ORIGINAL

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the matter of:

PHILADELPHIA ELECTRIC COMPANY

(Limerick Generating Station,
Units 1 & 2)

Docket No. 50-352
50-353

Location: Philadelphia, Pa.

Pages: 11,996 - 12,103

Date: Tuesday, June 19, 1984

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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PHILADELPHIA ELECTRIC COMPANY :
: Docket Nos. 50-352
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Commonwealth of Pennsylvania
Courtroom No. 5
Old Federal Courthouse
Ninth and Market Streets
Philadelphia, Pennsylvania

Tuesday, June 19, 1984

The hearing in the above-entitled matter reconvened, pursuant to recess, at 1:30 p.m.

BEFORE:

LAWRENCE BRENNER, ESQ., Chairman
Atomic Safety and Licensing Board
Nuclear Regulatory Commission
Washington, D. C. 20555

RICHARD F. COLE, Member
Atomic Safety and Licensing Board
Nuclear Regulatory Commission
Washington, D. C. 20555

PETER A. MORRIS, Member
Atomic Safety and Licensing Board
Nuclear Regulatry Commission
Washington, D. C. 20555

APPEARANCES:

On Behalf of Philadelphia Electric Company:

MARK J. WETTERHAHN, ESQ.
NILS N. NICHOLS, ESQ.
Conner and Wetterhahn, P.C.
1747 Pennsylvania Avenue, N. W.
Suite 1050
Washington, D. C. 20006

On Behalf of the Commonwealth of Pennsylvania, Governor's Energy Council:

ZORI FERKIN, ESQ.
Governor's Energy Council
P. O. Box 8010
1625 N. Front Street
Harrisburg, Pennsylvania 17105

On Behalf of the City of Philadelphia:

MARTHA W. BUSH, ESQ.
Deputy City Solicitor
1500 Municipal Service Building
Philadelphia, Pennsylvania 19102

Pro se and on Behalf of Friends of the Earth in the Delaware Valley:

ROBERT ANTHONY
Box 186
Maylan, Pennsylvania 19065

On behalf of the NRC Staff:

BENJAMIN H. VOGLER, ESQ.
ANN P. HODGDON, ESQ.
Office of the Executive Legal Director
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

* * *

I N D E X

EXHIBITS	IDENTIFICATION	EVIDENCE
Applicant:		
No. 157- Health and Safety Laboratory, U.S. Energy Research and Development Administration, 1977. Final Tabulation of Monthly 90Sr Fallout Data: 1954-1976	12,010	
No. 158-Richard J. Larsen, 1983. Worldwide Deposition of ^{90}Sr Through 1981	"	
No. 159-USEPA, 1976. Radiological Quality of the Environment	"	
No. 160-E.P. Hardy and L.E. Toonkel, 1982. Environmental Measurements Laboratory Environmental Report	"	
No. 161-USHEW, 1960-68. Radiological Health Data, Vols. 1-9	"	
No. 162-Limerick Generating Station Radiological Environmental Monitoring Program, 1971-1977, Prepared for Philadelphia Electric Company by Radiation Management Corporation, May, 1979	"	
No. 163-USEPA, 1976-1982, Environmental Radiation Data, Reports 6, 10,15, 18, 23-24, 25-26, and 29	"	
No. 164-Ronald G. Menzel, 1975. Land Surface Erosion and Rainfall as Sources of Strontium-90 in Streams	"	
No. 165-US Geological Survey, 1982. Water Resources Data for Pennsylvania Water Year 1982 Volume 1 - Delaware River Basin and Volume 2 - Susquehanna and Potomac River Basins	"	
No. 166-City of Philadelphia Water Dept., 1982. How Water in Philadelphia is Treated and Distributed	"	
No. 167-USNRC, 1977. Calculations of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50	"	

EXHIBITS	IDENTIFICATION	EVIDENCE
Applicant (Continued):		
No. 168-D.B. Simpson and B.L. McGill, 1980. User's Manual for LADTAPII - A Computer Program for Calculating Radiation Exposure to Man from Routine Releases of Nuclear Reactor Liquid Effluents	"	
No. 169-Bruce S. Aptowicz, 1984. Letter to Robert E. Martin, USNRC, dated 4/23/84 and private communication, S. Gibbon, PECO and B. Aptowicz, City of Philadelphia, 5/25/84.	"	
No. 170-Philadelphia Water Dept., 1982. Table of Pumping, Treatment, and Consumption Rates for FY '82.	"	
No. 171-Commonwealth of Pennsylvania Disaster Operations Plan, Annex E, Fixed Nuclear Facility Incidents, Feb.,'84	"	
No. 172-C.P. Straub, 1964. Low-Level Radioactive Wastes, Their Handling, Treatment and Disposal	"	
No. 173-E.P. Hardy, Jr., 1981. Environmental Measurements Laboratory Environmental Report, EML-390	"	

P R O C E E D I N G S

JUDGE BRENNER: Good afternoon.

We have papers up here from the Staff and I don't know what they are. They look like simply duplicate copies of testimony which we previously have received.

MR. VOGLER: Mr. Chairman, we distributed them this morning. Those are minor corrections to the Staff testimony. They have not only been delivered to you this morning but to the court reporter all the parties.

JUDGE BRENNER: All right. The front page is identical to the previous testimony, including the date.

MR. VOGLER: The second page is the change. You have Mr. Wescott's, Dr. Acharya, as we resubmitted the entire testimony, and the same with Mr. Lehr.

JUDGE BRENNER: All right. Thank you.

We have one miscellaneous matter. We have the City of Philadelphia's proposed offsite emergency planning contentions pending before us as they have now been narrowed by the exchange of pleadings before us.

We are going to have some questions to ask of the City and perhaps the other parties on that subject. I think to call it oral argument would be to make more of it than we intend to discuss but nevertheless we will need the representatives here cognizant with that issue presumably and we will get to it as soon as we can after the completion of the litigation of City 15 before us, so you won't get any further advance notice.

You will have to keep pace with the proceeding unless you want to suggest a different schedule. We will be ready any time the parties are.

All right, we have nothing further. If the parties have nothing further, we can proceed with admitting the Applicant's testimony and beginning the cross examination of the Applicant's witnesses.

MR. WETTERHAHN: Would you like to know appearances of counsel?

JUDGE BRENNER: Yes.

MR. WETTERHAHN: Appearing for the Applicant, Philadelphia Electric Company. My name is Mark J. Wetterhahn, with the firm of Conner and Wetterhahn. With me is Nils Nichols.

MR. VOGLER: I am Ben Vogler, counsel for the NRC Staff. With me here this afternoon is Ann P. Hodgdon, also counsel for the NRC Staff.

MS. BUSH: Martha Bush for the City of Philadelphia.

MS. FERKIN: Zori Ferkin for the Commonwealth of Pennsylvania.

JUDGE BRENNER: Welcome back to all of you.

Mr. Wetterhahn, you may proceed.

MR. WETTERHAHN: I would like to call Applicant's panel for Contention City 15. Applicant's panel consists of Mr. Bartram, Mr. Daebeler, Mr. Guarino, Dr. Kaiser, Mr. Levine, Mr. Schmidt, Mr. Toblin, and Dr. Waller.

They are seated here on the witness stand. I would ask the witnesses not previously sworn, I would ask the Board to swear them. That would be Mr. Bartram, Toblin, Guarino and Waller.

JUDGE BRENNER: All right, let's do that. We will have those gentlemen stand please, raise your right hand.

Whereupon,

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B.W. BARTRAM,
A.L. TOBLIN,
C.F. GUARINO,

and

R. WALLER

were called as witnesses on behalf of the Applicant and, having been first duly sworn, were examined and testified as follows, and,

xxx

G.F. DAEBELER,
G.D. KAISER,
S. LEVINE,

and

E.R. SCHMIDT

resumed the stand and, having been previously duly sworn, were examined and testified further as follows.

xxx

DIRECT EXAMINATION

BY MR. WETTERHAHN:

Q I will ask the following questions of the panel.

Did each of you prepare a statement of your professional qualifications with regard to your participation as witnesses in this proceeding?

A (Witness Bartram) Yes.

A (Witness Toblin) Yes.

A (Witness Guarino) Yes.

A (Witness Waller) Yes.

A (Witness Daebeler) Yes.

A (Witness Kaiser) Yes.

A (Witness Levine) Yes.

A (Witness Schmidt) Yes.

Q Are these professional qualifications true and correct?

A (Witness Bartram) Yes.

A (Witness Toblin) Yes.

A (Witness Guarino) Yes.

A (Witness Waller) Yes.

A (Witness Daebeler) Yes.

A (Witness Kaiser) Yes.

A (Witness Levine) Yes.

A (Witness Schmidt) Yes.

Q Do you adopt it as your testimony in this proceeding?

A (Witness Bartram) Yes.

A (Witness Toblin) Yes.

A (Witness Guarino) Yes.

A (Witness Waller) Yes.

A (Witness Daebeler) Yes.

A (Witness Kaiser) Yes.

A (Witness Levine) Yes.

A (Witness Schmidt) Yes.

MR. WETTERHAHN: For the information, the testimony of the new witnesses were supplied to the Board and parties with the testimony and professional qualifications of the other witnesses, are identical to those already bound into the testimony.

I would ask that they be bound into the record as if read at this point in time. Copies have been provided to the reporter.

JUDGE BRENNER: All right. What we are binding in now are the professional qualifications of Bartram, Guarino, Toblin and Waller, correct?

MR. WETTERHAHN: No. As the Board previously requested, we are binding all the witnesses --

JUDGE BRENNER: Fine. Thank you. And we will do that at this time in the absence of any objection.

The professional qualifications of the witnesses not previously admitted into evidence are now admitted into evidence and, in addition, as a convenience, we will bind in lrg6

the unchanged, previously admitted professional qualifications with them at this point in the transcript.

xxx Lay-In

(The professional qualifications are as follows:)

PROFESSIONAL QUALIFICATIONS

CARMEN F. GUARINO
President of Carmen F. Guarino Engineers Ltd.

EDUCATION

LaSalle College, B.A., Chemistry and Biology,
Engineering and Related Courses at Drexel University,
Temple University, Pennsylvania State College,
Manhattan College

PROFESSIONAL STATUS

Registered Professional Engineer in Pennsylvania (By Exam.)
Diplomate, American Academy of Environmental Engineers
Certified Sewage Treatment Operator, Class "A", Pennsylvania

EXPERIENCE

Employed by Philadelphia Water Department, 1950 to 1980. Held following positions; Chief Chemist, Water Pollution Control Plant; Superintendent, Northeast Water Pollution Control Plant; Superintendnet, Southeast and Southwest Water Pollution Control Plants; Assistant Chief, Water Pollution Control Plants (3); Chief, Water Pollution Control Division (Includes Water Pollution Control Plants, Industrial Waste Control, Sewer Maintenance, and Administration).

January 1, 1968 - Assumed duties as Deputy Commissioner

January 3, 1972 - Appointed Commissioner of the Philadelphia Water Department. Appointment terminated January 7, 1980.

June 1, 1980 - Founded Carmen F. Guarino Engineers Ltd. Presently serving as President.

January 1, 1981 - Technical Director of S.E.L.E.C.; a design construction firm in Torino, Italy.

PROFESSIONAL OFFICES

Advisor to the Governor of Pennsylvania in his capacity as a Member of the Delaware River Basin Commission, 1972 to 1980.

Commissioner, Fairmount Park Commission, 1972 to 1980

Trustee-at-Large, American Academy of Environmental Engineers, 1979-1980.

President, Engineers' Club of Philadelphia, 1979
Vice-President, Engineers' Club of Philadelphia, 1978

President, Water Pollution Control Federation, 1980-1981
President-Elect, Water Pollution Control Federation, 1979-1980

Vice-President, Water Pollution Control Federation, 1978-1979

President, Water Pollution Control Association of Pennsylvania, 1968-1969

President, Eastern Pennsylvania Water Pollution Control Operators Association, 1965

ASSOCIATIONS

WATER POLLUTION CONTROL FEDERATION

President, 1980-1981
President-Elect, 1979-1980
Vice-President, 1978-1979
Vice-Chairman, Technical Practice Committee, 1977-1980
Chairman, National Conference, 1977
Chairman, Committee on Operation of Wastewater Treatment Plants, Manual of Practice No. 11, 1974 to 1978
Executive, Committee Member
Board of Control Member
Pennsylvania Director, 1971

WATER POLLUTION CONTROL ASSOCIATION OF PENNSYLVANIA

President, 1968-1969

EASTERN PENNSYLVANIA WATER POLLUTION CONTROL OPERATORS ASSOCIATION

President, 1965

AMERICAN SOCIETY OF CIVIL ENGINEERS

Chairman, Water Pollution Management Committee, 1975-1976
Chairman, Urban Wastewater Engineering Committee, 1974
Representative to WPCF - Manforce Program, 1970
Committee on Sewerage and Sewage Treatment, 1968-1970

Philadelphia Section:
Board of Directors, 1970
Secretary, 1965-1968
Chairman, Hydraulic and Sanitary Engineering Division, 1966

AMERICAN ACADEMY OF ENVIRONMENTAL ENGINEERS

Trustee-at-Large, 1979-1980
Trustee-in-Charge, Committee on Upgrading Examinations-General Sanitary and Environmental, 1979
Trustee-in-Charge, Committee on Upgrading Examinations-Water Supply and Wastewater, 1979

INTERNATIONAL ASSOCIATION OF WATER POLLUTION RESEARCH

U.S. Chairman, "Instrumentation and Automation Workshop", Munich/Rome, 1981

U.S. Chairman, "Instrumentation and Control of Water and Wastewater and Transport Systems Workshop", London/Stockholm, 1977

U.S. Chairman, "Instrumentation and Automation Workshop", London/Paris, 1973

ASSOCIATION OF METROPOLITAN SEWERAGE AGENCIES

Board of Directors, 1978 to 1980

Member, National Society of Professional Engineers
Member, American Water Works Association
Member, American Public Works Association
Member, Instrument Society of American, Water and Wastewater Industries Division

PROFESSIONAL ACTIVIITES

Consulting Editoral Staff, Water & Sewage Works Journal, 1978-1982

Consulting Board Member, Milwaukee Water Pollution Abatement Program 1978 to 1980

Member, EPA-National Drinking Water Advisory Council, 1977-1979

Member, Mayor's Science and Technology Advisory Council, 1973 to 1980

Member, State Board of Certification of Sewage Treatment Plants and Water Works Operators

Chairman, "Water Plant Instrumentation and Automation Seminar", American Water Works Association Annual Meeting, New Orleans, Louisiana, 1976

Consulting for World Health Organization/Plan American Heath Organization - Prepared Pollution Control Abatement Plans for Rio de Janeiro, Brazil, 1975 & 1976

Participant, United States/Republic of China, "Environmental Pollution Seminar", Sponsored by National Science Foundation and National Science Council, Taipei, Taiwan, 1974

Participant, Technical Symposium, "Pure Oxygen in Sewage Treatment", Sponsored by Union Carbide Company, London, England, 1973

Consultant for EPA, Region III, Review Land Disposal of Sludge Process, London, England (and Environs), 1972

Consultant Work in Italy, Japan, Sweden, Switzerland and Africa

AWARDS

Simon W. Feese Lecture Award, American Society of Civil Engineers, 1979-1980

Morgan Award, Exemplary Inovative Treatment Technology, Water Pollution Control Federation, 1980

Instrument Society of America, Water and Wastewater Industries Division (Contributions to the Advancement of Automation Technology), 1978

George Washington Medal, Engineers' Club of Philadelphia, 1977

Haseltine Award, Pennsylvania Water Pollution Control Association (Outstanding Accomplishments in Solving Water Pollution Control Problems in Pennsylvania), 1977

Rudolph Herring Award, American Society of Civil Engineers (Technology Contributions), 1971

Arthur Sidney Bedell Award, Water Pollution Control Federation (Outstanding Service in the Field of Water Pollution Control and in the Operation of the Association), 1971

High Hat Award, Pennsylvania Water Pollution Control Association (Outstanding Service to the Water Pollution Control Profession), 1965

PAPERS AND PUBLICATIONS

Over 80 technical papers on water pollution control, municipal and industrial waste treatment, instrumentation, management, treatment and disposal of sludge and other related subjects.

PATENTS

Patent No. 685,723 issued June 6, 1978: Modification of Activated Sludge Process.

PROFESSIONAL QUALIFICATIONS

ALAN L. TOBLIN
Environmental Services Division
NUS Corporation

My name is Alan L. Toblin. My business address is 910 Clopper Road, Gaithersburg, Maryland 20878. I am a consulting engineer in the Radiological Programs Department.

I received a Bachelor of Engineering degree in Chemical Engineering from the Cooper Union in 1968 and a Master of Science degree in Chemical Engineering from the University of Maryland in 1970. I have taken additional graduate courses in Chemical Engineering at the University of Maryland.

At NUS Corporation since 1971, I have performed analytical and developmental work on computer codes for many projects. I have developed mathematical models of subsurface discharges of heated water in the presence of cross flows and physical boundaries in order to calculate the thermal and concentration distributions in the receiving water. I developed a mathematical model and a computer code for calculating the dispersion from a continuous point source of radioactive material in an aquatic environment, and I performed analytical and developmental work on a computer code to calculate the thermal and concentration contours due to heated surface discharges. I also worked on computer codes to calculate the ground-level deposition for the high altitude and low altitude release of particulates.

I coordinate efforts to meet water quality and quantity requirements for construction and operating licenses for power plants and other industrial facilities. I also perform analyses of heated water discharges and cooling water intake velocities for power plants, and I analyze experimental procedures and results of operation of thermal-hydraulic modeling of heated water intakes and discharges.

Recent projects have included the development of a computer code and analyses of the groundwater transport of chemically reactive species; the development of a methodology and a computer code to model the sediment transport in a river due to bottom disturbance; and the development of a methodology and corresponding computer code for calculating the transient behavior of a closed-cycle cooling system including any arbitrary configuration of cooling ponds, spray canals, and cooling towers, under varying meteorological conditions.

PROFESSIONAL QUALIFICATIONS

ROBERT WALLER
Director, Gaithersburg Office, PEC Division
NUS Corporation

My name is Robert Waller. My business address is 910 Clopper Road, Gaithersburg, Maryland 20878. I am Director of the Gaithersburg Regional Office of the PEC Division of NUS.

I received a Bachelor of Science degree in Chemical Engineering from Rensselaer Polytechnic Institute in 1958, a Master of Science degree in Environmental Engineering from Rensselaer in 1961, and a Doctor of Philosophy in Environmental Engineering Science from the John Hopkins University in 1966.

After receiving my Bachelor's degree, I worked for the New York State Department of Health in the Water Supply Section from 1958 to 1962. My primary responsibilities included the review and evaluation of the design and operation of new and existing water supply treatment plants throughout the New York State. Other areas of activity included the collection of data, evaluation of new water treatment techniques, establishment of emergency water supplies, and presentation of training courses.

From 1966 to 1969, I worked for E. I. du Pont de Nemours Company, Inc. I was responsible for technical assistance on more than 60 different problems involving over 30 different plants that manufactured a wide variety of organic and inorganic chemicals, as well as explosives, plastics, ammunition, paints, and pesticides. I developed waste treatment facility designs, planned and directed waste characterization and pollution abatement programs for individual plants, provided assistance for resolution of treatment plant operational problems, and provided liaison with regulatory agencies.

Working for Hittman Associates, Inc., from 1969 to 1972, I was responsible for all technical activities relating to water pollution control. These included industrial waste treatment consulting and process development, advanced waste treatment system development, planning and direction of governmental and industrial research and demonstration projects, and corporate research programs. I made technical contributions to the following projects: (1) environmental aspects of alternatives to the internal combustion engine, (2) alternative approaches to storm water management and erosion control, and (3) evaluation of the potential of desalting technology for meeting water resource needs.

From 1972 to 1980, I had overall corporate responsibility for program management, operations, and production for Environmental Quality Systems, Inc. I was project manager for more than 25 different projects and made significant technical and policy contributions to more than 20 other projects. Special areas of expertise included waste treatment process development and design, management of toxic and hazardous materials, process residue treatment and disposal, industrial waste treatment, emergency water and waste systems, areawide water quality planning, evaluation of emerging technology, control of non-point-source pollutants, and environmental impact analysis. In addition, I was a special UNESCO Consultant to the Kingdom of

Morocco and a member of a National Science Foundation Inspection Team evaluating damages to the water and sewage systems of Sendai, Japan after a major earthquake.

Since joining NUS Corporation in 1980, I have been responsible for the management and technical direction of projects involving hazardous, industrial, and municipal wastes. I act as principal-in-charge (PIC) on projects performed in the PEC Gaithersburg office as well as project manager on larger projects. Areas of responsibility include impact evaluation, problem definition, technology assessment, planning, evaluation and design of remedial action alternatives, and program planning. I managed a multidisciplined Public Works Group that completed over 40 facility planning and design assignments for government clients.

PROFESSIONAL QUALIFICATIONS

George F. Daebeler
Supervising Engineer, Environmental Branch
Philadelphia Electric Company

My name is George Daebeler. My business address is 2301 Market Street, Philadelphia, Pennsylvania, 19101. I am in charge of the Environmental Branch of the Nuclear and Environmental Section of the Mechanical Engineering Division of the Engineering and Research Department. In this position, I supervise engineers and other professional personnel responsible for environmental monitoring, radioactive effluent monitoring systems, and probabilistic risk assessment associated with the Limerick Generating Station.

I received a Bachelor of Science degree in Mechanical Engineering from Rennsselaer Polytechnic Institute in 1962 and a Master of Science degree in Nuclear Engineering from Pennsylvania State University in 1966.

I joined Philadelphia Electric in June, 1966 and was assigned to an organization which later became the Nuclear Section of the Mechanical Engineering Division. My work in this group included responsibility for nuclear fuel, various plant systems, and licensing activities.

In January, 1973, I became the head of the Safety and Licensing Branch and in November of 1975, I became a Senior Engineer and head of the Nuclear Steam Supply Branch where I supervised engineers responsible for nuclear reactor and safety system, including those associated with Limerick. In June, 1982, I became head of the Environmental Branch.

I am a registered Professional Engineer in Pennsylvania and a member of the American Society of Mechanical Engineers and the American Nuclear Society.

PROFESSIONAL QUALIFICATIONS

SAUL LEVINE
Vice President and Consulting Group Executive
NUS Corporation

My name is Saul Levine, and I am Vice President and Consulting Group Executive, NUS Corporation, 910 Clopper Road, Gaithersburg, Maryland 20878.

NUS Corporation is an internationally known consulting company in the field of energy and has some 1300 employees. My organization is responsible for performing nuclear power plant safety analyses, probabilistic risk assessments and reliability analyses, providing quality assurance services, supplying environmental services, and assisting NUS clients in reactor licensing.

I have been involved with the application of nuclear energy for nearly 30 years. I hold a Bachelor of Science degree from the U.S. Naval Academy and two degrees from the Massachusetts Institute of Technology: Bachelor of Science in electronics engineering and a Master of Science in nuclear engineering. After serving in the U. S. Submarine Service from 1945 to 1954, I reported, from 1955 to 1958, to Admiral Rickover as Project Officer for the U.S.S. Enterprise, the world's first nuclear powered aircraft carrier. In this position, I was responsible for directing all technical, financial, production, and administrative aspects of the reactor plant prototypes and the production plants for the U.S.S. Enterprise. From 1958 to 1962, I worked in the U. S. Navy's Special Projects Office, which was responsible for producing the submarine based

Polaris Missile System. I managed the design, integration, installation, testing, and performance evaluation of the Polaris Missile Submarine Navigation System.

From 1962 through the end of 1979, I was with the U. S. Atomic Energy Commission (AEC) and its successor, the U.S. Nuclear Regulatory Commission (NRC). During those years, I was Assistant Director for Reactor Technology; Assistant Director of the Division of Environmental Affairs; Project Staff Director for the Reactor Safety Study (WASH-1400)(1), which represented the first comprehensive evaluation of the likelihood and consequences of nuclear power plant accidents; Assistant Director, Division of Reactor Safety Research; Deputy Director, Office of Nuclear Regulatory Research; and Director, Office of Nuclear Regulatory Research.

In 1980 I joined NUS Corporation as Vice President and Consulting Group Executive. In this capacity I have been closely associated with work performed by NUS' Consulting Division in the area of probabilistic risk assessment. This group has performed several PRAs concerning plants such as Limerick, Susquehanna, Shoreham, and Ringhals 2. Many other smaller PRA tasks have also been performed such as mini-PRAs on a number of reactors and the review of PRAs done by others. In particular I have performed a technical management overview function for both the Limerick PRA and the Severe Accident Risk Assessment (SARA).

PROFESSIONAL QUALIFICATIONS

E. ROBERT SCHMIDT
Director, Systems Analysis
NUS Corporation

My name is E. Robert Schmidt. My business address is 910 Clopper Road, Gaithersburg, Maryland 20878. I am Director of the Systems Analysis Group of the Consulting Division and as such am responsible for directing all systems analysis consulting services associated with nuclear and nonnuclear technology, including radiological and nonradiological accident analysis, thermal-hydraulic and heat transfer analysis, and risk assessment and probabilistic safety analysis.

I received a Bachelor of Science degree in Mechanical Engineering from the University of Missouri in 1958 and a Master of Science degree in Nuclear Engineering from the same institution in 1959. After graduation I worked for General Electric for one year. I then worked for Internuclear Company from 1960 to 1963. During that time I developed design criteria and analyzed in-pile loops of the experimental gas-cooled reactor at Oak Ridge National Laboratory and participated in the design of several small reactors.

I have been with NUS Coporation since 1963 and during that the time I have been involved in all facets of the design, operation, and analysis of nuclear power plants. I was onsite startup consultant to the Governement of India, the Japan Atomic Power Company, and the Toyko Electric Power Company for the startup of four BWR units.

I have directed a vast amount of licensing and safety analysis work and have participated in many special nuclear technologies studies. Some of the most significant include a study of steam cycle conditions for a prototype large breeder reactor, safety analysis report review for foreign licensing authorities and domestic utilities, industrial and aircraft impact hazards analysis, containment and subcompartment temperature and pressure analyses, and the design and safety analysis of several spent fuel shipping casks.

