

RELATED CORRESPONDENCE

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In the Matter of

CAROLINA POWER & LIGHT COMPANY  
AND NORTH CAROLINA EASTERN  
MUNICIPAL POWER AGENCY

(Shearon Harris Nuclear Power  
Plant, Units 1 and 2

Docket Nos. 50-400 OL  
50-401 OL

AFFIDAVIT OF JOHN J. MAURO  
IN SUPPORT OF APPLICANTS' MOTION FOR SUMMARY  
DISPOSITION OF JOINT INTERVENORS'  
CONTENTION II AND CONTENTION 37B

City of New York

State of New York

SS.

AFFIDAVIT

John J. Mauro, being duly sworn, deposes and says:

1. I am currently Director of the Radiological Assessment and Health Physics Department of Envirosphere Company, a division of Ebasco Services, Inc. My business address is Two World Trade Center, New York, New York. The statement of my background and qualifications is attached hereto as Exhibit A. I have personal knowledge of the matters stated herein and believe them to be true and correct.

2. I hold a Ph.D. in Health Physics from New York University Medical Center - Institute of Environmental Medicine and am certified by the American Board of Health Physics. For the past 10 years I have personally performed, or have directed the performance of all calculations of radionuclide release rates and doses for Ebasco nuclear clients and have evaluated the effluent controls for those releases. These calculations and analyses have been performed for 10 nuclear power facilities and several facilities in the other parts of the nuclear fuel cycle. Included among these analyses is the source term and modeling challenged by joint-intervenor for the Shearon Harris Nuclear Power Plant.

3. This Affidavit is prepared in support of Applicants' Motion for Summary Disposition of Joint Intervenors' Contention II and Wells Eddleman's Contention 37B. Specifically, I will address Contention II(c) and (f), and the modeling portion of Contention II(b).

## II. Modeling

4. In Contention II(f) and a portion of II(b), Joint Intervenors attack the dose modeling procedure underlying the DES. Specifically, Joint Intervenors contend that long term somatic and genetic health effects of radiation releases in normal operation have been seriously underestimated due to three modeling defects: (1) using less rather than more reactive forms of radionuclides in the computation; (2) ignoring certain radionuclides altogether; and (3) underestimating effects from internal emitters due to incorrect modeling of internal absorption of radionuclides. Joint Intervenors Contentions are without merit.

5. A description of the modeling procedure utilized by Applicants and NRC staff is set forth in my Joint Affidavit with Mr. Guy Martin in support of Applicants' motion to be filed for Summary Disposition of Intervenor Wells Eddleman's Contention 29/30, Para. 4 - 8 . Briefly, the first step in the procedure is to calculate the Source Term, or the radionuclides released in liquid and gaseous effluents during normal operation. The second step is to calculate the atmospheric dispersion and aquatic dilution of released radionuclides calculated to be the Source Term. The third and final step of the methodology is to calculate, in accordance with Regulatory Guide 1.109, the radiation doses to the general public attributable to the radionuclides dispersed in the environment. Reg. Guide 1.109 includes 14 equations and over 4,000 calculational parameters, including hundreds of dose conversion factors.

6. The Regulations do not require modeling of all possible emissions and all possible pathways. If particular ones have no significant impact on dose they need not be included in the calculation. At the same time, there are numerous conservatisms built into all three steps of the modeling approach set forth above such that the dose, as determined by utilizing the model, can be expected to be greater than the average annual dose actually delivered in routine operation.

## REACTIVITY OF RADIONUCLIDES

7. Joint Intervenors contend the dose and resulting health effects are seriously underestimated because less, rather than more, reactive forms of radionuclides are utilized in the modeling. As an example Joint Intervenors reference the greater reactivity of plutonium in its No. 6 valence state, as against its No. 3 or No. 4 valence state. As a point of clarification, in this Contention Joint-Intervenors appear to be using the term reactivity to refer to the chemical form a radionuclide takes in the environment and which influences its rate of uptake by plants, animals and man.

