June 4, 1984

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
PHILADELPHIA ELECTRIC COMPANY	)	Docket Nos. 50-352
	)	50-353
(Limerick Generating Station,	)	
Units 1 and 2)	)	

TESTIMONY OF JOHN C. LEHR REGARDING RESPONSES TO CITY OF PHILADELPHIA'S ISSUE CITY-15 RELATED TO THE LIMERICK FINAL ENVIRONMENTAL STATEMENT

Q1. Mr. Lehr, please state your name, address and position with the U. S. Nuclear Regulatory Commission.

A1. My name is John C. Lehr. My business address is U. S. Nuclear Regulatory Commission, Washington, D. C. 20555. I am the Senior Environmental Engineer in the Environmental Engineering Section of the Environmental and Hydraulic Engineering Branch, Division of Engineering within the Office of Nuclear Reactor Regulation of the Nuclear Regulatory Commission.

Q2. Have you prepared a statement of your professional qualifications?

A2. Yes. My statement is appended to this testimony.

Q3. Please state the purpose of your testimony and identify your responsibilities therein.

A3. The purpose of my testimony is to respond to the City of Philadelphia's Issue CITY-15, with respect to drinking water treatment by the City of Philadelphia and the removal of

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radioactive contamination of open water bodies (and the city's water supplies sourced therefrom) that could occur as a result of fallout subsequent to an atmospheric release of radioactivity in severe reactor accidents that were analyzed in the Limerick FES. My testimony provides a description of the water treatment and distributing facilities of the City of Philadelphia, their sources of raw water supply, and the water treatment unit processes currently employed. It also discusses the information available on the effectiveness of various drinking water treatment processes in removing the radionuclides strontium-90 and cesium-137 from raw water; the likely ability of the existing treatment plants of the City of Philadelphia to remove these radionuclides from the intake waters; compares the likely effluent concentrations with applicable EPA Maximum Containment Level (MCL) set by the Clean Water Act, based on the Staff's estimated influent concentrations; and discusses possible mitigative measures, if needed.

Q4. What does CITY-15 provide?

A4. CITY-15 provides:

> The DES does not adequately analyze the contamination that could occur to nearby liquid pathways, and the City's water supplies sourced therefrom, as a result of precipitation after a release. A reasoned decision as to environmental impacts cannot be made without a site specific analysis of such a scenario.
>
> The DES addresses at great length releases to groundwater (DES at 5-34 et seq.), but gives only a cursory and conclusory discussion of contamination of open water (DES at 5-33). This issue is of crucial concern here as the two major water bodies at and near the facility are the City's only water supplies. The City also has open

reservoirs within its boundaries which could be contaminated through precipitation. For an issue of such great importance, insufficient consideration has been given here. The mandate of NEPA to take a hard look at environmental consequences has been ignored.

Q5. What are the sources of raw water for the City's water treatment plants?

A5. Approximately one half of the City's water requirement is supplied by the Delaware River. The remainder is supplied by the Schuylkill River. All water withdrawn by the City from the Delaware River is treated at the Samuel S. Baxter Plant, which pumps water from the river at a location above the outlet of Pennypack Creek. Water withdrawn from the Schuylkill River is treated either at the Queen Lane Plant or the Belmont Plant. These plants both withdraw water from the river pool formed by the Fairmont Dam. The Queen Lane Plant is located on the east side of the Schuylkill River, while the Belmont Plant is located on the west side of the river. All withdrawal locations are within the city limits.

Q6. What are the capacities of these water treatment plants?

A6. The 1982 values given by the City for raw water pumping, water treatment and filtered water pumping capacities are given in Table 1, which follows this testimony. The 1982 information supplied by the City indicates that the Water Department distributed an average of 345 million gallons per day to 1.69 million people and industry within the City limits. This information also indicates that an additional 11 million gallons per day were conveyed to the Bucks County Water and Sewer Authority for distribution in lower Bucks County.

Q7. What water storage capacity exists within the City's water treatment and distribution system?

A7. The filtered water storage capacities for the various in-plant basins and the other system basins, reservoirs and standpipes as of 1982 are given in Table 2. The total filtered water storage capacity as of 1982 amounted to about 1.083 billion gallons. In addition, treatment plant retention capacity of untreated and in process water as of 1982 was 124.4 million gallons at the Belmont Plant, 201 million gallons at the Queen Lane Plant and 216 million gallons at the Baxter Plant, for a total of about 541 million gallons.

Q8. What areas of the City are normally served by these treatment facilities?

