the reactor. The safety analysis report (SAR) shall be submitted as part of the license application. The ministerial regulation stipulates the outlines of the SAR almost equivalent to IAEA standard 35-G1. Comparing to the IAEA 35-G1 standard, there were several incomplete and missing chapters in the original SAR of TRR1/M1. The major update of the SAR was therefore conducted and took approximately one year. The update work included detail safety evaluation of core configuration which uses two fuel element types, the classification of systems, structures and components (SSC), the compilation of detail descriptions of all SSCs and the review and evaluation of radiation protection program, emergency plan and emergency procedure. Additionally, the code of conduct and operating limits and conditions were revised and finalized in this work. A lot of new information was added to the SAR as well, for example, the description of commissioning program, information on environmental impact assessment, decommissioning program, quality assurance program and etc. Due to the complexity of this work, extensive knowledge was required and work load had to be well managed due to limited number of personnel on the work. The key success factor for this work was to establish international cooperation with other organizations in the research reactor community especially the TRIGA owners. A lot of information exchange including external reviews was conducted through US-DOE and TINT collaboration program on Research Reactor Operation Action Sheet. Other organizations contributed greatly to the success of the work as well by providing consultation and information such as KAERI, JAEA and etc. The updated SAR had been successfully submitted to the regulatory body.

1. Introduction

The history of Research Reactor utilization in Thailand started when the Thai research reactor-1 (TRR-1) achieved its first criticality in 1962. Later in 1975, the TRR-1 was converted to become essentially a TRIGA reactor and was renamed to Thai Research Reactor-1/Modification 1 (TRR-1/M1). TRR-1 and TRR-1/M1 had been operated by Office of Atom for Peace (OAP) until 2007. During this period, Office of Atom for Peace had two functions for the reactor, that is, to operate and to regulate the reactor altogether. However, the Thai governmental office reformation in 2007 resulted in the separation of the reactor operating organization from the regulatory body. The separation was to comply with international practice on the independence of regulating and operating functions. A new organization called Thailand Institute of Nuclear Technology (TINT) was established in 2007 to be the operating organization of TRR-1/M1 while OAP becomes the regulatory body. In addition, a new ministerial regulation was issued in 2007 which stipulates the licensing and periodic safety assessment of a research reactor. This ministerial regulation basically requires the safety analysis report (SAR) be periodically updated and the contents of the SAR be consistent with the IAEA Safety Series no. 35-G1 [1]. TINT as a new operating organization was required by the ministerial regulation to submit a revised SAR in order to obtain an operating license. However, the preliminary SAR obtained from the supplier had not been recently updated and the contents of this document were not yet fully consistent with the IAEA Safety Series no. 35-G1. Thus, TINT conducted a major update of the SAR during the period of 2008 - 2010.

2. Status of the SAR before the update

In the core conversion from TRR-1 to TRR-1/M1 during 1975 - 1977, some components of the original reactor (TRR-1) remained in use for the modified reactor (TRR-1/M1) such as reactor building, reactor pool, reactor crane and ventilation system. Some components were modified for use with the converted core such as cooling loops and reactor bridge while some other components were newly installed, e.g. instrumentation and control system. The design and installation of the TRR-1/M1 was performed by General Atomics (GA), USA. The original SAR of TRR-1/M1 [2] available to the reactor staff before the SAR update was prepared during this time. This SAR contains the information and the safety analysis mainly for the modified and newly installed systems, structures and components. The detailed information about the systems, structures and components of the original TRR-1 was rarely available in the document.

The original SAR of TRR-1/M1 was quite generic and did not contain enough specific information to meet the content format of the modern IAEA Safety Series no. 35-G1. Nevertheless, this document was regarded as the working SAR but it had not been periodically updated. Also, there had been several incremental changes to the systems, structures and components throughout the utilization of TRR-1/M1 and, unfortunately, there was no systemic update to the SAR.

