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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

NRC STAFF TESTIMONY OF
EDWARD F. BRANAGAN, JR. ON JOINT CONTENTION II (c)

Q.1. Dr. Branagan, please state your name and affiliation.

A.1. My name is Edward F. Branagan, Jr. I am a Senior Radiobiologist in the Radiological Assessment Branch, Division of Systems Integration within the Office of Nuclear Reactor Regulation. A copy of my professional qualifications is attached.

Q.2. Dr. Branagan, what is the purpose of this testimony?

A.2. The purpose of this testimony is to address Joint Contention II subpart (c). Joint Contention II (c) as originally admitted states:

Joint Contention II

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: (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 actually will be causing health and genetic damage.

The Board modified this contention in it's Order of January 27, 1984 (pp 39-41). This modification focused on the following issues: (1) Whether the environmental impact statement should provide the total risk associated with exposure to radioactive effluents from normal operations for the 40-year life of the plant; and (2) whether the environmental impact statement should take into account the incremental impact on people who live near the plant for many years.

Q.3. Over what time period did the Staff estimate radiological impacts from exposure to effluents released from Shearon Harris during normal operation?

A.3. The time period for evaluating doses is described in the FES, page 5-26, as follows:[1/]

> When an individual is exposed through one of these pathways, the dose is determined in part by the amount of time he/she is in the vicinity of the source, or the amount of time the radioactivity inhaled or ingested is retained in his/her body. The actual effect of the radiation or radioactivity is determined by calculating the dose commitment. The annual dose commitment is calculated to be the total dose that would be received over a 50-year period, following the intake of radioactivity for 1 year under the conditions existing 20 years after the station begins operation. (Calculation for the 20th year, or midpoint of station operation, represents an average exposure over the life of the plant.) However, with few exceptions, most of the internal dose commitment for each nuclide is given during the first few years after exposure because of the turnover of the nuclide by physiological processes and radioactive decay.

1/ As utilized in this testimony, "dose" refers to the "dose equivalent" for an individual and the "collective dose-equivalent commitment" for a population.

Q.4. Did the staff present "the total risk represented by the life of the plant" in the FES?

A.4. No. Radiological impacts from exposure to effluents released from Shearon Harris during normal operations were presented on an annual basis in Section 5.9.3 and Appendix D of the FES.

Q.5. Why were radiological impacts presented on an annual basis, rather than summed over the life of the plant?

A.5. There are several reasons. First, applicable regulations (i.e., 10 CFR 20; and 10 CFR 50, Appendix I) contain annual limits or design objectives, rather than cumulative limits or design objectives. Second, the benefits from operating the plant were expressed on an annual basis in the FES. Integrating the impacts over the lifetime of the plant would be counterbalanced by integrating the benefits over the lifetime of the plant.

Q.6. Can the Staff provide an upper bound estimate of the incremental impact on people who live near the plant for many years as a result of exposure to radioactive effluents from normal operations?

A.6. Yes. The Staff has estimated the incremental impact on people who live near the plant for many years (hereinafter referred to as the cumulative impact) in the following manner. First, the Staff conservatively estimated the dose to the total body that a member of the public might receive from exposure to radioactive effluents from one year of normal operations. Second, the Staff multiplied

the dose from one year of operations by 40 years of reactor operations to estimate the cumulative dose for 40 years. Finally, the Staff estimated the risk of potential fatal latent cancers to the exposed individual by multiplying the cumulative dose by health risk estimators.

Q.7. For the purpose of estimating cumulative risk, how did the Staff estimate the dose that a member of the public might receive from exposure to radioactive effluents from normal operations of Shearon Harris Unit 1?

A.7. In Appendix D of the FES, the Staff presented its analysis which showed that the Shearon Harris plant had sufficient waste treatment systems to meet the dose design objectives in Appendix I of 10 CFR Part 50.[2/] Operation of the Shearon Harris facility will be governed by operating license Technical Specifications that will be based on the dose-design objectives of Appendix I to 10 CFR 50. Because these design-objective values were chosen to permit flexibility of operation while still ensuring that doses from plant operations are "as low as reasonably achievable," the actual radiological impact of plant operation may result in doses close to the dose-design objectives. For the purpose of this testimony, the Staff based its dose estimate to a maximally exposed individual on the annual

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2/ Some of the estimates in the FES pertain to operation of a two-unit facility. Since Unit 2 has been cancelled, the Staff in this testimony has provided cumulative risk estimates for operation of one unit at the Harris site.

dose-design objectives in Appendix I of 10 CFR Part 50 for exposure to the various types of radioactive effluents.

Q.8. What are the dose design objectives in Appendix I?

A.8. Appendix I of 10 CFR Part 50 provides numerical guidance on dose-design objectives for lightwater reactors to assure that doses to the public are as low as reasonably achievable.

