Test Program Activity

Mohamed A. Abdou

ITER Meeting
PPPL
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Test Program Activity

Objectives

1. Define the test program:
   - Design/engineering scaling of test elements and ancillary equipment
   - Operation scenario

2. Identify the **REQUIREMENTS** and **IMPACT** of testing on the design, operation and safety of ITER

3. Eventually: provide a quantitative evaluation of the "value" of ITER as a testing device

Observations

- Test Program includes:
  - active testing (test elements)
  - information from basic device
- Test Program includes plasma and all reactor-relevant engineering components

Test Program
Key Issues of Immediate Concern

- Recommendation on List of Parameters for ITER (wall load, fluence, steady state/pulsing, etc.) to Satisfy Test Requirements

- Blanket Module Versus Sector Testing

- Divertor Testing
  - Can the divertor for the basic device be used for testing?
  - If no, how else can testing be done?
  - If yes, can we replace a module, or do we need to replace all of the divertor?

- How Do the Test Modules Interface With the Rest of the Machine?

  e.g.,
  - temperature compatibility
  - magnetic compatibility

- How Do All the Ancillary Equipment for the Test Modules Fit Outside the Device?

Test Program
Key Issues of Immediate Concern (cont'd.)

- Reliability/Availability Considerations
  - Can test modules be designed to accommodate failure/damage?
  - What is the impact of scheduled and forced replacement of test modules on machine availability?
  - What are the targets for test module reliability/availability in order to be consistent with overall ITER availability goals?

- Safety Related Issues
  - How do we handle liquid metals? Volume?
  - Validation of plasma shutdown and control?
  - Can Vanadium-type ("unqualified") materials be tested in ITER?

- Benefits and Impact of Testing in Basic ITER Blanket in the Context of Overall Fusion Technology Development (testing before and after ITER)

- How Can Tritium Self-Sufficiency Potential for Fusion Reactors be Demonstrated in ITER?

ITER Test Program

1. Test Requirements
2. Test Program Logic & Definition
3. What is Learned from Basic Machine Components
4. Test Module Design
5. Ancillary Equipment
6. Reliability/Availability
7. Safety Aspects of Test Program
8. Cost

Table 2. Test Program

Task Leaders and Responsibility

Overall: M. Abdou

Task 1: Test Requirements	Task Leader: M. Tillack (UCLA)
Task 2: Test Program Logic and Definition	
Task 3: Information from Basic Machine Components	Task Leader: TBD
Task 4: Test Module Design	Task Leader: R. Mattas (ANL)
Task 5: Ancillary Equipment	
Task 6: Reliability and Availability	Task Leader: S. Thomson (FEDC)
Task 7: Safety	Task Leader: S. Piet (INEL)
Task 8: Cost	Task Leader: S. Thomson (FEDC)

Component Responsibility

In each of the above tasks, the responsibility for tests related to individual components/disciplines is as follows:

Blanket:	R. Mattas (ANL), M. Tillack (UCLA), C. Wong (GA)
HHF Components:	R. McGrath (Sandia A.)
Tritium Systems:	J. Anderson (LANL)
Shielding/Neutronics:	M. Youssef (UCLA)/J. D. Lee (LLNL)
Materials:	R. Puigh (HEDL)
Plasma:	TBD

Summary of Test Program Tasks

NOTE: *This activity includes tests for all components such as blankets, limiters/divertors, shield, magnets, heating.*

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

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 tests of smaller number of concepts, concept verification, reliability growth, etc.)

Summary of Test Program Tasks (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 much 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

   - Use Engineering Scaling to Define the Key Parameters and Features of Test Modules
   - Conceptual Design of "Examples" of Test Modules (blanket, HHFC, tritium processing, etc.)
   - Trade-offs in Size Requirements
   - Evaluate Ability of Test Modules to Accommodate Failure and Damage
   - Assess Benefits/Risks of Tests in Basic Blanket and Divertor
   - Scheme for Demonstrating Tritium Self-Sufficiency

5. Ancillary Equipment

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

Summary of Test Program Tasks (cont'd.)