Prior to my current position, I was Manager of the Reliability and Risk Assessment Department. I performed and directed risk assessments, degraded core accident evaluations, safety goal analyses, and detailed assessments of the probabilities and consequences of accidents involving hazardous material transport near a nuclear power station. I was also involved in a study of aircraft impact probabilities which included providing hearing board testimony.

Most recently I have been responsible for directing the Kuosheng, Susquehanna, and Ringhals 2 risk assessments. I also directed the Limerick external event risk assessment, and with Mr. Saul Levine, provided the technical monitoring of the Limerick inplant failure risk study. I also managed limited scope, mini-PRAs for six nuclear power plants.

I am a Registered Professional Engineer in the District of Columbia. I am a member of the American Nuclear Society, the American Society of Mechanical Engineers, and the Society for Risk Analysis.

PROFESSIONAL QUALIFICATIONS

BART W. BARTRAM
Manager, Radiological Programs Department
NUS Corporation

My name is Bart W. Bartram. My business address is 910 Clopper Road, Gaithersburg, Maryland 20878. I am manager of the Radiological Programs Department. In this position, I am responsible for the performance of radiological dose assessments and providing general consulting services in support of uranium fuel cycle facilities, including nuclear power plants, and other nuclear facilities.

I received a Bachelor of Science degree in Physics from Mount Union College in 1967, a Master of Science degree in Physics from the University of Washington in 1971, and a Master of Science degree in Mechanical Engineering from George Washington University in 1976.

From 1971 to 1972, I worked for the Custom Stack Analysis Company. I conducted pilot plant studies used in the development of a new type of venturi scrubber and a lime wet scrubbing system for removing sulfur dioxide from the flue gases.

I have been with NUS Corporation since 1972. I was responsible for the noise impact analysis of nuclear and fossil-fueled power plants and other industrial facilities. I performed background noise surveys, computer analysis of plant-contributed noise during construction and operation, analysis of alternative cooling system noise, analysis of transmission line electrical effects, and noise impact assessments.

I am involved in licensing and permitting activities associated with uranium mining and milling operations, including the preparation of U.S. Environmental Protection Agency (EPA) Prevention of Significant Deterioration permit applications, state air permit applications, source material license applications, and environmental reports. In addition, I was responsible for preparing the radiological inputs to an environmental impact statement for remedial actions on the Grand Junction and Rifle uranium mill tailings sites in response to the Uranium Mill Tailings Remedial Action Program under contract to Sandia National Laboratories.

Other areas of work include radiological dose assessments of Savannah River Plant facilities and operations, high-level waste repositories, and risk assessments of fission-reactors and plutonium-fueled space nuclear systems.

PROFESSIONAL QUALIFICATIONS

GEOFFREY D. KAISER
Manager, Consequence Assessment Department
NUS Corporation

My name is Geoffrey D. Kaiser. My business address is 910 Clopper Road, Gaithersburg, Maryland 20878. I am manager of the Consequence Assessment Department. In that position, I am responsible for managing projects relating to the consequences of accidental releases of radioactive, toxic, and flammable chemicals.

I received a Bachelor of Arts degree in Physics from Cambridge University (UK) in 1964; a Master of Arts degree in Physics from Cambridge in 1967; and a Doctor of Philosophy in Elementary Particle Physics, also from Cambridge University in 1968. Subsequently, I had postdoctoral research fellowships in theoretical particle physics at the Cavendish Laboratory at Cambridge and the University of Miami. I held a temporary lectureship in applied mathematics at the University of Durham (UK) during the academic year 1970/71 and served as a Senior Research Associate in theoretical particle physics at the Daresbury Nuclear Physics Laboratory, Warrington, UK, from 1971 to 1974.

From 1974 to 1980 I worked at the United Kingdom Atomic Energy Authority's Safety and Reliability Directorate (SRD) in the Environmental and Fission Product Group. In 1976, I was appointed Head of Physics and led a group which grew to include 10 people involved in the development of methods with which to predict the consequences of the accidental release of radiotoxic, chemically toxic, and flammable materials to the environment. During my time at SRD, I developed the nuclear consequence modeling code TIRION, which was widely used in the United Kingdom and abroad in applications to reactors, reprocessing plant, nuclear shipping, and the transport of plutonium by road, rail, and sea. The most important application of TIRION was at the Windscale Inquiry into the building of a reprocessing plant for oxide fuel. I also participated in and/or managed multidisciplinary projects relevant to the safety and environmental impact of advanced technologies, including participation in the well-known Canvey Island Study.

I was a frequent speaker at seminars and international conferences, and participated as a lecturer at courses arranged by the United Kingdom Atomic Energy Authority. I chaired several international working groups on consequence analysis.

In 1981, I joined NUS Corporation and in 1982, became Manager of the Consequence Assessment Department. Since that time I have been involved in many significant projects. I provided overall technical management for the phenomenological and consequence analysis portions of the Susquehanna Probabilistic Risk Assessment, and for the consequence analysis and transportation accident analysis for Limerick. I have recently been managing the Phase 2 probabilistic safety study for the Swedish State Power Board's Ringhals 2 plant, the purpose of which is to develop source terms for severe accidents. I am also responsible for the consequence analysis for the Industry Degraded Core Rulemaking Program. I have managed "mini-PRAs" for the Palo Verde and Hope Creek Nuclear Generating Stations and have written Chapter 7 of the environmental reports for Hope Creek and Limerick. I was a founder member, and also as author and co-editor, of the committee on the Safety of Nuclear Installations International Benchmark Comparison of Consequence Modeling Codes.

BY MR. WETTERHAHN:

Q Do each of you have a copy of a document entitled, "Testimony of B.W. Bartram, G.F. Daebeler, C.F. Guarino, G.D. Kaiser, S. Levine, E.R. Schmidt, A.L. Toblin, R. Waller Relating to Contention City-15," which consists of some 33 numbered pages, two tables and 11 figures?

A (Witness Bartram) Yes.

A (Witness Toblin) Yes.

A (Witness Guarino) Yes.

A (Witness Waller) Yes.

A (Witness Daebeler) Yes.

A (Witness Kaiser) Yes.

A (Witness Levine) Yes.

A (Witness Schmidt) Yes.

Q Dr. Kaiser, are there any corrections to this testimony?

A (Witness Kaiser) Yes, there are.

On page 14, in paragraph 20, in the first line of the paragraph and also in the seventh line, 0.65 manrem should be changed to 0.67 and in the fifth line, at the end of the line, 0.47 should be changed to 0.49.

Q Are there any other changes?

A No.

Q To the entire panel, did each of you participate in the preparation of this testimony as indicated by your names in the margin aside each paragraph?

A (Witness Bartram) Yes.

A (Witness Toblin) Yes.

A (Witness Guarino) Yes.

A (Witness Waller) Yes.

A (Witness Daebeler) Yes.

A (Witness Kaiser) Yes.

A (Witness Levine) Yes.

A (Witness Schmidt) Yes.

Q To the extent of your participation, is it true and correct to the best of your knowledge, information and belief?

A (Witness Bartram) Yes.

A (Witness Toblin) Yes.

A (Witness Guarino) Yes.

A (Witness Waller) Yes.

A (Witness Daebeler) Yes.

A (Witness Kaiser) Yes.

A (Witness Levine) Yes.

A (Witness Schmidt) Yes.

Q Do you adopt it as your testimony in this proceeding?

A (Witness Bartram) Yes.

A (Witness Toblin) Yes.

A (Witness Guarino) Yes.

A (Witness Waller) Yes.

(Witness Daebeler) Yes.

A (Witness Kaiser) Yes.

A (Witness Levine) Yes.

A (Witness Schmidt) Yes.

MR. WETTERHAHN: I would ask that the testimony which I just identified be bound in the record as if read.

JUDGE BRENNER: All right. In the absence of objection, we will admit the testimony that just identified into evidence and bind it into the transcript at this point as if read.

xxx Lay-in.

("Testimony of B.W. Bartram, G.F. Daebeler, C.F. Guarino, G.D. Kaiser, S. Levine, E.R. Schmidt, A.L. Toblin, R. Waller Relating to Contention City-15" are as follows:)

End 1.

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
(Limerick Generating Station,	)	50-353
Units 1 and 2)		

TESTIMONY OF B.W. BARTRAM, G.F. DAEBELER, C.F. GUARINO, G.D. KAISER S. LEVINE, E.R. SCHMIDT, A.L. TOBLIN, R. WALLER RELATING TO CONTENTION CITY-15

Contention City 15, as admitted by the Atomic Safety and Licensing Board, reads as follows:

> 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.

INTRODUCTION AND SUMMARY

B.W. Bartram
G.F. Daebeler

1. The purpose of this testimony is to estimate the public risk associated with the contamination of the City of

G.D. Kaiser S. Levine E.R. Schmidt A.L. Toblin	Philadelphia's ("City") drinking water after a severe accident at the Limerick Generating Station. A probabilistic treatment of the levels of contamination of the drinking water is also provided.
B.W. Bartram G.F. Daebeler G.D. Kaiser S. Levine E.R. Schmidt A.L. Toblin	2. This testimony considers the deposition of airborne radionuclides onto the Schuylkill and Delaware watersheds and predicts Complementary Cumulative Distribution Functions (CCDFs) of the concentration of those radionuclides that are the most important contributors to the longer term contamination of water supplies, strontium and cesium. This is accomplished using a computer model that was originally developed for use at Indian Point (Ref. 1, Appl. Exh. 153; Ref 2, Appl. Exh. 154). This testimony considers dry deposition as well as the "rainout" scenario postulated by the contention. CCDFs of the concentration of strontium and cesium are calculated for drinking water supplies taken from the Delaware and Schuylkill Rivers. The probability that these rivers will be contaminated above the Pennsylvania Emergency Management Agency's (PEMA) Protective Action Guides (PAGs) is shown to be very small. The probability of contamination of the drinking water supplies as a result of direct deposition onto the raw water basins or other open reservoir at the City's water treatment facilities is also discussed. It is shown that the contamination of drinking water after reactor accidents as a result of

atmospherically deposited radionuclides or as a result of direct deposition onto the raw water basins or other open reservoirs is a small contributor to risk compared with the risk arising from the airborne pathways and therefore may be properly neglected in terms of overall risk considerations.

B.W. Bartram
G.F. Daebeler
C.F. Guarino
G.D. Kaiser
S. Levine
E.R. Schmidt
A.L. Toblin
R. Waller

3. This testimony also contains in the context of an environmental impact evaluation some general discussion of countermeasures that could be considered in both the short and long term in the extremely unlikely event that water in the rivers or raw, in-process, or finished water were to be contaminated above PEMA's PAGs. It should be clear, however, that the Applicant believes that its evaluation demonstrates that the probability and risk associated with this pathway is so small that specific planning considerations are not required; in any event this testimony does not purport to consider the emergency planning requirements of 10 CFR part 50 Appendix E, or NUREG-0654.

DESCRIPTION OF MODEL

B.W. Bartram
G.F. Daebeler
G.D. Kaiser

4. The model used in the preparation of this testimony has the following parts; (1) calculation of the amount of radioactive material deposited in each watershed (i.e.,

S. Levine
E.R. Schmidt
A.L. Toblin

Schuylkill and Delaware) for each combination of fission product source term, weather sequence and wind direction, using CRAC2; (2) calculation of the consequent time dependent concentrations of radioactive strontium and cesium in the City drinking water supplies; (3) relating the drinking water concentrations to population dose; (4) repetition of the calculations for different wind directions, weather sequences and fission product source terms in order to compile CCDFs of radionuclide concentrations in water and CCDFs of population dose. The analysis focuses on strontium and cesium because, by virtue of their potentially large release quantities, relatively long radiological half lives, and recognized radiotoxicity, they dominate the long term contamination of ingestion pathways (Ref. 2, Appl. Exh. 154; Ref. 3, Appl. Exh. 155). WASH-1400 also considered strontium and cesium as the principal contributors to long-term doses received via the ingestion pathways (see WASH-1400 Appendix VI, p. 8-22, Ref. 4, Appl. Exh. 156). However, when considering population doses arising from the drinking of contaminated water in the short term (e.g., one month), consideration is given to other radionuclides, such as ^{133}I and ^{131}I as discussed in paragraph 18 below.

G.D. Kaiser
S. Levine
E.R. Schmidt

5. The amount of radioactive material initially deposited on the two watersheds is calculated by the CRAC2 code, using the methods and assumptions described in Chapter 10 and Appendix F of the Severe Accident Risk

Assessment (SARA) to calculate the point estimate CCDFs. For each weather sequence and source term, CRAC2 calculates the activity of each radionuclide deposited on the ground in Curies per square meter, as a function of distance from the reactor. This information, together with information on the plume width as a function of distance downwind, is used by the LIQPATH code.

G.D. Kaiser
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A.L. Toblin

6. The LIQPATH code is a modification by NUS of the code IPRES that was used at the Indian Point Hearings (Ref. 1, Appl. Exh. 153; Ref. 2, Appl. Exh. 154). LIQPATH takes the deposited levels of radioactivity provided by CRAC2 and calculates the total amount of strontium and cesium that is deposited in the Schuylkill or Delaware watershed. This is done in the code by essentially overlaying the plume footprint on a map of the watershed and integrating the deposited activity over that part of the plume that lies within the watershed. It should be noted that the deposition in the watershed also includes that directly deposited in the river.

B.W. Bartram
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E.R. Schmidt
A.L. Toblin

7. Once the total amount of each radionuclide that has been deposited within each watershed has been calculated, the LIQPATH code predicts the subsequent temporal variation of the concentration of each radionuclide in the City of Philadelphia drinking water. Physical phenomena which

influence these concentrations include radioactive decay, run-off, erosion, ground water transport, sediment scavenging enroute and possible removal of radionuclides by the water treatment system itself and are empirically treated as discussed below.

B.W. Bartram
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8. The LIQPATH code contains an empirical correlation that relates the quantity of a radionuclide deposited in the watershed to the subsequent concentration in City drinking water. This correlation, which is described in detail in Appendix 1, is based on the analysis by Codell (Ref. 2, Appl. Exh. 154), which correlated the measured rate of fallout of ^{90}Sr from atomic bomb tests with measured concentrations of ^{90}Sr in New York City tapwater over a period of about twenty years. This correlation is shown in Figure 1, which is reproduced from Codell's work. Within LIQPATH, this correlation is described by an empirical expression that contains a number of parameters (see pp 12 and 19 of Ref. 2, Appl. Exh. 154) that are determined by fitting the data as described in Appendix 1.

B.W. Bartram
G.D. Kaiser
A.L. Toblin

9. A correlation similar to that given for New York City drinking water is applicable to any watershed and any radionuclide, although the numerical values of the parameters may change. The appropriate parameters for a

given watershed can be calculated given a data base consisting of the salient variables (in this case deposition rate and drinking water concentrations). The parameters in the correlation can then be adjusted so that a best fit of the data base is obtained. This parametric adjustment has been made in the calculations described herein.

B.W. Bartram
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10. With regard to data on which to base the correlation parameters, a long term, continuous monthly record of fallout rate is available as a function of latitude (Refs. 5, 6 and 7, Appl. Exh. 157, 158 and 159) and has been used in the calculations described in this testimony. By far the best available data on tapwater concentrations is that for New York City, for which there is a nearly continuous, monthly data base of ^{90}Sr from 1954 through late 1981, and a seventeen-year data base of ^{137}Cs (Ref. 8, Appl. Exh. 160). This New York City tapwater concentration data base is unique. For the Schuylkill and Delaware Rivers, limited data are available from a number of sources. The Department of Health, Education, and Welfare (HEW: Ref. 9, Appl. Exh. 161) measured quarterly ^{90}Sr concentrations in the Delaware and Schuylkill Rivers at Philadelphia (and other rivers such as the Susquehanna) sporadically from the third quarter of 1959 through the third quarter of 1967. The Philadelphia

Electric Company (PECo; Ref. 10, Appl. Exh. 162) took ^{90}Sr measurements in the Schuylkill River in the vicinity of Limerick between June 1971 and October 1977. The Environmental Protection Agency (EPA; Ref. 11, Appl. Exh. 163) has taken infrequent ^{90}Sr measurements in the Delaware River at Trenton, New Jersey (as well as other rivers such as the Susquehanna) since 1976. A single ^{90}Sr measurement on May 8, 1979 was taken for the City of Philadelphia Water Department from finished water at each of its three major plants as well as from one distribution point. The results of this single measurement appear to be high when compared with the concurrent EPA readings and internally inconsistent (the concentration at the distribution point is greater than at any of the plants).

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11. Figure 2 shows the comparability of the concentrations in the Schuylkill, Delaware, and New York City tapwater. The Susquehanna River data indicate similar comparability. This is expected for the following reasons;

- The deposition (fallout) rate is latitude dependent (Ref. 7, Appl. Exh. 159); these watersheds are at similar latitudes (i.e., the quantities of ^{90}Sr and ^{137}Cs falling on each watershed per unit area are approximately equal).

- o The watershed dynamics (e.g., removal rates) in response to deposition is expected to be similar for these northeast United States sites, which have similar values for rainfall, run-off and sediment yield (i.e., the fractions of the total ^{90}Sr removed over a given time are equal, Ref. 12, Appl. Exh. 164).

- o The flow rates per unit watershed area are approximately equal for these systems, (Ref. 13, Appl. Exh. 165).

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12. In order to extend the limited Schuylkill and Delaware River radionuclide water concentration data bases (to obtain a long continuous record which can be used to find the appropriate coefficients of the equations in Appendix 1), the 1959 through 1967 HEW data for each river were correlated with the New York City tapwater concentrations. Since the range of HEW concentrations is much larger that that of the other measurement programs, the HEW correlations were applied to the 28 years of New York City data to simulate a 28-year monthly data base for each of the Delaware and Schuylkill Rivers at Philadelphia. This data base was then used to find the appropriate parameters in the expression relating initial deposition to concentrations in each of the Philadelphia rivers. Details are given in Appendix 1.

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A.L. Toblin

13. It is important to note that the New York City tapwater data have been correlated with the Schuylkill and Delaware river water data. This approach can be used because the New York City water has minimal treatment. There may be a further reduction in the predicted Delaware and Schuylkill drinking water concentrations to allow for some removal of strontium and cesium by the Philadelphia water treatment system (Ref. 14, Appl. Exh. 166). However, it is not expected that the system as presently operated will significantly reduce strontium and cesium concentrations between the river and the drinking water and no credit has been taken for such removal.

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14. As noted in paragraph 7, the expression relating the amount of each radionuclide deposited in the watershed to the subsequent tapwater concentrations encapsulates the important physical processes that occur as the radionuclide is transported from the watershed to the tapwater. Other calculations carried out by the LIQPATH code are straightforward. These include taking the input data file from CRAC2 and calculating the total amount of each radionuclide deposited in the watershed for each combination of source term and weather sequence, as described in paragraph 6. The calculation of drinking water concentrations is repeated for each combination of

weather sequence, wind direction and source term. The output of these calculations is the CCDF of concentrations in tapwater, as described below.

PUBLIC RISK - WHOLE BODY DOSE

B.W. Bartram
G.D. Kaiser
S. Levine
E.R. Schmidt
A.L. Toblin

15. The consumption of drinking water containing radionuclides from a postulated accidental airborne release from LGS would result in radiological doses to the population of Philadelphia. The method used to calculate these doses from the calculated concentrations in river water and the calculated concentrations arising from direct deposition onto raw water basins or other open water bodies at the City's water treatment works is described below. Doses resulting from water used outside the body make a very small contribution to total exposure and thus are not considered further here.

B.W. Bartram
G.D. Kaiser
A.L. Toblin

16. First, the formulas given in Appendix 1 for the time dependent concentrations of strontium and cesium in the river water were used; the nuclides ^{137}Cs, ^{134}Cs, ^{90}Sr and ^{89}Sr were included. The population was assumed to consume this water for fifty years and the resulting population doses calculated in accordance with the methods outlined in NRC Regulatory Guide 1.109 as implemented in

the LADTAP II computer code (Ref. 15, Appl. Exh. 167; Ref. 16, Appl. Exh. 168). An exception to the methods of Regulatory Guide 1.109 was the use of ingestion dose conversion factors as given in WASH 1400 (Ref. 4, Appl. Exh. 156, p. 8-24) so as to be consistent with the analysis of ingestion pathways given in SARA. The Regulatory Guide 1.109 conversion factors are based on recommendations of the International Commission on Radiological Protection, Publication 2, 1957 (ICRP 2), whereas the WASH-1400 conversion factors are much closer to the more recent recommendations of ICRP 30.

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G.F. Daebeler
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17. The LADTAP II methodology was applied separately to the Delaware and Schuylkill rivers and to each fission product source term, since the proportions of strontium and cesium differ between the two rivers and between different source terms. It is likely that the Schuylkill would be more heavily contaminated than the Delaware (see paragraph 21). According to the City, in an emergency, the Baxter plant, which takes water from the Delaware, can supply the City's entire needs with the exception of the Belmont High Service District and the Roxborough High Service District, which represents about 21 mgd out of the City's total needs of 324 mgd; or about 7 percent (Ref. 17, Appl. Exh. 169, and Ref. 18, Appl. Exh. 170). Therefore, it was assumed that 7 percent of the City's population would be supplied by the Schuylkill and 93 percent by the Delaware.

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18. With the assumptions given in paragraphs 16 and 17, it is straightforward to calculate a CCDF of population dose starting from the initial probabilistic treatment of concentrations of radionuclides in the river water. Since the calculations were done on the basis of strontium and cesium, this CCDF represents the chronic or long term contribution to the population dose. With regard to the contribution of other more short-lived radionuclides, such as radioiodine, a simplified calculation was made as follows. For each source term, weather sequence and winds direction, the isotopes of iodine deposited on the Schuylkill or Delaware watersheds were assumed to pass into the rivers immediately at a rate approximately fifty times that of Strontium. This factor of fifty is a bounding factor, as approximately 2 percent of the Strontium is expected to pass directly into the river (Ref. 12; Appl. Exh. 164). The population of Philadelphia was assumed to consume this water and the resulting increment in population dose was calculated using the methods of LADTAP II. In this way, the CCDF calculated for strontium and cesium was modified to include iodine.

B.W. Bartram
G.F. Daebeler
C.F. Guarino

19. A further potential source of radiation dose would be the consumption of water from the City's treatment works that might be contaminated by direct deposition (dry or wet)

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on raw water or finished water basins. In practice, much or all of this contaminated water could be bypassed, discharged to the river or sewers, or flushed through fire hydrants (see paragraph 30). For the purposes of this calculation, however, it is assumed that all of the contaminated water is processed through the City's distribution system at the usual rate of consumption. Again, the LADTAP II methodology was used to calculate population doses arising from the consumption of this water. When combined with the probabilistic distribution of concentrations in water calculated by LIQPATH, a CCDF of population dose results, which was combined with the CCDF described in paragraph 18 to give an overall CCDF of population dose to the people of Philadelphia. This CCDF is shown in Figure 3.

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20. The area under this CCDF is 0.67 man-rem per reactor year, which is made up of 0.02 man-rem per reactor year from the consumption of water contaminated by direct deposition into the system, 0.16 man-rem per reactor year from strontium and cesium deposited on the watershed and 0.49 man-rem per reactor year from the iodine deposited on the watershed. This figure of 0.67 man-rem per reactor year is to be compared with 70 man-rem per reactor year to the people of Philadelphia from the airborne pathway as considered in SARA. Note that the population dose via the water

pathway has been derived with many fewer assumptions about countermeasures than that via the atmospheric pathway; in CRAC2, protective actions such as interdiction of milk and decontamination of land are routinely assumed. As described below, countermeasures are possible in the liquid pathway case which could give further reduction in risk. Overall, it is concluded that the public risk via the water pathway is a small fraction of that via the atmospheric pathway. This conclusion is in agreement with that of other authors (Ref. 3, Appl. Exh. 155).

CONCENTRATIONS IN TAPWATER - RESULTS

B.W. Bartram
G.D. Kaiser
S. Levine
E.R. Schmidt
A.L. Toblin

21. Figure 4 displays the complementary cumulative distribution function (CCDF) of the concentration of ^{90}Sr in drinking water obtained from the Schuylkill, averaged over the first month and averaged over the first year, and then at 1 month, 6 months, and 5 years after the initial deposition. Figure 5 provides the same information for the Delaware River. These curves give the frequency with which the corresponding concentration is equalled or exceeded. It is apparent that the concentration of ^{90}Sr during the first month is considerably higher than that at later times (the average over the first month is given, since the parameters in the empirical correlation cannot predict in greater detail than the original data, which is

averaged on a monthly basis). After 1 month, the concentration in the river declines slowly.

B.W. Bartram
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E.R. Schmidt
A.L. Toblin

22. In order to judge the significance of the concentrations it is necessary to compare them with Federal or State Guidelines. The Federal Government has published standards for normal releases in 10CFR20 Appendix B and the values for ^{90}Sr, ^{137}Cs, ^{134}Cs, ^{133}I and ^{131}I are reproduced in Table 1. The Commonwealth of Pennsylvania Emergency Management Agency (PEMA) has published Protective Action Guides (PAGs) (Ref. 19, Appl. Exh. 171)which are also reproduced in Table 1. PEMA's PAGs are based on the USEPA National Interim Drinking Water Regulations, EPA-570/9-76-003, Appendix B; see also 40 CFR 141.16. As can be seen from Table 1, PEMA has two sets of PAGs which are applicable to the situation being considered. For uncontrolled discharges to surface water, and in circumstances where the water supply is influenced by contaminated run-off and fallout, the USEPA Appendix B concentrations multiplied by 12 will apply. This assumes that the exposure time will not exceed one year. The associated dose commitment to any organ is 50 mrem. Second, PEMA states that, for acute crisis conditions where no other water supply is available and the duration is less than thirty days, the average concentration may reach 1,000 times the USEPA Appendix B concentrations.

The associated dose commitment to any organ is 330 mrem. For accidents affecting Philadelphia drinking water, the PEMA standards have been assumed to apply.