The annual dose-design objectives in Appendix I for all unrestricted areas are as follows: 3 mrem/yr per reactor to the total body or 10 mrem/yr per reactor to any organ from all pathways of exposure from liquid effluents; 10 mrads/yr per reactor gamma air dose, or 20 mrads/yr per reactor beta air dose from noble gaseous effluents or 5 mrems/yr per reactor to the total body or 15 mrems/yr per reactor to the skin from noble gaseous effluents whichever is more limiting; and 15 mrems/yr per reactor to any organ from all pathways of exposure from airborne effluents that include the radioiodines and particulates.

Q.9. What dose did the Staff use in estimating the possible risk to an individual in the public?

A.9. The Staff has assumed that a hypothetical individual will be exposed to 5 mrems/yr to the total body. For 40 years of plant operation, the cumulative dose would be 0.2 rems. This is a conservative estimate of the dose to an individual, because it is unlikely that an individual will be simultaneously exposed at the dose-design

objective levels from gaseous and liquid effluents to the same body organs for 40 years. Actual doses to real individuals in the near vicinity of the site are expected to be a fraction of the dose of 0.2 rems. In order to obtain a dose of 0.2 rems, an individual would have to spend almost all of his or her time at the site boundary, and obtain almost all of his or her food grown at an offsite location where the highest concentrations of radionuclides are expected. The average dose to an individual within 50 miles of the site is expected to be about 500 times less than the preceding value. (FES, Table D-7, p. D-10).

Q.10. How did the Staff calculate the risk to an individual from this dose (i.e., 0.2 rems)?

A.10. The Staff estimated the risk of fatal cancers to the individual by multiplying a conservative estimate of the dose to the total body of an individual exposed to radioactive effluents from 40 years of operations by somatic (i.e., cancer) risk estimators.

Q.11. What risk estimators were used by the Staff in estimating potential health effects?

A.11. The following risk estimators (see FES, Section 5.9.3.1.1) were used to estimate potential health effects: 135 potential deaths from cancer per million person-rems and 258 potential cases of all forms of genetic disorders per million person-rems. The cancer fatality risk estimators used in this testimony are based on the "absolute risk" model described in BEIR I. Higher estimates can be

developed by use of the "relative risk" model along with the assumption that risk prevails for the duration of life. This would produce risk estimates up to about four times greater than those used in this testimony. The Staff regards this as a reasonable upper limit to the range of uncertainty. The lower limit of the range would be zero because health effects have not been detected at doses in this dose-rate range. The number of potential cancers would be approximately 1.5 to 2 times the number of potential fatal cancers. (BEIR III, 1980).

Values for genetic risk estimators range from 60 to 1500 potential cases of all forms of genetic disorders per million person-rems (derived from BEIR I, page 57). The value of 258 potential cases of all forms of genetic disorders is equal to the sum of the geometric means of the risk of specific genetic defects and the risk of defects with complex etiology.

Q.12. What would be the cumulative risk of cancer fatalities to an individual due to 40 years of plant operation?

A.12. Multiplying the preceding somatic risk estimator (i.e., 135 potential fatal cancers per million person-rems) by a conservative dose estimate of 0.2 rems, the Staff estimates that the risk of potential premature death from cancer to an individual exposed to radioactive effluents from 40 years of reactor operation is about 3 chances in one hundred thousand. This risk is a small fraction of the current incidence of actual cancer fatalities (about 20%,

American Cancer Society, 1978). As indicated in response to question 9, an individual would have to spend almost all of his or her time at the site boundary, and obtain almost all of his or her food grown at an offsite location where the highest concentrations of radionuclides are expected in order to obtain a dose of 0.2 rems over the plants lifetime.

Q.13. How does the Staff's estimate of the cumulative dose to an individual exposed to radioactive effluents for the plants lifetime compare with the dose from exposure to natural background radiation?

A.13. Exposure to natural background radiation in the United States varies from about 0.07 rems/yr to about 0.3 rems/yr depending on geographical location (Oakley, 1972). Assuming an average annual exposure of about 0.1 rems to natural background radiation for the State of North Carolina (Oakley, 1972), the dose to an individual exposed to radioactive effluents for the plants lifetime (i.e., 0.2 rems) is conservatively estimated to be about 3 percent of the dose from exposure to natural background radiation (i.e., about 7 rems over a 70-year lifetime).

Q.14. Has the Staff estimated the number of potential genetic disorders that may occur as a result of exposure to radioactive effluents from normal operations?

