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July 24, 1984

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

'84 JUL 27 A11:17

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
Carolina Power & Light Company and	)	Docket No. 50-400 CL
North Carolina Eastern Municipal	)	
Power Agency	)	
	)	
(Shearon Harris Nuclear Power	)	
Plant, Unit 1)	)	

JOINT INTERVENORS' FINDINGS OF FACT ON
JOINT CONTENTIONS II(e) AND II(c)

Pursuant to an oral order made by the Board on June 19, 1984, now comes the Joint Intervenors (Kudzu Alliance, Wells Eddleman, C.H.A.N.G.E., and the Conservation Council) with proposed findings of fact and conclusions of law concerning Joint Contentions II(e)--Concentration of radionuclides through interaction with fine particles--and II(c)--Calculations of radiological doses from normal releases. By telephone, Chairman Kelley granted an extension on the filing of these findings until July 24, 1984.

The purpose of litigating these environmental contentions is primarily to disclose fairly the reasonable risks associated with the operation of the Shearon Harris Nuclear Power Plant. These findings are to assist the Board in preparing its order relating to the environmental part of the Operating License.

Joint Contention II(e)--Fine Particles

Both the Applicants and the Staff have underestimated the detrimental health effects arising from the normal operation of the Harris plant as

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they do not accurately model the concentration of radioactive nuclides associated with fine airborne particles. The following are findings of fact which support this position:

1. Joint Contention II(e) states:

> "The longterm 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. . .radionuclides absorbed in or attached to fly ash from coal plants which are in the air around the SHNPP site. . ."
> (after modification in the Board's Order of January 27, 1984).

2. Applicants submitted testimony by Drs. John J. Mauro and Steven A. Schaffer, both of the Environsphere Division of Ebasco Services, which is the architect/engineer for the Harris plant (Tr. 1610). The NRC Staff presented Edward F. Branagan, Jr., Senior Radiobiologist within the Office of Nuclear Reactor Regulation. Dr. Mauro returned to the stand to respond to questions raised by the Board and cross-examination.

3. A copy of a paper by G. L. Fischer and D. F. S. Natusch, titled "Size Dependence of the Physical and Chemical Properties of Fly Ash" had been filed as Eddleman Exhibit No. 1 relating to Eddleman Contention 8f(1)--Health effects of coal particles. This paper is also relevant to this contention as reference was made to it at several places in the hearing (Tr. 1617 and 1647) and to some extent Joint Contention II(e) and Eddleman Contention 8f(1) deal with related matters.

4. Normal releases of radiation from the Harris plant causes radionuclides to attach themselves on airborn particles or fly ash by adsorption, absorption, ionization, and nucleation. Applicants' witnesses did not address the differences in the mechanics of these different processes and in fact

"were not that concerned about the mechanisms of the attachment" (Tr. 1664).

5. 98% of inhalable radioactive material is Tritium (Applicants' testimony, p. 4 top) so any increase would substantially raise the whole body dose (Tr. 1680). As Tritium has a half-life of approximately 12 years, it is possible to calculate the disintegrations of it per second (Tr. 1679). Tritium is primarily present as tritiated water vapor and often acts similarly to water vapor. In a process termed "nucleation", Applicants witnesses stated, "coal particulates can grow in size due to the water attaching to it" (Tr. 1669). Applicants did not take "electrostatic phenomena" into account (Tr. 1675). When taken into the body, Tritium is rapidly absorbed into body fluids (Tr. 1763). Tritium accounts for all or almost all of the radioactivity to the total body, GI tract, liver, kidney, and skin, and a substantial contributor to the lung and thyroid (Applicants' testimony, Table following p. 13). Applicants' witnesses did not address the increase of Tritium attaching to particles, only as water vapor (Tr. 1691). Tritium has a specific activity of 10^{-11} curies per gram "at the off-site location with the highest annual average Chi over Q" (Tr. 1746).

6. Applicants did not squarely address Tritium in its conclusions yet at one point treated Tritium as a wet particle (Tr. 1682). After Tritium is absorbed it delivers a radiological dose to the whole body, and in discussing this process, Applicants' witness stated, "it's more detrimental to deliver the dose to the whole body than to localize and deliver the dose to the lung" (Tr. 1689).

