MANAGING RTP CONSOLE UPGRADING PROJECT : BEST PRACTICE FOR NUCLEAR MALAYSIA AS TSO IN SUPPORTING NPP DEVELOPMENT

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ABSTRACT

Human Resource Development (HRD) is required for Nuclear Power Programme (NPP). To be a Technical Support Organisation (TSO) for NPP, Nuclear Malaysia should be ready to take the responsibility in supporting Nuclear Regulatory Agency (NRA) and NPP Operators. In nurturing Nuclear Malaysia as TSO, the prime important and focus of HRD for the NPP is the reactor engineering technology. Nuclear Malaysia gives various phases of supports needed to build NPP such as during siting, design, planning, licensing, construction, commissioning, operation and maintenance in its own way and capability. The current Nuclear Malaysia's unique approach is the TRIGA PUSPATI reactor (RTP) upgrading project. Research reactor plays an important role in R&D organization as a nuclear facility to assist the development of NPP. Therefore, upgrading the research reactor is needed to build the skills and gain knowledge of workers to work safely. After 29 years of operation, the RTP system is facing aging problems due to many components in the reactor are outdated. Therefore, immediate action should be carried out to mitigate the aging factor of the reactor to prevent the worsening of the aging problem, and to prevent untoward incident from happening. Action should also cover short and long term planning to prevent current situation from recurring. Currently, RTP is upgrading its console from analog to digital system. One of the achievements in this console upgrading project is the development and implementation of project management. This paper comprises the overview on the RTP console upgrading project, the project management and how this project can lead Nuclear Malaysia to be a good TSO for the development of NPP.

Katakunci/keyword : Human Resource Development, HRD, Technical Support Organisation, TSO, Nuclear Power Programme, NPP, RTP console upgrading project, project management.

HUMAN RESOURCE DEVELOPMENT (HRD) IN NUCLEAR POWER PLANT (NPP)

Currently, there is no nuclear power generation plant in Malaysia and neither is there a plan to embark on a nuclear power programme in the foreseeable future. The only nuclear reactor in this country is a 1 megawatt-thermal research reactor owned and operated by Nuclear Malaysia Agency. The authorities recently announced that Malaysia would operate its first nuclear power plant, which is expected to be operational in 2021.

The reactor HRD is important for NRA and NPP operators since they need technical supports to observe nuclear safety, localization and sustainability. HRD has to be developed locally in Malaysia and overseas in such a way of overseas training and formal education, on-the-job training and IAEA experts dispatch via multilateral collaboration and bilateral collaboration.

ROLES OF NUCLEAR MALAYSIA AS TSO IN NPP

Nuclear Malaysia is hoped to have the capability and ability to enter into a new phase which is in supporting the nuclear power program. Hence, Nuclear Malaysia shall have enough manpower recruits to acquire various capabilities. For the roles over the long term, Nuclear Malaysia is capable to develop the services, technologies and components which relevant to the TSO. In the short and medium term, Nuclear Malaysia plays the role to prepare the nation for public information and public acceptance (PI/PA), siting, construction, testing, commissioning and operation and maintenance. To do that, Nuclear Malaysia has to do the twinning with the vendor country who is the future suppliers of its Nuclear Power. So, within that package of the procurement perhaps, there should be the transfer of technology which includes the twinning of the TSO from Malaysia and the TSO from the potential supplier country. In that manner, they will work together and access the future nuclear power plant for the licensing, construction, operation, maintenance and waste

management. This is how the RTP upgrading project can be a good track for Nuclear Malaysia to be a good TSO in such that this project also involves the same phases of procedures to NPP development.