8. Joint Intervenors' Contention reflects a lack of understanding of the modeling techniques used by Applicants and the NRC staff. At no time in their computations is relative reactivity determined or utilized. The environmental and biological transfer rates used for the radionuclides included in the dose calculation make no assumption regarding reactivity. The rates, rather, are based on measured values for these parameters obtained by direct observation from laboratory and field studies. Hence, Joint Intervenors' Contention regarding relative reactivity is simply irrelevant to dose calculation modeling as here pertinent.

9. Joint Intervenors' example, plutonium, illustrates their own confusion. Not only is no particular form of reactivity used with respect to plutonium, but plutonium is a high-LET emitter and all high-LET emitters released from a nuclear power plant in routine operations in the aggregate account for less than one/billionth of total releases. This quantity does not impact dose or health effects estimates.

#### SOME RADIONUCLIDES IGNORED

10. Joint Intervenors also contend serious underestimates of health effects arise from omission of some radionuclides altogether from the calculations. Some radionuclides, indeed, are omitted from the calculations; however, this fully accords with applicable Regulations and has no affect on dose or health effects estimates.

11. Joint Intervenors' challenge is directed at the first step in dose calculation, namely, determination of the Source Term. Applicants and NRC staff include in Source Term all radionuclides having a potential to contribute significantly to exposure. No attempt has been made, nor is this required, to account for every possible radionuclide. This approach will not lead to any underestimate, let alone a serious underestimate, of dose or health effects for at least two reasons. First, the radionuclides omitted account for less than 1% in curies of the aggregate release from a nuclear power plant in routine operation, and this is an insignificant amount. Second, the Source Term is calculated conservatively based on actual releases as experienced in operating nuclear power plants. Based on these conservatisms, the releases in curies calculated for Shearon Harris can be expected to be (based on experience at operating plants) greater than the amount of release that will be experienced at Shearon Harris during routine operation. Accordingly, Source Term determination in the modeling is neither incorrect nor does it lead to serious underestimate of dose or health effects.



12. Joint Intervenors cite the LEAF Study in support of their Contention. This Study, whatever its merit (and it has been seriously criticized by the Wisconsin Department of Health), has nothing to do with the dose modeling by Applicants and NRC staff in this proceeding. The study referenced by Joint Intervenors addresses only the monitoring program of the Wisconsin Public Health Department, and the Study states this department limits its monitoring to three radionuclides. Whether accurate or not, this reference to Wisconsin State practices obviously has nothing to do with modeling by Applicants and NRC staff. In fact, the models and Source Term in this proceeding include dozens of radionuclides, not just three.

#### INTERNAL EMITTERS

13. Joint Intervenors contend that health effects are seriously underestimated from underestimating internal emitters due to incorrect modeling of internal absorption of radionuclides. Joint Intervenors thereby are questioning the dose conversion factors found in Reg. Guide 1.109. Contrary to Joint Intervenors' Contention, health effects are not seriously underestimated on this basis.

14. Reg. Guide 1.109, as I indicated, contains over 4,000 separate calculational values, including hundreds of dose conversion factors, for the parameters required to perform the dose calculation. Many of these parameters are subject to continual research, as may be attested to by a review of the papers recently published in the Health Physics Society Journal. As a result, at any point in time, individual values in Reg. Guide 1.109 may be judged to be marginally too high or marginally too low. Independent reviewers have indicated that there are isolated parameters which may be considered liberal; but they are

compensated for by numerous modeling assumptions and parameters which are conservative resulting in an overall estimate of dose which is reasonable, if not conservative.

15. Overall, as I have indicated, given the many conservatisms in the modeling process, the calculated dose can be expected to exceed the actual dose received from Shearon Harris operation.

16. Intervenors cite in support of their Contention variety of sources. The principle one being Translation 520 and the LEAF Studies. Translation 520 has been thoroughly discredited by the scientific community. See exhibit B attached hereto. The LEAF Study, relies on and actually use the absorption factors listed in Regulatory Guide 1.109. In no place in the LEAF Report is there any criticism of the absorption factors used by the NRC. Joint intervenors remaining references are irrelevant to the contention, are without merit or both.

