APEX Status:

Introductory Remarks

APEX Meeting

UCLA

November 2-4, 1998

Mohamed Abdou

SUMMARY ITEMS

- Considerable Progress has been achieved so far, but we still have a long, difficult road ahead of us.

- The APEX ambitious goals and team spirit are providing an environment conducive to innovation. New ideas are already emerging (liquid rotation in fast moving first wall jet, FRC, surface turbulence, heat transfer enhancement, low vapor pressure SnLi coolant, high temperature refractory alloy applications, etc.

* Mohamed Sawan will lead the Evaluation Criteria Group.

* Simple and Effective Evaluation Criteria have been prepared and will be presented Tuesday.

- Dai-Kai Sze will lead the "Tritium and Liquid Coolants / Breeders Data Base" group. [The scope of the flibe group is expanded to address Li, Flibe, SnLi, and other options].

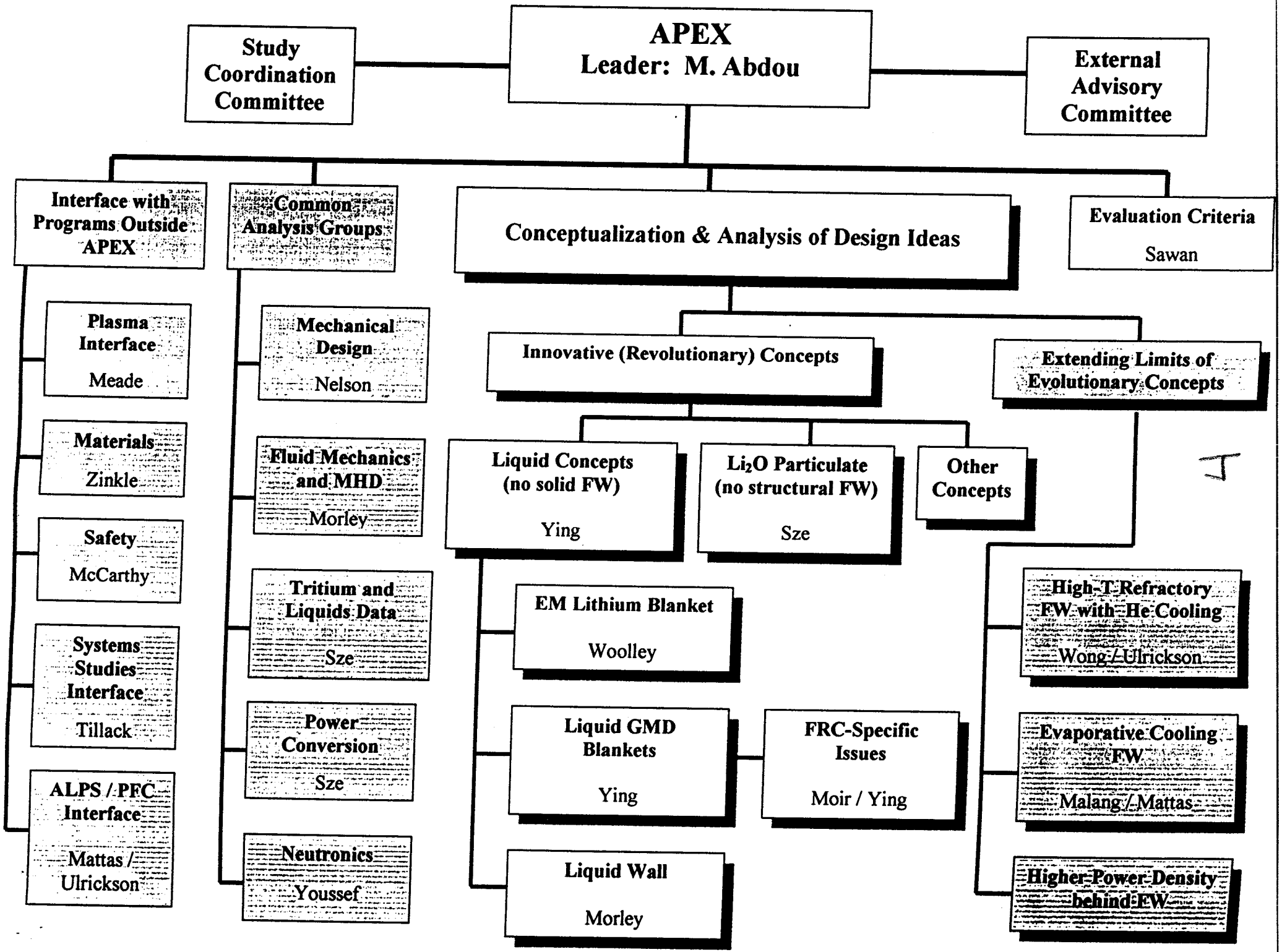
- An Interim Report Outline has been developed for discussion during this meeting.

