APEX Task III

Practical Engineering Issues Associated with the Design of a Liquid Wall

Plans for FY99

APEX Meeting
UCLA

November 10, 1999

Task III: Practical Engineering Issues Associated with the Design of a Liquid Wall

Task Co-Leaders: **Dai-Kai Sze and Brad Nelson**

Total Effort: **$585k**

This task focuses on investigating the practical engineering issues associated with the design of a liquid wall in a high power density fusion energy system:

1) inlet and exit nozzles
2) hydrodynamic configuration including flow around penetrations
3) integration of divertor functions with flowing liquid walls
4) particle exhaust (He Pumping)
5) liquid pumping
6) liquid temperature profiles and tradeoffs
7) tritium inventory and extraction
8) other engineering-type issues.

The expectation is that this task will also provide valuable input to Tasks I and II.

Strawman approach for task III

- Start with CLIFF flibe because it is better understood, but other systems could be considered

  2 cm flibe layer
  Reference blanket (TBD)

- Start with ARIES-RS as initial configuration

  Power adjusted to reflect higher, APEX power density

- Division of task to two leaders:

  Subtasks 1 - 3 Nelson
  Subtasks 4 – 9 Sze

- Divertor integration seen as critical task

Task III, Subtask 2:

Pumping and Divertor Function Integration (Nygren)

a) Design for Divertor Functions (SNL – 100k)

b) Hydrodynamics and Heat Transfer (UCLA – 40k)

c) Particle Pumping (UW – Igor 30k, ?-20k)

Task III, Subtask 3:

Liquid Wall Fluid Flow Configuration and Design

a) Definition of penetration requirements for plasma heating and flexibility (ORNL-10k)

b) Hydrodynamics and Heat Transfer for inlet, main flow, penetrations, and exit (UCLA-30k)

c) Liquid-bulk plasma interactions (PPPL-10k)

d) Plasma-liquid surface interactions (Rognlien-covered under C.C. Task A)

e) Design considerations and coupling to plasma edge constraints (LLNL-Moir-20k)

f) Structural design (ANL-Majumdar-20k)

g) Inlet nozzle stereolithography models (ORNL – 10k+ depending on no. of models)

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Task III, Subtasks 4 -6 :

III.4 Tritium Recovery and Control (Sze)

a) Tritium recovery, control, and inventory (Sze-30k)
b) Flibe-specific experience (ORNL-Toth?)
c) Tritium Processing (LANL-20k)

III.5 Nuclear Analysis

a) Neutronics (UCLA-Youssef-30k)
b) Activation (UW-Sawan-20k)

III.6 Material Analysis

a) Choice of structure for compatibility, temperature and other operating limits (ORNL- Zinkle-10k, UCLA-Ghoniem-10k)
b) Material issues including erosion for nozzles (ORNL-Zinkle-10k, UCLA-Ghoniem- 10k)

Task III, Subtasks 7 -9 :

III.7 Safety

a) Safety analysis (INELL-McCarthy-25k)
b) Flibe movement after disruption (ANL-Hassanein-20k)

III.8 Primary Loop Design and Power Conversion (ANL-Sze-10k)

III.9 Flibe Chemistry (ANL-Sze-20k)