STAFF
10/31/80

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
METROPOLITAN EDISON COMPANY, ET AL.	)	Docket No. 50-289 (Restart)
	)	
(Three Mile Island Nuclear Generating Station)	)	

NRC STAFF TESTIMONY OF TERRY L. JOHNSON RELATIVE TO GROUNDWATER CONTAMINATION AT TMI

Q.1 Please state your name and position with the NRC.

A. My name is Terry L. Johnson. I am an employee of the U. S. Nuclear Regulatory Commission assigned to the Hydrologic and Geotechnical Engineering Branch, Division of Engineering, Office of Nucl ar Reactor Regulation.

Q.2 Have you prepared a statement of professional qualifications?

A. Yes. A copy of this statement is attached to this testimony.

Q.3 Please state the nature of the responsibilities that you have had with respect to the Three Mile Island Nuclear Generating Units.

A. Prior to the March 28, 1979 accident at Unit 2, my involvement with Units 1 and 2 consisted of reviewing the hydrologic engineering aspects of the site, including flooding, flood protection, water supply, and groundwater contamination. Following the accident, I have been

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closely involved with the installation and sampling of the monitoring wells, which were constructed to detect potential liquid leaks of radioactivity from Unit 2 buildings. I have visited the site several times to observe the monitoring wells and pumping procedures and also to discuss the monitoring well program with NRC and GPU personnel.

Since that time, my principal responsibility has been to assist in the preparation of portions of the Programmatic Draft Environmental Impact Statement for decontamination of the facility. In addition, I continued to closely observe the monitoring well program and sampling data.

Q.4 What is the purpose of your testimony?

A. The purpose of my testimony is to respond to portions of Board Question 9 which states:

9. (Tr. 2397-98)

a. What measures are taken to monitor groundwater quality at the site?

b. What measures are taken to ensure against contamination of the groundwater under routine operations, accident conditions, and clean-up operations?

c. Is there any evidence at the present time of changes in the groundwater quality, including but not limited to radioactivity and boron, attributable to operations at TMI-1 and/or 2?

d. If changes in groundwater quality have occurred, distinguish, if possible, the sources of any contamination, i.e., routine operations at Unit 1, routine operations at Unit 2, unplanned or accident conditions at Unit 1, unplanned or accident conditions at Unit 2, or clean-up operations.

e. What mitigative measures are available, should groundwater contamination occur?

My testimony addresses Subsections a, c, d, and e. Phillip G. Stoddard addresses Subsection b.

Board Question 9(a)

