INTERIM REPORT

Accession No. ______________

Contract Program or Project Title: Investigation of Post-CHF Heat Transfer for Water-Cooled Reactor Application and Development of Two-Phase Flow Instrumentation

Subject of this Document:

Progress on contract no. NRC-04-74-180 in May 1980

Type of Document:

Monthly progress report

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Date of Document:

June 17, 1980

Responsible NRC Individual and NRC Office or Division:

Research Branch, Division of Reactor Safety Research

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Prepared for
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

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Enclosure 3

MONTHLY PROGRESS REPORT

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Prepared for:	Division of Reactor Safety Research U.S. Nuclear Regulatory Commission Washington, D.C. 20555
Contract No.:	NRC-04-74-180
NRC FIN No.:	A4055
Project Title:	Investigation of Post-CHF Heat Transfer for Water-Cooled REactor Application and Development of Two-Phase Flow Instrumentation
Submitted by:	J. C. Chen R. K. Sundaram S. Nijhawan S. Lau S. Webb D. Evans L. Lee

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INVESTIGATION OF POST-CHF HEAT TRANSFER FOR WATER-COOLED REACTOR APPLICATION AND DEVELOPMENT OF TWO-PHASE FLOW INSTRUMENTATION

1. Post-CHF Experiments (S. Nijhawan, R. Sundaram, J. Chen)

These experiments are aimed at investigating thermal non-equilibrium between phases during post-CHF conditions in a tubular test section. In particular, superheated vapor temperature in a two-phase mixture is measured under well-established wall and fluid conditions.

The initial phase of investigation is now considered to have been completed. Over 200 data points have been collected where vapor temperature has been measured at low pressures (150-450 kPa), low mass fluxes (18-70 Kg/m^2-s) and a wide range of equilibrium mixture qualities (10-75%). Of these, about 60% are at a constant distance of 1.205 m from the dryout location and the remaining 40% have varying dryout lengths (0.2-1.2 m). All of these data are considered steady-state post-CHF data.

Some of the parametric trends of these data were presented in the previous monthly report. Each data point consists of axial wall temperature information with vapor temperature measured at one axial location for a given system pressure, mass flow rate, wall heat flux and inlet equilibrium quality. This is typically shown in Figure 1. These data have now been compiled and are being incorporated into a separate report which will be transmitted to the NRC (see next section). A more complete parametric analysis of the data will also be included in the report.

Further experiments are being planned using the Lehigh two-phase loop facility. In particular, test sections are being designed to

a) incorporate several vapor probes at different axial locations and

b) investigate effect of spacers on the wall heat transfer.

2. <u>Correlation Development</u> (R. Sundaram, S. Nijhawan, J. Chen)

Improvement of post-CHF correlations is being continued. Proprietory data from the Babcock and Wilcox company are being used to improve the previously developed Lehigh post-CHF correlation. In particular, it has been found that at low flow rates, the wall-to-vapor heat transfer coefficient can be enhanced substantially due to the presence of heat sinks (droplets) in the bulk vapor stream. A correction factor to account for this effect is being developed and will be incorporated into the previous correlational scheme.

In a related effort, similar analysis has been carried out for the Lehigh post-CHF data which are at similar (low pressure and low flow) conditions as the B & W data. The vapor heat transfer enhancement effect has been observed in both sets of data and it also appears that the enhancement effect follows similar parametric trends. A semi-empirical correlation has been developed using the Lehigh data for prediction of the non-equilibrium vapor temperature as well as the enhanced vapor heat transfer rate. This analysis and correlation development along with the previous data collection have essentially constituted Mr. Nijhawan's Doctoral dissertation work which has now been completed. The work will be issued as a separate report and transmitted to the NRC. The report will contain the data described in the previous section of this report.

3. <u>Instrumentation Development</u> (S. Lau, L. Lee, R. Sundaram, J. Chen)

Current work is aimed at calibrating the film instrumentation module constructed by ORNL using the air-water counterflow rig at Lehigh. The module consists of two film thickness (δ) probes and two film velocity (EP) probes. The film thickness probes have been calibrated. EP probe calibration is in the final stage. The next monthly report will present the results of these calibrations.

Development of a probe to measure wall-liquid contact under post-CHF conditions is continuing. Initial problems with signal processing have been resolved and construction of the probe has been initiated.