B.W. Bartram
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E.R. Schmidt
A.L. Toblin

23. Returning to Figures 4 (Schuylkill) and 5 (Delaware), since ^{90}Sr is principally considered as a contributor to the long term accumulation of radiation dose, the most appropriate PEMA guide for comparison with ^{90}Sr concentrations is that for circumstances in which the water supply is influenced by contaminated run-off and fall-out, i.e. 96 pCi/l averaged over 12 months. The probability that the Schuylkill will be contaminated above this guide is one in 300,000 per reactor year, and the probability that the Delaware will be contaminated above this guide is one in 7 million per reactor year.

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A.L. Toblin

24. The above probabilities have been obtained by assuming that no preventive actions take place. As discussed in paragraph 34 preventative measures which could substantially reduce the long term impact of ^{90}Sr are possible. Assuming that such procedures could be implemented in one month, the probability of exceeding the PEMA one year limit in the subsequent year would be in the range of one in 2-1/2 million to one in 17 million per reactor year for the Schuylkill and about one in a hundred million to less than one in a billion per reactor

year for the Delaware. It should be noted that, as indicated in paragraph 20, even if the countermeasure are not taken, the man-rem contribution is a small fraction of that from other pathways.

B.W. Bartram
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S. Levine
E.R. Schmidt
A.L. Toblin

25. The discussion given in paragraphs 23 and 24 shows that the probability that there will be long term contamination of the Delaware even in the absence of protective actions is quite small, and that the probability that such contamination could not be dealt with using available techniques is vanishingly small (one in a hundred million per reactor year or less). For the Schuylkill, the corresponding probabilities are about a factor of thirty higher, but even so the implementation of reasonable countermeasures reduces the probability of exceeding the PEMA long term guide to one in seventeen million per reactor year. Thus, there is a very small probability that long term interdiction of the Schuylkill would be required, and a vanishingly small probability that long term interdiction of the Delaware would be required. Note that the calculations show that there is less than one chance in a billion per reactor year that either the Schuylkill or Delaware will be contaminated above PEMA one year PAGs by radiocesium.

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A.L. Toblin

26. In the short term, the PEMA one-month PAG (8000pCi/l of ^{90}Sr) applies. For ^{90}Sr alone, the probability of exceeding this limit is about once chance in 3 million per reactor year in the Schuylkill and less than one chance in a billion per year for the Delaware. However, the one month average is complicated by the fact that other radionuclides, such as ^{131}I, cannot be neglected; it is expected that the radioiodines will be significant (perhaps dominant) contributors to the dose (330mrem in one month) that is the basis for PEMA's PAG. The calculation of the rate at which iodine, deposited on a watershed, leaches into the river is not as well understood as for strontium. Therefore, a detailed quantitative analysis is not possible. However, using the model for iodine concentration averaged over the first month, as described in paragraph 18, the iodine would determine if the PEMA short-term PAGs were exceeded. There would be a chance of about one in a hundred thousand per reactor year that the PEMA short-term PAGs might be exceeded in the Schuylkill River, and about one in a hundred and fifty thousand that they might be exceeded in the Delaware River. These are upper bound probabilities and, furthermore, take no account of the possibility of countermeasures (see paragraph 30).

DEPOSITION ON WATER BASINS AND RESERVOIRS

B.W. Bartram
G.F. Daebeler
C.F. Guarino
G.D. Kaiser
S. Levine
E.R. Schmidt
A.L. Toblin
A. Waller

27. The problem described above is one of long term contamination of the rivers as a result of deposition of long lived radionuclides such as strontium and cesium on the watershed. A short term problem may exist if radionuclides are deposited directly onto the surface of the raw water basins at Baxter, Queen Lane and Belmont or the filtered water reservoir at East Park. (The Oak Lane and half of the East Park filtered water reservoirs are protected by floating covers with provisions to drain rain water to the sewers so that the filtered water would not be contaminated.) CCDFs of instantaneous ^{90}Sr, ^{137}Cs and ^{131}I concentration in these reservoirs are shown in Figures 6 and 7. Note that all three plants and the reservoirs are so close together (compared to a typical plume width) that they have essentially the same CCDF and would be contaminated at the same time.

B.W. Bartram
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C.F. Guarino
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R. Waller

28. As noted the concentrations given in Figures 6 and 7 are instantaneous values in the raw water in the basins. If this water were to be processed (without removal of any radioactivity) and distributed at the normal rate the contaminated water would be all gone after approximately 3 days. The 30 day average concentration would therefore be one tenth of that given in Figures 6 and 7. The likelihood that the PEMA 30 day PAG will be exceeded is

therefore approximately one chance in a million per reactor year based on ^{131}I. As described in paragraph 30 countermeasures based on available techniques are possible in this unlikely event. Again as noted in paragraph 20 the risk from contaminated water is small compared to that from other pathways.

POSSIBLE COUNTERMEASURES

B.W. Bartram
G.F. Daebeler
C.F. Guarino
G.D. Kaiser
S. Levine
E.R. Schmidt
A.L. Toblin
R. Waller

29. The preceeding testimony shows that the risk resulting from the contamination of the City of Philadelphia water supply is a small fraction of the risk from other pathways. In making this assessment the only action assumed to be taken was to maximize the use of Delaware River water. No credit was taken for countermeasures to either prevent the use of contaminated water or to remove activity from the water. The following section discusses, in general, possibly counter measures in order to place some perspectives on the risks involved. This discussion centers on short and intermediate term measures.

30. Countermeasures could be implemented in the unlikely event of an accident resulting in contamination of either the Schuylkill or Delaware River water sources or treatment plants, depending upon the nature and severity of the contamination. For those occurrences which result in the early contamination of a water supply in excess of

the PEMA 30 day PAG, the interdiction of that source would be possible with replacement water provided from the other sources, albeit with some usage restrictions likely. Direct deposition into the uncovered portion of the East Park Reservoir can be accommodated by isolating and bypassing this reservoir. Direct deposition in a raw water basin would be most readily accommodated by bypassing the basin and processing raw water without the pre-sedimentation provided by the raw water basins. The contaminated water could also be returned to the river or flushed from the system using, for example, fire hydrants. It should be noted that the water system has covered filtered water storage facilities with approximately two days supply of water (at normal usage rate) which would not be contaminated and could continue to be used. In addition, if the water to local areas is excessively contaminated, distribution of clean drinking water by trucks is possible while continuing to use the normal water supply for other purposes.

E.R. Schmidt
A.L. Toblin
C.F. Guarino
R. Waller

31. At lower contamination levels involving watershed deposition which are likely to persist for more extended periods of time, the affected water source would require some modifications in the water treatment processes to provide reductions in the finished water concentrations.

The treatment processes currently in use (Ref. 14, Appl. Exh. 166) include:

- o Pre-sedimentation of some suspended matter in the raw water.
- o Chlorination to destroy taste and odor causing materials and for control of bacteria.
- o Chemical addition of carbon or sodium chlorite for taste and odor control, lime for pH control, and alum or ferric chloride as flocculants.
- o Flocculation and sedimentation to remove suspended impurities.
- o Sand filtration to remove remaining suspended impurities.

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A. Waller

32. Extensive research on removal of various fission products from water was conducted from the early 1950s to the mid 1960s largely as a result of concern about fallout from atmospheric weapons testing during that period (Ref. 20, Appl. Exh. 172). As a result of that research, the decontamination factor provided by the current treatment processes can be anticipated to be no more than 2 (i.e.,

50% removal) for total radioactivity, and less than that for dissolved strontium, cesium and iodine. As stated in paragraph 13 no credit was taken for any removal in the treatment process.

E.R. Schmidt
A.L. Toblin
C.F. Guarino
A. Waller

33. Modifications to the current treatment process are feasible which could achieve reductions in the concentration of certain nuclides by factors of from 5 to 10. The addition of activated carbon with the other chemicals prior to flocculation gives a decontamination factor for iodine of from 4 to 5 (Ref. 20, Appl. Exh. 172, Table 8.3). Adding a layer of activated carbon to the surfaces of the sand filters would provide additional decontamination, perhaps by a factor of 2, for a total DF for radioiodine of from 8 to 10.

E.R. Schmidt
A.L. Toblin
C.F. Guarino
A. Waller

34. Dissolved strontium can be effectively removed by the use of a lime-soda softening process normally employed to remove dissolved calcium and magnesium carbonates and sulfates from "hard" water, due to the chemical similarity between magnesium, calcium and strontium (all are Group IIA elements). Decontamination factors of from 5 to 10 can be obtained by co-precipitation in an initial softening step with dosages of soda ash (sodium carbonate) in excess of those indicated by stoichiometric requirements alone. "Repeated-precipitation", in which a small quantity of calcium is added and

removed provides an equal decontamination factor in each step. Thus, a second step in which a DF of between 5 and 10 is obtained, would produce an overall process DF of between 25 and 100 (Ref. 20, Appl. Exh. 172). If it were necessary to provide this second stage of processing without constructing a major plant addition, the affected plant could be operated as two sequential process lines. That is, the treated effluent from one half of the plant would be returned to the rapid mixing stage of the other half to provide the second stage of treatment. This would, of course, also reduce the throughput capacity of the affected plant by half and would probably require additional pumping capacity.

CONCLUSION

B.W. Bartram
G.F. Daebeler
C.F. Guarino
G.D. Kaiser
S. Levine
E.R. Schmidt
A.L. Toblin
A. Waller

35. The contribution to the public risk via the drinking water pathway is small relative to that predicted for the City of Philadelphia via the airborne pathways. The probability that there will be long term contamination of the Delaware River by ^{90}Sr and ^{137}Cs even in the absence of protective measures is small, and the probability that such contamination could not be dealt with using available techniques, is vanishingly small (one in a hundred million per reactor year or less). For the Schuylkill River, the corresponding

probabilities are higher, but even so the implementation, of reasonable countermeasures reduces the probability of exceeding the PEMA long term guide to one in seventeen million per reactor year. Thus, there is a very small probability that long term interdiction of the Schuylkill River would be required, and a vanishingly small probability that long term interdiction of the Delaware River would be required. The probability that short term concentrations in excess of the PEMA one month PAG might occur has also been shown to be small. If the raw and finished water basins were to be contaminated by direct deposition, the probability tht the PEMA short term PAGs would be exceeded is small and the resulting contribution to public risk is small. Countermeasures to reduce or eliminate this source of risk are possible.

APPENDIX 1

DISCUSSION OF THE EXPRESSION RELATING
THE RATE OF DEPOSITION OF A RADIONUCLIDE
ONTO A WATERSHED TO THE TEMPORAL VARIATION
OF ITS CONCENTRATION IN TAPWATER

B.W. Bartram
G.D. Kaiser
A. Toblin

1. An integral part of the model described in the foregoing testimony relates the transient concentrations of radiostrontium (and radiocesium) in drinking water to the time history of the deposition of these nuclides. The relationship calculates the quantity of a radionuclide accumulated on land in a watershed by functionally relating the rate at which the nuclide is accumulated to both the rate at which it is deposited and its removal rate. The drinking water concentration is then considered to have components related to the immediate deposition rate (e.g., direct deposition on the water surface) and the quantity of nuclide on the watershed (e.g., erosion). Each of the functional relationships contain coefficients so that mathematical equations describing these relationships can be written. The following equations are taken from Codell's work (Ref. 2, Appl. Exh. 154 p. 12) and are applicable to any watershed and any radionuclide, although the coefficients may change;

$$\frac{dM}{dt} = AR\ (1-k_1) - (\lambda_1 + \lambda_2)\ M \qquad (1)$$

$$C = k_2\ AR + Mk_3$$

where

M is the accumulated activity of a radionuclide on land in the watershed, which is available for transport to surface water, Curies

C is the surface water concentration, curies/liter

A is the area of the watershed, m^2

R is the rate of fallout, curies/(yr-m^2)

k_1 is the fraction of the affected watershed covered by open water

k_2 is the coefficient relating the rate of fallout to surface water concentration, yr/liter

k_3 is the coefficient relating available accumulated fallout on land to surface water concentration, $liter^{-1}$

λ_1 is the radiological decay rate, yr-1

λ_2 is the effective loss of available fallout from land due to all causes other than radiological, yr^{-1}

B.W. Bartram
G.D. Kaiser
A. Toblin

2. For the case of an instantaneous deposition of an amount $\bar{D}$ Curies/m^2 of a radionuclide within a watershed of area A, the solution to equation 1 is

$$C = \bar{D}A\ k_3\ (1-k_1)\ \exp\ (-\ (\lambda_1 + \lambda_2)t) \qquad (2)$$

at time t years after the deposition takes place; t should exceed the averaging period for the data on which the correlation is based, in this case one month. The average tap water concentration over time t is given by

$$\bar{C} = \frac{\bar{D}A}{t}(k_2 + k_3(1-k_1)\ (1-\exp(-(\lambda_1 + \lambda_2)t))/\ (\lambda_1 + \lambda_2)\ ) \qquad (3)$$

B.W. Bartram
G.D. Kaiser
A. Toblin

3. As noted in the testimony at paragraph 14, the parameters in eqs. (1) through (3) were obtained after first correlating New York City tapwater data on radiostrontium with HEW data on radiostrontium concentrations in the Schuylkill and Delaware rivers. Figure 2 shows how closely the Delaware and Schuylkill data track the New York City data. Figures 8 and 9 show these correlations. Table 2 gives the values of these parameters for radiostrontium and radiocesium, the radionuclides of interest for long term contamination of the water supplies.

4. The correlation analysis leading to the coefficients for radiocesium was performed in a manner similar to that for radiostrontium. Deposition rates for ^{137}Cs were found by proportioning the ^{90}Sr rates by the ratio of ^{137}Cs to ^{90}Sr concentrations in surface air. This ratio (1.8) was found to be practically constant with time (implying equal deposition velocities for these nuclides) (Ref. 21, Appl. Exh. 173). New York City tapwater concentrations for ^{137}Cs are shown in Figure 2. It can be seen that these concentrations track the corresponding ^{90}Sr concentrations quite well, albeit at a much lower level. The ratio of ^{137}Cs to ^{90}Sr concentrations in New York City water (0.10) were applied to the derived Delaware and Schuylkill rivers ^{90}Sr concentration data bases in order to obtain the ^{137}Cs concentration data bases needed to find the radiocesium coefficients of Table 2.

References

1. Direct Testimony of Richard Codell before the Atomic Safety and Licensing Board Concerning Commission Question 1, presenting an analysis of the risk posed by contamination of the Hudson River, reservoirs and other bodies of water that could be caused by severe accidental radionuclide releases at the Indian Point Nuclear Power Plant.

2. Richard B. Codell, 1984. Potential Contamination of Surface Water Supplies by Atmospheric Releases from Nuclear Plants, Health Physics, to be published.

3. J. C. Helton, A. B. Muller and A. Bayer, Contamination of Surface Water Bodies after Reactor Accidents by the Erosion of Atmospherically Deposited Radionuclides, Health Physics, to be published.

4. U.S. Nuclear Regulatory Commission, 1975. Calculation of Reactor Accident Consequences - Appendix VI of Reactor Safety Study, WASH-1400 (NUREG 75/014), Washington, D.C.

5. Health and Safety Laboratory, U.S. Energy Research and Development Administration, 1977. Final Tabulation of Monthly ^{90}Sr Fallout Data: 1954-1976, HASL-329, New York, New York 10014.

6. Larsen, Richard J., 1983. Worldwide Deposition of ^{90}Sr through 1981, EML-415, Environmental Measurements Laboratory, U.S. Department of Energy, New York, New York 10014.

7. U.S. Environmental Protection Agency, 1976, Radiological Quality of the Environment, Office of Radiation Programs, Washington, D.C. 20460.

8. Hardy, E. P., Jr. and L. E. Toonkel, 1982, Environmental Measurements Laboratory Environmental Report, EML-405, Environmental Measurements Laboratory, U.S. Department of Energy, New York, New York 10014.

9. U.S. Department of Health, Education, and Welfare, 1960 through 1968, Radiological Health Data, Volumes 1 through 9.

10. Limerick Generating Station Radiological Environmental Monitoring Program, 1971-1977, Prepared for Philadelphia Electric Company by Radiation Management Corporation May, 1979.

11. U.S. Environmental Protection Agency, 1976 through 1982, Environmental Radiation Data, Reports 6, 10, 15, 18, 23-24, 25-26, and 29, Office of Radiation Programs, P.O. Box 3009, Montgomery, Alabama 36193.

12. Menzel, Ronald G., 1975, "Land Surface Erosion and Rainfall as Sources of Strontium-90 in Streams," Journal of Environmental Quality, Vol. 3, No. 3, pp. 219-223.

13. U.S. Geological Survey, 1982, Water Resources Data for Pennsylvania Water Year 1982 Volume 1 - Delaware River Basin and Volume 2 - Susquehanna and Potomac River Basins, Water Resources Division, P.O. Box 1107, Harrisburg, Pennsylvania 17108.

14. City of Philadelphia Water Department, 1982. How Water in Philadelphia is Treated and Distributed, 1180 Municipal Services Building, Philadelphia, Pa. 19107.

15. U.S. Nuclear Regulatory Commission, 1977. Calculations of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50, Appendix I, NRC Regulatory Guide 1.109.

16. Simpson, D. B., and B. L. McGill, 1980. User's Manual for LADTAPII - A Computer Program for Calculating Radiation Exposure to Man from Routine Releases of Nuclear Reactor Liquid Effluents, Oak Ridge National Laboratory, NUREG/CR-1276.

17. Aptowicz, Bruce S., 1984. Letter to Robert E. Martin, USNRC, dated April 23, 1984 and private communication, S. Gibbon, PECO and B. Aptowicz,City of Philadelphia, May 25, 1984.

18. Philadelphia Water Department, 1982. Table of pumping, treatment and consumption rates for FY '82.

19. Commonwealth of Pennsylvania Disaster Operations Plan, Annex E, Fixed Nuclear Facility Incidents, February 1984, p. E-12-42.

20. Straub, C.P., 1964 Low-Level Radioactive Wastes, Their Handling, Treatment and Disposal, Division of Technical Information, United States Atomic Energy Commission.

21. Hardy, E.P., Jr., 1981, Environmental Measurements Laboratory Environmental Report, EML-390, Environmental Measurements Laboratory, U.S. Department of Energy, New York, New York 10014.

Table 1

Protective Action Guides for Drinking Water
Concentrations (pCi/Liter)

	^{90}Sr	^{137}Cs	^{134}Cs	^{131}I	^{133}I
10CFR Part 20	300	20,000	9,000	300	1,000
PEMA - uncontrolled discharges to surface water and in circumstances where the water supply is influenced by contaminated run-off and fallout-exposure time not to exceed 1 year	96	2,400	240,000	36	120
PEMA - acute crisis conditions where no other water supply is available-exposure time not to exceed 30 days	8,000	200,000	2×10^7	3,000	10,000

Table 2

Coefficients Used to Relate Deposition and Surface Water Concentrations

(based on monthly average data)

	Schuylkill River				Delaware River			
	Sr-89	Sr-90	Cs-134	Cs-137	Sr-89	Sr-90	Cs-134	Cs-137
k_1	0.0096	0.0096	0.0096	0.0096	0.0207	0.0207	0.0207	0.0207
A (m^2)	4.903+9	4.903+9	4.903+9	4.903+9	2.015+10	2.015+10	2.015+10	2.015+10
λ_1 (yr^{-1})	4.804+0	2.502-2	3.388-1	2.310-2	4.804+0	2.502-2	3.388-1	2.310-2
λ_2 (yr^{-1})	7.209-2	7.209-2	7.392-2	7.392-2	9.178-2	9.178-2	9.360-2	9.360-2
k_2 (yr/l)	2.978-15	2.978-15	1.732-16	1.732-16	6.486-16	6.486-16	3.773-17	3.773-17
k_3 (l^{-1})	4.335-15	4.335-15	2.517-16	2.517-16	1.032-15	1.032-15	5.989-17	5.989-17

*4.903+9 = 4.903×10^9

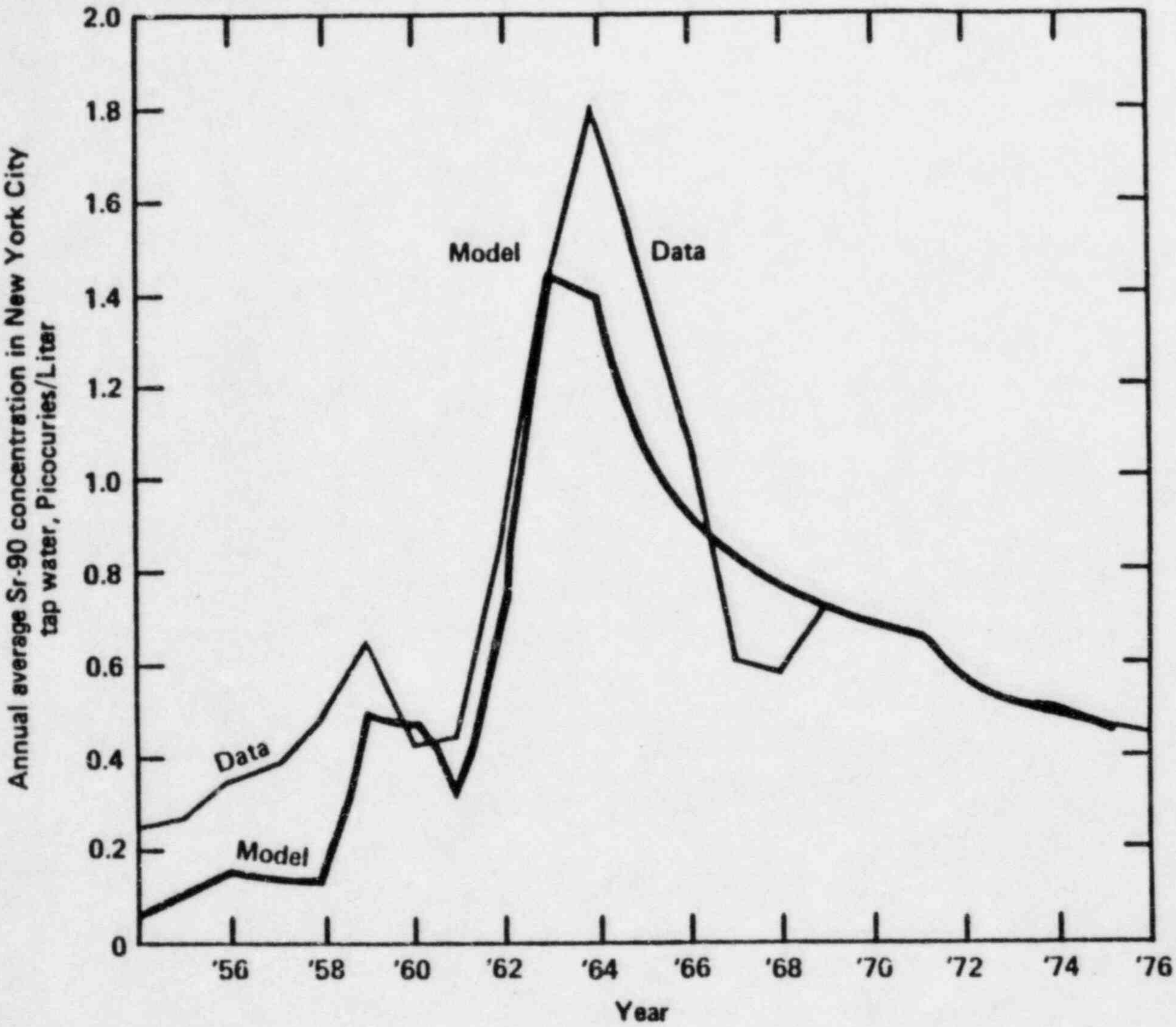

Figure 1 - Comparison of Empirical Correlation Relating Rate of Fallout to Concentration in Tapwater-New York City Data (Table 2 of Ref. 1, Appl. Exh. 153)

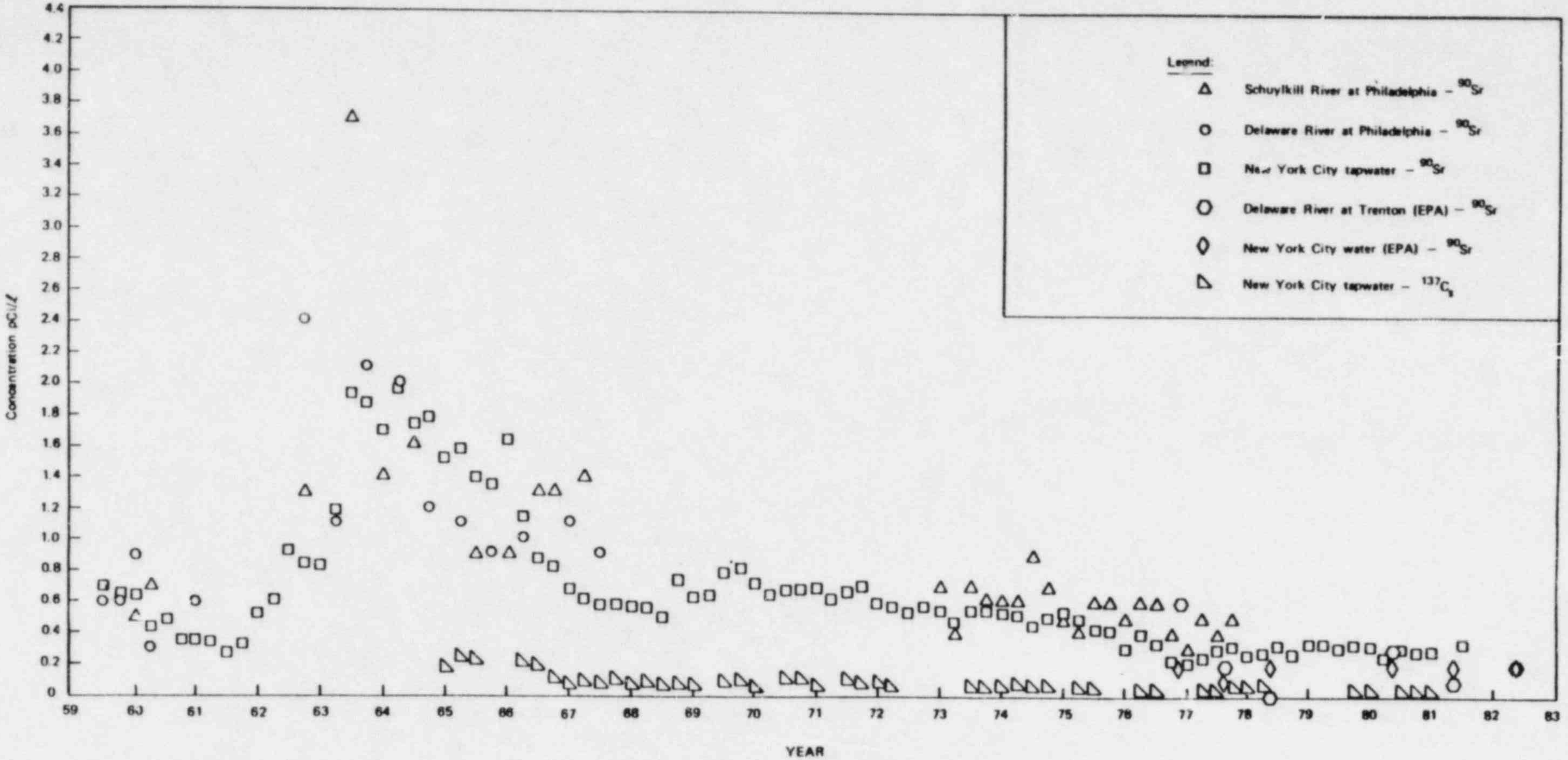

Figure 2. Time history of $^{90}Sr/^{137}C_s$ concentrations.

