UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
PENNSYLVANIA POWER & LIGHT COMPANY	)	
	)	
and	)	Docket Nos. 50-387
	)	50-388
ALLEGHENY ELECTRIC COOPERATIVE, INC.	)	
	)	
(Susquehanna Steam Electric Station,	)	
Units 1 and 2)	)	

9/4/81

SUPPLEMENTAL AFFIDAVIT OF JAMES RIOS
IN SUPPORT OF SUMMARY DISPOSITION
OF CONTENTION 2 (CHLORINE)

County of San Francisco)
: ss.
State of California)

James Rios, being duly sworn according to law, deposes and says as follows:

1. I am Supervising Engineering Specialist for the San Francisco Power Division of Bechtel Power Corporation and give this Supplemental Affidavit in support of Applicants' Motion for Summary Disposition of Modified Contention 2 (Chlorine). A summary of my professional qualifications and experience was attached as Exhibit "A" to my Affidavit, dated

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November 4, 1980, in support of Applicants' November 6, 1980 motion for summary disposition of the chlorine contention, which motion was granted in part and denied in part by the Licensing Board.

2. The chlorine contention, as modified by the Licensing Board's Memorandum and Order of March 16, 1981 (LBP-81-8) slip op. at 12, states that "no assessment has been made of the health effects of a higher level of chlorination [at the Susquehanna Steam Electric Station ("Susquehanna")] should a higher level become necessary because of the discharge of organic wastes into the river upstream from the plant. Nor have the quantities and health effects of trihalomethanes and halomethanes to be released been adequately assessed, at anticipated or higher-than-anticipated levels of chlorination." This Affidavit describes how chlorine will be used at Susquehanna and the amounts of chlorine that will be discharged by the facility into the Susquehanna River under its NPDES permit. It addresses the results of a study on the formation of chloro-organic compounds resulting from the use of chlorine at Susquehanna, which study establishes that the anticipated amounts of trihalomethanes and other halomethanes that will be produced by the facility will be negligible, and will not increase measurably the concentrations of those compounds at the intake of the Danville Treatment plant. Finally, it discusses the proposed ethanol production facility referred to by intervenor Citizens Against Nuclear Dangers ("CAND") as

dumping "millions of gallons of organic waste" into the river upstream from Susquehanna, and explains that, if and when the proposed ethanol production facility goes into operation, it will not discharge organic waste material into the river, so that there will be no need to increase chlorination of the water systems at Susquehanna as a result of the ethanol facility.

Use of Chlorine at Susquehanna

3. As stated in para. 3 of my November 4, 1980 affidavit, the purpose of chlorinating the various water systems in the Susquehanna facility is to arrest the cumulative growth of slime-forming biolife on equipment surfaces and to disinfect the potable water supply and the sewage effluent from the facility. Specifically, chlorine is used to keep stainless steel condenser tubes[1] free from slime films. Chlorination will also help prevent corrosion, because slime deposits can entrap river water debris, which in turn can lead to pitting under the deposits.

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1 The condenser is part of the circulating water system at Susquehanna. The primary function of the condenser is to maximize steam cycle efficiency by allowing steam to expand through the turbine to the lowest possible exhaust temperature, which corresponds to the lowest pressure (vacuum). The ability of a condenser to provide the lowest possible backpressure for a given load and cooling water temperature is adversely affected by biofouling of the condenser tubes, since the slime films formed are poor conductors of heat. Buildup of slime films (biofouling) on the condenser tubes would create a condenser back pressure that would lead to electrical output loss.

4. To assure a high degree of cleanliness of the condenser tubes and provide a means of minimizing the need to use chlorine for the prevention of biological slimes, the design of Susquehanna includes an "Amertap system" for mechanically removing deposited matter from the tubes. The Amertap system will continuously wipe clean the cooling water side of the condenser tubes while the condenser is in operation. This is accomplished by circulating a number of sponge-rubber balls through the tubes with the cooling water. The balls, slightly larger than the tube inside diameter, are injected into the inlet pipe, passed through the condenser tubes, collected in the tail pipe and then reinjected into the inlet pipe. This system is described in Section 3.4.3.1 of the Susquehanna Environmental Report-Operating License Stage ("ER-OLS").