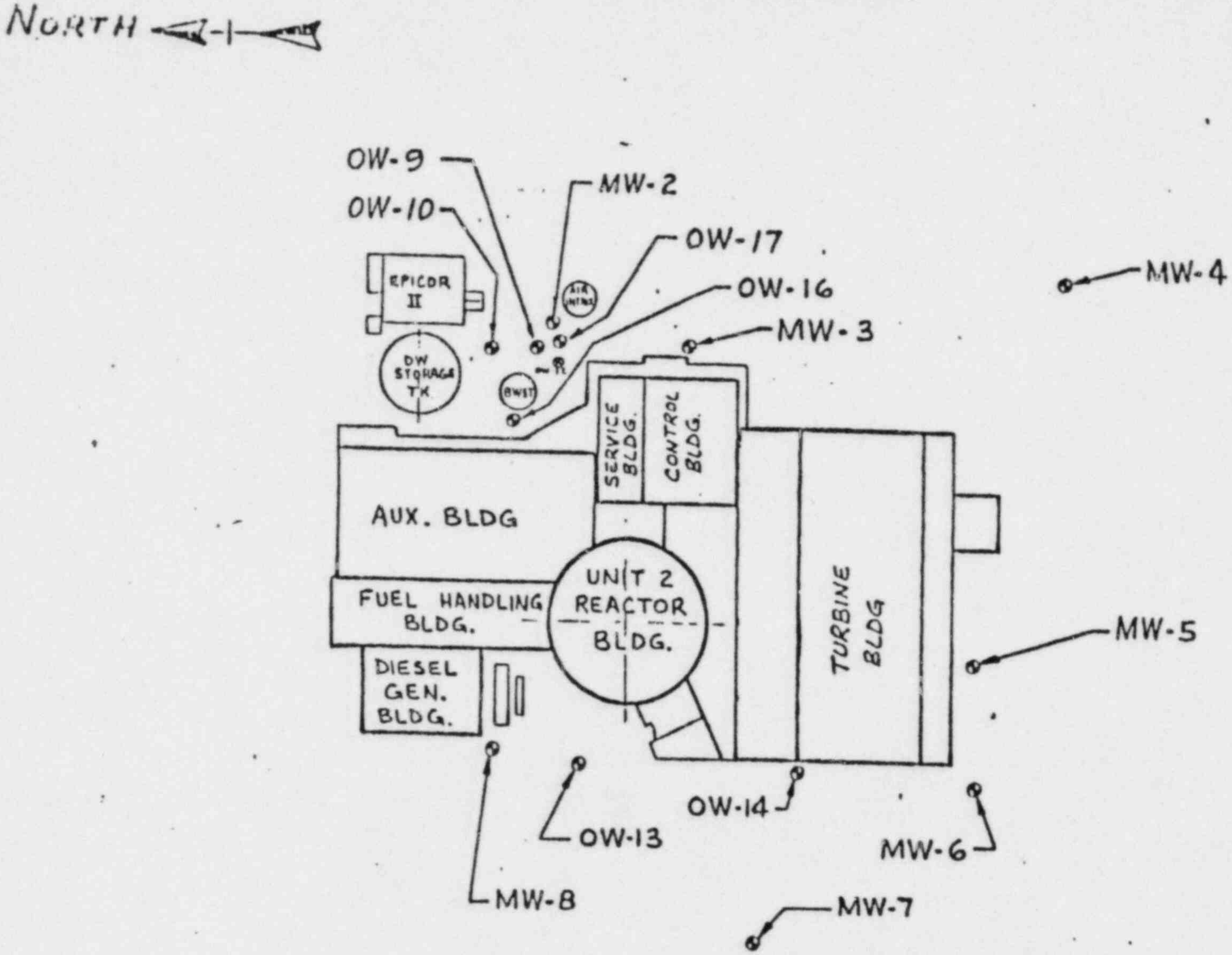
Q.5 Describe the measures taken by the licensee to monitor the quality of groundwater at TMI.

A.5. At the request of the NRC staff, the licensee installed a series of eight monitoring wells and, subsequently, nine observation wells at the TMI site. These wells were sited so as to detect leakage of contaminated water from the Unit 2 containment and auxiliary buildings. The location of the wells is shown in Figure 1.

The monitoring wells have been sampled at about one-week intervals since installation in late January, 1980. The observation wells, installed to clarify anomalous data from some of the monitoring wells, have also been sampled at about one-week intervals since completion in late April, 1980. The different designation (i.e., monitoring well vs. observation well)

WELL LOCATIONS

Fig. 1



COMMENTS:

1. MW-1 LOCATED IN NORTH PARKING LOT @ COORDINATES N 301,460.04 E 2,286,538.94
2. OW-15 LOCATED ON SOUTH END OF ISLAND @ COORDINATES. N 292,985.44

is insignificant; the differentiation is only between sets of data-gathering facilities. Sampling on all wells continues at the present time at intervals of one week.

The samples have been tested extensively for radioactivity and chemical contamination. To check for errors, the analyses were done by several different laboratories, including Teledyne Labs, Oak Ridge National Lab, and the Tennessee Valley Authority.

Board Question 9(c)

Q.6. Is there any evidence at the present time of changes in the groundwater quality, including but not limited to radioactivity and boron, attributable to operations at TMI-1 and/or 2?

A.6. Initial analyses of water samples from some monitoring wells showed concentrations of tritium above inferred background levels in the vicinity of major plant structures. Based on readings taken in nearby wells and in the Susquehanna River by EPA, it appears that the normal background level of tritium in the area is about 100 - 500 pCi/l; tritium levels in this range have been observed in MW-1, north of the plant structures.