SUMMARY ITEMS
(continued)

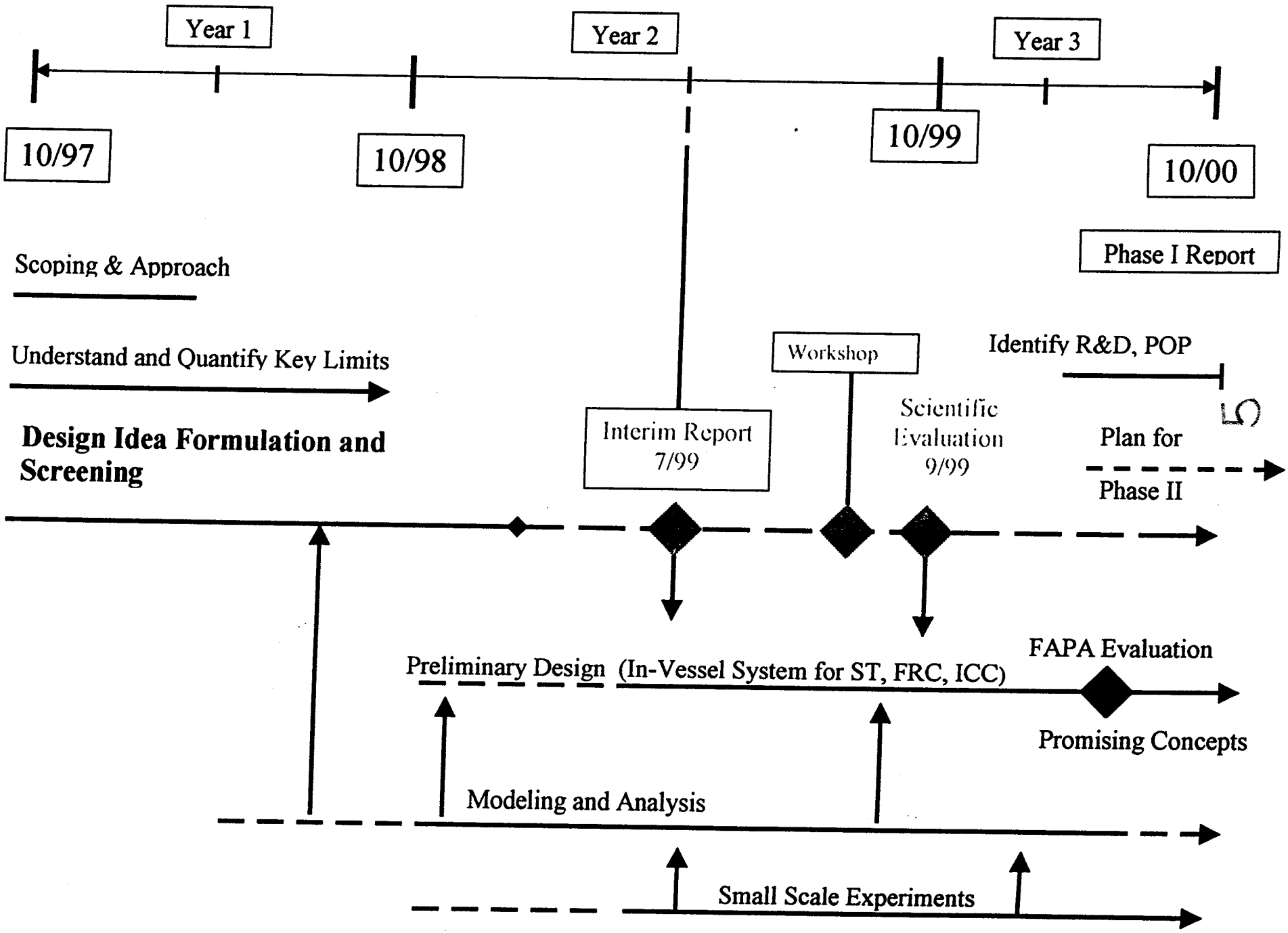
- Low Activation Goals and the Role of High-T Refractory alloys involve some important issues. Suggestion: A Group that specifically looks at this question in the context of APEX results. Group Chair: K. McCarthy. Senior Members: Zinkle, Ghoniem, Petti, Sawan, Youssef, Abdou.

