SNUPPS
Standardized Nuclear Unit
Power Plant System

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Executive Director

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SLNRC 81-083 FILE: 0290
SUBJ: RSB Review

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Docket Nos.: STN 50-482, STN 50-483, and STN 50-486

Dear Mr. Denton:

Technical review meetings were held with the NRC's Reactor Systems Branch on July 21 and August 12, 1981. As a result of the meetings, SNUPPS agreed to provide additional information. This letter contains some of the information requested.

1. Agenda item #14 from the 7/21 meeting concerned justification for the T-cold upper head temperature assumption in the LOCA analysis. Enclosure A provides the requested information.

2. Agenda item #16 concerned manual valves in the ECCS system which, if mispositioned, would degrade the function of redundant flow trains. The response to this item was included in FSAR Revision 6 (p. 6.3-36). The two valves indicated in that FSAR change were the only two that fell into the NRC's category for requiring locking and control room position indication. However, during our review of this matter, it was determined that a valve in the condensate storage system (V-015 on figure 9.1-12) presented a similar situation. It was decided to add control room position indication to this locked-open valve as well.

3. Agenda item 440.101 concerned the applicability of WCAP 7769 to SNUPPS. Westinghouse Topical Report WCAP-7769, Revision 1, "Overpressure Protection for Westinghouse Pressurized Water Reactors," is applicable to the SNUPPS units and is incorporated in the SNUPPS applications by reference in the FSAR. Tables 2-1 and 2-2 of WCAP-7769, Revision 1, present typical values for various parameters of each class of Westinghouse-designed nuclear steam supply systems (i.e., 2, 3, and 4 loop). As would be expected, actual values within each class vary to some degree due to the specific design details of each plant. SNUPPS parameters, as illustrated on the attached additions (see Enclosure B) to Tables 2-1 and 2-2 of WCAP-7769, are similar to those provided for the "typical" four loop plants.

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4. Agenda item 440.205 concerned the applicability of the Diablo Canyon tests to the SNUPPS design. Enclosure C provides the information requested by the NRC.

Very truly yours,

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Enclos es

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Enclosure A to SLNRC 81-083

UPPER HEAD T-COLD VERIFICATION

In order to achieve upper head temperatures in the T cold zone, bypass flow was diverted into the vessel head region. A study was performed and documented in Reference 1 to determine the amount of bypass flow necessary to achieve T cold conditions in the head. As descirbed in Section 2 of Reference 1, an analytical model for upper head temperature calculation was developed for both UHI and non-UHI plants. To estimate the upper head region fluid temperature with the analytical model, numerous boundary conditions must be known. The boundary conditions used were based on experimental data obtained from a series of three hydraulic tests conducted at the Westinghouse Forest Hills facility. These tests were the UHI flow distribution test, the 1/7 scale UHI upper internals test and the 1/7 scale 414 flow test.

To provide experimental verification of the analytical model, a 1/5 scale model upper head temperature test was developed as described in Section 3 of reference 1. Results for both UHI and non-UHI plants showed good agreement with analytical predictions. Further confirmation of the analytical procedures was obtained by an in-plant head fluid temperature measurement program as described in section 4 of reference 1. The program included measurements from 2, 3 and 4 loop plants. Both UHI and non-UHI plants were measured. All three types of upper core plate designs (flat, top hat, and inverted top hat) were included as well as both neutron shield configurations (thermal shield and neutron pad). As reported in Section 4 of reference 1, good agreement was reached between measurements and the analytical model for the above spectrum of non-UHI plant types. This provides good assurance that the upper head fluid temperatures have been adequately calculated by the analytical model described in Reference 1.

Recent data from a UHI plant (Sequoyah Unit 1), included in the in-plant head fluid temperature program, also shows good agreement between predicted and measured upper head temperatures.

In conclusion, assurance that upper head temperature can be maintained in the T cold zone has been provided by a verified analytical technique as described in Reference 1.

References:

1. R.H. McFetridge, D.C. Garner, "Study of Reactor Vessel Upper Head Region Fluid Temperature," WCAP-9401 Rev. 1, December 1978.

