Applicable Standard Document References for Ageing Management Issues Related to Indonesian Research Reactors

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Abstract. The recent development status of nuclear power technology in Indonesia includes the operation of three research reactors: GA- Siwabessy, Kartini Yogyakarta, and Triga Mark II Bandung, which have been operating for 31, 39, and 54 years, respectively. With over 30 years of nuclear research reactor operation, one of the issues that come to fore is ageing management. Ageing management includes the duties and issues involved with management, maintenance, operation, monitoring, and refurbishment. Nuclear engineers, researchers, and officials working at the Indonesia Nuclear Energy Agency and Indonesia Nuclear Energy Regulatory Agency have concerns and differing opinions on how these needed functions should be performed and implemented. Use of International Atomic Energy Agency technical documents is beneficial for many reasons, including the global basis and years of experience, however there are a variety of ageing management related documents that it is difficult to discern which ones are applicable to nuclear research reactor programs. This paper attempts to identify, clarify, and filter necessary ageing management documents to be used in the Indonesian nuclear research reactor program.

Keywords: Ageing management, research reactor, standard document

1. Introduction

Indonesian nuclear research reactors have been in operation for the past 54 years. These nuclear research reactors include Reactor Triga Mark II Bandung for approximately 54 years, 39 years for Reactor Kartini Yogyakarta and 31 years for RSG-GAS [1-3]. Even though these research reactors are still available today, it is not guaranteed that these facilities will be still be in top operational shape when new nuclear engineers and researchers may need to utilize them in the future. Therefore, a strategic plan for long term sustainability to evaluate the current status and measure the potential capabilities of each reactor needs to be developed [4]. After more than 30 years of nuclear research reactor multipurpose operation, Indonesia Nuclear Energy Agency (BATAN) is the organization most experienced and appropriate to prepare ageing management plans and reviews for the entire nuclear research reactor fleet.

This ageing management program is expected to prepare the framework for managing performance evaluations during operations and prepare necessary activities to prevent, detect, monitor, assess, and
reduce the effects of ageing Triga Mark II, Kartini Yogyakarta, and RSG-GAS [5]. By the state law from the president Republic of Indonesia about nuclear power No. 10 – 1997 in section III - article 8 had been state that for research development in nuclear safety is need to be concerned to avoid the negative effect from the utilization of nuclear reactor facilities [6]. By this statute, it is necessary to prepare ageing management for research reactors in advance, especially for RSG-GAS since it is still in good operational condition. Generally, the Indonesia Nuclear Energy Regulatory Agency (BAPETEN) guides and supervises BATAN on issues of operation and maintenance, especially for RSG-GAS. In addition, BAPETEN recommends all activities should follow the provision of BAPETEN Chairman’s regulation with reference from IAEA Safety Standards.

Usually in BATAN, available information about research is only related to operating procedures, facilities, required personnel requirements, neutron analysis, material structure studies, and testing nuclear fuel or equipment. This is unlike nuclear power plants, which have many regulations and requirements for system performance. It is necessary to survey whether all BATAN employees, especially the researchers which are not working in the reactor, will know the procedures for reporting reactor activity in preparing ageing management plans. Since BATAN researchers are from a different division from the nuclear research reactor operation and maintenance staff, very little information is available for the researchers to decide which documents should be followed to guide the ageing management activities. This is especially true for RSG-GAS, since the BATAN researchers did not directly contact with BAPETEN while performing the necessary tests. Even though some technicians may perform nuclear research reactor maintenance based solely on vendor supplied manuals, their managers may not understand the relevant issues. Additionally, for researchers who are not in direct contact with the nuclear research reactor, they will not be prepared when they are required to conduct research related items such as maintenance strategy, repairing methods, online monitoring, fuel pellet design, or even material hardness testing, without direct guidance from BAPETEN.

This paper will explore the existing requirements documents related to ageing management issues and how to give information regarding applicable documents for nuclear research reactor ageing management. This will be especially helpful to BATAN researchers, and related personnel, in assisting in their ageing management related research.

