

## Reference Training System and Program for the Countries Introducing Nuclear Power

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### 1. Introduction

There is a wide range of infrastructural issues that need to be considered in introducing a nuclear power program. IAEA has reported 19 issues for the national infrastructure development of nuclear power program. [1]. Human resources development is considered as one of the important issues. This means that a country should establish a training system and program in its early stage of the national nuclear energy development program [2].

The purpose of this paper is to suggest, based on the Korean experiences, a framework of the process of human resources development and required training system and program for the countries commencing their first nuclear power program.

### 2. Process of Human Resources Development (HRD)

HRD begins with identification of the strategic objectives and targets. The following are the suggested Government policy targets for HRD [3]: (1) young students at nuclear engineering related universities; (2) expected NPP operational personnel (operators, maintenance crews, mechanical, electrical, I & C, chemical, fuel handling, QA and QC, safety, and health physics engineering staff); (3) design and manufacturing personnel; (4) regulatory personnel (assessment, license, and inspection); (5) research and development personnel.

These engineers are usually recruited from graduates of universities. They are further trained at the training center after employment in the nuclear sector, and are encouraged to attend various technical training courses, seminars and symposia. Technical manpower who has been engaged in engineering work for more than 5 years after university graduation could be considered as a middle-level engineer. Many leading Korean industries started in their beginning stage to send their technical staff abroad for training, dispatched them to local universities for advanced degrees, or send them to training centers for retraining.

High-level engineers in Korea are cultivated by retraining of middle-level engineers, their active participation in engineering work and services for more than 15 years after university graduation, education at local universities for advanced degrees, and retrained for specific topics in foreign countries. In addition, a considerable number of scientists and engineers who have been educated abroad are recruited by the domestic nuclear community, so as to enforce the high-level technical manpower groups [4]. Figure 1 shows a

process of human resources development in Korea which was especially focused on cultivation of professionals needed for the national nuclear energy development.

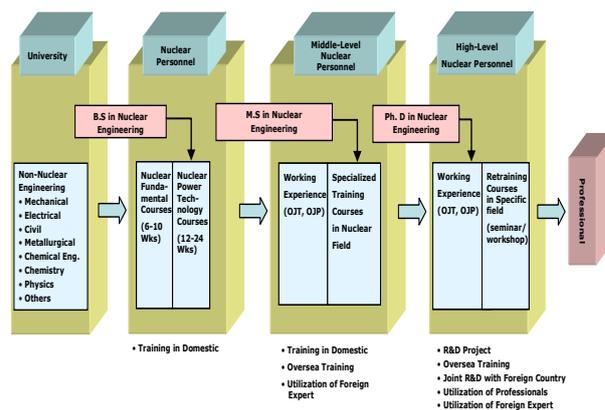


Figure 1. Process of Education and Training

### 3. Training System and Program for Nuclear Power

#### 3.1 Training for Project Management, Engineering, Procurement, QA/QC Personnel

All who are involved in these activities need the following training with experiences of similar pre-project, project management, engineering, procurement, QA/QC [5]:

- A basic course in nuclear power (6 months) or specialized courses in nuclear power technology (6 months to 1 year);
- A course on design concept and basic nuclear engineering;
- A specialized course on planning and implementation of nuclear power project;
- A specialized course on safety analysis review;
- A specialized course on quality assurance and quality control;
- On-the-job training course on design and engineering of nuclear power project.

#### 3.2 Training for Manufacturing of Equipment and Components Personnel

The following training program would be able to upgrade their qualifications gained from conventional engineering and technical areas [5]:

- Quality assurance and quality control;
- Codes and standards;
- Inspection and testing techniques (NDT, etc.);
- Electrical and mechanical systems and components;
- Metallurgy and properties of metals;
- Welding;
- Electrical and mechanical equipment layout;
- Instrumentation and cabling layout;
- Others.

### 3.3 Training for Plant Operation and Maintenance Personnel

The training of operators and maintenance crew is the most important part of human resources development for the nuclear power project due to the facts that training of plant operation personnel is directly related to the safe and reliable operation of nuclear power plants. Figure 2 shows an example of training areas for overall plant operational personnel, which include classroom training, laboratory, workshops, simulator and on-the-job training. The training of operation and maintenance for the country commencing the first nuclear power project was eventually implemented in a supply country with contract base [6].

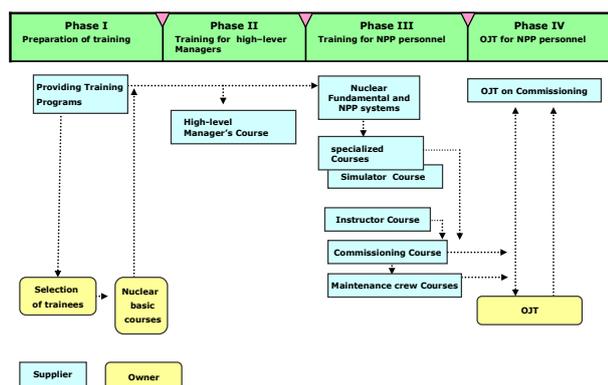


Fig 2. Expected Training System for Plant Operation and Maintenance

### 3.4 Training for Regulation and Licensing Personnel

The regulatory process involves many activities related to safety review and inspection of nuclear power plants, as well as, of rules and regulations based on the national regulatory philosophy. Developing countries, in particular, usually have difficulties in training of regulatory staff members because there are no activities for a nuclear power project. A training program for the regulatory staff could be categorized into three steps, such as fundamental training, advanced training and on-the-job training. An example of training programs for the regulatory body staff for the orientation of nuclear regulatory guidelines and license to be implemented in the supplier's country is given as follows [7]:

- Nuclear safety regulation;
- Overview of nuclear power plant system;

- Safety analysis review;
- Nuclear power plant quality assurance;
- Radiation protection and radioactive waste management;
- Environmental impact assessment;
- QA inspection of manufacture;
- Pre-operational inspection (installation);
- QA manual review and inspection;
- Resident's inspection;
- Pre-operational inspection (start-up test);
- Periodic inspection.

## 4. Conclusions

A suggestion is made regarding a training system framework which could serve as a reference to the human resource development in countries commencing their first nuclear power program. The framework covers a human resources development (HRD) process in terms of different level of target manpower groups, as well as, training systems and programs for the areas of project management, equipment manufacturing, plant operation and regulation.

There are two important groups for the nuclear human resources development. The first group is the manpower responsible for the planning and coordination of nuclear human resources development. The second group is the manpower responsible for implementation of nuclear human resources development program, i.e., instructors or trainers. The government-level organization responsible for the first nuclear power projects is recommended to focus on the development of these two groups as early as possible.

## REFERENCES

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