UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of PENNSYLVANIA POWER & LIGHT COMPANY and ALLEGHENY ELECTRIC COOPERATIVE INC. (Susquehanna Steam Electric Station, Units 1 and 2)	Docket Nos. 50-387 50-388

AFFIDAVIT OF FRAZIER L. BRONSON IN SUPPORT OF SUMMARY DISPOSITION OF CONTENTION 5(a)

County of Philadelphia)
: ss.
Commonwealth of Pennsylvania)

Frazier L. Bronson, being duly sworn according to law, deposes and says:

1. I am Vice President, Nuclear Services Division, Radiation Management Corporation ("RMC"). My business address is 3508 Market Street, Philadelphia, Pennsylvania. I give this affidavit in support of Applicants' Motion for Summary Disposition of Contention 5(a) in this proceeding. I have personal knowledge of the matters set forth herein and believe them to be true and correct. A summary of my professional

qualifications and experience is attached as Exhibit "A" hereto.

2. Contention 5(a) states that Applicants have underestimated the milk transfer coefficient for iodine used to calculate individual and population doses from operation of the Susquehanna plant, and cites an article in Health Physics, 35 pp. 413-16, 1978 as authority for that claim. As will be seen below, there is a range of reported values of that coefficient in the scientific literature and the value used by Applicants in computing the Susquehanna doses falls within that range. Nevertheless, even if the value suggested in the Health Physics article is taken to be more appropriate than the one used by Applicants, there will be no significant change in the individual and population dose estimates for Susquehanna.

3. The levels of radioactivity in the environment resulting from routine releases from a nuclear power plant and the radioactive doses imparted upon members of the public as a result of those releases are estimated at the plant's preoperational stage by means of mathematical models. Two types of models are utilized for that purpose: models for the transport of radionuclides from the release point at a plant to the body of man ("pathway models"), and models for the dose received by the individual once radionuclides reach his body through the various pathways ("internal dosimetry models") (Reference 1).[1]

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1 References cited are listed at the end of the Affidavit.

4. The NRC Staff ("Staff") commissioned the development of pathway and internal dosimetry models to permit the preoperational calculation of estimates of radioactive effluents from operation of nuclear power plants, dispersion of those effluents in the atmosphere and water bodies, their transport to man through various exposure pathways, and the resulting radiation doses. A set of pathway and internal dosimetry models for exposures due to gaseous releases from a nuclear power plant was developed for the Staff by Battelle Pacific Northwest Laboratories in the mid 1970's. Those models are described in Regulatory Guide 1.109 (Reference 2) and have been put in the form of a computer code named "GASPAR" which is widely used by the nuclear industry. The models include suggested parameters to be used in the absence of specific data (e.g., a milk consumption rate of 330 liters per year for an infant exposed to radioisotopes in his food). The Staff regards these models as acceptable for calculating the radiological impact of the plant operation on individuals and populations and determining compliance with Appendix I to 10 CFR Part 50, and recommends their use by license applicants (Reference 2).

5. In computing the radioactive gaseous effluents from the Susquehanna facility for use in the Operating License Stage Environmental Report ("ER") and the Final Safety Analysis Report ("FSAR"), RMC utilized the GASPAR computer code embodying the Regulatory Guide 1.109 models, and adopted most of

the general parameters cited in the Regulatory Guide. See Susquehanna ER, vol. 2, section 5.2.4.2 and Table 5.2-25, attached as Exhibit "B" hereto.

6. One of the exposure pathways to man included in the Staff's models is the ingestion of milk containing radioactive iodine isotopes. As with other operating nuclear power plants, minute amounts of radioiodines may be released by the Susquehanna units into the atmosphere. A fraction of the radioiodines released may eventually be deposited onto plant foliage or may be taken up by the plants' root system from activity initially deposited on the ground. In turn, some of the radioiodines thus deposited on pasture grass may be consumed by dairy cows as fresh forage. Finally, a fraction of the radioiodines ingested by the cow may find their way into the animal's milk and will be available for ingestion by humans consuming that milk.