17. In Contention II(c), Joint Intervenors claim the DES seriously underestimates health effects from operation of Shearon Harris because the DES estimates "effects over an arbitrarily short period of time compared to the length of time the radionuclides actually will be causing health and genetic damage". According to Joint Intervenors, effects should be estimated for the lifetime of all radionuclides released, and, at a minimum, should be estimated for 11,000,000 years. Intervenors state that anything less (joint intervenors answer to interrogatory II-26 to 28) is arbitrarily short. Intervenors are wrong.

18. In the Shearon Harris DES, annual health effects are estimated based on the calculated population dose, expressed in units of person rems delivered for each year of projected plant operation. Substantially lower levels of person rems will continue after operation and the DES does not expressly calculate the health effects therefrom. This is quite appropriate, certainly not arbitrary, and in no way affects the cost/benefit analysis made in the DES. To estimate health effects as Intervenor suggests, as against the approach taken in the DES, would be both scientifically inappropriate and unnecessary.

19. The Joint Intervenor's proposed approach is scientifically inappropriate because any resulting estimate would be misleading and specious. The DES estimate covers a period (operating lifetime of the plant) for which health effects are at least arguably foreseeable. Joint Intervenor's approach, on the other hand, requires as a critical assumption that there will be no advance in medicine or health control for hundreds, thousands, and even millions of years. Such an assumption, of course, is utter nonsense. Especially is this true for the health effects here pertinent -- cancer and genetic defects -- two areas in which there is an incredible medical ferment and development. It would be scientifically inappropriate for a professional to project continuing health effects thousands of years into the future. Accordingly for the NRC staff to have followed the approach in the DES and to have refrained from making estimates into the uncharted future, far from being arbitrary, is scientifically required.

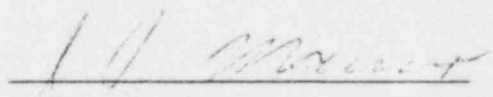


20. The DES approach is reasonable, and the Joint Intervenors' suggestion is unnecessary, because the NRC staff has selected for comparison the period in which the comparative proportion of dose and health effects would be greatest at Shearon Harris. Further computation, accordingly, is unnecessary. In making the cost/benefit analysis in the DES, the NRC staff compares Shearon Harris dose and resulting health effect for a year of reactor operation (RRY-referenced reactor year) with the dose and health effect from natural background radiation and with health effects spontaneously occurring in the population. The resulting calculated annualized dose (56 person-rem) and effect (.008 cancer deaths, etc.) are negligible in comparison to background radiation levels, spontaneously occurring health effects, or in comparison with any other standard. The RRY comparison by the Staff, nonetheless, represents the highest comparative impact for any year following plant shutdown or for any period of time beyond the period of Shearon Harris operation. This is because dose or effect in years following plant shutdown never will be greater than a small fraction of dose or effect in any year of operation, while the comparative figure (be it background radiation, spontaneously occurring health effects, or otherwise) will not be so reduced. Thus, in a year following reactor shutdown, the numerator in any ratio (dose or effect attributable to Shearon Harris' prior operation) will be less than that for a reference reactor year, but the denominator (the comparative natural background radiation, etc.) will be unchanged. Necessarily, the ratio in such a later year will be less than in the reference reactor year. Similarly, if we sum any periods of time (be it 100, 1000, 10,000 or more years) this

comparative projection still will not increase. Of course, if we sum all years of operation, the ratio will be constant as that ratio is calculated in the DES as a constant for all 40 reactor years. If we sum any greater periods, the resulting ratio necessarily will be lower than for a reference reactor year, since, again, the additional years will add comparatively less to the numerator (additional dose or effect from Shearon Harris power operation) than to the denominator (cumulative natural background radiation, cumulative spontaneously occurring health effects, etc.)

