

# The Philippine Experience in Regulating a Nuclear Power Plant

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## **Introduction**

- The Philippines signed the bilateral agreement with the United States under the Atom for Peace Program on July 27, 1955
- The IAEA statute entered into force for the Philippines on September 2, 1958



## **Legal Bases**

- Republic Act No. 2067 known as the Philippine Science Act of 1958 was enacted by Congress on June 13, 1958
  - created the Philippine Atomic Energy Commission to conduct R&D in the production of atomic energy and to ensure the safety of its application

- R.A. 5207 or the Phil. Atomic Regulatory and Liability Act was enacted on June 15, 1958.
  - Empowered PAEC to issue license for the construction, possession or operation of any atomic energy facility



- July 1958, the Phil. Government entered into a new international agreement with the US government., which included the possible construction of two nuclear power plants and the long term supply of enriched uranium

# Atoms for Peace Program

- RA 6395, was enacted in 1971, authorizing the National Power Corporation (NPC) to establish and operate nuclear power plants.



## **Atoms for Peace Program**

- The Philippine Government at the initiative of PAEC asked the U.N. for aid in looking into the technical and economic feasibility of using nuclear power to supplement available conventional energy requirements to meet projected power requirements in Luzon



# Road of Events to PNPP

- In 1963, a pre-investment feasibility study for the construction of a nuclear power plant in the Philippines was made by the IAEA in coordination with the PAEC
- In 1965, the pre-feasibility study was completed with the following recommendations:
  - use of NPP in the Luzon grid by the early 1970's
  - legislation for the regulation of nuclear power and third party liability under the Vienna Convention on Civil Liability for nuclear damage be enacted



# Road of Events to PNPP

- 1968 - USA and PHI signed a new bilateral agreement for cooperation on civil uses of atomic energy
- 1972 - IAEA/UNDP assistance sought to conduct a feasibility study for a NPP in the PHI

# Road of Events to PNPP

- 1973 - President F. Marcos announced the government's decision to acquire and establish a NPP in Bataan, Luzon Islands
- 1976 – the contract for the PNPP was signed by the NPC and Westinghouse which provided for the NPP's completion in mid-1983, same design as Korea Kori – 1 & 2



# ■ Bataan Nuclear Power Plant Site Investigation





# Bataan Nuclear Power Plant Profile

Feasibility Study - 1965

Contract with Westinghouse signed-1976

- Nuclear Thermal Output – 1,876 MWt
- Net Electrical Output – 620 MWe
- Two-loop Pressurized Water Reactor
- Safe Shutdown Earthquake – 0.4 g
- Operating Basis Earthquake – 0.2 g
- Main contractor - Westinghouse



# Site Studies conducted for BNPP

## ■ Demography

(Minimum Exclusion Radius = 1 km applied)

- Settlements (geographic units/population)
- Industrial facilities
- Land use
- Transport links (access roads, air and sea ports)
- Domestic Water supply



# Site Studies conducted for BNPP

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## ■ Hydrology

- Surface waters characterization – site is bounded by streams draining off to the South China Sea. No surface water users within the sphere of influence of the facility
- Offshore and coastal water study
  - Temperature – Max 31.5°C in June. Min 28.4°C in November with 0.2 deg C diurnal fluctuation due to solar heating
  - Salinity – Pycnoline is at 80-100 m depth at sufficient distance offshore to affect nearshore densities. Difference between surface and bottom salinity is < 1 ppt (i.e. 33.6 at surface and 34.0 at bottom at summer when salinities are highest)
  - Currents – On both sides of Napot Pt, the magnitude of current is small (Max at 18 cm/sec)
  - Dispersion characteristics – diffusion potential of 9.2 m<sup>2</sup>/sec at temporal scale of five hours from drouge release
  - Tides – diurnal (range is 1.0 and 1.4 m I June nd December) and semidiurnal (range is 0.2 to 0.7 m)
  - Waves – Severe storm surge formation inhibited by narrow shelf which drops to 1300 m at the West Luzon Trough. Waves break at fringing reef terraces before reaching Napot pt.
  - Tsunami – reorded at the east side of southern Philippines
- Flood - site with adequate protection from stream and ocean flooding (Typhoon, Precipitation)
- Groundwater – Artesian aquifers in pyroclastics and sediments within the site region. Recharge points at craters. The topographic and hydrologic location of the BNPP effectively precludesthe chance of large scae piezometric gradient reversals and induce saltwater intrusion.