7. The most critical individuals for estimating the effects of radioiodines in milk are the infants (age 1 or less).[2] The basic formula relating the dose received by an infant ingesting milk and the amount of radioiodines released from a nuclear power plant can be expressed as

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2 The infant is the critical age group for radioiodine ingestion doses because the dose conversion factor (that is, the biological effect on the organ per unit of radionuclide intake) for iodine doses to the thyroid is highest for infants. For instance, for I-129, the dose conversion factor is 6.79×10^{-2} mrem/pCi for infants, 2.79×10^{-2} mrem/pCi for children, 9.55×10^{-3} mrem/pCi for teenagers, and 7.23×10^{-3} mrem/pCi for adults. See Susquehanna ER, Appendix E, Table E-2. The Food and Drug Administration has determined (based on evaluation of scientific studies) that the infant, and not the fetus, is the critical segment of the population with respect to radioiodine ingestion. 43 Fed. Reg. 58790, 58792 (December 15, 1978). This result is also borne out by a recent study for the NRC (Reference 6)

$$R = \chi \cdot k \cdot \frac{1}{\lambda_{eff}} \cdot Q \cdot F_s \cdot F_p \cdot F_m \cdot U_m \cdot D \cdot V_d$$

where:

χ = Equilibrium air concentration (pCi/m^3)

k = A unit conversion factor (86400 sec/day)

$1/\lambda_{eff}$ = Effective mean-time on pasture vegetation (days)

Q = Total daily dry matter intake of a dairy cow (kg/day)

F_s = Fraction of dry matter intake composed of fresh forage

F_p = Fraction of a year that dairy cows receive fresh forage

F_m = Intake to milk transfer factor (days/liter)

U_m = Annual milk consumption rate for infants (liters/year)

D = Thyroid dose conversion factor for infants (mrem/pCi)

R = Annual dose to the thyroid (mrem/year)

V_d = Air concentration to grass fraction ($\frac{m^3/sec}{kg}$).

The coefficient at issue in Contention 5(a) is F_m, the transfer coefficient to milk, which is the fraction of the radioiodine ingested daily by a cow that is secreted in one liter of milk during equilibrium conditions. As the formula shows, F_m is just one of nine multiplicative parameters that go into the dose calculation.

8. The value of F_m utilized in the radioiodine in milk dose calculations for the Susquehanna plant was 0.006 days/liter. This is the general value suggested by the Staff in Appendix E to Reference 2.

9. Recent surveys of the technical literature indicate that a range of values of F_m have been obtained by experimentation and environmental monitoring. The article at

35 Health Physics 413 (1978) (Reference 5) cited in the contention is one such survey. It shows values of F_m for cow milk ranging from 0.0042 to 0.013 days/liter. As the article points out, the value utilized by the Staff, .006 days/liter, is within the range of reported values.

10. The existence of such a range of values is not unusual and does not imply that the value chosen by the Staff for F_m is erroneous. Most measurements of the parameter have been conducted over only short time periods, whereas the model parameters are assumed to be averaged over the length of the grazing season (Reference 1). In the absence of measurements extending over long periods of time, there is no reason to believe that the Staff's value is less accurate than others in the range.

11. Even if the F_m value proposed in the Health Physics article (0.01 days/liter) were considered preferrable to the one utilized by Applicants, this would not require altering the doses calculated in the Susquehanna ER and the FSAR. Each of the nine parameters in the dose equation is obtained through a combination of discrete measurements and estimation, and therefore the value assigned to each parameter lies within a band of error that can be reduced, but not eliminated totally. To compensate for the uncertainty in the estimates, the Staff has chosen in many cases the upper end of the range; for instance, the Staff recommends, and RMC used in calculating the radioiodine doses attributable to the

Susquehanna plant, values of 1.0 for F_s (the fraction of the total dry matter intake of a cow composed of fresh forage) and for F_p (the fraction of the year in which a cow receives fresh forage). However, a survey conducted by RMC staff members of the dairy farms in the vicinity of the Susquehanna site revealed that the applicable values for those parameters at Susquehanna are 0.42 and 0.5, respectively. Thus, the dose underestimation produced by failing to adopt the Health Physics article value for F_m would be more than compensated by the overestimation built into the model by using 1.0 for F_s and F_p.

12. Another conservative assumption is associated with "D", the thyroid dose conversion factor for infants. According to a statistical analysis of the various parameters in the formula (Reference 1), the value of this parameter suggested by the Staff and used by RMC for Susquehanna (.013 mrem/pCi), is about 100% larger than the most probable value of the parameter (.0068 mrem/pCi). Therefore, another overestimation factor of two is built into the iodine health effect estimates obtained using the Staff's model.

