Nuclear Power Project Management - Indian Scenario

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1.1 Abstract

Nuclear Power Corporation of India Limited (NPCIL), a Govt. of India Enterprises is responsible for the safe, reliable and economic construction, commissioning and operation of Nuclear Power Plants (NPPs) in India. Nuclear Power Plants are capital intensive, technology driven and constantly dictated by the evolving nuclear safety requirements and hence are vulnerable to steep cost escalation and time over run.

This paper deals with the Project Management capabilities of NPCIL, in the construction of NPPs within the scheduled time and budget satisfying all statutory and regulatory norms and expectations of various stakeholders.

The construction of NPP involves activities of civil construction, mechanical and electrical erection, process and instrumentation. The complexity of the implementation demands well laid out integrated approach. Activities are normally distributed amongst several private and/or public organizations, each being responsible for a limited group of activities with a common goal.

Manufacturing, Construction and Erection are carried out by the qualified contractors selected by tender process. Selection of materials, construction methodology and supply chain is planned in advance. Quality and Safety management plays an important role in the construction process. Change management and change control are inevitable as the designs are constantly updated to take care of the International norms and stipulations with regard to nuclear safety.

NPCIL has been exhibiting the Project Management capabilities in completing the projects well in time within the budget, thus satisfying the expectations of the key stakeholder, the people of India.

1.2 Keywords:

Nuclear Power Project, Quality and safety management, integrated approach, change management.

1.3 Introduction

India, after 6 decades of independence has possessed with a big source of educated and skilled work force. In population, India is the second largest in the world. But the per capita energy consumption is nearly 40 times lesser than that of highly developed economies like USA and Canada. Even this small per capita consumption aggregates into a big figure because of the huge population. The dwindling fossil fuel supplies have forced the country to think about alternative arrangements in which nuclear power certainly plays a major role. As of now only around 3.0% of the total electricity consumption of the country comes from nuclear power plants. Of course there are several reasons for the slow development of nuclear power plants such as the Nuclear Non Proliferation Treaty to which India is not a signatory till date and it hampers the development of civil nuclear programs due to restrictions on trade of nuclear materials.

One of the major challenges the country is facing today is timely completion of the projects without cost and time over run and making it available to generate the desired

power for the country. The purpose of the paper therefore is to understand the Indian scenario in project management of nuclear power projects.

1.4 Economics of Nuclear Power Project and Present Scenario:

Nuclear power plants are capital intensive, high technology, and complex systems which are continuously evolving and increasing safety requirements. Investment costs and their amortization make up the predominant part of the future power generation costs and effectively determine the competitiveness of the nuclear power option with power from fossil fuels or hydroelectric stations.

Coal and gas are the driving forces in case of Thermal Power Project- the main contributor of power in India- but have developmental constraints out of resource availability as well as control on Green house effects. Nuclear energy is, in many places, competitive to other sources of energy despite relatively higher capital costs and the need to internalise all waste disposal and decommissioning costs. If the social, health and environmental costs of fossil fuels are also taken into account, nuclear is the preferred option as it is an environmentally benign power.

Present power generation of various modes along with their percentile contribution to the total and demand projected for year 2032 are given in Table-1.

Table -1. Power generation and Projected demand

Present Scenario			**Projected demand in 2032**	
Fuel	**GWe**	**%age**		
Total Thermal	**104.0**	**64**	Thermal (coal, oil and gas)	390 Gwe
Hydro	**37.0**	**23**	Hydro-electric	150 GWe
Nuclear	**4.6**	**3**	Nuclear	63 GWe
Renewable	**16.4**	**10**	Renewable	97 GWe
Total	**162.0**		Total	700 GWe

1.5 Profile of Nuclear Power Corporation of India Limited:

India is self-sufficient in the life cycle management of nuclear power technology from uranium exploration and mining, fuel fabrication, heavy water production, design, construction, operation & maintenance of NPPs to reprocessing of fuel and waste management. Indian nuclear scientists have mastered the life extension of the nuclear power plants.

