

April 27, 1983

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of)
)
UNION ELECTRIC COMPANY) Docket No. STN 50-483 OL
)
(Callaway Plant, Unit 1))

AFFIDAVIT OF ROGER E. LINNEMANN, M.D.
ON REED CONTENTION 9 (RADIOLOGICAL EXPOSURES)

City of Philadelphia)
) ss.
Commonwealth of Pennsylvania)

ROGER E. LINNEMANN, being duly sworn, deposes and says as follows:

1. I am a medical doctor with particular expertise in the area of radiological health. I am certified by the American Board of Radiology and the American Board of Nuclear Medicine. I am Clinical Associate Professor of Radiology at the University of Pennsylvania School of Medicine and a visiting Clinical Associate Professor of Radiology at Northwestern University School of Medicine. I am also Vice Chairman of

Radiation Management Corporation ("RMC"), a consulting firm which I established in 1968 to provide emergency medical expertise and support in the event of an accident involving injury to employees of nuclear power plants and to provide routine radiological health consulting on radiation health and safety to workers in nuclear facilities. Presently, RMC's Emergency Medical Assistance Program provides 24-hour emergency support to some 20 nuclear power plant sites throughout the country. Additionally, we have laboratory capability to measure radiation in the working environment of a nuclear power plant as well as in the outside environment. We did extensive analysis of the environment around Three Mile Island during the TMI-2 accident. This analysis included, among other things, Iodine concentrations in the food pathway chain. On behalf of Union Electric Company, RMC is currently developing a training program for medical personnel who might be called upon in the event of a radiological emergency at the Callaway Plant. This program involves the developing of the proper facilities, supplies, equipment and personnel at the Callaway Memorial Hospital to enable the hospital to provide emergency treatment and care of the radiation injury as well as the contaminated and injured patient. In addition, plant personnel will be trained in the first aid and rescue of radiation injuries, and the local ambulance support will be trained in the transportation of radiation injuries. This will be annual training combined with an exercise to maintain proficiency at the

Callaway Memorial Hospital in the event of a radiation injury occurring at the site. A summary of my professional qualifications and experience is attached hereto as Exhibit "A". I have personal knowledge of the matters stated herein and believe them to be true and correct. I make this affidavit in response to Reed Contention 9 (Radiological Exposures) in this proceeding.

2. The purpose of this affidavit is to establish that means for controlling radiological exposures of local emergency workers in the event of an accident at the Callaway Plant have been established as required by 10 C.F.R. § 50.47(b)(11).

3. With respect to the concern expressed by Mr. Reed in Contention 9(A) regarding excess exposures to workers, it is highly unlikely that any emergency worker would unknowingly receive a significant, much less lethal, dose of radiation. First of all, the emergency worker will have a high range pocket dosimeter with him which he will have been taught to read. Secondly, workers are instructed to read their dosimetry at least once each thirty minutes. Third, the EOF will have a total assessment of the area's radiation contamination and exposure and will maintain constant communication between emergency worker teams. Emergency workers would be directed to stay away from areas with unexpectedly high levels of radiation.

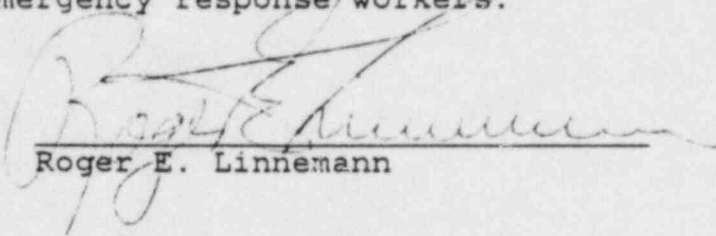
4. With respect to the concern expressed by Mr. Reed in Contention 9(B) regarding the need to monitor for contamination

at a site near where duty is performed, as previously stated, emergency plans and training provide for emergency workers to be monitored both by self at thirty minute intervals if the worker is in an area in which contamination may be present, as well as by others. Should a self-survey indicate contamination, workers will be taught to remove themselves from the area, if possible, and then use self-decontamination procedures (for example, removing outer clothing or washing exposed parts of the skin). As I have stated in my affidavit in response to Reed Contention 10, serious contamination of the skin is highly unlikely in any type of reactor accident. It is virtually impossible to get enough radiation on the skin to cause radiation damage. The purpose of decontamination is a personal hygiene measure to reduce the possibility of incorporating radioactive atoms internally. Therefore, in the period immediately following the accident (first 24 hours) attention to survey and decontamination is not the first order of priority. Also spread of contamination is not the major problem. The major problem is to reduce the external exposure from gamma radiation to the population and emergency workers through appropriate protective actions. However, decontamination centers will be available for the survey and decontamination of emergency workers throughout the emergency. These centers will be outside of, but within a reasonable distance of, the affected area. Moreover, emergency workers will be required to report directly to the nearest decontamination

