UCLA FNT
ITER-Related Effort in FY88

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FY88 FNT Effort for ITER at UCLA

I. Test Program

- Testing Requirements
- Test Program Logic & Definition
- What is Learned from Basic Machine
- Test Module Design (Engineering Scaling)

II. "Basic" Tritium-Producing Blanket

- Criteria for Selection
- Design and Analysis of Low-Risk Reactor-Relevant Blanket

III. Shielding

- Evaluate Safety Factors Used in Determining Peak Radiation Damage and Nuclear Heating Parameters in S.C. Coils.
- Improve Sensitivity/Uncertainty Analysis Methods in 2-D Geometry

IV. Impurity Control and Exhaust System

- (Support) Thermomechanical Analysis

Summary of Suggested Test Program Activity

NOTES: - *This activity includes tests for all components such as blankets, limiters/divertors, shield, magnets, heating. While Nuclear Technology is a critical part, the test program technical activity should study all other components.*
- *Activity to be carried out in collaboration with other organizations*

1. Test Requirements

   - Provide Input on the Requirements of the Test Program on the Major Design Features of the Facility:
     - Major Parameters (e.g., wall load, pulsing/ steady state, fluence, availability, test area)
     - Engineering Design (configuration, maintenance, access, etc.)
   - Develop Ideas for Improving the Value of the Tests [Much information and methodology from FINESSE]

2. Test Program Logic & Definition

   - Test Matrices with Geometry, Test Duration and Device Time
   - Overall Phases for Device
   - Sequence and Logic of Tests (e.g., for blanket: initial scoping with small test elements for a large number of concepts followed by submodule test of smaller number of concepts, concept verification, reliability growth, etc.)

Summary of Suggested Test Program Activities (cont'd.)

3. What is Learned from Basic Machine Components

   - The operation of the individual components (magnets, heating, current device, pumps, etc.) in an integrated system will provide useful information on performance and reliability. Define and quantify such information and identify any improvements in design to increase usefulness of tests.

4. Test Module Design

   - Apply Engineering Scaling to Define the Key Parameters and Features of Test Modules [Much information and methodology from FINESSE]

   - Develop and Analyze Conceptual Design as "Examples" of Test Modules

5. Ancillary Experiments

   - Determine general features of ancillary equipment necessary to support test elements and modules (e.g., heat rejection system, tritium recovery loops, etc.)

Testing Program
"Suggestions on Organization"

It is suggested that the Test Program Activity in ITER be an identifiable, visible technical task with its leader reporting directly to the managing director in the same fashion as leaders of other technical areas (plasma physics, nuclear, etc.; see attached figure for illustration). Combining the test program with another activity (e.g., nuclear area) has many serious drawbacks.

The test program activity can be broken down into several subtasks, as shown on the attached page. Contributions to the various subtasks would come from many of the ITER designers and from various areas of the fusion community.

<u>Incentives</u>

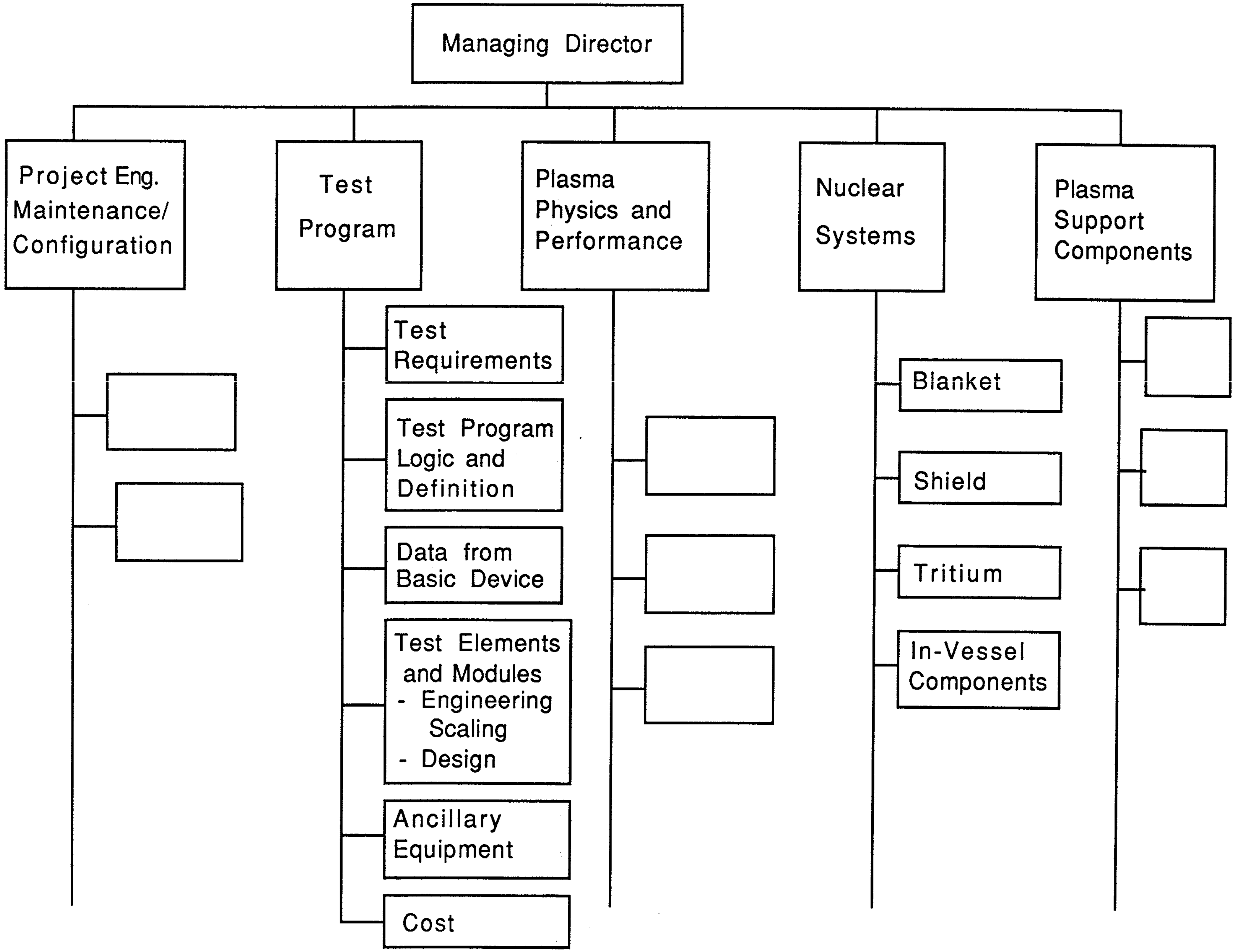
1. An identifiable Test Program Activity task will give greater visibility and focus to the testing activity (physics/engineering components and systems) which is the primary function of ITER. It also seems prudent to invest considerable effort within this activity investigating various issues of testing, thus providing ITER designers with input on the test requirements and also developing the major features of an effective test program (what to test, how, when, etc.)