2. Literature

2.1. Ageing Management

Ageing management is the engineering process, operation, maintenance strategy and action to control ageing degradation for structure, system and component (SSCs) [7]. Ageing is defined as a general process for SSCs which gradually change because of use [8, 9]. International Atomic Energy Agency (IAEA) Specific Safety Guide No. SSG-10, is a specific safety guide which has recommendations and guidance on how to comply with safety requirements, provide examples of cases from other countries as well as reasonable recommendations that can be followed [8]. IAEA safety standards are applicable, as relevant for the all facilities and activities, whether existing or new. Safety management during research reactor ageing implementation is very important in managing the monitoring, prediction, and timely detection of ageing issues. Based on research reactor experience, several kinds of issues that are considered include:

- Degradation of SSCs from physical ageing, which is gradual deterioration in the physical characteristics,
- Obsolescence of SSCs from non-physical ageing, which is management of current standards document or technology that is can out of date.

2.2. Operation

IAEA has a set of documents, Safety Standards, which consist of safety fundamentals, safety requirements, and safety guides that are applied by the IAEA to be used by member states, national authorities, and by other international organizations in relation to their own activities [8]. Operation of
research reactor is a big issue should be concerned. The most important operation requirement to be follow is that a research reactor shall be able to meet its safety goals at any time, independent of age or other considerations. If the goals cannot be achieved, then the reactor must be shut down, regardless of its age [9]. There is ageing management issue should be taken related to operation of the research reactor [7]:

- Support ageing management program by the management of the operating organization.
- Early implementation of an ageing management program,
- Understanding the SSC ageing rather than reactive approach responding SSC failures,
- Optimal operation of the SSC to slow down the rate of ageing degradation,
- Develop implementation of maintenance and testing activities with operational limit and condition, design requirements and manufactures,
- Minimize human performance factors that can caused premature degradation,
- Use the correct procedure.
- Managing the storage of spare parts,
- Availability of the necessary competences for dealing with complex ageing issues,
- Internal and external communication
- Feedback of operation experience.

2.3. Maintenance

Maintenance is one of the important areas of research reactor safety with all the performed activity to achieve the purpose of research reactor which is designed, constructed and modified [10]. Safety systems are normally used to achieve the three basic requirements, which is [11]:

- To shutdown the reactor and maintain it in a safe shutdown condition for all operational states or accident conditions.
- To provide for adequate heat removal from the core after shutdown, including accident conditions.
- To contain radioactive materials in order to minimize their release to the environment.

The design shall ensure high reliability, and shall include provisions to facilitate regular inspection, testing and maintenance. Based on requirement No.29 in IAEA SSR-3 it has been state that during maintenance and testing, a qualification program shall be implemented for a research reactor facility to verify that the item of important to safety is capable to perform the intended function when necessary [10].

2.4. Monitoring

During ageing management, we have to look at the monitoring or inspection and testing reports. There might be information regarding detecting ageing mechanisms and the degradation effect. A monitoring capability shall provide for all essential processes, equipment during, and following an accident. If necessary, a remote monitoring and shutdown capability shall be provided [11]. Ageing effect can be measured by a change in measureable parameters. For this issue, there is several testing can be develop to detect the ageing effect of the research reactor [9]:

- Testing – Consider to ageing effect cannot be measured directly, the scheduled activities should be prepared to facilitate the timely performance for the test. Testing method may be used to look for signs of deterioration.
- Performance Test – Ageing effect can be measured by checking the performance of the system. The result from the performance test should be examined which may indicate ageing problems.

2.5. Refurbishment

IAEA Safety Standards No.SSG-24 provides recommendation for the operation organization for the utilization and modification projects for research reactor [12]. In the context of this safety guide, the
modification is for the existing reactor, for the SSCs, or the item for software important to safety, and experiment or an experimental device. SSG-24, for a successful implementation of a utilization of modification project, here is the planning management that should be follow [12]:

- Planning and prioritization of work
- Addressing all relevant regulatory requirements
- Addressing the requirements derived from the operational limits and conditions;
- Evaluate the feedback of operational experience from similar utilization or modification project.
- Addressing the maintenance requirements for the experiment or modified system or components.
- Ensuring the availability the personnel with suitable skills.
- Establishing the operating procedures.
- Documenting the required inspections and test, including requirements for commissioning and experiment or modification.
- Documenting the required training and instruction.