5. Use of the Amertap system will reduce the use of chlorine at Susquehanna; however, chlorine and chlorine-containing compounds will still be used to arrest the growth of biolife on equipment surfaces and, to a much lesser extent, for other uses such as disinfecting the potable water supply and the sewage effluent.[2]

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2 As shown on Table 3.6-2 of the ER-OLS, attached as Exhibit "A" hereto, there will be an average total consumption of 32,070 lb of chlorine per month of which only 25 lb will be used on the potable water supply and 75 lb will be added to the sewage effluent.

6. Susquehanna will use a typical fresh water utility chlorination program in which a timer is set to provide 20 minutes of chlorination every 8 hours for each unit. Liquid chlorine will be injected at a point about two minutes water travel time upstream from the outlet of the condenser. The proximity of the chlorine injection point to the condenser permits using smaller dosages of chlorine and of dechlorinating chemicals. Liquid chlorine will be evaporated and the gas mixed with circulating water in an eductor. The resultant gaseous-water mixture will be injected upstream of the condenser, through a distributor that will distribute it evenly across the flowing circulating water, effecting rapid mixing. The actual dosage added under varying conditions of circulating water composition and temperature will be automatically controlled at the minimum by a free chlorine residual analyzer sampling the condenser outlet.

7. The United States Environmental Protection Agency ("EPA") has set an average concentration limit for free chlorine residuals contained in cooling tower blowdown discharges to surface waters at 0.2 mg/l, with a maximum limit of 0.5 mg/l at any time. 40 C.F.R. Part 423. In addition, total chlorine residuals shall not be present in cooling tower blowdown discharges for more than two hours per day for any one cooling tower.[3] Susquehanna will utilize a sulphur dioxide

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3 The EPA discharge limits are contained in the NPDES permit issued by EPA for Susquehanna.

dechlorination system to meet these EPA standards. The dechlorination system will have an adjustable timer. To assure that the chlorine residuals being discharged to the Susquehanna River are minimized, the adjustable timer shall be set so that dechlorination commences soon after the chlorination commences. Under this arrangement there should be no detectable residual chlorine[4] in the cooling water blowdown at any time. The operation of the dechlorination system is described in Section 3.6.10 of the ER-OLS.

8. At Susquehanna, dechlorination will be carried out with sulfur dioxide (SO_2) gas, which reacts instantaneously with free chlorine as follows:

$$SO_2 + H_2O + HOCl \longrightarrow H_2SO_4 + HCl$$

and with chloramines as follows:

$$NH_2Cl + SO_2 + 2H_2O \longrightarrow [NH_4]HSO_4 + HCl$$

The acid product of these reactions will be neutralized by reacting with the alkalinity of the cooling tower blowdown water and will form harmless chlorides and sulfates which are naturally contained in the Susquehanna River.

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4 "No detectable residual chlorine" is defined as any amount that is under 0.04 mg/l, which is the laboratory detectable limit in the test procedure recommended by EPA in document EPA-625/6-74-003, "Methods for Chemical Analysis of Water and Wastes," published in 1974. The test method recommended by EPA can be found in, "Standard Methods for the Examination of Water and Wastewater," 13th Edition, Method 204A. The total chlorine residual is also expected to be below the detectable limit of 0.01 mg/l, which is the new laboratory limit for some of the analytical procedures contained in the 14th edition of Standard Methods for the Examination of Water and Wastewater.

Results of a Pilot Plant Study on Formation of Trihalomethanes and Other Chloro-organic Compounds When Chlorinating Concentrated Susquehanna River Water

9. Most rivers contain organic humic compounds, which upon reacting with chlorine can form trihalomethanes and halomethanes.[5] The trihalomethanes consist of chloroform ($CHCl_3$), bromoform ($CHBr_3$), dibromochloromethane ($CHClBr_2$) and bromodichloromethane ($CHCl_2Br$). In addition to the trihalomethanes, other halomethanes can be formed from the reaction between chlorine and waterborne organics.

