Reactor Technology Assessment Methodology: The Assessment Process and Approach

IAEA Nuclear Power Technology Development Section
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Outline: Reactor Technology Assessment

Key Discussion Questions

What is it?  When do I perform it?  Who should do it?  How is it to be done?  Why should it be done?

IAEA Programme Plans to Support Technology Assessment and Selection
What is it not?

- **INPRO:** Technology Assessment (NESA)
  Reactor technology and systems assessment, including potential mix of reactor types, fuel cycles, and supporting infrastructure

- **INIG:** Integrated Nuclear Infrastructure Review (INIR)
  Assists Member State in evaluating the status of their national infrastructure for the introduction of a nuclear power programme.

- **Owner/Operator:** Project Feasibility Study
  Evaluation and determination of whether a selected nuclear reactor project is an appropriate choice, given the project details, including the infrastructure, site, and technology choices. A project feasibility study may assist in defining the envelope or constraints for the Technology Assessment.

- **IAEA Safety Department:** ‘Generic Safety Assessment’
Technology Assessment and Selection

What is it?

Purpose

- **OVERALL**: Determines NPP technology to fulfil energy delivery needs using a systematic process beginning with Policy Objectives
- Assists in refining Infrastructure development
- Develops specific questions to obtain the information from vendors that is required to perform the Technology Assessment
- Develops technical requirements for the bid specification
- Provides the technical core for performing the bid evaluation
- Delivers documented decision-making rationale for the technology choice

Content

- The structured technical evaluation documenting the Policy Objectives and requirements and how well they will be met
Technology Assessment and Selection
The “give” and the “take”

What will the IAEA process approach provide

- A decision-making tool kit for Technology Assessment and Selection
- Approaches for information gathering and assessment that are designed to be technology-neutral
- A process that should allow increased level of detail as it moves from requirements for the bid specification to performing the bid evaluation to monitoring project implementation

What does the IAEA process approach expect

- The Technology Assessment and Selection is performed and completed by the Member State
- The Member State has responsibility and authority for technology decisions that are made at any stage in the process
Technology Assessment within Infrastructure Development

When do I perform it?

**MILESTONE 1**
Ready to make a knowledgeable commitment to a nuclear programme

**PHASE 1**
Considerations before a decision to launch a nuclear power programme is taken

**MILESTONE 2**
Ready to invite bids for the first nuclear power plant

**PHASE 2**
Preparatory work for the construction of a nuclear power plant after a policy decision has been taken

**MILESTONE 3**
Ready to commission and operate the first nuclear power plant

**PHASE 3**
Activities to implement a first nuclear power plant

**OPERATION OF THE FIRST NUCLEAR POWER PLANT**

First nuclear power plant project

Nuclear power option included in national energy strategy

**PRE-PROJECT**

**PROJECT DECISION MAKING**

**CONSTRUCTION**

**COMMISSIONING**

**FEASIBILITY STUDY**

**BIDDING PROCESS**

**REACTOR TECHNOLOGY ASSESSMENT**
Ownership and the Assessment Task Team members are critical success factors

- Owner/Operator shall take full responsibility for the conduct and results of the Technology Assessment
- Technical / managerial Technology Assessment Task Team is assembled with its mission to report the results directly to the (top) decision-maker
- Task Team with full expertise in design, engineering, construction, and operation of facility and its environs
- Consultants should be used as required to supplement the Task Team with specific expertise, reporting to the Task Team management
Key Discussion Questions

What is it?  When do I perform it?  Who should do it?  How is it to be done?  Why should it be done?

