

# Localization of Manufacturing Capabilities in Setting Up Nuclear Power Plants

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**Abstract.** Nuclear renaissance is now imminent and is inevitable in view of rapidly increasing global warming concerns. A steep shift towards environmentally benign sources of energy remains an unavoidable choice as continents are warming up pushing seas into human habitation and disturbing global ecology. Accordingly, Indian government in its integrated energy policy document has planned for raising nuclear power capacity to generate 63 GWe by 2030. This envisages estimated investments of US\$22 billion in the next 15 to 20 years.

Setting up of nuclear energy generation capacity, however, remains a painstakingly slow process primarily due to complex, multidisciplinary efforts required to crank up a reactor. A robust supply chain remains key to expediting this process. In the light of this, it is critically important to ensure supply-chain for materials and components and putting in place cost effective project management to complete the projects on time and within the budgets. In this context, the participation of industries and their preparedness to meet the challenges are necessary. This would also require investments towards up gradation of manufacturing technology, training of manpower and mobilization of resources at the construction site. The industry would also need to enhance detailing and design engineering capabilities for the plants. It is only when such capabilities have been brought up that the possibilities of time-bound setting up of nuclear plants can be realized. In this paper, various issues with regard to project cost, regulatory and licensing, technology and gestation period etc for new build plants relevant to manufacturing industry are discussed. The plans for enhancing manufacturing capabilities for the critical path items of the project schedule with viable business, ensuring returns to stakeholders and financing and investment cycle are brought out. The various steps and initiatives being taken by Bharat Forge Ltd, the flagship company of Kalyani group for supply of forgings for nuclear reactor, vessels, steam generators, turbine generators and other safety critical components including pumps, valves, pipes and tubes, and other integration work for the balance of plant are summarized. In close association with its sister concerns like Kalyani Carpenter special Steels, the challenges to manufacture critical pieces of metal with advanced materials and alloys are being addressed. The paper would briefly touch upon these efforts on advanced materials and alloys. The company has planned significant investments for setting up an integrated manufacturing facility to clear the global bottleneck in the supply of ultra-heavy forgings for not only for light water reactors but also for a variety of other applications like conventional island rotors, shafts, etc. Bharat Forge is also setting up a dedicated steel plant and a large foundry to address the requirements of cast pieces, casings and the like in nuclear and conventional islands. The overall effort of the Group is to develop in-house capabilities for meeting most component specific requirement of nuclear power plants.

Civil structuring involves execution by prior qualification with proven skills for specialized civil works needed in the construction of nuclear plants. Another group company is also gearing up to enhance its capabilities to undertake construction projects and execute EPC contracts. This company is also in dialogue with a number of nuclear design and engineering outfits of the world to sew up formidable combination of design, engineering, construction and execution strengths.

In the context of Indian Nuclear Power Program, the various initiatives taken for overall human resource development to meet the demands requiring skills in high end technology manufacturing and project management are included. Kalyani Group's trans-continental efforts to join hands with various educational and training institutions to create and replicate world-class talent pool are part of this paper.

## 1. INTRODUCTION

The nuclear power development is under renaissance after about 20 years of stagnation. Due to increasing realisation of effects of green house gases causing global warming, the adoption and renewal of accelerated development of nuclear power capacity is an obvious inevitable among other renewable energy options to be pursued.

Currently there are around 436 nuclear power reactors operating in 30 countries plus Taiwan. In 2007 they provided about 15 percent of the world's electricity. Nuclear power capacity worldwide is increasing steadily. Most reactors on order or planned are in the Asian region, though plans are firming for new units in Europe, the United States and Russia.

As of April 09 , 110 nuclear reactors are planned and another 272 have been proposed. As per nuclear energy outlook the projections of contribution in low case scenarios is 372 to 580 Gwe and 1400 Gwe in high case scenario , in 2050. This would mean about 40-50 units / year in 2030 to 50-60 / year in 2050.