- Note that ISFNT-5 in Rome, September '99, is an excellent opportunity to present the APEX work. Please submit good papers. Abstracts are due January 19, 1999. Please let M. Abdou know of the title and authors for papers you plan on submitting. (We need to ensure coordination among us and good visibility at the Conference).

* Next APEX Meeting will probably include the US-Japan High Power Density Workshop. (Date: February, 1998, either 9-12 or 16-19).


Study Coordination Committee
APEX
Leader: M. Abdou
External Advisory Committee
Interface with Programs Outside APEX
Common Analysis Groups
Conceptualization & Analysis of Design Ideas
Evaluation Criteria
Sawan
Plasma Interface
Meade
Materials
Zinkle
Safety
McCarthy
Systems Studies Interface
Tillack
ALPS / PFC Interface
Mattas / Ulrickson
Mechanical Design
Nelson
Fluid Mechanics and MHD
Morley
Tritium and Liquids Data
Sze
Power Conversion
Sze
Neutronics
Youssef
Innovative (Revolutionary) Concepts
Extending Limits of Evolutionary Concepts
Liquid Concepts (no solid FW)
Ying
Li2O Particulate (no structural FW)
Sze
Other Concepts
EM Lithium Blanket
Woolley
Liquid GMD Blankets
Ying
FRC-Specific Issues
Moir / Ying
Liquid Wall
Morley
High-T Refractory FW with He Cooling
Wong / Ulrickson
Evaporative Cooling FW
Malang / Mattas
Higher Power Density behind FW

APEX Schedule and Milestones for Phase I



Interim Report Schedule

1. Detailed Outline (February 15, 1999)
   January 31, 1999 Key Author for each section:
   -Send detailed outline for your Chapter with names of key authors for each section
   Mid-February: Finalize Report Outline

2. Draft Assembly (June 1)
   -Section Authors send first draft to Chapter Key Author with copies to other authors
   -Comments to be sent back to authors by June 15
   -Second Draft to Key author by June 30

3. Draft Report (July 1)
   -Key Authors send Chapters to M. Abdou and to all members of the team
   -Comments from Team to Authors by July 15

4. Final Interim Report (July 30) [Firm Deadline]
   -All Chapters mailed to M. Abdou

5. Mail Report (August 15)
   -UCLA will mail Report to Community

APEX Interim Report
Draft Outline

Executive Summary (Abdou)

1. Introduction (Abdou)

2. Overview (Abdou, Morley, Ying, Sze, Mattas, Zinkle, Nelson)

3. Study Approach (Abdou, et al)

4. Thick Liquid Blanket Concept (Ying, Gulec, Moir, Nelson, Youssef, Sze, Hassanein, Smolentsev, et al)
   - 4.1 Introduction
   - 4.2 Idea Description
     - 4.2.1 Applications to Tokamaks
     - 4.2.2 Applications to ST
     - 4.2.3 Applications to FRC
   - 4.3 Heat Transfer Analysis
   - 4.4 Fluid Mechanics Analysis
   - 4.5 Initial Mechanical Design Description
   - 4.6 Neutronics Analysis

4.7 Evaluation of Liquid Options (Li, flibe, SnLi)
4.8 Performance Summary and Tables (Tables per Evaluation Criteria Requirements)
4.9 Key Issues and R&D