Nuclear Power Corporation of India Limited (NPCIL) is a Public Sector Enterprise under the the Department of Atomic Energy (DAE), Government of India is

responsible for design, construction, commissioning and operation of nuclear power plants. The Company was registered as a Public Limited Company under the Companies Act, 1956 in September 1987 with the objective of operating the atomic power stations and implementing the atomic power projects for generation of electricity in pursuance of the schemes and programmes of the Government of India under the Atomic Energy Act, 1962. NPCIL is operating 19 reactor units with a total power capacity of 4560 Mwe, out of which 17 are small sized and 2 are mid-sized.

1.6 The Stake Holders:

Nuclear power project has various key stack holders who play a vital role in the project implementation. They are,

— Public authority — Regulatory body — Owner— Designer / Consultant— Main contractor

Public Authority: Department of Atomic Energy [DAE], Govt. of India plays the role of public authority in implementing the government's decision and setting up regulatory and promotional requirements.

Regulatory Authority: While DAE plays the role of Governing agency, a special regulatory body Atomic Energy Regulatory Board [AERB] is established to deal exclusively with nuclear safety regulations, surveillance and control, without conflict of interest with the promotional side.

Owner: NPCIL is the owner organization of the project and is responsible for forecasting milestones and for ensuring timely, economic and safe completion of the projects ensuring that the project meets the established needs, within the guidelines laid down by the Public authority and the regulatory body.

Designer / Consultant: NPCIL has separate engineering and project directorates. Engineering Directorate is responsible for the design activities and it performs the design activity either directly or through external consultants. Consultants are taken on specific engineering tasks in contracts or subcontracts.

Main Contractor: Organizations in charge of the execution of various portions (contract packages) of the nuclear power project are called main contractors. The scope of a main contract typically comprises construction of a single or set of structures, systems or services. The main contractor would plan, engineer and commission the contracted portion of the project in a complete manner according to the specifications and requirements of the owner and with allowance for the interfaces to other contractors. A main contractor independently manages the subcontracts for their portion of the project, with a consent right by the owner.

1.7 Project management at NPP's:

The principal object of the Project Management is to construct and commission the Power projects within the scheduled time and cost and to achieve adequate quality levels in works and equipment so that high availability of generating equipment is ensured

The function of project management can be defined as the overall direction and co-ordination of project implementation tasks. This is a very complex responsibility in nuclear power projects involving large risks and hence, the owner cannot delegate direct responsibility for control and supervision of the project and hence totally getting involved in fulfilling this commitment in the most efficient way. NPCIL adopts a matrix organizational structure at project sites having various specilised groups like civil, mechanical, electrical and instrumentation, project management services, engineering support, QA/QC and a dedicated HR, Finance and contract management groups independently reporting to the Project head, who is responsible for the project management. Each group manages their specialized nature of works through different contracts and the project head plays a role of integration of all.

The major phases involved in the Project Management (PM) of nuclear power plant are

- Pre-Project activities
- Approvals (Agreements, Financial sanctions, etc)
- Project Planning
- Project Execution
- Project Closure & handing over to Operation group

1.8 Pre-Project activities

There are various activities which are to be completed as pre-project activities. These activities are more important and involve various specialised agencies and decide various stakeholders of the project. Site selection is carried out by site selection committee, appointed by the Dept. of Atomic Energy, looking in to various selection criteria specified by the regulatory body. Pre Project activities include, Site selection and land acquisition, Site investigation, Selection of technology and Obtaining in principle approval from the Govt. of India, Carrying out Environmental Impact Assessment, Obtaining clearances from various agencies like MOEF, AERB, state Pollution control board, SEBs, etc, and Development of site infrastructure.

Pre Project activities also covers- 3-D modeling of the plant using advanced software packages to enable the design to be construction friendly, to pre-plan the activities, to avoid interference in the field & for planning life cycle management of the plant. It also covers, Engineering and review of Design Basis Reports, finalisation of construction methodology, package formulation, pre-qualification of vendors and contractors, scope finalisation & optimisation, preparation of Project cost estimates, economic feasibility of project & financial sanction, finalisation of baseline schedule & mile stones and finalisation of Supply chain Management system.

