GA–C23333

DIRECT ENERGY CONVERSION FISSION REACTOR

for the period June 1, 2001 through September 30, 2001

by

L.C. BROWN

Prepared under
Nuclear Energy Research Initiative (NERI)
Program. DE-FG03-99SF21893
for the U.S. Department of Energy

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DISCLAIMER

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Nuclear Energy Research Initiative (NERI)
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Technical Progress Report
June through September 2001

Highlights

- The stability of a string of fission electric cell cathodes to regular perturbations in electric field was investigated in two dimensions.
- The model of the fuel recycle loop of the Vapor Core Reactor was expanded to include the fission product species SrF_2, ZrF_4, MoF_6, Xe, CeF_3 and NdF_3.

Introduction

Direct energy conversion is the only potential means for producing electrical energy from a fission reactor without the Carnot efficiency limitations. This project was undertaken by Sandia National Laboratories, Los Alamos National Laboratories, The University of Florida, Texas A&M University and General Atomics to explore the possibilities of direct energy conversion. Other means of producing electrical energy from a fission reactor, without any moving parts, are also within the statement of proposed work. This report documents the efforts of General Atomics. Sandia National Laboratories, the lead laboratory, provides overall project reporting and documentation.

Current Quarter Accomplishments

Magnetically Insulated Fission Electric Cell

Work has begun on modeling the side forces on a string of cathodes. Previously it was shown analytically, for a limiting case, that a single cathode could not be maintained near the center its anode. A single cathode was assumed to be supported on a small rod inside the anode. The length of the rod was three meters, the length of a string of cathodes in the reactor. If the cathode was off center by an infinitesimal amount, no reasonable tension in the support rod could prevent the cathode from being pulled to the anode, thus shorting the system. Steve Slutz of Sandia suggested that the side forces can be mitigated by deliberately offsetting alternate electrodes in opposite directions so as to increase the angle of the central rod at each electrode and thus increase the restoring force. The geometry was modeled on ANSIS assuming that the top and bottom cathodes were mounted one foot from the support to provide the required electrical isolation. The side forces still gave an unacceptable deflection for any reasonable tension. Analytical results were obtained for the case in which the end supports are one-half the cathode to cathode center distance. For this case the results are encouraging.

Fission Fragment Magnetic Collimator Reactor

No work was done on the Fission Fragment Magnetic Collimator Reactor during this period.

Vapor Core Reactor

Work on the Aspen Model of the Vapor Core Reactor primary flow loop continued. The model incorporates the fission product species SrF_2, ZrF_4, MoF_6, Xe, CeF_3 and NdF_3, in addition to the fuel UF_4 and the carrier He. Theses fission species account for more than 70 percent of the fission products formed. They also represent species that are more volatile than UF_4, have similar volatility and are less volatile. The effort has concentrated on reducing the circulating activity while

minimizing the impact on thermal efficiency. The model is not complete but the fission products have been concentrated into minimal volumes without seriously affecting efficiency. An attempt has been made to keep the circulating activity at no more than ten times the instantaneous generation rate.

Planned Next Quarter Activities

We will continue analysis of the fuel recycle loop of the gas core reactor concept. As time permits we will extend the cathode model to three dimensions.