6. Reliability and Availability Analysis for Test Elements

   - Failure of test elements could have serious impact on the availability of ITER
     - Assess impact
     - Derive reliability/availability targets for test module from device operation requirements

   - Targets for reliability/availability of test elements (pieces, modules, sectors, etc.) are necessary to define the R&D necessary to successfully perform the test program

7. Safety Aspects of Test Program

   - Evaluate features of test module that might impact meeting the overall ITER safety requirements

   - Evaluate Safety Issues
     - Plasma shutdown and control
     - Compatibility of liquid metal testing
     - Compatibility of test module temperature with the rest of ITER
     - Magnetic compatibility
     - Risk/benefit of testing vanadium

   - Identify Safety-Related Tests

8. Cost

   - Cost of the entire test program (capital and operation)

Test Program
Observations/Guideline

- Much Work was Done in the Past
  - Maximize use of previous work
  - More effort on unresolved key issues

- Be Prepared for International Discussion
  - Document the technical basis to support recommendations on all important areas
  - Review previous work, ensure no technical flaw, develop group consensus, document
  - Near-term work should emphasize testing issues of largest impact on selection of ITER design parameters and features
  - Must address issues known to be of serious concern to other countries (e.g., reliability/ availability, some safety issues, sector vs. module)

Table 3. Test Program

Person-Month (for period Dec. 87 to Sept 88)

	UCLA	ANL	FEDC/ ORNL	SANDIA	LANL	GA	LLNL	PPPL	HEDL	INEL
Tasks 1,2: Test Requirements, Logic and Definition	9	2		4	1	0.5	2	2	1	
Task 3: Information from Basic Machine Components	2	1	2	2	1	0.5				
Tasks 4,5: Test Module Design and Ancillary Equipment	3	6		6	1	1				3
Task 6: Reliability and Availability	0.5		2				1			
Task 7: Safety										
Task 8: Cost			2				1			
Management	2									
TOTAL	15	9	6	12	3	2	4	2	4	3

