

SUSTAINING NUCLEAR FUEL SCIENCE AND TECHNOLOGY BASE

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Abstract. According to national energy policy, Indonesia is going to utilize nuclear energy for electricity supply. To sustain the activity of nuclear power plants, the continuity of nuclear fuel supply is an absolute necessity; therefore, it will become industrially prospective. As a nuclear research center and guidance in nuclear energy system in Indonesia, Batan plays a role to promote this prospect. In this point of view, Batan should have the competency especially in nuclear fuel cycle technology, and in this case PTBN is viewed as the competent center since PTBN's main task is to conduct the development of nuclear fuel technology. From the legal point of view, PTBN does not have the mandatory to operate nuclear fuel fabrication commercially. However, PTBN has the capability to prepare competent man power through training and coaching in nuclear fuel fabrication. As a matter of fact, the present condition shows that some of the equipments does not function properly or are not utilized optimally or are not operable. Besides, the process documents available have not yet validated and qualified, and the man power is also not yet qualified. Furthermore, some of the employees who are experienced and knowledgeable in nuclear fuel research are going to retire while they have not trained the junior employees—causing a big gap in skill and experience. Since 2003 PTBN has prepared some programs to solve those problems. Knowledge management system has been implemented implicitly at PTBN, although some obstacles are encountered on tacit knowledge. This may be overcome through on the job training and progressive discussion while the senior personnel are encourage to guide the junior by counseling.

1. Introduction

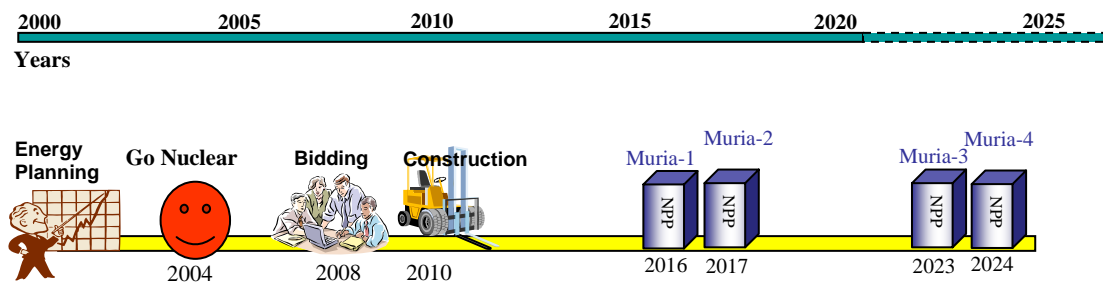
The national development and economic growth of a country can be recognized by its escalating energy demand, and it also the case with Indonesia. In order to fulfill this energy demand, the Indonesian Government has made efforts to optimize the use of various—fossil and non fossil—potential energy resources in synergy (energy mix). Up to 2025, fossil energy such as oil, coal and gas is not anymore dominated by oil, while the utilization of coal and gas will become greater than before [1]. Besides, non-fossil energy resources such as hydro, geothermal, biofuel, biomass, solar, wind and nuclear will play the role of fulfilling energy demand significantly as stated in national energy policy [1, 2].

According to national energy policy, Indonesia is going to utilize nuclear energy for electricity supply, and up to 2025, the use of nuclear energy is projected at about 2% of the total primary energy or 4 to 5% of the national electricity supply. This energy demand is described in NPP road map (picture 1), which consists of NPP preparation, construction and operation up to 2025. Accordingly, services of nuclear fuel will be needed to assure NPP operation as long as its service life time. In order to sustain the activity of nuclear power plants, the continuity of nuclear fuel supply is an absolute necessity. Furthermore, nuclear fuel is of strategic materials that the supply of nuclear fuel must be taken under control. This fact is prospective for national industry to take part in nuclear fuel supplies actively.

For that reason, as a nuclear research center and guidance in nuclear energy system in Indonesia, Batan plays a role to promote this prospect. In this point of view, Batan should have the competency especially in nuclear fuel cycle technology, and in this case PTBN is viewed as the competent center since PTBN's main task is to conduct the development of nuclear fuel technology. Consequently, PTBN should serve as knowledge resource and media for nuclear fuel technology transfer and dissemination to national industry. This competency has been performed in term of mastering its science and technology base. In this case, PTBN

is noticed to have the capability to function suitably since PTBN is equipped with documents for fuel fabrication industry, e.g. bidding, construction and commissioning and qualified man power.

