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SCHWENCER,A. Licensing Branch 2

SUBJECT: Forwards info discussed during 841114 meeting re steam bypass.Info provided to close out NRC questions.Info will be incorporated in FSAR Amend 17.

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December 6, 1984
(NMP2L 0279)

Mr. A. Schwencer, Chief
Licensing Branch No. 2
Division of Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Schwencer:

Re: Nine Mile Point Unit 2
Docket No. 50-410

Enclosed for your use is information regarding Steam Bypass for Nine Mile Point Unit 2 which was discussed with the Nuclear Regulatory Commission staff durng a meeting on November 14, 1984. The information is provided to close out this staff question.

The enclosed information will be included in Final Safety Analysis Report Amendment 17.

Very truly yours,

C. V. Mangan
Vice President
Nuclear Engineering & Licensing

NLR:ja
Enclosure
xc: R. A. Gramm, NRC Resident Inspector
    Project File (2)

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of )
Niagara Mohawk Power Corporation ) Docket No. 50-410
(Nine Mile Point Unit 2) )

## AFFIDAVIT

C. V. Mangan, being duly sworn, states that he is Vice President of Niagara Mohawk Power Corporation; that he is authorized on the part of said Corporation to sign and file with the Nuclear Regulatory Commission the documents attached hereto; and that all such documents are true and correct to the best of his knowledge, information and belief.

cvmangan

Subscribed and sworn to before me, a Notary Public in and for the State of New York and County of Onondaga, this 6 day of December, 1984.

Janis M Macro
Notary Public in and for
Onondaga County, New York

My Commission expires:

JANIS M. MACRO
Notary Public In the State of New York
Qualified In Onondaga County No. 4784555
Commission Expires March 30, 1985

drywell leakage consideration, it is considered constant.

$V$ = Velocity of flow, ft/sec

$g_c$ = Conversion factor, 32.2 lbm-ft/lbf-sec$^2$

$v$ = Specific volume of the fluid flowing in the leakage path, ft$^3$/lbm.

If the bypass leakage path flow rate is $\dot{M}$(lbm/sec) and the flow area is A (sq ft), the above equation can be rewritten to give:

$$\dot{M} = \frac{A}{\sqrt{K}} \sqrt{2g_c\ (PD - PW)\ 144/v} \quad \text{lbm/sec} \qquad (6.2\text{-}2)$$

Thus for a given drywell-to-wetwell pressure differential, the leakage flow (capacity) is dependent on $A/\sqrt{K}$ and the specific volume of the fluid flowing in the leakage path (which depends on the drywell internal pressure).

The purpose of the steam bypass analysis is to determine the leakage rate (in terms of bypass leakage capacity, $A/\sqrt{K}$) that would result in drywell pressurization to design pressure for the complete spectrum of line break sizes. The results of this analysis are summarized on Figure 6.2-28. This figure shows that allowable bypass leakage capacity ranges from approximately 0.057 sq ft for a large break to 0.074 sq ft for small steam line breaks.

The size of RCPB break determines the magnitude and duration of the pressure differential across the drywell leakage paths. When a very large break occurs, such as the DER of a main steam line, the high mass and energy flow from the RCPB pressurizes the drywell, generating a high pressure differential across the assumed leakage paths and producing high leakage flow rates. This short duration of reactor blowdown gives a large allowable bypass leakage capacity. When blowdown is over, the pressure differential across the leakage path dissipates and leakage flow and primary containment pressurization cease.

Small and intermediate breaks, on the other hand, result in slow RCPB depressurization. The reactor is scrammed due to the high drywell pressure resulting from the energy and mass released from the RCPB break.

During this period, the blowdown flow from the RCS forces the drywell air into the wetwell. The blowdown steam is condensed in the suppression pool, after the water level in

the downcomer vents is depressed from the incoming steam and air. This results in an essentially continuous pressure differential between the drywell and suppression chamber of at least 4.76 psid. The allowable bypass leakage capacity for these conditions is an $A/\sqrt{K}$ of 0.05 sq ft.

The bypass leakage analysis is performed assuming that only steam leaks through the bypass paths. This assumption conservatively minimizes the allowable bypass leakage capacity by maximizing the primary containment pressurization from the assumed leakage. The results shown on Figure 6.2-28 are also based on the following assumptions:

1. The pipe break, loss of offsite power and failure of Division II diesel generator occur at time zero.

2. Reactor coolant makeup is provided by high and low pressure ECCS pumps depending upon the reactor pressure and water level. Feedwater is unavailable due to the loss of offsite power and unit trip.

3. To maximize steam flow from the reactor vessel through the pipe break, it is assumed that the operator throttles the ECCS flows at 10 minutes after the accident. It is also assumed that the operator does not initiate controlled reactor cooldown or actuate the ADS.