The roles and functions of Nuclear Malaysia as TSO should be clear. The first role which is also one of the goals and objectives of Nuclear Malaysia is to support Nuclear Regulatory Agency for example in supporting Atomic Energy Licensing Board (AELB) to regulate and monitor NPP operator in the aspect of nuclear safety which depends on AELB capabilities. This include safety assessments of NPP during planning, siting, construction, commissioning, plant health evaluation, management and work procedures, outsourcing procedures, quality assurance (QAP), operation and maintenance management evaluation for safety, waste management and ALARA engineering. The second role of Nuclear Malaysia as TSO is to support nuclear industries such as Non-Destructive Test (NDT) companies. There are some NDT companies that serving the oil and gas industries which are needed to bring their capabilities into nuclear power plant serving company. As TSO, Nuclear Malaysia also is responsible to provide the technical support to the NPP operators. The roles and functions of Nuclear Malaysia as TSO are more focusing on the safety evaluation and to provide the solution for the NPP operators and industries. In the foreign company, TSO is being utilised by the stakeholders and the public to access nuclear and radiation safety as an independent accessor. Another function of the TSO is to provide the research and development and to keep abreast with the technology development as well as to support the findings and to provide solution to any related problems. In order to enhance the capacity and the capabilities for the HRD in conducting research and development (R&D), Nuclear Malaysia also needs physical infrastructure such as the laboratories with completed of tools, equipments and facilities as for this time being, one of the physical infrastructure that Nuclear Malaysia has is the Reactor TRIGA PUSPATI which was designed to effectively implement the various fields of basic nuclear research and education.

RTP UPGRADING PROJECT

Nurturing the TSO is very important especially for Nuclear Malaysia which is well-known as nuclear technology R&D organisation to take the responsible as TSO to support nuclear power programme in Malaysia. The current of Nuclear Malaysia's unique approach is the Reactor TRIGA PUSPATI (RTP) upgrading project.

The reactor upgrading project is consist of core design for high power reactor and related systems, thermal-hydraulic calculation and cooling system design for high power reactor, instrumentation and control system for research reactor, development of advance instrumentation technology, safety analysis including PSA, development and acquisition of a reactor training simulator, reactor beam utilization and NDT tools for NPP operation and maintenance support and nuclear safety, reactor beam instrument design and localization in nuclear instrumentation.

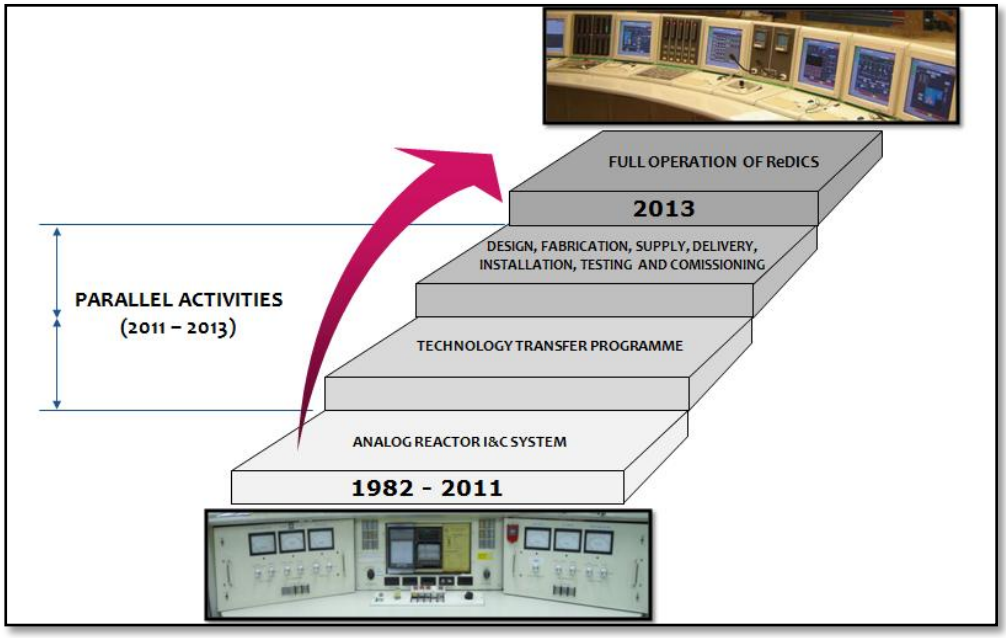

Figure 1. Activities in the RTP Console Upgrading Project

In 2010, there is an instrumentation and control project where the reactor control console is upgraded from analogue into digital which is planned to be commissioned and fully operated in 2013. Figure 1 shows the activities that will be included in that project. Nuclear Malaysia also has an ongoing project and R&D to upgrade its RTP from 1MWth to 3 MWth. Furthermore, this project helps Nuclear Malaysia to develop its own HRD in research reactor technology through the procurement of TTP.

