TPA TECHNOLOGY STATUS

PRESENTATION TO THE TPA INDUSTRIAL ADVISORY COMMITTEE

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15 JANUARY 1986
TPA TECHNOLOGY METHODOLOGY STEPS

STEP

1. Characterize Issues

2. Specify Objectives

3. QUANTIFY EXPERIMENTS, MODEL NEEDS

4. EVALUATE FACILITIES
   - Existing
   - New

5. DEVELOP PATHWAYS
   - a
   - b

   COMPARE PATHWAYS

TEST PLAN
TPA TECHNOLOGY STATUS SUMMARY

- Completed Steps 1 and 2
  - Characterize Issues
  - Specify Objectives

- Interim Report is being reviewed

- Phase II will focus on Steps 3-5
  - Major Experiments and Facilities
  - Technical Logic Network
DEFINITION OF ISSUE?

• DIFFICULT TO DEVELOP PRECISE MEANING

• OFTEN USED TO CONvey DIFFERENT MEANINGS:

   PROBLEM

   UNCERTAINTY WITH NEGATIVE CONSEQUENCE

   ELEMENT

   TECHNICAL AREA, TOPIC

• Seldom used to mean positive.
ISSUE CHARACTERIZATION ITEMS
IN TECHNOLOGY REPORT

1. Description

2. Potential Impact on Design
   - Feasibility
   - Attractiveness

3. Design Specificity
   How Generic/Specific Relative to
   - Class of Designs
   - Technology Component
   - Confinement Concepts

4. Overall Level of Concern
   Overall Importance to Fusion
   Composite: Based on 2, 3 and other factors
POTENTIAL IMPACT ON DESIGN

Feasibility Issues

- May Close the Design Window
- May Result in Unacceptable Safety Risk
- May Result in Unacceptable Reliability, Availability or Lifetime

Attractiveness Issues

- Reduced System Performance
- Reduced Component Lifetime
- Increased System Cost
- Less Desirable Safety or Environmental Impact
EXAMPLES OF ISSUES
PRIMARY ISSUES FOR MATERIALS

• Radiation Effects on Materials Properties
  - Mechanical
  - Thermophysical
  - Thermochemical
  - Others

• Baseline (Unirradiated) Properties
  - Necessary for Scoping Prior to Irradiation

• Fabrication/Joining
PRIMARY ISSUES FOR BLANKET

**LIQUID METAL**

- MHD Effects
- Compatibility
- Irradiation Effects Structure

**SOLID BREEDER**

- Tritium Recovery, Inventory
- Thermomechanical Interactions
- Irradiation Effects Structure/Breeder/M

- Fuel Self Sufficiency
- Tritium Extraction, Control
- Failure Modes and Effects
PRIMARY ISSUES FOR PLASMA INTERACTIVE COMPONENTS (PIC)

- Particle Exhaust, Recycling
- Erosion/Redeposition
- Energy Removal/Recovery
- Thermomechanical Loading and Response
- Radiation Effects
- Tritium Permeation and Inventory
- Fabrication
EXAMPLES OF OBJECTIVES
OBJECTIVE

- Identifies what must be achieved and a direction for achievement

ATTRIBUTE

- A specific or quantifiable parameter to indicate the degree to which its associated objective is met

- Variety of Measurement Scales
  
  Natural, Proxy, or Constructed
FUSION NUCLEAR TECHNOLOGY

OBJECTIVE

Show that it will be possible to develop attractive nuclear technology subsystems under conditions relevant to fusion energy sources.

Provide a predictive capability which can be used to assess the performance of fusion nuclear subsystems.
BLANKET OBJECTIVE
DEVELOP ATTRACTIVE BLANKET TECHNOLOGY
FOR ENERGY AND FUEL PRODUCTION AND RECOVERY

ATTRACTIONNESS (Subobjective)