3. Methodology
To complete ageing management project, there is process should be complete following the technical area [7]:

- Maintenance, periodic testing and inspection,
- Periodic safety review,
- Equipment qualification,
- Reconstruction of the design basis,
- Configuration management,
- Continued safe operation.

To perform the above-mentioned procedures, both the researchers and the nuclear engineer shall refer to the BAPETEN Chairman’s requirements and IAEA safety standards series. Figure 1 is the regulatory framework that should be follow related to research reactor activity in Indonesia. If we look at the regulatory framework pyramid in Figure 1, BAPETEN has already elaborated the rules that can be related to the implementation of ageing management programs. Therefore, the implementation of ageing management can be done through work breakdown structure in Figure 2, which is the hierarchical and decomposition of the ageing management project into phases, deliverables, methodologies, that show a subdivision of effort required to be complete.
From IAEA Safety Standards No.NS-G-4-2, Maintenance, Periodic Testing and Inspection of Research Reactor, the recommended testing and inspection methods and techniques are [13]:

- Visual examination provides information on the general condition of SSCs examination,
- Surface examination, to delineate or verify the presence of surface or near-surface flaws or discontinuities,
• Volumetric examination, for indicating the presence, depth or size of a surface-breaking or subsurface flaw or discontinuity and usually involves radiographic, ultrasonic or eddy current techniques,
• Other testing techniques such as hydrostatic testing of pressure equipment and helium leak testing.

In summary, Table 1 shows the requirements related to ageing management in quotation from IAEA Standard Series.

| Description          | Requirement                                                                                                                                   | Reference Document                  |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
| Ageing Management    | The operating organization for a research reactor facility shall ensure that an effective ageing management program is implemented to manage the ageing of items important to safety so that the required safety functions of structures, systems and components are fulfilled over the entire operating lifetime of the research reactor. | Requirement No.86, IAEA Specific Safety Requirement No. SSR-3 [10] |
|                      | The ageing management program shall determine the consequences of ageing and the activities necessary to maintain the operability and reliability of structures, systems and components. |                                     |
|                      | The ageing management program shall be coordinated with, and be consistent with, other relevant programs, including the programs for in-service inspections, periodic safety review and maintenance. |                                     |
|                      | A systematic approach shall be taken to provide for the development, implementation and continuous improvement of ageing management programs. |                                     |
| Periodic safety review | On the basis of the results of the periodic safety review, the operating organization shall take any necessary corrective actions and shall consider making justified modifications to enhance safety. | Requirement No.87, IAEA Specific Safety Requirement No. SSR-3 [10] |
| Extended shutdown    | The operating organization shall take appropriate measures during an extended shutdown to ensure that materials and components do not seriously degrade; taking measures to prevent accelerated corrosion and ageing. | Requirement No.87, IAEA Specific Safety Requirement No. SSR-3 [10] |
| Material Selection   | Where material data are unavailable, a suitable material surveillance program shall be adopted and results derived from this program used to review the adequacy of the design at appropriate intervals. | IAEA T-TECDOC-792 Management of Research Reactor Ageing [10, 12]. |
| Codes and standards  | Codes and standards applicable to systems, structures and components shall be identified and their use justified. | Code on the Safety of Nuclear Research Reactor Design, Safety Series No.35-S1 [11] |
| Maintenance          | Their design shall ensure high reliability, and shall | Safety Series No 35-S1               |
include provisions to facilitate regular inspection, testing and maintenance.

A maintenance group shall be established by the operating organization to implement the programs for maintenance, periodic testing and inspection

| Operation | The operating organization for a research reactor facility shall ensure that the research reactor is operated in accordance with the operational limits and conditions. |
|-----------|----------------------------------------------------------------------------------------------------------------------------------|
| Requirements 71. IAEA Specific Safety Requirement No. SSR-3 [10] | |