IAEA Programme Plans to Support Technology Assessment and Selection
Technology Assessment and Selection Process: Basic Steps (Slide 1)

1. Establish a competent Technology Assessment Team/Group
   • Organization & HR

2. Develop the key criteria and requirements based on relevant policy goals and objectives, such as
   • National energy plan
   • National infrastructure: the grid, site, and environmental characteristics
   • Local conditions: industry, economy, workforce, and demography
   • Regulatory and safety requirements, emergency planning needs
   • Economics: plant costs and financing expectations
   • Security, physical protection and safeguard requirements
   • Performance requirements

3. Assure that the relative importance of each of the selected policy goals and objectives has been established

4. Identify NPP designs and technologies that are commercially available and have the potential to meet the general criteria
5. Identify and evaluate key technical features and requirements that are tied to the policy goals and objectives

6. Develop specific input requirements and associated questions for technology holders to obtain consistent information required to perform the assessment

7. Determine factors and importance weighting associated with the assessment elements and features

8. Evaluate influences or quantify uncertainty and risk assessment factors

9. Perform assessment and derive rankings using decision-making process approaches

10. Integrate and validate the results of the combined assessments
Technology Assessment and Selection Process
High-Level Task Flowchart

1. Establish a competent Reactor Technology Assessment Team
   - Policy goals and objectives
   - Develop general criteria and requirements
   - Identify NPP designs and technologies that are commercially available and have the potential to meet the general criteria
   - Identify and evaluate key NPP technical features and requirements
   - Develop specific input and questions for Technology Holders
   - Evaluate influences or quantify uncertainty and risk factors
2. Perform assessment and derive rankings using decision-making process approaches
3. Integrate and validate the results and recommendations of the combined assessments
Common User Considerations (CUC)
Common User Considerations (CUC)

- Sustainability of the nuclear power programme
- Demand for power generation capacity
- Electrical grid characteristics
- Site Characteristics
- Environmental Impact
- Nuclear safety, regulatory framework, and licensability
- Radiation protection
- Nuclear fuel cycle policies
- Nuclear Waste Management
- Safeguards
- Security and emergency planning
- National participation, industrial development
- Human resource development
- Economics on the nuclear energy system (NES)
- Financing of NES Projects
## Technology Assessment Process

### Key Features for Technology Assessment

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<thead>
<tr>
<th>Feature</th>
<th>Rating</th>
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<tbody>
<tr>
<td>Site Considerations and Grid Integration</td>
<td>High</td>
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<tr>
<td>Technical Characteristics and Performance</td>
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<tr>
<td>Major Systems and Components</td>
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<td>Nuclear Fuel Performance</td>
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<td>Radiation Protection</td>
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<td>Owners Scope of Supply</td>
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<td>Supplier/Vendor Issues</td>
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<td>Project Schedule Capability</td>
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<td>Technology Transfer and Technical Support</td>
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Key Features for Technology Assessment
Technical Characteristics and Performance

- Size
- Plant Lifetime
- Proven Technology and Licensability
- Standardization
- Simplification
- Constructability
- Operability and Manoeuvrability
- Inspectability and Maintainability
- Plant Availability and Capacity Factor
- Sustainability – Operation for Planned Lifetime
- Reliability
- Nuclear Safety and Regulatory Issues
Technical Characteristics and Performance Example Weighting Factor Ranges

- Size: High
- Plant Lifetime: Low
- Proven Technology / Licensability: High
- Standardization: Medium
- Simplification: Medium
- Constructability: Low
- Operability / Manoeuvrability: f(locale)
- Inspectability / Maintainability: Medium
- Plant Availability & Capacity Factor: High
- Sustainability – Achieve Planned Lifetime: Low
- Reliability: Medium
- Nuclear Safety & Regulatory Issues: High
Key Features for Technology Assessment
Major Systems and Components

- Nuclear Steam Supply Systems (NSSS)
- Balance of Plant (BOP)
- Instrumentation & Controls Systems
- Electrical Systems
Major Systems and Components

**Nuclear Steam Supply Systems (NSSS)**

- Reactor Design
- Reactor Internals Design
- Reactor Coolant System Design
- Residual Heat Removal and Shutdown Cooling Design
- Emergency Core Cooling System Design
- Containment Design
- Reactor Water Clean Up System Design
- Chemical Volume Control System Design
- Fuel Rod and Control Rod Design
- Fuel Pool Cooling Design
- Water Storage, Liquid Radwaste and Gaseous Radwaste Design
- Main Steam Design
- Ultimate Heat Sink
Major Systems and Components