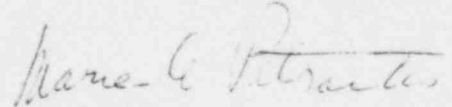
21. In sum, the NRC staff and the DES has determined the maximum ratio of health effects from Shearon Harris operation. To make additional calculations that would only lessen that comparative ratio is not only unnecessary, it is nonsensical.

22. There is nothing in Goffman's book which addresses the NRC's utilizing "arbitrarily short period of time" in considering health effects. Dr. Caldicott makes no statement regard "arbitrarily short period of time" in evaluating routine releases from a nuclear power plant. The January-February 1982 issue of Nuclear Safety does not contain an article by T. H. Pigford. Kepfords testimony, as referred by joint-intervenors, I understand was rejected by the NRC Appeal Board.

  
John J. Mauro

Subscribed and Sworn to  
Before me  
3rd day of October 1983.

My commission expires

  
MARIE G. PETRAITIS  
Notary Public for the State of North Carolina  
My Commission Expires 10/31/84  
Commission Expires 10/31/84

4/83

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JOHN JOSEPH MAURO  
Certified Health Physicist

SUMMARY OF EXPERIENCE (Since 1970)

Total Experience - 12 years total experience. Six years experience in calculating projected exposures of radionuclides in the environment and evaluating the biological significance of these exposures. Six years experience in managing radiological and hazardous chemical consulting projects.

Professional Affiliations - Health Physics Society  
ANSI Committee N18 - Guide to Standard Format  
and Content of Emergency Plans for Nuclear  
Power Generating Facilities

Education - PhD, New York University, 1973 - Biology, Radiological Health  
MS, New York University, 1970 - Biology, Radiological Health  
BS, Long Island University, 1967 - Biology, Bacteriology

Awards - Alvin Gruder Memorial Award  
Founders Day Award

REPRESENTATIVE ENVIROSPHERE PROJECT EXPERIENCE (Since 1973)

1973 to Present

Radiological Assessment Scientist/Director Radiological Assessment and  
Health Physics Department

Responsible for evaluating the radiological impact of nuclear power plant operation for Ebasco's client utilities. Prepared the requisite sections of the Environmental Reports and Safety Analysis Reports and defended these analyses before the NRC, the Advisory Committee on Reactor Safeguards, State Site Certification Boards and the Atomic Safety and Licensing Boards. Provided these services for 10 nuclear power plants.

Responsible for the calculation of projected radionuclide inventories and liquid and gaseous source terms associated with various aspects of normal plant operation and hypothetical accidents. Experienced in the calculation of the projected environmental transport, distribution and concentration of radionuclides released in the liquid and gaseous effluent of nuclear power facilities; the calculation of the projected exposures to man and organisms other than man due to radionuclides in the environment; and the evaluation biological effects of exposure to radiation.

JOHN JOSEPH MAURO (Continued)

Experienced in the design of environmental radiological surveillance programs for nuclear power facilities. Has installed and calibrated radiation detection instrumentation at low level radiological laboratories and participated in the training of laboratory personnel.

Has managed the preparation of several emergency response plans and implementation procedures for commercial nuclear power facilities and for state agencies responsible for emergency response planning.

Has provided radiological and emergency response training to health physicists, nuclear engineers and members of state and local agencies responsible for emergency planning.

Has managed the preparation of the environmental/radiological technical specifications and offsite dose calculation manuals for several nuclear power facilities.

Has managed numerous consulting projects in the area of decommissioning, environmental monitoring, environmental dosimetry in-plant health physics for the nuclear fuel cycle.

Has performed several toxic chemical studies in support of nuclear power plant control room design and in the assessment of the radiological and chemical toxicity of low level radioactive wastes.

PRIOR EXPERIENCE (2 years)

Private part-time consulting work.

Worked on the radiological effects sections of a nuclear power plant environmental impact report. Drafted answers to interrogatories from an AEC licensing hearing.

