NUCLEAR TECHNOLOGY AND NATIONAL PARTICIPATION

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ABSTRACT

The evolution from the initial turnkey approach into a split-package and eventually into a multiple-package approach requires a firm long-term policy for the nuclear program together with careful planning and realistic assessment. Definition of the possible areas and the extent for the national participation is a critical determining factor for the implementation of the program.

In this study; importance of a throughout survey with its elementary methods and objectives is presented. Extent of national participation together with its evolutionary aspects investigated through analysis of some countries’ experiences and IAEA guides. The beneficial effects of national participation in a nuclear power program is underlined.

1. SURVEY OF NATIONAL INDUSTRY

The assessment of the existing capabilities is fundamental since it is the groundwork on which the modifications and additions will have to be made. It is necessary to perform a throughout survey of the national industries. Realistic assessment of present and potential capabilities of national industries will constitute the extent of the national participation program.

The survey of national industrial capacity is a local effort and should be performed by a local group of official, commercial and industrial organisations. The assistance of an experienced foreign nuclear consultant firm can be useful. Cooperation with IAEA via expert missions will help the survey become more realistic. The investigation of the nuclear technological evolution of some countries will help the planners benefit from the results of the survey.

The main objective of the survey is to assess the present and potential capabilities of the national industries. The survey must be based on a realistic assessment of the effective existing capacity and should start with the identification of national industries whose are potential constituents of the nuclear power program.

The methodology of a national survey could consist of following;

- Component based listing of the nuclear power project
- Definition of the key design features and relevant standards for each component
- Identification and classification of present and potential manufacturers for each component
- Definition of the present and prospective capabilities of each firm inspected
- Identification of deficiencies in the national industry
- Assessment and Implementation of the remedial and promotional actions
Components can be classified according to their quality class, special testing requirements, delivery time and cost order of magnitude. It is advisable to make another important classification respecting each component’s relevance to nuclear safety, plant reliability, plant maintenance, cost, provenness and any other important parameter.

An integral part of the survey should be a cost / benefit basis evaluation of required investments for the development of technology.

An important result that should be derived from the survey is the identification of deficiencies in the industry which will suggest convenient remedial actions to improve the program.

Results of the survey will determine the extent of the national participation. The survey will generate important information regarding the strategy of national participation.

In order to motivate participation of domestic industry and to guarantee a positive and efficient evolution of the national participation, planners should take promotional actions. Some promotive actions can be outlined as follows;

- Establishing a plan of nuclear power plant program
- Performing periodic analysis of local industrial potential
- Supporting potential domestic suppliers that have the basic capability for manufacturing but requiring some additional equipment and technological know-how
- Transferring technical knowledge of complex equipment through technical assistance and technology transfer agreements from experienced technology suppliers.

The study has to be reviewed and revised constantly, taking into account the development of local industry as well as the evolution of technology.

2. EXTENT AND EVOLUTIONARY ASPECTS OF NATIONAL PARTICIPATION

There is a minimum level of nuclear know-how, material and experienced personnel that the country must have available in order to execute the project efficiently and safely. These levels of activities are called 'essential' activities to enforce the nuclear power project. National energy supply, electric power system, nuclear power program planning, legal and organisational framework, manpower development, safeguards and physical protection, public relations and information are some of the essential activities for the feasible execution of the project.

National participation could be expanded into many other areas of activities such as detailed design engineering, safety analysis, component and systems testing and manufacturing of some components with careful implementation of a realistic program.

Non-nuclear constituents represent an extensive part of the NPP. These materials and equipment production capabilities are found in a wide range of conventional applications. General classification of the types of equipment used in an NPP is presented in Table 1.

The first objectives to attain in the introduction of nuclear technology are those activities that are labour intensive and not too specific to nuclear power. The production of those materials and components that are not too demanding in quality would be the initial parts of the national participation program. Instead of concentrating on development of capabilities with limited and
unique applicability; whatever can be readily converted and lucratively transferred to other sectors should be encouraged. Table 2 illustrates a qualitative estimation with respect to the technical difficulty of and required investments for the manufacturing of some NPP components whose local manufacture may be considered.

Japan has 52 nuclear power units having the share of 37 % in overall electricity generation. The plants of which construction started in 1980 and after are all of the Japanese standard designs. Introduced with the nuclear technology from abroad, Japan has become a nuclear technology exporting country by means of a realistic long term program. Table 3 shows development stages of Japanese Nuclear Power Program.

