REFERENCE

1. A. J. GOLDMAN, A feasibility study of fast U^{233}–Th breeder reactors. NDA 2134-3 (October 10, 1960).

ARTHUR J. GOLDMAN

Nuclear Development Corporation of America
White Plains, New York
Received December 30, 1960

Re: The Application of Statistical Methods of Analysis for Predicting Burnout Heat Flux

The statistically derived prediction method for burnout heat flux proposed by Jacobs and Merrill in the December issue (*1*) appears to contain certain features which call for further elaboration. The over-all correlation (*1*), Formula No. 8 of Fig. 12, e.g., contains 14 positive and 10 negative terms, and the burnout heat flux is obtained numerically as an often small difference between two large numbers. The associated sensitivity of the solution can be considerable for certain combinations of the variables.

Of particular interest is the effect of tube diameter on burnout heat flux when all other independent variables are held constant at their midranges, shown in Fig. 14 of reference 1. The large dependence shown completely lacks substantiation. In fact, direct experimental studies of the diameter effect have been made at the Savannah River Laboratory (*2*), and for subcooled low-pressure water flow in heated annuli with the flow gap varied from $\frac{1}{16}$ to $\frac{3}{8}$ in. and heated length fixed at 24 in., no effect on burnout was observed. Similar studies have been reported in the Russian literature (*3*) for subcooled water at 40 atmospheres flowing in a rectangular test section; as flow gap was decreased from 0.079 to 0.008 in., no effect on burnout was noted until the gap reached 0.028 in. Other Russian studies (*4*) with high-pressure water and tubular test sections of 0.157 to 0.473 in. i.d. indicated the same absence of a diameter effect. These three independent studies, made with annular, rectangular, and tubular test sections in a pressure range of 3 to 220 atmospheres, strongly suggest that a diameter effect is encountered only when the flow gap dimension becomes comparable to bubble dimensions. In the individual studies used for development of the burnout correlation of reference 1, diameter was held constant; and the apparent diameter effect, obtained by correlation of different sets of data, appears spurious.

The inapplicability of the prediction method (with the present constants) to rectangular channels is indicated by comparisons we have made between recent pertinent ORNL data (*5*) and the prediction equation. With all variables selected within the ranges used for development of the equation, the experimental values are $\backsim$1.7-fold larger than the corresponding calculated values. Whereas L and D are associated with surface area for round tubes, thereby incorporating, indirectly, enthalpy increase to the burnout point and allowing use of inlet bulk temperature, such is not the case with the length and equivalent diameter of rectangular channels.

Extrapolation of the proposed correlation (*1*) beyond the range of the data used in its development should scrupulously be avoided, as indicated by the authors. To illustrate the extreme danger inherent in carrying such an arbitrarily derived relation beyond its stated limits, a particular example may be cited. In a very high velocity (172 fps) subcooled burnout test conducted at ORNL (*6*), an experimental burnout heat flux of 17.25×10^6 Btu/hr ft^2 was attained. The conditions of this test were such that only the tube diameter was in the recommended variable range for the prediction equation, which gave a positive error of 1127%. The simpler "local phenomenon"-type equations of Gunther (*7*) and of Bernath (*8*) [a type of equation much chastised in reference (*1*)] gave errors of -30.9% and -18.9%, respectively. It would thus appear that some of the functional relations expressed by Formula No. 8 of reference 1 are seriously in error. If so, one might question the adequacy of the variable ranges cited as an application criterion, and use of the correlation in an untested region of Fig. 13 (*1*) could give erroneous results.

The authors should state where the coolant pressure is to be evaluated, since axial pressure gradients may be large enough to make site selection important. An extreme combination of the recommended variable ranges gives an isothermal ΔP of 70 psi, too large to be neglected. Similarly, a statement should be made concerning the applicability of the correlation to the bulk-boiling regime. The data in references 7 and 14 of the paper, e.g., primarily relate to tests with net steam generation, with only 8 of the tests of reference 14 conducted in the subcooled region. I assume that the method is applicable only to local-boiling burnout.

REFERENCES

1. R. T. JACOBS AND J. A. MERRILL, *Nuclear Sci. and Eng.* **8,** 480 (1960).
2. S. MIRSHAK AND W. S. DURANT, private communication to W. R. Gambill, January 29, 1960.
3. N. L. KAFENGAUZ AND I. D. BAUAROR, *Teploenergetica,* **3,** 76–78 (1959).
4. B. A. ZENKEVICH, *J. Nuclear Energy,* Part B: Reactor Technology, **1,** 137 (1959).
5. W. R. GAMBILL AND R. D. BUNDY, ORNL report, 1960 (not yet released).
6. W. R. GAMBILL, R. D. BUNDY, AND R. W. WANSBROUGH, ORNL-2911, Table 2 (test No. 10) (1960).
7. F. C. GUNTHER, *Trans. Am. Soc. Mech. Engrs.* **73,** 115 (1951).
8. L. BERNATH, Preprint No. 110, Third National Heat Transfer Conference, ASME-AIChE, Storrs, Connecticut (August, 1959).

W. R. GAMBILL

Oak Ridge National Laboratory
Oak Ridge, Tennessee
Received January 19, 1961

Re: The Application of Statistical Methods of Analysis for Predicting Burnout Heat Flux—Rebuttal

Mr. Gambill has raised several questions concerning the work reported in our recent article (*1*) which appeared in this journal. The following points have been raised·

1. Where was the pressure evaluated?