UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
CAROLINA POWER & LIGHT COMPANY	)	
AND NORTH CAROLIA EASTERN	)	Docket Nos. 50-400-OL
MUNICIPAL POWER AGENCY	)	50-401-OL
	)	
(Shearon Harris Nuclear Power	)	
Plant, Units 1 and 2)	)	

AFFIDAVIT OF G. HOYT WHIPPLE IN SUPPORT OF APPLICANTS' MOTION FOR SUMMARY DISPOSITION OF JOINT CONTENTION II

County of Leon	)	
	)	SS:
State of Florida	)	

G. HOYT WHIPPLE, being duly sworn, deposes and says as follows:

1. I am a private consultant on radiation control. My business address is 3301 Rutland Loop, Tallahassee, Florida 32312. A summary of my professional qualifications and experience is attached hereto as Exhibit A. I make this Affidavit in support of Applicants' Motion for Summary Disposition of Joint Intervenors' Contention II, in particular Part (e) in this proceeding.

2. My nearly forty years of professional experience has been devoted to the control of radiation and radioactivity in the environment and in the work place.

Included in this experience has been the design and evaluation of programs to measure the release and distribution in the environment of the radioactive materials discharged from nuclear power plants, and the radiation doses which result from these materials. Also, for the past several years, I have worked with the Utility Air Regulatory Group on the possible consequences of the radioactive materials contained in the fly ash discharged to the atmosphere from coal-burning power plants.

INTRODUCTION

3. The purpose of this Affidavit is to demonstrate that there is no factual basis for Joint Intervenors' Contention II (e), and to describe the emissions from a nuclear power plant and the insignificance of high LET radiation in this connection.

4. Joint Contention II (e), as admitted to this proceeding, reads as follows:

> The long term somatic and genetic health effects of radiation releases from the facility during normal operations, even where such releases are within existing guidelines, have been seriously underestimated for the following reasons:
>
> ...
>
> (e) The radionuclide concentration models used by Applicants and the NRC are inadequate because they underestimate or exclude the following means of concentrating radionuclides in the environment: rainout of radionuclides or hot spots; radionuclides absorbed in or attached to fly ash from coal plants

which are in the air around the SHNPP site; and incomplete mixing and dispersion of radionuclides.

CONTENTION II (e)

5. Contention II (e) alleges that somatic and genetic health effects have been underestimated for two reasons:

i) precipitation (wet deposition or rainout) and incomplete mixing and dispersion will lead to "hot spots" and will produce concentrations of radionuclides, and hence doses and health effects, higher than those which have been calculated; and

ii) the absorption or attachment of radioactive materials emitted to the atmosphere by the Harris Plant in or to particles of fly ash, already present in the air, will lead to concentrations, and hence doses and health effects, higher than those which have been calculated by Applicants and the NRC.

INCOMPLETE MIXING

6. The models used by Applicants and the NRC to compute concentrations in the environment of the radioactive materials discharged from the Harris Plant (NRC Regulatory Guides 1.109, 1.111, 1.112 and 1.113) produce

values which are loaded with pessimism. Thus, the calculated doses and health effects are always higher than those expected. The conservatism built into these models is described in the following citations:

C.V. Gogolak, H.L. Beck & M.M. Pendergast
Calculated and Observed Kr-85 Concentrations within 10 km of the Savannah River Plant Chemical Separation Facilities.
Atmospheric Environment 15: 497-507, 1981.

J.M. Iacovino
U.S. PWR Gaseous Release Trends.
Trans Amer Nuc Soc 34: 115-116, 1980.

S.F. Marschke & J.J. Mauro
Radiocesium Transport in Reservoir Bottom Sediment -- A licensing Approach.
Trans Amer Nuc Soc 34: 126-127, 1980.

F.O. Hoffman, D.L. Shaeffer, et al.
Evaluation of Models for Assessing Compliance with Environmental Radiation Regulations.
Trans Amer Nuc Soc, 1977 Winter Meeting, pp. 120-122.

"Affidavit of Brian D. McFeaters In Support of Applicants' Motion for Summary Disposition of Intervenor Wells Eddleman's Contention 80," dated August 31, 1983 ("McFeaters Affidavit"),

The models predict values for annual average concentrations and doses which are acknowledged to be intentionally high.