Tritium readings taken in other monitoring and observation wells have been variable. An indication of these fluctuations and magnitude of tritium levels can be seen in Tables 1 and 2.

EFFICIENCY, LINE NO. 336

Table 1

Tritium
Monitoring Well Results
(pCi/liter)

Date	MW-1	MW-2		MW-3		MW-4	MW-5		MW-6		MW-7	MW-8	Pond
1/24	-	-		-		-	-		-		-	-	-
1/25	-	-		-		170± 70	-		-		-	-	-
2/20	-	-		290± 90		-	-		-		-	-	-
2/25	-	1530±150 (a)		-		-	-		-		-	-	-
2/29	-	-		-		-	-		280± 90		-	-	-
3/5	-	-		-		250± 90	-		-		-	-	-
3/7	-	-		-		-	-		-		-	160± 80	-
3/11	200± 90	-		-		-	-		-		-	-	-
3/26	-	-		-		200± 80	-		-		300±80	-	-
3/27	-	-		370± 80/	660±110 (c)	-	380± 80		-		-	-	-
3/28	-	2500±180		-		-	-		990±100/	560±100 (f)	-	-	-
4/1	990±100	-		-		-	-		-		-	-	-
4/2	-	1550±100/	1770±140 (b)	300± 80/	240± 90 (d)	-	-		430± 80/	310± 80(g)	-	870± 90	-
4/3	-	-		-		-	290± 70/	300±70(e)	-		-	-	-
4/9	150± 90	1530±160		770±110		<170	80± 70		330± 80		260±90	640±110	-
4/11	210± 90	1010±110		700± 80		320± 80	120± 70		320± 80		240±80	1060±100	190±70
4/12	250± 80	920±110		720±100		350± 80	260± 70		440± 80		270±80	1020±100	<100
4/13	150± 70	980±110		690± 90		350± 80	330±100		530± 80		380±80	790±100	100±80
4/14	170± 70	1010±100		590± 90		270± 80	230± 70		430± 80		480±80	860±100	90±80
4/15	290± 70	610± 80		1040±100		290± 80	210± 70		370± 80		300±60	570± 90	110±80
4/16	100± 90	670± 90		580± 80		230± 80	130± 80		200± 70		320±90	410± 70	<100
4/17	170± 70	730±110		1080± 90		290±110	240±150		430± 90		490±90	830± 80	<100
4/18	160± 80	890±100		860±100		160± 80	130± 60		300± 80		270±70	660±100	-
4/19	210± 90	720±100		550± 90		300± 80	120± 80		380± 80		420±90	870±100	<130
5/2	130± 70	490± 80		1090± 90		360± 70	350± 70		910± 80		310±80	710±100	
5/8	260± 80	910±100		860± 90		380± 80	260± 80		920± 90		280±80	630± 90	
5/16	100± 60	670± 90		980±100		310± 90	130± 80		790±100		270±100	570± 70	
5/23	170± 80	880± 80		1270±130		520±130	200± 80		750±110		300±110	790±110	
5/30	140± 80	950±100		920± 80		820±100	250± 90		730±110		290± 90	540±130	
6/6	200± 90	950±100		1260±130		670±120	270± 90		870± 80		380±110	680±120	
6/13	220± 60	710± 80		1200±100		580± 80	370±100		580±110		660±110	500± 70	

(a) recheck = 1600±120

(d) sampling for 8:19 & 8:2[illegible]

Table 1, continued

Tritium
Monitoring Well Results
(pCi/liter)

Date	MW-1	MW-2		MW-3		MW-4	MW-5		MW-6		MW-7	MW-8	Pond
6/20	190± 80	not analyzed		1430±140		470±120	230± 90		640±120		280± 90	550±130	
6/27	230±110	1480±110		1370±120		490± 80	320± 80				320± 80	410± 80	
7/7	240±120	1310±100		1400± 90		450± 70	120± 60		420± 90		440± 90	630± 90	
7/18	160± 80	1900±190		1250±130		510±130	250± 90		360±110		370±110	800± 80	
7/25	180± 80	2130±210		1350±140		560±130	290± 90		410±120		310±110	480±120	
7/30	190± 80	1930±190		1570±160		390±110	260± 90		320±110		330±110	490±120	
8/6													