A8. The City's information indicates that the Baxter Plant normally provides water to the area of the City east of Broad St. The Queen Lane Plant normally serves the area west of Broad St. and east of the Schuylkill River. The Belmont Plant serves the area of the City west of the Schuylkill River. Flexibility in the system exists such that the entire City area, except for an area west of the Schuylkill River known as the "Belmont High Service District," may be served by the Baxter Plant, provided it is fully available, based on an average daily demand. The demand of the Belmont High District is about 12 million gallons per day.

Q9. What modes of treatment are used by the three City water treatment plants?

A9. All three plants use similar treatment process sequences. These consist of natural sedimentation, chemical addition, flocculation, sedimentation, disinfection, rapid sand filtration and final chemical addition. Initial chemical addition at the plants, following natural sedimentation, consists of prechlorination and carbon addition as needed for taste and odor control and addition of flocculating chemicals, consisting of ferric chloride and lime at the Baxter and Queen Lane Plants and alum and lime at the Belmont Plant.

Final chemical addition consists of flouride for reduction of dental decay, chlorine or chlorine dioxide and ammonia for maintenance of a disinfecting residual in the distribution system; in addition, zinc phosphate and lime are added as needed for corrosion control in the distribution systems from the Queen Lane and Belmont Plants.

Filtered water from the Baxter Plant that is stored in the Oak Lane Reservoir and from the Queen Lane Plant that is stored in the Roxborough Filtered Water Basins is rechlorinated prior to entering the distribution system.

Effects of Normal Water Treatment on Radioactive Contaminants

Q10. Please state which radionuclides you have addressed with regard to drinking water treatment by the City of Philadelphia and explain why you have addressed them.

A10. I have addressed only the removal of strontium-90 and cesium-137 because, as stated in the testimony Dr. Fliegel and Mr. Wescott, the Staff believes that only the long lived radionuclides, such as strontium-90 and cesium-137, would contribute significantly to the total population dose from drinking water. It was concluded that all other radionuclides would contribute far less than 10% total dose from this pathway.

Q11. Have drinking water treatment processes generally in use been shown to be effective in removing these radionuclides?

A11. Removal, in terms of percent of the total activity in the intake water, by municipal treatment plants has been found to vary depending on the radionuclide or combination of radionuclides being considered and on the treatment processes used.

In a study of three municipal treatment systems using flocculation sedimentation, disinfection and sand filtration, Bell et al. (5) found only moderate removals of total activity associated with radioactive fall-out from nuclear test detonations. Measurements of the activity in the effluent from the sand filters indicated the following ranges of removal:

Plant	Observed Activity Removal Range, %
Lawrence, Mass.	13-75%
Cambridge, Mass.	34-52%
Rochester, NY	0-65%

In another study of dissolved strontium in municipal water supplies of some 60 cities across the United States, Alexander et al. (6) found similar removals compared to the previous study when examining systems using coagulation as treatment. Higher removals were found for systems using coagulation followed by softening, using lime and soda ash or using ion exchange softening only. The strontium-90 removal percentages were as follows:

Treatment	Sr-90 Removal, %
Alum or ferrous sulfate	10-31
Alum or ferrous sulfate, plus lime	10-75
Alum or ferrous sulfate, plus lime and soda ash	10-85
Alum or ferrous, plus lime and phosphate	10-70
Softening only (phosphate, ion exchange)	69-76

The City of Philadelphia was included in this study. The results of the indicated treatment of alum and lime flocculation followed by chlorination for a tap water blended from two treated source waters indicated a removal of as much as 44% of the strontium-90.

In a study of water treatment system removal of a very low level of strontium-90 in the raw water (i.e., about 10 pCi/L), Schultz (7) found removals of from 0-24%. This system used natural sedimentation, flocculation with alum or ferrous sulfate, chlorination and sand filtration.

Q12. Is there other information available on the removal of the specific radionuclides of concern to the Staff by water treatment unit processes?

A12. Yes. There have been many laboratory and small scale pilot plant studies on cesium-137, strontium-89, and strontium-90 removal. These studies have investigated coagulation, sand filtration, coagulation followed by sand filtration and softening by lime and soda ash.

Q13. What do these studies indicate regarding removal of these radionuclides by coagulation?

A13. A summary of the literature results is given below.