Although there have been efforts to revise the original SAR by the reactor staff throughout the operating period, the revised SAR had only been a drafted version and had never been officially published. One problem for the update was that the update work did not have a good document control system. As a number of reactor staffs worked on the revised SAR, it eventually became difficult to identify the most updated document. Despite that, the structure of the revised SAR was prepared according to the IAEA Safety Series no. 35-G1 even though some chapters were missing or incomplete. Tab 1 summarizes the status of the SAR before the update.

Tab 1: the status of the SAR before the update

Characteristics of SAR chapters	Chapter Number
Missing chapters	Chapter 14: Environmental Assessment Chapter 15: Commissioning Chapter 18: Quality Assurance

	Chapter 19: Decommissioning
Chapters with significantly incomplete content	Chapter 2: Safety Objectives and Engineering Design Requirements Chapter 3: Site Characteristics Chapter 4: Building and Structures Chapter 5: Reactor Chapter 6: Reactor Coolant Systems Chapter 9: Electrical Power Chapter 10: Auxiliary Systems Chapter 11: Reactor Utilization Chapter 12: Operational Radiological Safety Chapter 13: Conduct of Operations Chapter 16: Safety Analysis Chapter 17: Operational Limits and Conditions Chapter 20: Emergency Planning and Preparedness
Chapters with content near completion	Chapter 1: Introduction Chapter 7: Engineered Safety Features Chapter 8: Instrumentation and Control system

3. Improving SAR

As mentioned earlier, there had been efforts to update the SAR periodically throughout the operating period. However, since there was no specific and independent mandate enforced during the time before separation of OAP and TINT, no official revised SAR had been published from these efforts. After the separation and the issue of the ministerial regulation, the importance of SAR update had taken higher priority. A small group of the reactor staffs (4 – 5 members) were assigned to perform this task. Initially, due to the demand of other work, the staffs could only share approximately 20% of their workload for this task and no detailed execution plan was yet established. As a result, the SAR update did not have a good progress and there seemed to have communication difficulties among the staffs. These difficulties included repetitive work among the staffs, use of inconsistent information, delay in obtaining critical information from one another, and etc. Moreover, the task was very intensive and complex and there were not enough reactor staffs knowledgeable in all areas of the safety analyses. Eventually, the project team realized the importance of establishing a project plan for successful execution of the SAR update.

3.1 Project planning

A project plan was established by the project team. A weekly meeting was organized to review the progress and to discuss the standing issues among all project team members. The plan was broken down according to the SAR chapters. List of to-do activities were laid down in the plan along with time schedule. The natures of the activities were diverse such as finding information on the field, writing descriptions, performing calculations and analyses, interfacing with regulatory body and organizing the project. At the weekly meeting, the work progress of the previous week was reviewed and the work of the upcoming week was discussed. In addition, the project team set up centralized network file storage to save the updated files with revision control such that all members could assess the correct files with convenience.

Sometime later, the regulatory body set the dateline for the submission of the revised SAR or the reactor shall be temporarily prohibited from operation. The SAR update work was then given the highest priority. The project staffs eventually took at least 80% of their workload for more than half a year.

3.2 International Cooperation

Although many activities were performed by the project team themselves, some detailed information of the reactor and associated systems was not available to the reactor staffs. This information included the detailed information and safety analysis of the TRIGA fuel as well as other information for comparison such as system descriptions and analyses. It was obvious from the view of the project team that this task needed external assistance from international research reactor community. Several informal communications with other facilities (i.e., KAERI, JAERI, Moroccan research reactor) were exchanged throughout the project. In addition, a formal arrangement with the McClellan Nuclear Research Center (MNRC) through the existing cooperation with U.S. Department of Energy was established as well. The cooperation with MNRC greatly speeded up the SAR update work since both reactors share a number of similarities such as fuel type, power range, etc. Independent verifications of several analyses were also performed by the staffs of the MNRC.