This HRD is made to achieve the target of Nuclear Malaysia such that in 2015, the engineers and scientists in Nuclear Malaysia may be able to re-design its own RTP. Furthermore, besides replacing the old analog I&C system, this RTP upgrading projects is hoped to train the RTP personnel to be capable to do the licensing and thus applying the licence as well as producing Safety Analysis Report (SAR). Nuclear Malaysia may also be ready to train and educate its personnel into the training and education of National Nuclear Workforce and making full use of its training reactor of TRIGA research reactor to embark the basic knowledge before it goes into more serious Nuclear Power Plant training. Throughout the TTP, there will be HRD enhancement in the I&C system and technology. For all this purposes, it can be said that the procurement of this new digital I&C system may enhance the TSO capabilities in Nuclear Malaysia to be ready for future NPP.

The main focus in this paper is the project involving instrumentation and control (I&C) system for research reactor which is to upgrade the RTP control console from analog to digital. The comprehensive studies on the current I&C system have been done to determine the problems occur in the system as well as the solutions that might overcome the problems. After doing the technical analysis, operation reports, console audit and getting the advices from the experts via the Brain Gain Programme, it comes to a solution that immediate action should be carried out to mitigate the aging factor of the reactor console to prevent the worsening of the aging problem, and to prevent untoward incident from happening. Action should also cover short and long term planning to prevent current situation from recurring. Thus, many efforts have been done in a way to upgrade the control console such as by studying the techno economic for upgrading reactor from 1MW to 3MW, carrying out the reactor technology survey and preparing the technical specification for the new digital I&C system.

Reactor Digital Instrumentation and Control System (ReDICS)

I&C consists of hardware that controls and ensures the safety of nuclear reactor by acquiring data from sensors and monitoring the status of process variables such as temperature, pressure, and level; conditions and isolates these sensor signals; displays and processes the sensor data on recorders, indicators, and the computer; and issues commands to controllers, safety logic circuitry, or safety actuation systems.

Before entering into the main subjects, the reasons are shown first why it is necessary to make a point to the use of digital technology to replace the current analog system.

Over the past fifteen years, the nuclear power industry has embraced digital I&C for upgrading nuclear power plants using digital and paperless recorders, digital indications, digital display systems, and so on. The industry is also moving toward the use of digital technology for the process control.

A state-of-the-art instrumentation and control system using microprocessor technology is proposed to replace the present analogical systems. The new system can eliminates most manual data logging, provides automatic or manual reactor operation modes, provides complete real-time operator display, replays historical operating data on monitor or printer, eliminates spare parts replacement problems and meets all applicable international standards.

Digital I&C systems are widely used in almost all industrial applications in one form or another. The use of microprocessors and computers is not new especially in nuclear power plants.

To ensure that nuclear reactor continue to provide reliable performance and meet current safety standards, the I&C systems should be periodically modernized. The nuclear industry has faced problems in finding spare parts for analog I&C systems whose hardware was produced 20-30 years ago. Physical ageing of equipment combined with lack spare parts has increased failure rates and operation and maintenance costs. Furthermore, a number of vendors have reduced their support for analog systems, and there may be instances in which the original supplier is no longer in business.

Owing to the considerable improvements in the reliability of digital electronics in recent years, many nuclear utilities have decided to replace old analog I&C systems by computerized systems. Advances in digital technology provide the following additional incentives for upgrades:

- more complex functions can be performed;
- greater precision can be achieved;
- a greater amount and variety of information can be compiled and used;
- the user interface can be made more flexible;
- it is easier for the system to detect and deal with anticipated internal faults;
- functional changes can be made without physical changes or even physical access;
- standard processors of known reliability can be used in many applications.

Digital computer systems are used in I&C systems important to safety to perform functions of protection, data acquisition, computation, control monitoring and display. If properly designed, they can offer the advantages of improved reliability, accuracy and functionality in comparison with analog systems. The computer system may take many forms, ranging from a large processor supporting many functions to a highly distributed network of small processors devoted to specific applications. Computer systems may be used to advantage in detecting and monitoring faults internal and external to reactor operation systems and equipment important to safety.

All new nuclear power plants are being designed with integrated digital I&C systems as the backbone of protection, controls, alarms, and display and monitoring. Most research reactors built since 1980 have their controls performed by digital systems. Several reactors manufactured before this year, have changed their systems from analog to digital.

Development and Implementation of Project Management

Project management involves planning the project, organizing the committee (organizing), recruitment (staffing), direction (directing), monitoring, control, introducing something new (innovating) and represents. The successful of project management is proved by achieving the objectives of the project which to be completely done within the time and budget requirements.