1.9 Approvals

Following are the various approvals required before start of the project and during the project execution which are taken up by the designated project group.

- Site clearance from Site Selection Committee and approval by Govt. of India
- Environmental clearance from MoEF, Govt. of India

- Bio-sphere reserve clearance
- Coastal regulation zone clearance
- Forest clearance
- Consent to establish from state pollution control board (Air act and Water act)
- Siting clearance from Regulatory body (AERB)
- Stage clearances from AERB

1.10 Project planning

Planning of a nuclear power project, a primary task is completed in advance keeping in mind the complex nature of the design. Master control network which is Level-1 network is prepared integrating civil construction works of various facilities, mechanical and electrical equipment erection, piping works, instrumentation and process control systems installation and system commissioning. The power plant is generally divided in to four major areas namely, Nuclear Island (NI), Conventional Island (CI), Cooling water systems and Balance of Plant (BOP).

Few of the major work packages considered in the level-1 network which is also known as integrated network are elucidated below.

- Defining the milestones and preparation of base line schedules
- Geotechnical data and soil survey & Preliminary safety analysis report
- Reactor building- Civil construction , Erection of Polar crane, Reactor vessel, Steam generator, Primary loop piping, Erection of Containment, Recirculation system & Other pressure components
- Erection of Condenser , Turbo-generator, Main control panel
- Cooling tower construction
- Piping erection , supply and pre-fabrication contract(s)
- — Reactor building or Phase I and — Auxiliary building or Phase II
- Mechanical erection contract(s)
- Electrical execution contract(s)
- Piping supports supply, erection contract(s)
- Hydro tests, Hot functional tests, Nuclear tests
- Fuel safety analysis report
- Fuel loading, Operation permit
- Commercial operation

Though nuclear power projects were having longer gestation period in the past, NPCIL has developed an effective and efficient project management capabilities in this decade with integrated approach and the projects are planned to be completed within 5 yrs from the zero date. The first pour of structural concrete is considered as the zero date for the project.

At the end of planning and before beginning the execution, finalisation of bid specification and prequalification of bidders are taken up. Specifying, obtaining and evaluating nuclear power plant bids is the most important and most concise project related activity during the pre-contract phase. Although utility engineering and planning personnel from different departments, as well as outside help from consultants, might be involved in this effort, it is appropriately organized as a project management activity.

1.11 Project Execution

The stage begins with the signed contract and ends with the handover of the completed and tested plant to the Operation & Maintenance group (O&M) who are considered to be the customer to the project group. Since large amounts of materials and equipment are ordered, manufactured, supplied and installed in this phase and the most important manpower resources are mobilized, the largest part of the overall cost is incurred and hence, the highest degree of co-ordination is necessary. It is in this phase that project manager has to show his capabilities and use most of the PM tools and techniques. Although the project management activities may be continuous from the preproject phase to the execution phase, the contract signing represents a major step in project work. The project ceases to be merely a planning exercise and becomes instead a real entity. The Project Execution phase consists of, Contract management, scope, time, cost and quality management and project Risk and change management.

1.11.1 Project Contract Management

In India, nuclear power projects are implemented through various contracts. The various types of contracts adopted are item rate works contracts, EPC contracts, Procurement contracts, labour contracts. Largely, the civil contracts are item rate contracts and are the long gestation contract in the life span of the nuclear power project starting from the pit excavation to final painting. This is managed by the civil group of the project. Major mechanical and electrical equipments like reactor pressure vessels, calandria, steam generators, turbines, generators, diesel generators, transformers, cables, etc., are purchased from pre qualified suppliers through procurement contracts. The Contracts and Materials management (CMM) group manages these contracts. The suppliers include both domestic and international and hence the international contracts are also managed for the timely supply of the equipments. Erection of supplied mechanical equipments and supplying, fabricating, erecting the piping works are managed by mechanical group. Erection of electrical equipments and huge quantum of cabling works are carried out by the electrical group. The instrumentation works covering panel erection, instrumentation cabling and activation of circuits and instruments are managed by instrumentation group. The major equipments weighing around 300MT and more are handled using huge crawler mounted 650MT capacity cranes.