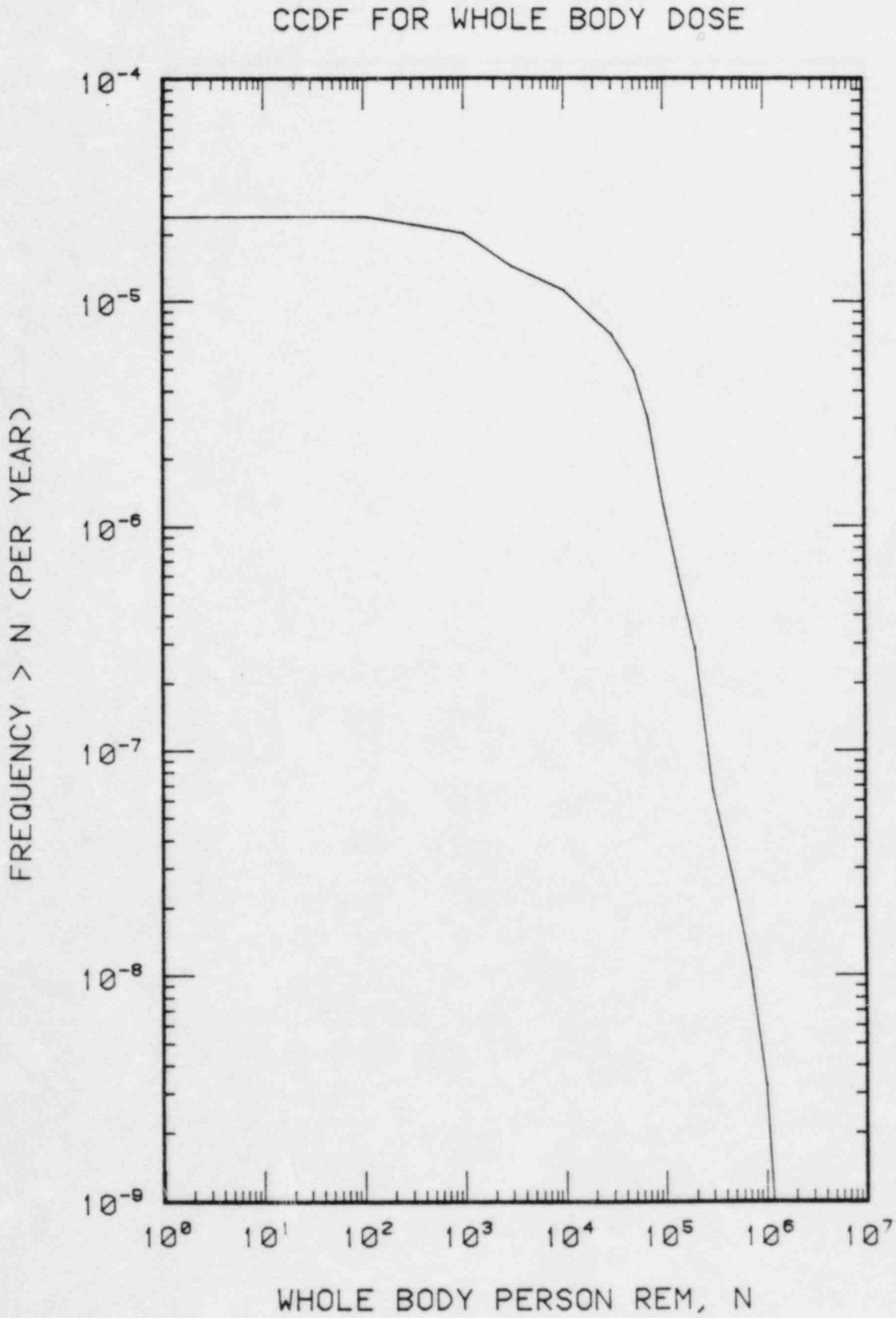

Figure 3 CCDF For Whole Body Dose - Drinking Water Pathway - City of Philadelphia Only

Revised 6/12/84

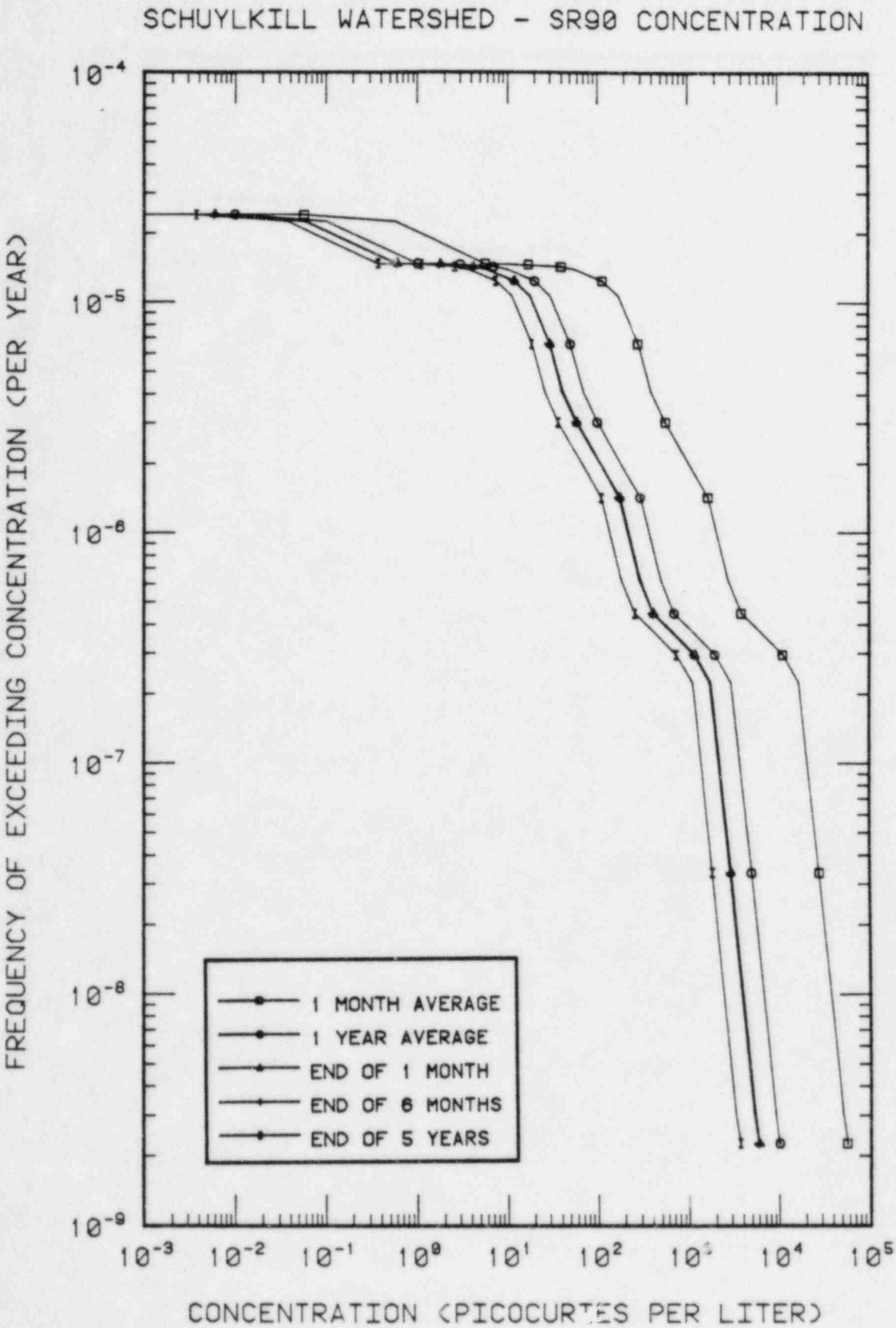

Figure 4(a) - CCDF of Concentration of ^{90}Sr in Schuylkill Water

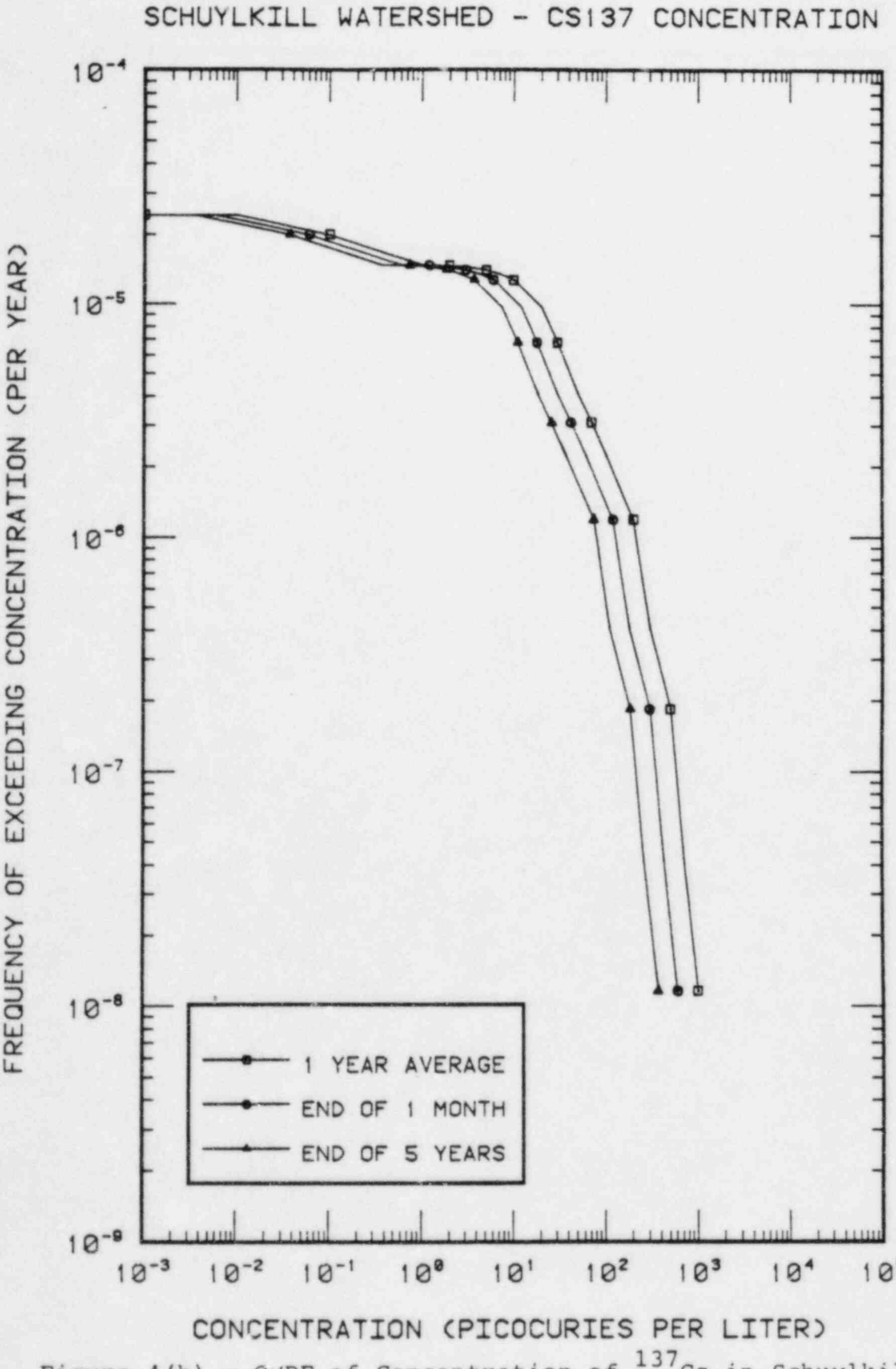

Figure 4(b) - CCDF of Concentration of ^{137}Cs in Schuylkill Water

Revised 6/12/84

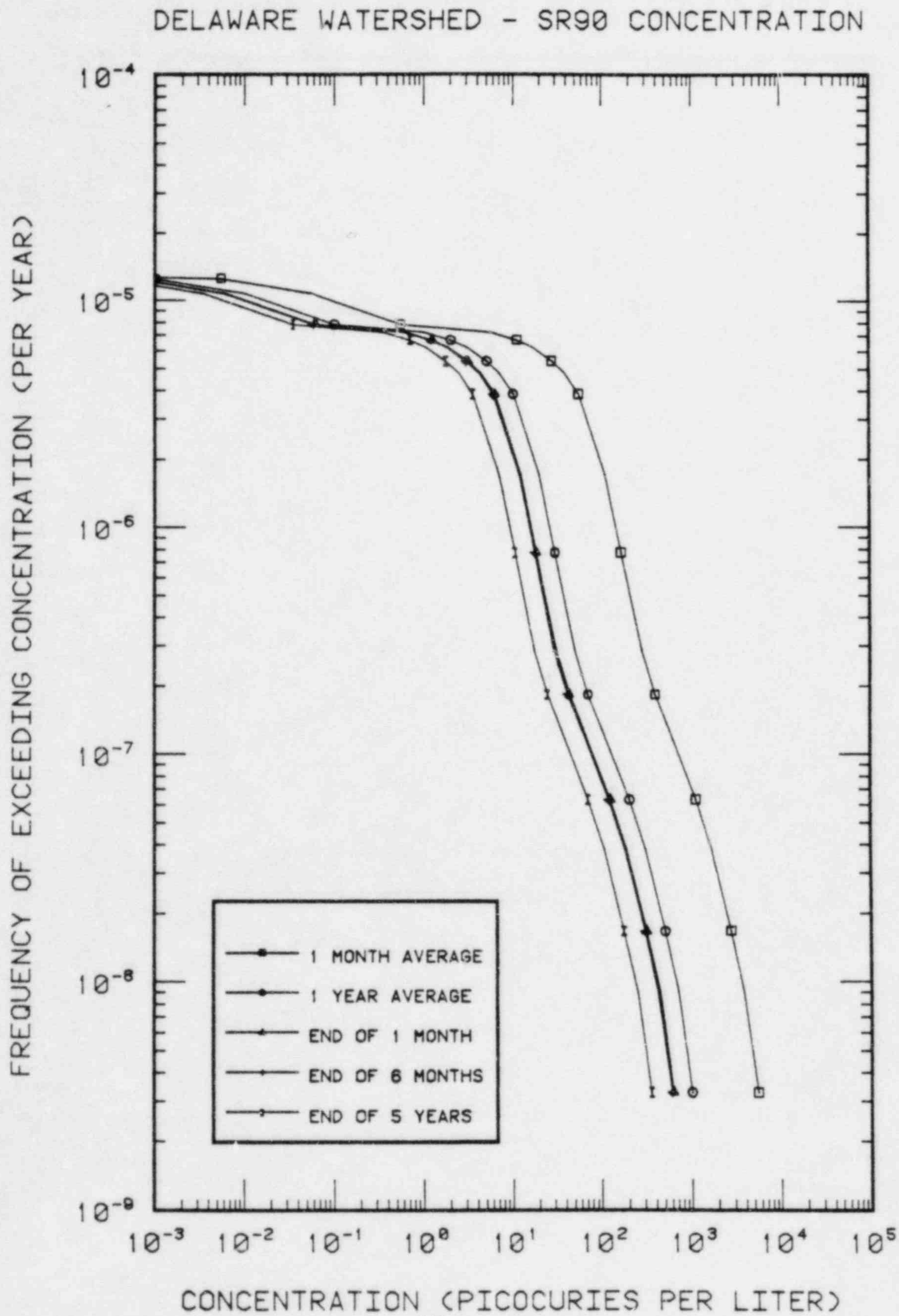

Figure 5 (a) CCDF of ^{90}Sr Concentration in Delaware watershed

Revised 6/12/84

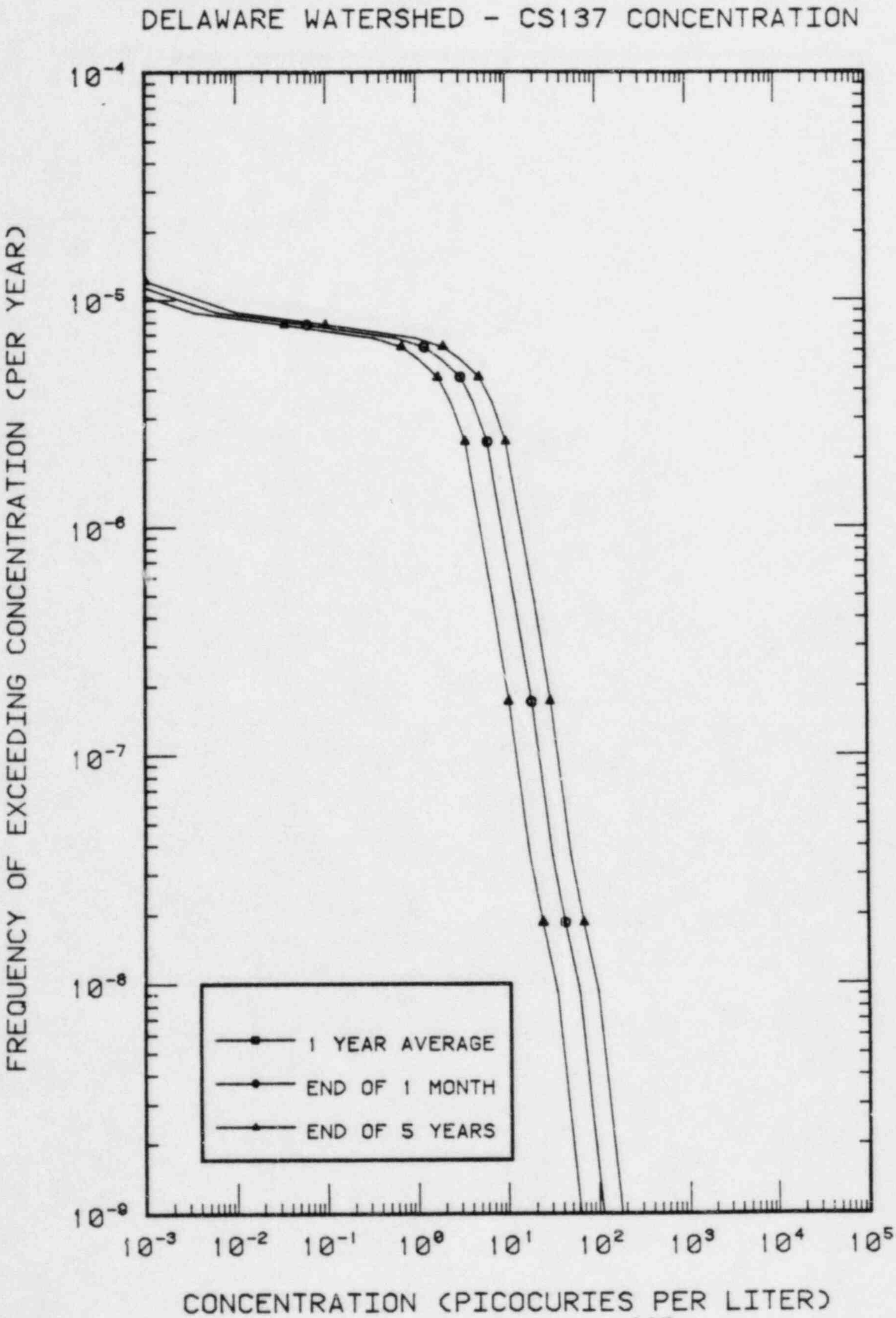

Figure 5(b) CCDF of Concentration of ^{137}Cs in Delaware water

Revised 6/12/84

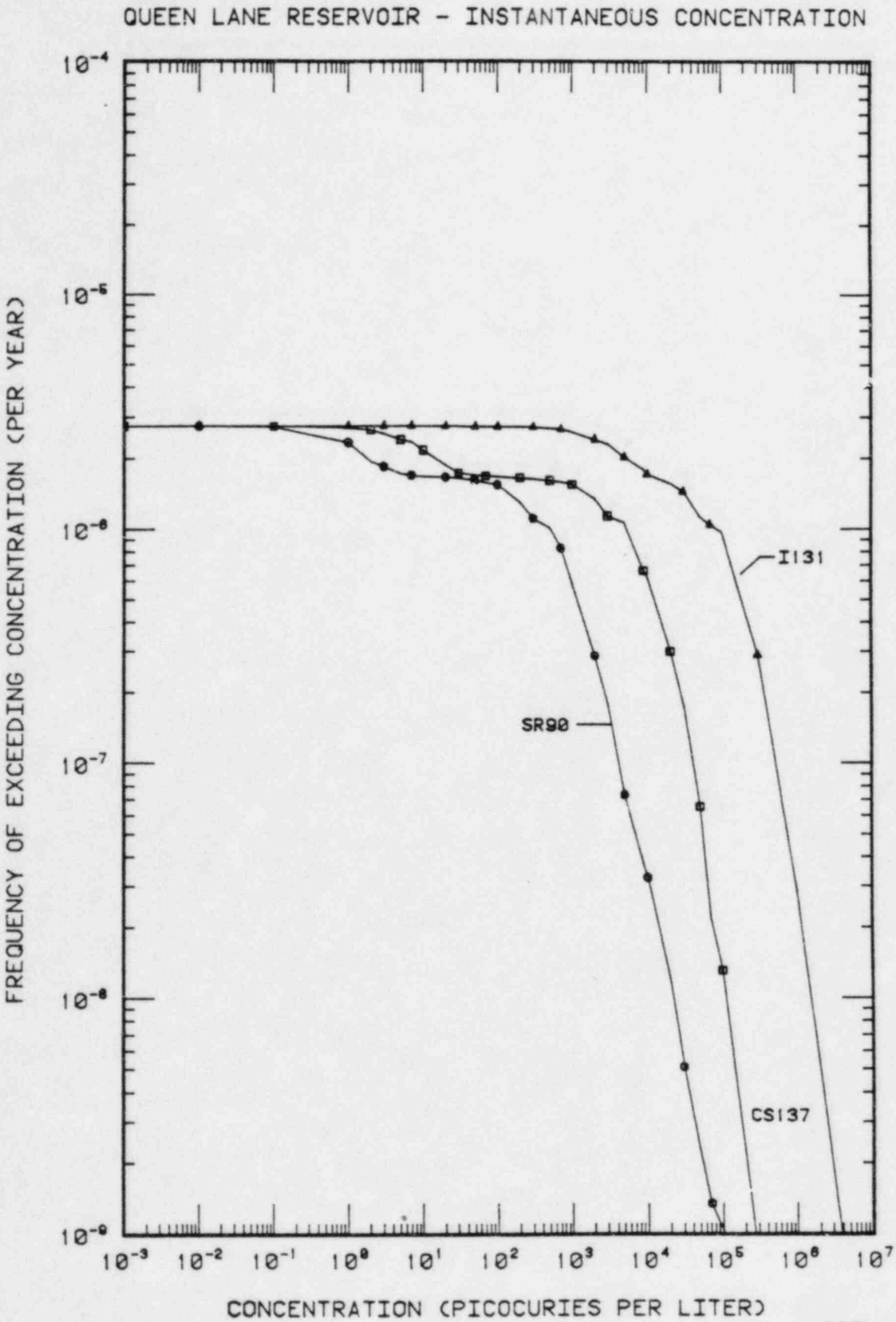

Figure 6 CCDF of Instantaneous Concentration of ^{131}I, ^{137}CS and ^{90}Sr in the Queen Lane (and Belmont) Raw Water Basins