13. Other conservative assumptions make it likely that the doses computed by means of the model will overestimate those that would be received by members of the public, even if a parameter such as F_m is underestimated. For instance, the model assumes maximum consumption (330 liters/year) of milk containing radioiodines for the most sensitive age group members (infants), and assumes that all milk comes from cows constantly located at the pasture nearest to the plant.

14. If the estimate for any of the parameters in the dose computation were to be grossly in error, the measurements of radioactive iodine in milk in the vicinity of nuclear power plants would be higher than the concentrations estimated using the model. RMC has performed a large number of measurements of radioiodine concentration in milk from dairy farms located near operating power reactors. References 3 and 4 are representative of the data that RMC has obtained. They show that all measurements of radioiodine in milk attributable to routine plant operations[3] have been at or below the minimum detection levels for iodine (approximately .04 pCi/liter). Those measurements are two orders of magnitude lower than the maximum radioiodine concentration in milk for Susquehanna using the staff model.

15. The measured concentrations of radioiodines demonstrate that the Staff model, taken as a whole, gives conservatively high radioiodine concentration estimates and hence conservatively high dose estimates. A possible discrepancy in the F_m parameter (i.e., the 0.01 days/liter recommended in the Health Physics article instead of the .006

3 Some measurements of radioiodine in milk taken shortly after the Chinese nuclear weapon tests in 1974, 1976 and 1978 have been considerably above the minimum detection level. These measurements, however, reflected only the presence of radioiodine in the fallout from the tests and were equally high at background measuring stations away from the nuclear power plants.

days/liter recommended by the Staff and used for Susquehanna) is more than offset by overestimation of other parameters.

Frazier L. Bronson

Sworn to and subscribed before me this 15th day of June, 1981.

Notary Public

SHELLY KOFFLER
Notary Public, Phila., Phila. Co.
My Commission Expires March 23, 1985

PROFESSIONAL STAFF

Frazier L. Bronson, C.H.P.
Vice President, Nuclear Services Division

Mr. Bronson joined RMC as Director of Radiological Physics in 1969. He was responsible for the operation and management of the Radiological Safety Department's analytical laboratory. He designed, constructed and calibrated the following instruments/systems: Mobile Whole Body Counter; Computer-based Multiple Pulse Height Analyzer with alpha, beta and gamma scintillation, and solid state detectors. Thermoluminescent Dosimetry System; Gamma Calibration and Exposure Facility; Low Level Gamma Environmental Measurement System; Automatic Alpha and Beta Counting Systems, Air Flow Calibration System; and Ultra-Sensitive Beta-Gated Gamma Coincidence Counters for I-131 in milk. He is consultant to the nuclear utility industry in the areas of general health physics, air and liquid sampling techniques; personnel dosimetry, effluent measurement systems, environmental monitoring methodology, portable and laboratory instrumentation, and measurement and dose assessment of accidental overexposures to external or airborne radiocontaminants.

He was then made General Manager of RMC's Midwest Office in Northbrook, Illinois where his responsibilities included; developing definitive marketing programs with universities, nuclear power plants, hospitals, and similarly-related institutions; maintain RMC's continuing Emergency Medical Assistance Program (EMAP); coordinating training/exercise programs for supporting hospitals and plant personnel; establishing a Radiation Emergency Medical (REM) Team (including accident response, communications, transportation, and training of RMC Team personnel); performing technical consultation services.

Currently, as Vice President, Nuclear Services, he is responsible for the company's four regional Radiation Safety and Consulting offices (Philadelphia, PA; Washington, DC; Chicago, Illinois; and Denver, Colorado), plus Whole Body Counting services and New Product Development.

Mr. Bronson received a B.S. degree in Nuclear Engineering from the University of Missouri School of Mines and Metallurgy; and a M.S. degree in Radiological Health from the University of Oklahoma.

Mr. Bronson is a member of the American Board of Health Physics Certification Panel; National Health Physics Society; Delaware Valley Chapter of the Health Physics Society (Secretary/Treasurer and President); Midwest Chapter of the Health Physics Society (Secretary and President); American Nuclear Society; Institute of Electrical and Electronics Engineers (Nuclear Science Group); and the American Association of Physicists in Medicine.

continuously throughout the year. The Sunbury facility draws Susquehanna River water intermittently during August and September to supplement other sources of water. Usage values have been adjusted to reflect this fact.