4. <u>Analysis of Flow-Film Heat Transfer</u> (S. Webb, J. Chen)

An analytical model is being developed to predict post-CHF dispersed flow heat transfer. The concept utilizes the basic conservation equations with an appropriate distribution of heat sinks (vapor mass sources). Results of this development will be compared to the post-CHF data obtained at Lehigh (Item 1).

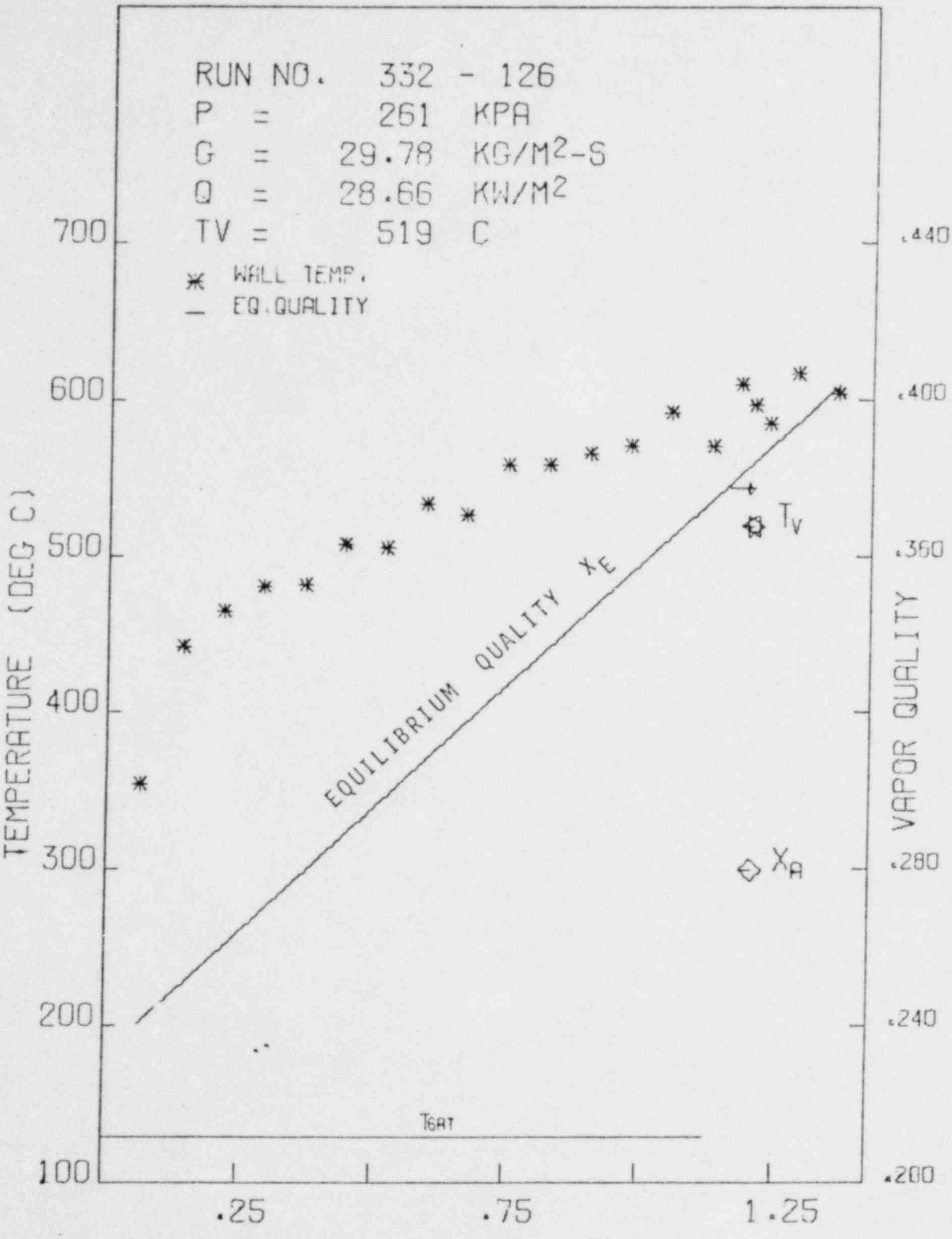

Figure 1: Typical Post-CHF data with Vapor Temperature measured at one axial location.