# Site Studies conducted for BNPP

- **Meteorology (normal and extreme)**
  - Precipitation extremes – 442 mm for 24 hr, 1500 mm month
  - Thunderstorms – 60 days a year
  - Cyclones – over 90% form to the east and move westward
  - Tornadoes – only 2 to occur in any four-year period at speeds of 182-253 kph
  - Winds – extreme winds associated with tropical cyclones but weakens on landfall, lower wind speed than normally expected for region with high typhoon incidence. Maximum recorded= 78 knots
  - Moisture and Fog – Moisture 65% cold months to >80% in summer. Fog formation is between April to September at visibility of <1 mile. Associated with winds from south-southwest
  - Typhoon surge/Waves – typhoon surge with superimposed wind wave activity results to max wave of 14.2 m
  - Temperature – highest is 38 deg C, lowest is 13 deg C



# Site Studies conducted for BNPP

## ■ Geology

- Acquisition and interpretation of infra-red (IR) imagery, aerial photographs and side-looking airborne radar (SLAR) imagery
- Evaluation of Remote sensing data including Earth Resources Technology Satellite (ERTS) imagery. Magnetic and gravity data for lineament analysis
- Field mapping, trenching, test pitting, drilling



# Site Studies conducted for BNPP

## ■ Geology

- Rock/soil analysis for geotechnical investigation of the site
- Geochronology to determine petrogenesis and tectonic model of the site
  - Geochemistry
  - Petrographic analysis
  - Radiometric age dating (K-Ar, C<sup>14</sup>, Fission-track and geomagnetics)

# Site Studies conducted for BNPP

- Seismology
  - Microseismic survey
  - Seismic refraction survey
  - Shear-wave studies
  - Magnetometer survey
- Offshore Geophysics to determine presence or absence of significant faulting in the near site part of the South China Sea
  - Seismic reflection profiling
  - Side scanning sonar
  - Magnetic profiling



# Findings

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BNPP

## Lithology

- Foundation material of volcanic agglomerate not susceptible to liquefaction
- Volcanic activity is at the east side of Mt. Natib

## Structures

- Faults and fractures identified all pass in excess of 25 km from site at their closest approach. Faults were mapped only at Mariveles Harbor and at the caldera area of Mt. Natib. Therefore, surface faulting is not a factor in plant design
- There is no activity in Bataan with magnitudes higher than 3.0. Epicentral data do not indicate any association of seismicity with postulated structural lines in western Luzon. These points to the absence of any active fault or structural line passing through Bataan.





# Findings

- Microseismic survey notes that Manila Bay Fracture Zone is active at microseismic level. Also notes that Alcaraz and Santos postulated long faults (lineaments) passing thru Bataan.
- These lineaments were noted in remote sensing analysis but ground studies failed to identify the nature of such lineaments. No faults were mapped. Seismic refraction and magnetic survey did not show geological discontinuities in the site.



# Findings

- Hydrologic studies showed no hydrologic conditions would preclude the construction and operation of BNPP. Napot Pt has sufficient water supply and dispersion of effluents, and provides adequate protection from stream and ocean flooding (tsunamis, storm surge and wind waves).
- Paleomagnetic study showed reversals are due to rotation and translation and that Cabigo and Caragman Pts are part of rock glide, Napot Pt is not. Reversal may be due to compaction/degassing of ignimbrites.