To make this RTP upgrading project works smoothly, a project management team was developed at early stage of the project (See Figure 2.) The objectives of the development of this project management team are to train the young engineers and scientists in organizing a project while gaining the valuable experiences by observing and participating in the project management with the contractor/supplier.

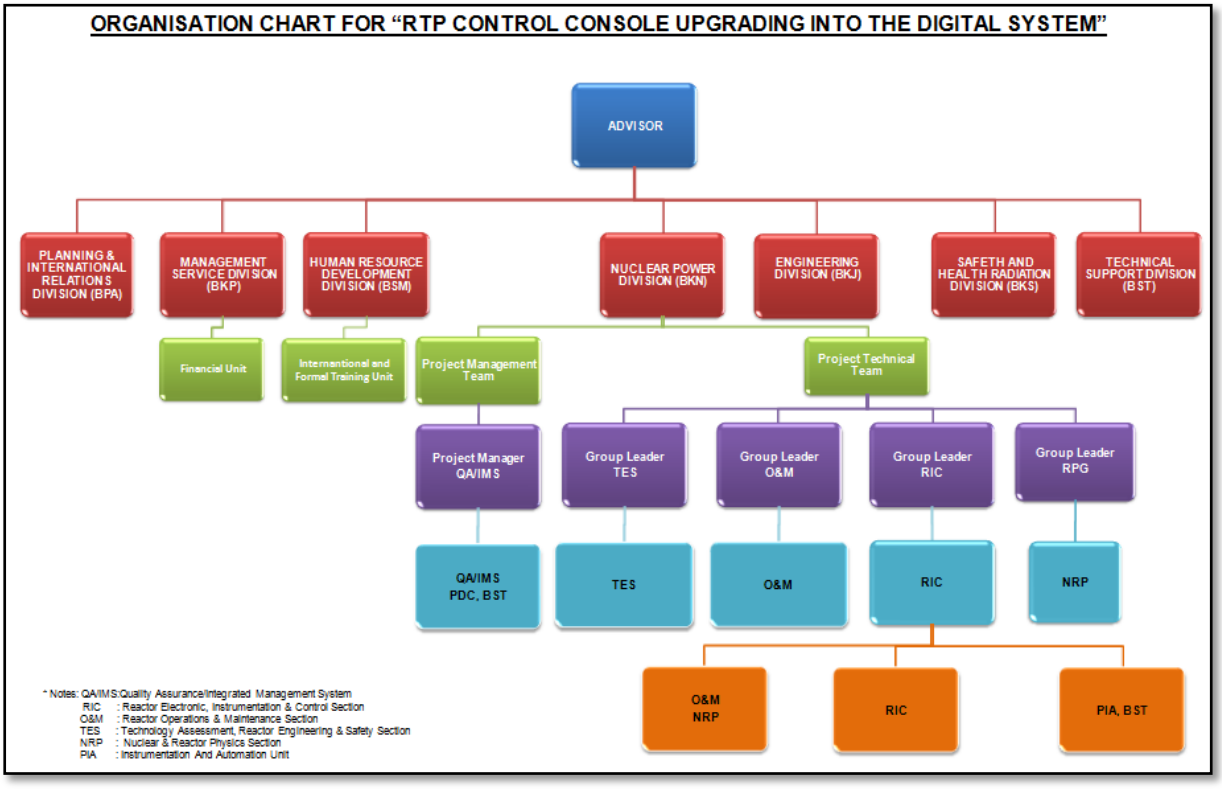

Figure 2. Organisation Chart for RTP Console Upgrading Project

This project management has appointed top management from some divisions in Nuclear Malaysia as advisors, who are encouraged to contribute their expertise, ideas and useful knowledge to help the success of the project. This project is lead by the project manager that has been appointed by the project advisor. Project manager is directly responsible in the project management, providing staff, budget, giving direction, planning, and guilty control over a project. Project manager develops plan where the project is controlled and traced (tracked) to ensure the project reaches the target. For this purpose, the project manager requires the information that is correct and timely. This information should be provided together with the planning and control system, which outlines the scope of work and performance measurement to ensure the project follows the original plan. The project management committee which consists of management team and technical team are needed to manage and balance the needs and expectations in such to ensure the success of the project.

