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October 18, 1984
5211-84-2256

Office of Nuclear Reactor Regulation
Attn: J. F. Stolz, Chief
Operating Reactors Branch No. 4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Sir:

Three Mile Island Nuclear Station, Unit 1 (TMI-1)
Operating License No. DPR-50
Docket No. 50-289
Plant Shielding - DHR System Option

Attached is the information concerning our alternate Decay Heat Removal System configuration which was requested during our discussion on September 6, 1984 of GPUN letter of July 27, 1984 (5211-84-2179). This evaluation shows that simultaneous suction from the Decay Heat Dropline and the Reactor Building sump does not produce entrained air in the DH suction piping because the RB sump acts as a surge volume ensuring that the water level in the dropline is above the inlet to the suction at all times.

Sincerely,

H. D. Hukill
Director, TMI-1

HDH/LWH/MRK/lr/0116A
Attachment
cc: J. Van Vliet

A001
1/1

Simultaneous Suction On Decay Heat Dropline And Reactor Building Sump

BACKGROUND

The DHR System is used as a method of controlling boron concentration in the core following an accident. Of the three methods for controlling boron precipitation outlined by Babcock & Wilcox (Ref. 1), the following two methods were found to be acceptable by the NRC and were adopted at TMI-1:

1) Gravity drain from the decay heat dropline to the reactor building sump through the LPI string not in operation and continue low pressure injection through the operable string.

2) Forced circulation with Hot Leg Injection via the auxiliary pressurizer spray line.

The first mode utilizes either DH string to provide a letdown path from the RCS hot leg with the water ultimately being pumped back to the core flood line. In order to establish this flow path, the dropline must be aligned to the RB Sump by opening DH-V1, 2, 3 and one of the suction cross connect valves, DH-V12 A or B, and respective sump isolation valve DH-V6 A & B. DH-V1, 2, 3 and 6 are motor operated valves which are operated from the control room; DH-V12 A & B are local, manually operated valves. Post accident radiation levels have been calculated to be sufficiently high to potentially preclude local operation of these valves.

The second Boron Control Mode requires that the 'A' DH string be operable or that the cross connect from the 'B' DH string be open in order to inject to the Hot Leg via the pressurizer. The path to the pressurizer is established by opening the DH-V64 and RC-V4 valves and closing the RC-V3 valve. Operation of RC-V3 and RC-V4 valves is from the control room; DH-V64 is operated by a local handwheel and could be made inaccessible due to post accident radiation levels.

In order to ensure that control of boron precipitation is possible, post LOCA, GPUN has proposed that the following changes be made:

1) Lock open DH-V12B to provide for a letdown path to the RB sump from the DH dropline without the need to enter a high radiation area.

2) Installation of a remote operator (reach rod) on DH-V64 to allow for operation of this valve from a shielded location.

DISCUSSION

The proposed solution to the problem of plant shielding with respect to DH system operation during emergency operating conditions, including long term boron precipitation control as outlined above, were proposed to the NRC in GPUNC letter 5211-84-2179, dated July 27, 1984 (Reference 2).

These methods were also discussed briefly on September 6, 1984, with representatives of the NRC. GPUN was requested to provide further information concerning the effect on DH system operation by taking suction from the RB sump and the DH dropline simultaneously.

This alignment can result from failure of the DH-V6A valve to open upon switching LPI Modes from the BWST as a source of water to recirculation from the RB sump (as discussed in Attachment 2 of Reference 2). This failure effectively eliminates the 'A' DH pump from operation in the recirculation mode, since its suction line is closed. Low pressure injection would continue in this case through the 'B' string in the recirculation mode. Boron control would be established by opening the DH dropline to allow for letdown flow from the hot leg. The sketch in Figure 1 shows the flow path and relative elevations of the DH pump, RB sump, and RCS hotleg.

As shown in Figure 1, the dropline comes off the bottom of the "B" hot leg at elevation 312'-6". The connection with the decay heat pump suction is a "tee" at elevation 263'-0" (labeled PT A). Since this is a common point between two flow paths, the pressure at this point is determined from the hydraulic conditions in the two paths. The Bernoulli Theorem can be applied to the evaluation of either path. That is:

$$HEL_1 + \frac{144\ P1}{\rho_1} + \frac{v_1{}^2}{2g} = HEL_2 + \frac{144\ P_2}{\rho_2} + \frac{v_2{}^2}{2g} + h_L$$

for either of thw two paths.