7. At certain times and places, incomplete mixing, incomplete dispersion, or precipitation (wet deposition or rainout) will produce concentrations higher than the annual average concentrations. Such conditions prevail over limited areas for short times, and the resulting momentary peaks will not, therefore, affect concentrations and doses averaged over a year to any appreciable extent. The atmospheric dispersion model (Regulatory Guide 1.111) takes

into account those factors which could result in incomplete mixing and already predicts values for plume concentrations that are conservatively high. The extent of these inherent conservatisms are shown by field studies which reveal that the models consistently exceed actual measured concentrations by a factor of two, and often by an order of magnitude. See McFeaters Affidavit at Exhibit B, page 16 and references cited therein. Wet deposition (rainout) is not directly taken into account in the atmospheric dispersion model. Wet deposition could tend to concentrate radioactive materials on the ground and to have an impact on dose only if a nuclear plant were located in an area with a pronounced rainy season that coincides with the local grazing season. Such is not the case in North Carolina in the vicinity of the Harris Plant site. See "Affidavit of Brian D. McFeaters In Support of Applicants' Reply to Wells Eddleman's Motion For Partial Summary Disposition on Eddleman Contention 80," dated September 26, 1983, at Exhibit B, page 4; "Affidavit of Irwin Spickler in Support of Summary Disposition of Eddleman Contention 80," dated September 26, 1983 at paragraph 8. Otherwise, because of the random and infrequent contribution of wet deposition to radioactivity concentrations, as compared with continuous dry deposition, wet deposition will have an insignificant impact on total radioactivity concentrations and, thus, on total annual dose.

8. The magnitude of the projected somatic and genetic health effects is related to the radiation dose an individual receives for each year of exposure. It matters not at all that this dose is acquired at a rate which varies from day to day. What does matter is the total annual dose, which is made up of incremental doses received along a variety of pathways: inhalation, external exposure and ingestion of various food materials. This variety, and time, smooth out peaks and hollows. Therefore, the NRC models give concentrations, doses and health effects which are unaffected by incomplete mixing, incomplete dispersion, rainout and "hot spots."

COAL FLY ASH

9. The absorption or attachment of radioactive material from the Harris Plant in or to fly ash particles was not included in the radiation dose modeling for the Harris Plant. To the extent such absorption or attachment occurs, it will tend to reduce the radiation doses to people and, therefore, to produce fewer health effects than those which have been predicted.

10. The absorption or attachment of radioactive particles and gases from the Harris Plant in or to particles of coal fly ash in the atmosphere, if it occurs, will result in particles larger than the original particles. Larger

particles are less likely to penetrate deep into the lung and to be retained there than small particles. Intervenors recognized this in their response to Interrogatory II-40:

> ... the problem is the deposition of these coal particles directly in the deep lung, which [deposition] is most severe for those below 0.5 micron diameter, but applies to some extent to some particles below 10 microns and many below 2 microns in diameter.

The larger the particle, then, the less the hazard. If radioactive gases and particles combine with fly ash, this will result in particles larger than the originals and, accordingly, these radioactive gases and particles will become less likely to enter and remain deep in the lung.

11. Further, fly ash particles tend to be highly insoluble; see, for example:

> D.R. Kalkwarf, P.O. Jackson & J.M. Hardin,
> "Lung-Clearance Classification of Radionuclides in Coal Fly Ash,"
> Pacific Northwest Laboratory and
> U.S. Environmental Protection Agency
> issued (but not published) September 1982.

Thus, the absorption or attachment of radioactive gases and soluble radioactive materials in or to fly ash particles tends to place them in an insoluble form. In this form they are less available for transport along food pathways than they were in their original form and are less likely to irradiate humans.

12. In response to Applicants' Interrogatory II-62, Intervenors offer the following citations in support of their contention about attachment of radioactive material to

fly ash particles:

C. Aranyi, D.E. Gardner & J. Lewtas Huisingh,
Evaluation of Potential Inhalation of Particulate Silicious (sic) Compounds by in Vitro Alveolar Macrophage Tests: Applications to Industrial Particulates Containing Hazardous Impurities.
page 48, whole article is cited here, in
ASTM Special Technical Publication 732, 1981

C. Aranyi, F.J. Miller, et al.
Cytotoxicity to Alveolar Macrophages of Trace Metals Absorbed on Fly Ash.
Environmental Research 20: 14-23, 1979

N.E. Garrett, J.A. Campbell and H.F. Stack,
The Utilization of the Rabbit Alveolar Macrophage and Chinese Hamster Ovary Cell for Evaluation of the Toxicity of Particulate Materials: II. Particles from Coal-Related Processes.
Environmental Research 24: 366-376, 1981

"There may be relevant info in
Pulmonary Toxicology of Respirable Particles, ed. Chas. Sanders, F.T. Cross, G. Gangle, J. Mahaffey, USDOE, 1980."