Project management software is used for the better and effortless planning of this project. This software allows the project manager to do planning, completing and managing all the details to be completed in accordance with the layout to achieve the project objectives. This software will help in the preparation of project documents, track progress, analyzing costs, assessing the quality of the project and managing many projects at a time (See Figure 3).

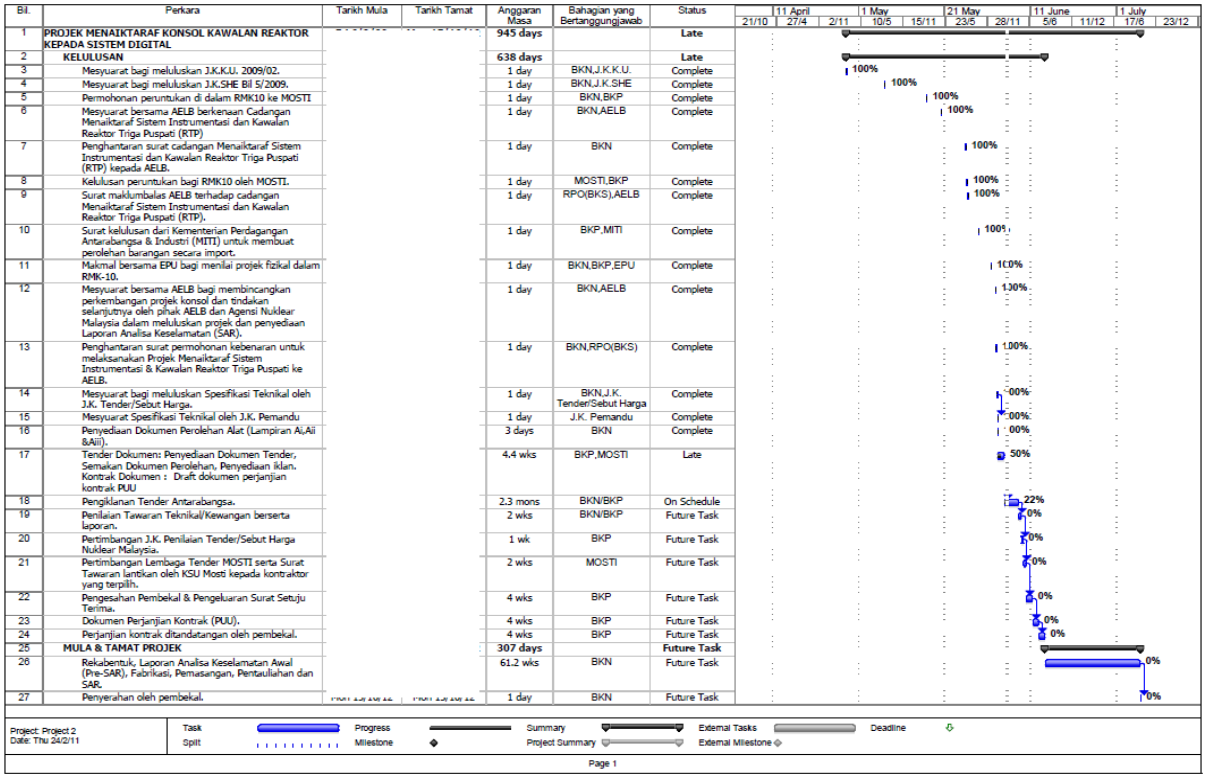

Figure 3. Project Management tools/software

This project is divided into several tasks that must be achieved in order to attempt the desired goals. Among the tasks that need to be implemented are as follows:

i. Provides a complete technical specification on the desired design and system for the new digital console.
ii. Determine start and end dates
iii. Obtain management approval at every stage
iv. Performed by a human or non-human resources (money, material, etc.),
v. Designed, implemented and controlled, with limited resources (budget, people, equipment, time limited, etc.).

Nuclear Malaysia has divided the project into phases or stages to allow better management control. All phases of this project known as the Life Cycle project (project life-cycle). This project is a very complex task that requires a fraction of careful coordination and control of time, cost and performance. Like living things, the project also has a life cycle. From a slow start, it will continue to progress until the peak and then decline and eventually be terminated. This project requires the project team to provide a schedule to ensure that the project can be done in a specified timeframe and wage rates apply. Project management is applied in this project with the use of the knowledge, skills, tools and techniques. It is all of the merger process to enable the project to be completed in line with the changes in the life cycle project for achieving project goals.

