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TITLE: A "FIRST STEP" Towards ICF Commercialization

AUTHOR(S): W. W. Saylor, S-4
J. H. Pendergrass, S-4
D. J. Dudziak, S-4

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Los Alamos

Los Alamos National Laboratory
Los Alamos, New Mexico 87545

# A "FIRST STEP" TOWARDS ICF COMMERCIALIZATION

W. W. Saylor, J. H. Pendergrass, and D. J. Dudziak
University of California
Los Alamos National Laboratory
Los Alamos, New Mexico 87545

## INTRODUCTION

Production of tritium for weapons and fusion R&D programs and successful development of Inertial Confinement Fusion (ICF) technologies are important national goals. A conceptual design for an ICF facility to meet these goals is presented.

FIRST STEP (Fusion, Inertial, Reduced-Requirements Systems Test for Special Nuclear Material, Tritium, and Energy Production) is a concept for a plant to produce SNM, tritium, and energy while serving as a test bed for ICF technology development. A credible conceptual design for an ICF SNM and tritium production facility that competes favorably with fission technology on the bases of cost, production quality, and safety was sought. FIRST STEP is also designed to be an engineering test facility that integrates systems required for an ICF power plant and that is intermediate in scale between proof-of-principle experiment and commercial power plant. FIRST STEP driver and pellet performance requirements are moderate and represent reasonable intermediate goals in an R&D plan for ICF commercialization. Repetition rate requirements for FIRST STEP are similar to those of commercial size plants and FIRST STEP can be used to integrate systems under realistic ICF conditions.

## DESIGN SUMMARY

Wetted-wall reactors, conservative pellet gains, modest driver requirements, and reasonable extrapolations of existing technology are combined to arrive at a credible design.[1,2] The reaction cavity is surrounded by a blanket structure that contains fissionable isotopes for energy multiplication and for tritium and SNM production (Fig. 1).[3]

Three leading ICF driver candidates are considered in this process--long and short wavelength lasers and heavy-ion accelerators. A heavy-ion accelerator is used in the reference design, although the overall design is relatively independent of the choice of driver. The facility layout allows interfacing common plant systems with a variety of first wall/blanket/driver combinations.

For economical tritium, SNM, and energy production, neutron economy is important. Reactor first walls and blanket fuel assemblies will have to be replaced several times during the life of the facility and ease of access without long shutdowns is important. LMFBR-type fuel assemblies for the breeding material in the blanket are composed of long, straight rods that must be configured around a spherical chamber. The use of liquid lithium for first wall protection, heat removal, and tritium production necessitates inert atmospheres and steel cell liners in certain parts of the facility.

The reference facility design (Fig. 2) is summarized in Table I. Extensive analysis indicated that geometry shown in Figure 1 will provide good neutron utilization combined with ready first wall and refueling access. Horizontally oriented 650-cm long fuel assemblies are placed circumferentially inside the cylinderical annulus and 100-cm long fuel assemblies are in each "end plug" of the blanket structure.

## CONCLUSION

A conceptual design of a tritium-breeding facility that serves as a "FIRST STEP" towards ICF commercialization has been presented.

TABLE I

Principal FIRST STEP Reference Design Parameters

| Parameter | Value |
|---|---|
| Thermonuclear Power | ~400 $MW_t$ |
| Gross Thermal Power | ~1500 $MW_t$ |
| Driver Type | Heavy Ion |
| Ion | $^{238}U(+1)$ |
| Ion Energy | 10 GeV |
| Pulse Energy | 1-3 MJ |
| Pulse Repetition Rate | ~20 Hz |
| Target Yield | 20 MJ |
| Target Gain | 7-20 |
| First Wall Coolant | Natural Lithium |
| Blanket Coolant | 60% $^6Li$, 40% $^7Li$ |
| Blanket Fertile Species | $^{238}U$ |
| Cavity Radius | 2 m |

REFERENCES

1. J. H. Pendergrass, T. G. Frank, and I. O. Bohachevsky, "A Modified Wetted-Wall Inertial Reactor Concept," Proc. 4th Topl. Mtg. Technology of Controlled Nuclear Fusion, King of Prussia, Pennsylvania, October 14-17, 1980, CONF-801011 (July 1981).