The last reference is to the Proceedings of the Nineteenth Annual Hanford Life Sciences Symposium, Richland, Washington, October 22-24, 1979, DOE Symposium Series 53, CONF-791002.

I have reviewed each of the cited references and find that none of them has any application to the matter of radioactive material attached to coal fly ash.

ROUTINE NUCLEAR POWER PLANT EMISSIONS

13. The routine emissions of radionuclides from a nuclear power plant are of four kinds:

a. fission products produced by the fission process, e.g., Xe-133,

b. activation products produced by the capture of neutrons by non-radioactive atoms present in the reactor core, e.g., Co-60,

c. transuranic isotopes produced by the capture of neutrons by uranium, e.g., Np-239, and

d. members of the natural uranium series, e.g., Rn-222.

14. The first two kinds are beta and gamma emitters, and constitute all but about one part in a billion of the total radioactive release. Most (99.9%) are inert radioactive gases, e.g., Xe-133 and Xe-131m.

15. Low-LET radiations are X rays, gamma rays and beta particles, and have an RBE (or quality factor) of 1. Alpha particles and neutrons are high-LET radiations. Alpha particles have an RBE of 20, and neutrons have an RBE of 10. No neutrons are emitted to the environment by nuclear power plants. The alpha emitters, e.g., Pu-239, Ra-226, consitute no more than one part in a billion of the total radioactive release.

16. Given the vanishingly small amount of high-LET radiation released from a nuclear power plant in routine

operation, these releases do not affect the estimates of health effects from such operations.

G. Hoyt Whipple

G. Hoyt Whipple

Subscribed and sworn to before me
this 30th day of September, 1983

Notary Public

My Commission expires

Exhibit A

BIOGRAPHICAL DATA

September 1983

NAME; G. Hoyt Whipple

BORN: May 4, 1917. San Francisco, California

EDUCATION:

Public Schools, Rochester, New York
Wesleyan University, 1935-1939, B.S. in chemistry
Massachusetts Institute of Technology Graduate School, 1939-1942, no degree
University of Rochester Graduate School, 1950-1953, Ph.D. in biophysics

EXPERIENCE;

M.I.T. Division of Industrial Cooperation, 1942-1947, Loran, Radar, food dehydration and aerial bomb fuses.
General Electric Company, Hanford Works, Richland, Washington, 1947-1950, research and development on health physics problems and instruments
University of Rochester Atomic Energy Project, 1950-1957, teaching in health physics and research in biophysics
University of Michigan School of Public Health, 1957-1982, Associate Professor of Radiological Health, 1957-1960, Professor of Radiological Health, 1960-1982, Professor Emeritus of Environmental and Industrial Health, May 1982

PROFESSIONAL SOCIETIES;

American Association for the Advancement of Science
American Industrial Hygiene Association
Health Physics Society
Society for Risk Analysis

CERTIFICATION;

American Board of Health Physics
American Board of Industrial Hygiene, in Radiological Aspects of Industrial Hygiene

ACTIVE CONSULTANTSHIPS:	Since
Rochester Gas & Electric Corp.	1954
Utilities Air Regulatory Group	1980
Kerr-McGee Corp.	1981
Carolina Power & Light Co.	1983

PREVIOUS CONSULTING:

U.S. Air Force
U.S. State Department
International Atomic Energy Agency
World Health Organization
U.S. Atomic Energy Agency
Eastman Kodak Co.

PUBLICATIONS BY G. HOYT WHIPPLE

1. Results of Some Statistical Tests of Particle Counters (with W.R. Portch). Hanford Works Report AECD-4022, 1948.

2. Extrapolation Chamber Measurements of the Beta-Ray Surface Dose from Uranium (with H.E. Leap, Jr.). Hanford Works Report HW-11379, October 1948.