10. To determine the extent to which trihalomethanes and other halomethanes would be formed at Susquehanna during chlorination of the circulating cooling water, a pilot plant study has been carried out. Samples of Susquehanna River water were collected and analyzed. The river water samples were taken in front of the Susquehanna intake structure, to assure that the samples would be representative of actual operating conditions.

11. The average values for the analyses results are tabulated in Table 1, Column 1. From the Table, it can be seen that the existing concentrations of trihalomethanes and other

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5 The relationship between the formation of these substances and the chlorination of waters containing humic compounds is described in "Natural and Model Aquatic Humics: Reactions with Chlorine," by R.F. Christman, J.D. Johnson, J.R. Hass, F.K. Pfaender, W.T. Liao, D.L. Norwood, and H.J. Alexander, in "Water Chlorination Environmental Impact and Health Effects", Vol. 2, by Ann Arbor Science Publishers, Inc. (November 1977).

halomethanes in the Susquehanna River are near the estimated limit of detection for these analyses. Only chloroform and bromodichloromethane were slightly above the limit of detection, showing up at average river water concentrations of 0.13 μg/l and 0.25 μg/l, respectively.

12. The river water was then concentrated 3.8 times (average), which is the concentration expected to take place in the cooling towers at Susquehanna. The concentration was achieved by heating the river water to 90-98.6°F, and passing warm dry air through the water to simulate cooling tower conditions. The concentration was verified volumetrically and by checking the chloride concentration. Sufficient chlorine was added to produce a free chlorine residual of 0.2-0.3 mg/l at the end of two minutes. This simulates the conditions that will exist during actual chlorination of the circulating cooling water, since it will take approximately two minutes for the chlorine to travel from the point of chlorine injection to the point where the water reaches the condenser outlet.

13. To simulate the conditions affecting the concentration of trihalomethanes and other halomethanes in cooling tower blowdown, the concentrated-chlorinated water was then aerated for 30 minutes and dechlorinated with a stochiometric amount of sodium bisulfite solution, sufficient for the removal of a chlorine residual of 0.3 mg/l. This process resulted in chloroform and bromodichloromethane concentrations

of 3.9 and 0.45 µg/l (average value), while the concentrations of other trihalomethanes were below the limits of detection. Of the other halomethanes, only methylene chloride was detected, at a concentration of 0.2 µg/l (average). These results are tabulated in Table 1, Column 2.[6]

14. It is important to note that the estimated total average concentration of trihalomethanes in the plant discharge (2.34 µg/l) is far below the maximum limit of 100 µg/l set by EPA in the National Interim Drinking Water Regulations, 40 C.F.R. Part 141 as amended by 44 Fed. Reg. 68641, Nov. 29, 1979, for public water systems. This estimate takes into account that the trihalomethanes contained in the cooling tower blowdown of one of the towers at Susquehanna will be diluted by the second cooling tower's blowdown, since the blowdown from both towers is conveyed by common piping to the discharge point and the towers receive chlorination at different times. It does not take into account, however, that after diluting the plant discharge with the river flow of a 7-day 10-year low-flow condition (which provides a dilution factor of 37), the increase in the concentration of trihalomethanes in the river

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6 The samples of Susquehanna River water, and concentrated-aerated-chlorinated and dechlorinated water were analyzed for trihalomethanes and other halomethanes using a gas chromotograph-mass spectrometer in a method essentially identical to EPA Method 624. See "Guidelines Establishing Test Procedures for the Analysis of Pollutants, Purgeables-Method 624," 44 Fed. Reg. 69532 (1979).

water downstream from Susquehanna is at or below the estimated limits of detection. See Column 4 of Table 1 for the calculated results of mixing cooling tower blowdown with river water. This evaluation is very conservative, since the average river water flow is approximately 15 times higher than the 7-day 10-year low-flow condition used for calculating resultant river water concentrations of trihalomethanes and halomethanes in Table 1.