Figure 1. Schedule for Test Program Activities

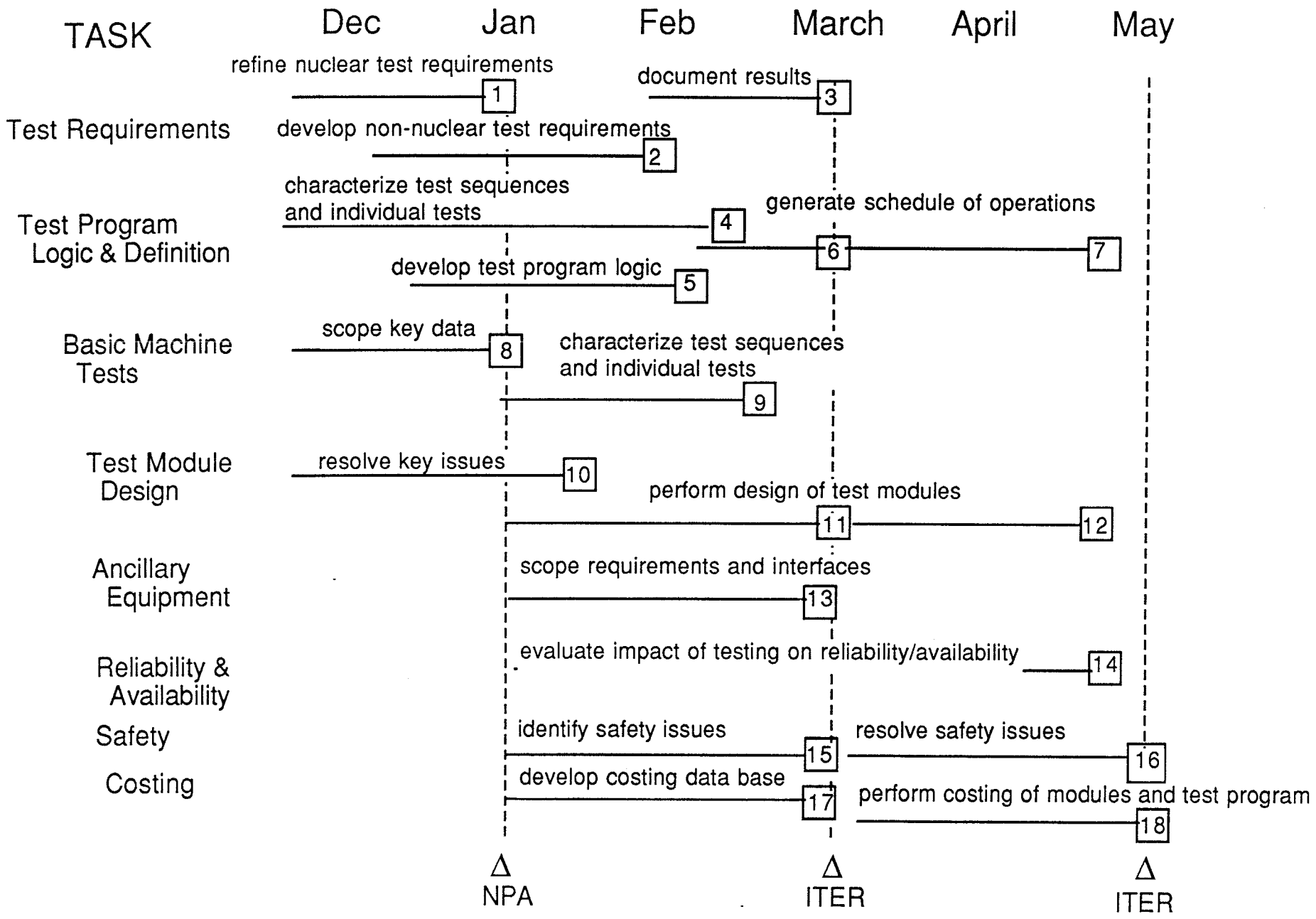

Table 1. Milestones for the Test Program Activity

1. Reassess test requirements under pulsed operations
2. Distribute for review non-nuclear test requirements
3. Complete documentation of test requirements
4. Distribute for review description of tests and test sequences
5. Distribute test program logic and obtain community consensus
6. First draft of complete schedule of operations
7. Final draft of complete schedule of operations
8. Complete preliminary assessment of key measurements
9. Distribute description of tests and test sequences
10. Obtain group consensus on resolution of key issues
11. Complete scoping design of test modules
12. Complete initial design of test modules
13. Distribute preliminary list of subsystems, interfaces, and interface conditions
14. Derive targets for test module reliability/availability
15. Complete initial identification of safety issues
16. Develop recommendations to resolve safety issues
17. Complete costing data base
18. Provide test module, ancillary equipment, and test program costs

Schedule

A. January 18 - March 15

Emphasize Key Issues of Importance in International Discussions

- Issues of largest impact on selection of parameters and major design features of ITER

B. March 15 - June 15

- Complete work on list of "key issues of immediate concern"
- Address new issues brought up by other countries

C. June 15 - September 15

- Develop details of the test program
- Documentation

AGENDA

Test Program Meeting

PPPL

(19 January, 10:00am-12:00noon)

Introduction/Overview (20 min.)	Abdou
Review of Previous Work (15 min.)	Tillack
Test Requirements & Program Logic (15 min.)	Tillack
Test Module Design & Ancillary Equipment (15 min.)	Mattas
Test Module Safety (10 min.)	Piet
Information from Basic Machine Components (5 min.)	Abdou/Thomson
Reliability & Availability (15 min.)	Thomson
Materials (10 min.)	Puigh
Other Comments on Specific Areas (10 min.)	Anderson, McGrath, Baker
Discussion (30 min.)	