3. Fast Neutron Sensitivity of the CP Meter (with E.E. Baker and F.R. Gydesan). Hanford Works Report HW-13658, 1948.

4. Fast Neutron Counter for Health Physics Measurements (with J.S. Reddie). Hanford Works Report HW-17561, 1950.

5. Fast Neutron Survey of the Small Rochester Cyclotron. University of Rochester A.E.P. Report UR-142, pp. 96-125, 1950.

6. Biological Effects of Ionizing Radiations (with M. Ingram, W.B. Mason and J.W. Howland). University of Rochester A.E.P. Report UR-196, 1952

7. Luminous Bacteria as a Radiological Test Organism, with Special Reference to the Radiations from a 130-Inch Frequency Modulated Cyclotron (thesis). University of Rochester A.E.P. Report UR-249, 1953.

8. Luminous Bacteria as a Radiobiological Test Organism. J. Cell and Comp. Physiol. 43:415-424, 1954

9. Personnel Protection in the Radioactive Inhalation Program (with J.N. Stannard, G.J. Miller M.L Ingram and T.T. Mercer). University of Rochester A.E.P. Report UR-310, 1955.

10. The Management of Power Reactor Wastes. AIHA Quarterly, 17:421-425, 1956.

11. Radiation Hazard Control for a Power Reactor. Mechanical Engineering, pp. 253-258, March, 1957, and Problems in Nuclear Engineering, Vol. I, pp. 61-67, New York, Pergamon, 1957.

12. Radiation Safety in the Nuclear Industry (with Walter D. Claus). Whaley-Eaton Service, Atoms for Peace, April 11 12 and 19, 1957.

13. Health Physics Instrumentation for a Power Reactor. Electrical Engineering, July, 1957, p. 606-611, and in Adv. in Nuc. Eng. Vol. II, Pergamon, New York, 1957.

14. Polonium Urinalysis (with Carolyn A. Krebs). University of Rochester A.E.P. Report UR-501, 1957.

15. Pre-Operational Environmental Survey for a Power Reactor, AIHA Quarterly, 18:4, 315-318, 1957.

16. Health Physics Responsibilities to Management. Health Physics, 1:71-75, 1958.

17. Health Physics Training. Symposium on Health Physics in Biology and Medicine Held at the University of Puerto Rico School of Medicine, San Juan, May 26-28, 1958. U.S.A.E.C. Report: TID-7572, pp. 14-24.

18. A Generalized Atomic Energy Program (with W. Kerr). Proc. Second U.N. International Conf. on Peaceful Uses of Atomic Energy. Vol. I, pp. 165-171, 1958.

19. Izobrazba Zdravstvenog Fizicara (Training for Professional Health Physicists). Arhiv za Higijenu Rada i Toksikologiju, Vo. 10, No. 4, pp. 345-351, Zagreb, 1959.

20. The Problems of Monitoring, Univ. of Illinois. Proceedings Second Sanitary Engineering Conference on Radiological Aspects of Water Supplies, pp. 50-53, January, 1960.

21. Surveying for Environmental Radioactivity-U.S. View. Proc. of the Thirteenth International Congress on Occupational Health, pp. 171-178, 1960.

22. The Pre-Operational Environmetal Survey for the Enrico Fermi Reactor - 1958 (with J.V. Nehemias). AIHA Journal 21: 144-150, 1960.

23. Environmental Radioactivity Prior to Nuclear Power Plant Operation (with J.V. Nehemias and N.C. Kothary). J. Am. Water Works Assoc. 52:1291-1302, 1960.

24. Irradiation of Bacterial Luciferase in Vivo (with C.H. Burns and A.D. Nevill). Science, Vol. 135, No. 3502, pp. 430-432, February 9, 1962.

25. Radiation in Perspective. Educational Horizons (official publication of Pi Lambda Theta), Vol. 40, No. 4, pp. 235-240, Summer, 1962.

26. Personal Radiation Exposures in Facilities Licensed to Use Radioisotopes in 1960 (with D.E. Barber). U.S.A.E.C. Report No. TID-16553, October, 1962.

27. Pre-Operational Environmental Survey for the Enrico Fermi Atomic Power Plant: 1958-1962 (with C.A. Pelletier) Amer. Ind. Hyg. Jour. 24:172-179, 1963.

28. Radiation Regulations. Health Physics 9:221-224, 1963.

29. The Photometric Estimation of Luciferase in Luminous Bacterial Cells (with C.H. Burns and A.D. Nevill). Analyt. Biochem. 5:393-415, 1963

30. Detection and Quantitation of Fallout Particles in a Human Lung (with Audrey V. Wegst and Charles A. Pelletier), Science, 143:957-959, 1964.