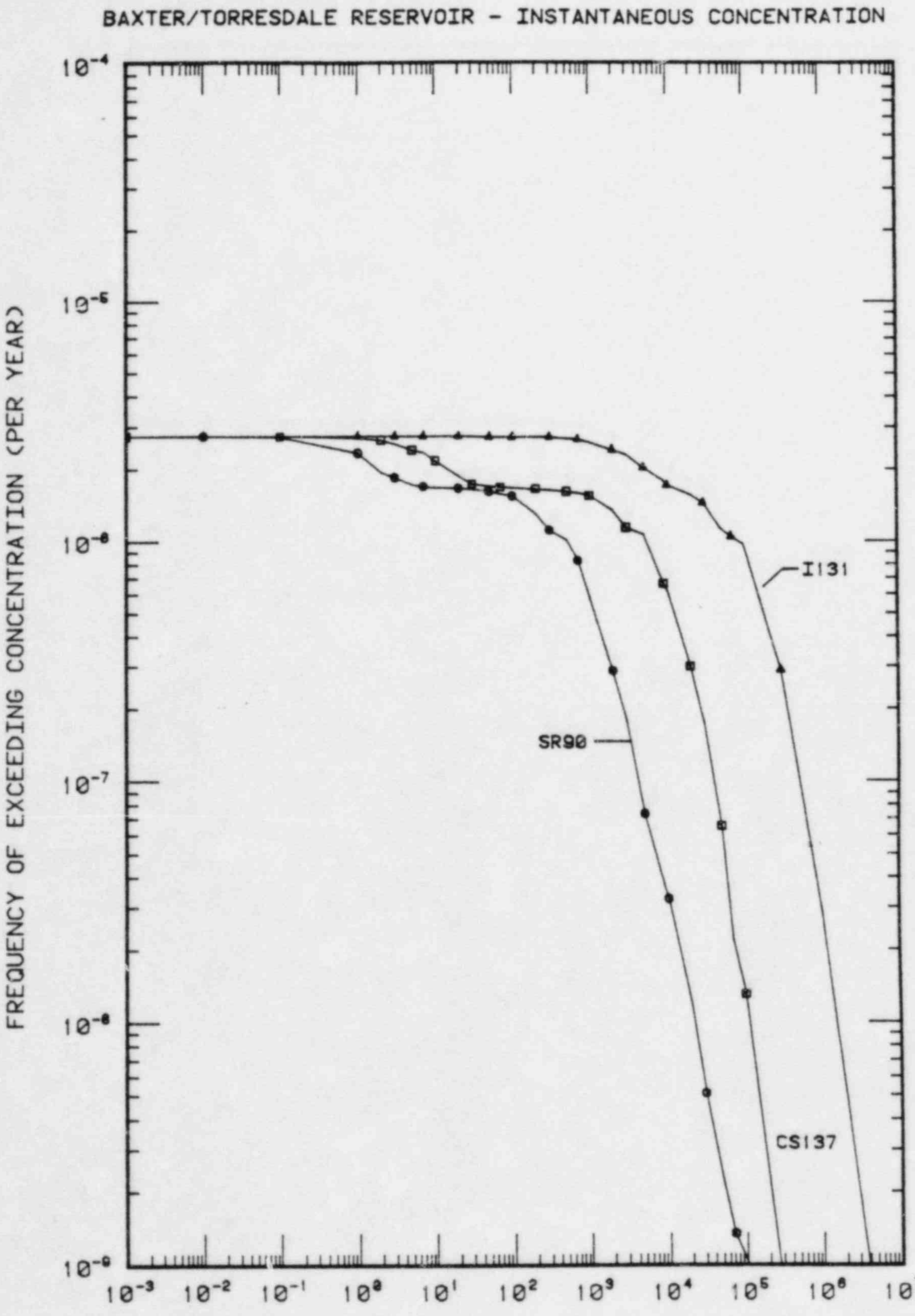

Figure 7 CCDF of ^{131}I, ^{137}Cs and ^{90}Sr Concentration in the Baxter Reservoir

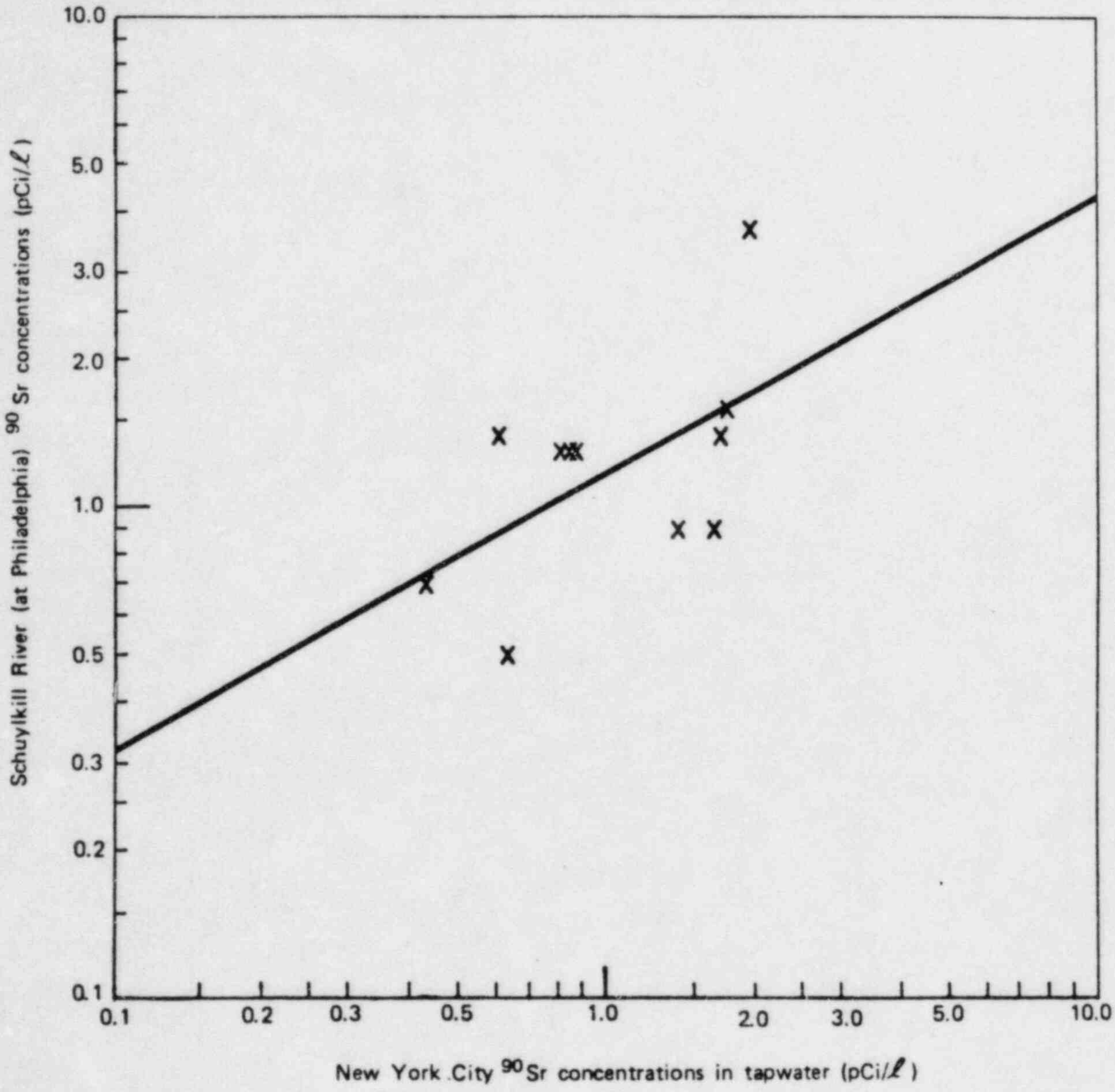

Figure 8. Correlation between ^{90}Sr concentrations in Schuylkill River water and New York City tapwater.

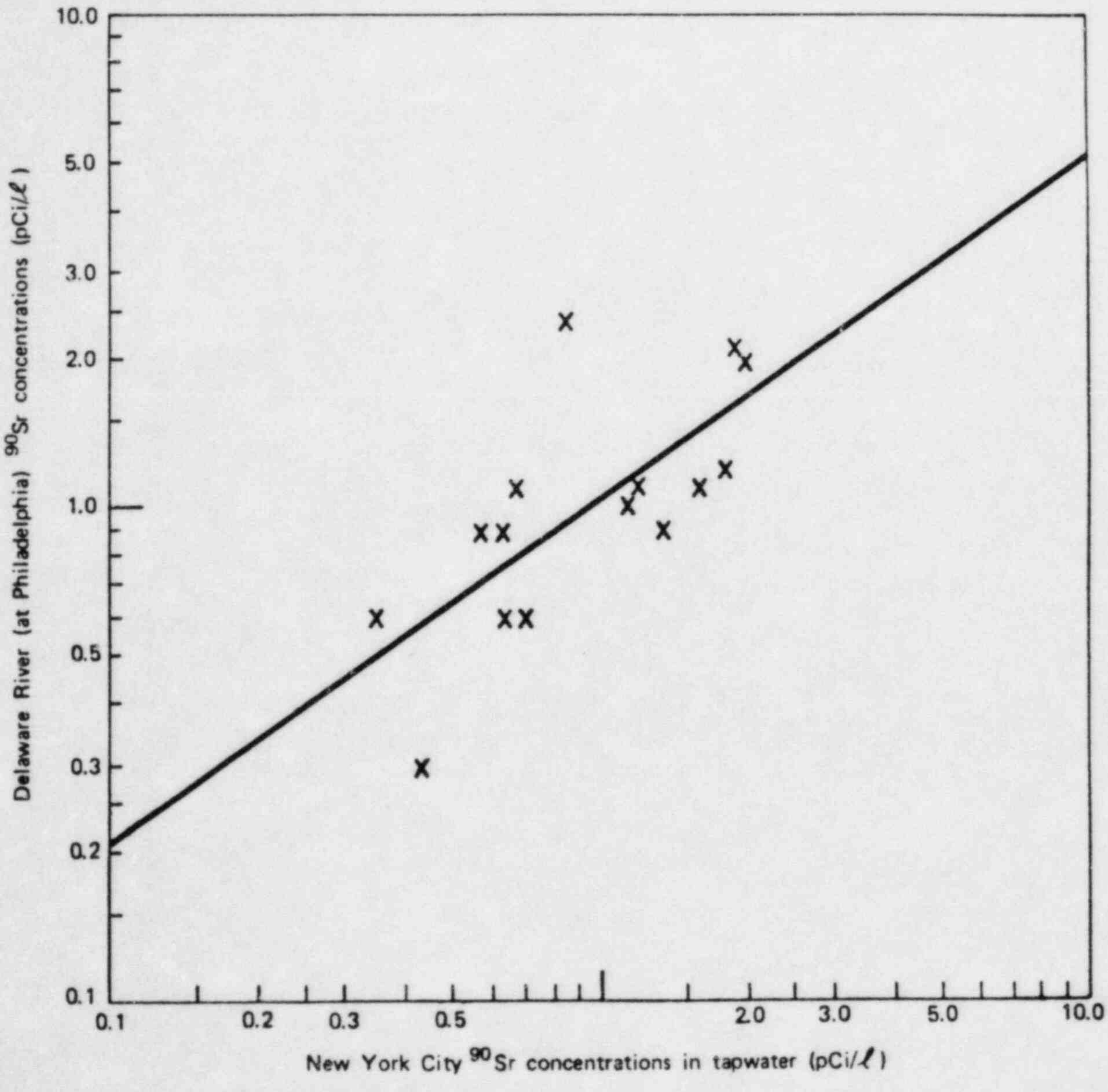

Figure 9. Correlation between ^{90}Sr concentrations in Delaware River water and New York City tapwater.

Sim 2-1

Q Mr. Levine, do you have a document of some five pages entitled "Applicant's Exhibits" before you?

A (Witness Levine) Yes, I do.

Q Does this five-page list of exhibits indicate the specific page of the references which were relied upon by you in your testimony?

A Yes, it does.

Q And are these the copies that had been previously provided to the Board and parties as references?

A Yes.

MR. WETTERHAHN: Your Honor, these identify Applicant's Exhibits 153 through 173 that I am going to ask be marked into evidence and provide three copies to the reporter at this point in time. I would ask that this copy entitled "Applicant's Exhibits be both bound in the transcript and inserted in front of each of the sets of exhibits for the convenience of the Board and parties.

JUDGE BRENNER: I have just received this document, Applicant's Exhibits in coming on the bench here. So I haven't read it, and it consists of five pages. Is it correlated exactly with the references?

MR. WETTERHAHN: Yes, it does, and it indicates the specific pages that were previously supplied to the Board and parties which are contained in the exhibit books such

Sim 2-2

that the Board and parties know identically what is being offered into evidence. Instead of doing it orally, I just put it in writing.

JUDGE BRENNER: All right, ine.

MR. WETTERHAHN: I am sorry, offered for identification. They are not being offered in evidence.

JUDGE BRENNER: That was my next question. All right. So Applicant's Exhibit 153 for identification would correlate with Applicant's Reference 1 and, similarly, Applicant's Exhibit 173 for identifiation would correlate with Applicant's Reference 21.

MR. WETTERHAHN: That is correct.

JUDGE BRENNER: All right, and these would be exhibits for identication only.

MR. WETTERHAHN: That is correct.

JUDGE BRENNER: As to the extent the portions are indicated on this list.

MR. WETTERHAHN: Yes. Applicant as no intention at this point in time of offering them. I understand that the City may wish to offer some parts of some of the exhibits which have been identified, but that I guess is for another time.

JUDGE BRENNER: All right.

In the absence of objection then, we will, first of all, bind into the transcript at this point this five-

Sim 2-3

page document entitled "Applicant's Exhibits, and also the Applicant's Exhibits will be marked for identifiation as indicated on this list, and that would be Exhibits 153 through and including 173.

(The documents referred to were marked Applicant's Exhibits Nos. 153 through and including 173 for identification.)

INDEXXXXXXX

(The five-page document entitled "Applicant's Exhibits" follows:)

APPLICANT'S EXHIBITS

Appl. Exh. 153 Direct Testimony of Richard Codell before the Atomic Safety and Licensing Board Concerning Commission Question 1, presenting an analysis of the risk posed by contamination of the Hudson River, reservoirs and other bodies of water that could be caused by severe accidental radionuclide releases at the Indian Point Nuclear Power Plant. This document consists of 45 consecutively numbered pages and six unnumbered pages containing "exhibits" one through eleven.

Appl. Exh. 154 Richard B. Codell, 1984. Potential Contamination of Surface Water Supplies by Atmospheric Releases from Nuclear Plants, Health Physics, to be published. This document consists of 31 consecutively numbered pages and eight unnumbered pages containing figures one through eight.

Appl. Exh. 155 J. C. Helton, A. B. Muller and A. Bayer, Contamination of Surface Water Bodies after Reactor Accidents by the Erosion of Atmospherically Deposited Radionuclides, Health Physics, to be published. This document consists of 34 consecutively numbered pages and ten unnumbered pages containing Tables one through nine.

Appl. Exh. 156 U.S. Nuclear Regulatory Commission, 1975. Calculation of Reactor Accident Consequences - Appendix VI of Reactor Safety Study, WASH-1400 (NUREG 75/014), Washington, D.C. Five page document consisting of a cover page, title page and pages 8-22, 8-24 and 8-25.

Appl. Exh. 157 Health and Safety Laboratory, U.S. Energy Research and Development Administration, 1977. Final Tabulation of Monthly ^{90}Sr Fallout Data: 1954-1976, HASL-329, New York, New York 10014. Six page document consisting of a cover page and pages i, ii, A-73, A-74, and A-75.

Appl. Exh. 158 Larsen, Richard J., 1983. Worldwide Deposition of ^{90}Sr through 1981, EML-415, Environmental Measurements Laboratory, U.S. Department of Energy, New York, New York 10014. Two page document consisting of a cover page and page 30.

Appl. Exh. 159 U.S. Environmental Protection Agency, 1976, Radiological Quality of the Environment, Office of Radiation Programs, Washington, D.C. 20460. Two page document consisting of a cover page and page 67.

Appl. Exh. 160 Hardy, E. P., Jr. and L. E. Toonkel, 1982, Environmental Measurements Laboratory Environmental Report, EML-405, Environmental Measurements Laboratory, U.S. Department of Energy, New York, New York 10014. Three page document consisting of a cover page and pages II-301 and II-302.

Appl. Exh. 161 U.S. Department of Health, Education, and Welfare, 1960 through 1968, Radiological Health Data, Volumes 1 through 9. This document includes excerpts from a number of reports:

Report	April 1960	consists	of	a	cover	page	and	page	38;
"	June 1960	"	"	"	"	"	"	"	19;
"	Sept. 1960	"	"	"	"	"	"	pages 29 and 30;	
"	Dec. 1960	"	"	"	"	"	"	pages 19 and 21;	
"	March 1961	"	"	"	"	"	"	page 131;	
"	June 1961	"	"	"	"	"	"	"	252;
"	Oct. 1961	"	"	"	"	"	"	"	451;

	Report	Dec. 1961	consists of a cover page and page 531;
	"	Mar. 1962	" " " " " " " 91;
	"	Aug. 1962	" " " " " " pages 293 and 294;
	"	" 1964	" " " " " " page 391;
	"	Oct. 1964	" " " " " " " 496;
	"	Dec. 1964	" " " " " " " 608;
	"	Mar. 1965	" " " " " " " 158;
	"	July 1965	" " " " " " " 396;
	"	June 1966	" " " " " " " 357;
	"	Aug. 1967	" " " " " " pages 450 and 451;
and	"	Nov. 1968	" " " " " " " 663 and 664;

Appl. Exh. 162 Limerick Generating Station Radiological Environmental Monitoring Program, 1971-1977, Prepared for Philadelphia Electric Company by Radiation Management Corporation May, 1979. This docuemnt consists of a cover page and Table B-1 consisting of 10 unnumbered pages.

Appl. Exh. 163 U.S. Environmental Protection Agency, 1976 through 1982, Environmental Radiation Data, Reports 6, 10, 15, 18, 23-24, 25-26, and 29, Office of Radiation Programs, P.O. Box 3009, Montgomery, Alabama 36193. Report 6 consists of a cover page and four unnumbered pages; Report 10 consists of a cover page and four pages numbered 19-22; Report 15 consists of a cover page and four pages numbered 18-21; Report 18 consists of a cover page and four pages numbered 18-21; Report 23-24 consists of a cover page and four pages numbered 25, 26, 28, and 29; Report 25-26 consists of a cover page and four pages numbered 33, 35, 36 and 37; Report 29 consists of a cover page and four pages numbered 21, 23, 24, and 25.

Appl. Exh. 164 Menzel, Ronald G., 1975, "Land Surface Erosion and Rainfall as Sources of Strontium-90 in Streams," Journal of Environmental Quality, Vol. 3, No. 3. This document consists of five pages, numbered 219-223.

Appl. Exh. 165 U.S. Geological Survey, 1982, Water Resources Data for Pennsylvania Water Year 1982 Volume 1 - Delaware River Basin and Volume 2 - Susquehanna and Potomac River Basins, Water Resources Division, P.O. Box 1107, Harrisburg, Pennsylvania 17108. The excerpt from Vol. 1 includes a cover page and pages 94 and 141; the excerpt from Vol. 2 includes a cover page and page 144.

Appl. Exh. 166 City of Philadelphia Water Department, 1982. How Water in Philadelphia is Teated and Distributed, 1180 Municipal Services Building, Philadelphia, Pa. 19107. This document consists of pages one through seven, an unnumbered page containing a map entitled "Philadelphia Water Facilities Water Pressure Districts", pages 10 through 15, and a closure page.

Appl. Exh. 167 U.S. Nuclear Regulatory Commission, 1977. Calculations of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50, Appendix I, NRC Regulatory Guide 1.109. This document consists of a cover page, pages iii through vi and pages 1.109-1 through 1.109-80.

Appl. Exh. 168 Simpson, D. B., and B. L. McGill, 1980. User's Manual for LADTAPII - A Computer Program for Calculating Radiation Exposure to Man from Routine Releases of Nuclear Reactor Liquid Effluents, Oak Ridge National Laboratory, NUREG/CR-1276. This document consists of pages iii, v, vii, ix, and pages one through 21.

Appl. Exh. 169 Aptowicz, Bruce S., 1984. Letter to Robert E. Martin, USNRC, dated April 23, 1984 and private communication, S. Gibbon, PECO and B. Aptowicz, City of Philadelphia, May 25, 1984. The April 23, 1984 letter consists of two consecutively numbered pages.

Appl. Exh. 170 Philadelphia Water Department, 1982. Table of pumping, treatment and consumption rates for FY '82. This document consists of two consecutively numbered pages.

Appl. Exh. 171 Commonwealth of Pennsylvania Disaster Operations Plan, Annex E, Fixed Nuclear Facility Incidents, February 1984. One page numbered E-12-42.

Appl. Exh. 172 Straub, C.P., 1964 Low-Level Radioactive Wastes, Their Handling, Treatment and Disposal, Division of Technical Information, United States Atomic Energy Commission. This document consists of a cover page and pages 155-202.

Appl. Exh. 173 Hardy, E.P., Jr., 1981, Environmental Measurements Laboratory Environmental Report, EML-390, Environmental Measurements Laboratory, U.S. Department of Energy, New York, New York 10014. This document consists of a cover page, pages C-102 through C-115, an unnumbered page and pages C-64 through C-79.

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JUDGE BRENNER: Off the record.

(Discussion off the record.)

JUDGE BRENNER: Mr. Wetterhahn.

MR. WETTERHAHN: I have nothing further for these witnesses and I would make them available for cross-examination at this point in time.

JUDGE BRENNER: All right. We have just received the City's cross-plan, at least within the last half hour. I think the date for receiving the cross-plan was actually yesterday, which would have been helpful to us. Nevertheless, you may proceed with your cross-examination.

MS. BUSH: Thank you, Your Honor.

I XXXXX

CROSS-EXAMINATION

BY MS. BUSH:

Q Gentlemen, I believe you state on page 2 of your testimony, paragraph 2, "The probability that these rivers will be contaminated above the PEMA protective action guides is shown to be very small; is that correct?

A (Witness Levine) Yes.

Q Does that statement in its terms apply to the -- well, if you could look at Applicant's Exhibit 171, I believe you have the PEMA standards listed there.

(Pause.)

With regard to the statement in the testimony in paragraph 2, which particular of the three drinking water

Sim 2-5

PAG's that are listed there were you referring to?

A (Witness Kaiser: We were referring to the second and the third PAG's.

Q Taking the third PAG, paragraph 3, under paragraph (c) on page E-12-42 of Applicant's Exhibit 171, was it your application of that standard in situations where the duration of the exposure would be less than 30 days? Did you apply that standard only in situations where the exposure would be less than 30 days?

A I think we would prefer to phrase it that we made comparisons rather than applied. When we made comparisons, we did so with our calculations of the one-month average concentrations.

Q And when you made the comparisons using Standard 2 in subparagraph C-2, that then was a comparison made in situations where the exposure was for longer than 30 days?

A Yes. For PAG No. 2 the comparisons were made against our calculations of the one-year average exposure, average concentration in water.

Q Are you familiar with the EPA established Manual of Protective Action Guides and Protective Actions for Nuclear Incidents?

A I am not familiar with that document.

Q Are you familiar with the PAG levels established by that document for airborne contamination?

Sim 2-6

MR. WETTERHAHN: Objection. It is bound by the witness' answer. He is not familiar with the document.

JUDGE BRENNER: I had a question as to the previous question. I take it, Ms. Bush, that your questions are directed to the panel unless otherwise indicated.

MS. BUSH: Yes, and the question is not intimate familiarity with the document is why my follow-up question is that I thought that they might know the PAG level and not the document itself.

JUDGE BRENNER: All right. Let's put ---

MS. BUSH: To anyone on the panel.

JUDGE BRENNER: Wait. Let's put the second one aside. I want to find out if Dr. Kaiser said I am not familiar with it. I presume by now that the panel has been instructed that these questions are directed to all of them unless the questioner indicates otherwise.

WITNESS LEVINE: I am very generally familiar with the document. I have skim read it, but I do not know the details in it.

BY MS. BUSH:

Q Are you familiar with the PAG levels that are established and therefore airborne radioactive materials, general population of one to five projected whole body gamma dose, one to five rems?

A (Witness Levine) I remember reading that.

Sim 2-7

Q Are you aware of whether there are protective action guides or PAG levels that have been established by the EPA similarly for water contamination?

A Not in that document. They are not in that document.

Q Are there others that are not in this document?

A Not that I am aware of.

A (Witness Kaiser) Perhaps I could add something. According to the page of FEMA PAG's that we are looking at, these are based on the USEPA national interim primary drinking water regulations, EPA 570/9-76-003 Appendix B, and I believe that in that document there are some levels established for the consumption of drinking water contaminated by various radionuclides.

Q Thank you.

I believe on page 3, the end of paragraph 2 you conclude that the contamination of water is a small contributor of risk compared to the risk arising from airborne pathways. I take it from that that you are making a statement as to the absolute valuve of the risk as well as the relative importance of the risk.

A (Witness Levine) Well, the statement at that point is a relative statement that the risk from the waterborne pathway is a small fraction of the airborne pathway, and in fact it is six percent of the airborne pathway.

Sim 2-8

Q And would your testimony be that on an absolute level it is a risk level that is properly neglected or could Ijust ask your opinion in terms of an absolute ---

A I would characterize the risk as being very small. The health effects in terms of cancer fatalities predicted from the water pathway would, in our calculations, be one ten-millionth of the cancer fatalities already occurring in the City of Philadelphia from other causes.

Q And I take it then from that that we could infer that it is your opinion then that the risk associated with water contamination is one that would not rise to the level of requiring any alternative considerations in the design of the ---

A I am not sure what you mean by alternative considerations.

Q The design of the plant.

A Certainly not in the design of the plant, no.

Q How about operation of both units, not operating one unit, it doesn't rise to that level of concern?

A I see no need for any operational restrictions because of that.

Q Then in the next paragraph you state at the end of that paragraph that "The testimony does not purport to consider emergency planning requirements." My question is does this mean that the testimony doesn't attempt to ascertain

Sim 2-9

or evaluate or address the feasibility of potential protective ations or the adequacy of any current systems that have the potential to provide some protection in the event of an emergency?

A Our testimony does discuss some actions that could be taken to mitigate the consequences of a water pathway. On the other hand, we are addressing that matter only as analysts. We are not addressing the matter as a matter of emergency planning.

Q When you say you are addressing it as analysts and not as emergency planners, can I take it from that that you are not presenting this testimony, or the matters that you considered in the testimony, that you are not presenting them as at this time alternatives that are workable emergency planning alternatives?

A I am not sure exactly what that means, but I would tell you that in my opinion I would not do emergency planning in the conventional sense based on consequences as small as these. There are limited resources in this world and there are many other places to spend our resources to improve public health and safety rather than look at this water pathway.

On the other hand, it is not up to me to decide what emergency planning measures need to be taken. That is a matter for the NRC and other civil authorities.

Sim 2-10

Q But you do present these as reasonable or realistic alternatives in the event that they would be used for emergency planning?

A We think we present factors of dose reduction or health effect reduction that are probably achievable if need be.