Straub (3) reports that coagulation has been shown to be capable of removing 97-100% of particulate radioactivity, but only 4-81% of soluble radioactive material. For cesium-137, laboratory studies by Eliassen et al. (1) using jar tests with alum and ferric chloride as coagulants demonstrated removals of 0-37%. In another laboratory study by Lacy (2), using a fission product mixture containing 50% cesium-137 and 10% strontium-90, with ferric chloride and limestone as coagulants, activity removal was higher, being attributed to the high cesium content of the mixture, but still only reached 51-59%. The addition of turbidity in the form of clays aided somewhat in cesium removal. Laboratory studies reported by Straub (3) showed removals of 35-65% for 100 mg/l added turbidity. High removals, 87% and 98% were achieved, but with very high added turbidities of 750 mg/l and 5000 mg/l, respectively.

Strontium removal by coagulation alone using alum coagulant was very low, 0-6% (Straub, et al., 4). Adding 100 mg/l clay turbidity increased coagulation removal only to 57% (Straub, 3). Laboratory studies by Lauderdale, as reported by Straub (3), using phosphate coagulation with lime produced removal of about 98%. This process may be useful in removing fission product mixtures that contain strontium as one of the more hazardous constituents.

Q14. What do these studies indicate regarding removal of these radionuclides by sand filtration?

A14. The laboratory studies of high rate filtration cited by Straub (3) produced low removals, 1-13%, of strontium by sand/fitration and low to moderate removals, 10-70%, of cesium. These removals were associated with retention of activity by straining of already formed floc not removed during sedimentation or by absorption on the biological life in the Schmutzdecke (Downing, et al., (8)).

Q15. What do these studies indicate regarding removal of these radionuclides by the combined treatment?

A15. The studies by Straub (3 and 9) indicate moderate removal of strontium-90 and cesium-137 when in a mixture of radionuclides. The percentage removals are given below:

Radoinuclide	Removal, % Coagulation/Sedimentation	Sand Filtration	Overall
Mixture, containing: 35% Sr-90, Y-90	61	17-23	68-70
Mixture containing:			
27% Cs-137	21	76	81
27% Sr-90, Y-90	10	18	26

Q16. What is your conclusion with regard to the ability of the water treatment plants of the City of Philadelphia to remove these radionuclides from the water withdrawn from the Schuylkill and Delaware Rivers?

A16. The combination of drinking water treatment processes currently employed by the City of Philadelphia will likely not result in a high degree (i.e., over 90%) of removal of the radionuclides of strontium, cesium from the intake water, based on my review of the laboratory and municipal treatment plant study results cited above.

Q17. Do you conclude that a high level of removal of these radionuclides would be required in the event of an accident at the Limerick Generating Station of the type considered in this testimony?

A17. Yes, but only for strontium radio-isotopes. However, a high degree of removal may be necessary only by the Queen Lane and Belmont plants.

Q18. What is the basis for your conclusion?

A18. The bases for my conclusion are the Staff's conclusion that only strontium-90 would contribute significantly to population dose, the Staff's probability distribution concentrations of strontium-90 for the Schuylkill and Delaware watersheds and the U.S. Environemntal Protection Agency Maximum Contaminant Level (MCL) for strontium-90 in community water systems under the Safe Drinking Water Act (40 C.F.R. § 141.16(b)) of 8 pCi/L.

Based on the Staff's estimated first year average activity concentration due to strontium-90 of 155 pCi/L in the Schuylkill River (which is estimated to only have a 5% chance of not being exceeded) removal by the water treatment plant would have to amount to 94.8% or more to meet the EPA MCL at the point at which the water enters the distribution system. Removals of greater than 98% would have to be achieved for Schuylkill River activity concentrations due to strontium-90 with a 50% or less chance of exceedance (i.e., 877 pCi/L or more). By contrast, the estimated strontium-90 related activity in the Delaware River with a 50% probability of exceedance (i.e., 15 p.Ci/L) would require only a 46.7% removal. Removal of 76.5% or more of the activity in the Delaware River water due to strontium-90 would be required only for activity concentration due to strontium-90 in excess of 34 pCi/L, which the Staff estimates to have a 40% or less probability of occurrence.

Q19. In your opinion, do the existing City of Philadelphia water treatment plants have the capability to reduce these activity concentrations to within the EPA MCL for strontium-90 activity?

A19. Based on my review of the laboratory and municipal treatment plant study results cited above and the present designs of the Belmont, Queen Lane and Baxter water treatment plants (using coagulation, sedimentation and sand filtration), reduction of this activity to the MCL would not be expected for the Queen Lane and Belmont plants for virtually any of the first year average post accident estimated activity levels. For the Baxter plant, required removals to comply with the strontium-90 MCL Delaware River first year average post accident activity levels, with a 40-50% probability of exceedance, are possible.

