SOME EXPERIENCES OF THE FIRST COMMERCIAL NUCLEAR POWER PLANT IN JAPAN

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THE FIRST NUCLEAR POWER PLANT IN JAPAN

Name of the plant : TOKAI-1

Owner of the plant : The Japan Atomic Power Company

Gross design electrical output : 166MWe

Reactor type : Co_2-cooled graphite moderated metallic natural uranium fueled reactor

Supplier : English GEC

CHRONOLOGY OF TOKAI-1

Date of order: 1959

Start of preparation work: February 22, 1960

Start of construction: January 9, 1961

The first criticality: May 4, 1965

The first electric power generation: November 10, 1965

Start of commercial operation: July 25, 1966

Date of close-down: March 31, 1998

OVERVIEW OF NUCLEAR WORLD

1953	August: Calder Hall Unit-1 (60MWe GCR) construction started. December 8: President Eisenhower's ATOMS FOR PEACE speech	
1955	April: Shippingport (100MWe PWR) construction started. August : The first Geneva Conference	November 30: Japan Atomic Energy Research Institute was established. (June 15 in 1956: The institute was reorganized.) December 14: The three bills of atomic energy were approved by the Diet.
1956	May: Dresden-1 (210MWe BWR) construction started. October 17: Calder Hall Unit-1 commercial operation started.	January 1: The three laws of atomic energy came into effect. January 1: Atomic Energy Commission of Japan was established.
1957	July 29: IAEA was established. Berkeley-1&2 (160MWe GCR) construction started. Bradwell-1&2 (129MWe GCR) construction started. October 10: Windscale Unit-1 accident December: Shippingport commercial operation started.	November 1: The Japan Atomic Power Company was established.
1958	May: Yankee Rowe (185MWe WH-PWR) construction started. May: Indian Point-1 (285MWe B&W-PWR) construction started. September: The second Geneva Conference	
1959		TOKAI-1 was ordered.
1960	July: Dresden-1 commercial operation started.	December: JPDR construction started.
1961	July: Yankee Rowe commercial operation started.	January 9: TOKAI-1 construction started.
1962	June: Bradwell-1 commercial operation started. June: Berkeley-1 commercial operation started. October: Indian Point-1 commercial operation started. October: Berkeley-2 commercial operation started. November: Bradwell-2 commercial operation started.	

FUNDAMENTAL POLICY

The three non-nuclear principles

Not to make, possess, or allow the entry into Japan of nuclear weapons

Our experiences of the exposure to nuclear explosions
August 6, 1945:Hiroshima
August 9, 1945:Nagasaki
March 1, 1954:Bikini atolls

Peaceful use of nuclear energy and antinuclear sentiment

On the 14th of December in 1955, the three bills of atomic energy(*) were approved by the Diet.

(*)**原子力3法:原子力基本法、原子力委員会設置法、原子力局設置に関する法律**

STRATEGY FOR NUCLEAR POWER DEVELOPMENT

Sovereign independence line	Fast catch-up line
Fundamental research for development Scientists and academic sectors Introduction of research reactor	Acquisition of industrial experience Engineers and industrial sectors Introduction of large-scale commercial plant

On the 30th of November in 1955, Japan Atomic Energy Research Institute was established.

On the 1st of November in 1957, the Japan Atomic Power Company was established.

ORGANIZATION FOR NUCLEAR POWER PROJECT

Governmental sector's view	Private sector's view
The state of technology: Far away from maturity	The state of technology: Approaching maturity
Technological risk: High	Technological risk: Low
Economic aspect: Uncertain	Economic aspect: Bright

On the 19th of July in 1957, Atomic Energy Commission of Japan made a decision that all the nine electric power companies in Japan should be the responsible entity of the enterprise in cooperation with EPDC(*) on the supposition of introducing a Calder Hall type NPP from UK.
(*) EPDC (Electric Power Development Corporation) was a government-financed establishment for strategic development of large hydro-power plants.

SITE SELECTION

Topography: Terrain from the viewpoint of plant layout, construction work, cooling water intake, etc.

