Summary of the General Session of APEX-13 Meeting
November 17, 2000

The main topics discussed in this morning session follow. Some of the items from the Steering Committee meeting held in the evening of November 16 were carried out for more discussion and input from the whole APEX team (see the SC summary). Action items decided during this session, including those agreed upon in the SC meeting, are shown in RED:

(1) The objective, mission, role, and future plan of the Liquid Surface Technology (LST) Working Group
(2) The conducting shell and its usefulness in the context of liquid wall deployment
(3) Alternate Concepts
(4) Direction and Plans for Task IV and Task III
(5) Direction and Plans for task II and I
(6) Materials
(7) Resolve allocations for FY01
(8) Date and format of the next APEX meeting
(9) Plans for the Peer Review Meeting in the Spring

Liquid Surface Technology (LST) Working Group

Major part of discussion was devoted to this new initiative. The formation of this working group was proposed by Sam Berk during the town meeting held in the evening of November 14 under the leadership of Mike Ulrickson. The objective of this group is to enable plasma experiments, such as NSTX and C-Mode, to meet their near-term objectives and goals by developing two-stage plan for deployment of liquid surface technology. The first phase will assess options with input from experiment team, PMI, materials, thermal and mechanical design, and MHD analysis, to arrive at a baseline option that could lead to improving the plasma confinement and operation parameters . The second phase will dwell on developing a sequence that could lead to a larger module design with similar inputs including flow system and fabrication. The group will draw expertise for this short-term application from both the ALPS and APEX teams who will continue their original long-term mission of developing innovative concepts for high power density chamber technology and high heat flux components for divertors/limiters. It is envisioned that deployment of LST in NSTX to start in the first quarter of 2003, but it could be later, depending on the operation schedule of the devise. Sam Berk suggested naming this group "Application of Liquid-plasma Interaction Science and Technology Working Group", ALIST WG. Mike Ulrickson has already plan to visit PPPL after the Thanksgiving's Holiday to further discuss and solidify the objectives of this WG.

In the context of LST deployment in Tokamaks, Leonid Zakharov (PPPL) emphasized the substantial improvement and benefit of exploring new plasma operating regime by adopting the lithium wall initiative in Tokamaks and Stellarators. He proposed the deployment of copper solid wall first as a stabilizer and then introduce lithium walls to improve plasma confinement

The Conducting Shell and Plasma Control

A lengthy discussion focused on this topic during the meeting. Mohamed Abdou (UCLA) indicated that this shell could be 3-4 cm liquid Li falling freely at the front surface or be confined between two solid layers. Its closeness to the plasma will allow much higher elongation and hence better plasma performance. The liquid conducting layer could satisfy liquid continuity requirement without breaking the modularity of solid walls behind it. There is a risk involved but the benefit is tremendous. The design of this shell and quantifying the requirements needed to achieve continuity and plasma control was emphasized in the discussion. Learning from the design of plasma control and feedback system in DIIID and ARIES study was encouraged. The deployment of the conducting shell in the context of LW application was viewed by participants as a stand-alone and separate task within APEX study that should involve both physicists and engineers. It was decided (Mohamed Abdou) to initiate this effort by arranging for a conference call with Bob Kaita (PPPL), Mike Kotschenreuther (UT) and Neil Morley (UCLA) to discuss this matter and to

suggest the involvement of other people from the fusion community such as Tony Taylor (GA), C. Kessel (PPPL), and Mike Shaffer (GA).

Alternate Concepts

Ralph Moir (LLNL) will continue to explore LW in other alternate concepts. He emphasized that weak toroidal magnetic field is a major characteristic in FRC (as opposed to strong field in Tokamaks) which makes the application of LW quite feasible. Intermediate magnetic field is found in Spherical Tokamaks (ST) and RFP where Li can be flown almost along the field line. It was argued that Stellarators have toroidal variations in the magnetic field which would require 3D analyses. Richard Nygren (SNL) pointed out that at least the geometrical differences in these alternate concepts should be well characterized in order to find means to integrate the divertors with the FWs in these concepts. The participants preferred to examine first simpler geometry and Ralph will therefore start to evaluate liquid wall concepts in Spheromaks and continues this evaluation in FRC. It was also decided to have Tom Rognlien (LLNL) continue his plasma edge modeling and expand his effort to these alternate concepts.