Only a long term nuclear power program can justify the sizeable effort needed to plan and implement the national infrastructure development and the supporting organisational structures and activities. Having a long term realistic nuclear power program, Korea has improved its national nuclear capabilities in many respects. Korean experience of national participation in nuclear technology is summarised in Table 4. Another example respecting the role of national participation can be encountered for Spain. Increasing share of domestic participation in Spain and the improvement in the national activities for each development stage are figured out in Table 5.

There are technical and economical limitations that should be considered carefully during the implementation of the programme. The limitations which will shape the extent of the program are outlined in Table 6.

Local participation should be supported with proven experience, otherwise it is unavoidable to face with risks in terms of schedule delays, poor performance and cost overruns. Risks originating from strict requirements regarding quality, reliability and manufacture on schedule should be considered carefully. Deficiencies in quality and reliability reduce the availability of power plant and result in a higher unit cost of electricity generation. Interest in national participation should never be allowed to supersede the safety requirements.

Planners should consider evolutionary aspects of local involvement. Guideline prepared by IAEA lists a series of progressive levels. Each of the levels listed below could be achieved with increasing experience and involvement together with a long-term realistic nuclear power program.

- **Level I.**
  Local labour and some construction materials
  On-site, non-specialised purposes
  Civil engineering work

- **Level II.**
  Local contracting firms
  Civil work with full or partial responsibility
  Some design work
• **Level III.**
Locally manufactured components
Non-critical parts of BOP
• **Level IV.**
Locally manufactured components
Incorporation with nuclear designs and standards
• **Level V.**
Special factories
Manufacture of heavy and specialised nuclear components

With each successive NPP built, the level of local expertise increases.

Increasing local participation in the nuclear program will improve industrial competitiveness and the country’s self-sufficiency.

More local participation will also have the following beneficial effects;

• Limit the need for foreign loans
• Raise the national engineering capability
• Increase local employment and enforce qualification of manpower capabilities

3. CONCLUSIONS

Electricity generation is the primary objective of a nuclear power program. However, the implementation of a nuclear power project includes national participation with at least a certain amount of essential activities.

From the very beginning of the nuclear program, importance of national participation must be fully appreciated, current and potential capabilities of the country must be clearly identified. This requires a comprehensive survey of the national infrastructure to assess those sectors of the nuclear program where outside dependency can be reduced and self-sufficiency eventually attained.

Only a long term nuclear power program can justify the sizeable effort needed to plan and implement the national infrastructure development and the supporting organisational structures and activities.

National participation requires great care in the definition of objectives as well as the definition of plan of action together with careful monitoring.

A carefully implemented national participation program, reduces the foreign exchange content of the overall costs of the plant, provides employment to local people, gradually upgrades the quality of the industry and the last but not the least, improves country’s self sufficiency.

REFERENCES:

3. RODRIGUEZ, A. Garcia, EA, Spain, *Transfer of Technology*


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**Table 1. The types of equipment used in an NPP**

<table>
<thead>
<tr>
<th>Mechanical Equipment</th>
<th>Fabricated Equipment</th>
<th>Electrical Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fabrication basically requires casting, forging, machining etc e.g pumps, valves, compressors</td>
<td>Production mainly requires bending, forming, welding, etc e.g tanks, heat exchangers, vessels, filters</td>
<td>e.g motors, transformers, control systems, relays, instruments</td>
</tr>
</tbody>
</table>

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**Table 2. Some of Components used in an NPP**