# Regulations and Standards

- Nuclear Regulations and Standards Code of PAEC/PNRI Regulations (CPR)
  - CPR Part 3: "Standards for Protection Against Radiation"
  - CPR Part 4: "Rules and Regulations on the Safe Transport of Radioactive Materials"
  - CPR Part 7: "Licensing of Atomic Energy Facilities"
  - CPR Part 8: "Atomic Energy Facility Operators Licenses"
  - CPR Part 11: "Licenses for Industrial Radiography"



## **Application for a Provisional Permit**

- Provisional permit authorizes the applicant to commence construction of a facility including clearing, grading, and construction of temporary roads
- Construction of the nuclear power plant 620 MWe, Pressurized Water Reactor (PWR) was commissioned in February 1976



- NPC filed with PAEC to start groundwork in preparation for the nuclear power plant site in Morong, Bataan on 21 October 1976



# **Application for a Provisional Permit**

- PAEC under Commissioner Librado Ibe issued a provisional permit to NPC on December 20, 1976 for the groundwork preparation for the nuclear power plant in Bataan
  - authorized limited work
- Site grading and excavation was completed in April 1977



# International Cooperation related to PNPP

- International Atomic Energy Agency
  - Training of human resources from the regulatory body and the operator
  - Expert missions to assist the PAEC in drafting regulations, evaluation of PSAR, FSAR and other PNPP documents, evaluation of safety issues, inspection and audit of PNPP activities, and licensing of reactor operators



- Pre-OSART and OSART Missions
- United Nations Development Program
  - Human resources development
- US NRC
  - Provision of experts; host to Filipino trainees



# Construction Permit

- The holder of a provisional permit shall, at the time of submission of a safety analysis report-construction phase, file an application for license to construct and operate the facility
- A preliminary safety analysis report (PSAR) was filed with PAEC in June 1977
- NPC filed its application for a Construction Permit on July 12, 1977



# Construction Permit

- An IAEA Safety Mission was conducted in July 1977 to assist in the review of the submitted PSAR
- PAEC granted NPC a limited work authority for the nuclear power plant on 3 October 1977
- NPC started the erection of the containment vessel
- A follow up IAEA Safety Mission was conducted in May 1978 to assist in the review of geological characteristics of the Bataan site



# Construction Permit

- PAEC issued the Construction Permit in April 1979
  - Order to suspend construction due to the Three Mile Island Accident
  - Puno Commission was formed to evaluate safety concerns
  - Public hearings on PNPP safety were carried out from July 1979 to August 1980
  - Suspension of the construction was lifted in September 1980 with amendments to include design upgrades and new schedules



# New Schedules

- Construction was subsequently resumed in September 1980
- Project completion was moved back to January 1985
- Plant was essentially completed in July 1985 ready for fuel loading
- Planned start of commercial operation December 1985 after various tests are completed.
- Plant output would have been raised gradually, initial 185Mw to 310Mw in October 1985 and finally to 620Mw in December 1985



# License to Operate (1)

- The regulation states that holder of a provisional permit shall, at the time of submission of the Safety Analysis Report-Operating Phase, file an amendment to its application for license to construct and operate for the issuance of a license to operate
- NPC submitted the Final Safety Analysis Report to PAEC in August 1982 in preparation for the application for license to operate



## **License to Operate (2)**

- NPC filed an application for a License to Operate in June 1984
- An IAEA OSART I Mission Review conducted a construction appraisal review in July 1984
- A follow up IAEA OSART II Mission Review conducted an operational readiness review in February 1985
- Public hearings began for plant licensing in June 1985



# License to Operate (3)

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- In September 1985, the Supreme Court required the reconstitution of the Philippine Atomic Energy Commission and issued an Injunction restraining PAEC from rendering a decision on the application of NPC for a License to Operate
- In February 1986, the Supreme Court ordered PAEC to reopen public hearings after reconstitution of its membership (from a single Commissioner with one Deputy Commissioner to a collegial body of one Commissioner with four Associate Commissioners)
- In view of this, earliest optimistic plant completion date was moved and estimated to October 1987



