PSEG

Public Service Electric and Gas Company 80 Park Place Newark, N.J. 07101 Phone 201/622-7000

September 11, 1975

Mr. B.J. Youngblood, Chief
Environmental Projects Branch 3
Division of Reactor Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Youngblood:

THERMAL DISCHARGE SURFACE DISTRIBUTION ANALYSIS
DELAWARE RIVER ESTUARY
SALEM NUCLEAR GENERATING STATION
DOCKET NOS. 50-272 AND 50-311

Public Service Electric and Gas Company hereby transmits, for your review, the thermal discharge surface distribution analysis, as requested by Mr. F.J. Miraglia of your staff.

Very truly yours,

R.L. Mittl
General Manager - Projects
Engineering and Construction
Department

THERMAL DISCHARGE SURFACE DISTRIBUTION ANALYSIS
IN THE DELAWARE RIVER ESTUARY
SALEM NUCLEAR GENERATING STATION, NOS. 1 AND 2 UNITS

History

During July 1968, Pritchard-Carpenter, acting as consultants for the Public Service Electric and Gas Company (PSE&G), published a report titled "Dispersion and Cooling of Waste Heat Released into the Delaware River Estuary". This report has been included as Appendix A.4 of PSE&G's operating license stage Environmental Report for the Salem Nuclear Generating Station, Units 1 and 2. The report was the result of numerous tests performed by Pritchard-Carpenter utilizing the U.S. Army Corps of Engineers Waterways Experiment Station's hydraulic model of the Delaware River. The model is located in Vicksburg, Mississippi. Tests were run to determine the optimum location and design of the power plant circulating water system intake and discharge and to determine the size of the isotherms which would result in the estuary from plant operation. The design station cooling water temperature rise of 13.6°F was used in all model work.

In April 1973 the United States Atomic Energy Commission (AEC) published its Final Environmental Statement for the Salem Nuclear Generating Station. Using the phenomenological data provided by Asbury and Frigo and modifying their method of thermal plume size prediction the AEC staff independently developed an estimate of the thermal discharge surface distribution. The AEC staff also used a discharge temperature of 13.6°F above the ambient water temperature for their determinations.

During 1975, while work progressed on the Salem Environmental Technical Specifications it became apparent to PSE&G engineers that the design cooling water temperature rise of 13.6°F would not serve as a suitable thermal discharge limit. Analysis showed that under certain normal full load operating conditions the discharge temperature could be as much as 16.5°F above the ambient. This fact prompted additional thermal plume analysis.

Extrapolation of Tidal Plume Data

PSE&G personnel plotted the areas calculated by the AEC staff shown in Table 5.1 of the Final Environmental Statement on an Asbury-Frigo curve. This is shown in Figure 1. Using a 16.5°F temperature rise, PSE&G then used the curve to re-estimate plume sizes. It was desirable to relate the results to the tidal variations as determined in the physical model of Pritchard-Carpenter. For each isotherm a ratio of the 16.5°F area to 13.6°F area was calculated. Respective ratios were multiplied by the isotherm areas determined by Pritchard-Carpenter yielding new tidal isotherm area estimates for the 16.5°F discharge temperature. The progression of calculations and the 16.5°F tidal estimate are shown in Tables 1 and 2.

Environmental Implications

Organisms entrained in the cooling water will be subjected to a sudden temperature rise in the condenser. This exposure and its effects are limited to, and by, entrainment time in the cooling system. During normal operation this period of entrainment will be less than 4 minutes. Under the most severe conditions, entrainment time will be less than 8 minutes for 1/5 of total cooling flow; 4/5 of total flow will be passed through the system within 4 minutes. This time-temperature exposure will effect minimum impact on entrained organisms. Studies by Hoss, et. al.,[1] Schubel[2], and Ichthyological Associates (unpublished) show total survival among potentially entrainable organisms which were exposed for 10 minutes to a ΔT of 16.5°F, and relatively high survival after similar exposure to a ΔT of 27.5°F. Due to handling problems the Cynoscion regalis (Weakfish) and the Anchoa Mitchilli (Bay Anchovy) were not included in these tests. However, the overall impact on all species is not expected to be significant for the following reasons:

1. Infrequency of the occurrence of the 27.5°F ΔT as indicated in the bases for Specification 2.1.2.

2. Comparatively small amount of water utilized for cooling purposes compared to tidal flow (on the order of 1%).

3. With respect to weakfish:

   (a) Most are spawned at least 15 miles south of Artificial Island. Relatively few of entrainable size (<50 mm total length) have been taken by Ichthyological Associates, Inc. in the Artificial Island region.

   (b) The vicinity of Artificial Island is the northern perimeter of a large nursery area which extends south through the Delaware Bay.

   With respect to bay anchovy:

   (a) Large numbers occur throughout the Delaware Bay estuary.

   (b) The majority of the population will not be exposed to the Salem intake.

REFERENCES

1. Hoss, D. E., W. F. Hettler, Jr. and L. C. Coston. 1973. Effects of thermal shock on larval estuarine fish--Ecological implications with respect to entrainment in power plant cooling systems. In the Proceedings of the Symposium on the Early Life History of Fish, Oban, Scotland.

2. Schubel, J. R. 1975. Some comments on the thermal effects of power plants on fish eggs and larvae. In: Fisheries and Energy Production - A Symposium. Saul B. Saila (ed.) D. C. Heath and Co.

PSE&G ADJUSTED AEC STAFF
THERMAL PLUME ESTIMATES

Isotherm of Temperature Rise °F	13.6°F T AEC Surface Area Estimate ft^2 X 10^6 (a)	16.5°F T PSE&G Surface Area Estimates ft^2 X 10^6 (b)	16.5°F T Area / 13.6°F T Area
.5	250	310	1.2
1	120	140	1.2
1.5	55	92	1.7
2	22	39	1.8
3	3.3 (c)	11	3.3
4	2.3	3.9	1.7
5	1.1	2.0	1.8
6	0.62	1.0	1.6
8	0.25	0.43	1.7

NOTES:

(a) Table 5.1, United States Atomic Energy Commission Directorate of Licensing, Final Environmental Statement, Salem Nuclear Generating Station - Units 1 and 2. Areas are by modified Asbury and Frigo method.

(b) Areas are by same modified Asbury and Frigo method as (a) using AEC curve on Figure 1.

(c) Point does not fit curve shown in Figure 1.