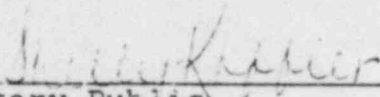
center at the conclusion of the emergency, thereby minimizing the spread of contamination.

5. With respect to the concern expressed by Mr. Reed in Contention 9(C) regarding the need to ensure that workers understand what to do if they are contaminated, all off-site emergency workers will be adequately equipped with radiation instrumentation and trained to use the instruments and interpret the results. The readings of the instrumentation will be in milliRoentgens or Roentgens (mR or R) per hour. A self-reading low range dosimeter such as the CDV-138 (0-200 mR), a self-reading high range dosimeter such as the CDV-742 (0-200 R), and the thermoluminescent dosimeter (TLD) are standard civil defense instrumentation which is used at many off-site locations around nuclear power plants in this country. The worker will be taught, for the purposes of emergency work, the principles of Roentgen/hour to Rem/hour equivalents. For all practical purposes, for the types of radiation encountered in a nuclear power plant, the differences between these two measurements are insignificant. They will also be taught the significance of different dose-effect relationships. The guidelines for emergency worker exposure provide that if contamination is present or exposure reaches 0.5 mR above background, emergency workers are directed to the nearest decontamination center. Also, as previously stated, workers will be taught to use self-decontamination procedures.

6. Finally, with respect to the concern expressed by Mr. Reed in Contention 9(D) regarding the use of Roentgens/hour, although emergency workers' equipment will read Roentgens/hour, training will be provided for workers to understand the relationship between Roentgens/hour and Rems/hour and workers will be able to quickly perform this conversion under emergency situations. Attached as Exhibit "B" is an outline of the proposed training for emergency response workers.


Roger E. Linnemann

Subscribed and sworn to before me
this 20th day of April, 1983.


Notary Public

SHELLY KOFFLER
Notary Public, Phila., Phila. Co.

My Commission Expires My Commission Expires March 23, 1985

CURRICULUM VITAE

ROGER E. LINNEMANN, M.D.
Vice Chairman
Radiation Management Corporation

ROGER E. LINNEMANN, M.D.
Vice Chairman
Radiation Management Corporation
3508 Market Street
University City Science Center
Philadelphia, PA 19104
(215)243-2950

EDUCATION

University of Minnesota, Minneapolis, MN. B.A. (Cum Laude) 1952

University of Minnesota, Minneapolis, MN; B.S., M.D. 1956

Walter Reed Army Hospital, Washington, D.C.; INTERNSHIP 1956-1957

Walter Reed Army Hospital, Washington, D.C.; RESIDENCY (Radiology) 1962-1965

Certified by American Board of Radiology 1964

Certified by American Board of Nuclear Medicine 1972

Licensed to practice Medicine in 1) Commonwealth of Pennsylvania; 2) Illinois;
and 3) Minnesota

Sandia Base, New Mexico; Nuclear Weapons Orientation Course 1961

Walter Reed Army Institute of Research, Washington, D.C.; Medical Aspects of
Nuclear Warfare 1962

US Department of Agriculture Graduate School (Evening), Washington, D.C.
Russian Language 1963-1965

PROFESSIONAL EXPERIENCE

| | |
|--------------|------------------------------------------------------------------------------------------|
| 1981-present | Vice Chairman and Chief Medical Officer, Radiation Management Corporation |
| 1969-1981 | President/Chief Executive Officer, Radiation Management Corporation |
| 1974-present | Clinical Associate Professor of Radiology, University of Pennsylvania School of Medicine |
| 1977-present | Visiting Associate Professor, Clinical Radiology, Northwestern University Medical School |
| 1969-1974 | Assistant Professor, Clinical Radiology, University of Pennsylvania School of Medicine |
| 1968-1969 | Nuclear Medicine Consultant, Philadelphia Electric Company |

PROFESSIONAL EXPERIENCE (Continued)