Q20. What would this situation mean, in your opinion, in terms of the continuity of the Philadelphia drinking water supply?

A20. Until the strontium-90 activity concentration in the Schuylkill River decreases to a level at which the treatment processes used by the Queen Lane and Belmont plants could deliver water within the EPA limit or until modifications are installed at these plants that can treat water with higher influent strontium-90 activity levels, the Baxter plant could provide for the water needs of the City, with the exception of the Belmont High Service District (Aptowicz, (10)).

(Note that the 1982 rated peak capacity of the Baxter plant was 423 MGD, while 1982 average distribution to the City and Bucks County was 356 MGD). Water delivery to the Belmont High Service District, with a 1982 average demand of about 12 MGD, would have to be by emergency means, such as tank trucks or emergency water pipeline construction.

Q21. What alternatives do you believe would be available to the City either under the EPA MCL requirement or under a strontium-90 activity concentration limit above the EPA MCL that may be approved by the City of Philadelphia, the Commonwealth of Pennsylvania and the U.S. Environmental Protection Agency?

A21. Aside from reliance on the Baxter Plant and emergency measures, as stated in my previous response, alternative treatment methods, such as lime-soda softening, could be employed to improve the removal of strontium-90 activity from the influent water. However, modifications to the treatment plants, likely to involve new construction, would be necessary if the treatment capacity is to remain the same.

The following alternatives can normally be considered when a potable water supply is threatened with contamination or interruption: water rationing, use of stored or bottled water, construction of temporary or permanent pipelines from the points of use to a safe and adequate supply, dilution by a known safe water supply, delivery of safe water by auxiliary means (e.g. tank truck) or use of special decontamination equipment or procedures. The Staff has not made any analyses of the technical or economic aspects of the use of any of these alternatives for the City of Philadelphia in the event that the present water supplies are rendered temporarily or permanently unusuable by an accident at the Limerick Generating Station of the type discussed by Dr. Acharya in his testimony.

REFERENCES

1. "Studies on Radioisotope Removal by Water Treatment Processes," Rolf Eliassen, Warren J. Kaufman, John B. Nesbitt and Morton I. Goldman, in Journ. AWWA, 8/51, pp. 615-37.

2. "Removing Radioactive Materials from Water by Coagulation," William J. Lacy, in Wat. & Sew. Wks, 10/53, pp. 410-11.

3. Low-Level Radioactive Wastes, Conrad P. Straub, USAEC, 1964.

4. "Studies on the Removal of Radioactive Contaminants From Water," Conrad P. Straub, Roy J. Morton and Oliver R. Placak, in Journ. AWWA, 10/51, pp. 773-792.

5. "Passage of Nuclear Detonation Debris Through Municipal Water Treatment Plants," Carlos G. Bell, Jr., Harold A. Thomas Jr., Barnet L. Rosenthal, in WASH-275, "Sanitary Engineering Conference, Baltimore Maryland, April 15-16, 1954" USAEC.

6. "Strontium and Calcium in Municipal Water Supplies," George V. Alexander, Ralph E. Nusbaum and Norman S. MacDonald, in Journ. AWWA. 7/54, pp. 643-54.

7. "Removal of Low Level Radioactive Wastes By A Sanitary Water Treatment Process," N.B. Schultz, ORNL Report No. K-C-785.

8. "Observations On The Removal of Radio-Isotopes During The Treatment of Domestic Water Supplies: II. Radio-Strontium," A.L. Downing, A.B. Wheatland, and G.E. Eden, in Journ Inst. of Water Egnrs., 7/53, pp. 555-72.

9. Report of the Joint Program Of Studies On The Decontamination Of Radioactive Waters, ORNL Report-2557, Oak Ridge National Laboratory, Public Health Service.

10. Letter: Mr. Bruce S. Aptowicz, Manager, Water Operations, Water Dept. City of Philadelphia to Mr. Robert E. Martin, U.S. Nuclear Regulatory Commission, April 23, 1984.

Table 1. City of Philadelphia Water Treatment System Capacities

Plant	Raw Water Pumping Station Capacity	Plant Water Treatment Capacity: Rated	Plant Water Treatment Capacity: Peak	Average Treated Water Output, 1980	Filtered Water Pumping Capacity
Belmont	140	78	108	64	
Queen Lane	200	120	150	98	
Schuylkill River	340	198	258	162	248
Baxter	480	282	423	215	
Delaware River	480	282	423	215	606

Note: All values in million gallons per day.