Task IV and Task III Plans

Several concepts (11) were put on table by Clement Wong (GA) for discussion as a possible options for evaluation in FY01 in Task IV. LiPb/SiC (similar to ARIES AT) and Flibe/W-Cloth received the highest priority. It was agreed to start first with LiPb/SiC option and maintain coordination with Task III management (Sze/Nelson) who will adopt the same concept but with a 2 cm–thick Sn layer flowing in front of the FW. It was emphasized that the proposed work in APEX on LiPb/SiC concepts is different from the ARIES-AT study in the sense that the FW design and configuration to handle high power density will be different. Determining the wall load and temperature windows and limits will be the main focus in Task III and IV. Task III will also evaluate the Flibe concept with a structural material yet to be determined after meeting and consulting with the Japanese partners in the US/Monbushu collaboration. Mohamed Abdou suggested spending the first seven-month in FY01 looking into the LiPb/SiC concept before starting to evaluate the Flibe concept. Mahmoud Youssef (UCLA) pointed out that the best structural material to be used with Flibe as far as TBR is concerned is ferritic steel, SiC, and Vanadium alloys when beryllium is used as a multiplier.

The direction in FY01 for Task IV assessment will be: (1) evaluation of LiPb/SiC and possibly other concepts, (2) R&D requirements and (3) experiment on studying the effect of magnetic field on the boiling regime within the EVOLOVE concept. The direction in FY01 for Task III will be: (1) Sn/LiPb/SiC concept evaluation and (2) oversees all other design issues for liquid walls, including alternate concepts. Designing the nozzles and penetrations in LW concepts is still viewed as critical issues to be carried under Task III.

Management of Task III will provide Mohamed Abdou with technical and management plan for FY01. It was also emphasized to maintain continuous coordination with the ARIES team.

Task II and Task I Plans

It was agreed that Task II will only focus on modeling and experiments whereas all design issues will be under Task III. Main collaborators in Task II from outside UCLA are PPPL, SNL, and ORNL and the main experimental facilities are M-TOR and FLYHI. At the moment, the modeling for coupling 3-D heat transfer/MHD is in developing stage. Neil Morley (UCLA) will distribute a memo showing the techniques that are currently available and the timeline for expanding the heat transfer/MHD capabilities for free surface liquid flow. Coordination effort with other experiments done outside APEX study (e.g. Japanese experiments) will be maintained under Task II.

Part of Task I will encompass the work scope of the ALIST WG (see above), identification of R&D that are directed towards fulfilling the needs of NSTX, and thermal and MHD analysis specific for NSTX. The work under Task I will be most impacted by ALIST WG.

Materials

The compatibility issues of W and SiC with liquid materials such as Flibe was raised. Steve Zinkle (ORNL) indicated that to fully resolve this question we need to perform full-blown experiments that also address tritium chemistry and Fluorine generation. It was pointed out that such approach is expensive and outside the scope of APEX. The materials support will be focusing on guiding APEX team on the best materials and compatibility issues for which some data currently exist. Sam Berk will further discuss with Zinkle the support APEX can receive from the materials program within APEX budget.

Allocations for FY01

During the general session resources allocation for Task IV was agreed upon. Allocations for other tasks were previously discussed under reduced budget for FY01 and were indorsed during the Steering Committee Meeting.

Date and Format of the Next APEX Meeting

The next physical meeting for APEX will be held at UCLA during the 2nd or 3rd week of April, 2001. Final date will be determined based on minimizing any time conflicts. The next electronic meeting is scheduled during the 1st week of February, 2001. Confirmation of these dates will be issued soon.

Plans for the Peer Review Meeting

Sam Berk indicated that the date of the Peer Review Meeting for APEX is flexible and can be arranged after the physical APEX meeting scheduled to be held in April, 2001.

Mahmoud Youssef
APEX Scientific Secretary
Date: November 21, 2000