Table 2

Tritium Results
Observation Well Groundwater

(pCi/liter)

Date	OW-9	OW-10	OW-13B	OW-14	OW-15	OW-16	OW-17
4/25	2610±160	1480±100					
5/2	350± 90	170± 90				1090±110	3210±200
5/8	320± 70	430± 90		1320±120	200± 90	1030±110	3220±200
5/16	440± 80	350± 70	440± 70	1280±110	<140	1120±110	3560±220
5/23	290±100	360±110	360±110	1230±120	150± 80	950± 80	3620±360
5/30	360±110	430±120	400±120	1270±130	130± 80	770±110	3500±350
6/6	370±110	390±110	350±110	830± 80	190± 80	770±110	3710±370
6/14	270±100	460± 80	300± 90	730± 90	220± 90	590±100	3830±240
6/20	320±110	380±110	350±110	610±120	100± 80	820± 80	3620±360
6/27	490± 80	310± 90	390± 90	640±100	not sampled	760±100	3910±260
7/7	560±110	910± 90	410± 80	540±100	210± 80	580± 90	4180±330
7/18	500±130	680±120	370±110	670±120	150± 80	680±120	3620±360
7/25	490±120	340±110	290± 90	510±130	140± 80	720±110	4630±460
7/30	550±130	880± 80	350±110	530±130			3830±380
8/6							

The above tables were taken from the licensee's September 16, 1980 submittal to NRC, which included analyses of samples taken as recently as July 25, 1980. It can be seen from these tables that levels of tritium are above the background level measured offsite. However, these tritium levels are all less than the Maximum Permissible Concentration (MPC) of 3,000,000 pCi/l, as specified in 10 CFR Part 20, Appendix B.

Concentrations of other radionuclides were also found to be below MPC for unrestricted areas. In April, samples from nine sampling locations were sent to TVA laboratories for analysis. Tables 3 and 4 indicate the concentration of various radionuclides which were detected in samples taken from April 11 through April 15, 1980. The labs reported that the radionuclide levels detected were essentially the normally occurring environmental levels.

In addition, there is no evidence of nonradioactive chemical concentrations exceeding allowable limits for discharge to the Susquehanna River.

Board Question 9(d)

Q.7. Can the sources of the changes in the groundwater quality be determined?

A.7. The highest tritium levels occurred at wells which were located near the Unit 2 Borated Water Storage Tank (BWST). The fittings and valving appurtenant to the BWST have been known to be leaking onto the immediately surrounding ground surface. This leakage occurred several months to more than a year ago. At the request of the NRC staff, additional

TABLE 3

TENNESSEE VALLEY AUTHORITY
Radioanalytical Laboratory

TMI - Water Samples - Gamma Analysis Results (pCi/L)

