

## Chapter - I Introduction

Nuclear energy is fast emerging as an important source to serve India's growing energy needs. Nuclear power production in the country began in 1969 and has grown from an installed capacity of 320 Mega Watt (MW) in 1969 to 6,780 MW in 2017 and planned to be 9,580 MW by end of 2022 and 14,380 MW by end of 2027<sup>1</sup>. Important organizations related to regulation, generation and distribution of nuclear energy in India are the Department of Atomic Energy, Atomic Energy Regulatory Board and Nuclear Power Corporation of India. A brief of these three organisations is given below:

**The Department of Atomic Energy (DAE)** was set up on 3 August 1954 and is engaged in the design, construction and operation of nuclear power/research reactors and supporting nuclear fuel cycle technologies covering exploration, mining and processing of nuclear minerals, production of heavy water, nuclear fuel fabrication<sup>2</sup>, fuel reprocessing and nuclear waste management.

**Atomic Energy Regulatory Board (AERB)** was constituted on 15 November 1983 and entrusted with the responsibility for laying down safety standards and framing rules and regulations covering regulatory and safety functions envisaged under the Atomic Energy Act, 1962. AERB has developed safety standards for nuclear and radiation facilities, covering aspects such as siting<sup>3</sup>, design, construction, operation, quality assurance and decommissioning.

**Nuclear Power Corporation of India Limited (NPCIL)** is a central Public Sector Enterprise formed on 17 September 1987 under the administrative control of the Department of Atomic Energy (DAE), Government of India (GoI). It is responsible for design, construction, commissioning and operation of nuclear power reactors. NPCIL is presently operating 22 nuclear power plants, (twenty one owned by NPCIL and one owned by DAE<sup>4</sup>), with an installed capacity of 6,780 MW. The reactor fleet comprises of two Boiling Water Reactors (BWRs), 18 Pressurized Heavy Water Reactors (PHWRs) and two 1,000 Mega Watt VVER (*Voda Voda Energo Reactor*- water cooled and water moderated reactor) at Kudankulam. In addition, NPCIL has six nuclear power projects under various stages of construction/commissioning aggregating 4,800 MW capacity. The details are given in **Annexure I**.

<sup>1</sup> As per draft National Electricity Plan (December 2016) released by Central Electricity Authority, GoI.

<sup>2</sup> Nuclear Fuel fabrication is the last step in the process of turning uranium into nuclear fuel rods.

<sup>3</sup> The process of selecting a suitable site for a facility including appropriate assessment and definition of the related design bases.

<sup>4</sup> Rajasthan Atomic Power Station, Rajasthan Unit 1.

## 1.1 Kudankulam Nuclear Power Project (KKNPP)

KKNPP is being implemented at Kudankulam situated in Thirunelveli district, Tamil Nadu. Under the KKNPP project, it was planned to set up six nuclear power plants each of 1,000 MW, in phases with Pressurized Water Reactor (*Voda Voda Energo Reactor*) technology. In the first phase, it was planned to construct Units I and II. The project is being implemented in technical collaboration with Government of Russian Federation (Russian Federation). An Inter-Governmental Agreement (IGA) was signed between the GoI and the erstwhile Union of Soviet Socialist Republics (USSR) in the year 1988 to implement the project.

However, due to internal development in the erstwhile USSR, the project implementation could not progress. After resuming negotiations with the Russian Federation, supplementary agreement to IGA, was signed in the year 1998 between the Russian Federation and the GoI to implement the project. M/s Atomstroyexport (ASE), a Joint Stock Company under the Ministry of Russian Federation for Atomic Energy (Rosatom), represented the Russian side for setting up the Nuclear Power Station (NPS) at Kudankulam. Indian side was represented by NPCIL in execution and implementation of KKNPP. The scope of work of the respective sides was as follows:

- The Russian scope of work included project engineering and design, supply of equipment, special materials/spare parts from Russian Federation, training of operations/maintenance personnel of Indian side, associated services like project management activities, quality assurance / quality control (QA/QC) activities, designer's supervision at all stages of project implementation etc.
- The Indian scope of work included civil construction works, preparation of detailed erection procedures, erection of all mechanical, electrical and Instrumentation & Control (I&C) system equipment/ components, commissioning of the plant under technical assistance of Russian side personnel and operation of the NPS units etc.
- The third countries supplies were partly in Indian Scope and partly in Russian Scope.

KKNPP is based on technology of pressurized water reactor, cooled and moderated by light water<sup>5</sup>. Its core containing the nuclear fuel is located inside a pressure vessel. The reactor is located inside an airtight primary containment building which is surrounded by a secondary containment. The reactor has steam generators in each loop. Each Unit of KKNPP i.e. Unit I (1,000 MW) and Unit II (1,000 MW) consists of four Primary Coolant System loops transferring the heat energy from the reactor to the Steam Generators (SGs). The steam produced in the SGs is fed to the Turbine Generator to generate electricity.

## 1.2 Status of the project

As against scheduled completion date of 30 October 2007 for KKNPP Unit I and 30 October 2008 for KKNPP Unit II, the Unit I started commercial operation on 31 December 2014 and the Unit II started commercial operation on 31 March 2017.