NPCIL being a PSU, the contracts are awarded and managed in a most transparent manner. The payments to the work done by the contractors are computerized and managed online in the intranet through a custom made Works Contract Management Software (WCMS). This ensures the fast processing of the payments to the contractors and hence maintains the liquidity which helps in uninterrupted progress. A senior management official is entrusted with the responsibility of integrating the activities of various groups as per the plans and manages the interfaces successfully and timely.

1.11.2 Project Scope and Time management

Project Management Services (PMS) group of the project plays a key role in scope and time management. They integrate the plans of various groups, collect the project status, prepare the status & progress reports and communicate the same to the concerned officials of the project. This group also plays the role PMO. They design the templates for the uniform progress monitoring & reporting and monitor the project progress with the baseline plans. They communicate various milestones of each group along with the resource requirement so that the execution agencies get the timely alarm for mobilsation of the required resources. Nuclear power projects being a complex one, this group also plays the facilitator role in the integration of various resources and resolving the related conflicts between various execution groups. They also report the progress of the project to the other stakeholders as per the approved communication plans. Project Management Information System (PMIS) is designed and deployed to ensure the required information is received and delineated at the right time to the right people.

1.11.3 Project Cost Management:

The project gets its financial sanction initially from Govt. of India specifying the debt-equity ratio and the overall project cost. Every year, the project prepares the yearly budget requirements which get approved at the corporate level. Depending on the overall allocation of funds, it gets allocated to a particular project. The cost management is done in a collective manner by the Project Finance & Accounts group and the Project Management Services group. Periodic reports and annual reports on account of budgeted provision along with the percentage of finanacial progress are issued for optimization of fund utilization.

1.11.4 Project Quality Management:

Quality Management System principles are practiced in NPCIL with due sanctity right from its inception. Well defined 3 tier document in the form of a corporate level Quality management document, a Project level Quality Management document and construction Quality manual which provides thorough insight to the areas of concern and criteria for acceptance. Implementation of Quality Management system is carried out by a dedicated Quality Assurance group covering all disciplines of the project. They carryout quality assurance activities as part of execution process and change, non-conformance, document controls are carried out as control functions. Regular quality audits at various levels are done.

1.11.5 Project Risk and change Management:

Nuclear power projects are some of the highest risk projects. They can be both Internal & external. Internal risks, to name a few, are contractor delays resulting in Time & Cost overrun, Regulatory bodies have veto power over project direction, Quality deficiencies that requires immediate corrective and preventive action causing delays. External risks due to Economic recession, Inflation and high interest rates, increase in market value of raw materials.

As the nuclear power design is a progressively evolving one in line with the international stipulations and guidelines formulated time to time, freezing of the design is not possible. Hence, the design changes in the process or the construction inputs are expected. To take care of this requirements, NPCIL has got in place a well defined change management system by which the involved agencies review and approve the changes before its implementation.

1.12 Project Closure & handing over to Operation group:

The process of Project closure is well planned, budgeted and scheduled. Nuclear Power Projects have an established mechanism of performing this phase. Once the construction activities are completed, the execution group undertakes preparation and submission of Construction Completion Certificate [CCC] and System Transfer Document [STD] meaning compilation of the documents right from tender specification document to as- built drawing level and Equipment History Dockets to erection status. These sets of compilations are made with a checklist prepared to cover the entire scope of work extensively and precisely. On due verifications, these CCC's and STD's are signed by the execution group, reviewed by QA and design groups and subsequently accepted by Operation/ Commissioning group in a formal handing over – taking over process.

1.13 Conclusion:

Project management of a nuclear power project in India is basically dealing with the complex technological requirements and getting it executed through the contractors. It is observed that the Indian contracting agencies are also growing with the technological developments in line with international standards. Be it manufacturing of critical equipments or the construction & erection, till now, the Indian industry has responded positively. The capacity addition projected for the nuclear power growth in the country demands much more commitment from the Indian industry and development of new players too. With the commitment of the industry and the application of project management tools and technologies, nuclear power would come up in a big way and would satisfy the expectations of the nation from this industry.

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