		Bi-214	Pb-212	Pb-214	K-40	Co-58
MW1	4/11/80	82 ± 5		74 ± 5		
MW2	4/11/80	69 ± 4	3 ± 2	57 ± 4	95 ± 18	
MW3	4/11/80	54 ± 3	11 ± 2	54 ± 4		
MW4	4/11/80	23 ± 3	6 ± 2	21 ± 3	121 ± 18	
MW5	4/11/80	42 ± 3	11 ± 2	39 ± 3		
MW6	4/11/80	36 ± 3		33 ± 4	78 ± 18	
MW7	4/11/80	44 ± 3	10 ± 3	34 ± 3		
MW8	4/11/80	33 ± 4	4 ± 2	33 ± 4		
Pond	4/11/80	22 ± 3	9 ± 3	10 ± 3		
MW1	4/12/80	42 ± 3	13 ± 3	35 ± 3		
MW2	4/12/80	36 ± 3		15 ± 4	72 ± 25	
MW3	4/12/80	23 ± 3		25 ± 3		
MW4	4/12/80	55 ± 4	7 ± 3	39 ± 3		
MW5	4/12/80	40 ± 4		35 ± 4		
MW6	4/12/80	38 ± 4		32 ± 3		
MW7	4/12/80	48 ± 4		40 ± 4	72 ± 18	
MW8	4/12/80	25 ± 3		28 ± 3		
Pond	4/12/80	14 ± 3	15 ± 3			
MW1	4/13/80	39 ± 4		32 ± 4		
*MW2	4/13/80	22 ± 1	11 ± 1	12 ± 2	59 ± 6	1.2 ± 0.8
MW3	4/13/80	16 ± 3		17 ± 3		
MW4	4/13/80	12 ± 2		14 ± 3		
MW5	4/13/80	21 ± 3	12 ± 3	24 ± 4		
MW6	4/13/80	13 ± 3		17 ± 3	151 ± 19	
MW7	4/13/80	20 ± 3		16 ± 3		
MW8	4/13/80	25 ± 3	6 ± 2	20 ± 3		
Pond	4/13/80	16 ± 3		15 ± 3		
MW1	4/14/80	35 ± 3	8 ± 3	29 ± 3		
MW2	4/14/80	23 ± 3			55 ± 11	
MW3	4/14/80	25 ± 3		19 ± 3		
MW4	4/14/80	16 ± 3		15 ± 3		
MW5	4/14/80	17 ± 3	5 ± 2	15 ± 3		
MW6	4/14/80	15 ± 3		10 ± 3	172 ± 21	
MW7	4/14/80	13 ± 3	9 ± 2	13 ± 3		
MW8	4/14/80	23 ± 3	7 ± 2	19 ± 3	76 ± 18	
Pond	4/14/80	7 ± 3			99 ± 16	

TABLE 3 (continued)

TENNESSEE VALLEY AUTHORITY
Radioanalytical Laboratory

TMI - Water Samples - Gamma Analysis Results (pCi/L)

		Bi-214	PB-212	PB-214	K-40	Co-58
MW1	4/15/80	27 ± 3	7 ± 3	22 ± 3		-
*MW2	4/15/80	24 ± 2	8 ± 2	18 ± 2	49 ± 8	1.1 ± 1.2
MW3	4/15/80	32 ± 3	10 ± 3	22 ± 3	40 ± 13	
MW4	4/15/80	25 ± 3	8 ± 3	15 ± 3		
MW5	4/15/80	15 ± 4		11 ± 4	102 ± 16	
MW6	4/15/80	10 ± 3			140 ± 23	
MW7	4/15/80	18 ± 3	8 ± 2	16 ± 3		
MW8	4/15/80	16 ± 3		11 ± 2	109 ± 17	
Pond	4/15/80	17 ± 3	9 ± 2	13 ± 3		

Error Term = 1 standard deviation; LLD values may be found in Procedure QC-100 of our laboratory manual.

3.5L of sample was placed in a 3.5L Marinelli beaker and counted for eight hours. Nuclide identification and quantification was performed by ND4420 software. Samples were not filtered prior to analysis. Either a 14 percent, 16 percent, or 27 percent Ge(Li) detector was used for the analysis.

*These samples were counted for 24-36 hours on a 27 percent Ge(Li) detector.

No other radionuclides were detected in the sample.

lts (pCi/g-dry)

BWST ! @10 ft	BWST #3 @5 ft	BWST #4 @10 ft	BWST #5 @5 ft
77 ± .03	0.66 ± .03	0.74 ± .03	0.80 ± .04
40 ± .05	0.44 ± .04	0.57 ± .04	0.58 ± .05
66 ± .02	0.54 ± .02	0.60 ± .02	0.65 ± .02
73 ± .22	10.15 ± .21	10.75 ± .16	10.92 ± .22
74 ± .01	0.68 ± .01	0.76 ± .01	0.80 ± .01
66 ± .02	0.59 ± .02	0.66 ± .01	0.65 ± .02
66 ± .02	0.54 ± .02	0.60 ± .02	0.65 ± .02
24 ± .01	0.22 ± .01	0.24 ± .01	0.27 ± .01
ND	0.01 ± .01	0.02 ± .01	ND

C-100 of our laboratory manual.

eight hours. Nuclide identification and
hand ground prior to analysis. Either
: analysis.

observation wells were drilled to confirm that the BWST was the source of contamination. Soil samples were taken near the BWST during the drilling of the observation wells. The concentrations of various radionuclides were measured at various depths in the soil column, from ground level to a depth of over 25 feet.