Space: For construction work, establishing exclusion boundary

Cooling water: Amount, stability, temperature, environmental impact by intake and discharge

Ground: Characteristics and depth of base rock, chronological record of earthquakes

Population: Map of population density around the site

Access: Roads, shipping by water

Public acceptance: Sentiment of local people, attitude of local authorities

Others: Airport, military installation, volcano, flood, tsunami

There were a few sites considered. Tokai-Mura was one of them and finally selected. A reason for this decision was that there was Japan Atomic Energy Research Institute already located nearby.

SELECTION OF REACTOR TYPE

Technological aspects: Proven, operating experiences, supplier's capacity

Fuel supply: Long term guarantee, spent fuel treatment, failed fuel treatment

Construction cost: Terms of contract, construction period, liabilities

Generating cost: Guaranteed output, plant availability, maintenance cost, refueling

Service for operation and maintenance: Information supply, technical assistance

Future potential: Technological potential, economic potential

SELECTION OF PLANT SIZE

Project risk: maturity and reliability of the plant technology

Scale merit of plant size: High economic risk in poor operation records

Construction cost: Slow capital turn-over and global investment trend

Maintenance: Burden to maintenance staff

Size of power grid: Accidental shut-down at full power operation

Outlook for demand and supply: Single step fulfilling or multi-step

NURTURING OF TALENT

Basic training

Harwell reactor school (in UK)

Calder Hall reactor operation school (in UK)

International Institute of Nuclear Science and Engineering (in USA)

Practical training

Calder Hall NPP (in UK)

GEC factories (in UK)

Domestic OJT

Evaluation of the tenders

ORDER AND CONTRACT

Tender invitation

Design requirements, Selection of applicants if necessary, etc.

Tender examination

Technical examination, Cost evaluation, Competency etc.

Order and contract

Turn key or Cost and fee, Terms of contract (Output guarantee, Penalty etc.) etc.

Fuel supply contract

Burn-up guarantee, Responsibility for fuel failure, Spent fuel treatment etc.

Others

Insurance

We received the tender from three groups, GEC, AEI and EE, and selected GEC.
Atomic Energy Authority supplied fuels.

PROJECT IMPLEMENTATION

Site examination

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Public hearing

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Application for construction permit

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Safety examination

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Site preparation

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Construction permit

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Construction

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Commercial operation permit

LESSONS LEARNED FROM PROBLEMS ENCOUNTERED

Group 1: Problems inherent in nuclear reactor technology

core physics parameter change due to irradiation, Refueling scheme, Fuel temperature measurement etc.

Group 2: Problems created by application of conventional technology to nuclear engineering

Graphite, Reactor vessel steel, Various quality requirements etc.

Group 3: Problems caused by hasty application of innovative technology

SRU tube vibration, Refueling machine, Hollow fuel rod etc.

Group 4: Problems made known later

Positive temperature coefficient, Steel oxidation, Carbon deposition, Evolution of safety standards etc.

Group 5: Problems specific to the country

Aseismic design of reactor core, Additional safety system against earthquake etc.

Group 6: Problems due to the first of a kind

Delay of completion, Increase in construction and maintenance cost, Lower availability factor etc.

EPILOGUE(1)

- Changing phase of the world

  Enthusiasm at the time of the first Geneva conference in 1955 was cooling down. Journalism turned to be more and more unfriendly to us. Hostile criticism embarrassed us. Some of them were groundless.

  Memory of the Suez crisis in 1956 faded out and cheap oil from the Middle East flooded the world.

  Rapid technical progress was made in thermal power plants.

  Nuclear power had to challenge high efficiency modern thermal power plants in the cost performance.

EPILOGUE(2)

- The rise of American light water reactors

  In December 1963, only three years after the construction of TOKAI-1 was started, Oyster Creek NPP (650MWe BWR) was ordered by the Jersey Central Power and Light Company, and the great bandwagon marketing for American light water reactors was initiated.

  They claimed that generating cost of Oyster Creek was cheaper than any other generating system.

EPILOGUE(3)

- Problems to be solved

  - Reserve fund for decommissioning
  - Radioactive waste disposal
  - Spent fuel reprocessing in associated with Pu credit