31. Monitoring for Noble Radioactive Gases with Photographic Film (with D.E. Barber). Colloque International sur la Pollution Radioactive des Milieux Gazeux, Presses Universitaires de France, Paris, 1965, Vol. II, pp. 523-527.

32. Management, Emergency Organizations, Policy and Plans Emergency Manuals, Training, Drills and Exercises, in L.H. Lanzl, J.H. Pingel and J.H. Rust, eds. Radiation Accidents and Emergencies in Medicine, Research nad Industry, Chas. C. Thomas Co., 1963, pp. 223-228.

33. Concentrations of Radioactive Particles in Surface Air. November 1962 through March 1963 (with C.A. Pelletier and A.V. Wegst) Health Physics 10:917-921, 1964.

34. The Reversible Depression of Bacterial Luminescence During Exposure to X-Radiation. (with C.H. Burns and A.P. Jacobson) Radiation Research 24:494-502, 1965.

35. Use of Surface/Air Concentrations and Rainfall Measurements to Predict Deposition of Fallout Radionuclides (with C.A. Pelletier and H.L. Wedlick) Radioactive Fallout From Nuclear Weapons Tests, pp. 723-736. U.S.A.E.C. Symposium, Series No. 5, November 1965.

36. Report to the Atomic Energy Commission by the Radioisotopes Licensing Review Panel, September 5, 1967 (with G.F. Trowbridge, et al).

37. Some Long-Term Environmental Health Aspects of the Engineering Applications of Nuclear Explosives. Report UCID-15251, 1967.

38. Environmental Planning: A Health Physicist's View. APHA Journal, 58:1410-1413, 1968, and Selected Readings in Health. The MacMillan Co., 1970, pp. 397-400.

39. Radioactive Hazards in the Water and Waste Water Industries. Presented at the Seminar on Safety and Hazards in the Water and Waste Water Industry, March 1968.

40. Statement for the Subcommittee on Air and Water Pollution. U.S. Senate, Committee on Public Works. July 1968.

41. Objectives of Environmental Surveillance: The American Viewpoint, in W.C. Reinig, ed., Environmental Surveillance in the Vicinity of Nuclear Facilities, pp. 14-18, C.C. Thomas, 1970.

42. An Environmental Survey for the Nine Mile Point Power Reactor (with T.W. Philbin), in W.C. Reinig, ed., Environmental Surveillance in the Vicinity of Nuclear Facilities, pp. 93-104, C.C. Thomas, 1970.

43. Approaches to the Calculation of Limitations on Nuclear Detonations for Peaceful Purposes, Proc. for the Symposium on Public Health Aspects of Peaceful Uses of Nuclear Explosives, U.S. Dept. of HEW, 1969, pp. 684-694.

44. The Threat of Nuclear Power. Nuclear Science Newsletter No. 2. (Publication of the Institute of Electrical and Electronic Engineers, Inc.) New York, and Brinewell, Vol. 28, No. 6, July 1970.

45. The Use of Stable Element Concentrations in Pre-Operational Environmental Monitoring. (with J.C. Golden, Jr.) Proc. Fifth Annual Health Physics Society Midyear Topical Symposium. Health Physics Aspects of Nuclear Facility Siting, November 1970, pp. 329-336.

46. Nuclear Power: You Never Had It So Good. The Environmental and Ecological Forum 1970-71. U.S.A.E.C. Office of Information Services. TID-25857, pp. 156-169, 1972.

47. "As Low As Practicable " in Theory and Practice. Proceedings of the Third International Congress of the International Radiation Protection Association, September 9-14, 1973, National Technical Information Service, Washington, D.C. CONF-730907, pp. 1017-1021.

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50. What is a Safe Dose of Radiation? A talk prepared for and published by the Atomic Industrial Forum, Inc., Washington, D.C., March 1979.

51. On the Necessity for Risk. Keynote address at the First Annual Conference, Gas-Cooled Fast Reactor Program, May 10-June 1, 1979, San Diego, California, Published in the Proceedings, Helium Breeder Associates, San Diego, 1979.

52. Radiation Protection. A statement and testimony in the Hearings before the Subcommittee on Energy Research and Production, and the Subcommittee on Natural Resources and the Environment of the Committee on Science and Technology, U.S. House of Representatives, June 15, 1979, pp. 767-792. Also published by the Atomic Industrial Forum, Washington, D.C., August 1979.

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