The tests on the soil samples recovered from the well drilling operations show higher concentrations of tritium at locations above the water table and close to the BWST. Infiltration of precipitation has carried the contamination downward to the water table, through which it has been transported to other locations. Based on the well data, soil samples, and the fact that the BWST has leaked, we conclude that the analysis of the test data supports the hypothesis of the BWST leakage through the fittings as the source of contamination.

Board Question 9(e)

Q.8. What measures were available to prevent contaminations of the groundwater?

A.8. If contamination exceeding the concentrations prescribed in 10 CFR Part 20 were to occur, there would be several methods to prevent additional contamination of the site groundwater and the Susquehanna River. Examples include:

(1) The monitor wells could be pumped, such that the contaminated groundwater is removed. The wells are located to permit a large volume of groundwater to be pumped, probably into onsite storage tanks.

(2) A slurry wall of bentonite or other relatively impermeable material could be installed to surround the contaminated area. The wall would inhibit the passage of groundwater to offsite locations. We estimate that at least a year's time would be available to install the wall, since it would take the groundwater this long to migrate to the Susquehanna River.

If, for any reason, mitigative methods could not be implemented, further movement of contaminated groundwater could not be prevented. In order to assess the effects of contaminant movement, the NRC staff performed an analysis to determine the concentration of radioactive material in drinking water supplies should a massive leak occur from the reactor building. For the purpose of the analysis, we conservatively assumed that the entire volume of contaminated water (700,000 gallons) in the reactor building was released to the site groundwater environment over a period of about 2-1/2 days. Based on these conservative postulations, we found that the levels of radioactivity in drinking water from the Susquehanna River would be below the levels specified in 10 CFR Part 20, Appendix B. The computed levels were:

Nuclide	Computed Concentration	MPC
SR-90	4.5×10^{-8} µCi/ml	3×10^{-7} µCi/ml
CS-137	2.9×10^{-10} µCi/ml	2×10^{-5} µCi/ml
H^3	2.7×10^{-7} µCi/ml	3×10^{-3} µCi/ml

These levels were computed using a flow in the river of 34,000 cfs, corresponding to the average annual discharge.

Terry L. Johnson
Hydrologic Engineering Section
Hydrology-Meteorology Branch
Division of Site Safety and
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Office of Nuclear Reactor Regulation

Professional Qualifications

I am a hydraulic engineer on the staff of the Hydrology-Meteorology Branch, Division of Site Safety and Environmental Analysis, Office of Nuclear Reactor Regulation

My formal education consists of study in civil engineering at West Virginia University, where I received a BSCE in 1968. I have had courses in hydrology, hydraulics, water resources, fluid mechanics, soil mechanics, water supply, geology, hydrogeology, economics, chemistry and advanced mathematics.

My present employment with the NRC (formerly AEC) dates from June 1974 in the areas of hydrologic engineering. My responsibilities in the licensing review of nuclear facilities are in the areas of flood vulnerability, adequate water supply, impacts on surface and groundwater, and in hydrologically-related environmental matters. I participate in the development of technical bases for Safety Guides and Standards in these areas of interest. I have testified as an expert staff witness on hydrologically-related matters in NRC proceedings.

From 1969 to 1974, I was a hydraulic engineer with the Baltimore District Corps of Engineers, Baltimore, Maryland. I was responsible for the design and review of various engineering projects, such as reservoirs, spillways, outlet works, flood-control channels, erosion protection, and coastal engineering works. The projects included parts or all of the States of New York, Pennsylvania, Maryland, Virginia, West Virginia, and the District of Columbia. I also received training in computer programming and application to various hydraulic design problems and in hydrologic engineering.

I am a member of the American Society of Civil Engineers and the American Geophysical Union.