Q I would like to turn to Figure 3, if we could, please. This curve presents a distribution of probabilities of consequences in terms of whole body person rem exposures; is that correct?

A Yes.

Q Are the probability values that are located on the curve, are they mean values that are an average or a mean of another range of probability curves, or does this curve present all of the probabilities that the CRAC 2 outputs?

A These are point estimate values of the probability of all of the accident sequences discussed in SARA. That is the ensemble of all those accident sequences.

Q So, for example, for one accident sequence you would have made numerous runs with different meteorological data and perhaps different -- well, let's leave it at different meteorological data, and for each source term then you get a point estimate that is translated on this curve?

A (Witness Kaiser) This curve -- well, as you say, to answer the first part of your question, for each of

Sim 2-11

source terms, CRAC 2 was used, and subsequently a further code that converts output from CRAC 2 into concentrations in drinking water. So it wasn't just CRAC 2 that was used.

Yes, for each source term a variety of meteorological conditions was covered, and then the overall CCDF that you see here is essentially a sum of individual CCDF's for each source term.

A (Witness Levine) But not every point in those calculations lies on that curve. There are many more points that lie below that curve.

Q Within each source term that is run; is that what you are stating?

A Yes.

Q Now there would be points that would be above the curve within each source term that is run also?

A (Witness Kaiser) No, there wouldn't.

Q All of them would be below?

A That is correct.

Q So we could take, say, the whole body dose point of 40,000 rems and any probability that is associated with that point are you saying would be within the curve and therefore it would be a lower probability?

A (Witness Levine) The curve does not show a value of 40,000 rems.

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Q Whole body personrems?

A Yes.

Q Does it show 40,000 whole body personrems?

A Yes it does.

Q Is it correct then what your testimony stated then? Any value for 40,000 whole body personrems would be at a lower probability than the probability on the curve?

A (Witness Kaiser) Yes. For each individual source term, there would be a CCDF which looks similar in shape to this one, but lies below it.

Then if you look at the fixed value of 40,000 personrem that you have suggested and read upwards from that, you would find frequencies associated with each of the source terms in turn.

If you added those frequencies, that would give you the frequency corresponding to the one on the overall curve that we have shown.

Q Did you say that you would add up the frequencies that would be higher on the curve than the point at 40,000 whole body personrems?

A No. If you sum the frequencies for the individual source terms, the frequency will come out to be that that is shown on the CCDF on Figure 3.

Q In terms of each one for a source term with the different meteorological conditions, is the consequence value that is portrayed on Figue 3, is that a mean value?

A No. In the context of this figure, the mean value would essentially be the value you get by taking the area under than CCDF. There isn't a single consequence shown on this curve which seems to be the implication of your question.

Q It shows different probabilities and different -- the consequences associated with differing probabilities?

A It shows the probability of equaling or exceeding the corresponding consequence magnitude.

Q Let me take one consequence again of say 40,000 whole body personrems. Are there various probabilities associated with that one consequence in terms of different weather conditions and within different source terms?

A There are, yes.

Q And is there any indication on this table of what those would be? Could I look at the figure on it and know what the range of those would be?

A No, you can't tell just by looking at this figure.

A (Witness Levine) All you can tell from the figure is that they are beneath the curve shown.

Any individual one you pick would be beneath the curve.

Q Does that mean --

JUDGE BRENNER: Off the record.

(Discussion off the record.)

BY MS. BUSH:

Q Then is it correct if I took any point for a consequence value, say 40,000 whole body personrem, drew a line, a vertical line, would that then give me the range of where the probabilities associated with that number would be?

A (Witness Kaiser) Yes, if I understood your question correctly, it would, so long as you don't go above the curve that is shown there.

Q And all of the range of consequences, the meteorologically related consequences, bad weather, they are on this curve or below it, is that correct?

A Yes. This curve represents the results of all the calculations with all of the source terms and all of the weather conditions considered.

If you try to take out a single source term or a single weather sequence, the probabilities would lie below those shown on this curve.

Q The range within the source term also, your statement holds true for the range of consequences and probabilities that you would obtain from the CRAC II from running any given source term?

A (Witness Levine) All the source term, not any given one but all of them.

Q Each and every one of them?

A Yes.

Q So all of the range of consequences within each and every source term would be under the curve?

A (Witness Kaiser) Yes.

A (Witness Levine) Yes.

Q Now the CRAC II -- would the CRAC II along with the water model that you used, particularly for this area, have the ability to output a similar CCDF curve for latent cancer fatalities?

A (Witness Kaiser) Yes, the collection of codes that we have used would have that capability.

Q Did you do that for this analysis or associated with this?

A We did not output CCDFs such as that shown on Figure 3 for latent cancers.

Q Did you output any DDCFs for latent cancers, for water contamination?

A No, but we did calculate some areas under such CCDFs, in other words, the mean values of risk.

Q Do you have that in written form?

A We do.

Q I will review that during the break.

Now in calculating your health effects, is it correct that you did not reduce the strontium or cesium levels between the river and the drinking water in your analysis?

A Yes, that is correct.

Q Your analysis was for 50 years, is that correct?

A That is correct.

Q Did you choose a 50-year period because that is some significant period in terms of the length of contamination?

A We wanted to be comparable to the calculations that were done for the air pathways in SARA.

Q Would contamination then belong within the 50 years for the water?

A At progressively lower and lower levels, it would persist.

Q Do you know what level the contamination would be after 50 years? Ballpark figures?

A (Witness Toblin) The contribution to the health effects of the risk after 50 years is one percent of the total.

End 3.

Q I take it that would be the consequence aspect when you say "risk." At that point you are really only talking about consequences, not the probability of the accident?

A (Witness Kaiser) That is correct.

Q I would like to ask a few questions on page 12 about the various conversion factors. You used the WASH-1400 conversion factors, is that correct?

A Yes.

Q And Regulatory Guide 1.109 uses the same WASH-1400?

A No, it doesn't. It doesn't use the same.

Q Uses ICRP 2, that is what the Regulatory Guide uses?

A Yes.

A (Witness Bartram) Regulatory Guide 1.109 uses dose conversion factors from NUREG-0172 which have been derived based on ICRP 2 methodology.

Q Can you state in general terms the relationship between the two conversion factors? Which would be higher, which would be lower?

A The WASH-1400 does conversion factors for cesium and iodine are somewhat comparable to those in Reg Guide 1.109, however in the case of Strontium 90, the whole body dose conversion factor in Reg Guide 1.109 is approximately 20 times lower than the WASH-1400 number. I stand corrected. The WASH-1400 whole body dose conversion factor for Strontium 90 is approximately 20 times lower than in Reg Guide 1.109.

The WASH-1400 dose conversion factors are based on more updated internal metabolic data and they are consistent with the more recent recommendations of the ICRP and ICRP publications 20 and 30.

Q What is currently considered to be the range of reasonable conversion factors for Strontium?

A Do you mean in terms of numerical values?

Q Well, say within the range of WASH-1400 to the IC_-- the Reg Guide 1.109?

MR. WETTERHAHN: Objection. Asked and answered.

MS. BUSH: I then give the answer in terms of the same kind of factors you talked about before.

JUDGE BRENNER: Why don't you restate the question because I am confused now?

BY MS. BUSH:

Q What is currently the range of what various people in the field consider the range of conversion factor, and could you state you answer in similar terms that you have been discussing it before, in terms of factors of 20 in relationship to Reg Guide 1.109?

A (Witness Bartram) I can't state a range. However, I can state the dose conversion factor value, if that is what you would like to have.

Q All right, what is the value you use?

A   Okay. For Strontium 90, the whole body dose conversion factor from WASH-1400 is 8.4×10^{-5} millirem per microcurie ingested. Based on Reg Guide 1.109, the dose conversion factor is 1.86×10^{-3}. In most of the other cases, the dose conversion factors for the other radionuclides and organs between Reg Guide 1.109 and WASH-1400 are comparable. That is within about a factor of two.

JUDGE BRENNER: Mr. Anthony, you gave us some documents that we didn't have a chance to read when you handed them to us and we might have a reaction to them after the break if you want to stay, when I will have a chance to read them.

We will be taking a break in about an hour or so. You can go and come back if you want.

Now we may not have any reaction, but I want a chance to read them.

Okay, I am sorry for the interruption.

BY MS. BUSH:

Q   What currently in the field is considered the range of reasonableness in terms of conversion factors for strontium?

A   (Witness Kaiser) We take the position that the numbers based on ICRP 30 represent a consensus of informed individuals in the field and this, therefore, is the best value to use at the present time.

Q   Is there any controversy in the field as to what the range of appropriate conversion factors should be?

A (Witness Bartram) There is no controversy that has really occurred over this matter before. I do want to clarify one thing, that those conversion factors that we used were from WASH-1400, which are not quite the same as ICRP 30 dose conversion factors, but they are close to them.

In the case of Strontium 90, this difference has never really been a problem in the past because in most situations, Strontium 90 is usually not a dominating radionuclide. But I would say as far as the best technically correct dose conversion factor, we would normally go by the recommendations of the ICRP.

So we are basically talking about methodology that was originally established back in 1959 in ICRP 2 on which the Reg Guide 1.109 factors are based.

Then over the past 15 or 20 years, there has been a progression in the methodology so that now currently, we have ICRP Publication 30, which represents a model that utilizes the most updated internal metabolic data. It is also fairly consistent with the WASH-1400 numbers.

Q When you say "fairly consistent," is there a difference with strontium?

A Once again, it is between WASH-1400 and ICRP 30. The factors are very close.

Q Is that the one you said would be a factor of two?

A Somewhat, yes.

Q I believe your testimony is that it is likely that the Schuylkill will be more heavily contaminated than the Delaware? Would you please enumerate the factors that create this effect?

A (Witness Kaiser) The main factor that contributes to this effect is that any plume that is emitted from the reactor has to travel some distance over the Schuylkill watershed before it reaches the Delaware watershed, so that if the wind were blowing in that direction, it is highly probably that under some weather conditions all of the contents of the plume would be dropped onto the Schuylkill watershed before the Delaware watershed is reached and of course the other aspect, probability-wise, is that for some wind directions the plume would not travel over the Delaware at all.

So those two factors together combine to make the probability of certain levels of contamination in the Delaware lower than they are in the Schuylkill.

Q Is it your testimony that the Schulkill watershed is large -- is of such a size that it increases the probability of its being contaminated?

A The size has not really much to do with it. It is the fact that the LGS is in the Schuylkll watershed.

Q I'm sorry, I didn't hear. The what?

A The LGS, the station is in the Schuylkill watershed.

Q So it is a distance question?

A Yes, it's a question -- the plume has to travel over the Schulykill watershed before it gets anywhere else, therefore it is more likely that there will be contamination in the Schuylkill watershed than elsewhere.

Q When you say that it has to cross the Schuylkill, aren't there some directions it can go and not cover the Schuylkill?

A I am talking about the watershed rather than the river itself. The watershed is the area within which water or rainfall will drain into the Schuylkill.

Q And is it correct depending on the size and direction and intensity of the plume, even though the Schulykill watershed will be contaminated under accident scenario, some of it would be extremely minor contamination depending on the direction of the plume?

A The levels of contamination in the Schuylkill watershed would vary over a very wide range depending on the source term itself, that is the amount of radioactive material released, and on the weather conditions.

Q And those are the two variables, the source term and the direction of the plume and the rain, that affect the degree of the Schuylkill comtamination?

A The source term itself, the weather conditions, whether it is raining or not, and to some extent the direction.

Q And in all cases, the Schuylkill would be more contaminated than the Delaware?

A That is not absolutely true. You could envisage some weather conditions where it would happen the other way around, but they would be extremely rare.

Q Can you tell us for what period the Schuylkill would be contaminated above the levels such that you would have an associated dose commitment to any organ of 50 millirem?

What is the maximum time?

A We didn't calculate the maximum time.

Q And I take it you didn't calculate that for the Delaware?

End 4. A We didn't.

Q Did you calculate assuming an accident occurs the minimum time for either of those rivers?

A Could you repeat the question, please?

Q Assuming an accident occurs, did you calculate the minimum amount of time that the Schuylkill will be contaminated to that level associated dose commitment to any organ of 50 millirem?

A The answer to that question is the minimum time is zero.

Q Because there are some accident situations where neither river will be contaminated?

Is that why -- ?

A Where neither will be contaminated above 50 millirems the corresponding levels that give you 50 millirems in one year.

Q Now your Figure 3 assumes that all of the city except 7 percent would be supplied by the Delaware, is that correct?

A Yes.

Q And you assume the average daily flow of 324 million gallons per day?

A (Witness Schmidt) The manrem is based only on the consumption of water in terms of drinking and not the throughput of the city water supply.

Q In making this analysis, did you consider problems associated with -- any potential problems associated with salinity in the Delaware River, salinity levels in the Delaware River if the consumption level were as assumed in the Figure 3?

A (Witness Kaiser) No.

Q Did any of the witnesses give that any consideration?

A (Witness Guarino) Do you mind repeating the question?

Q Yes, did any of the witnesses give any consideration to any problem that might occur of salinity in the Delaware River if this level of consumption were relied on?

A I didn't consider that.

Q In considering it now, is it your opinion that it would be something that would be of concern?

A No, I don't think so.

Q Do you say that because -- why do you say that?

A I really don't see any tie-in myself between salinity and the matter we are discussing today and I don't think that the salinity of the Delaware River water at least in the intakes have ever gone to the level of 250, which is considered sort of a max, 250 milligrams per liter.

Q Now my particular question is, if you have all but seven percent of the City's intake coming from the Delaware and none from the Schuylkill, would that create a salinity problem?

A Absolutely not.

Q Why do you say that?

A Because the only time in my memory and in the history of the City's water department that they ever thought they would have a problem would be when you had a draught and even at that time, the so-called salt line, which would be the 250 milligram per liter level, never went beyond the Ben Franklin Bridge and you are still I guess close to 10 miles away from the intake of the Baxter Water Treatment Plant.

JUDGE COLE: Excuse me, Ms. Bush. Mr. Guarino, did you ever restrict the withdrawal rates at the Baxter plant as a result of consideration of the salinity line?

WITNESS GUARINO: Yes, they did. They did -- that is not me but the present water commissioner, Commissioner Marrazzo, a few years back when there was a draught did institute conservation measures.

JUDGE COLE: Do you know what rates of withdrawal were involved in those operations, sir?

WITNESS GUARINO: No, but I would like to give an opinion about that. I don't think that the conservation measures really did any good because the problem is if you used it, if you used the water, the water would go to the river, so there wouldn't be any difference as far as I am concerned in the salt line coming up.

If you took the water out of the river and you didn't return it, then you might have some impact. But to me, you could have used the water. It would have returned to the river and if it was then the salt line would not have been impacted.

JUDGE COLE: Are you saying, sir, that most of the water that is withdrawn at the Torresdale-Baxter plant is discharged back into the Delaware River at a point above where the saltwater would extent up the river?

WITNESS GUARINO: That's right. The salt line is a result of lack of fresh water coming from, say, upstate, so you could use it. It would not change the quantity of water. As a result it would have no impact or very little impact on the saltwater line.

JUDGE COLE: All right, sir. Do you know what levels of operation of the Torresdale or the Baxter plant that were involved during this period of conservation?

WITNESS GUARINO: I don't know for sure but I doubt that the conservation measures had much of an impact on the use of water.

JUDGE COLE: Do you know if the conservation measures that were employed then were as a result of the problem of a scarcity of water or as a result of a potential problem of saltwater intrusion upriver towards the intake?

WITNESS GUARINO: My personal opinion of that was that the City felt obligated to do something like that because they were asking New York to agree to conserve water, those where the impact would be.

If you know the story of the river water, the more water New York uses, the less comes down for Philadelphia to use.

JUDGE COLE: That has been a problem for years.

WITNESS GUARINO: So I think there was a request by the Delaware River Commission strongly worded, maybe in order for New York to use less water, so I think that Phiiadelphia also felt that they should institute conservation methods. But my personal opinion is that it did not have much of an impact on salt water line.

JUDGE COLE: My question really was, was it as a result of a potential saltwater problem or was it just a water scarcity problem?

WITNESS GUARINO: Pardon?

JUDGE COLE: Was it a result of a potential saltwater intrusion problem into the water supply or was it something else?

WITNESS GUARINO: That is what it was for, potential saltwater intrusion.

JUDGE COLE: All right, sir, thank you.

Side 2
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BY MS. BUSH:

Q Is it correct from your previous answer then that the level of usage at average daily flow, that assumption does not affect your Figure 3 because you had a certain level of assumption of consumption per individual?

A (Witness Schmidt) The seven percent number was based on the consumption of the areas which could not be supplied from the Delaware, their normal consumption divided by the total of City consumption. Therefore , we got a percentage -- that is where the seven percent came from.

That was used then to represent the fraction of the people, the population supplied by the Schuylkill or supplied by the Delaware.

The actual consumption of water for drinking is one liter a day. The consumption per person for all uses in the City is I think 200 gallons a day.

Q Did you do any analysis with CRAC II to determine health effects if the seven percent of the population, some larger percentage of the population had to consume water from the Schuylkill?

A (Witness Kaiser) Yes, we did.

Q What assumptions did you make as to number of people that would consume Schulykill water?

A We made the assumption that the normal proportions would apply, which is 55 percent fed by the Delaware, 45 percent fed by the Schuylkill.

Q Is that in your testimony?

A No, it's not.

Q And did you do a similar figure as to Figure 3?

Was it that kind of a result?

A It is a similar result. We didn't draw out the figure, but we do have essentially the areas under that curve. It makes a factor of 324 increase in the values of public risk.

Q In the total risk number?

A Yes.

A (Witness Levine) The risk from the water pathway.

Q From the water pathway?

A Yes.

Q Now would that factor of three or four apply equally all along the CCDF curve or would you know?

A (Witness Kaiser) Yes, you would essentially -- no, that is not true. I correct myself. It would not apply equally along the curve because at the lefthand end of our curve, you cannot exceed the core melt frequency.

Q Could you explain that answer further?

A Yes. The maximum conceivable frequency of any effect resulting from an accident of the reactor cannot exceed the core melt frequency.

Q And that is the number where the line intersects the vertical axis?

A Yes.

Q So, to get the health effects, if there is the 45 - 55 breakdown or something in between, can we multiply that factor of four times anything other than the total risk number?

A No. It only applies to the mean value of the area under the curve.

Q Did you do any analysis that assumes specifically a certain period of time where the Schuylkill would be consumed at the normal rate and then reliance on the Delaware for all but seven percent?

A No, we didn't.

Q Was your assumption that the Delaware could be used for all but seven percent based -- what was it based on? What was that assumption based on?

A (Witness Schmidt) That was based on information from the City which cited Belmont High area could not be supplied from the Delaware with approximately 12 million gallons per day consumptions plus some verbal discussions which indicated another area that would have some difficulty. Those two areas added up to seven percent of the normal daily consumption as one year average, I think, in '82.

Q Did the City -- was one of the documents you relied on the letter from Mr. Aptowicz to Mr. Martin dated April 23, 1984, which is, I believe, Applicant's Exhibit Number 17 in the book, Exhibit Number 169?

A Yes, as cited in our testimony.

Q Now did Mr. Aptowicz also discuss in there at page 2, third from the last paragraph, several condidtions upon the implementation of that switchover from Schulylkill to Delaware?

A Yes, he did.

Q Now I would like to ask what your knowledge is in terms of -- and this might be another witness -- what would be involved in terms of the switchover as discussed on page 2, third from the last paragraph, by Mr. Aptowicz?

MR. WETTERHAHN: Objection. We are getting beyond the scope of the contention into specific planning aspects. Certainly the witness stated for purposes of this analysis what he has relied upon. I believe that is as far as this line of questioning may proceed under the contention as raised.

MS. BUSH: Shall I respond?

JUDGE BRENNER: Yes, go ahead.

MS. BUSH: My interest here is the range we have of an assumption of immediate cutover and an assumption we have some general results on, no cutover at all, and I would like to establish for the record what the witnesses know in terms of what it would take to make that cutover and they are mentioned in Mr. Aptowicz's letter.

I would like to explore that a little bit.

JUDGE BRENNER: The objection is overruled. As long as the witnesses are making certain assumptions for their result, it is open to the cross examiner to pursue those assumptions and that this is part and parcel of some of some of the assumptions being made.

WITNESS SCHMIDT: Let me first make a comment that we do not assume instantaneous switchover. As we state in our testimony, the City has two days or more of covered, finished water, which would not be contaminated. Those are two days at normal consumption rates.

If an accident such as the kind -- the one we are talking about occurred, there would be many more days than just two available.

So the switchover or the transfer has to be considered in that light.

BY MS. BUSH:

Q Are you saying there would be much more available on the assumption that there would not be a large part of the population to consume the water?

A (Witness Schmidt) I am saying the two days at normal consumption rate, the normal consumption rate is for the City, I think, 200 gallons a day, which is fairly high. A lot of that is industry. Steps could be taken to reduce the consumption rate and extend that two days, to take whatever actions were necessary.

End 5.

Sim 6-1

A (Witness Levine) It has nothing to do with the presence or absence of people. The point is there is clean water available in covered finished water ponds which would remain uncontaminated, and if cons rvation measures were imposed, that water would last much longer than two days.

Q I will pick up that line of discussion later. My questions now I would like to ask in terms of was any consideration given and, if so, what was it, to the operations or procedures that would be involved in crossing over to the Delaware source? Was articulation a consideration of that process made, or can you discuss it now?

A We have some people here who are generally familiar with this system, but in no way did we make a detailed evaluation of specific procedures that would have to be followed, which valves would have to be turned on or off, or what-have-you to make this switch. We did not do that.

Q Can you now make any general determination of how long it would take to switch valves or do any of the necessary work to make the switchover?

A (Witness Guarino) I will try to answer that question. Most of this is based on the letter from Bruce Aptowicz who is the Manager in Water Operations, a letter dated April 23rd. I think the paragraph which is third from the bottom on the second page is what most of our

Sim 6-2

testimony is based on. We didn't attempt to go into detail, but we assumed that they know what they are doing and they indicated it can be done.

I can offer an opinion beyond that, and that is I think that those valves, it is part of the City's distribution system and I think they should be operable and they should be able to make the switch in I think a reasonable amount of time.

Q Some of those valves are used only when there is a need to shut off service for one area to do maintenance; is that correct?

A Yes, and also particularly in the summertime when they have the hydren problem. They use the system to its maximum to keep pressure in the system. So you use all valves that are available.

Q So you know whether at any one time all valves are operable and in good repair?

A I don't know that. I would assume that in a good system that they would be.

Q Do you mean they would have an ongoing maintenance program, or do you mean at all times all would be in good repair?

A I would assume that a system the size that the City of Philadelphia has, a system in which the City depends on a water supply, should have a maintenance force

Sim 6-3

if they are going to make sure that the valves that are installed are operable.

Q Is the maintenance program so that valves that are not operable can be made operable?

A I would assume that would be a necessity in operating the system such as Philadelphia has.

Q Therefore, can we logically assume that some valves are not operable if there is a maintenance program?

A No, I wouldn't assume that. I would assume if that were the case that would be a minority and that even if it was a problem, I would guess they would have the means of making the valve operable in a reasonable period of time.

JUDGE COLE: Excuse me, Ms. Bush.

MS. BUSH: Yes.

JUDGE COLE: Mr. Guarino, I guess the way you answered the question troubles me a little when you say that you assume that they could do this and it seems that they should be able to. Sir, you were responsible for the City water system for a number of years. Can you speak with a little more authority about what they can or can't do?

WITNESS GUARINO: Sure. They can operate the valves. Nothing in this world is perfect, and I wouldn't want to say it is a hundred percent. One critical valve, for instance, is a line that comes across your avenue, which

Sim 6-4

would feed the area we are talking about.

I can't remember any time that we wanted to use it that it didn't work. So that as perfect or as imperfect as this world is, that systems, the valves that are installed will function, and if they don't function, they have the means of making them function.

JUDGE COLE: All right. Thank you.

BY MS. BUSH:

Q Now would it involve changing the valves to go from, in terms of turning the valves on, to go from reliance on the Schuylkill River to reliance on the Delaware?

A (Witness Guarino) I am sorry. Would you repeat that?

Q Would the valves have to be adjusted or changed so that the distribution system would be such that everyone could be served from, or all but seven percent could be served by the Delaware?

A All but seven percent.

Q In other words, would the valves have to be turned on?

A Yes, you would. You would have to depend on the system working as designed and as installed.

Q Would there be some time involved in maintenance people going out and turning the valves on, even valves that were operable?

Sim 6-5

A Yes, there would be.

Q Now is it also correct that at any given time some mains are out of service for maintenance problems or maintenance repairs?

A Yes, that is applicable at any time, including today.

Q And do you agree with the statement in the letter that for this plan to work that one must assume that the Baxter plant is fully on line, that is there is no significant equipment out for maintenance?

A Yes.

Q Now I believe that in your analysis, the CRAC analysis you looked at what you grouped as three different sources of contamination, that is the strontium and cesium, which I believe you characterize as chronic long-term, the short-lived radioiodine and basin contamination; is that correct? It is paragraph 18 and 19.

A (Witness Kaiser) That is correct.

Q Now is the probability distribution associated with each of these consequences the same?

A No, it is not as you can see by looking at, say, Figures 4A and 4B, one of which refers to strontium and the other to cesium, and also looking at a further figure, Figure 6, which refers to the direct deposition onto the reservoir.

Sim 6-6

Q In paragraph 20 you give the ratio of these three sources of contamination, or fractions for each of them that make up the total fraction of .67; is that correct?

A Yes.

Q So that is a risk number comparison? It is a total area under the curve comparison?

A The .67 man-rem per year is the area under Figure 3.

Q So the probability curve on Figure 3 is made up of a total of the three curves from the three different areas that you have outlined?

A Yes. It contains contributions from the cesium and strontium and from the iodine in the rivers, plus deposition directly on the reservoirs.

Q So that is an addition of those probabilities? Figure 3 adds those probabilities?

A It combines them. Addition isn't quite the right word. Essentially yes.

Q What wouldn't addition be correct? It is not like an addition of all of the source term to get the total probability of an accident, or is it?