7. The Ebasco model presented by Applicants makes the following assumptions:

a) 75% of the inhaled particles is deposited in the lung (Tr. 1711; Applicants' testimony, p. 7), of which one-third stays in the deep lung (Tr. 1839);

b) the annual average of fine particles is determined to be 100 $\mu g/m^3$ (PEDCo 1982; Applicants' testimony, Att. 2, p. 2-3);

c) the deposition velocity for fly ash is 0.21 cm/sec based on a median size particle of 2 μm (Applicants' testimony, p. 15);

d) half of the insoluble particles deposited in the deep lung are removed within 24 hours (Applicants' testimony, p. 7);

e) soluble particles pass through the lung into the body fluids (testimony, p. 9)

f) the plume pattern from the Harris plant will concentrate into a standard Gaussian distribution (Tr. 1793).

8. Most of the above assumptions were found deficient upon cross-examination. The amount of inhaled material which is deposited varies between 10 and 100% depending on the size of the particle (Applicants' testimony, p. 8) with a minimum of 30 to 60 % being deposited into the deep lung (Tr. 1839; reference to EPA document). There was no effort made to determine what the size range of particles is in the vicinity of the Harris plant or what the composition is of the discharge from the Cape Fear plant which is 12 miles up-wind from the Harris plant to the south-southwest (Tr. 1819). Particles from the Cape Fear plant, which burns coal, would reach the Harris plant within one hour (Tr. 1800). Neither of Applicants' witness had experience in precipitator technology (Tr. 1806) or how precipitator efficiency could effect the distribution (Tr. 1828) or resistivity of the fly ash (p. 1828). There was uncertainty as to the assumed deposition and clearance patterns (Tr. 1795). Deposition velocity of particles ranged from 0.12 cm/sec to 1.81 cm/sec (Tr. 1798; Reg Guide 1.111) or from 0.015 cm/sec to 4.0 cm/sec (EPA 1982). There has been no site-specific study (Tr. 1790) and there is also the need to go back with an environmental surveillance program to confirm the model (Tr. 1798). The PEDCo study relied upon by the Applicants contains a discrepancy in the amount of fine particles found in North Carolina; one table states that there is 56 $\mu g/m^3$ of particles less than 15 microns, another states that there is 56

$\mu g/m^3$ of particles less than 2.5 microns, a substantial difference (Tr. 1736).

9. There was no study done of adsorption or absorption of noble gases onto coal particulates (Tr. 1837) by the Applicants or by the Staff (Tr. 1882). The Staff relies on UN Report (Appendix C, cite on Tr. 1912) which does not mention noble gases or whether they were looked for in association with radioactive nuclides on fly ash (Tr. 1924).

10. Applicants' witnesses state that newer models of determining the radiological doses from airborne particulates are more precise as they are based on new information and research (Tr. 1720 - 1724). Witness Mauro cannot state specifically whether the new models would produce different results but states that "it is more realistic treatment of the behavior of radionuclides" (Tr. 1724 - 1725). Applicants have not used the newer models in preparing their testimony (Tr. 1728 - 1729).

11. Although radioactive material deposited in the lungs may go to the lymph nodes via macrophages (Tr. 1701, 1705 et seq.), dose conversion factors were not given for the lymph nodes (Tr. 1726; see table following Applicants' testimony p. 13).

12. Figure 1 (Applicants' testimony following p. 9; also EPA Fig. 11-9 on p. 11-28) portrays an "eye-fit" or judgmental band consisting of the results of various studies of the deposition of monodisperse aerosols of varying diameters (For discusion, see Tr. 1620 et seq.). A substantial number of test data results exceed the uppermost limit of the band which may be increased when one looks at the ranges of Altshuler et al. (1967) which portrays normal breathing in volume (500 ml) and rate (15 breaths/minute) and Salhofen et al. (1981) which portrays slow, moderate breathing (Tr. 1633). The percentage of particles deposited varies considerably upon mouth vs. nose breathing, shallow vs. deep, rapid vs. slow, and as a composition of these, whether one is awake

or asleep. The use of a monodisperse aerosol in these tests disregards the possibility for the agglomeration of the particles and may prove irrelevant to this proceeding as a result (Tr. 1625).

13. The testimony prepared by the staff assumes that 100% of the inhaled particles remain in the lung, while in the FES it was assumed that 75% would remain (Staff testimony, p. 4). The Staff assumes no difference between the deep lung and the upper lung (Tr. 1877). The Staff bases its entire analysis on the thyroid, which it considers the maximally exposed organ although it is not the most sensative organ to radiation (Tr. 1947). Releases of radiation which effect the thyroid are primarily radioactive iodine and radioactive particulates (which includes Tritium) (see FES, Table D-7 on p. D-10). Dose conversion factors for other organs are readily available and are discussed in Staff testimony (pp. 3 - 4). The Staff concludes that after recalculation, "the dose to the thyroid of the maximally exposed individual from inhalation of iodines and particulates would be increased from 0.2 mrems/year to about 0.3 mrems/year. These dose estimates are based on inhalation of iodines and particulates from the reacor and do not include exposure to naturally occuring radionuclides in coal fly ash" (Staff testimony, p. 4).