Expected concentrations of radionuclides of Susquehanna SES origin in Susquehanna River water for the eight points discussed above have been presented in Subsection 5.2.2.

Total body and organ doses to a maximum hypothetical individual based on the assumptions discussed above are presented in Table 5.2-24, Calculated Maximum Individual Dose. This individual is assumed to consume aquatic biota and receive shoreline exposure at the edge of the initial mixing zone and consume drinking water from the nearest downstream supply. All other individuals in the vicinity of Susquehanna SES receive doses less than this hypothetical individual.

5.2.4.2 Gaseous Pathway

Individual and population doses through the atmospheric environment from gaseous effluents of Susquehanna SES were calculated using the equations and assumptions presented in USNRC Regulatory Guide 1.109, March 1976, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50 Appendix I" (Ref. 5.2-1). The USNRC computer code "GASPAR" was used for this evaluation. The input parameters used in the evaluation are presented in Table 5.2-25, Input Parameters Used in the Calculations. The details of dose calculations are presented in Appendix E to this report.

The southwest boundary of the site is expected to have the highest off-site concentration of gaseous effluents. The results of individual dose calculations for various organs at this location are presented in Table 5.2-26, Calculated Maximum Individual Dose. Table 5.2-26 also includes doses at the vegetable garden and dairy farm where highest off-site concentrations are expected. The individual receiving the highest dose is hypothetical and resides at the southwest corner of the site. All other individuals in the vicinity of the Susquehanna SES would receive doses less than this hypothetical individual.

5.2.4.3 Direct Radiation from Facility

Direct radiation from the Susquehanna facility makes up a small portion of the overall maximum individual dose. These doses were estimated based on doses calculated for construction workers in

TABLE 5.2-25

INPUT PARAMETERS USED IN THE CALCULATION OF INDIVIDUAL DOSES TO MAN FROM GASEOUS EFFLUENTS OF SUSQUEHANNA SES

	CRITICAL BOUNDARY LOCATION	CRITICAL VEGETABLE GARDEN	CRITICAL DAIRY FARM
LOCATION	South-west boundary of site	West vegetable garden	North-west dairy farm
Distance from vents	0.379 miles	0.7 miles	0.7 miles
Transit time	0.09 hours	0.10 hours	0.13 hours
X/Q (normal)	2.1E-5 sec/m^3	1.4E-5 sec/m^3	3.9E-6 sec/m^3
X/Q (depleted)	1.9E-5 sec/m^3	1.2E-5 sec/m^3	3.6E-6 sec/m^3
Deposition	4.2E-8 1/m^2	2.1E-8 1/m^2	7.8E-9 1/m^2
Occupancy	8766 hr/yr	8766 hr/yr	8766 hr/yr
Leafy vegetable consumption	0	26 kg/yr	0
Other vegetable consumption	0	520 kg/yr	0
Milk consumption	0	0	330 l/yr
Meat consumption	0	0	0
Inhalation usage	1900 m^3/yr	2700 m^3/yr	1900 m^3/yr
Critical age group	infant	child	infant

REFERENCES

1. Britz, W. et al, "Propagation of Uncertainties in Environmental Pathway Dose Models", Upgrading Environmental Radiation Data, Health Physics Society Committee Report HPSR-1 (Aug. 1980), Office of Radiation Programs, U.S. Environmental Protection Agency Report EPA 520/1-80-012.

2. Office of Standards Development, U.S. Nuclear Regulatory Commission, "Regulatory Guide 1.109 -- Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I" (Rev. 0, March 1976).

3. Peach Bottom Atomic Power Station Radiological Regional Environment Monitor Program, RMC Report 16 (May 1981).

4. Artificial Island Radiological Environmental Monitoring Program, Report RMC-TR-81-03 (March 1981).

5. Hoffman, F., "A Review of Measured Values of the Milk Transfer Coefficient (fm) for Iodine," 35 Health Physics 413-18 (1978).

6. Book, S.A., "Relative Hazard of Radioiodine as a Function of (A) Radiation Quality and (B) Age at Exposure," NRC Report NUREG/CR-1228 (April 1980).