

Managing an Expanding Nuclear Power Programme








Amer Manzoor
February, 2019



Nuclear Power Program of Pakistan

- Pakistan has an established Nuclear Power Program well ahead of IAEA 3rd Milestone of Nuclear Power Infrastructure Development. At present five Nuclear Power Plants are in operation while two plants are under construction
- Pakistan Nuclear Power Program envisages to increase its share in the Energy Mix from 3.78% to about 6% by 2030 and to generate at least 8800 MW electricity using Nuclear Energy as outlined by Government of Pakistan's Energy Security Plan of 2005.
- Pakistan Nuclear Power Program visualizes gradual indigenization of the Nuclear Power Plants by integrating the local industry in its endeavor and ensuring development of necessary industrial infrastructure to support this initiative

Operational Nuclear Power Plants

	KANUPP	C-1	C-2	C-3	C-4
					
Capacity (Gross)	137/100 MW	325 MW	330 MW	340 MW	340 MW
Grid Connection	04-10-1972	13-06-2000	14-03-2011	15-10-2016	25-06-2017
Commercial Operation	07-12-1972	15-09-2000	18-05-2011	06-12-2016	19-09-2017
Life Time Capacity Factor	32%	75%	82%	91%	95%
Current Capacity Factor	58% (2016)	96% (Cycle-12)	100% (Cycle-5)	91% (Cycle-1)	95% (Cycle-1)
Highest Continuous Operation Record	167 Days (2016-2017)	280 Days (24-02-2017)	302 Days (20-11-2016)	113 Days (17-05-2017)	-

Under Construction Nuclear Power Plants

	K-2	K-3
	 A photograph showing the construction of a large, cylindrical nuclear reactor vessel for unit K-2. The structure is surrounded by scaffolding and construction equipment, including cranes, in an outdoor setting.	 A photograph showing the construction of a large, cylindrical nuclear reactor vessel for unit K-3. The structure is surrounded by scaffolding and construction equipment, including cranes, in an outdoor setting.
Capacity (Gross)	1100 MW	1100 MW
Groundbreaking	26-11-2013	26-11-2013
First Concrete Date (FCD)	20-08-2015	31-05-2016
Commercial Operation	2020	2021
Percent Complete	75%	60%

Nuclear Power Development

- Strong National Commitment:
 - A strong commitment of the government to the nuclear power programme is very essential for its success for resolving issues like financing, providing sovereign guarantees, ensuring implementation of grid developments, amending legislation as per requirement, providing mechanism for compensation for nuclear damage
 - CHASNUPP-1 was an example of strong national commitment. As a result all the finances of the project were arranged indigenously by Pakistan Government.
- Public awareness for acceptance of nuclear power plant construction specially near populated cities is essential

Nuclear Power Development

- When PAEC decided to introduce Chinese Nuclear Power Plants in Pakistan:
 - One CANDU Reactor was already in operation (since 17 years)
 - A complete set of experienced Manpower was available at KANUPP, Karachi.
 - PAEC was self sufficient in Human Resource
 - Nuclear Laws and Regulations were already in place
 - PAEC engineers/scientists had ample exposure to the IAEA trainings/workshops/documents
 - PAEC Nuclear Operation personnel were also involved in WANO activities

Nuclear Power Development

- Task Specific Teams were prepared and assigned targets for the contract negotiations regarding:
 - Feasibility studies and Financial arrangements
 - Regulatory requirements
 - PWR technical know-how
 - HR Planning
 - Site study finalization
 - Grid capabilities
 - Assessment of local capabilities
- Training of the language of the Supplier's country to employees and hiring of the Chinese language experts
- A competent regulatory framework with funding sources to fulfill its responsibilities

Nuclear Power Development

- Based on feedback of previous Units during construction, installation, commissioning, operation and RFO-1, hundreds of design improvements were carried out in later units.
- During the C-2 construction period as per recommendations of the country's NRB, fourteen IAEA expert mission were conducted to review the PSAR based on the IAEA's safety standard NS-R-1.
- The review conducted by IAEA was supported by PAEC, PNRA and the Chinese contractor and recommendations were incorporated in the later NPPs as far as possible.
- A well established Quality Assurance Program was prepared by utility (based on IAEA Code of Quality Assurance)
- QA Audits of the Contractors were carried out.

Challenges - Development of Manpower

- Trained and Experienced Manpower is required for:
 - QA inspection/surveillance during construction, equipment manufacturing, installation and commissioning.
 - Safe and Secure operation of a NPP.
- Typically 4 to 5 years are required for training of O&M manpower. Most Importantly, enough Licensed manpower like Main Control Room Engineers and Supervisors are needed.
- In C-1 unit, the total initial training at the Reference NPP was for more than **2000 Man months**.

Nuclear Safety

- Pakistan attaches great importance to nuclear safety at all levels.
- Safety parameters, emergency preparedness and response, nuclear waste management and decommissioning, operators training protocols and procedures are continuously reviewed and enforced.
- The approach to ensure safety of nuclear power plants is in accordance with national regulatory system
- Pakistan carried out detailed assessment of its own nuclear power plants after Fukushima accident

National Nuclear Security Regime

- Pakistan operate power plants, research reactors, agriculture centres, medical centres and also employ industrial applications of nuclear technology.
- More than 45 years of experience in safe and secure operations of nuclear power plants under IAEA Safeguards.
- Experience is based on National Legislative, regulatory and administrative framework
- The elements of nuclear security include robust command and control system led by the National Command Authority (NCA), multi-layered defense for a nuclear threat, rigorous regulatory regime and international cooperation

Education & Training in Nuclear Security

- Centre of Excellence was established in 2014 comprising of three main institutes:
 - Pakistan's Centre of Excellence for Nuclear Security (PCENSE) organizes training in nuclear security, physical protection, material control & accounting, transport security and personnel reliability from the operator's perspective (750 acres of land mass).
 - National Institute of Safety and Security (NISAS) organizes training courses for nuclear safety and security in the regulatory perspective.
 - Pakistan Institute of Engineering and Applied Sciences (PIEAS) conducts academic courses at Masters Level in nuclear security.

International Cooperation

- Party to the Convention on Physical Protection of Nuclear Material including its Amendment
- Party to Nuclear Safety Convention, Convention on Early Notification of a Nuclear Accident and Convention on Assistance in case of a Nuclear Accident or Radiological Emergency
- Member of UN Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)
- Member of NSGC, INSAG, ADSEC and CSS
- Voluntary subscribed to Code of Conduct on Safety and Security of Radioactive Sources

Thank You

Contact: manzoor_amer@yahoo.com