A.14. Yes. The Staff estimated the number of potential genetic disorders associated with exposure of the general public to radioactive

effluents from normal operations in the following manner. First, the Staff estimated the collective dose-equivalent commitment (hereinafter referred to as the population dose) to the population within 50 miles of the plant from exposure to radioactive effluents from one reactor-year of normal operations to be about 15 person-rems to the total body (FES, Table D-7, p. D-10). The cumulative population dose would be about 620 person-rems for 40 years of operation. Second, the Staff multiplied the cumulative population dose by genetic risk estimators to obtain the number of potential genetic disorders.

Q.15. What are the Staff estimates of the number of potential genetic disorders due to exposure to radioactive effluents?

A.15. Multiplying the cumulative population dose from exposure to radioactivity attributable to the normal operations (ihat is, 620 person-rems) by the preceding genetic risk estimator, the Staff estimates that about 0.16 of a potential genetic disorder may occur. The value of 0.16 is the sum of the number of potential genetic disorders that may occur over all future generations of the exposed population (within 50 miles) due to exposure to radioactive effluents from 40 reactor-years of operation. This value is small compared with the current incidence of actual genetic ill health in each generation (about 11%, BEIR III (1980)) of the population of about 1,750,000 persons within 50 miles of the plant.

Q.16. What do you conclude with respect to the issue raised in the Board's modification of Joint Contention II(c)?

A.16. I conclude that potential "long term somatic and genetic effects of radiation releases from the facility during normal operation" were estimated over an appropriate period of time. The risk of long term somatic and genetic effects of radiation releases from the facility during normal operation are a small fraction of the current incidence of actual cancer fatalities and actual genetic ill health in each generation. Estimation of cumulative risk instead of annual risk would not change that conclusion.

References

Advisory Committee on the Biological Effects of Ionizing Radiation, BEIR I, "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," National Academy of Sciences/National Research Council, November 1972.

Advisory Committee on the Biological Effects of Ionizing Radiations, BEIR III, "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," National Academy of Sciences/National Research Council, July 1980.

American Cancer Society, "Cancer Facts and Figures - 1979," 1978.

Oakley, D. T., "Natural Radiation Exposure in the United States," EPA Report ORP/SID 72-1, U.S. Environmental Protection Agency, Washington, D.C., 1972.

EDWARD F. BRANAGAN, JR.
OFFICE OF NUCLEAR REACTOR REGULATION

PROFESSIONAL QUALIFICATIONS

From April 1979 to the present, I have been employed in the Radiological Assessment Branch in the Office of Nuclear Reactor Regulation of the U.S. Nuclear Regulatory Commission (NRC). As a Senior Radiobiologist with the Radiological Assessment Branch, I am responsible for evaluating the environmental radiological impacts resulting from the operation of nuclear power reactors. In particular, I am responsible for evaluating radioecological models and health effect models for use in reactor licensing.

In addition to my duties involving the evaluation of radiological impacts from nuclear reactors, my duties in the Radiological Assessment Branch have included the following: (1) I managed and was the principal author of a report entitled "Staff Review of 'Radioecological Assessment of the Wyhl Nuclear Power Plant'" (NUREG-0668); (2) I served as a technical contact on an NRC contract with Argonne National Laboratory involving development of a computer program to calculate health effects from radiation; (3) I served as the project manager on an NRC contract with Idaho National Engineering Laboratory involving estimated and measured concentrations of radionuclides in the environment; (4) I served as the project manager on an NRC contract with Lawrence Livermore Laboratory concerning a literature review of values for parameters in terrestrial radionuclide transport models; and (5) I served as the project manager on an NRC contract with Oak Ridge National Laboratory concerning a statistical analysis of dose estimates via food pathways.

From 1976 to April 1979, I was employed by the NRC's Office of Nuclear Materials Safety and Safeguards, where I was involved in project management and technical work. I served as the project manager for the NRC in connection with the NRC's estimation of radiation doses from radon-222 and radium-226 releases from uranium mills, in coordination with Oak Ridge National Laboratory which served as the NRC contractor. As part of my work on NRC's Generic Environmental Impact Statement on Uranium Milling (GEIS), I estimated health effects from uranium mill tailings. Upon publication of the GEIS, I presented a paper entitled "Health Effects of Uranium Mining and Milling for Commercial Nuclear Power" at a Conference on Health Implications of New Energy Technologies.

I received a B.A. in Physics from Catholic University in 1969, a M.A. in Science Teaching from Catholic University in 1970, and a Ph.D. in Radiation Biophysics from Kansas University in 1976. While completing my course work for my Ph.D., I was an instructor of Radiation Technology at Haskell Junior College in Lawrence, Kansas. My doctoral research work was in the area of DNA base damage, and was supported by a U.S. Public Health Service traineeship; my doctoral dissertation was entitled "Nuclear Magnetic Resonance Spectroscopy of Gamma-Irradiated DNA Bases."

I am a member of the Health Physics Society.