So far, PTBN has conducted its role through joint research and on the job training with vendors or national and international research institutions. However, in carrying out the related activities PTBN encounters many obstacles, for instance, knowledge gap between senior and junior personnel, not well organized documentation system, and equipments ageing. To overcome these problems, it is necessary to establish a comprehensive strategy through systematic, sustainable programs suiting with time, funding capability and the dynamic of its man power.



Picture 1. Road map Indonesian NPP [2].

2. The facts or current status

The strategy establishment should be based on the current status of nuclear fuel development nationally and internationally and also on the current PTBN condition. Generally the trend of nuclear fuel development follows the NPP technology itself with no basic change. Modification of nuclear fuel design is intended only for improving nuclear fuel performance to meet with utility demands (such as operational flexibility and reliability) and for economic consideration. Refurbishing in design is commonly intended to increase fuel durability by solving the main problems of fuel failure such as cladding hydradation, UO_2 pellet densification, pellet cladding interaction, cladding corrosion, grid/rod wear, debris fretting corrosion and swelling. Beside by fuel element design modification, reliability improvement may also be made through the fabrication side especially in quality control. Today, the NPP development has achieved to GEN IV which uses nuclear fuel element more efficiently and safely.

Referring to the technology development as mentioned above, consequently BATAN as a research institution follows the technology trend. In developing nuclear fuel technology, BATAN has a vast experience in research and development of nuclear fuel element since 1976, mainly for PHWR nuclear fuel element and also experience in conversion of enriched UO_2 from UF_6 since 1980s. Other than that BATAN is capable of nuclear fuel fabrication for research reactor. With these experiences, BATAN is considered competent for taking part in nuclear fuel technology development, except for PWR type component preparation. Regarding the later issue, Batan intends to capture the technology of PWR type component preparation since it is not a difficult technology to master and the technology uses general components available in industries. Equipped with experiences and facilities, Batan is prepared with training materials for man power preparation when nuclear fuel fabrication is built and operated in Indonesia while still continuing to serve as technology development means.

From the legal point of view, PTBN does not have the mandatory to operate nuclear fuel fabrication commercially. However, PTBN has the capability to prepare competent man power through training and coaching in the field of nuclear fuel fabrication and serve as knowledge resource in nuclear fuel technology. Beside the PTBN current status of development and experiences, the strategy establishment should also consider the present PTBN condition. The present condition shows that some of the equipments does not function properly or are not yet utilized optimally or are not operable because of ageing, limitation in funding capability and rare components for maintenance and repairs. In addition, the process documents and quality control available have not yet validated and qualified, while output records are also still spread as paper work and not yet organized in more systematic document archives.

Another consideration is the man power condition. At present the competence of man power is organized in levelized degree system. The level of degree indicates competence: from technical to decision maker level and from beginner to expert level. This levelized system characterizes the potential of available man power or the mapping of man power. The present condition shows that the man power's capability is not well distributed at same level and/or there is a decreasing trend in the expert and skilled level because of the increasing personnel approaching retirement age and a big knowledge gap between senior and junior personnel. This condition may be described as a portion of the personnel who are experienced and knowledgeable in nuclear fuel research are going to retire while they have not trained the junior personnel, causing a big gap in skill and experience.

3. The programs on PTBN

With the concern for knowledge transfer and considering the status and condition of PTBN, some programs have been established with underlying vision: PTBN as knowledge resource in nuclear fuel development for domestic level and as partner in technology development at international level. As a result, since 2003 PTBN has established three strategic programs:

1. BATAN, especially PTBN should be capable of playing the role as *center of excellent* in nuclear fuel technology, which is characterized by the mastering its *science and technology base*,
2. Making available of documents for nuclear fuel industry establishment, including quality assurance documents and records as the implementation evidence,
3. Competent man power as knowledge resource in nuclear fuel technology, as R&D technician and staff, and as coach and instructor for educating and training man power for nuclear fuel industry operation.

Those three substantial programs set up targets that must be achieved not in long time and also to be the foundation in the activities planning.

The first target mastering science and technology base (STB) is characterized by PTBN's preparedness for operable and functional equipments. The output or product of PTBN is quantified by the fact that nuclear fuel development cycle functions satisfactorily, and PTBN succeeds in the production of at least one qualified pin of nuclear fuel element in accordance with the established specification, which is proven by pre and post irradiation testing. Furthermore, the qualified production process documents including quality management system are made available. Activities for achieving this target include:

- a) improvement in effectiveness of the equipments and infrastructures required, covering fabrication and post irradiation test facilities.