Balance of Plant (BOP)

- Main Feedwater Design
- Main Condenser and Condensate System Design
- Circulating Water Design
- Service Water Design
- Reactor Building Closed Cooling Water Design
- Turbine Building Closed Cooling Water Design
- Main Turbine Design and Steam Bypass Design
- Heating, Ventilation, and Air Conditioning Systems
- Feedwater Heating System
- Extraction Steam and Heater Drains Design
- Service Gas Design
- Fire Protection Systems
- Simulator Design and Fidelity
Major Systems and Components

Instrumentation & Controls Systems

- Reactor Protection System
- Engineered Safeguards Actuation System
- Balance of Plant Engineering Safeguards Actuation System
- Feedwater Control System Design
- Steam Bypass Control System Design
- Nuclear Instrumentation Design
- Radiation Monitor System Design
- Remote Shutdown System Design
- Compliance with Accident Monitoring Instrumentation Criteria
- Main Control Room and Human Factors Design
Major Systems and Components

Electrical Systems

- Offsite Power System Design
- Onsite Power Distribution System Design
- Diesel Generator Design
- Class 1E DC System Design
- Class 1E 120 Volt Instrument AC System Design
- Non-Class 1E DC System Design
- Non-Class 1E Uninterruptable Power Supply
- Transformers
- Switchgear
Technology Assessment Process

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# Technology Assessment Process

## Risk and Uncertainty Areas for Consideration

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<th>Considerations</th>
<th>Relationship with Designer / Vendor</th>
<th>Relationship with Suppliers</th>
<th>Strength of Vendor/Supplier Relationship</th>
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<tr>
<td>Relationship Considerations</td>
<td>(High)</td>
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<td>Technical Support Available</td>
<td>(Varied)</td>
<td>Vendor Long Term Technical Support (High)</td>
<td>Experienced Utilities: Willing to Help (High)</td>
<td>User/Utility, including Owners Groups (Low)</td>
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<td>Potential Risk Contributors</td>
<td>(High)</td>
<td>Project Schedule Risk</td>
<td>Long Term Fuel Supply Security</td>
<td>Project Financing Assistance/Assurance (Very High)</td>
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Technology Assessment and Selection Process:
Perform Assessment: Derivation of Rankings

Five Point Scoring System

1. Unacceptable Performance
2. Average Performance
3. Superior Performance

Nine Point Scoring System

1. Unacceptable Performance
2. Quartile 4
3. Quartile 3
4. Quartile 2
5. Quartile 1
6. Average Performance
7. Superior Performance
8. 4
9. 3
10. 2
When you have completed the Technology Assessment process, you will have identified the following:

- **Important design features and critical factors in the decision-making process**
- **Programmatic features which are required to achieve success**
- **Future strategies to improve success**
2011  Steps to develop and deliver the “Reactor Technology Assessment for Near Term Deployment” report:

- Develop Draft Report to incorporate IAEA and industry experience from 2007 to present for internal review
- Issue reviewed Report for Consultancy review and input
- Integrate Consultancy input and incorporate process approach alternatives into final draft
- Workshop with Member States and vendors to introduce and demonstrate Technology Assessment features [5-9 December]
- Develop Final Report for review and publication
2012  Steps to deliver the “Reactor Technology Assessment for Near Term Deployment” practice and experience:

- First Interregional Training Course on Tools and Methodologies for Nuclear Reactor Technology Assessment
  Vienna, Austria  July
- Technology Assessment Workshop Vietnam  May
- Technology Assessment Workshop Malaysia  October
- Technology Assessment Workshop Chile  December

2013 NPTDS Plans include continuing Technology Assessment & Selection capacity building for Member States, and issuing the document that has been approved.

TM in June, Expert Mission (Uruguay) summer, workshop.
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IAEA Programme Plans to Support Technology Assessment and Selection
Thank you for your attention!