15. Further, the chloroform and bromodichloromethane concentrations of 0.19 and 0.26 µg/l, which represent the calculated results of mixing cooling tower blowdown (plant discharge) with river water, are an order of magnitude less than EPA's ambient water quality criterion of 1.9 µg/l presented in "Water Quality Criteria," 45 Fed.Reg. 79318, dated Nov. 28, 1980. This criterion applies to the ambient concentration in the river itself, not the facility discharges.

16. The only other halomethane (methylene chloride) whose formation was detected during the pilot plant tests would be undetectable in the mixture of cooling tower blowdown and river water. Even the concentration of methylene chloride in <u>undiluted</u> cooling tower blowdown would be an order of magnitude less than the EPA's ambient water quality criterion of 1.9 µg/l.

17. The results of this pilot plant study are confirmed by experiments carried out on three cooling towers at the Oak Ridge Flux Isotope Reactor.[7] With water makeup to the

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7 The results of Oak Ridge experiments are reported in "An Experimental Assessment of Halogenated Organics in Water From

cooling towers containing 100 μg/l of chloroform and after passing through the cooling tower, the concentration at Oak Ridge was found to be 1 μg/l most of the time.

Comparison of Chlorine Dosages at the Danville Water Treatment Plant With Those Attributable to Susquehanna

18. The Danville Water Treatment Plant takes water from the Susquehanna River about 30 miles downstream from the Susquehenna site, and after treatment supplies water to about 9,000 persons in the Danville area. After clarification and filtration the water treatment plant injects approximately 3.3 mg/l of chlorine to maintain an average of 0.6 mg/l and a peak of 1.1 mg/l of total chlorine residual. Loss of chlorine residual in the total distribution system is reported to be minimal. Chlorination is on a continuous 24-hour basis.

19. The desired free chlorine residual at the Susquehanna condenser outlet during chlorination will be the lowest residual which will maintain a clean condenser. Reports in the literature indicate that a 0.2-0.3 mg/l free chlorine residual will be more than adequate to maintain the condenser tubes free from biofouling, especially with an Amertap mechanical condenser tube cleaning system. The chlorine dosages that

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(continued)
Cooling Towers and Once-Through Systems," in Vol. 2 of the above referenced "Water Chlorination Environmental Impact and Health Effects."

will be required for treating the condenser cooling water at Susquehanna were determined by recent tests to be 2.16 mg/l (average). This dosage produced a free chlorine residual of 0.3 mg/l on concentrated Susquehanna River water (concentration factor of 3.8), and simulates actual operating conditions. This residual was measured two minutes after chlorination of the sample, which is approximately the time it takes for the circulating water to flow from the point of chlorine injection to the condenser outlet.

20. The chlorine dosage requirement at Susquehanna will be approximately two-thirds of that required for chlorinating drinking water at the Danville Water Treatment Plant. The length of chlorination at Susquehanna is 1/12th that at the Danville Water Treatment Plant, because at Susquehanna the chlorine will be injected intermittently for approximately one hour per unit per day, while at the Danville Water Treatment plant the chlorine is injected continuously, 24 hours per day.

21. Further, the concentration of any trihalomethanes or other halomethanes discharged from Susquehanna is so low that any increase in concentration over the ambient river concentration at the intake of the Danville Water Treatment Plant would be at or below the limit of detection. Therefore, the increase, if any, would be negligible.

Results of Review of Synfuel Energy Corporation's Environmental Study for an Ethanol Production Plant

22. The Synfuel Energy Corporation ("Synfuel") has prepared an environmental study for a proposed ethanol production plant approximately 15 miles upstream from Susquehanna. A review of that study has provided the following information:

a. Synfuel would not be discharging to the Susquehanna River or its tributaries any waste waters that can be contaminated with organic chemicals produced at the proposed plant or brought on site. The effluent from the initial distillation step in ethanol production, called "stillage"--which is high in biological and chemical oxygen demand--would be kept out of surface waters. In fact, the stillage is a valuable feed byproduct and would be recovered.

b. The only wastewater which Synfuel plans to discharge to a surface water (Newport Creek) is cooling tower blowdown, which would meet discharge requirements to the Susquehanna River.

c. The annual volume of Synfuel's cooling tower blowdown would be 36,500,000 gallons, not hundreds of millions of gallons as alleged by CAND.

d. All other plant wastewaters, some of which are high in organics, would be routed to the Industrial Park Sanitary Wastewater Treatment System.