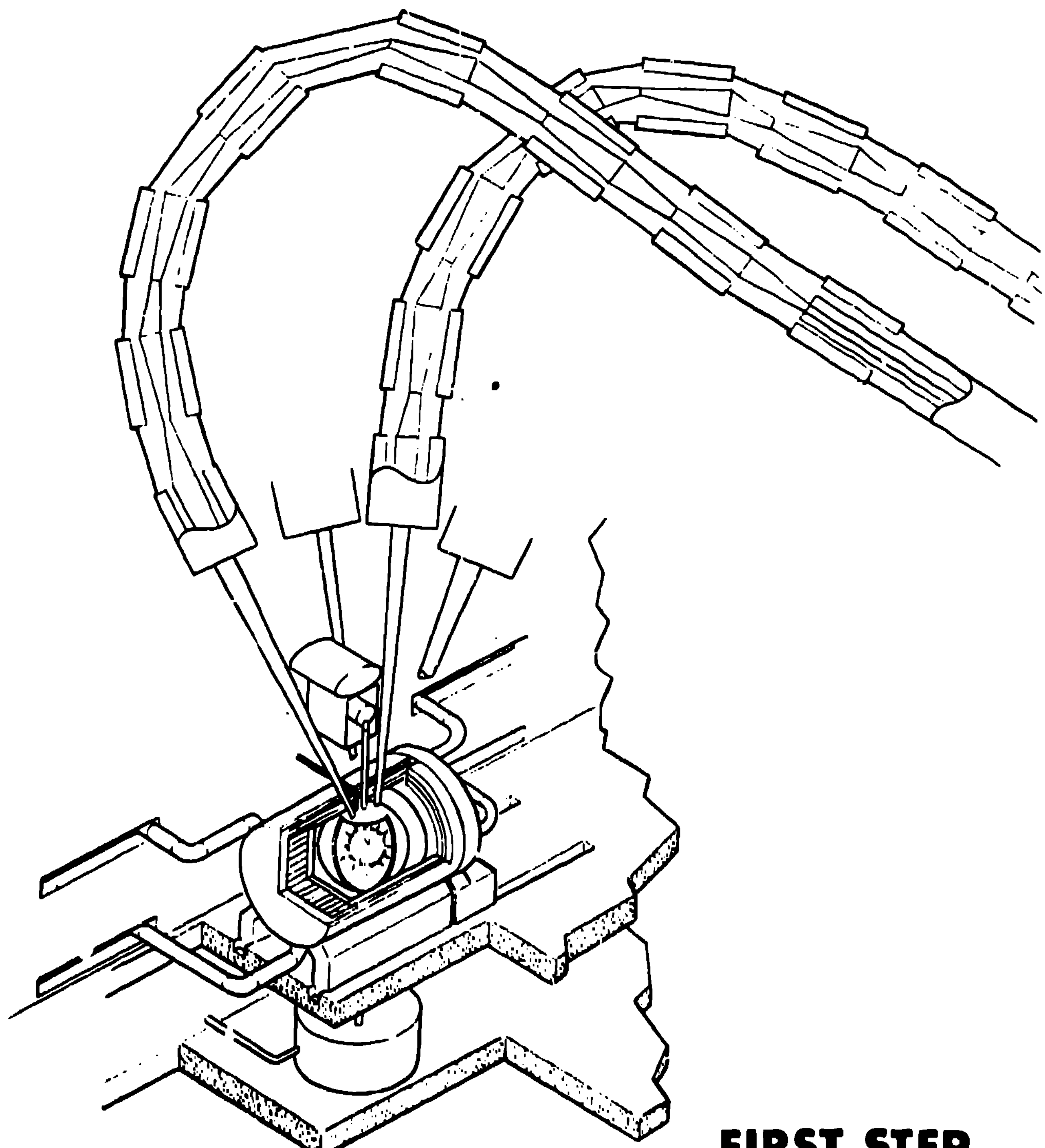
2. I. O. Bohachevsky and T. G. Frank, "Production of Tritium in Low-Pellet Gain ICF Facilities," Los Alamos National Laboratory report LA-9657-MS (April 1983).

3. J. H. Pendergrass, G. R. Thayer, and M. E. Battat, "Fissionable Blankets for Inertial Confinement Fusion," Trans. Am. Nucl. Soc. 45, 181 (1983).