<sup>5</sup> Water containing the normal proportion (or less) of deuterium oxide, i.e. about 0.02 per cent especially to distinguish it from heavy water.

The KKNPP Units III, IV, V and VI are also being implemented with cooperation from Russian Federation. General Framework Agreement (GFA) for Units III and IV was signed on 10 April 2014. Works for KKNPP Units III and IV started in February 2016 and as on date are in progress. GFA for Units V and VI was signed on 1 June 2017 and work is yet to commence (31 July 2017).

### 1.3 Cost of the Project

The cost of the project comprising Units I and II was initially estimated / approved for ₹ 13,171 crore in 2001 which was revised to ₹ 17,270 crore in 2013 and later to ₹ 22,462 crore in 2014.

The capitalized project cost<sup>6</sup> incurred till 31 March 2017 was ₹ 11,523 crore and ₹ 10,212 crore for Unit I and Unit II respectively.

#### Photograph 1.1 Kudankulam Nuclear Power Plant- Units I and II



Since start of commercial operation of Unit I on 31 December 2014, 10,573.55 million KWh units of nuclear energy were generated, out of which 9,699.74 million KWh were exported<sup>7</sup> at ₹ 3,844.24 crore. There is also an installed capacity of wind power for 10 MW (8 units of 1.25 MW each) at the KKNPP site, under which 50.09 million KWh were generated out of which 49.22 million KWh were exported at a value of ₹ 9.35 crore.

Site Director heads the KKNPP assisted by a team comprising of Station Director, Chief Superintendent, Technical Service Superintendent, Deputy General Manager (Finance) and other executives and officials. As on 31 March 2017, the sanctioned strength<sup>8</sup> of KKNPP was 1,886, against which men-in-position was 1,010.

<sup>6</sup> Capitalized Project cost includes all capital and revenue expenditure incurred for the project till start of commercial operation of the plant.

<sup>7</sup> Electricity sold to State Electricity Boards.

<sup>8</sup> Represent permissible strength for KKNPP Units I, II, III and IV.

## 1.4 Audit Objectives

The performance audit was conducted to assess whether:

- NPCIL exercised prudent financial management during implementation of KKNPP.
- The tariff was fixed in accordance with applicable Regulatory Rules and Act.
- The project was implemented in an economic and efficient manner.

## 1.5 Scope and Methodology

The scope of the audit was to examine project implementation of KKNPP Units I and II along with financial implications. 37 Russian contracts (valuing ₹ 10,188.95 crore), out of 171 contracts (valuing ₹ 10,482.52 crore) were selected and in respect of Indian Contracts, 106 (valuing ₹ 1,511.73 crore) out of 1,842 contracts (valuing ₹ 2,212.92 crore) were selected on the basis of Stratified Random sampling<sup>9</sup>.

An Entry Conference was held on 3 June 2016 with the Management of NPCIL wherein the scope, objectives and methodology of audit were discussed and the audit criteria were agreed upon. The records pertaining to June 1998 to October 2016 were test checked during performance audit; matter relating to the period upto March 2017 have also been included, wherever necessary. Field audit was conducted at Kudankulam plant, Tamil Nadu and the corporate office of NPCIL at Mumbai, Maharashtra. Relevant records pertaining to project initiation, implementation and commissioning were test checked. Both the Units of KKNPP viz. Units I and II were selected.

Inspite of various reminders, Audit was not provided records pertaining to dates of completion of final safety review and submission date to AERB and details of items damaged during commissioning of Unit I. In absence of these information, the scope of audit was limited as it could not review issues relating to these records.

The draft Report was issued to the DAE and NPCIL on 25 May 2017. NPCIL communicated its response vide letter dated 28 June 2017. The DAE's reply to the draft Report is awaited (August 2017).

An Exit Conference was held with DAE and NPCIL on 7 July 2017 wherein Audit shared its findings and recommendations with them. The audit observations including recommendations, after suitably incorporating the replies of NPCIL on Financial Management, Tariff and Revenue Generation and Project Implementation and deliberations which had taken place in Exit Conference, are given in subsequent chapters.

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<sup>9</sup> *Stratified random sampling is a method of sampling that involves the division of a population into smaller groups known as strata. In stratified random sampling, the strata are formed based on members' shared attributes or characteristics. These subsets of the strata are then pooled to form a random sample.*

## 1.6 Audit criteria

The audit was conducted with criteria drawn from the following:

- Inter Government Agreement between Government of India (GoI) and erstwhile USSR and supplementary Agreement between the Government of India and Federation of Russia.
- Relevant policy decisions of the GoI and Russian Federation
- Decisions of the Board of Directors of NPCIL
- General Framework Agreement (GFA)/ Draft Project Report
- Program Evaluation and Review Technique Chart / Integrated Action Plan Network
- Site Inspection Reports and related environmental reports

## 1.7 Acknowledgement

Audit acknowledges the co-operation and assistance extended by the Management of NPCIL at various stages of the performance audit.