New York University Institute of Environmental Medicine  
Assistant Research Scientist (2 years)

Performed research work on the life history of white perch in the Hudson River. Aided in the cataloging and enumeration of invertebrates in the Hudson River. Participated in a project to develop techniques to determine and ability of various micro-organisms to organify inorganic mercury.

Publications and Presentations

Mauro, J J and M E Wrenn 1972. A review of radiocesium in aquatic biota. Presented at the Health Physics Society Annual Meeting, Las Vegas, Nevada, June 12-16.



JOHN JOSEPH MAURO (Continued)

Mauro, J J and M E Wrenn 1973. Reasons for the absence of a trophic level effect for radiocesium in the Hudson River Estuary. Presented at the IRPA meeting held in Washington, D.C. in October. Published in the proceedings of that meeting.

Mauro, J J, and J Porrovecchio. Numerical criteria for in-plant as low as is reasonably achievable proceedings of the 9th Mid-Year Topical Symposium of the Health Physics Society.

Mauro, J J, D Michlewicz and A Letizia 1977. Evaluation of environmental dosimetry models for applicability to possible radioactive waste repository discharges, Y/OW1/SUB-77/45705, September.

Mauro, J J 1978. Comparison of gaseous effluent standards for nuclear and fossil fuel power production facilities. Proceedings of the December 1978 Annual Meeting of the American Nuclear Society.

Mauro, J J, J Thomas, J Ryniker and R Fellman 1979. Airborne uranium, its concentration and toxicity in uranium enrichment facilities, K/PO/SUB-79/31057/1, February.

Mauro, J J, K E Lind, J D Levine, L Yemin, H J Howe, Jr and C W Pierce 1979. Safety related research required to support future fusion research reactors. Presented at the Annual Meeting of the American Nuclear Society-San Francisco, November.

Mauro, J J and E P O'Donnell 1979. A cost-benefit comparison of nuclear and nonnuclear health and safety protective measures and regulations. Nuclear Safety, Vol. 20 No. 5, September-October.

Mauro, J J 1980. A real time computer program for offsite radiological impact assessment. Presented at the 1980 Annual Meeting of the American Nuclear Society. TANSO 34 1-899.

Mauro, J J, R Bhatia and G Martin 1980. Effects of containment purge on the consequences of a loss of coolant accident. Presented at the 1980 Annual Meeting of the American Nuclear Society. TANSO 34 1-899.

Mauro, J J and S Marschke 1980. Radiocesium transport into reservoir bottom sediments - a licensing approach. Presented at the 1980 Annual Meeting of the ANS. TANSO 34 1-899.

Mauro, J J and D Michlewicz 1981 deployment concepts for Real Time Environmental Dosimetry Systems. Presented at the 1981 Annual Meeting of the Health Physics Society.

Mauro, J J and E P O'Donnell 1982. The role of the Architect/Engineer in the Emergency Planning Process. Presented at the Annual Meeting of the American Nuclear Society. June 6-10, 1982.



JOHN JOSEPH MAURO (Continued)

Mauro, J J and W R Rish 1982. Dealing with Uncertainties in Examining Safety Goals for Nuclear Power Plants. In NUREG/CP-0027. Proceedings of the International Meeting on Thermal Reactor Safety.

Mauro, J J, S Schaffer, J Ryniker, and J Roetzer. Survey of Chemical and Radiological Indices Evaluating Toxicity. National Low-Level Radioactive Waste Management Program. DOE/LLW-17T. March, 1983.

Summary of Critiques of the "Heidelberg Report"I. NRC Review, NUREG-0668

The NRC critique of the Heidelberg Report focused on the key elements of the source terms, atmospheric dispersion factors and dose conversion factors. The NRC found that the liquid and gaseous source terms used in the report were many times greater than the average source terms from operating plants in the U.S. and therefore do not reflect U.S. operating experience.

