NORTHEAST UTILITIES

THE CONNECTICUT LIGHT AND POWER COMPANY
WESTERN MASSACHUSETTS ELECTRIC COMPANY
HOLYOKE WATER POWER COMPANY
NORTHEAST UTILITIES SERVICE COMPANY
NORTHEAST NUCLEAR ENERGY COMPANY

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February 15, 1985

Docket No. 50-423
B11456

Director of Nuclear Reactor Regulation
Mr. B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Reference: (1) W. G. Counsil letter to B. J. Youngblood, Revised Response to Question 480.9, dated November 30, 1984.

Dear Mr. Youngblood:

Millstone Nuclear Power Station, Unit No. 3
Discussion of Critical Flow Models Used in Containment Subcompartment Analyses

In Reference (1), Northeast Nuclear Energy Company (NNECO) provided the results of the Millstone Unit No. 3 pressurizer subcompartment reanalysis which was performed to address Staff concerns identified in Question 480.9 and SER Open Item 10. As in the original analysis, the thermal homogeneous equilibrium flow model (HEM) was used in the revised subcompartment analysis. Use of the HEM versus the Moody flow model which is used by the Staff in performing confirmatory calculations has been the subject of discussion between NNECO and the Staff on several occasions.

The attached discussion provides justification of why NNECO considers the HEM the more appropriate choice of flow models for performing the subcompartment pressure analysis for the pressurizer cubicle.

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We remain available to discuss this topic with the Staff, as necessary. If you have any questions or concerns regarding this submittal, please feel free to contact our licensing representative directly.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY
et. al.

BY NORTHEAST NUCLEAR ENERGY COMPANY
Their Agent

W. G. Counsil

W. G. Counsil
Senior Vice President

C. F. Sears

By: C. F. Sears
Vice President

STATE OF CONNECTICUT)
) ss. Berlin
COUNTY OF HARTFORD)

Then personally appeared before me C. F. Sears, who being duly sworn, did state that he is Vice President of Northeast Nuclear Energy Company, an Applicant herein, that he is authorized to execute and file the foregoing information in the name and on behalf of the Applicants herein and that the statements contained in said information are true and correct to the best of his knowledge and belief.

Jennifer J. Powers

Notary Public
My Commission Expires March 31, 1989

DISCUSSION OF CRITICAL FLOW MODELS USED FOR SUBCOMPARTMENT ANALYSIS

There are currently two acceptable vent critical flow correlations approved for use in performing subcompartment analyses (see SRP 6.2.1.2.II.4). The correlations are the frictionless Moody with a multiplier of 0.6 for water-steam mixtures and the thermal homogeneous equilibrium model (HEM) for air-steam-water mixtures.

The HEM critical flow correlation is used for the subcompartment pressure calculations primarily because of the significant air mass present during the important period of choked flow. The pressurizer and steam generator subcompartment analysis results show that a significant quantity of air does exist up to the time the peak pressure occurs. The HEM correlation appropriately models the air present in the subcompartment while the frictionless Moody correlation does not consider the presence of air. The subcompartment analyses are performed with the computer program THREED, which is described in FSAR Section 6.2.1.2.

Since two-phase critical flow models are widely used in safety calculations, a number of studies have been undertaken that compare critical flow data obtained from experiments with flows predicted by the above-mentioned theoretical flow models. A sizeable list of references for the experimental data is presented in both Henry (1971) and Ardron (1976). Figures 1 and 2 from Henry and Ardron respectively, present the unit area critical flowrate as a function of quality. Values are taken from experimental data and from both HEM and Moody critical flow correlations. The experimental data and flowrates presented in Figure 1 are for an upstream pressure of 17.6 psia, and the data and flowrates in Figure 2 are for 100 psia. Both figures include data for qualities between 0.1 and 0.7. This pressure and quality range are selected to bound the pressures and qualities in subcompartment analyses, thereby establishing the applicability of the experimental data in comparison with the analytical flow models. The pressurizer and steam generator subcompartment calculated peak pressures are close to the lower pressure (17.6 psia) in the selected range, while the upper reactor cavity peak pressure is close to the upper pressure (100 psia). The quality up to the time of peak pressure is between 0.4 and 0.7 for all subcompartment analyses. For comparison purposes, a Moody correlation with a 0.6 multiplier is shown on Figures 1 and 2. The data used to plot this curve is taken from the Moody tables in the COMPARE-Mod 1 code (Los Alamos 1980).

A review of Figures 1 and 2 indicate that both the 0.6 Moody and the HEM correlations generally underpredict the flow in comparison to the experimental data. The use of these correlations, therefore, provides a conservative overprediction of the peak pressure in the upstream volume.

The 0.6 Moody correlation appears inconsistent compared to experimental data and the HEM correlation at the lower upstream pressure (Figure 1). The flowrates are slightly overpredicted at low quality, and underpredicted at higher quality. At higher pressures, (Figure 2) and especially at higher qualities, HEM and 0.6 Moody critical flowrates are similar with HEM being slightly more conservative.