India has 17 reactors under operation and has plans to reach 20000MW by 2020 and to 63000MW by 2030. Prime minister of India has announced in the recent inaugural address at the international conference on peaceful uses of Atomic Energy “ India's three stage strategy could yield potentially 470,000 MW of power by 2050”This offers a huge business opportunity for all facets of nuclear power technology.

In the above the key challenges are mobilising adequate infrastructure , technology adoption to ensure self reliance , human resources and investments. It is therefore prudent that indian industry capabilities are augmented for manufacturing and supply of materials for large/heavy safety critical items for reactors . The case in point is to clear the major bottle neck for ultra heavy forgings for reactor vessels and inconel tubes for steam generators . Additionally industry have to prepare itself to take up work involving several technologies and stringent quality standards. The knowledge of metals,metallurgy and joining processes is crucial in these domain as part supplier in the supply chain of materials and components.

The associated need is the challenge to maintain low cost for ensuring viable competitive and affordable tariff. Larger extent of localisation is needed for optimizing the cost and schedule .

## **2. NUCLEAR POWER IN INDIA**

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India follows closed end fuel cycle to sustain development of nuclear energy and effective utilisation limited uranium resources ,to fuel second stage FBRs and utilise abundant resources of Thorium , as its three stage nuclear power reactors development programme for self reliance and energy security.

## **3. IMPORT OF REACTORS**

The various types of reactors under consideration for import are:

- PHWR (CANDU,Indian)
- PWR(EPR,AP1000,VVER1000-Areva,Westinghouse&Russian designs respectively)
- BWR ( General electric, USA )

Most of the supplies for new plants will come from a range of international suppliers, with the major vendor companies focused on design, engineering and project management stages. Apart from obvious economic advantages in concentrating the production of key components in a limited number of centres, there is also a justifiable demand to maximise local supply. This can mean a high level of technology transfer, clearly important for gaining orders. Westinghouse's readiness to transfer the technology for its AP1000 to China was apparently a major factor in its selection.

Meeting this ambitious new build programme, poses challenges to adopt technology of 3<sup>rd</sup> generation nuclear reactors to be imported and put in place progressive indigenization in manufacturing, constuction and operations and manpower training and development.

#### **4. LOCALIZATION IN THE MANUFACTURING AND PROJECT CONSTRUCTION MANAGEMENT**

This is being followed as a priority issue in this direction by the enterprises interested in this business space.

India has followed this strategy while building pressurised heavy water reactors and industry had risen to this and has adequately mastered the technology needed for these types of reactors. The track record of the performance has been commendable with major parameters of operation characteristics better than the global average. This trend has to be encouraged to create enabling environment for absorbing and adopting foreign advanced technologies. This approach is believed to offer competitive advantage to international players intending to build reactors in India.

#### **5. LOCALIZATION THROUGH TECHNOLOGY TRANSFER**

The foreign bidders prefer to introduce initial NPPs on a turnkey basis and to restrict domestic roles to non-safety related areas such as civil engineering and construction work with the supervision of the foreign contractors. This has to be complemented through on the Job training and on the Job Participation under the direction of foreign suppliers.

On the basis of above learning experience, localization plan is generally put in place / evolved.

The next units in the plant site may be taken up on non turn key basis as contracts. This step is also to be pursued in close collaboration with foreign vendors for the development of standardized processes till the technology is digested and quality demands for nuclear class work are established.

##### ***5.1. Following contributions are derived through localization***

- Saving foreign currency
- Increase in capacity factor and reduction in gestation period for timely supply of spare components, from localized suppliers.
- Quality management culture to local suppliers. This additionally offers a strong driving force to improve the quality of both nuclear and non-nuclear products & competitiveness.
- This benefit of nuclear power technology transfer is also propagated into other industrial sectors including steel-making, ship-building as well as heavy equipment manufacturing.
- For the new entrants or also those who are in the process of adopting and scaling up manufacturing capacities as per improved and latest machineries and technology, can not evolve competitively in isolation until tailored to safety, quality, regulatory international standards and rules

#### **6. NEED FOR INTERNATIONAL COLLABORATION**

Close international collaboration and study of world technology and safeguards are among the important activities in the technology adoption of new build nuclear plants.