## **License to Operate (4)**

- On April 26, 1986, the Chernobyl accident happened
- Philippine government decided to mothball the plant in June 1986
- Consequently, the contract with Westinghouse was suspended, and the plant was placed in preservation mode



## ■ Operating License Stage

- NPC (utility) withdrew its application for an Operating Permit in August 1986
- PAEC stopped all regulatory activities related to the PNPP. These included inspection/audit of PNPP activities, licensing of reactor operators, review/evaluation of safety issues, formulation/review of regulatory guides/standards, criteria, etc.



## **PAEC Reorganization in 1989**

- Executive Order 128- reorganized the Phil. Atomic Energy Commission to the now Philippine Nuclear Research Institute under the Department of Science and Technology



## **Sale of the PNPP Nuclear Fuel 1997**

- 1986-1997 NPC becomes site and facility caretaker in 1986. Fuel remains in plant from 1986 to 1997 in the fuel pool. No core loading of fuel ever took place.
- 1997 Nuclear fuel was sold to Siemens and shipped out in December 15, 1997
- 1997-present, the site is maintained by NPC



# Current Developments

- 2007 All financial obligations were paid by the national government (2.2 billion dollars).
- 2008 A House Bill on the establishment of an independent regulatory body was filed.
- 2008 IAEA Experts Team visited the Philippines at the request of the national government to consider plans for rehabilitation of PNPP-1.



# Current Developments

- In June 2009, the Inter-Agency Core Group on Nuclear Power was established through a joint department order between Department of Energy (DOE) and Department of Science and Technology (DOST) of the Government of Philippines
- In September 2009 a bill is introduced in the Philippine congress on the need to update the acceptability / suitability evaluation of the site. This Bill is now pending in the House of Representatives.



# Current Developments

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## INTERNATIONAL SEISMIC SAFETY CENTRE SITE SAFETY REVIEW MISSION

### ADVISORY MEETING IN RELATION TO SITE SELECTION AND EVALUATION STUDIES FOR NUCLEAR POWER PLANTS IN THE PHILIPPINES

Mission date: 14-16 April 2010

Location: Vienna

Organized by: International Atomic Energy Agency  
Technical Co-operation Project RAS0053

#### IAEA Advisory Team:

GODOY, Antonio	IAEA, Acting Section Head, ISSC/NSNI
GUERPINAR, Aybars	IAEA, ISSC Consultant
OVIDIU, Coman	IAEA, ISSC
CONNOR, Chuck	USA
OKUMURA, Koji	Japan
SAKAI, Toshiaki	Japan
SERVA, Leonello	Italy

**OBJECTIVE** - to review the status and completeness of available documentation and to prepare a more detailed work plan for reviewing the BNPP site safety.



# **Present Activities of PNRI in Enhancing Safety Infrastructure**

- Institutionalization of nuclear safety culture
- Human resource development
- Regional/International Cooperation (ANSN,EU,IRSN)
- National Linkages (universities and relevant govt. agencies)



# **Present Activities of PNRI in Enhancing Safety Infrastructure**

- establishment of Integrated Management System for PNRI based on IAEA GS-R-3
- maintenance of certification of Nuclear Regulatory Div. on ISO 9001:2008 QMS



# **Present Activities of PNRI in Enhancing Safety Infrastructure**

- Review/revision/development of regulations and standards :
  - CPR Part 5 “Reactor Site Criteria” is now being developed
  - CPR Part 7 – Licensing of Atomic Energy Facilities ( 1974) is being revised



## **Present Activities of PNRI in Enhancing Safety Infrastructure**

- Capacity building:
  1. Conduct of continuing local training courses on “Introduction to Nuclear Power” and “Introduction to Nuclear Engineering”, participated by DOE, NPC and PNRI technical personnel
  2. nuclear safety training of regulatory personnel and other staff





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