This is a 40 million gallon per day wastewater treatment facility owned by the Wyoming Valley Sanitary Authority. There, the biological treatment system would break down the complex organic chemicals in the wastewaters into harmless constituents.

e. Pennsylvania Distillery Waste standards, to which the ethanol plant would be subject, require that distillery wastewaters be completely evaporated or be treated to remove not less than 95% of the 5-day BOD (biological oxygen demand).

23. Since Synfuel would not be discharging from its proposed facility wastewater containing organics which might act as nutrients for condenser-fouling organisms, or which could require additional chlorine, there would not be a necessity for increasing chlorination of the water systems at Susquehanna, should the proposed Synfuel facility be constructed and operated.

James Rios

Sworn to and subscribed before me this 4th day of September, 1981.

State of California
County of San Francisco ss

Notary Public

OFFICIAL SEAL
RUDOLPHO M. SIERRA
NOTARY PUBLIC-CALIFORNIA
City and County of SAN FRANCISCO
My Commission Expires Apr. 1, 1983

TABLE 1 AVERAGE CONCENTRATIONS OF TRIHALOMETHANES AND OTHER HALOMETHANES AT VARIOUS POINTS IN THE SUSQUEHANNA FACILITY (a)

Compound	(1) Concentration in River at Susquehanna Intake	(2) Concentration in Circulating Cooling Water After Chlorination, 30 Min. of Aeration, and Dechlorination	(3) Calculated Concentration in Plant Discharge	(4) Calculated Concentration After Mixing in River (7-day 10-year low flow)	(5) Estimated Detection Limit (Average)
TRIHALOMETHANES					
Chloroform	0.13	3.90	2.02	0.19	0.10
Bromodichloromethane	0.25	0.45	0.32	0.26	0.18
Dibromochloromethane	N.D. (b)	N.D.	N.D.	N.D.	0.15
Bromoform	N.D.	N.D.	N.D.	N.D.	0.30
Total Trihalomethanes	0.38	4.35	2.34	0.45 (c)	-
OTHER HALOMETHANES					
Methylene Chloride	N.D.	0.20	0.15	N.D.	0.10

(a) All concentrations in µg/l (ppb)
(b) N.D. = not detected
(c) The maximum amount of trihalomethanes set by EPA in the National Interim Drinking Water Regulations for public water systems is 100 µg/l. EPA's Water Quality Criteria call for 1.9 µg/l concentration of any trihalomethane in river water as the suggested limit.

TABLE 3.6-2

BIOCIDE STORAGE

	Circulating Water	Service Water	Emergency Service Water Residual Heat Removal	Raw Water Clarifier Feed	Potable Water	Sewage Effluent
Flow of treated stream(1) gpm	900,000	60,000	30,000	426	17	17
Anticipated dosage mg /Cl_2 added/l treated flow	2	2 (plus 2 additional)	3	2.5	2.5	5-10
Concentration of injection fluid mg/l	1300	1300	120,000	3600	3600	120,000
Concentration of source mg available Cl_2/l	(Liquid chlorine) - 1,000,000			(12 1/2% hypochlorite) - 120,000		
Consumption lb. available(4) Cl_2/month	30,000 lb.	1800 lb. addl	10 lb.	60 lb.	25 lb.	75 lb.
Chlorine source	1 ton liquid containers		small drums of 12 1/2% hypochlorite solution			
Applicable regulations on	NRC Reg Guide 1.95 and 1.78		NIOSH Criteria Document 76 170			
Compliance with applicable storage regulations	Complies	Complies	Complies	Complies	Complies	Complies

(1) Two units at full load under most unfavorable meterological conditions.
(2) End of circulating water system is condenser outlet. End of service water system is the most remote exchanger.
(3) Any residual in spray pond following a prolonged emergency will be allowed to decay.
(4) Total consumption 32,070 lb/month (1069 lb/day).