The key organizations in advanced countries must be collaborated and associated to collect information and policies and to finalize plans for NPP developments. The encompasses major issues including the current state of technology development, the economic efficiency, the know-how, in design/analysis and the construction and operation activities of NPPs, and the process of site selection, fuel cycle policy, strategy of securing nuclear fuel, and financing options etc.

## **7. LEARNING BY PARTICIPATING**

It is a recommended strategy for helping domestic industry to accumulate experiences by strictly-controlled participation. Localization essentially does not mean every item is made indigenously, but sufficient capability must be created to ensure self reliance and minimize dependence on imports. The extent of foreign sourcing cannot be eliminated and is neither intended.

## **8. LOCALIZATIONS IN CONSTRUCTION ACTIVITIES**

The localization in the process of the successful construction activities requires excellent skills for concrete handling in order to guarantee radiation protection and structural integrity. Association with foreign vendors is recommended to further upgrade the construction methodologies and deployment of high lift cranes & mechanized tackles.

## **9. MANUFACTURE OF FOREIGNERS FOR NUCLEAR PLANTS**

Availability of heavy forgings is a major constraint in the supply chain to the manufacturers of nuclear power plant components and generally so in oil & gas , petrochemical and others involed in the energy sector.

To reduce the bottle neck in the supply chain of the main crtical path of long delivery NSSS components globally industry is gearing up by capacity addition.

Globally many companies have planned investments to add capacities for heavy forgings needed for nuclear plants.

This has been generally justified in view of following advantages:

Forging presses to make parts for nuclear reactors can and also cater to other industries.

The requirements for nuclear are unusual in terms of size and also in terms of the highest most exacting quality standards. Forging plants that currently carry the ASME N- stamp accreditation are limited & hence this offers business opportunities.

The capacity additions to cater to nuclear industry will also benefit for the turbine, pressure vessel, and oil and gas markets which occasionally have the need for large forgings.

The minimum requirement for making the largest reactor components is a 15,000 ton press taking to build the pressure vessel closure head and turbine parts as integral single products needing steel ingots of 500-600 tons.

Presently, only Japan Steel Works are approved to make these parts, and JSW claim to have 80% of the world market for large nuclear forgings.

China First Heavy Industries (CFHI) have the largest forging press at 15,000 tons commissioned in 2006 and is investing a further to raise production to 240,000 tons per year.

Both CFHI and Harbin Boiler Co have extensive experience domestically and the required international approvals to start bidding for work under license from Westinghouse and Mitsubishi.

Russia's main reactor component supplier, OMZ's Komplekt-Atom-Izhora, is doubling the production of large forgings so as to be able to manufacture three or four pressure vessels per year from 2011.

Doosan Heavy Industries is currently undertaking a major investment in casting and forging capacity, including a 17,000 ton forging press which will come on line in about 2010.

Areva has also partnered with Bharat Forge Limited, a major forging company in India to form a JV for integrated manufacturing facilities for ultra heavy forgings and components for nuclear plants

## **10. BHARAT FORGE FORAY IN NON-AUTOMOTIVE SECTOR**

The company is diversifying to capture opportunities in energy sector which emerges from the national objective to sustain 7-8% economic growth. The company has planned to leverage the company's strength in material science and metals & engineering steel and forgings in auto sector. The company has global presence. To move forward in this space of business with the emerging growth in energy sector particularly under nuclear renaissance the company has taken proactive actions to expand its capacities.

For the manufacture of heavy forgings a 4000 T press is commissioned which can forge upto 70T ingots to produce long and hollow products. A 80MT counter blow hammer and also a ring rolling mill suitable for 4.5 m dia and 500mm length is commissioned. Company has also entered into JV partnership with state owned power sector company [NTPC] to manufacture high pressure piping ,pumps ,valves related forgings for fossil and supply to other power projects.