Joint Contention II(c)--Calculations of radiological doses

Both the Applicants and the Staff have underestimated the longterm health effects of normal radiation releases as they examine the effects over an arbitrarily short period of time and disregard certain health effects. The following are findings of fact which support this position:

14. Joint Contention II(c) states:

> "The longterm somatic and genetic health effects of radiation releases from the facility furing normal operations, even where such releases are within existing guidelines, have been seriously underestimated for the following reasons: (c) the work of Gofman and Caldicott shows that the NRC has erroneously estimated the health effects of low-level radiation by examining effects over an arbitrarily short period of time compared to the length of time the radionuclides will be causing health and genetic damage." (see Board's Order of January 27, 1984).

15. Applicants submitted testimony by Dr. John J. Mauro and Mr. Stephen F. Marschke, an engineer, both of the Environmshpere Division of Ebasco Services, which is the architect/engineer for the Harris plant. The NRC Staff presented Edward F. Branagan, Jr., Senior Radiobiologist within the Office of Nuclear Reactor Regulation.

16. Applicants demonstrate radiological doses and the resultant risks to the population within a 50-mile (80 kilometer) radius around the plant (see Applicants' testimony p. 4). The doses to this population occur through ingestion of fish in the main reservoir and Cape Fear River, external exposure from air submersion and deposited radioactivity, and internal exposure from inhalation and ingestion of contaminated food (Applicants' testimony pp. 4 - 5). Exposure to the entire US population occurs primarily through the dispersion of airborne gases, most notably Krypton-85 (Tr. 2023). Table 1 (Applicants' testimony p. 6) shows that approximately 94% of the total annual whole body person-rems for the US consists of gaseous emissions from the plant.

17. Applicants show that annual whole body doses due to normal releases from the plant are determined to be 15.4 person-rems (50-mile radius) and 25.7 person-rems (US as a whole). 40-year whole body doses are determined to be 624 person-rems (50-mile) and 1738 person-rems (US). An additional 8 person-rems (50-mile) and 706 person-rems (US) would be added over the 100-year period following the shutdown of the plant (Applicants'

testimony pp. 6 - 7, incl. Table 1). This "residual dose" increases the total dose to the US population over the life of the plant by approximately 40% yet is disregard in determining the total risk from the plant (Tr. 1991 - 1992; Applicants' testimony, Attachment 3, Table B, p. 3-6). Staff witness Branagan said it would be reasonable to include the residual dose in the FES (Tr. 2063).

18. Cumulative absolute risk of fatal cancers was determined to be .10 (50-mile) and .25 (US) using risk coefficients and the methodology presented in BEIR I (Applicants' testimony, p. 13; Attachment 6 for details). Cumulative relative risk was determined to be approximately four-fold higher, that is, .40 (50-mile) and 1.0 (US) (Tr. 2049; Staff concurs, Tr. 2104). Both absolute risk and relative risk are found in the BEIR report (Tr. 1999).

19. Maximum individual doses for the life of the plant was determined to be about 2×10^{-5}. This was also calculated using the age specific cancer risk coefficients and the methodology presented in BEIR I (Applicants' testimony, p. 13; Attachment 6). This did not address the risk from conception to birth of the fetus which would increase this by approximately 5% (Tr. 1987). The risk to the fetus of radiological doses is higher than to an adult (Tr. 1979 et seq.).

20. This risk of not having the plant in operation is zero (0.0) and risks should be compared to no plant rather than to background levels (Tr. 2129). Studies of actual background levels of radiation purported to be conducted by Applicants will not be made part of this record so the Board should disregard the discussion of them on Tr. pp. 2002 - 2010. The FES at Table 9.1 presents background levels of radiation at 87.8 mrems/year but does not include internal doses from naturally occuring Potassium-40 which would add an additional 20 mrems/year (Tr.2003).

21. Nonfatal cancers can be determined by multiplying the risk of fatal cancers by approximately two times (Applicants, Tr. 2040) or by 1.5 to 2.0 times (Staff testimony, p.7; BEIR III, 1980).

22. The Applicants analysis assumes that there are no gender-based differences (Tr. 1976 - 1977). It is not correlated to any actual exposure to any individual or individuals (Tr. 1988). It assumes a constant population in the 50-mile radius around the plant and for the US (Applicants' testimony, p. 8) although doubling the population or increasing the food production would significantly increase the amount of person-rems (Tr. 2041).