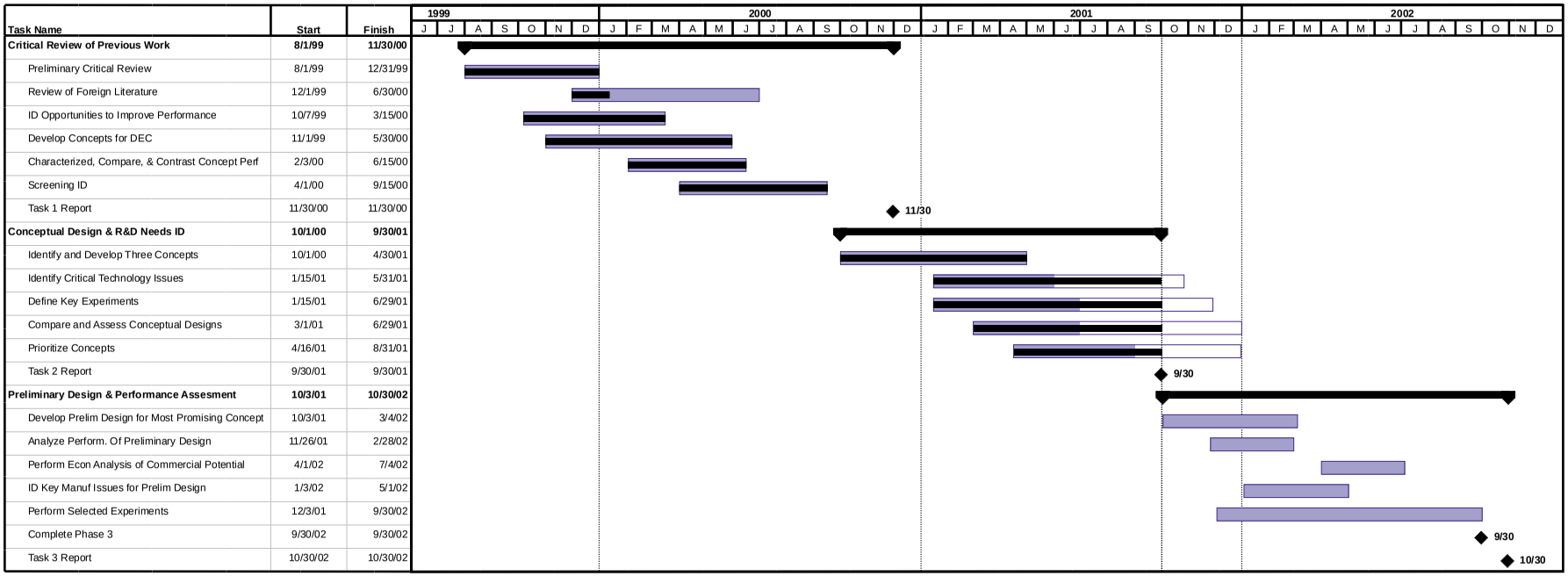
Schedules and Budgets

The GA contract was out of synchronization with the contracts of the other participants. This has been rectified with the granting of a no cost extension by DOE. This reporting period was extended from August 14 to September 30. Future reporting periods will be on a quarterly basis.

The overall project is behind schedule, as previously reported by Sandia. A decision was made at meeting at Sandia to delay the down selection to a single direct energy conversion concept. Status of all tasks of the combined project schedule is indicated in Table 1 and Fig. 1. Expenditures to date and projected expenditures for the rest of Phase 2 are given in Fig. 2.

Table 1. Summary of NERI Tasks – Phases 1–3

Identification Number	Milestone/Task Description	Planned Completion Date	Actual Completion Date	Comments
1A(i).	Preliminary critical review of previous work	Jan 2000	Jan 2000	Work complete
1A(ii).	Review foreign literature	Nov 2000	N/A	Task abandoned due to classification issues
1B.	Identify opportunities for improvement	Mar 2000	Mar 2000	Work complete
1C.	Develop new/alternate concepts	May 2000	May 2000	Work complete
1D.	Characterize/compare alternate concepts	Jun 2000	July 2000	Work complete
1E.	Screen to 3 promising concepts	Jul 2000	Sept 2000	Work complete
1F.	Final (annual) Report for Task 1	Nov 2000	Nov 2000	Work complete
2A.	Identify and develop 3 concepts	Apr 2001	April 2001	Work complete
2B(i).	Identify critical technology issues	May 2001		Behind schedule Expected 10/01
2B(ii).	Define key experiments	Jun 2001		Behind schedule Expected 11/01
2C.	Compare and assess conceptual designs	Jun 2001		Behind schedule Expected 12/01
2D.	Prioritize concepts	Aug 2001		Behind schedule Expected 12/01
2E.	Final (annual) Report for Task 2	Oct 2001		Work in progress
3A.	Preliminary design of most promising concept	Mar 2002		Phase 3
3B.	Analyze technical performance	Jul 2002		Phase 3
3C.	Analyze economic performance	Jul 2002		Phase 3
3D.	Identify manufacturability issues	Jun 2002		Phase 3
3E.	Perform selected experiments	Sep 2002		Phase 3
3F.	Complete Phase 3 and project	Oct 2002		Phase 3
3F'.	Final Report for Phase 3 and project	Oct 2001		Phase 3



Task Name	Start	Finish
Critical Review of Previous Work	**8/1/99**	**11/30/00**
Preliminary Critical Review	8/1/99	12/31/99
Review of Foreign Literature	12/1/99	6/30/00
ID Opportunities to Improve Performance	10/7/99	3/15/00
Develop Concepts for DEC	11/1/99	5/30/00
Characterized, Compare, & Contrast Concept Perf	2/3/00	6/15/00
Screening ID	4/1/00	9/15/00
Task 1 Report	11/30/00	11/30/00
Conceptual Design & R&D Needs ID	**10/1/00**	**9/30/01**
Identify and Develop Three Concepts	10/1/00	4/30/01
Identify Critical Technology Issues	1/15/01	5/31/01
Define Key Experiments	1/15/01	6/29/01
Compare and Assess Conceptual Designs	3/1/01	6/29/01
Prioritize Concepts	4/16/01	8/31/01
Task 2 Report	9/30/01	9/30/01
Preliminary Design & Performance Assesment	**10/3/01**	**10/30/02**
Develop Prelim Design for Most Promising Concept	10/3/01	3/4/02
Analyze Perform. Of Preliminary Design	11/26/01	2/28/02
Perform Econ Analysis of Commercial Potential	4/1/02	7/4/02
ID Key Manuf Issues for Prelim Design	1/3/02	5/1/02
Perform Selected Experiments	12/3/01	9/30/02
Complete Phase 3	9/30/02	9/30/02
Task 3 Report	10/30/02	10/30/02