RTP upgrading project implementation plan

The project development was proposed to start in 2008. A working paper was proposed for consideration and approval from the Steering Committee of Safety, Health and Environmental Management System. A proposal for this RTP upgrading was also been sent to Atomic Energy Licensing Board (AELB).

After getting all the approvals, the detailed system design was developed including the technical specification, technical drawings, system operation procedures and system security features. The needs of training and the HRD will also be included in the project development package.

The development of hardware system as well as the software system will be implemented after contractor selection has been approved. The contract will be signed only after Nuclear Malaysia as the user are satisfied and agreed with the proposal submitted. The proposal which consists of the activities / tasks, schedule and budget will be included in the contract documents. After the contract signed by all parties involved, the actual work project can be implemented.

The Nuclear Malaysia personnel are proposed and encouraged to get involved in the system development process including design process which including both conceptual and detailed design, fabrication, system testing and installation. The ReDICS design includes instrumentation for monitoring RTP and other auxiliary systems during all operational states and accident conditions. It records all variables crucial to the reactor operation and safety. There will be an operation and maintenance course given by the contractor/supplier to the selected RTP personnel after the installation after the new I&C system is successfully installed.

The contractor/supplier has to provide the local training at site during the installation, testing and commissioning to the selected designers/engineers/operators of Nuclear Malaysia. The contents of the training for the Reactor I&C maintenance will be included Basic System Design, System Cabling & Connection, System Testing, Calibration, Troubleshooting & Repairing, Preventive Maintenance and Quality Control (QC) while contents of the training for the Reactor operators will be included Basic System Design, System Testing, Calibration, Power Calibration, Control Rod Calibration, Start-up Checklist, Reactor Operation Modes, Shut-Down Checklist, Report and Data Management.

There will be a Technology Transfer Programme (TTP) conducted by the contractor/supplier during the conceptual design, detailed design, fabrication, quality control, verification & validation and industrial testing of the new I&C system to the personnel of Nuclear Malaysia. TTP is a part of Human Resource and System Development Programme which can build the design capabilities in such that this joint programme can develop and design the hardware and software modules for console control system. For the construction part, the users are encouraged to participate in the testing and QA/QC of the hardware and software modules for console control system as well as in the installation, commissioning and licensing of console control system at RTP. Last but not least, this TTP will provide the Training programme on Operation & Maintenance of the RTP.

Categorization criteria, approval routes and specific safety requirement

Figure 4 shows the overall process for a modification project of Category A. The RTP upgrading project which falls in the Category A is the modifications that:

(i) Involve changes in the approved operational limits and conditions,

(ii) Affect items important to safety, or

(iii) Entail hazards different in nature or more likely to occur than those previously considered.

This process may differ according to the type of modification to be conducted. Figure x also indicates the interaction between the operating organization and AELB during different stages of the project implementation.

Modifications under Category A shall be subjected to safety analysis and Quality Assurance Program (QAP) for design, fabrication, installation, and commissioning in order to ensure that they satisfy the same requirements as the existing facilities.