5. Electromagnetically Restrained Lithium Blanket (R. Woolley, et al)

6. Liquid Wall Concept, CLIFF (Morley, Ying, Gulec, Nelson, Smolentsev)

7. Data Base for Liquid Breeders and Coolants, Li, flibe, LiPb, and LiSn (Sze, et al)

8. Li2O Particulate Flow Concept, APPLE (Sze, Igor, Sawan, Tillack, et al)

9. Evaporative Cooling Concept, EVOLVE (Mattas, Malang, Sawan, et al)

10. High-T Refractory Alloys with He Cooling Concept (Wong, Nygren, Ulrickson, Youssef, et al)

11. Plasma-Interface Issues and Edge Modelling (Meade, Rognlien, Brooks, Mattas, Uchimoto, Hassanein, et al)

12. Materials Considerations and Data Base (Zinkle, Ghoniem, Billone, Majumdar, Mattas)

13. Safety Consideration and Analysis (McCarthy, et al)

14. Activation Considerations for Structural Materials (McCarthy, Zinkle, Ghoniem, Petti, Sawan, Youssef, Abdou, et al)

15. Tritium (Sze, Willms)

16. Power Conversion (Sze, et al)

17. Evaluation Criteria (Sawan, et al)

18. Key Issues and R & D, near term and intermediate term (Abdou, all lead authors for Chapters)

APEX Community Workshop

- We plan to hold an APEX Workshop for the community

Purposes

-Communicate Progress, New Idea, and Results of Analysis to the community
-Receive Feedback from community
-Stimulate others to think of new ideas

- Date for the Workshop
  -After Interim Report is Issued
  -Interim Report will be issued August 15 but there are scheduling conflicts
  -Snowmass: July 11-24
  -IEA Workshop on Beryllium: September 15-17
  -ISFNT-5 (Rome) is September 19-24
  -ICFRM (Colorado, Springs) is October 11-15

Date for Workshop?
September 8-10?
October 19-21?

Scientific Evaluation Criteria

(1) Does the concept meet the minimum functional requirements?
- Tritium breeding
- Tritium extraction
- Vacuum
- Plasma exhaust
- Power extraction

(2) Does the concept have potential for improved attractiveness?
- High power density and heat flux handling
- High power conversion efficiency
- High availability (low failure rate and short maintenance time)
- High safety & environmental attributes
- Low cost

(3) What are the design margins and uncertainties? (e.g., in temperatures, stresses, and TBR)

(4) Were major critical issues addressed and R&D needs identified?

Scientific Evaluation Approach

- The evaluation group will develop the criteria for the Scientific Evaluation
- The evaluation group will add more details to the evaluation criteria with some quantitative requirements (e.g., for TBR)
- The evaluation criteria will be utilized to compare different options in the same concept (e.g., compare performance of different breeders in liquid wall concepts)
- Immediately after the community workshop, the evaluation group will collectively evaluate the concepts based on information in the interim report and feedback from the community workshop
- Experts from outside the team might be added to the evaluation group during the concept evaluation

Agenda for APEX Study Meeting

University Of California-Los Angeles
Faculty Center, California Room
November 2-4, 1998

Monday, November 2

8:30 a.m.	Coffee/Muffins	
Session I: Study Status and Direction (Chair: Sam Berk)		
9:00 a.m.	OFES Remarks	Berk
9:15 a.m.	Status	Abdou
9:50 a.m.	Secretary's Announcements	Youssef
Session II: APPLE and EVOLVE Concepts (Chair: Richard Mattas)		
10:00 a.m.	APPLE Concept:	
	• Progress	Sze
	• Particulate Flow Dynamics	Tillack
	• Configuration and Engineering	Igor
11:00 a.m.	EVOLVE Concept:	
	• Status of EVOLVE	Mattas/Malang
	• Neutronics of EVOLVE	Sawan
12:00 noon	Group Discussion	
12:30 p.m.	Lunch	
Session III: Liquid Wall Concepts (Chairs: Neil Morley and Brad Nelson)		
1:30 p.m.	Recent Analysis and Design Implementation for the Convective Liquid Flow First Wall (CLiFF) Concept	Morley
1:50 p.m.	Progress on the GMD Thick Liquid Wall Design for Advanced Tokamak Configuration	Ying
2:20 p.m.	Heat Transfer Issues for Liquid FW Concepts:	Gao/Ying
	• Turbulent Heat Transfer Enhancement	
	• Impact of Temperature Distribution on Flow Stability	
2:40 p.m.	Mechanical Design for Piping and Penetrations in Liquid Concepts	Nelson
3:10 p.m.	Coffee Break	
3:25 p.m.	Axisymmetric Simulation of EM Restrained Lithium Blankets	Woolley
3:55 p.m.	Shield Performance and Magnet Protection in Thick Liquid Wall Concepts	Youssef
4:10 p.m.	Summary of the Flibe Assessment Group and Report on the ORNL Flibe Meeting	Sze
5:00 p.m.	Sn-Li, A Coolant/Breeder Material Developed for APEX/ALPS Applications	Sze
	• Breeding Potential Relative to Other Liquid Breeder	Sawan
	• Safety Issues Of Li-Sn and Flibe	McCarthy
5:50 p.m.	Group Discussion	
6:15 p.m.	Adjourn	