TABLE 2-1

PRESSURIZER AND STEAM GENERATOR SAFETY VALVE RELIEF CAPACITY

Plant	Engineered Safeguards Design Power Rating - MWt	Number of Safety Valves	PRESSURIZER Capacity per Valve lb/hr	PRESSURIZER Total Capacity lb/hr	STEAM GENERATOR Number of Safety Valves	STEAM GENERATOR Total Capacity lb/hr
I. Four-Loop Plants						
Consolidated Edison Company of New York Indian Point Nuclear Generating Unit No. 2	3216	3	408,000	1,224,000	20	14,619,000
Indiana and Michigan Electric Company Donald C. Cook Units No. 1 and No. 2	3381	3	420,000	1,260,000	20	17,153,800
Public Service Electric and Gas Company Salem Nuclear Generating Station Units No. 1 and No. 2	3500	3	420,000	1,260,000	20	14,800,000
SNUPPS	3579	3	420,000	1,260,000	20	18,229,608
II. Three-Loop Plants						
Virginia Electric and Power Company Surry Power Station Units No. 1 and No. 2	2546	3	293,330	879,990	15	11,176,725
Duquesne Light Company Beaver Valley Power Station	2774	3	345,000	1,035,000	15	12,148,647
Carolina Power and Light Company H.B. Robinson Unit No. 2	2300	3	288,000	864,000	12	10,068,845

TABLE 2-2

TYPICAL PLANT THERMAL-HYDRAULIC PARAMETERS

	Units	2-Loop	3-Loop	4-Loop	SNUPPS
Heat Output, Core	MWt	1,780	2,652	3,411	3,411
System Pressure	psia	2,250	2,250	2,250	2,250
Coolant Flow	gpm	178,000	265,500	354,000	382,800
Average Core Mass Velocity	10^6 lb/hr-ft^2	2.42	2.33	2.50	2.62
Inlet Temperature	°F	545	544	552.5	558.8
Core Average T_{mod}	°F	581	580	588	591.8
Core Length	Ft	12	12	12	12
Average Power Density	kw/l	102	100	104	103.46
Maximum Fuel Temperature	°F	<4100	<4200	<4200	<4200
Fuel Loading	kg/l	2.7	2.6	2.6	2.7
Pressurizer Volume	Ft^3	1000	1400	1800	1800
Pressurizer Volume Ratioed to Primary System Volume		0.157	0.148	0.148	0.147
Peak Surge Rate for Pressurizer Safety Valve Sizing Transient	Ft^3/sec	21.8	33.2	41.0	43.2
Pressurizer Safety Valve Flow at 2500 psia - +3% Accumulation	Ft^3/sec	26.1	36.1	43.3	43.2
Ratio of Safety Valve Flow to Peak Surge Rate		1.197	1.087	1.056	1.00
Full Power Steam Flow per Loop	lb/sec	1078	1076	1038	1051
Nominal Shell-side Steam Generator Water Mass per Loop	lb	100,300	106,000	106,000	107,000

Enclosure C to SLNRC 81-083

COMPARISON OF SNUPPS TO DIABLO CANYON

SNUPPS and DIABLO CANYON Unit 1 have been compared in detail to ascertain any differences between the two plants that could potentially affect natural circulation flow and attendant boron mixing. Because of the similarity between the plants, it was concluded that the natural circulation capabilities would be similar, and, therefore, the results of prototypical natural circulation cooldown tests being conducted at DIABLO CANYON will be representative of the capability at SNUPPS.

The general configuration of the piping and components in each ractor coolant loop is the same in both SNUPPS and DIABLO CANYON. The elevation head represented by these components and the system piping is similar in both plants.

To compare the natural circulation capabilities of SNUPPS and DIABLO CANYON, the hydraulic resistance coefficients were compared. The coefficients were generated on a per loop basis. The hydraulic resistance coefficients applicable to normal flow conditions are as follows:

	DIABLO CANYON UNIT 1	Ft/(gpm)^2 SNUPPS
Reactor Core & Internals	7.6×10^{-10}	7.2×10^{-10}
Reactor Nozzles	36.8×10^{-10}	27.6×10^{-10}
RCS Piping		
RV outlet to SG inlet		4×10^{-10}
SG outlet to RCP inlet		10×10^{-10}
*RCP discharge to RV inlet		10×10^{-10}
RC loop	24×10^{-10}	24×10^{-10}
Steam Generator	114.4×10^{-10}	122.0×10^{-10}
	182.8×10^{-10}	180.8×10^{-10}

Flow Ratio: $\dfrac{\text{SNUPPS}}{\text{Diablo Canyon}} = \dfrac{(182.8)^{1/2}}{(180.8)} = 1.0055$

The general arrangement of the reactor core and internals is the same in SNUPPS and DIABLO CANYON. The coefficients indicated represent the resistance seen by the flow in one loop.