Jan-Aug 1968 Assistant Professor, Radiology, University of Minnesota
School of Medicine (investigated use of isotopes in kidney
function evaluation)

1957-1968 Employed by United States Army

1965-1968: Commanding Officer, Nuclear Medicine Research Detachment,
Europe; Radiological Health Consultant, US Army-Europe.
(responsible for plans, procedures and training of military
hospitals and personnel in the evaluation, evacuation and
treatment of radiation casualties. In January, 1966 sent
to Palomaris, Spain for evaluation of medical and environmental
aspects of the mid-air collision involving nuclear weapons)

1961-1962: Research Associate, Department of Radiobiology, Walter Reed
Army Institute of Research, Washington, D.C. (investigated
use of anti-radiation drugs in treatment of cancer)

1957-1961: General Medical Officer, Europe

Languages: German, Russian

PROFESSIONAL APPOINTMENTS

1982-present American Medical Association Council on Scientific Affairs
Subcommittee on the Management of Radiation Accident Victims

1979-present Health Physics Society Standards Committee

1978-present General Dynamics Electric Boat Division Radiological Health
Consultant

1978-present Edison Electric Institute Utility Radiation Standards Group

1973-present University of Pennsylvania Radiation Safety Committee

1973-present The Atomic Industrial Forum, Inc. Public Affairs & Information
Committee

1970-present The American Nuclear Society Subcommittee for Writing Emergency
Procedures Standards

1969 & 1975 Atomic Energy Commission ad hoc Committee on Medical Aspects
of Radiation Accidents

1966-present American College of Radiology

1969-present Commission on Radiologic Units, Standards and Protection

1969-present Committee on Radiation Exposure of Women

1969-present Committee on Radiological Aspects of Disaster Planning

1967-1978 International Affairs Committee

1965-1968 U.S. Delegate to NATO Radiation Protection Committee & Medical
Aspects of Nuclear Warfare Committee

PROFESSIONAL APPOINTMENTS (Continued)

1971-present Department of Defense & Environmental Protection Agency
Medical Liaison Officer's Network (MLON)-State of
Pennsylvania Representative

PROFESSIONAL MEMBERSHIPS

American College of Radiology
American Public Health Association
American Medical Association
Society of Nuclear Medicine
Philadelphia Roentgen Ray Society
Pennsylvania Medical Society
College of Physicians of Philadelphia
Radiological Society of North America, Inc.
American Institute of Physicists/American
Association of Physicists in Medicine
American College of Nuclear Physicians
American Council on Germany
Union League of Philadelphia

AWARDS & HONORS

1978 Association of Medicine & Security, Madrid, Spain
(Honorary Member)

1968 University of Minnesota Radiological Research Scholar
(National Research Council)

1968 United States Army Legion of Merit

PRESENTATIONS

1980 Korea Women's Association (Seoul, Korea)
presented paper, "Energy: The Basis for Health in Developing
and Developed Countries", at International Symposium on the
Expulsion of Environmental Pollution

1980 Korean Association for Radiation Protection (Seoul, Korea)
presented seminar on emergency management of radiation injuries

1980 Ministry of Health (Madrid, Spain)
presented paper, "Definitive Treatment of Radiation Injuries",
at First Seminar on Assistance to Those Wounded by Radioactive
Elements and Ionizing Radiations

PRESENTATIONS (Continued)

- 1979 Reinisch-Westfalisches Elektrizitätswerk (Essen, Germany)
presented paper, "Energy: The Basis for Health in Developing
and Developed Countries", at The Seventh Energy Workshop
- 1978 The Swedish State Power Board (Vallingby, Sweden)
presented seminar, "Management and Treatment of Radiation
Injuries", and conducted radiation emergency medical
exercise at the Ringhals Nuclear Power Plant
- 1978 Deutsche Gesellschaft für Wiederaufarbeitung (Hannover, Germany)
appeared before the Prime Minister and Parliament of
Lower Saxony as an International expert to testify on the
safety of a reprocessing plant at Gorleben, Germany
- 1978 International Atomic Energy Agency (Vienna, Austria)
presentation at Symposium on Late Effects of Ionizing
Radiation
- 1978 Asociación de Medicina y Seguridad en el Trabajo de
Unesa para la Industria Eléctrica (Madrid, Spain)
presented one-day seminar entitled, "Primary Management
of Radiation Injury"
- 1977 International Atomic Energy Agency (Vienna, Austria)
presented paper, "Emergency Medical Assistance Programs
for Nuclear Power Reactors", at Symposium on Handling of
Radiation Accidents
- 1967 University of Freiburg Institute of Radiobiology (Freiburg,
Germany); presented seminar on diagnosis and treatment of
radiation injuries