4. For small breaks which do not depressurize the reactor, it is assumed that reactor pressure is maintained by automatic operation of the SRVs in the power actuated relief mode according to the relief setpoints defined in Table 5.2-2.

5. The containment spray mode of the RHR system is assumed to operate at the minimum design flow rate of 7450 GPM (one loop available) 30 minutes after the accident. The system supplies 95 percent of this flow to the drywell atmosphere and 5 percent to the suppression chamber atmosphere.

6. It is assumed that no heat or mass transfer takes place between the pool surface and the suppression chamber atmosphere.

7. Passive heat sinks, summarized in Tables 6.2-1 and 6.2-2, absorb energy from the drywell and suppression chamber. The UCHIDA heat transfer correlation is used and condensate film revaporization is limited to 8%.

The Unit 2 analysis is based on the manual initiation of containment sprays instead of automatic sprays as required by the Standard Review Plan (NUREG-0800). The containment

spray system is QA Category I and classified as an engineered safety feature.

For the worst-case event of steam bypass, it has been determined that the operator has 30 min following the accident to establish spray flow with one loop of the RHR system. The manual initiation of the containment spray can be accomplished in approximately 2 to 4 minutes considering the valve stroke times involved.

The containment transient (before and after operator action) for the worst-case steam bypass event is shown on Figure 6.2-28A.

The rate of heat transfer to the passive heat sinks is dictated by the temperature difference between the containment atmosphere and the sink surface and by the nitrogen-to-steam mass ratio of the atmosphere. The surface heat transfer coefficient is determined for each heat sink as a function of the appropriate nitrogen-to-steam mass ratio from the UCHIDA correlation, which yields coefficients ranging from the minimum value of 2.0 BTU/HR-FT$^2$-°F to the maximum value of 280 BTU/HR-FT$^2$-°F. When the surface temperature of the heat sink (Ts) is greater than the saturation temperature of the atmosphere (Tg) the minimum UCHIDA coefficient is used. When Ts is less than Tg, the UCHIDA condensing heat transfer rate is compared to the convective heat transfer rate and the larger of the two is selected. The condensing heat transfer rate is given by:

$$q_{cond} = h_u A (T_g - T_s)$$

The convective heat transfer rate is given by:

$$q_{conv} = h_c A (T_a - T_s)$$

where:

$h_u$ = UCHIDA condensing heat transfer coefficient

$h_c$ = 2.0 BTU/HF-FT$^2$-°F for convection

$A$ = Heat sink surface area

$T_a$ = Drywell or suppression chamber atmosphere temperature

$T_g$ = Saturation temperature of the drywell or suppression chamber atmosphere

$T_s$ = Heat sink surface temperature

Under superheated drywell or suppression chamber atmosphere conditions, heat sink condensate is subject to revaporization due to convective heat gain from the superheated atmosphere. Partial revaporization limited to 8 percent of the condensate mass is assumed in this analysis.

The heat transfer coefficients for the primary containment wall (heat sinks 7 and 14 of Table 6.2-1) are shown in Figure 6.2-28B.

The spray drop thermal efficiency of 90 percent has been assumed in the steam bypass analysis. However, a sensitivity study with spray thermal efficiency reduced to 50 percent demonstrates that there is no limitation on bypass capability due to this assumption. Figure 6.-2-28C shows that drywell and suppression chamber peak pressures occur at the time of spray initiation with either 50 percent or 90 percent spray thermal efficiency.

Heat transfer from the drywell atmosphere into the suppression chamber atmosphere through the steel downcomer pipes is included in the bypass analysis. However, at the time of spray initiation (1800 sec), the downcomer metal is at 291°F compared to the spray water temperature of 114°F. Therefore, about 8.34 million BTUs of sensible heat is stored in the downcomer pipes. In the worst case, this energy could vaporize the suppression chamber spray water for about 5 minutes after spray actuation. A sensitivity study including this additional energy source shows that there is no additional limitation on steam bypass capability due to this heat source.

The steam bypass analytical model assumes that nitrogen purged from the drywell due to steam blowdown is forced through the downcomer vent system and enters the suppression chamber atmosphere as dry nitrogen at the suppression pool temperature. For the limiting steam bypass case, the majority of the drywell nitrogen mass is purged to the suppression chamber by about 300 seconds after the pipe break. In this time interval, pool temperature increases from 90°F to 102°F. A sensitivity study considering nitrogen saturated with vapor at pool temperature indicates that the dry nitrogen carryover assumption has negligible effect on the steam bypass capability. With saturated nitrogen carryover, peak containment pressure at 1800 sec increased by approximately 0.25 psi.

Energy absorbed (integrated energy) by the containment heat sinks and sprays at various times is provided in Table 6.2-27A. The energy and mass balance is shown in Table 6.2-53.