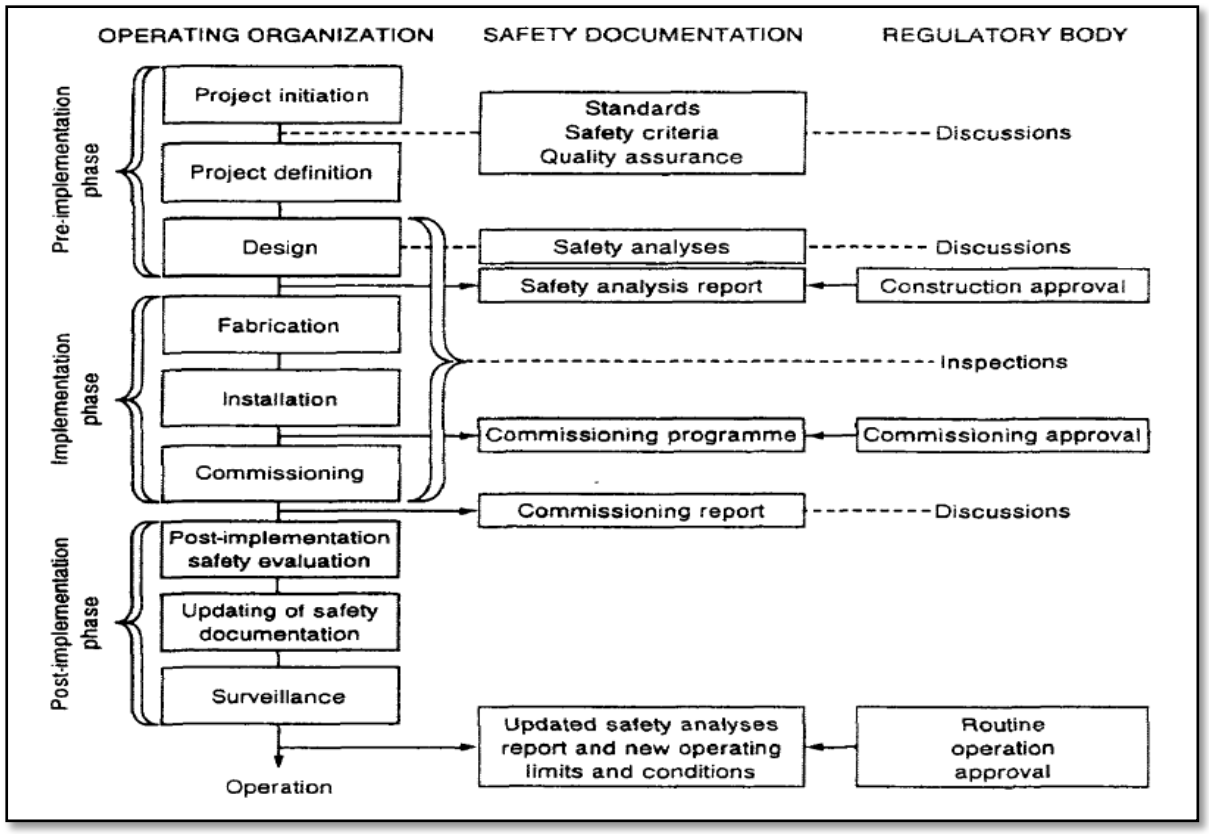

Figure 4. Flow chart indicating interaction between the operating organization and AELB for the approval process of Category A modification projects

Reference is made to Figure x, which indicates the necessary interaction between the operating organization and the AELB during the planning and implementation of Category A modification projects. The operating organization shall inform the AELB on any proposed modification at an early state of the process (at the project definition stage).

The approval process of a modification project shall be performed at different appropriate stages as indicated in Figure 4. The approval of routine operation of a modification project will be based on the results of its commissioning stage. In addition to the approval of routine operation, some modification projects may also require construction and commissioning approval. These projects require hold points during their implementation for regulatory review, assessment and for the approval process. In these cases, the hold points shall be determined by the AELB and discussed with the operating organization during the pre-implementation phase. Some other projects may only require revision of the safety analysis, for example, proposed change to a safety system setting, which normally does not require fabrication, installation or commissioning stages.

Schedule indicating the time-scale for submitting safety documents for regulatory review and assessment shall be determined by the operating organization on a case by case basis and has to be agreed upon by the AELB during the pre-implementation phase of a modification project.

For obtaining a construction approval, the operating organization shall submit to the AELB information which demonstrates that the design of the modification will result in a safe facility and that construction will achieve the design intents. Application for construction approval shall be supported by a revised safety analysis report (or safety analysis report for modification).

For obtaining a commissioning approval, the operating organization shall submit to the AELB information which demonstrates that the modified SSCs were installed according to the design intents and the commissioning programme is designed to check and verify the safety of the modified reactor. Application for commissioning approval shall be supported by a revised safety analysis report for modification that includes all the information indicated above, as amended, and a commissioning programme for modification.

For obtaining the approval for routine operation of a modified reactor, the operating organization shall submit to the AELB all the information indicated above, as amended, as well as the commissioning results including an assessment that the design intents of the modification project have been achieved.

CONCLUSION

It can be seen that the managing RTP upgrading project especially in upgrading the analog research reactor console into digital system is a good practice for the engineers and scientists in Nuclear Malaysia to be one of the TSO team in supporting NPP. To make this RTP upgrading project a success, Nuclear Malaysia surely needs HRD roadmaps as well as strategies on how to implement them. The expected results for this HRD programme is Nuclear Malaysia, especially Reactor Group will be prepared to accept and absorb training in higher technology. The project management team in this project has shown a good success in result as a starting point towards more successful projects in the future.