PUBLICATIONS

1. Linnemann, Roger E. "Berlin: The Young-Old City". Senior Citizen (September 1961)
2. Linnemann, Roger E. "This Way to Berlin". The American Benedictine Review:14, No. 4 (December 1963)
3. Linnemann, Roger E. "The Acute Radiation Syndrome and its Impact on the Chain of Evacuation". Medical Bulletin, U.S. Army Europe:22, No. 12 (December 1965)
4. Linnemann, Roger E. and Robert T. Wangemann. "Medical Support of Nuclear Weapons Accidents". Medical Bulletin, U.S. Army Europe (November 1967)
5. Linnemann, Roger E. and O. Messerschmidt. "Erholungsvorgaenge bei Grosstieren nach Ganzkoerperbestrahlung", :dem 6, Jahrbuch von der vereinigung Duetscher Strahlenschutzaeerzte (1968)
6. Linnemann, Roger E. "Command Radiation Guidance". Military Medicine: 33, pp. 771-716 (September 1968)
7. Loken, Merle K., Linnemann, Roger E. and George S. Kush. "Evaluation of Renal Function Using a Scintillation Camera and Computer". Radiology: 93, No. 1, pp. 85-94 (July 1969)
8. Linnemann, Roger E., Loken, Merle K. and Colin Markland. "Computerized Compartmental Renograms to Study Kidney Function". Journal of Urology: 103, pp. 533-537 (May 1970)
9. Linnemann, Roger E. and J.W. Thiessen. "Regional Approach to the Management of Radiation Accidents". Journal of the American Public Health Association: 61, No. 6, pp. 1229-1235 (June 1971)
10. Linnemann, Roger E. and Robert H. Holmes. "Nuclear Accidents and Their Management". Emergency Medical Care, pp. 281-292, Spitzer, Stanley and Wilbur W. Oaks (eds.) New York: Brune and Stratton, Inc. (1971)
11. Linnemann, Roger E., Rasmussen, N.C. and F.K. Pittman. Nuclear Energy: Issues and Answers. Atomic Industrial Forum, Inc. in cooperation with Pennsylvania Power & Light Company (April 1973)
12. Linnemann, Roger E. "Accentuate the Positive". Trial: 10, No. 4, p. 13 (July/August 1974)
13. Linnemann, Roger E. "Accentuate the Positive". Congressional Record: 109, pp. 4964-4967. Washington, D.C." United States of America Proceedings and Debates of the 93rd Congress, Second Session (July 23, 1974)
14. Linnemann, Roger E. and J.W. Thiessen. Editorial, "In Defense of Radiation and Cells". The New York Times (May 23, 1974)

(Continued)

Roger E. Linnemann - Publications

15. Linnemann, Roger E. Nuclear Radiation and Health. Springville, NY Nuclear Fuel Services, Inc. (September 23, 1974)
16. Linnemann, Roger E. Editorial, "In Defense of Nuclear Power Plants", The Philadelphia Inquirer, p. 11A (March 6, 1975)
17. Linnemann, Roger E. "Nuclear Power Plants Pose Minimal Health Risks", Perspective. News Bureau of the University of Pennsylvania, Philadelphia, PA (February 1975)
18. Linnemann, Roger E. "Medical Aspects of Power Generation". Impulse. Massachusetts: Electrical Council of New England (June 1975)
19. Linnemann, Roger E. "Bugs in the Nuclear Fuel Cycle". Spectrum, p. 59, Gadi Kaplan (ed.) Piscataway, NJ: The Institute of Electrical and Electronic Engineers, Inc. (September 1975)
20. Linnemann, Roger E. and Fred A. Mettler, Jr. "Emergency Medical Assistance Programs for Nuclear Power Reactors". International Atomic Energy Agency Symposium on the Handling of Radiation Accidents, IAEA-SM-215/22, Vienna Austria (1977)
21. Linnemann, Roger E. "Why ALARA?" Transactions of 1979 American Nuclear Society Conference, Atlanta, GA (June 3-7, 1979), Vol. 32, TANS AO 32 1 832 ISSN 0003-018x (1979)
22. Linnemann, Roger E., Hackbarth, C.J. and Ray Crandall. "The Contaminated and Injured Patient". Proceedings of Twenty-fourth Annual Meeting of the Health Physics Society, July 9-13, 1979 (Philadelphia, PA)
23. Linnemann, Roger E. "The Three Mile Island Incident in 1979: The Utility Response". The Medical Basis for Radiation Accident Preparedness, K.F. Hubner and S.A. Fry (eds.), Elsevier/North-Holland, pp. 501-509 (1980)
24. Linnemann, Roger E. "Initial Management of Radiation Injuries". Journal of Radiation Protection, 5, No. 1, pp. 11-25 (December 1980)
25. Linnemann, Roger E. "Facilities for Handling the Contaminated Patient". Radiation Accident Preparedness: Medical and Managerial Aspects, Science-Thru-Media Company: New York (1980)
26. Linnemann, Roger E. "A Systems Approach to the Initial Management of Radiation Injuries". Systems Approach to Emergency Medical Care, Appleton-Century-Crofts: New York (1980)
27. Linnemann, Roger E., Stephen M. Kim and Frazier L. Bronson. "Three Mile Island: Medical and Public Health Aspects of a Radiation Accident". Journal of Radiation Protection, 6, No. 1, pp. 45-52 (October 1981)