Looking first at the drop line path:

HEL_1 =	Elevation of water in the drop line (since line may not be full, this must be treated as a variable).	= h
P_1 =	Pressure in the "B" hot leg which is assumed to be equal to the reactor building pressure since this operation will not occur until at least 24 hours following the accident.	= P_{RB}
ρ_1 =	Density of recirculation water.	= ρ_{RCS}
v_1 =	Velocity of water within dropline.	= v_{DL}
HEL_2 =	Elevation of PT A.	= h_A
P_2 =	Pressure at PT A. dropline.	= P_A

v_2	=	Velocity of water within drop line.	$= v_{DL}$
ρ_2	=	Density of recirculation water.	$= \rho_{RCS}$
h_L	=	Frictional loss in the drop line. Assumed to be Zero since the flow through this line will be small.	= 0

Thus,

or, solving for h:

$$h + \frac{144\ P_{RB}}{\rho_{RCS}} + \frac{v_{DL}}{2g}^2 = h_A + \frac{144\ P_A}{\rho_{RCS}} + \frac{v_{DL}}{2g}^2 + 0$$

$$h = h_A + \frac{144}{\rho_{RCS}}(P_A - P_{RB}) \qquad (1)$$

Now, looking at the ECCS recircultion pathway,

HEL_1	=	Elevation of water in the reactor building. Conservatively assumed to be the RB floor elevation.	$= h_{RB}$
P_1	=	Pressure in the reactor building.	$= P_{RB}$
V_1	=	Velocity at the sump surface.	= 0
HEL_2	=	Elevation at point A.	$= h_A$
P_2	=	Pressure at point A.	$= P_A$
ρ_1	=	Density of recirculation water.	$= \rho_{RCS}$
ρ_2	=	Density of recirculation water.	$= \rho_{RCS}$
V_2	=	Velocity in the suction pipe at point A. Based on: Recirculation flow = 3000 gpm pipe cross sectional area = 0.94 Ft^2	= 7.1 FT/SEC
h_L	=	Frictional loss in suction line. Based on:	= 3.0 Ft

$$h_L = \frac{fLv^2}{D2g} + h_s + K\frac{v^2}{2g}$$

Where,

$f\frac{L}{D}$ = Piping resistance = 2.73

h_s = frictional loss through screen. = 0.23 Ft

K = entrance resistance = 0.78

or,

$$h_L = (2.73 + 0.78) \frac{v^2}{2g} + 0.23$$

Thus,

$$h_{RB} + \frac{144P_{RB}}{\rho_{RCS}} + 0 = h_A + \frac{144P_A}{\rho_{RCS}} + \frac{v_2^{\ 2}}{2g} + 3.0$$

or,

$$\frac{144}{\rho_{RCS}} (P_A - P_{RB}) = h_{RB} - h_A - \frac{v_2^{\ 2}}{2g} - 3.0 \qquad (2)$$

Substituting equation (2) into equation (1) gives:

$$h = h_A + h_{RB} - h_A - \frac{v_2^{\ 2}}{2g} - 3.0$$

$$h = h_{RB} - \frac{v_2^{\ 2}}{2g} - 3.0$$

$$h = 280'\text{-}0" - 0.78' - 3.0' = 277.2 \text{ Ft.}$$

CONCLUSION:

The results of this calculation gives a dynamic head of 14.2 Ft. (277.2' - 263') at the point where the dropline enters the decay heat pump suction line. This is determined to be sufficient to maintain the suction piping flooded and free of entrained air. The reactor building sump in this case functions as a surge volume, ensuring that the water level in the dropline is above the inlet to the suction at all times.