The peak pressures calculated in the pressurizer and steam generator subcompartments are more closely represented by the data shown in Figure 1. Since the flowrates from the breaks in both subcompartment models are relatively low, a significant amount of air occupies the subcompartment volumes up to the time of peak pressure. It is stated in the subcompartment analysis procedures (Gido 1979) that the presence of air plays an important role in the subcompartment analysis. Further, the HEM correlation is recommended since it models the presence of air in the nodes.

In every case the HEM correlation is conservative compared to the experimental data. In addition, both Henry and Ardron suggest that HEM shows good agreement with experimental data and consistently provides a lower bound to all data reported. Accordingly, the HEM correlation was selected for use in the Millstone Unit 3 subcompartment analyses.

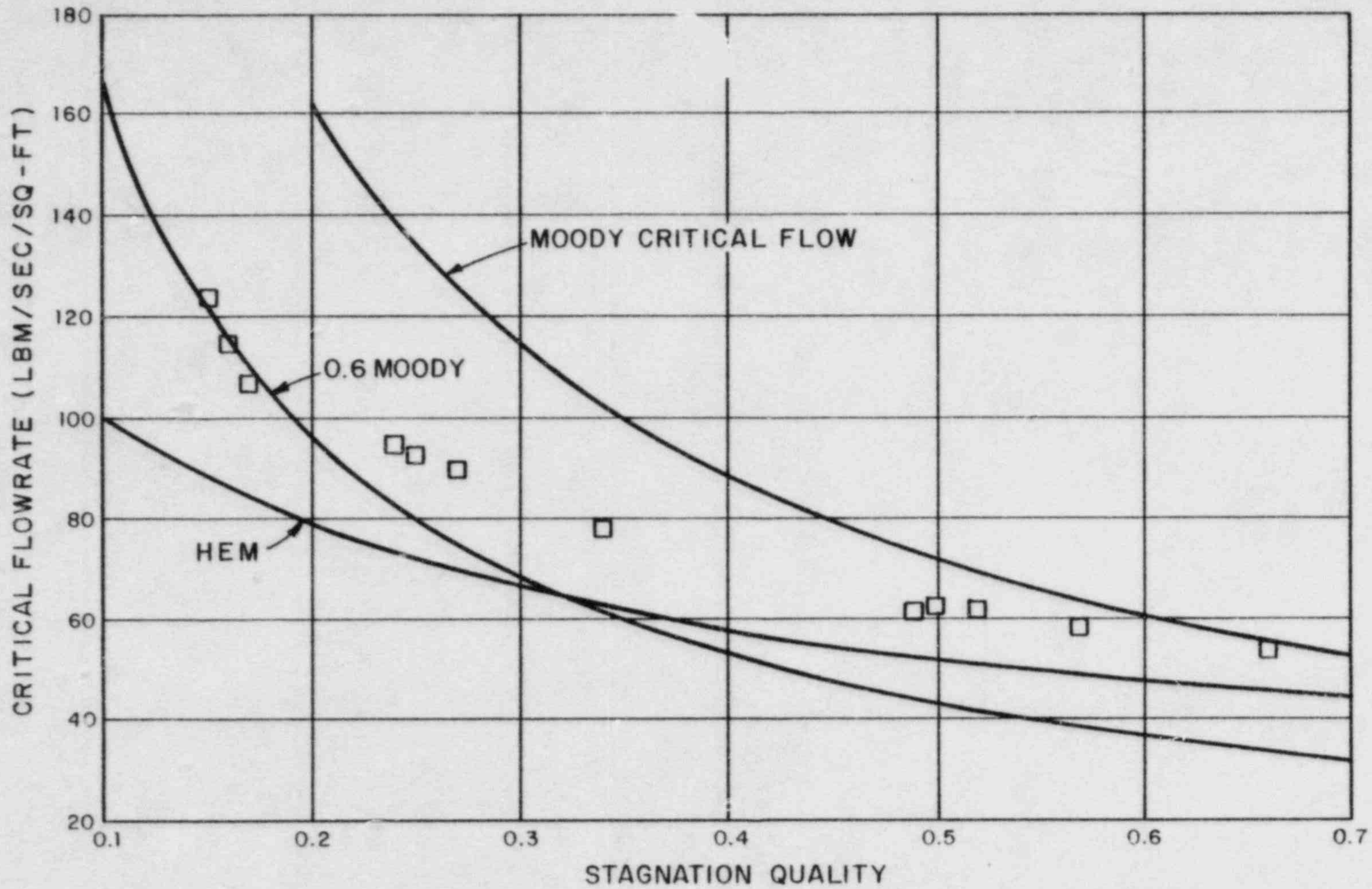
References:

1. Henry, R.E., and Fauske, H.K. The Two-Phase Critical Flow of One-Component Mixtures in Nozzles, Orifices, and Short Tubes. In: Journal of Heat Transfer, Transactions of the ASME, May 1971.