PROFESSIONAL TESTIMONY

| | |
|-------------|-------------------------------------------------------------------------------------------------------------------------------|
| in progress | Union Electric Company Emergency Planning/Licensing Hearings for Callaway Nuclear Power Plant |
| in progress | Long Island Lighting Company Emergency Planning Hearings for the Shoreham Nuclear Power Station |
| in progress | Texas Utilities Generating Company Emergency Planning Hearings for the Comanche Peak Steam Electric Station |
| in progress | Pennsylvania Power & Light Company Susquehanna Steam Electric Operating License Hearings |
| in progress | Florida Power & Light Company Turkey Point Steam Generator Repair Hearings |
| in progress | John Benek v. Pennsylvania Power Company <u>et al.</u> #199 of 1977 Eminent Domain |
| 1981 | Southern California Edison Company Emergency Planning Hearings for the San Onofre Nuclear Generating Station |
| 1979 | Gorleben Nuclear Fuels Reprocessing Plant Hearings before the Prime Minister and Parliament of Lower Saxony, Hanover, Germany |
| 1979 | Florida Power & Light Company Turkey Point Nuclear Station Operating License Hearings |
| 1971 | Long Island Lighting Company Shoreham Nuclear Power Station Operating License Hearings |
| 1970 | Baltimore Gas & Electric Company Calvert Cliffs Nuclear Power Plant Operating License Hearings |
| 1970 | Northeast Utilities Service Company Millstone Nuclear Power Station Operating License Hearings |

EXHIBIT "B"

TOPIC IV. EMERGENCY RESPONSE WORKER TRAINING (Section A)

A. Nuclear Power Plant Operation

1. Introduction to radioactive material as fuel source
2. Safety systems in nuclear power plants

B. Ionizing Radiation

1. Radioactive Emissions
2. Terminology
3. Exposure v. Contamination
4. Personal Protective Actions

C. Medical Significance of Radiation Exposure

1. Acute Radiation Injuries
 - a. total body
 - b. partial body
 - c. external contamination
 - d. internal contamination
2. Current knowledge of low level effects
 - a. cancer
 - b. genetic
 - c. in-utero

D. Off-Site Releases of Radiation

1. Plume release characteristics
2. Release hazards to the population
3. Shelter vs. Evacuation

TOPIC IV. EMERGENCY RESPONSE WORKER TRAINING (Section B)

A. Workers' Role in Off-Site Response Plan

1. Police
2. Firemen
3. Ambulance personnel
4. Health Department/Nursing Service

B. Communication Systems

1. Notification of Workers
2. Inter-agency communications
3. Rumor control
4. Requests for assistance

C. Special Equipment

1. Dosimetry
 - a. use and function
 - b. terminology
 - c. distribution
 - d. record keeping requirements
2. Survey Instruments
 - a. use and function
 - b. terminology
 - c. quick-sort Procedures
 - d. public reaction

D. Responding to the Accident Victim

1. Defining the problem
2. Hazards involved

3. Contamination control techniques
4. Decontamination techniques
5. Personal protective actions