

Task IV: High-Temperature Refractory Solid Wall

Scope:

This task will investigate the key issues and develop a practical design for high-temperature refractory solid walls. The primary focus will be on the EVOLVE concept (two-phase lithium flow with tungsten alloy). The task allocation here is for EVOLVE. Effort on the helium-cooled concept will be deferred for now (but such effort can be pursued if the EVOLVE tasks are completed early, or performed in piggyback mode).

FY 2000 Tasks:

Coordination (GA-Wong-30k, Malang-15k)

EVOLVE

1. Design:

- a. First wall and blanket 3-D design, configuration and structural support (ORNL-40k)**
- b. First wall design and analysis (SNL-20k)**
- c. Blanket design and analysis (GA-20k)**
- d. Structural analysis of key locations (GA-20k)**
- e. Nuclear analysis (TBR & afterheat) and activation (UW-40k, UCLA-10k)**
- f. Safety design and analysis (INEEL-25k)**

2. R&D, Analysis and Modeling:

a. For First Wall

a-1 Spray concept: evaluate uniformity and heat removal capability of the first wall heat removal including wetting and MHD effects (UW-15k, ANL-15k)

a-2 Heat pipe concept: evaluate heat removal capability including MHD effects (ANL-15k)

a-3 Analysis (SNL-20k)

a-4 Fabrication (SNL-20k)

a-5 R&D planning and preliminary testing (SNL-20k)

b. For Blanket

b-1 Flow and boiling heat removal uniformity in tray design including MHD effects (UW-25k, GA-15k)

b-2 Tritium management, including extraction, inventory and migration at high temperature (ANL-15k)

3. Data base

a. W-alloys evaluation/modeling, projected properties, compatibility, design limits, fabrication and costing (ORNL-40k, UCLA-10k)

b. Structural Design criteria for refractory alloy (ANL-20k)

4. Power conversion system, most likely CCGT (GA-20k)

EVOLVE

Technical Feasibility Issues

These tasks will allow the evaluation of thermal and nuclear performance, fabrication, costing, maintenance, safety design evolution and R&D items.

(Task definition)

- **FW/Blanket module configuration design with refractory alloy**

A clear 3-D picture(s) should be provided on the FW and blanket design, including cooling of the walls, piping connections and structural support, including structural analysis.

Continue the assessment of the suitable W-alloy.

Assessment of the fabrication and costing of W-alloy.

- **First wall design, Li vaporization + MHD effects**

Spray approach:

Evaluation and selection of the reference design that would provide uniformity and heat removal capability of the first wall including spatial variation of heat deposition, wetting and MHD effects with high thermal performance and low pumping power.

Capillary approach:

Evaluation and selection of the reference design that would provide uniformity and heat removal capability of the first wall including spatial variation of heat deposition, wetting and MHD effects with high thermal performance and low pumping power.

- **Blanket design, Li boiling + MHD effects**

Evaluation and selection of the reference cascade flow blanket design, including fluid flow uniformity and boiling heat transfer in the tokamak magnetic field configuration to remove the generated power from the blanket breeder and module structure while maintaining high thermal performance and meeting all design criteria.

Performance and acceptance issues

- **Tritium management**

Assessment of tritium management, including extraction, inventory and migration at high temperature, recommend designs to meet routine release goal.

- **Nuclear design and analysis**

Determination of 3-D TBR, afterheat, activation, dpa, He generation activation dose and projected fluence limit of the reference design.

- **Safety design and evaluation**

LOFA and LOCA evaluations and providing necessary safety design to meet the non-evacuation goal.

- **Power conversion**

Evaluation and optimization of the CCGT system.

- **System study**

Provision of reference toroidal designs and COE assessment