- b) implementation of integrated quality assurance system such as for the qualification of nuclear fuel pin, for the safety of personnel and the security of facilities and equipments during operation, for test and technology development laboratory, and for environmental aspect.
- c) research and development of nuclear fuel and structure materials.

The second target is regarding documents required by nuclear fuel industry, which are readily available. The major document needed is guidance document for nuclear fuel industry, which is the same as or similar to guidance document for nuclear energy system (NES Guidance) application. Other document needed is the derived level of NES Guidance. This document serves as incentive for industrial enterprise. Such documents are those for non nuclear reactor facility equal to URD for NPP. Other documents that are necessary to be prepared are supporting documents for the construction of nuclear material industry, e.g. pre feasibility study or pre fabrication design including data of environment, economic estimation, capacity design, etc. Activities involved in this document preparation include data and information collection, determination of format and document content, document draft compilation, review, assessment, approval and publication.

The third item concerns with competency of man power as knowledge resource in nuclear fuel technology, competency of R&D staff and technician, and competency of coach or instructor for man power training of personnel who will operate nuclear fuel fabrication. Hence, in this context PTBN functions not only as a center for nuclear fuel research but also as an institution authorized for man power certification.

PTBN's human resources are potential man power and their skill and expertise may be developed by this ongoing program dynamically. Activities for man power program consist of:

1. Qualification of man power through coaching or training and competency testing.
2. Character building for personnel at structural and functional levels through on the job training on matters from R&D formulation program (including programs for operation, maintainance and repair of nuclear facilities, planning, implementation and control). The result of these activities is documented and later to be used as base for decision maker to determine the status of man power competency.
3. Facilitation for man power to participate in nuclear fuel R&D collaboration nationally and internationally including other trainings or scientific events which can enhance their knowledge and skill.

Principally this kind of programs is in accordance with IAEA program, i.e. Nuclear Fuel Cycle and Material Section, the purpose of which is to enhance the capability of member states:

- a) to complete in pile fuel performance and nuclear fuel management, and
- b) to develop advanced nuclear fuel technology in order to assure the economic of nuclear fuel cycle reliability and efficiency

The stated program by IAEA could be an opportunity for PTBN to enhance its man power competency. The program has shown positive progress such as the implementation of revitalization for several equipments, testing laboratory accreditation, preparation for calibration laboratory accreditation, operator coaching, nuclear fuel research development, active participation in INPRO and the implementation of total quality management system in accordance with IAEA code and guidance.

The programs of PTBN described above implies that there is an effort to preserve or sustain, enrich and enhance, disseminate and apply the knowledge in nuclear fuel technology in harmony with Indonesia's nuclear energy program and also to participate in nuclear fuel R&D at international level. We consider this effort as knowledge management system and learning organization for us to be capable of continuous knowledge development with environmental concern. The implementation of this system requires man power with pioneer attitude, scientific culture, and industrially oriented with safety and communication concern. This issue was in fact stated in 1980 when nuclear facilities in Serpong were constructed; however, this attitude has been degrading with time. Therefore, in order to achieve and to enact the programs, this attitude must be promoted insistently again because this attitude has not yet been transferred from the senior to the junior culturally altogether with the tacit knowledge.

4. Summary

The competency is performed in term of mastering its science and technology base. In this case, PTBN is noticed to have the capability to function suitably since PTBN is equipped with documents for fuel fabrication industry such as bidding, construction and commissioning and qualified man power.

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In fact knowledge management system has been implemented implicitly at PTBN, although some obstacles are encountered on tacit knowledge. This may be overcome through on the job training and progressive discussion while the senior personnel are encourage to guide the junior by counseling.

REFERENCES

- [1] ENERGY AND MINERAL RESOURCES DEPARTMENT, Blue Print: National Energy Management 2005-2025, <http://www.esdm.go.id>
- [2] LANGENATI, Ratih, et al., Preparatory Program for The Establishment of Nuclear Fuel Fabrication Facility to Sustain Nuclear Power Plants Development in Indonesia, Proceedings Series, BATAN, Malang (2006).
- [3] ACT NUMBER 10 Year 1997 on Nuclear Energy.
- [4] HERUTOMO, Bambang, Nuclear Fuel Element, Training on NPP Safety, PUSDIKLAT-BATAN, 2006.
- [5] INTERNATIONAL ATOMIC ENERGY AGENCY, Managing Nuclear Knowledge: Strategies and Human Resources Development, Proceedings Series, IAEA, Vienna (2006).