The NRC found that the atmospheric dispersion factors were derived using data assembled from five separate meteorological stations. No single station was used to obtain the basic wind speed, stability class and wind direction joint frequency data. As a result, combinations of wind speed, direction and stability class are used which have no meaning in reality. Using approximations, the NRC believes that the peak X/Q used in the Heidelberg Report may be high by a factor of 10 or more.

The NRC found that the soil to plant concentration factors (Biv values) were not supported by the literature cited. Specifically, the Cs and Sr Biv values were selected at the high end or well beyond the high end of the experimental data.

Also, the dose conversion factors for Cs-137 and Sr-90 are much higher than those used by the NRC and are not supported by

experimental data. The NRC factors are based on International Council on Radiation Protection ("ICRP") guidelines.

As its final critique, the NRC reviewed environmental radiological surveillance data around operating reactors in the U.S. the NRC determined that if Heidelberg models were valid, then high, easily detectable levels of I-131 and Cs-137 would be found in the vicinity of operating reactors, when in fact they are not.

## II. The University of Heidelberg

Dr. E. K. F. Brutz, Dean - Faculty of Biology of the University of Heidelberg, in a letter to the NRC, stated that the Heidelberg Report was not prepared or sponsored by the University, but rather was prepared by a group of graduate students aided by a few junior faculty members. The group represented itself as being sponsored by the University, against the direct instructions of the President of the University. Dr. Brutz referred to the group as a "bunch of students setting out to prove their philosophy right" and coming up with "data based more on fancy than fact." He was also apologetic that the NRC had to "go through the pains having to referee such silly claims."

The degree to which the University was concerned with the Heidelberg Report is demonstrated by the legal action brought by the University to restrain the authors of the Report from referring to their group as the Tutorium Environmental Protection at the University of Heidelberg.

### III. Ministerium Fur Arbeit Gesundheit Und

#### Sozialordnung Baden (German

#### government nuclear power plant licensing agency)

J. Narrog of the German licensing agency was extremely critical of the Report, referring to it as "less a serious scientific report but rather a public relations paper of opponents against nuclear energy. All European institutions, which dealt with the report, came to similar statements."

On a more technical side, J. Narrog demonstrated that there was no agreement between the average radionuclide release rates for operating power plants in Germany and the Heidelberg Report source terms. In addition, site specific meteorological data have shown the Heidelberg dispersion factors to be at least 2 fold too high. Finally, J. Narrog stated that environmental surveillance programs at operating plants in Germany have "never showed numbers in the magnitude of the estimated concentration values of the Heidelberg Report for CS-137, CS-134 and I-131."

### IV. Federal Energy Production Office -

#### Nuclear Installation Safety

#### Division (Germany)

Drs. J. Czarencki, J. Halter, H. Pfeiffer, H. Fritz-Niggli and H. Brunnen published an extensive critique of the Heidelberg Report. Quoting from the critique, "The selection of the literature is one sided, obsolete and incomplete . . . . Insufficient or missing scientific knowledge and deficient

knowledge of the literature result in serious assumptions and assertions and incorrect conclusions . . . . In its conclusions, it is based on unsubstantiated statements, incorrect assumptions, unidentifiable calculations, exaggerated and unrealistic numerical values for the parameters used."

V. National Radiological Protection Board,  
Harwell, England:

G. S. Linsley echoed many of the above statements. In addition, he cited experimental work in England which supported the Biv values used by the NRC.

VI. Society for Reactor Safety (GRS)

The German Society for Reactor Safety was very critical of meteorological modeling used in the Heidelberg Report. They believe the Report's long-term diffusion factor is high by a factor of 3, and the deposition velocity of airborne particles is high by a factor of 4. The critique also included a retraction statement made by D. Teufel, co-author of the Heidelberg Report, regarding previous statements made in support of their dose conversion factors. Teufel admitted to the administrative court that, "[t]his cannot be checked by us precisely. The statement was probably made a little prematurely. It fell back to me, to my graduate work, in which this statement was made and which I must now retract."