3.3 Interface with regulatory body

The experience showed that it was very important to constantly have a review meeting with the regulatory body. The meetings for this SAR update were both informal and formal. The meetings were important in that it provided opportunities to clarify with the regulatory body on any standing issues. The staffs of the regulatory body were given a drafted version of the revised SAR to perform an early (but informal) review. It was found that interfacing with the regulatory body created mutual understanding to gain trust. Moreover, the regulatory body had a chance to familiarize with the revised SAR before the final submission. This significantly reduced the review period by the regulatory body and misunderstanding during the regulatory review session.

3.4 Difficulties of the SAR update

During the SAR update work, the project team encountered many difficulties. The most difficult task was probably finding information which was not available. Even though some old documents were available in the storage, they were not clearly categorized. The staffs took quite a long time to look through these documents to gather the required information. Another difficulty for the project team was to identify the applicable engineering codes and standards adopted by the designer. The project team rectified this by analyzing from the existing documents and comparing with other similar facilities. Additionally, the information about site characteristics was not readily available at the beginning. Fortunately, the project team could retrieve enough information from national databases of several government agencies. For many systems, structures and components, the descriptions and analyses were not available or were inaccurate. The project team had to perform the detailed on-field surveys to gather the actual information for comparison with the existing information.

One of the extensive tasks for the SAR update was to perform various kinds of safety calculations such as neutronics analysis, thermal hydraulics analysis, transient analysis, radioactive material dispersion calculation and etc. Safety calculations were revised because of the introduction of the mixed core using two TRIGA fuel element types (8.5% wt. and 20% wt). The analyses of the mixed core configuration were not available originally. It was fortunately that the staffs had been conducting some of these calculations earlier as researches. The existing reactor modeling was then used as the basis for the safety calculations. Lastly, the operational programs such as Conduct of Operations, Operating Limits and Conditions (OLCs), radiation protection program, emergency plan and decommissioning plan which were incomplete or missing before the SAR update project were finalized during the SAR update.

4. Major lessons learned

Based on the experience of this SAR update project, the project team identified the following lessons learned:

- The update of SAR requires a lot of information from the safety and other relevant documents. This kind of documents shall be properly organized, categorized and

maintained as much as possible. A document control system shall be applied for these documents as part of the QA program.

- Project management and document control system shall be established during the SAR update work. Without this, the success of the project is rarely possible.
- Competencies in performing relevant research reactor calculations, .e.g. reactor physics analysis, thermal hydraulics analysis, transient analysis, shielding calculation, radioactive material dispersion calculation shall be maintained among the reactor staffs. These are very valuable for the SAR update work.
- The update of SAR is a very extensive work. Close cooperation with other facilities especially the ones with high level of similarities is very critical for the success of the project.
- Good cooperation and communication with other facilities will relieve the issue of lacking expertise in some areas.
- It is important to establish formal and information communication with the regulatory body. This seems to increase workload at the beginning but eventually will reduce the amount of time and efforts during the regulatory review session.
- A periodic and systematic SAR update shall be included as part of the QA program for the research reactor operation. Modifications which affect the details in SAR shall require the revision of SAR promptly and accordingly. This will reduce the effort to update SAR from incremental changes to facility at one time.
- The SAR update, however, is a good exercise for research reactor staffs to be familiar with the detail of their facility. As many research reactor staffs as possible should be involved in this activity.

5. Conclusion

After the separation between the regulatory body and operating organization, the SAR of TRR-1/M1 had been updated to comply with the newly issued Thai Ministerial regulations. The SAR update task was quite cumbersome and took a lot of time and manpower. The SAR update plan was established and played a crucial role in successful management the work. Many difficulties were encountered during the work but were rectified. Information sharing through international cooperation was a critical element in order to succeed this task. The updated final SAR had been successfully submitted to the regulatory body.

6. References

[1] IAEA Safety Series No. 35-G1, “Safety Assessment of Research Reactors and Preparation of the Safety Analysis Report”, IAEA, Vienna (1994).
[2] “Standard TRIGA Mark III Safety Analysis Report”, General Atomic Company, 1975