Table 2. Water Treatment System Filtered Water Storage Capacity

In-Plant Filtered Water Retention Capacity:

Belmont	1.8	
Queen Lane	90	
Baxter	193	
		Total: 284.8

Other System Filtered Water Retention Capacity:

Roxborough Filtered Water Basins	28.6	
Open Reservoirs	747	
Standpipes	22.5	
		Total: 798.1
		Grand Total: 1082.9

Note: All values in millions of gallons.

PROFESSIONAL QUALIFICATIONS

JOHN C. LEHR

U.S. Nuclear Regulatory Commission

I am currently employed as Senior Environmental Engineer in the Office of Nuclear Reactor Regulation, Division of Engineering, in the Environmental Engineering Branch. I have the responsibility for the independent review and analysis of the proposed site, alternative sites, site selection methodology, station construction, and design and operation of those features of nuclear power plants as they may affect natural water resources, existing water quality and use, water quality and usage goals as established by the responsible agency and other impacts on the aquatic environment. In this capacity, I have prepared the abiotic aquatic impact sections for NRC environmental impact statements (EIS) on numerous construction permit and operating license applications. For operating license applications, I have provided the technical specifications in the area of water quality and chemical discharge limitations and monitoring requirements. I have provided the technical expertise in the NRC overview function of contractor prepared EIS's in the area of abiotic aquatic impact assessments, including the need for mitigative actions and establishment of coordination with state and regional EPA offices. In the above capacities, I have been responsible for the water quality related aspects of NRC licensing actions for over 70 applications. I have also been responsible for the water quality related sections of several NRC NEPA alternate site investigations of proposed nuclear power plants, including the Seabrook Units 1 and 2 plant. I have provided written testimony and served as an expert witness at NRC licensing hearings on a variety of subjects dealing with aquatic impacts relative to power plant siting, construction and operation.

I have acted as a consultant to other NRC branches and provide analyses of water quality problems through technical assistance requests, particularly to the Division of Operating Reactors on matters pertaining to assessment of chemical effluent impacts and changes in abiotic effluent limitations and water chemistry monitoring programs for operating plants.

I have served as the coordinator and principal investigator in an in-house study to determine actual releases of residual chlorine from operating nuclear power plants. In addition, I am the Division technical representative on several inter-office NRC Research Review Groups. As such, I am responsible for defining and coordinating research needs in the area of abiotic aquatic environmental concerns and for providing the technical guidance for on-going research programs in this area. Examples of research activities governed by these review groups are asbestos in cooling tower waters, residual chlorine and chlorination by-products in power plant discharges in fresh and marine waters and investigation of the occurrence of pathogenic organisms in power plant cooling waters.

I have been designated as the in-house technical originator responsible for development of Environmental Standard Review Plans addressing staff NEPA reviews of site water quality, plant water uses, plant chemical and sanitary wastes, water quality related impacts of plant operation, abiotic aquatic monitoring and chemical treatment system alternatives. In a related activity, I have participated as a member of the Standard Environmental Technical Specifications Task Group responsible for the abiotic aquatic monitoring sections of the McGuire Units 1 and 2 and the Three Mile Island Unit 2 ETS.

I have participated in technical conferences with and coordinated water quality related activities with the U.S. Environmental Protection Agency, the U.S. Army Corps of Engineers, and other Federal, State and local agencies regarding implementation of the National Environmental Policy Act, the Federal Water Pollution Control Act and its amendments, the Toxic Substances Act, the Safe Drinking Water Act and the memoranda of understanding between the NRC and EPA and COE.

I have also developed expertise and been designated as the responsible technical specialist in the areas of sound level prediction techniques for power plants and their transmission lines and techniques for estimation of community response to environmental sound levels, as influenced by power plant construction and operation. I have been responsible for sections of NRC environmental impact statements addressing these areas for several proposed and operating nuclear power plants. I have also provided written testimony and served as an expert witness at NRC licensing hearings for noise impacts related to nuclear power plant construction and operation.

I have a Bachelor of Science degree in Mechanical Engineering from Drexel Institute of Technology (1969) and a Master of Science degree in Environmental Engineering from Drexel University (1972) specializing in water associated problems in the environment. My academic background includes studies in water chemistry, domestic and industrial waste treatment, and water resources management.

From 1969 to 1972, I was employed as a mechanical engineer at the U.S. Army Frankford Arsenal, Philadelphia, Pennsylvania. I was assigned as Project Manager of materials handling, and pollution control efforts for the Small Caliber Ammunition Modernization Program. I participated in the development of solid and liquid waste management and noise control programs for metal parts manufacturing facilities.