To ensure that drywell bypass leakage conforms to the design basis, a leak test is conducted at the drywell to suppression chamber design pressure differential of 25 psid. The acceptance criterion for this test is that the measured leakage must be less than 10 percent of the bypass leakage capacity based on an $A/\sqrt{K}$ of 0.054 sq ft.
At the first refueling outage a leak test will be conducted to verify bypass leakage. The schedule for subsequent bypass leakage tests will be the same as the schedule for the Type A tests conducted in accordance with Technical Specification.

Negative Primary Containment Differential Pressure

The maximum negative differential pressure for the primary containment results from the assumed inadvertent actuation of the containment spray system during normal plant operation with minimum spray water temperature and minimum air mass inside the containment. The term air mass is used for simplicity and refers to the nitrogen inerted atmosphere.

Containment depressurization following a postulated pipe break in the drywell is less severe than inadvertent spray actuation because the suppression pool temperature, which dictates the final containment temperature and pressure, is increased due to blowdown steam condensation in the pool. In addition, the air mass inside the Mark II primary containment is constant during normal operation and the drywell floor vacuum breakers allow air to return to the drywell during post-LOCA drywell depressurization to limit the upward pressure differential on the drywell floor.

The following assumptions and analysis describe the worst-case negative containment pressure differential resulting from inadvertent spray actuation.

