APEX 5-Year Goal

Fundamental understanding of free surface fluid flow phenomena and plasma-liquid interactions verified by theory and experiments.

APEX: FY 2000 Task II

Explore high pay-off liquid wall options.
Include:

a) tokamaks and other confinement schemes,
b) flibe and liquid metals (Li and Sn Li),
c) concepts with physics advantages, and
d) concepts with engineering advantages.

APEX FY00 Task II: Exploration of High-Payoff Liquid Wall Concepts

Scope:

1. Continue the main APEX mission of exploring high payoff liquid wall concepts that increase the attractiveness of fusion energy

2. Emphasize understanding the key scientific issues.

3. Include:
   - concepts for thick liquid walls utilizing both liquid metals and Flibe
   - thin liquid metal walls that have the potential to improve the physics performance of plasma.
   - other new concepts that are advanced in APEX this year

4. Pursue the continued development of much-needed, generic modeling tools for liquid walls, as well as the initiation of experiments that address fundamental LW issues

Task II: Subtasks

1. **Exploration of thin and thick Liquid Metal wall concepts**

2. **Exploration of thick Flibe blanket concepts**

3. **Exploration of Liquid Walls for non-tokamak plasma confinement schemes**

4. **Materials, safety, and nuclear analysis for high payoff Liquid walls**

Exploration of Thin and Thick Liquid Metal Wall Concepts

1. Bulk Plasma-Liquid metal wall interactions including
   - Effects of liquid lithium walls on discharge evolution, including startup, fueling and transport phases and potential beneficial effects of H gettering and low recycling (PPPL-50k)
   - Effect of liquid metal walls on plasma stability, including potentially beneficial effects of conducing shell and the associated engineering and design requirements on liquid walls (PPPL-50k, UT-50k)

2. Plasma-liquid surface interactions with lithium (covered under ALPS/APEX PLSI)
   - Determine first-wall temperature limits based on Lithium impurity influx in ARIES with optimal assumptions. (LLNL)
   - Brief assessment of advantages of different device geometries and plasma-engineering intervention techniques such as auxiliary heating for impurity wall influx. (LLNL)
   - Work with CDX-U people to get initial UEDGE edge-plasma and impurity influx model in place (minimal calculations) and other ALP/APEX related tasks. (LLNL)

3. LM-MHD numerical tool development and analysis of potential LM wall designs
    - Effect of temporal and spatial field gradients on free surface flow (UCLA-150k)
    - Submerged walls for poloidal flow (UCLA-above)
    - Applied currents and their potential (UCLA-above, Others??)
    - Other flow configurations for better performance during startup (UCLA-above, UT-32k)

4. LM experimental facility setup and initial exploratory experiments with flow on inclined plane with and without field gradients and applied currents. (covered under Task I)

Exploration of Liquid Walls for Non-tokamak Plasma Confinement Schemes

1. Continuation of FRC work

2. RFP, Stellarator, Others??

Materials, Safety, and Nuclear Analysis for High Payoff Liquid Walls

1. Identifying compatible liquid-structure combinations and temperature and other operating limits.

2. Preliminary assessment of erosion rates for various coolant/material combinations as a function of temperature and coolant velocity (focus on key areas such as nozzles and potential non-structural insulators or semiconductors like SiC)

3. Analysis of safety issues for liquid walls

4. Flibe and Sn-Li vapor and

5. Nuclear analysis and activation