KNOXVILLE, TENNESSEE 37902
W10C126, 400 Commerce Avenue

GPU EXHIBIT 476 FOR IDENT.
3/18/82 N. A. RUDOLPH

February 8, 1979

Babcock and Wilcox
Post Office Box 1260
Lynchburg, Virginia 24505

Attention: Mr. James McFarland

Gentlemen:

BELLEFONTE NUCLEAR PLANT UNITS 1 AND 2
NUCLEAR STEAM SUPPLY SYSTEMS
CONTRACT 77C82-84774-2
LETTER NO. K-3478

SMALL BREAK LOCA ANALYSIS - N4M-2-14(AR)

We acknowledge receipt of your letter No. B-0102 (MEB 790125 565) and have the following comments.

TVA will require the following clarification and additional explanation to complete its review of the subject analysis and reference letter. The attachment to the reference letter contains the following statements:

1. "After natural circulation ceases, the system pressure will be controlled by a 'volume balance.' That is, the system pressure will balance at a point where the volume of fluid discharged through the break equals the volume of steam being created in the core."
2. ". . . the volume relief out the break increases with increasing system pressure. . . . "
3. "The volume of steam being generated in the core decreases with increasing pressure."

Statements 2 and 3 appear to be inconsistent with the requirement given in statement 1. Your technical basis for acceptability of the B&W small break LOCA analysis as a conservative prediction of minimum core coverage for breaks smaller than 0.05 $ft^2$ appears to require that statement ~~three~~ be correct as written. We assume that statement 2 is incorrect. Please clarify.

We were also wondering if you considered the system to be in "thermal balance" as well as "volume balance." That is, the system pressure will balance at a point where the volume of fluid discharged through the break equals the volume of steam being created in the core and the heat content of fluid discharged through the break equals the decay heat being created in the core. The system equation based on a "thermal balance" shows the volumetric steam flow ratio (final value/initial value) to be directly

X040184

1

8307130176 790228
PDR ADOCK 05000289
P
HOL

proportional to the enthalpy and density ratios (initial value/final value). Since steam density increases much faster than the enthalpy decreases over the range of interest, the net effect is a decrease in volumetric flow with increasing system pressure. This is in agreement with statement 3. However, the mass (volume X density) of fluid converted to steam is proportional to the enthalpy ratio only, which is increasing with increasing pressure. Therefore, the net effect of increasing system pressure is to increase the rate of loss of system inventory (mass).

It is this increasing inventory depletion coupled with a decreasing makeup rate from the HPI pump at elevated pressure that forms the basis for TVA's concern. One way for B&W to alleviate this concern is to show that a "thermal balance" does not have to pertain; otherwise, it would appear that the B&W small break LOCA analysis may not be an acceptable bounding predictor of minimum core level for breaks smaller than 0.05 $ft^2$.

Please reconfirm your position as stated in the reference letter and provide TVA with an appropriate explanation for not requiring a "thermal balance." Such a reply should resolve most of our remaining questions concerning very small break LOCA behavior.

Of course, concepts such as "volume balance" and "thermal balance" should be recognized as oversimplifications which may apply only to a few special cases. The rigorous solution must be based on mass and energy conservation principles applied to the entire system including all inputs, outputs, and phase changes within the system.

Please give us your written response by March 15, 1979.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

D. R. Patterson, Chief
Mechanical Engineering Branch

2/6

In triplicate
cc: Mr. J. L. Atchison

X0401B5