A No. I don't know whether you want to get into this. It is really just in the details of the calculation. Sometimes the Delaware and the Schuylkill might be contaminated at the same time and sometimes only the Schuylkill or sometimes

Sim 6-7

only a reservoir or occasionally a reservoir in one of the rivers.

You have to go back down to individual weather conditions in order to generate the CCDF. So strict addition is not quite right. It is close enough I would say if you want to look at it that way.

Q Would the figures given in paragraph 20 that break out each of the three areas, would they provide us a ratioing effect that we could use at any point along the curve, the CCDF curve on Figure 3?

A No, they wouldn't.

Q Why is that?

A As I mentioned previously, none of the frequencies can exceed the core melt frequency. So that you would not expect the left-hand end of the CCDF to change in the same way as some of the points further along the curve.

Q Now you understood my question to be about the figures that are in paragraph 20?

A Yes.

Q Do those numbers then in paragraph 20 show that the dominant risk contributor is iodine?

A They do, but let me stress that the calculation we report here for the iodine is a bounding calculation. We believe it is very conservative.

Q Because of the dissipation of iodine?

6-8

A No. We believe it is conservative because when we were preparing this testimony we did not have access to some articles in the literature that we have since reviewed. Therefore, we felt we had to make a rather conservative assumption about how rapidly the iodine makes it way into the river, and you can see that that assumption from our testimony was that the rate at which iodine makes it into the river is about 50 times the rate that strontium makes it into the river.

Having reviewed some more items in the literature we concluded that that was excessively pessimistic for reasons that my colleague, Dr. Toblin, will explain in a moment.

Let me first give you the differences in the results that that makes. A rough ball-park estimate is that contributions of the iodine are reduced by about a factor of ten. If you go to paragraph 20, the 0.67 man-rem per reactor year that appears in the first line and in the seventh line would become 0.24 and the contribution from the iodine, which is presently 0.49 would become 0.06.

Q What assumption of rate of conversation into the river did you use?

A (Witness Toblin) When we did these bounding calculations we assumed, as you see here, that 50 times as much iodine got into the river as strontium. However, when we looked further into the literature what we found was that

6-9

much of the iodine, or most of the iodine will be associated with sediments which wouldn't make their way into the drinking water.

What we found was that approximately five percent of the iodine will in fact be dissolved and make it into the drinking water should no other measures be taken. So these numbers that Dr. Kaiser just gave you are based on those considerations.

Q So the factor of 50 times as much iodine as strontium was reduced to five?

A To five, correct.

Q When you say associated with sediments, would that be sediments in the river and sediments in the treatment process?

A Those would be sediments as they were coming off the watershed, that would be tied up with the sediments coming off of the watershed.

Q So it would be in the streams and in the land, the sediments? Where would the iodine stay or go?

A Well, you know, there are a lot of possibilities. When you start to look at it on a microscale type of thing, you know, you have to consider whether it is raining or whether it is not raining. But if it were raining and the water and the iodine came down with the rain, and again depending on how hard it was raining and so on and so forth,

Sim 6-10

the indications are that approximately five percent will end up dissolved in the river and there may be, or there may or will be some in sediments that come off of the watershed into the river. What that fraction is is going to depend on a lot of things.

Q Then 95 percent would be sediment in the river; is that what you are saying?

A No. There would be a certain amount that would be involved with the sediments. Some of that sediment would deposit on the river and some of it would be removed during the water treatment processing.

Q Do you know what percentage would be in the river and what percentage would be in the water treatment process sedimentation?

A No, I don't.

A (Witness Levine) But remember that in two months there will be no radioactive iodine left.

Q Its half life is two months?

A Its half life is eight days.

Q What was our original opinion based on and what is the literature that you referred to that is the basis of your new opinion?

A (Witness Toblin) What was presented here in the written testimony was not really an opinion of what we thought would be realistic. It is a bounding calculation. In other

Sim 6-11

words, we didn't have any better information go go on, although we felt that it would be somewhat better than is presented here. But being that we didn't have anything specific to go on, we presented bounding conservative numbers.

Q And what is the literature that you reviewed?

A We have the literature here and there are two papers, one of which is entitled "Iodine 131 in Water Supplies After Nuclear Attack." What it did was study the quantities of iodine that made it into the water from fallout directly after some nuclear testing back in 1962. This paper comes from Nature Magazine I know, October 1964, Volume 18, No. 6, and its authors are Osmond, Kerr, Metson. They measured iodine fallout in a number of locations and then measured iodine concentrations in the local waters.

Q Was there another article?

A Yes, there is one other reference that we used, and its title is "Factors Affecting Strontium 85 and Iodine 131 Removal by Runoff Water" by E. R. Graham from the publication Water and Sewage Works, November 1963, Volume 110, No. 11.

MS. BUSH: I would like an opportunity to review those articles during the break and pick up on my question again.

BY MS. BUSH:

Q In the alternative run where you had 45 percent

Sim 6-12

and 50 percent, you assumed no consumption of the Schuylkill for two days; is that correct?

A (Witness Kaiser) No, that is not the case. We assumed that that consumption continued from time zero.

Q And for the base case run did you assume that for that seven percent that was consumed from the Schulykill, did you assume that they started consuming it from time zero?

A Yes, we did.

Q Assuming that the iodine washout is as initially testified to, would that under those conditions have been the major contributor to health consequences?

A Yes, it would assuming that on interdiction or other countermeasures were put in place.

Q Now the comparison of the .67 to .24 to the total 70 airborne figure, that is a risk comparison, is it not?

A Yes, it is.

Q With regard to that Figure 3 CCDF curve that you gave us, there was no similar figure for Philadelphia for airborne effects, was there, or was there?

A No, there wasn't, more more precisely we didn't draw such a figure.

Q Were there comparative figures in terms of the airborne contamination like a tabular form for this, for Philadelphia?

MR. WETTERHAHN: I am going to have to object. It is beyond the scope of the contention. We are talking about water here and now I think we have gone back to a few weeks ago where we were talking about some airborne contamination, and I fail to see the relevance.

JUDGE BRENNER: Well, I think you testimony used a comparison and that is the relevance, but let me let Ms. Bush speak for herself.

MS. BUSH: Well, I want to know comparatively the testimony presents certain things for the water, and I want to understand and I want the record to show what we have in terms of comparing that to the airborne.

WITNESS LEVINE: Well, I gave numbers ---

JUDGE BRENNER: Wait a minute. I am still trying to understand this.

MS. BUSH: Therefore, my question is do we have a number that we can compare this to in the format -- not a number, but a presentation that is similar to this for the airborne that we can compare it to. Either it is or it isn't in the record, and I don't know what prejudice the company thinks would happen for the record to be clarified in this way.

JUDGE BRENNER: All right. I am not sure how far we will pursue it in detail, but I am looking at, just because it is a handy summary to look at, and there are other

Sim 6-14

places in the testimony, but I am looking at page 3, the continuation over of paragraph two, and I think that is enough of a basis to allow the questioning along these lines to continue for now, that is the comparison drawn by the applicant there.

Now I am sure Ms. Bush has no intention of reproducing a whole record that may have already been produced on another matter.

MS. BUSH: No.

JUDGE BRENNER: We are going to allow it to proceed for now and we will see where it goes. Right now your objection as to lack of relevance is overruled.

Do you want to rephrase the question since we have had a lot in between, although Mr. Levine seems to have the question.

WITNESS LEVINE: I think we have already answered the question.

JUDGE BRENNER: Well, let's get it again and then we will know for sure.

BY MS. BUSH:

Q Would you answer it again?

A (Witness Levine) Yes, sure. I gave earlier in my testimony today that the ratio of latent cancer fatalities resulting from the water pathway compared to the airborne pathway was six percent. Now you seem to be

Sim 6-15

interested in comparing CCDF's. You would apparently like to see a CCDF of the airborne pathway latent cancer fatalities. We do not preduce such a curve. But the best way to compare CCDF's is not by looking at one versus another because it is difficult to understand how much of a difference there is between the two.

The best way to compare them is by looking at the area under the curve, and that is what I presented.

Q In terms of the six percent number, is it correct that you just testified that the latent cancerns associated with water contamination are six percent of those associated with airborne contamination?

A Yes, to the people in the City of Philadelphia.

Q Now is that a comparison of mean valves; that is a point estimate of the ---

A It is a comparison of the expected values.

Q And by expected values do you mean a point estimate for probabilities and a point estimate for consequences?

A It is the area under the point estimate curve of latent cancer fatalities for the water pathway compared to that under the airborne pathway.

Q So it is a comparison of two average risk numbers?

MR. WETTERHAHN: Objection. Asked and answered. I don't know how the witness could be more precise.

Sim 6-16

MS. BUSH: I haven't asked that question that I know of.

JUDGE BRENNER: We will allow the question on those terms and get an answer on those terms.

End Sim
Mimi fols

WITNESS LEVINE: I don't know what you mean by average. People talk about the expected value loosely as average but it is really not an average because events like this have not happened and an average implies a statistical average of data that has occurred, so it is not an average. It is a comparison of expected values, which is the area under the curve.

JUDGE BRENNER: Ms. Bush, we are ready to take a break whenever it is convenient for you.

MS. BUSH: It is convenient at this point, your honor.

JUDGE BRENNER: Okay, we will break until 3:30 using that clock.

xxx (Recess.)

JUDGE BRENNER: Back on the record.

We want to digress for a moment since Mr. Anthony is waiting and we will deal with his motions, which we received at the start today, namely about 1:15 or so.

Mr. Anthony, you can stay where you are --

MR. WETTERHAHN: You can join us at this table.

JUDGE BRENNER: He does not have to. We are going to do all the talking, but whatever is convenient for him.

We received two written motions on behalf of FOE which is the Intervenor in the case. They are entitled, "Anthony/FOE Motion in Addition to Motion 5/18/84 versus

PECO Motion of 5/9/84 for Expedited Partial Decision on Low Power License."

However, notwithstanding the caption, it deals exclusively with matters related to the Part 70 new fuel license and changes thereunder and actions thereunder taken and proposed.

A companion, separate motion which we received at the same time, dated June 18th -- the first motion I read was dated June 19th -- the second motion is entitled, "Anthony/ FOE Contentions Based on New Matter, Letter from J.W. Gallagher/ J.S. Kemper, PECO, 6/7/84 " requesting "remaining portion of a license, (Part 70)" to move fuel to the refueling for inspection and storage in the fueling pool and petition for a stay.

You have got to get a little more concise in your motion captions, Mr. Anthony.

No answers will be necessary to these two motions. We are going to deny them summarily right now.

They deal with the new fuel shipment. Our previous order finding no health and safety or any other impact to the then-proposed contentions of the actions under the proposed Part 70 license and then subsequently issued, Part 70 license still apply.

We are not going to revisit the issue again, even if we had jurisdiction to do so.

Based on our previous order and ruling, which order was affirmed quite thoroughly and our opinion by the Appeal Board, a related matter raised in these motions is that Mr. Anthony is still complaining that he never received a stay since his appeal is still pending before the Commission. That matter I can explicitly state we do not have jurisdiction over. In fact that matter was raised before the Appeal Board and they declined to continue a stay after reviewing our decision on the merits.

The matter then went up to the Commission and as I recall, I don't have it in front of me, the Commission declined to issue a stay also. I don't have the date of the order.

And that is where that stands. So no further action by us will be taken on that aspect.

As to the other aspect, complaining that there may be some health and safety impacts, our decision and the Appeal Board's decision thoroughly takes care of that.

The fact that there may be changes under the license or conditions does not affect the very basic findings which we made in rejecting the contentions.

There is a premise in one of the motions that is incorrect. The premise is that any further changes under the license has to come before and through the Board. That premise is simply incorrect given our previous rulings in this case.

So that terminates that matter as of now.

You can step up if you want to say something.

If you want to be comfortable, you can take a seat, but we are not going to debate the matter. It is pretty straightforward given our previous rulings.

MR. ANTHONY: I am at a little of a loss, Judge Brenner, to understand your comment about not having jurisdiction, since I have a copy of an order from the Commission dated March 22, which delegates the exercise of review functions over Part 70 to this Board and I have another notification, the 26th of March, also delegating authority to this Board.

JUDGE BRENNER: Yes, I think you didn't listen very carefully to what I said. I will explain it again if you want.

I was very careful on the jurisdictional point, I thought, as to your basic premise that there are matters here that may adversely affect health and safety and we should litigate them, which matters are totally unspecified I might add.

I did not say we did not have jurisdiction.

I said assuming we had jurisdiction, our previous ruling, which we carefully considered and which the Appeal Board affirmed, mandates the same result. And we have already reached that result and described it in great detail and on that basis we can summarily deny your further motion.

There is also a respectable argument that we no longer have jurisdiction, having ruled under our initial jurisdiction, and that ruling now being on appeal through the Appeal Board first and now before the Commission.

But we are not using that as a reason for not addressing the substance. The part that I did definitely state we do not have jurisdiction over is your request for a stay based on your appeal now pending before the Commission of our earlier ruling.

MS. HODGDON: Judge Brenner, may I speak?

JUDGE BRENNER: No. In a minute you can, though.

And that is the best answer I can give to your question. I am not going to belabor it.

MR. ANTHONY: Perhaps you haven't had a chance to really study the content?

JUDGE BRENNER: We have. I have read it at least three times and I purposely waited for the break so I can reread it twice carefully during the break.

Motions are only three pages. It does not take that long to read and digest.

MR. ANTHONY: The request for a stay is not based on the former dealings with the Part 70. This is request on a current letter of June 7, which to me bypasses completely just as the application of last June, a year ago, bypassed me and you and this is the same situation.

JUDGE BRENNER: Well, you have not correctly described your unwritten motion or not fully described it because what you just said is inconsistent with the fourth paragraph of the June 19th motion.

Be that as it may, your other point I have also addressed, and labelled it an incorrect premise, that the Applicant had to come through and before this Board each and every time some change was being contemplated under the Part 70 license.

Given our prior rulings, that premise is incorrect. That is as far as I want to take it now.

I will ask the Staff to provide Mr. Anthony with a copy of the transcript pages of this matter so he can have them for purposes of any rapid reference that he might want to make to some of the body.

Now, Ms. Hodgdon --

MS. HODGDON: We will do that. I did not wish to address the merits of this matter at all. I merely wanted to point out one pertinent fact and that is that we received in our office yesterday a copy of a notice that the Commission had let the time expire for reviewing ALAB 765, which was the Appeal Board's decision on the Part 70 matter without taking review of it.

JUDGE BRENNER: Thank you. I did not know that, but that only reinforces everything I have said so far.

MR. ANTHONY: What does that mean?

JUDGE BRENNER: It means the Appeal Board decision is the final Agency action.

MR. ANTHONY: Thank you. And how to I proceed to appeal?

JUDGE BRENNER: I am not going to begin to advise you on this, because I think we already ruled on this the last time and you have been through the appelate process. That is my personal opinion.

MR. ANTHONY: The appeal runs from today?

JUDGE BRENNER: I think this matter has already thoroughly been exposed of earlier today. The fact that you have chosen to file additional motions of it does not in my opinion give you new rights of appeal. But you pursue that through whatever avenue you think is proper. I am just not going to advise you on it.

MR. ANTHONY: And when would I have an answer on the new contentions that have been submitted?

JUDGE BRENNER: Those are your other previously filed motions?

MR. ANTHONY: Yes.

JUDGE BRENNER: You will have an answer when we rule on them.

MR. ANTHONY: Thank you.

JUDGE BRENNER: We just received the Staff's answer and the Applicant's answer to your Supplemental, Third Supplemental Motion, the other day and we will rule on them in due course. We have got priorities in this case and we will decide what is important to get to when.

It may be we will rule on them in a partial initial decision and maybe we will rule on them in a separate order in advance of that. I don't know.

MR. ANTHONY: Thank you.

JUDGE BRENNER: All right.

I wanted to digress to this matter, since Mr. Anthony had been patiently waiting and I wanted to take it up while he was still here.

MR. ANTHONY: Thank you.

JUDGE BRENNER: All right. We can resume the cross examination at this point.

End 7.

BY MS. BUSH:

Q I believe you state at the top of page 15, paragraph 20, as described below, "counter measures are possible in the liquid pathway case which could give further reduction in risk."

Is it correct that you have in your numbers here presented in paragraph 20, already taken into account, a substantial counter measure of interdiction of the Schuylkill for all but 7 percent of the population?

A (Witness Levine) No, I don't believe so. You have advice from the City that they can furnish water adequately to the City, mostly from the Delaware and 7 percent from the Schuylkill and I don't believe that is a substantial interdiction.

Q Well, the numbers that you have here discussed in paragraph 20 already assume something other than our normal supply of water. Is that correct?

A That is correct. I don't regard the change though as a substantial interdiction.

Q In Figure 4(a),4(b), 5(a) and (b), did you use in your one month probability figures the third PAG that is listed on Applicant Exhibit 171, which is the state emergency planning document?

MR. WETTERHAHN: Objection. That question is not comprehensible.

JUDGE BRENNER: Let's see if it is to the witnesses. I think I understand it.

WITNESS KAISER: The curves were drawn without consideration of PAGs.

MR. WETTERHAHN: I'm sorry, could you repeat your answer. I didn't hear it.

WITNESS KAISER: The curves were drawn without consideration of PAGs.

MR. WETTERHAHN: Okay, thank you.

BY MS. BUSH:

Q Your probability figure that you have on page 17, paragraph 23, of probability of exceeding 96 picocuries per liter averaged over 12 months for the Schuylkill to be one in 300,000 per reactor year, that assumes -- that looks at the contamination of the river, not the consumption of the individual, is that correct?

A (Witness Kaiser) That is correct.

Q Now you previously had for that number, one in 500,000 per reactor year, did you not? In your prior testimony? Would you accept that subject to check?

A Subject to check, yes.

Q Could you explain the reason for the changes in that probability number and if it is applicable to other probability numbers in the testimony?

A Yes. After we had done the calculations for the first submittal of the testimony, we found that in CRAC II there was an error. This error has to do with the way that the width of the plume is treated as a function of the duration of release. In the description of the CRAC II model, it is stated that the width of the plume increases as the duration of release increases and there is a simple mathematical formula given in order to describe that increase.

However, in one particular part of the CRAC II code, the developers of the code omitted to include that particular increase in the plume within a calculation of the area covered by the plume.

Now this meant essentially that the calculations we had done were done with a plume that was somewhat too narrow and therefore covered too small an area of the watershed, so that when we calculated the total quantity of material that was deposited on the ground we were underestimating it.

When we made the correction to CRAC II, this made the changes, one of which you just referred to.

I should add that this has no effect on any of the airborne calculations that are reported in SARA or in any testimony that we might have given previously.

Q How did you ascertain that an error had been made?

A Looking at some intermediate outputs of the total quantity of material deposited in the watershed of the

Schulykill River, the worst case is that all of the strontium in the plume would generate because of rain, be deposited within the Schuylkill watershed, so that as a kind of check, the total amount of material that our liq path code calculates said our watershed should equal the total amount released from the reactor and we found, in fact, that the liq path was somewhat underestimating to the quantity. That is what sent us back to the CRAC II code.

Q Is there any range associated with this probability value in the sense of any uncertainty in the calculation or any judgments in the calculation which would lead you to conclude that there is a range of probabilities that we might look at?

A There are, as in any calculations of this nature, uncertainties and in this particular set of calculations, we did not attempt to do an uncertainty analysis such as was done in the SARA report for the airborne pathways.

But yes indeed, there would be uncertainties associated with this number.

Q Can you give me an opinion as to what the range of this probability would be in terms of some kind of uncertainty band?

A One of the most important inputs to that would be the range of uncertainty on the core melt frequence and that would be as in SARA.

Q How would we then apply that to this number?

A The range given in SARA, Supplement 2, for the core melt frequency, starting from the point estimate of core melt frequency would be a factor of three in the upward direction or a factor of six in the downward direction.

Q Well, this one in 300 contains a lot of different probability numbers, or does it?

In terms of meteorological event?

A Yes, it does.

Q Could we apply the core melt frequency factors of three and six straight to this number, one in 300,000?

A Yes, you could.

I don't want to be misleading. There are other uncertainties as well as that particular one I discussed.

Q That was my next question.

A Yes.

Q For the other uncertainties, do they total this amount of uncertainty, all of the others together?

A As I say, we have not done an assessment such as the one that was done in SARA for the airborne pathways. That was a very large undertaking. There was not time to do that for this particular exercise.

A (Witness Levine) I would also say it is of not great value considering how small these risks are. It is not of value to estimate uncertainties on vanishingly small risks in my opinion.

Q Well, for the uncertainties that you did calculate, for the core melt frequency, did you testify that they are applicable to this water pathway, one in 300,000 figure?

A (Witness Kaiser) Yes, I did.

Q Now for the airborne pathway, you calculated other uncertainties. That is what you testified, is that correct?

A Yes, we did.

Q Other sources of uncertainty?

A Yes, we did.

Q Would they be applicable to this?

A Some of them would. For example, uncertainties in the magnitude of the source term.

Q And what is the range of factors in that uncertainty?

A I have not done the calculation and I cannot estimate the impact on that figure of one in 300,000.

A (Witness Levine) I would like to say that making uncertainty analyses is a very complex affair. It requires extensive analysis and extensive judgment and it is improper to take a few numbers and multiply them together to get an estimate of uncertainties. That is not a proper way to do uncertainty analyses and that is what you are trying to ask us to do here on the stand.

Q Did you make the calculation for the magnitude of source term uncertainty associated with airborne?

A (Witness Kaiser) We did incorporate source term uncertainty into the overall uncertainty results, yes.

Q So you can't -- your testimony is you can't do that in terms of factors, either for the airborne or for the water?

A We did not in the airborne calculation go into the detail required to look at the uncertainties on a source term by source term basis or, to put it more precisely, we never looked at it in enough detail to get the figures at our fingertips.

It would require more digging in our files and so on to do that.

As far as these results are concerned, it would require more analysis, I think to make a reasonable estimate of the overall uncertainties on CCDF, such as this shown in Figure 4(a).

A (Witness Levine) Nor have we estimated any uncertainties in the airborne pathways for the City of Philadelphia.

Q In Supplement 2, you do have uncertainties associated with airborne but not isolated for Philadelphia?

A That is correct.

A (Witness Kaiser) I think just a slight correction. Supplement 2 is core melt frequency uncertainties and Supplement 3 contains uncertainties on risks.

Q Is it correct that you did a CCDF for iodide concentrations in Figure 6?

A Yes.

Q And is the reason you did not do an analysis similar to Figure 4 and 5 for iodine because of the short half-life?

A I guess in part that is true, yes, but we were also as I stated earlier conscious that we were doing a bounding analysis and we really wanted to minimize the number of results we presented that were highly conservative.

Q The iodine concentrations under your earlier sssumption resulted in iodine being a major contributor to risk, is that correct?

A (Witness Levine) A major contributor to the water pathway risk for the City of Philadelphia.

Q Yes.

Now is it your testimony in response to my previous question that you did not do a Figure 4 or 5 type analysis for iodine because you thought that was a bounding conservative assumption, the 50 times factor for the --

A (Witness Kaiser) Yes.

End 8.

T9 MM/mm1

Q The number that you have in paragraph 25, of one in 100 million per reactor year or less, could you state for me how you derive that number?

A (Witness Kaiser) I think first you should turn back to Figure 5(a). Then you should note -- let me turn to the point in the testimony, the section on possible countermeasures, paragraph 34, where the testimony talks of decontamination factors of from 5 to 10.

We said that if you can obtain such a decontamination factor, say 5, if you turn back to Figure 5(a), that is the equivalent to saying that the PAG could be increased to a factor of 5 greater than the 96 picocuries per liter, which applies in the absence of countermeasures.

So, if you move along the bottom axis of that curve up to 500, and then you move vertically until you intercept the one year average curve, and then you move horizontally across to the frequency axis, you will see that you intercept at about 10^{-8}.

So, that's the basis of saying one in a 100 million years for that.

Then, going back to paragraph 34 of that testimony, it also speaks of achieving a DF of 25 to 100 in the case of a two-stage process. And if you applied that factor of 25, you would go down to well below one chance in 100 million per year when you go back to the same kind of calculations I

mm2

just showed you.

So, that is the basis for the statement that you just asked me about.

Q When you state at the top of page 19, that in the short term the one-month PEMA PAG applies. By that are you concluding that the PAG applies if the concentration does not stay at 1000 picocuries per liter over a month? That is, it can stay that long for a month?

A The way we use this PAG is to compare one month averages, one-month average concentrations with the 8000 picocuries per liter for strontium.

Q So you are saying that that is the appropriate comparison of 8000 picocuries per liter as long as you are looking at a month period?

A Certainly my understanding of what the third PAG mans, third PEMA PAG.

Q It's your understanding that that PAG means that it would stay -- the concentrations can go to 8000 as long as there are only 8000 for a month?

A It applies to the average concentration over a month. So that you could well see peaks and troughs in that time.

Q So your sentence, the second sentence in paragraph 26 is that there is one chance in 3 million per reactor year, that it will stay at -- that it will reach 8000 and

mm3

stay there for only a month?

A One chance in 3 million that it will average 8000 or more over a period of a month.

Q And reduce below that after that month.

A No, it makes no comment on what happens after one month. It merely looks at the first month average.

Q So it could stay on average above that for a month beyond that, or it could not. We don't know from this analysis.

A The way to answer your question would be simply to look at, say Figure 4(a). And if you want to see the probability that it still exceeds the 8000 picocuries per liter after one month, six months or five years, that probability can be read off of the curve.

So, if you were thinking of a long time, like five years, you would see that the five-year curve if extrapolated down to 10^{-5} axis, won't even reach 8000 picocuries per liter.

So in that case, the probability would be less than one chance in a billion per year. So I think what I am trying to say is that the probability that such high levels persist for a long time, is very, very small.

Q Can we tell the probability of those levels lasting beyond one month into two or three months?

A Well, you could look at the end of one-month curve

mm4

and do the same kind of -- perhaps the six-month curve, if you are talking of longer periods -- if you extrapolate that curve down to the 10^{-9} axis, it probably would not quite reach the 8000 picocuries per liter.

So, s would deduce from what we have in front of us, that the probability of these levelis persisting beyond a month or so is very small, indeed.