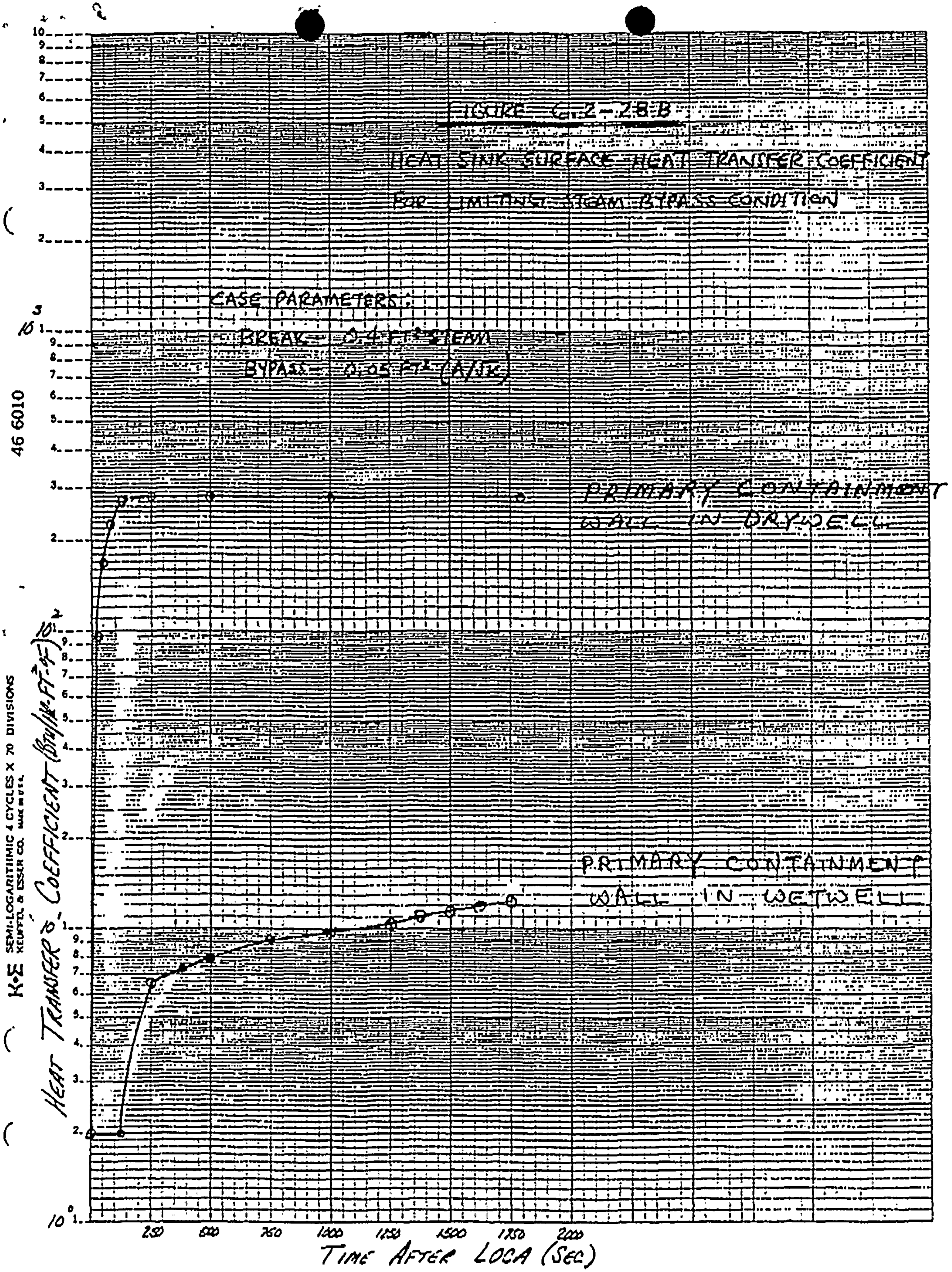

FIGURE C.2-28B

HEAT SINK SURFACE HEAT TRANSFER COEFFICIENT FOR LIMITING STEAM BYPASS CONDITION

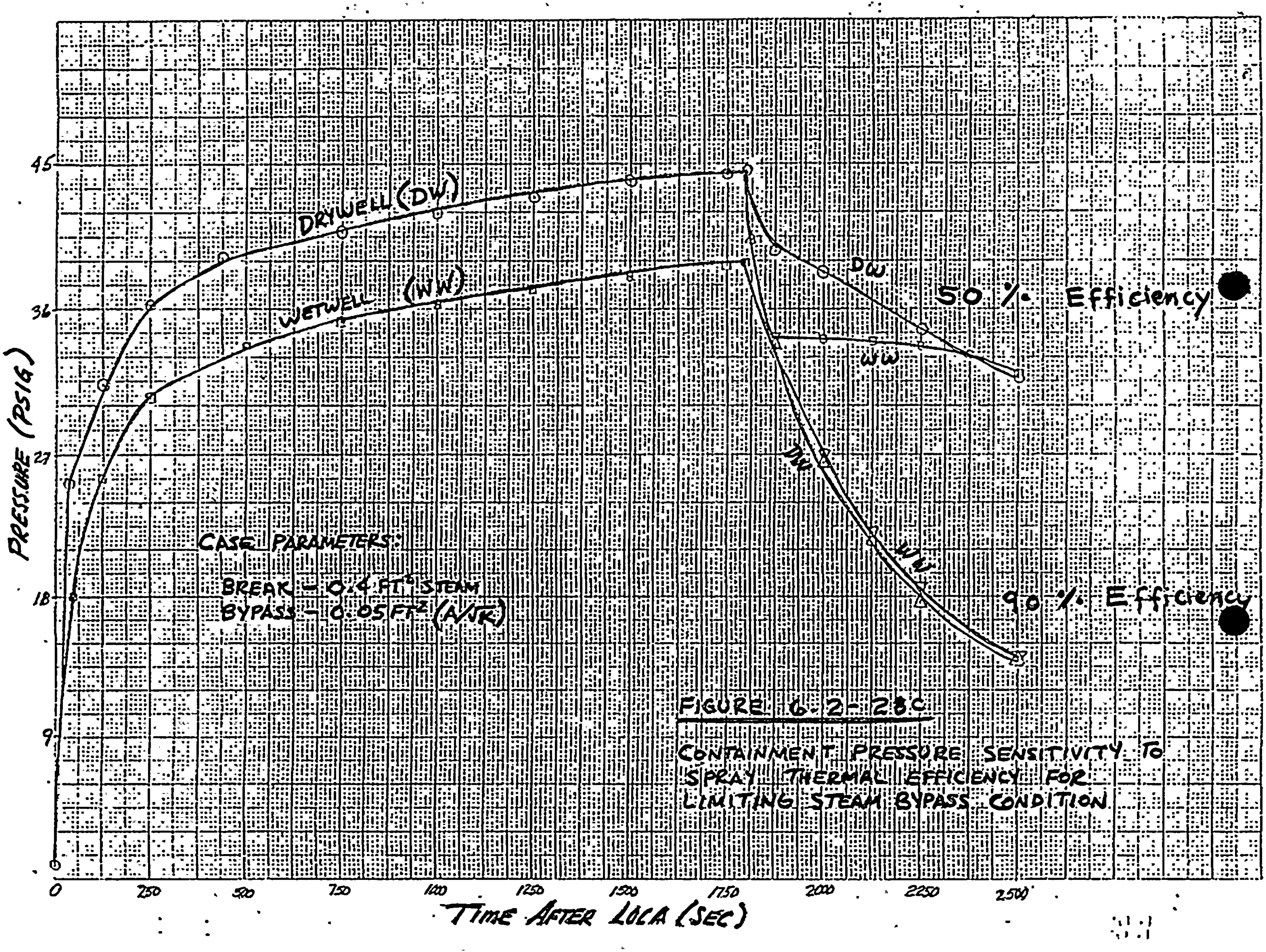

FIGURE 6.2-28C

CONTAINMENT PRESSURE SENSITIVITY TO SPRAY THERMAL EFFICIENCY FOR LIMITING STEAM BYPASS CONDITION