TABLE 1

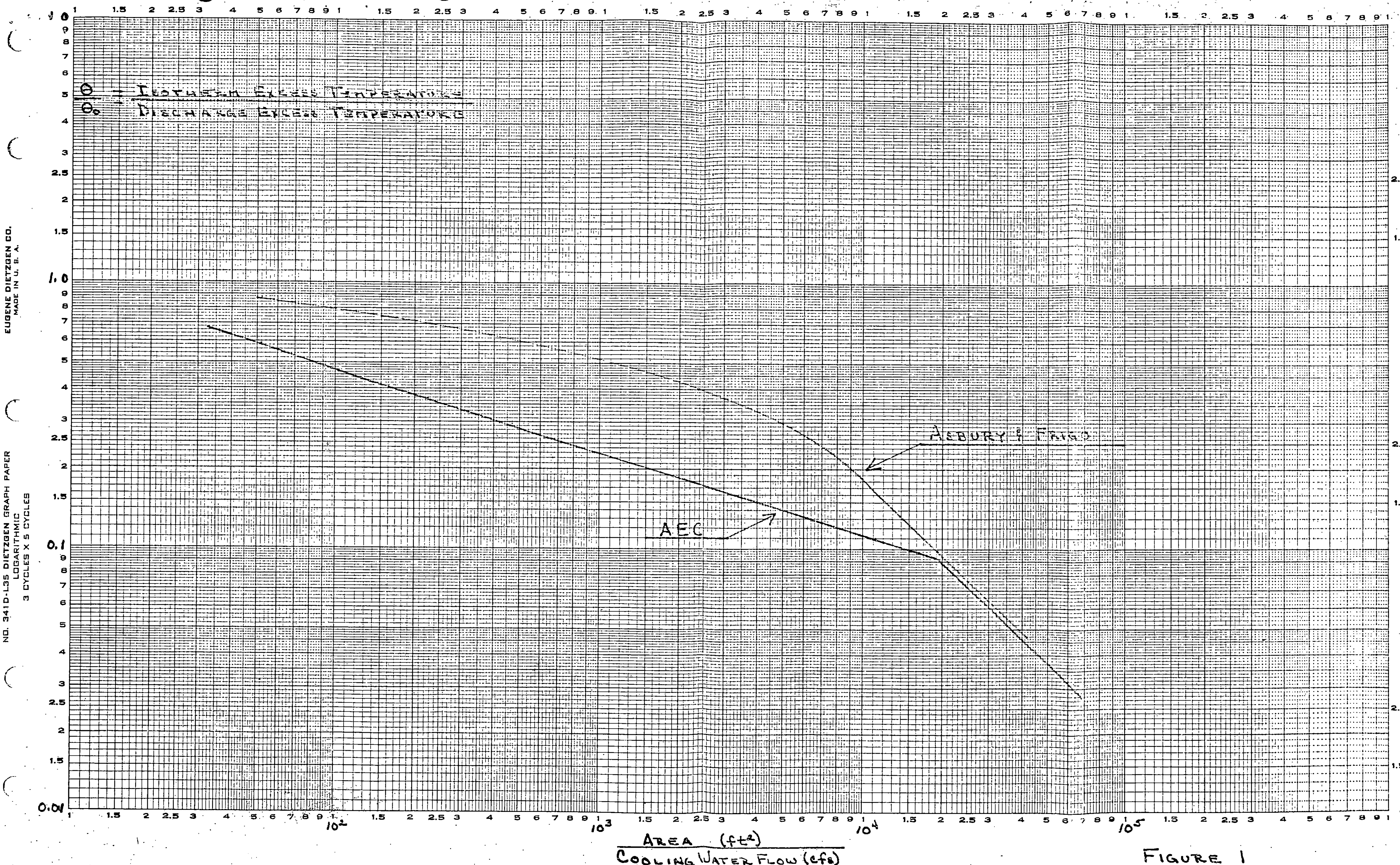
PSE&G ADJUSTED PRITCHARD-CARPENTER
TIDAL THERMAL PLUME ESTIMATES

Tidal Hour	13.6°F Discharge Above Ambient Carpenter Estimates Area ft² X 10⁶			Adjusted Carpenter Estimates 16.5°F Discharge Above Ambient Area ft² X 10⁶ (a)		
	4°F	5°F	6°F	4°F	5°F	6°F
0	6.1	2.3	.59	10	4.1	.94
1-1/2	.97			1.7		
3	1.6			2.7		
4-1/2	3.0	1.1		5.1	2.0	
6	3.3	1.8		5.6	3.2	
7-1/2	1.4			2.4		
9	4.5			7.7		
10-1/2	6.2			10		

NOTE:

(a) These areas are found by multiplying the original Carpenter estimates by the appropriate 16.5°F to 13.6°F area ratio found in Table 1. That is 1.7, 1.8 and 1.6 for the 4, 5 and 6°F isotherm respectively.

TABLE 2



Θ/Θ₀ = Isotherm Excess Temperature / Discharge Excess Temperature
Asbury & Frigo
AEC
1.0
0.1
0.01
10²
10³
10⁴
10⁵
Area (ft²) / Cooling Water Flow (cfs)
EUGENE DIETZGEN CO. MADE IN U.S.A.
NO. 341D-L35 DIETZGEN GRAPH PAPER LOGARITHMIC 3 CYCLES X 5 CYCLES

FIGURE 1