Fig. 1. Project Schedule.

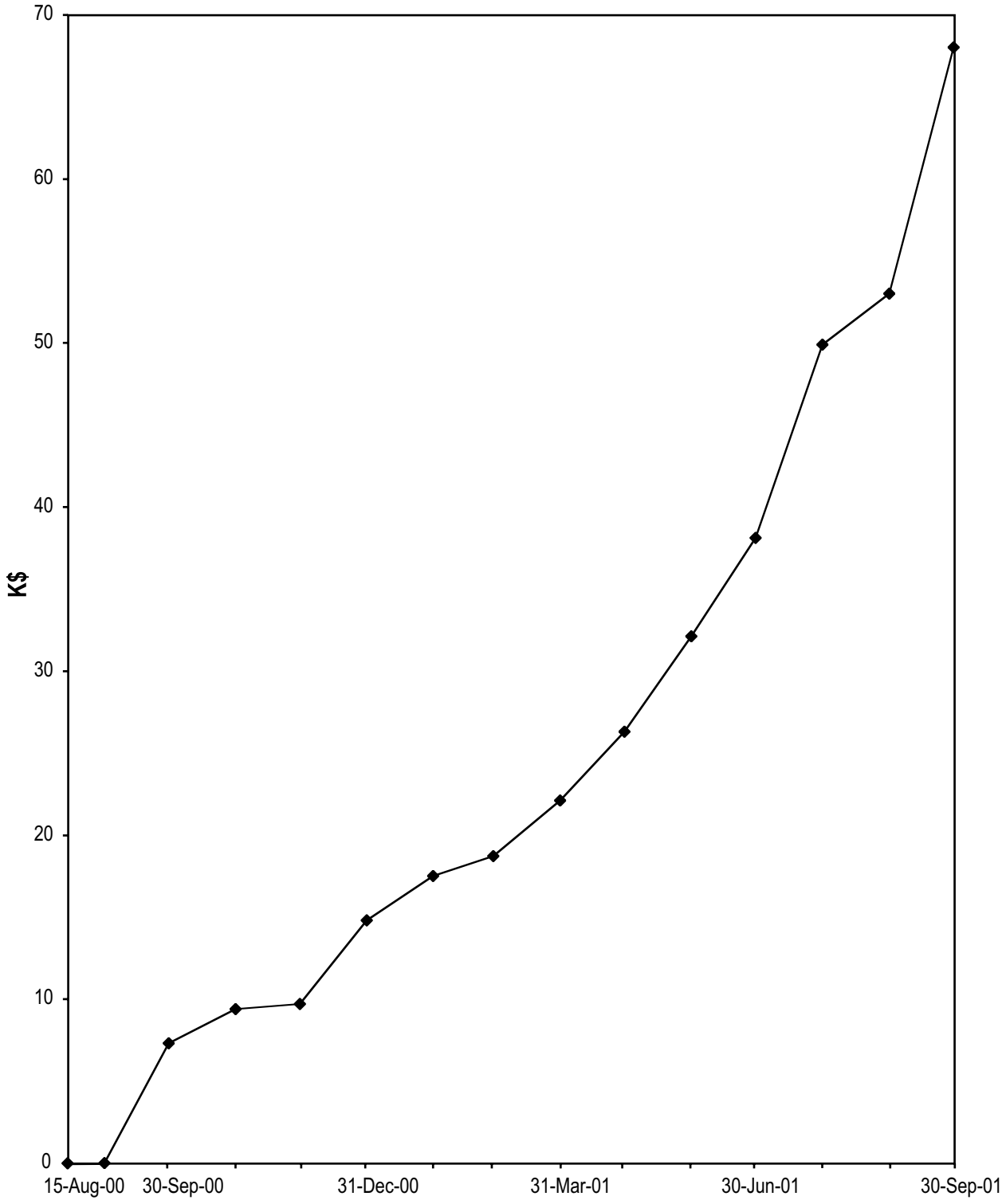


Fig. 2. Spending Profile