ECONOMICS/PERFORMANCE (Sub-Subobjective)
ATTRIBUTE: CS-E

SAFETY/ENVIRONMENT (Sub-Subobjective)
ATTRIBUTE: CS-S

PREDICTIVE CAPABILITY AND UNDERSTANDING (Subobjective)
ATTRIBUTE: CS-P
<table>
<thead>
<tr>
<th><strong>Economics/Performance</strong></th>
<th><strong>Safety/Environment</strong></th>
<th><strong>Prediction/Understanding</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Neutron Wall Load</td>
<td>• Chemical Reactivity</td>
<td>• MHD</td>
</tr>
<tr>
<td>• Surface Heat Flux</td>
<td>• Response to Loss-of-Coolant</td>
<td>- Fluid Velocity Profile</td>
</tr>
<tr>
<td>• Tritium Breeding</td>
<td>• Vulnerable Tritium Inventory</td>
<td>- Pressure Drop</td>
</tr>
<tr>
<td>• Thermal Efficiency</td>
<td>• Long-term Activation</td>
<td>- Heat Transfer</td>
</tr>
<tr>
<td>• Energy Multiplication</td>
<td>• Afterheat</td>
<td>- Corrosion</td>
</tr>
<tr>
<td>• Blanket Thickness</td>
<td>• Routine Radioactivity Release</td>
<td>• Tritium Inventory</td>
</tr>
<tr>
<td>• Reliability</td>
<td>• Others</td>
<td>- Solubility</td>
</tr>
<tr>
<td>• Lifetime</td>
<td></td>
<td>- Transport</td>
</tr>
<tr>
<td>• Sector MTBF/MTTR</td>
<td></td>
<td>- Etc.</td>
</tr>
<tr>
<td>• Blanket/Transport Loop Cost</td>
<td></td>
<td>• Materials Interactions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Breeder/Structure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Coolant/Structure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Purge/Breeder</td>
</tr>
</tbody>
</table>
Plasma Technology Objective

Establish the scientific and technological base required for plasma technology.

Magnet Objective

Improve magnets for fusion experiments and establish a data base for the confining magnetic fields technology under conditions applicable to fusion reactors.

Heating and Current Drive Objective

Establish scientific and technological data base for reliable operation of subsystems for heating plasmas to high temperatures and creating desired particle distributions and efficient confinement.

Fueling Objective

Establish scientific and technological data base for reliable operation of subsystems for fueling large, high temperature plasmas.

Remote Maintenance Objective

Develop design inputs, equipment and procedures to support machine availability goals.

Plasma Interactive Components Objective*

Establish the scientific and technological data base for reliable operation of subsystems that provide for plasma particle and energy removal, input power transmission, and impurity control.

*Also shown under Nuclear Technology in Fig. 4.4-1.
EXAMPLES OF PLANNED EFFORT ON
EXPERIMENTS, FACILITIES AND TEST PLAN
Table 2-23. Representative Costs of Key Liquid Breeder Blanket Facilities

<table>
<thead>
<tr>
<th>Item</th>
<th>Capital Cost(^a) (M$)</th>
<th>Operating Cost(^b) (M$/yr)</th>
<th>Duration (years)</th>
<th>Total Cost (M$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced liquid metal flow facility (LMF1)</td>
<td>7-10</td>
<td>0.5</td>
<td>4-6</td>
<td>10-15</td>
</tr>
<tr>
<td>Integral Parameter Experiment (LMF2)</td>
<td>7-10</td>
<td>0.5</td>
<td>4-6</td>
<td>10-15</td>
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<tr>
<td>MHD mass transfer facility (MHDm)</td>
<td>8-12</td>
<td>1.0</td>
<td>6-8</td>
<td>15-20</td>
</tr>
<tr>
<td>Thermal convection loops (~4)</td>
<td>2-4</td>
<td>0.8</td>
<td>4-6</td>
<td>5-9</td>
</tr>
<tr>
<td>Forced convection loops (~4)</td>
<td>4-6</td>
<td>0.8</td>
<td>4-6</td>
<td>7-11</td>
</tr>
<tr>
<td>Tritium extraction test (2)</td>
<td>2-3</td>
<td>0.4</td>
<td>3-4</td>
<td>3-5</td>
</tr>
<tr>
<td>Tritium transport loop test</td>
<td>6-8</td>
<td>0.6</td>
<td>5-7</td>
<td>9-12</td>
</tr>
<tr>
<td>Thermomechanical Integrated Test Facility (TMIF)</td>
<td>20-25</td>
<td>2.0-3.0</td>
<td>8-10</td>
<td>35-60</td>
</tr>
<tr>
<td>Analysis and model development</td>
<td>--</td>
<td>2.0-4.0</td>
<td>15</td>
<td>30-60</td>
</tr>
</tbody>
</table>

\(^a\)In 1985 constant dollars

\(^b\)Does not include analysis of data