The reactor vessel outlet nozzle configuration for both plants is the same. The radius of curvature between the vessel inlet nozzle and downcomer section of the vessel on the two plants is difference. Based on 1/7 scale model testing performed by Westinghouse and other literature, the radius on the vessel nozzle/vessel downcomer juncture influences the hydraulic resistance of the flow turning from the nozzle to the downcomer. The DIABLO CANYON vessel inlet nozzle radius is significantly smaller than that of SNUPPS, as reflected by the higher coefficient for DIABLO CANYON.

*The SNUPPS reactor coolant pumps include wiers. The Diablo Canyon pumps do not include wiers; however, the effect of wiers is negligible (confirmed by tests which indicate a 5 gpm loss of head across the wier).

The resistance coefficient for the RCS piping for both plants is the same.

Steam generator units were also compared to ascertain any variation that could affect natural circulation capability by changing the effective elevation of the heat sink or the hydraulic resistance seen by the primary coolant. It was concluded that there are no differences in the original design of the steam generators in the two plants that would adversely affect the natural circulation characteristics. Indeed the circulation should be enhanced in the SNUPPS as the water feeds into the hot side.

As indicated, the difference between the total resistance coefficients for the two plants is insignificant. It is expected that the relative effect of the coefficients would be the same under natural circulation conditions such that the natural circulation loop flowrate for SNUPPS would be within two percent of that for DIABLO CANYON.

The coefficients provided reflect the flowrate and associated heat removal capability of an individual loop in the plant. The comparison, therefore, does not take into consideration the number of loop available nor the core heat to be removed. An evaluation of the SNUPPS steam relief and auxiliary feedwater systems has been performed to demonstrate that cooling can be provided via two steam generators following the most limiting single active failure, i.e., the failure of an atmospheric relief valve.

Loop circulation flow is dependent on reactor core decay heat which is a function of time based on core power operating hist ry. Under natural circulation flow conditions, flow into the upper head area will constitute only a small percentage of the total core natural circulation flow and therefore will not result in an unacceptable thermal/hydraulic impedance to the natural circulation flow required to cool the core.

For typical 4-loop plants (including SNUPPS) there are two potential flow paths by which flow crosses the upper head region boundary in a reactor. These paths are the head cooling spray nozzles, and the guide tubes. The head cooling spray nozzle is a flow path between the downcomer region and the upper head region. The temperature of the flow which enters the head via this path corresponds to the cold leg value (i.e., T_{cold}) Fluid may also be exchanged between the upper plenum region (i.e., the portion of the reactor between the upper core plate and the upper support plate) and the upper head region via the guide tubes. Guide tubes are dispersed in the upper plenum region from the center to the periphery. Because of the nonuniform pressure distribution at the upper core plate elevation and the flow distribution in the upper plenum region, the pressure in the guide tube varies from location to location. These guide tube pressure variations create the potential for flow to either enter or exit the upper head region via the guide tubes.

To ascertain any difference between the upper head cooling capabilities between DIABLO CANYON and SNUPPS, a comparison of the hydraulic resistance of the upper head regions was made. These flow paths were considered in parallel to obtain the following results:

	DIABLO CANYON UNIT 1	SNUPPS
Flow area (ft^2)	0.77	.844
Loss coefficient	1.51	1.45
Overall hydraulic resistance (ft^{-4})	2.57	2.038
Relative head region flowrate (Based on hydraulic resistance)	1.00	1.12

As indicated above, the effective hydraulic resistance to flow in SNUPPS is slightly less than DIABLO CANYON. Assuming that the same pressure differential existed in both plants, the SNUPPS head flow rate would be 112 percent of the DIABLO CANYON flow.

It can, therefore, be concluded that the results of the natural circulation cooldown tests performed at DIABLO CANYON will be representative of the natural circulation and boron mixing capability of SNUPPS. The results of these tests will be reviewed for applicability. A natural circulation cooldown test will be performed at SNUPPS prior to startup following the first refueling if the DIABLO CANYON prototype test is not completed or does not provide satisfactory results during the first fuel cycle at SNUPPS.

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