TABLE I

Criticality Factor c for Infinite Slab and Isotropic Scattering

Thickness (mean-free-path)	Syros and Theocharopoulos (Ref. 3)	Dahl and Sjöstrand (Ref. 1) Flux Equation (9 Polynomials)	Dahl and Sjöstrand Flux Equation (20 Polynomials)	Dahl and Sjöstrand Current Equation (20 Polynomials)	Kaper et al. (Ref. 5)
1	1.61384	1.61537 85	1.61537 854	1.61537 81	1.61537 852
2	1.27625	1.27710 18	1.27710 1823	1.27710 15	1.27710 1824
4	1.10799	1.10846 78	1.10846 78324	1.10846 76	1.10846 78323
6	---	1.05829 59	1.05829 58957	1.05829 57	1.05829 58956
8	---	1.03640 20	1.03640 20305	1.03640 19	1.03640 20303
10	1.02466	1.02487 94	1.02487 93734	1.02487 92	1.02487 93733
20	1.00702	1.00713 58	1.00713 57395	1.00713 56	1.00713 57393

why the eigenvalues of Syros and Theocharopoulos[3] are systematically lower.

E. B. Dahl
N. G. Sjöstrand

Chalmers University of Technology
Department of Reactor Physics
S-41296 Göteborg, Sweden

August 14, 1979

Comments on "Neutron-Induced Fission in a DT-Plutonium Plasma"

In two papers by Perkins,[1,2] the neutron and fusion rate enhancement by in-flight reactions created by knock-ons from fission fragment slowing down in a compressed DT-plutonium plasma has been calculated. It is found that this effect can increase the number of neutrons per fission by a factor of ~2 if the plasma temperature is near ~100 keV. This effect was predicted in a previous study by the present author,[3-5] but due to lack of research support, it was not possible to perform the tedious numerical calculations. However, no matter how important this effect might be, the higher order (but in a lower temperature range), much larger, effect resulting from the plasma heating by the fission products is completely ignored in Perkins' work. Only an analysis taking this effect into account can claim to be complete. We therefore feel the need to call the readers' attention again to the significance of this effect.

If in a high-density plasma, composed of a mixture of fissionable and fusionable material, a fission process takes place, the kinetic energy of the fission products, after being slowed down by inelastic collisions, will lead to a rise of the plasma temperature. The rate in the rise of temperature will be directly proportional to the fission energy released per unit of time if, in the temperature range, the energy density of the black body radiation aT^4 is small compared to the kinetic energy density NkT. Since the kinetic energy density is proportional to the plasma density but not the black body radiation, high plasma densities shift the range where the kinetic energy density is larger than the black body radiation energy density to higher temperatures. At the contemplated high plasma densities, the interesting temperature range is between 1 and 10 keV, where the fusion cross section averaged over a Maxwellian rises as $\langle\sigma v\rangle \simeq \text{const}\cdot T^{4.37}$. Because of this rapid rise in $\langle\sigma v\rangle$ with T, a small increase in T will greatly enhance the production of fusion neutrons. This, in turn, will accelerate the fission process. Calculating this effect, of course, implies solving the time-dependent problem, which was not done by Perkins. However, the calculation by Perkins shows that the nonthermal enhancement of fusion processes by fission product knock-ons is quite important at temperatures near ~100 keV. At this temperature, the value of $\langle\sigma v\rangle$ reaches a plateau and is therefore not very sensitive to T, and hence the rise in the fusion rate with T is here unimportant. On the other hand, according to Perkins' results, in the temperature range from 1 to 10 keV, the fusion enhancement by fission product knock-ons is not very important. It therefore follows that both calculations supplement each other, mine in the temperature range from 1 to 10 keV and Perkins' in the range near ~100 keV. In the interesting intermediate region, from 10 to 100 keV, a more complete calculation would be highly desirable. In the temperature range above 10 keV, the value of $\langle\sigma v\rangle$ does not depend on T with such a large power as in the range below 10 keV, but the knock-on effect begins to become important above 10 keV. This latter effect could be approximated by putting a larger ν value for neutron multiplication into the time-dependent analysis.

F. Winterberg

University of Nevada System
Desert Research Institute
Reno, Nevada 89506

September 17, 1979

[1]S. T. PERKINS, *Nucl. Sci. Eng.*, **69**, 137 (1979).
[2]S. T. PERKINS, *Nucl. Sci. Eng.*, **69**, 147 (1979).
[3]F. WINTERBERG, in *Laser Interaction and Related Plasma Phenomena*, Vol. 3, p. 519, Plenum Press, New York (1973).
[4]F. WINTERBERG, *Plasma Phys.*, **15**, 71 (1975).
[5]F. WINTERBERG, *Nucl. Sci. Eng.*, **59**, 68 (1976).

Reply to "Comments on 'Neutron-Induced Fission in a DT-Plutonium Plasma'"

I was very interested in the comments presented by Winterberg.[1] Winterberg has performed calculations on the fission

[1]F. WINTERBERG, *Nucl. Sci. Eng.*, **73**, 110 (1980).

amplification of the thermal fusion rate and the resulting feedback in a high-density plasma composed of fissionable and fusionable constituents. I have performed corresponding calculations of the enhanced suprathermal fusion rate and the resulting neutron production created by knock-ons from fission fragment slowing down. By comparison to a fissile nuclear reactor, Winterberg's results are analogous to a description of the thermal region, while my results are analogous to a description of the epithermal-fast region. I would agree with Winterberg that not only do the calculations supplement each other, but that they are both necessary. However, including both results in a detailed calculation requires solving the complete spatial and time-dependent problem. Since this is system dependent and implies a detailed design study, it was beyond the scope of the study presented in my paper.

S. T. Perkins

Lawrence Livermore Laboratory
P.O. Box 808
Livermore, California 94550

October 15, 1979

ACKNOWLEDGMENT

This work was performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore Laboratory.