Tuesday, November 3

8:00 a.m.	Coffee/Muffins	
Session IV: He-Cooled Refractory Metal FW/Blanket/Divertor Concept (Chair: Mahmoud Youssef)		
8:30 a.m.	The Helium-Refractory First Wall Blanket CAD	Nelson
8:50 a.m.	Design Model for Dual Channel He Cooled Heat Sink	Nygren
9:05 a.m.	Profiles of Heating Rates and Damage in the He-Cooled Refractory Metals Concept	Youssef
Session V: Materials and Data Base Evaluation (Chair: Steve Zinkle)		
9:15 a.m.	Updated Data on Corrosion of Structural Materials (including volatile oxidation of Mo, W, oxygen partial pressure vs. temperature limits)	Ghoniem
9:40 a.m.	Thermomechanical Properties of W-Re Alloys	Zinkle
10:05 a.m.	Coffee Break	
Session VI: FRC Configuration (Chair: Robert Woolley)		
10:20 a.m.	FRC Design Status	Gulec/Moir/ Santarus
10:30 a.m.	Liquid Blanket Configurations for FRC	Gulec
11:20 a.m.	Group Discussion	
Session VII: Plasma Interface Issues (Chair: Richard Mattas)		
11:30 a.m.	Bremsstrahlung Radiation Spectrum	Uchimoto
11:50 a.m.	Impurity Ion Penetration into the Edge Plasma Region	Rognlien
12:20 p.m.	Lunch	
1:30 p.m.	Summary of Work of ALPS/APEX Plasma Modeling Group	Rognlien/Brooks
2:00 p.m.	Disruption/Surface Stability	Hassanein
2:20 p.m.	Summary of Japanese Activities on Liquid Metal Studies	Nygren
2:50 p.m.	Group Discussion	
3:15 p.m.	Coffee Break	
Session VIII: Evaluation Criteria and Discussion on Concepts (Chairs: M. Abdou and M. Sawan)		
3:30 p.m.	Evaluation Criteria	Sawan
3:45 p.m.	Discussion on Evaluation Criteria	
4:15 p.m.	Discussion by Participants on all Concepts and Options for Concepts (Key Issues, suggestions, etc. from APEX team point of view)	
6:00 p.m.	Adjourn	

Evening: Group may wish to meet for dinner. Wendy can help with reservations.

Wednesday, November 4

8:00 a.m.	Coffee/Muffins	
Session IX: Key Issues and Plans (Chairs: Mahmoud Youssef and Mohamed Sawan)		
8:30 a.m.	Each speaker is to summarize key technical issues, planned tasks (what will be done and who will do it) for the next 6 months, and schedule other open technical and management issues.	
	CLIFF (15 min)	Morley
	GMD and FRC (15 min)	Ying/Gulec
	APPLE (15 min)	Sze
	EVOLVE (15 min)	Mattas/Malang
	He-cooled Refractory (15 min)	Nygren
	Mechanical Design (15 min)	Nelson
	Materials (10 min)	Zinkle
	Safety (10 min)	McCarthy
	Plasma Disruption (10 min)	Hassanein
10:30 a.m.	Coffee Break	
10:45 a.m.	Virtual Laboratory for Technology	Baker

Session X: Study Direction (Session Chair: Mohamed Abdou)

11:00 a.m.

- Comments and Suggestions on Future Directions
- Interim Report Outline and Schedule
- Solicitation of New Ideas
- Competitive Proposals Process
- Next Meeting Plans
- Plans for US-Japan Workshops

12:30 p.m. Adjourn