Testing Program
"Suggestions on Organization"
(cont'd.)

2. Testing issues are difficult and require the use and development of approaches and methods that are different from those for the design. Although some of the technical analysis tools are the same for both design and testing, the depth and emphasis in using the tools are different.

3. The test program covers many areas besides the blanket. Combining the nuclear design and the test program might not lead to an optimum balance among areas within the test program.

4. Some reasonable separation between those developing specifications for the test program and those who will carry out the test program is healthy. There must be, of course, strong technical interactions and collaborations.


Managing Director
Project Eng. Maintenance/ Configuration
Test Program
Plasma Physics and Performance
Nuclear Systems
Plasma Support Components
Test Requirements
Test Program Logic and Definition
Data from Basic Device
Test Elements and Modules - Engineering Scaling - Design
Ancillary Equipment
Cost
Blanket
Shield
Tritium
In-Vessel Components

Tritium-Producing Blanket

- Comprehensive effort is required to evaluate the many issues involved

- Effort requires the capabilities and experience of a number of organizations

Suggested Effort

1. Evaluate the required performance parameters for the blanket (e.g., TBR) as function of ITER operating parameters (e.g., fluence)

2. Develop Criteria for Selection

   e.g.,
   - risk to ITER from blanket operation
   - reactor relevance
   - R&D required before ITER
   - R&D required after ITER

3. Design, Analysis and Evaluation of a Number of Promising Design Options

4. Recommend a Specific Blanket Concept for ITER. Examine in Detail the Key Design and R&D Issues for this Concept

Tritium-Producing Blanket

UCLA Effort

(Complementary to other organizations)

- Developing Criteria for Selection

- Design and Analysis for One or Two Low-Risk, Reactor-Relevant Blanket Concepts

Examples

- Solid Breeder Blanket with Low-Temperature, Low-Pressure Coolant

  - Low-risk, reactor-relevant

  - Main issue: predictable/controllable thermal interface

- Li-Bi-Pb Breeder with Pb-Bi Coolant

  - Oxide formation nearly eliminates pressure drop

  - Low temperature operation

  - Liquid breeder can be replaced by liquid shield (e.g., Pb-Bi) when breeding not needed

Solid Breeder Blanket As Candidate For ITER Tritium-Producing Blanket

Advantages

- Well-studied reactor-relevant material and configuration
- Low temperature, low pressure, low risk water coolant
- Reactor-relevant breeder operating temperature through the use of breeder/clad interface conductance control
- Enhanced tritium breeding through the use of multiplier
- Helium purge flow:
  - Chemistry control for enhancing tritium release
  - Tritium processing from helium well demonstrated and tested through all the in-situ experiments

Solid Breeder Blanket As Alternate For ITER Producing Blanket

Issues

- Breeder/clad interface thermal conductance

  - Control to enable breeder operation at reactor-relevant temperature.

  - Work in this area can also prove beneficial to studies of other design concepts, not only in reproducing reactor-relevant temperature but also in providing the flexibility of allowing for any power variation.

- Choice of solid breeder among leading candidates for reactor blanket

  - Material form (sphere-pac) and fabrication
  - Chemical stability
  - Past comparison studies (FINESSE, BCSS)
  - Recent experimental data

- Beryllium multiplier

  - Material compatibility
  - Swelling

- Purge flow

  - Through sphere-pac or in separate channel
  - Pressure drop
  - Local tritium concentration

Solid Breeder Blanket as Alternate for ITER Tritium-Producing Blanket

Schematic of breeder/clad interface gap whose thermal conductance can be controlled to decouple the solid breeder and coolant temperatures