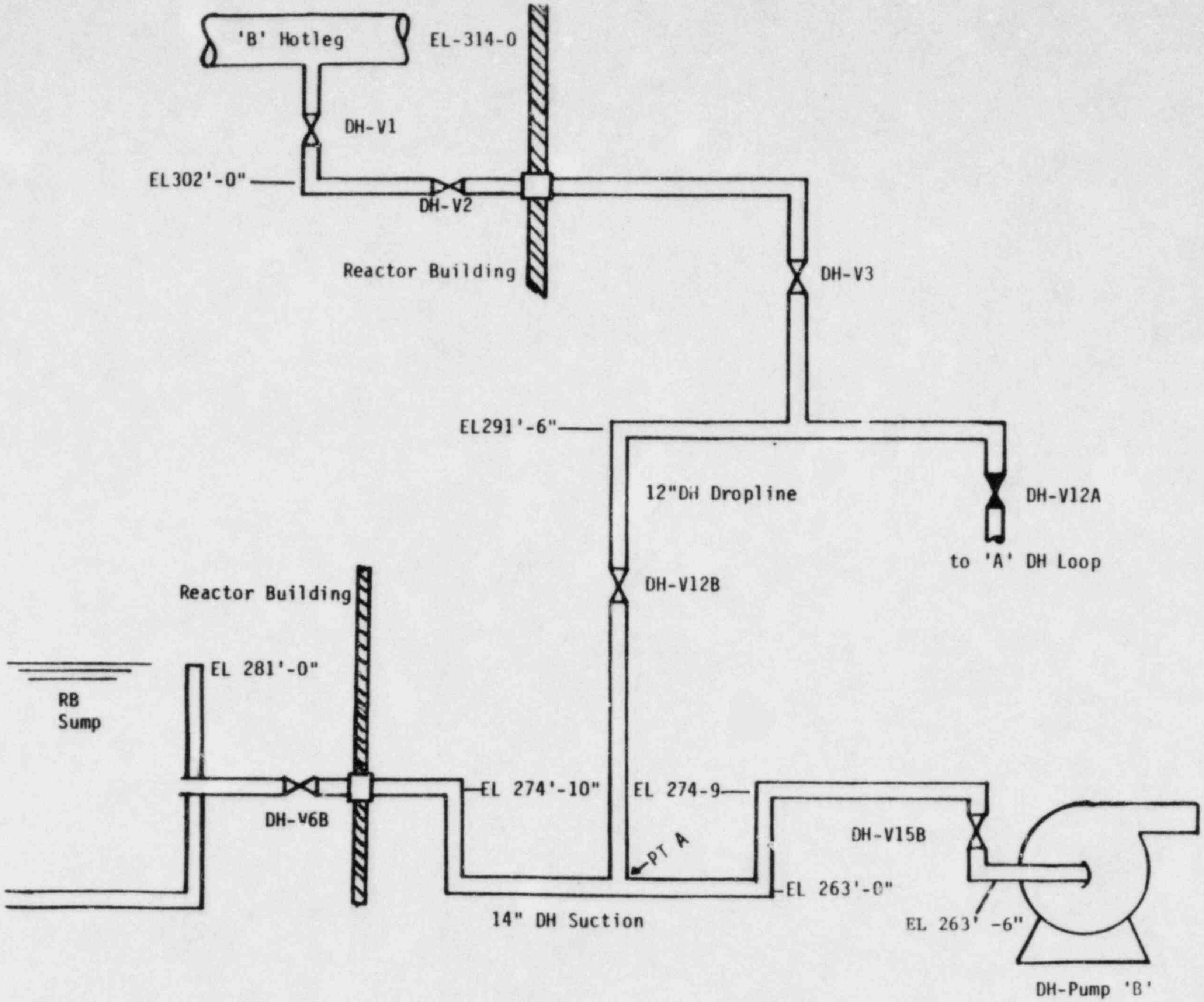
This calculation is considered conservative since it assumes the water level in the reactor vessel is below the RCS hot leg nozzle. In fact, whenever the water level in the reactor vessel exceeds EL 312'-6", water will flow down the dropline and into the suction line as the head in the dropline exceeds the pressure at PT A. This will continue until a hydraulic equilibrium is achieved between the level in the dropline and the level in the sump.

Similarly, if the dropline is empty when the RB sump valves are opened, water from the sump will fill the line up to the equilibrium level calculated above.

REFERENCES:

1. Topical report 10103A, Rev. 3 "ECCS Analysis of B&W 177 FA Lowered Loop NSS".

2. GPUN letter No. 5211-84-2179 to NRC, Dated July 27, 1984.


'B' Hotleg
EL-314-0
DH-V1
EL302'-0"
DH-V2
Reactor Building
DH-V3
EL291'-6"
12"DH Dropline
DH-V12A
to 'A' DH Loop
DH-V12B
Reactor Building
EL 281'-0"
RB
Sump
EL 274'-10"
EL 274-9
DH-V6B
DH-V15B
PT A
EL 263'-0"
14" DH Suction
EL 263' -6"
DH-Pump 'B'