2. Ardron, K. H., and Furness, R. A. A Study of the Critical Flow Models Used in Reactor Blowdown Analysis. In: Nuclear Engineering and Design 39 (1976) 257-266, 1976.

3. Los Alamos Scientific Laboratory, COMPARE-Mod 1 Code, LA-7199, Addendum 1, NUREG/ER-1185, August 1980.

4. Gido, R.G., Gilbert, J.S., Tinkler, C.G., Subcompartment Analysis procedures, Los Alamos Scientific Laboratory, LA-8169-MS, NUREG/CR-1199, December 1979.

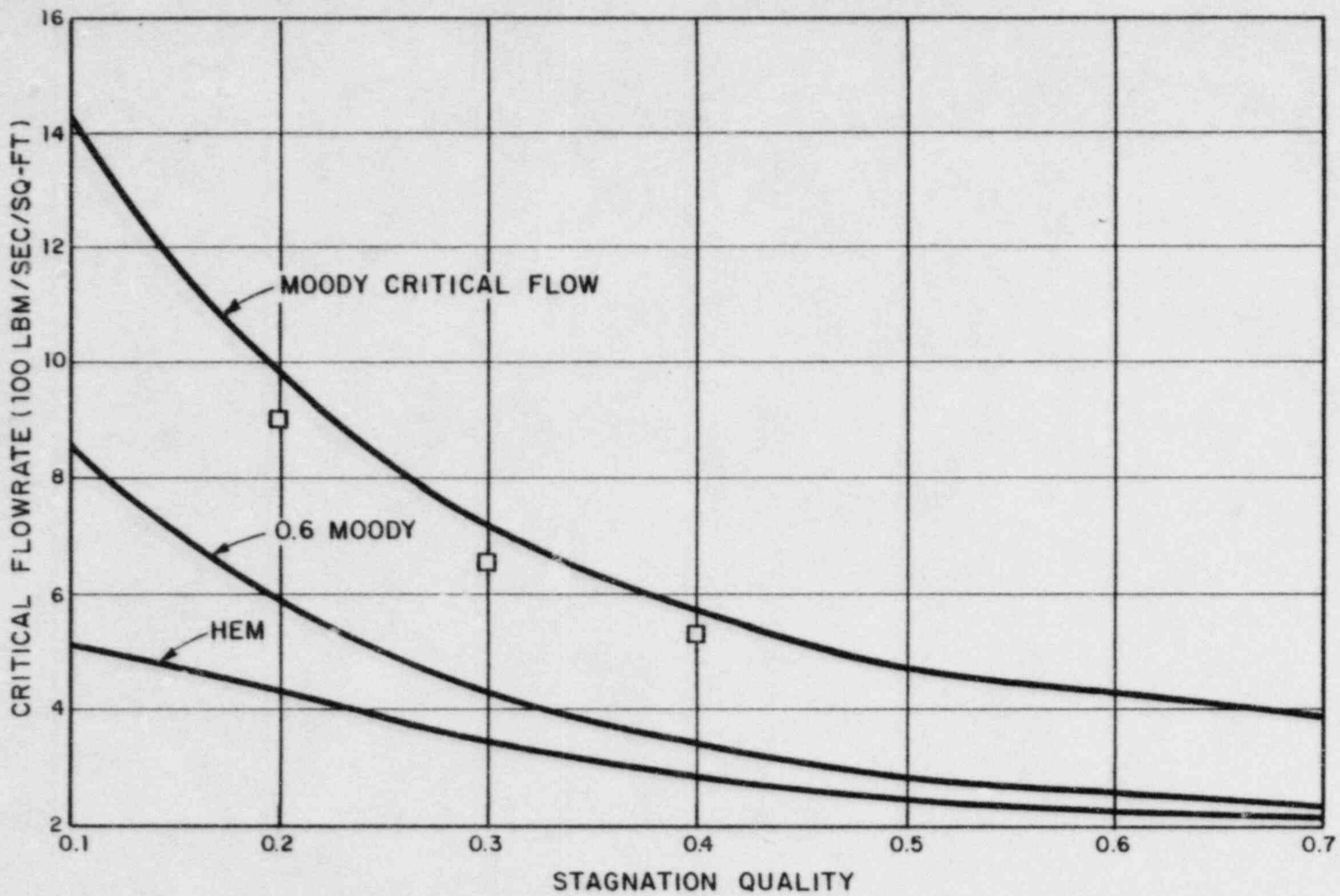


NOTES:

□ - EXPERIMENTAL DATA

HEM - HOMOGENEOUS EQUILIBRIUM MODEL

FIGURE 1
COMPARISON OF HEM & MOODY CRITICAL FLOW WITH TEST DATA AT 17.6 PSIA
MILLSTONE NUCLEAR POWER STATION
UNIT 3



NOTES:

□ - EXPERIMENTAL DATA

HEM - HOMOGENEOUS EQUILIBRIUM MODEL

FIGURE 2
COMPARISON OF HEM & MOODY CRITICAL FLOW WITH TEST DATA AT 100 PSIA
MILLSTONE NUCLEAR POWER STATION
UNIT 3