23. Staff analysis assumes a 5 mrem/year exposure to the whole body to the maximally exposed individual (Staff testimony p. 5; Tr. 2100). Staff witness declared this to be a conservative risk (Tr. 2090) as this person "would have to spend almost all or his or her time at the site boundary, and obatin almost all of his or her food grown at an off-site location where the highest concentrations of radionuclides are expected in order to obtain a dose of 0.2 rems over the plants (sic) life"(Staff testimony, p. 8 top). This person would also get additional exposure due to gaseous and liquid effluents which would give that person a dose greater than 8 mrems/year (Tr. 2087). There was basis given for the Staff assumption of 5 mrem/year (Tr. 2099 - 2100).

24. Staff witness declared that it was conservative to assume that releases of radiation from the Harris plant would not exceed the dose design objectives found in Appendix I of 10 CFR 50 (Tr. 2082). He states in his prefiled testimony that "the Staff based its dose estimates to a maximally exposed individual on the annual dose design objectives for exposure to various types of effluents (Staff testimony, p. 4; Tr. 2066). The values in the FES (Appendix D) are however less than the dose design objectives

(Tr. 2066). This is not realistic as there is nothing to insure that the plant will not surpass its dose design objectives. The review of emissions from other operating plants found in Table 4-1 (Applicants' Attachment 4) shows that some of the releases from operating plants are much higher than the average and likely exceed the dose design objectives (Tr. 2071 et seq.). The conversion of curies per reactor per year into person-rems can be performed by the GASPAR computer program (NUREG - 0597)(Tr. 2081).

25. Although Staff declares that relative risk gives an upper reasonable limit to the range of uncertainty of risk estimates (Tr. 2104), others, most notably Drs. John Gofman and Carl Morgan, give substantially higher risks associated with exposure to radionuclides (Tr. 2114).

26. The Staff uses a figure of 258 cases of all forms of genetic disorders per million person-rems (Staff testimony p. 7). A reasonable upper limit would be approximately six times that or approximately 1500 cases (Tr. 2119).

27. Neither the Staff or Applicants made any study or other calculations of fetal losses (Applicants, Tr. 2040; Staff, Tr. 2130). The Applicants did not calculate the genetic defects which would arise from the plant's operation (Tr. 2037) and the Staff did not perform any study on the radiation-caused effects on the fetus which might result in birth defects, learning or other cognitive damage (Tr. 2130).

28. Neither the Applicants or the Staff made any analysis of the risk of the plant's operation to the world population (Applicants, Tr. ; Staff, Tr. 2124). Judge Foreman stated that the world population is approximately 4 billion (although the figure is closer to 4.75 billion) so the cumulative risk of cancers and genetic defects could be figured out and should be included.

29. An understandable method would be to list all risk figures over the 40-year life of the plant rather than annually.

Conclusion

30. In regards to Joint Contention II(e), the Applicants' analysis is inadequate because, among other reasons discussed above, it disregards effects from Tritium which attach to particles present around the plant, it makes several assumptions which unnecessarily minimize the risk, it does not address the mechanics of how radioactive material is attached to the particles or how different size particles effect body organs, and it is not based on any site-specific analysis of the area. Staff analysis is also inadequate as it assumes an additional 33% increase in the amount of particles which remain in the lung over what is stated in the FES, it makes no analysis of noble gases or their daughters, and it only analyzes risks to the thyroid which is not the most sensative organ.

31. In regards to Joint Contention II(c), the Applicants' analysis is inadequate because, among other reasons discussed above, it ignores residual doses to the US population in its risk assessment, it does not analyze the additional danger to the fetus, and it relies solely on absolute risk rather than a range including relative risk. Staff analysis is also inadequate because it assumes without any basis that the maximally exposed individual will receive 5 mrem/year exposure to the whole body, it assumes that the Harris plant will not exceed its dose design objectives, and it views relative risk to be the upper limit. Neither Staff or Applicants did any analysis on all aspects of genetic disorders or fetal losses.

32. As a result, modifications must be made in both the ER and the FES which show the reasonable risks associated with the operation of the Harris plant. More accurate and complete analyses must be conducted in order to

correct the flaws mention above. The Board's Order should include a realistic time-table for completing the needed analysis.

Respectfully submitted,

John Runkle

John Runkle
for the Joint Intervenors

This is the 24th day of July, 1984

CERTIFICATE OF SERVICE

I hereby certify that copies of JOINT INTERVENORS' FINDINGS OF FACT ON JOINT CONTENTIONS II(e) AND II(c) have been served on the following by deposit in the U.S. mail, first class postage prepaid, or by hand-delivery on this 24th day of July, 1984.

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