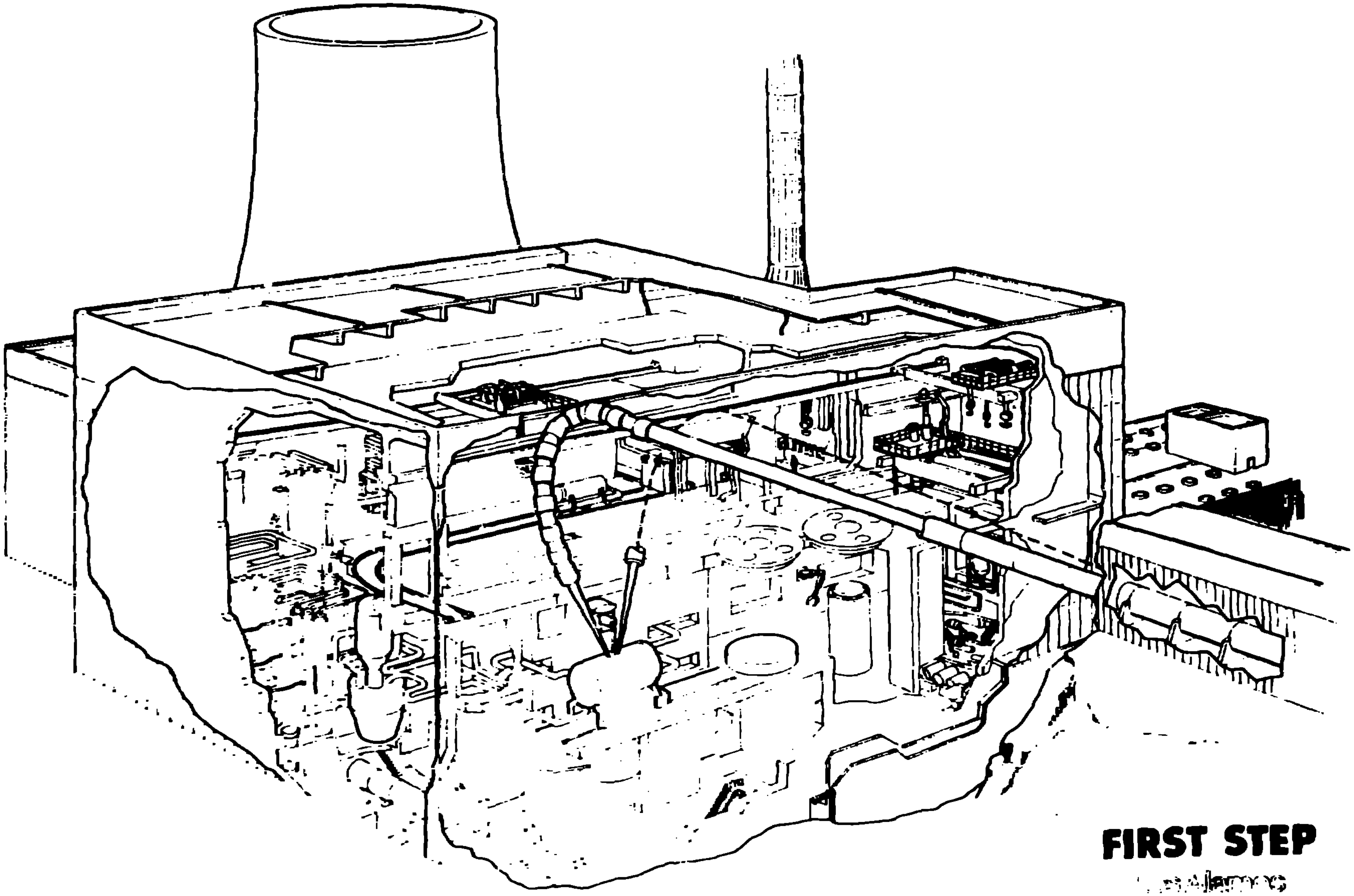
Figure Captions

Fig. 1. Artist's conception of FIRST STEP reaction cavity and blanket.

Fig. 2. Artist's conception of FIRST STEP plant.



**FIRST STEP**



FIRST STEP