Another JV company with ALSTOM is targeted to manufacture sub critical and super critical turbine generators in 300-800 MW range for coal based power plants and gradually adding capabilities for supply to gas and nuclear power plants. Discussions in this direction are affirmatively progressing .The JV company will also manufacture and supply range of heat exchangers, condensers , deaerators and plant auxiliary .The plants are planned at port based location.

To this end Bharat Forge Ltd and Areva are in dialogue for entering into jointventure cooperation to set up integrated manufacturing [ steel melting, forging , machining and fabrication , assembly of finished components] facility at water front coastal location.The company will instal a 12/14,000T open die press to forge upto 500MT ingots with associated state of the art steel making, machining , fabrication ,inspection and testing facilities in comprehensive manner to meet quality needed for nuclear plants.The facility will have a casting bay to manufacture heavy castings .It will be equipped with horizontal and vertical heat treatment , rough and finish machining , state of the art inspection and testing and assembly shops.

This integrated facility will have 125 T, Electric arc furnace with VD/VCD.

The primary focus is to meet the indigenous requirements and also exports for supply to civilian nuclear power reactors .The items will include reactor pressure vessels, steam, generators pressurizers and stainless steels for reactor internals etc.

## **11. FORAY IN EPC & CIVIL CONSTRUCTION**

For the construction of nuclear power plants, civil structuring involves execution by prior qualification with proven skills for specialized civil works needed. Another Kalyani group company is also gearing up to enhance its capabilities to undertake construction projects and execute EPC contracts. The company is also in dialogue with a number of nuclear design and engineering outfits of the world to sew up formidable combination of design, engineering, construction and execution strengths.

## **12. TRAINING OF MANPOWER**

India has one of the largest talent pools across all age groups in the world.For the Nuclear sector needs, unique training modalities to imbibe Nuclear work culture. This demands very high standards

of in-built Quality, Reliability, Safety and Process Control since a very limited access for inspection and maintenance of components becomes available due to dose uptake concerns. This therefore makes it prudent to create quality assurance discipline to be inculcated, in addition to high standards of technical skills. The manufacturing process control, documentation, daily production mock ups has to be way of life for Engineers, Technicians, Quality Surveyors, Plant Operators and construction workmen alike. In this context it is imperative to continuously train large talent pool.

As per estimates about 300,000 both skilled & unskilled work-force is required to accomplish India's ambition in power industry. It is thus necessary to put in place a systematic training centralized agency to train the talent pool to cater to the need of industries working on nuclear program.

Talent will be required in all categories alike. Some of the proposed steps to address the constraints are:

- Hiring retired trainers / experts from industry.
- Adopting few Industrial Training Institutes (ITIs) across the country in different regions. Industry to use the infrastructure of these as it is and hire the trainers.
- Customize the curriculum of different trades to develop Nuclear workmanship skills. Industry will contribute the incremental costs for operating these facilities to make ITIs as "Centers of Excellence" for Indian Nuclear Program.
- In first phase, training will be focused to impart the basic skills in technical trades such as Welder, Fitter, Machinist etc. Even within welding trade in first phase basic skills in simple welding processes of SMAW, GTAW & SAW will be imparted.
- In the second phase, the special advanced needs of specific industries for high-end machines like Orbital & other programmable automatic welding etc. will be taken up as industry sponsored projects.
  
- Such projects will require additional funds for specialized welding machines & expert trainers. As these projects require longer lead times and will not be required by general industry.

### **13. CONCLUSIONS**

Government policy to facilitate localization is a very essential element for ensuring the national objective of achieving self reliance, viability of investments for such projects.

Industry has to take proactive initiatives to develop human resources immediately to meet the ambitious plan for nuclear power growth in India.

The initiatives being taken by Bharat Forge a flagship company of Kalyani group will facilitate localization in the nuclear power space by addressing the major constraints in the supply chain for building nuclear light water reactors.

The plans are to establish facilities equipped for manufacture of forgings and finished safety critical components for nuclear steam supply system components and also for turbine, generators etc. The company is also gearing up for undertaking turnkey EPC contracts for new build nuclear plants.