Q You started to say if you look at the one month -- end of one-month curve?

A Yes. If you look at the end of one-month curve and start at 8000 on the bottom axis, go up, you intercept that one-month curve -- I'm reading -- at the end of one month it is very similar to the end of six months. It doesn't even intercept that curve.

Q You say at the bottom of paragraph 26, that these are upper bound probabilities.

What elements in your analysis lead you to say "upper bound probabilities"? Page 19.

A These are in reference to the iodine calculation, and as I explained before, we feel that the iodine calculation is very much a bounding calculation. It is reported in this testimony.

Q On the other than iodine, which I understand you used 50 initially as the bounded calculation, for the other calculations, would not the bounding be the range of

mm5

uncertainty associated with these values?

A Are you suggesting, for example, that we should apply a factor of 50 to the amount of strontium that gets into the river?

Q No. I'm saying I understand how you used the words "upper bound" in terms of specifically iodine. I didn't understand that before you responded just now.

But, with regard to strontium and cesium, I take it you are not saying that the strontium and cesium curves that you have here are upper bounds. However, you were saying that for iodine?

A That's correct.

Q Now, if we wanted to look at a bounding for strontium and cesium, would we look at the uncertainty factors associated with this type of analysis?

A Yes. In principle you could do an uncertainty analysis.

Q And would that be an appropriate bounding?

A Yes.

If we did a complete uncertainty analysis similar to that which was done in SARA for the airborne pathways, then the upper estimate that we would attain would, in our opinion be a suitable bounding result.

Q Now I believe on page 22, paragraph 30, you talk of interdiction of the water, do you not?

mm6

Specifically the sentence that starts at the bottom of page 21 and continues to the top of page 22?

A (Witness Schmidt) Yes, we do.

Q Now, you have not looked closely at the elements that would go into any potential replacement water from other sources, have you?

A No.

Q And would you agree that one of the factors that would affect the viability of that option would be the availability of excess capacity by any potential sources, of any potential sources?

A One of a large number of factors. It would only be apparent at the time of the particular accident.

Q What would be the other factors?

A The measured concentrations in the river.

Q Are you speaking there of the need for replacement power? Replacement water?

A A decision on what is feasible can only be made based on all of the factors that are available at the time of an accident.

Q My question, sir, to you; assuming that an accident has occurred with such contamination that replacement water sources would be needed from other sources, as you discuss is a possibility on the top of page 22.

Had you considered what factors would be -- what

mm7

elements would have to be resolved for that to be an eventuality, or to practically implement it?

A We have not gone into any detailed assessment. We have looked at the kind of things that could be done, looked at consumption rates for drinking, and we feel that things could be done considering -- which would be a function of the severity of the accident and the particular set of circumstances that occur at the time of the accident.

Q Now you have testified that we would have to know the capacity available from potential replacement sources, is that correct?

A If you wanted to determine if you could get water from another source, you would have to look at the capacities that are available at that time.

Q Now would you also have to look at whether their water sources would be contaminated?

MR.WETTERHAHN: Objection. We are beyond I think, any reading of this into specific discussion of hypotheticals under what would happen if specific conditions, and not the range or the risks associated with the contamination of City's water supply.

I think we crossed boundaries into emergency planning. Or at least beyond the scope of this contention, which was to assess what the risks were.

MS. BUSH: One of the risks -- the risk calculation

mm8

that is presented here in the testimony, is with certain assumptions as to the matters that I am cross examining about. This one is replacement water.

JUDGE BRENNER: As stated in that sentence that starts at the bottom of the one you referenced, starts at the bottom of page 21, continues over to page 22?

MS.BUSH: Yes.

JUDGE BRENNER: We are not going to cut her off at this point. We may get to some point, but I don't think so from her cross plan, which we have some benefit of. So, we will allow the question.

Go ahead.

WITNESS SCHMIDT: Pardon me. The risk assumptions we have made, or the assumptions we have made in determining the risk, make only the assumption in accordance with information provided to us, that 93 percent of the City would be supplied from the Delaware, 7 percent from the Schuylkill. That is the only assumption made relative to interdiction, if you consider that interdiction.

BY MS. BUSH:

Q But you go on, do you not, to testify that these assumptions did not take credit for countermeasures to either prevent the use of contaminated water or to remove activity from the water.

The following section discusses in general,

mm9

possible countermeasures in order to place some perspective on the risk involved.

So, is my understanding correct that you presented these short and intermediate-term measures as a way to indicate to the Board that the health effects that you calculate, or the risks that you calculate should be put in the perspective that they possibly could be less if these countermeasures were implemented. And these were the countermeasures that were available?

A (Witness Levine) I would say it slightly differently. I would say that we have already presented data to show that the water pathway risks are exceedingly small; we have not examined in great detail what could be done about emergency planning. But, we have suggested some things that might be done at the time by those who might want to do something, just for perspective, as it says.

MS. BUSH: Your Honor, may I proceed with my questions?

BY MS.BUSH:

Q Would one of the elements that would have to be considered in determining whether this replacement water option were available, replacement water from other sources, be whether that water source were contaminated?

A (Witness Levine) I think that is a decision that people who are in charge of whatever action is taken

mm10

after an accident, would have to do at the time. We are not prepared to go into such detail.

Q My question simply is, is that one of the matters they would have to consider?

And I take it your testimony is yes.

A I would say yes, they would probably have to consider 100 other factors too, as referenced in that EPA document that you referenced earlier today.

end T9

T10 MM/mm

Q Now with regard to the other countermeasure that you discussed, the approximately two-day supply of water -- and I believe you touched on that earlier -- is it your testimony that we would have less than normal usage of water, or there is a likelihood that we would have less than normal usage of water during this two-day period?

A (Witness Schmidt) No. The statement is made that there is at normal usage rates, two days of water.

If the authorities felt it desirable to restrict water usage, then there would be more than two days of water available.

Q Did you have a particular method in mind as to how water consumption could be restricted?

A No.

Q Do you know of any way in which it could be restricted?

A I guess I have lived in areas where they have had problems and they have had all kinds of public information announcements to restrict water usage; stop sprinkling, things like this. And these are certainly feasible.

Q Do you expect that -- let me back up a minute.

Then the kind of restrictions you are talking about would be voluntary restrictions or appeals to the public to reduce consumption?

A I have no idea. I am not an emergency planner,

mm2

and I don't know what legal requirements or nonlegal requirements would be imposed at this time. I'm saying things are feasible. That's all. That's all we said.

Q Well, on the water consumption rate and the normal uses that result in two days supply, have you considered, or do you think it would be a large probability that people might, in fact, increase their usage and store water supply if they felt the supply were threatened?

A I don't know. I have not looked into that. The two days is at normal usage rate. If you have a given quantity of water which exists, and if you want to know how long it lasts, you have to specify a usage rate. And we just specified normal usage rate.

Q So it could be less than normal usage rate, or greater? And that would affect how many days' supply you have?

A Yes. The City water consumption rate varies from day to day from week to week and year to year.

Q Mr. Guarino, do you have any idea what might happen in terms of the consumption patterns of individuals in the event that there were an accident?

A (Witness Guarino) Well, it would be an emergency, I surmise media, newspapers -- if not newspapers, the radio, TV, all the available media would let the general public know that there was an emergency and the person in charge

mm3

would then take the necessary steps to make sure that the public health is safeguarded, and that the water supply would last a sufficient length of time.

Q Do you have an opinion as to how the appropriate authorities might control the consumption of water?

A I have not gone into detail. This has not been our objective to try to figure out just what the City should do. But, as you realize, there are many ways that I think they would consider going.

It was mentioned earlier that as far as drinking and washing and cooking, the average person uses about 60 gallons per day. And if you take that number and you divide it into the amount of filtered water that is available, for instance, it would last some six or seven days.

So, there are many, many ways available to those people who are responsible to safeguard the City's water supply and prolong its use.

Q Are there some ways that you know from your experience when you were Water Commissioner that the consumption level can be controlled?

A Yes, there are.

One was, we spoke about earlier, you implement conservation methods. Butin this case, it would be different than anything that, say, we did in the past, because in the past the conservation measures were put into effect when, say,

mm4

the hydrants were being used excessively and the City was concerned about carrying enough pressure to fight fires. And, of course, supply water for drinking purposes.

But in those cases you would tell people to keep the hydrants off. You would ask their cooperation in that regard. In case of something -- this is an emergency, this is something which the odds are so great -- so small, that it is going to happen, that if it does happen then it is going to require a special effort on the part of those in charge to make sure that the water lasts a long time.

And that could be simply a matter of industry's not using the water and just using it for health and for human life.

Q Are the matters that you have just discussed, matters that are methods of control that are voluntary on the part of the consumer in response to a request by the public authorities?

MR. WETTERHAHN: If we haven't gone beyond the limits, we are getting to specific legalities of emergency planning.

MR. VOGLER: Staff would like to join in that on the basis of emergency planning, Mr. Chai-rman.

JUDGE BRENNER: Well, I don't understand that. I don't understand your statement.

MR. VOGLER: Staff feels that the questioning is

mm5

getting into an area of emergency planning, which is not the subject of this hearing and which these witnesses were not put on the stand for. Staff is concerned about that.

Therefore, we join in the Applicants' objection on that ground.

JUDGE BRENNER: Okay. I understand now. Thank you.

That last point per se wouldn't make it objectionable, if it was also producing productive results relevant to this contention, too. Sometimes you can have the same information being relevant to two areas. But you have reached the point of diminishing returns now and I am going to sustain the objection on that basis.

BY MS. BUSH:

Q I believe you might have answered the question before, but what percentage removal are you concluding can occur for strontium through the treatment process as you are discussing on pages --

A (Witness Levine) We haven't concluded anything. We have suggested some numbers that might be achievable.

Q And what percentage removal are you suggesting for strontium?

A Factors of 5 to 10 for strontium removal on one pass, and 25 to 100 on two-pass removal.

Q The same question for cesium. Would it be the

mm6

same answer?

A We have not looked at cesium.

Q How about iodine?

A Factor of 8 to 10 on iodine.

Q I believe you have discussed in paragraph 33, the use of activated carbon prior to flocculation, is that correct?

A (Witness Waller) That's correct.

Q Is that material, in terms of a treatment material for water, relatively more expensive than most of the chemicals that are used?

A That chemical is being used at all the three Philadelphia plants right now. It is in place and is being used.

Q Is it being used in the manner that you suggest here?

A Yes.

The ability to apply the activated carbon in the places that we are talking about is available at each of those plants.

Q The ability to apply it is available. But, is it being used currently?

A It is currently used for taste and odor control when there is a taste and odor control problem. It is a standard operating procedure to apply activated carbon. So,

mm7

in the event of an emergency as we are talking about here, i- would be very minimal effort to proceed to feed activated carbon in such amounts that would cause the decontamination factors that we have included in our testimony.

Q The amounts of activated carbon that we are talking about for decontamination, are they substantially greater than the amounts of activated carbon used currently for taste and odor control?

A No. We are talking on the order of 5 to 15 milligrams per liter and each of the three plants have a capacity to feed on the order of 25 to 28 milligrams per liter.

Q My question is slightly different, and that is in terms of the number of times or the period of time in which you add the activated carbon to the water for current usage, that is not regular for the odor and taste control, is it?

A That's correct. It is not regular over the period of the year, but when it is fed, it is fed for a day or two or three on a continuous basis. The equipment is all arranged and set up for continuous feed. It just happens not to be fed continuously over 365 days, but there is no reason why it couldn't be.

A (Witness Schmidt) I might add, iodine has an eight-day half life, so after two months it is gone. So you don't need to do it for 365 days.

mm8

Q So we are talking about doing this for two months-for a two-month period?

A (Witness Levine) Or less.

Q Now is that the same for the activated carbon that you would add to the sand filters? Is that for the same purpose with iodine?

A (Witness Waller) Yes.

Q So it would be the same period of time?

A Yes.

Q So, for that one we are really talking about a minor incremental expenditure?

A Yes, I would say very minor.

Q Now the next item that you talk about in paragraph 34, the lime softening process is already used in the water.

Is that correct or not?

A No. The treatment plant does not use the lime-soda softening process now.

Q That would be a procedure that would be adding material to the current process similar to the carbon, is that correct?

A It would require adding chemicals to the treatment process, to the treatment train, exactly.

Q It wouldn't require capital expenditures?

MR. WETTERHAHN: Objection. I think we have gotten beyond the limit of this contention. If the City is

mm9

contending that it wouldn't expend any amount of money to safeguard its citizens, I can't believe it. The question of feasibility is another story.

But, as far as costs, I think we are getting to the ridiculous.

MS.BUSH: Mr. Wetterhahn has raised a substantive issue and a relevancy issue. And I think the prior argument as exploring the feasibilities of this applies.

MR. WETTERHAHN: I am not objecting--

JUDGE BRENNER: Wait a minute.

I understand the objection.

(Board conferring)

Unless you have established or have a basis that does not appear to us, to show that something is so costly as to in itself become infeasible, then cost, per se, is not relevant.

You are talking about potential future measures. We are not going to sit here and determine that X dollars is okay. Then, when you go over the line it is too expensive for the City to expend.

If you want to explore feasibility to show even the limited context in which you have now established through your earlier cross examination, that we can use this information for, that is the information of paragraph 29 and beyond, principal countermeasures, we will hear about

mm10

feasibility and you can ask about it.

But, just how much does it cost in and of itself is not very relevant.

MS. BUSH: Well, I am not going to make arguments as to how much it costs. I think it is important for it to be on the record more fully than we have here in the testimony what is involved in these processes and --

JUDGE BRENNER: All right. We are allowing you to do that and we have been.

You know, there is something else. I might as well make note of it now, because it might come up later on in our findings. There are certain evidentiary propositions, and when a party with access and knowledge does not come forward with any information, then we can infer from that silence that the facts that might have been brought forward by that party would not materially contradict the information already being put in the record.

I think you are all aware of that evidentiary principal, at lest in a civil trial. A criminal case would be different, of course.

And here, you know, you have got the whole City water supply people at the City's disposal in terms of witnesses, and the City as a party to this case has not chosen to put forward any. The testimony relies on certain information from City people, and also certain information

mm11

known to one or more of these witnesses, which information would also be within the knowledge of City people.

So, if you have got any major contradictions with anything they are talking about, the best way to have presented that would have been through your own witnesses.

MS. BUSH: I don't think these witnesses will disagree with -- I think they will honestly provide an answer of facts, which is what I am eliciting.

JUDGE BRENNER: I just wanted to make note of that. Some of your questions earlier, particular in that reference 17 of the letter and so on.

But go ahead.

Why don't you ask a different question, or rephrase the question so that we are getting at feasibility.

I might note for the benefit of the other parties, since they don't have your cross plan, that you are just about done with these witnesses.

MS. BUSH: Adversary process.

JUDGE BRENNER: I don't understand that comment, Ms. Bush.

MS. BUSH: Well, I am just going along asking questions about the testimony, and I constantly get objections.

I want the witnesses to clarify what they know and I constantly get objections.

JUDGE BRENNER: Let's not have a long dialogue,

mm12

because I think the percentage of success of those objections has not been very high. So, you have been okay most of the time.

MS.BUSH: I agree with that.

BY MS. BUSH:

Q Now, the lime-soda softening process is a procedure that would be added to the current operations. It is not a change in the configuration of the plant. Is that correct?

A (Witness Waller) That is correct. It follows the same sequence of unit operations that are currently at each of the plants. The addition of chemicals, mixing, the -- provoding the opportunity for floc to form and to grow and provide the opportunity for floc to settle.

And those conditions currently exist at all three plants.

end 11
Mary fls.

Sim 12-1

Q Now you go on to talk about co-precipitation and repeated precipitation. Are those two next steps or are they a similar procedure?

A (Witness Waller) Co-precipitation is thought to be the mechanism by which strontium comes out of solution. It gets co-precipitated with calcium. The lime-soda softening process is a very widely used state-of-the-art process used primarily for softening of water to remove calcium hardness, and it has been found that strontium comes out with it in a manner that is described as co-precipitation.

Repeated precipitation, on the other hand, is a variation of the lime-soda process by which higher amounts of calcium and associated strontium are removed by repeating the precipitation process, in other words, in a multi-stage type of operation. If you wanted to go to higher removal efficiencies or higher decontamination factors, you would repeat the process of adding chemicals, rapid stirring, flocculation and sedimentation.

Q So that then is the process where you would put the water that comes out of the end of the treatment process back and in and then precipitate it again?

A Yes, if we found, or the decision-makers found that it was necessary to get higher decontamination factors than one could get with a single-pass system, this would be, in my opinion, a feasible method of achieving higher

Sim 12-2

decontamination factors.

Q Now when you say it would be a feasible method of getting higher decontamination levels, your feasibility, are you speaking to the fact that this process actually does reduce the contamination, or are you talking about the practical feasibility at the treatment plants?

A Both. I am saying that on the basis of the review of the literature it appears to me entirely feasible to achieve very high decontamination factors by using the repeated precipitation system.

Upon visiting the plants and looking at the physical facilities, and from my background in the water treatment field, I believe it is feasible to implement these steps at any or all of the three plants.

Q Now what in general terms would that involve to bring the water back around and put it through again?

A Okay. That would require emergency measures and more likely than not some pumping that is not their low-head pumping. In other words, pumps that did not have to lift it a very high amount, lift it a considerable amount simply because you would be taking it from the end of the final clarifiers, the settling basins and returning it back to the front of that system. You would be recycling it, in other words,

So for the medium range time period, perhaps

Sim 12-3

after the first week or so when your covered filtered water ran out, one would be able to implement a repeated precipitation process by the installation of pumps to lift the water out of the backend of the clarifiers and recycle it to the front.

Q Would you need to build mains or whatever size pipes to convey the water from the end of the process back around to the beginning?

A That of course is a planning detail, but from a process point of view, I would just volunteer that, yes, you could, but it would not have to be particularly extensive. The distances aren't that great, and it could be above ground. But we have not gone into any engineering analysis beyond that, except to say that certainly for emergency conditions I believe it is feasible.

Q Have you made any judgment as to how long it would take to construct this?

A No.

Q How about any analysis or consideration of the effect on our overall ability to supply the customers if you have the throughput cut in half?

A We have not done any of the emergency planning that would be required to identify what would be the detailed impact on the customers of the Philadelphia Water Company. If you did repeat precipitation, you would cut

Sim 12-4

back on some of the capacity, but the considerations of how much to whom and when we believe is well beyond the scope of our analysis.

Q Now going back to paragraph 3 you state there about three-quarters the way down the paragraph "The probability and risk associated with this pathway is so small that specific planning considerations are not required."

I notice there that you talk about the probability and the risk associated with the pathway. Is your answer the same if you talk about the consequences?

A (Witness Levine) Yes.

Q Do you have available to you there a range of the consequences in terms of latent cancer fatalities associated with this path?

A We have only made at best a point estimate calculation.

Q I know for the purposes of the testimony you did, but did you make any other calculations not for the purposes of the testimony?

A No. We have a point estimate and an expected value.

Q Now would you agree that it is not unusual in risk aversion to demand a lower risk as the potential consequences increase, that is as the stakes get higher?

A I think we have very little experience with that.

Sim 12-6

Q So you are saying that you don't have an opinion on that?

A I think we all have very little experience with risk aversion to try to treat it in the way you are talking about it.

Q Would you agree that the public in general would demand lower risk as the potential consequences increase?

A Yes, but the consequences here are already vanishingly small.

Q You are talking about the mean ---

A Without interdiction, without any treatment.

Q --- the mean point consequences?

A I am talking about the expected value consequences.

Q They might be better off like the man who campaigned against cigarette smoking, for instance. It might save a lot more lives.

MS. BUSH: We could do both, right?

WITNESS LEVINE: It depends on how many resources you have.

JUDGE BRENNER: All right. Let's stay with the testimony.

(Laughter.)

MS. BUSH: That is all I have.

JUDGE BRENNER: How much cross-examination do you have? I have got your plan, but I don't have a good time

Sim 12-6

estimate from reading it.

Commonwealth, incidentally, has filed no cross plan and they will be restricted as indicated to follow up.

MR. VOGLER: Twenty to 30 minutes perhaps.

JUDGE BRENNER: I don't want to lose the time. It is 10 till 5. Let's start the staff's cross-examination and when you get to a convenient stopping point around 5 we will stop and then continue your cross tomorrow.

So you can begin your cross-examination. We will give the Commonwealth an opportunity for follow-up after the staff's questions if the Commonwealth has any.

NDEX XXXXX

CROSS-EXAMINATION

BY MR. VOGLER:

Q Earlier you remarked that the PEMA protective action guides 2 and 3 would apply to dose and concentration levels, and I am referring to the Applicant's Exhibit 19 or Reference 19.

My question is would PEMA guide No. 1 there also apply to a situation?

A (Witness Kaiser) PEMA guide No. 1 refers to controlled liquid discharges. So if in the course of the accident there were controlled liquid discharges, I presume this standard would apply, this guide, but I don't think it would apply to the runoff from the watershed, which is the subject of our calculations.

Sim 12-7

Q I am interested, Dr. Kaiser, in the last line of the PAG No. 1 where they are talking about four millirem a year to any organ. That would be in your consideration if ycu applied guide No. 1? Would that change your conclusions?

A I don't think I understand your question.

Q Maybe I can come back to it.

Mr. Guarino, you were asked about the salt water front on the rivers and in view of your past history with the City of Philadelphia, do you remember any times when the City was concerned about salt water intrusion?

A (Witness Guarino) Yes, they were. There is a drought it seems like every 10 or 15 years, and when that occurs they worry about the salt front.

Q Is the City of Philadelphia's water usage considered important when they are concerned about the salt front?

A Yes.

Q Why is that?

A What is an important commodity. It is used in the homes for drinking, it is used for washing and it is used for industry.

Q In these situations when they areconcerned about that during a time of draught, did the City ever appeal for conservation of water uses?

Sim 12-8

A Yes.

Q Was it successful in your opinion?

A It is controversial because, as I mentioned earlier, most of the water that is used is returned to the river and the salt line comes up, not because you use water or don't use water, but because of the amount of water that comes from New York. That is the deciding factor and not the amount of water that Philadelphia uses.

I made that point because the water comes by the door and if you don't use it, it goes to the ocean wasted.

Q In that regard -- were you finished?

A May I have a second?

Q Surely.

(Pause while witnesses confer.)

JUDGE BRENNER: While they are thinking, Mr. Vogler, I am a little lost. I thought you would pick up with your cross plan and I guess you are not doing that.

MR. VOGLER: I am functioning now off of what took place from Ms. Bush.

JUDGE BRENNER: All right.

WITNESS GUARINO: Would you repeat the question because I lost track. Was there a question?

BY MR. VOGLER:

Q We were talking about the City's appeal for conservation and whether or not it was successful in your opinion.

Sim 12-9

A Yes, I would say it was successful. Once again, how do you determine that? Do you determine that by the salt line, because I am making the point that I don't believe the salt line changes at all because most of the water that is used is returned to the river. It is not a matter of quality. It is quantity. They use less water, but I am not sure that the reduction made any impact on the salt line, what they were trying to do.

Q In the event we have such a situation with the salt front and the Schuylkill River has been contaminated so that it cannot be used, would the unused flow from the Schuylkill help mitigate salt water intrusion?

A Yes, absolutely, and that is the point that I wanted to make is that if you use it on one side and didn't use it on the other, of course that water would go down, and the confluence of the Schuylkill with the Delaware is in Philadelphia, and it would have the same impact to push the salt line away.

Q Thank you.

Also earlier I believe it was Mr. Bartram who responded that the strontium 90 whole body dose conversion factor was 8.4 times 10 to the minus 5. We don't have the transcript in front of us. Do you know what the WASH-1400 value is for adults in that?

A (Witness Bartram) For strontium 90 the whole

Sim 12-10

body dose conversion factor was 8. .mes 10 to the minues 5.

Q And that would be for adults?

A That is for WASH-1400.

Q This is for units what we are talking about?

A Pardon me?

Q For units? What units?

A It is in terms of millirem per pico curie ingested.

Q Thank you. With regard to Figure 6, is that for iodide or for iodine 131 regardless of its chemical form?

A (Witness Kaiser) That is for iodine 131. The chemical form of iodine 131 was not considered except insofar as it was assumed that -- the chemical was not considered, period.

Q Fine. On the subject of iodine, turning your attention to paragraph 18 of your testimony, you advise that your calculation regarding iodine is a bounding one.

Why did you utilize this approach for iodine, the bounding calculation?

A (Witness Toblin) At the time we prepared this written testimony, we didn't have any quantitative information as to how the iodine would behave on the watershed. So we felt -- well, we performed this bounding calculation and presented it as such realizing that it was conservative, but

Sim 12-11

that we didn't have any better information at that time to go on.

Q In other words, you weren't able to obtain a better estimate of exposure under the water pathway?

A At that point in time, yes.

Q Taking this information into account, can you compare the health effects from the waterborne pathway to those of the airborne pathways?

A (Witness Levine) I have already given that testimony I believe.

Q I know.

A The waterborne pathway is six percent of the airborne pathway without any treatment of the water.

JUDGE BRENNER: We can stop now, if this is convenient, Mr. Vogler.

MR. VOGLER: I can stop now.

JUDGE BRENNER: Some of these questions were repetitious.

MR. VOGLER: Fine. I will take that into consideration for tomorrow.

JUDGE BRENNER: All right.

We will begin at 9 o'clock tomorrow.

We will go off the record now.

(Wherepon, at 5:02 p.m., the hearing adjourned, to reconvene at 9:00 a.m., Wednesday, June 19, 20, 1984)

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CERTIFICATE OF PROCEEDINGS

This is to certify that the attached proceedings before the NRC COMMISSION

In the matter of: Philadelphia Electric Company

Date of Proceeding: Tuesday, June 19, 1984

Place of Proceeding: Philadelphia, Pennsylvania

were held as herein appears, and that this is the original transcript for the file of the Commission.

Mimie Meltzer
Official Reporter - Typed

Mimie Meltzer
Official Reporter - Signature

Mary Simons
Official Reporter - Typed

Mary C Simons
Official Reporter - Signature