<table>
<thead>
<tr>
<th>COMPONENTS</th>
<th>Specific to NPP</th>
<th>Number per unit</th>
<th>Limited</th>
<th>Medium</th>
<th>High</th>
<th>Very High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switchgears</td>
<td>NO</td>
<td>~2100</td>
<td>♦</td>
<td>♦</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat Exchangers</td>
<td>FEW</td>
<td>~350</td>
<td>♦</td>
<td>♦</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary Pumps - Nuclear</td>
<td>YES</td>
<td>~70</td>
<td></td>
<td>♦</td>
<td>♦</td>
<td></td>
</tr>
<tr>
<td>Auxiliary Pumps - Non-Nuclear</td>
<td>NO</td>
<td>~250</td>
<td></td>
<td>♦</td>
<td>♦</td>
<td></td>
</tr>
<tr>
<td>Valves - Nuclear</td>
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<td>~1150</td>
<td></td>
<td>♦</td>
<td>♦</td>
<td></td>
</tr>
<tr>
<td>Valves - Nuclear and Special</td>
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<td>~150</td>
<td></td>
<td>♦</td>
<td>♦</td>
<td></td>
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<tr>
<td>Valves - Non-Nuclear</td>
<td>NO</td>
<td>~10000</td>
<td></td>
<td>♦</td>
<td>♦</td>
<td></td>
</tr>
<tr>
<td>Heat Exchangers</td>
<td>FEW</td>
<td>~350</td>
<td></td>
<td>♦</td>
<td>♦</td>
<td></td>
</tr>
<tr>
<td>Transformers</td>
<td>NO</td>
<td>Several</td>
<td></td>
<td>♦</td>
<td>♦</td>
<td></td>
</tr>
<tr>
<td>MV Motors</td>
<td>NO</td>
<td>~1000</td>
<td></td>
<td>♦</td>
<td>♦</td>
<td></td>
</tr>
<tr>
<td>Tanks</td>
<td>FEW</td>
<td>~300</td>
<td>♦</td>
<td>♦</td>
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</table>

♦ Technical Difficulty
♦ Required Investment
### Table 3. Development of Japanese Nuclear Technology

<table>
<thead>
<tr>
<th>Stages</th>
<th>Activities</th>
</tr>
</thead>
</table>
| **Introduction & Learning** | • Foreign main contractor  
• National Industry as subcontractors in the supply of equipment and field installation works  
• Development of governmental and private infrastructure systems, a variety of institutions, laws and technical standards |
| **Transition & Assimilation** | • National industry as subcontractors with regard to NSSS  
• National industry as direct contractors for BOP  
• Accumulation of experience in the application of technology and development of manpower |
| **Development**             | • National Industry as the main contractor  
• Enhancement of technology by national efforts |

### Table 4. Korean Experience of National Participation in Nuclear Technology

<table>
<thead>
<tr>
<th>Stages</th>
<th>Activities</th>
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</table>
| **Total Dependence and Imitation Period** | • Construction of 3 units  
• Turnkey with foreign suppliers  
• Acquisition of the basics of nuclear technology  
• Identification of available activities to be localised |
| **Self-Reliance Preparation Period** | • Construction of 6 units  
• Construction Project Management with local efforts  
• National suppliers as subcontractors for detailed design in BOP, site design, procurement for BOP equipment  
• Gradual increase in local participation |
| **Self-Reliance Promotion Period**   | • Construction of 3 units  
• Component based projects led by national firms  
• Technology transfer and joint design contracts with foreign suppliers |
| **Self-Reliant Period**              | • Construction of 4 units*  
• Overall responsible taken by local suppliers in all aspects of project management  
• Reduction in the share of foreign suppliers ** |

* 2 of the units are Korean Standard NPP  
** Role of foreign suppliers is reduced to a limited consulting with successful implementation of a technology self-reliance program during previous stages.
Table 5. Development Stages of Spanish Nuclear Program

<table>
<thead>
<tr>
<th>Phases</th>
<th>Activities</th>
<th>Share of domestic participation</th>
</tr>
</thead>
</table>
| 1<sup>st</sup> Stage | • Construction of 3 units  
• Turnkey approach  
• Accumulation of certain experience* | 40 % |
| 2<sup>nd</sup> Stage | • Construction of 7 units  
• Introduction/Updating of standards favouring the increase of national participation**  
• Direct Project Management Approach instead of turnkey approach | 70 % |
| 3<sup>rd</sup> Stage | • Construction of 7 units  
• Continuous implementation of a realistic and steady national participation program  
• Acquisition of technical experience, know-how  
• Beneficial spin-off effects on local industry | 85 % |

* This offered a better general approach to the 2<sup>nd</sup> phase of the program.
** The government made use of its possibilities directly, established certain standards governing the actions and promoted the industrial infrastructure. Intensive process of technology transfer took place in this stage.

Table 6. Limitations for expansion of national participation program

<table>
<thead>
<tr>
<th>Financial and Economic Limitations</th>
<th>Technical Limitations</th>
</tr>
</thead>
</table>
| • Availability of funds for expanding the facilities in order to gain new technologies  
• Adequacy of the market size to justify the investments required  
• Cost competitiveness of the items on the international market | • Ability to meet delivery schedule  
• Ability to meet stringent quality requirements  
• Availability of relevant technology and know-how  
• Availability of qualified manpower |