STANDARD FORM NO. 64

Office Memorandum • UNITED STATES GOVERNMENT

TO : Marvin M. Mann, Assistant Director, Division of Inspection, AEC Headquarters

DATE: August 1, 1960

FROM : Vincent A. Walker, Inspection Specialist, Division of Compliance, AEC Headquarters

Vincent A. Walker

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Dir.
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Mgmt.
Inv.
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Action.

SUBJECT: RESULTS OF VISIT TO WTR ON JULY 29, 1960

SYMBOL : INS:VAW

The main determination that I believe you wanted me to examine was the conclusion presented in WTR-49, "Report on WTR Fuel Element Failure April 3, 1960" that "boiling disease" was not the cause of the incident. I also participated in the discussion regarding the operating limitations with regard to the extent of boiling permissible.

In WTR-49 the following statement is made on page 25 "Comparing Figure 41 with Figure 40 local boiling occurs over a greater length of the fuel element with the reduced flow. This creates an increase pressure drop whose effect is not considered significant. Using the data reported by J. B. Reynolds in ANL-5178, it can be shown that the increased pressure drop caused by local boiling is not adequate to account for even the assumed 15 % reduction in flow. Additional flow restriction must be postulated to produce a dangerous condition." The analysis which led to this conclusion was examined and is included here for your information. The basic equation used is:

$$\frac{\Delta P_{t(nb\&lb)}}{\Delta P_{t\,(iso)}} = \frac{L_{nb}}{L_t}\left(\frac{\Delta P_{nb}}{\Delta P_{iso}}\right) + \left[1 - \left(\frac{L_{nb}}{L_t}\right)\right]\frac{\Delta P_{lb}}{\Delta P_{iso}}$$

where

ΔP_t (nb & lb) = total pressure drop including non-boiling and local boiling lengths

$\Delta P_{t(iso)}$ = total pressure drop under isothermal conditions

L_{nb} = length of channel which is in non-boiling

L_t = total length of channel

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ΔP_{nb} = non-boiling pressure drop (friction only)

ΔP_{iso} = pressure drop under isothermal conditions (friction only)

and ΔP_{lb} = local boiling pressure drop

For an average velocity of 6.2 fps $\frac{\Delta P_{t(nb\&lb)}}{\Delta P_{t(iso)}} = 1.29$

For an average velocity of 15 per cent less than 6.2 fps:

$\Delta P_{t(nb\& lb)} / \Delta P_{t(iso)} = 1.15$

The fallacy in this argument, it seems to me, is that during the experiment the pressure drop across the hot channel is established by the pressure drop through an average channel which is transferring heat by forced convection only. The method of analysis used by Westinghouse does not determine if a hydrodynamic instability would obtain in the hot channel assuming the flow supplied to it is 15 per cent less than the average; the only real criterion, in my opinion, is whether or not hydrodynamic stability exists. From the analysis presented to you on May 24, 1960 it is evident that a 30 per cent reduction in flow results in an instability with subsequent burnout. It is not known if a 15 per cent reduction would have the same effect.

In the application of this equation a uniform heat flux of 4.0×10^5 Btu/hr, ft^2 was used whereas the inspector found that the average heat flux in the boiling length was more nearly 5.0×10^5 Btu/hr, ft^2. The correlation cited by Reynolds was not used but instead a rough graphical approximation was made.

It seems to me that the Scientific Support Section is not aggressive in the execution of its duties. An example of this is the fact that they were advised of Lowdermilk's burnout work on June 1, 1960 (including the report number), and they have not yet obtained a copy of this report according to Mr. Elmer Hemmerle. Also, this lack of effort in pursuing all avenues is further evidence that the cause of the incident had been concluded before the investigation began.

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It is stated in WTR-49 that Mirshak's correlation was multiplied by 0.60 in order for burnout to obtain. Mirshak in his report states that the deviation in the experimental data was ± 16 per cent. Furthermore, it seems unreasonable to predicate complete and sudden voiding of the coolant channels upon burnout of a 1/2-inch diameter section.

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