UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

AFFIDAVIT OF BRIAN D. MCFEATERS
IN SUPPORT OF APPLICANTS' MOTION FOR
SUMMARY DISPOSITION OF INTERVENOR WELLS EDDLEMAN'S
CONTENTION 80

County of Wake)
SS:
State of North Carolina)

BRIAN D. MCFEATERS, being duly sworn, deposes and says as follows:

1. I am a Project Scientist - Meteorological Supervisor employed by Applicant Carolina Power & Light Company. My business address is 7C3 Center Plaza Building, 411 Fayetteville Street Mall, Raleigh, NC 27602. A summary of my professional qualifications and experience is attached hereto as Exhibit "A". I have personal knowledge of the matters stated herein and believe them to be true and correct. I make this Affidavit in support of Applicants' Motion for Summary Disposition of Intervenor Wells Eddleman's Contention 80 in this proceeding.

2. The function of the Physical Sciences sub-unit, meteorological operations at Carolina Power & Light Company is to provide the company with professional expertise in all matters associated with meteorological data collection, analysis and assessment as they affect Carolina Power & Light Company. This function includes operation of onsite meteorological monitoring stations at nuclear plant sites, emergency preparedness support through operational synoptic forecasting assistance, atmospheric analysis of diffusion and transport for potential accident and routine nuclear plant operation and professional consultation services as related to meteorological concerns affecting the company. As a member of the Operational Training & Technical Services Department, I have direct supervisory responsibility for all meteorological monitoring and assessment activities and have prepared the diffusion studies and assessments for the Shearon Harris Nuclear Power Plant.

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3. I have prepared a technical paper attached hereto as Exhibit "B", the statements contained therein are incorporated into this Affidavit as if set forth in full herein. The purpose of Exhibit B is to demonstrate that there is no factual basis for Eddleman Contention 80, because Applicants' mixing and dispersion models employ state-of-the-art techniques and utilize conservative assumptions that assure that actual concentrations of radionuclides should never exceed the estimates obtained from use of the models.

Brian D. McFeaters

Subscribed and sworn to before me this 31st day of August, 1983.

Franklin Murray
Notary Public

My commission expires OCTOBER 4, 1986.

FRANKLIN MURRAY NOTARY PUBLIC WAKE COUNTY, N.C.

EXHIBIT A

BRIAN D. MC FEATERS
PROJECT SCIENTIST - METEOROLOGICAL SUPERVISOR
OPERATIONAL TRAINING & TECHNICAL SERVICES DEPARTMENT
CAROLINA POWER & LIGHT COMPANY

EDUCATION:	The Pennsylvania State University - B. S. Meteorology - June 1972
	Member American Meteorological Society
	Member American Nuclear Society Member Eastern North Carolina Nuclear Society

PROFESSIONAL EXPERIENCE:

Present to August 1981	Project Scientist - Meteorological Supervisor - Operational Training & Technical Services Department. Presently supervising the Physical Sciences sub-unit which is responsible for all meteorological and seismological concerns of the company. The sub-unit supports nuclear power plants with operation of onsite meteorological monitoring stations and diffusion analysis, with emergency preparedness support through operational synoptic forecasting, with analysis and assessments of atmospheric transport and dispersion and through general professional consultations on all meteorological and seismological activities as they relate to the company.
August 1981 to September 1976	Senior Scientist - Meteorologist - Technical Services Department, Licensing & Permits Section. Responsible for the meteorological program and operation of the meteorological monitoring stations, assuring that all regulatory requirements had been fulfilled. Additionally responsible for the preparation of the FSAR and ER sections pertaining to meteorology and atmospheric dispersion.
September 1976 to May 1973	Scientist - Meteorologist - Westinghouse Electric Corporation, Environmental Services Division, Pittsburgh, PA. As a staff scientist, responsible for conducting and assisting in the preparation of environmental impact statements for both fossil and nuclear power plants. Conducted and wrote meteorological analysis for both the FSAR and ER at the Clinch River Breeder Reactor as well as other nuclear power and fuel fabrication facilities. Developed computer models to assess dispersion from fossil, nuclear and cooling tower facilities.

May 1973 to January 1976	Forecast Meteorologist - DeNardo & McFarland Weather Services, Inc., Pittsburgh, PA. A staff forecaster responsible for the preparation of public weather forecasts for radio and television and for the briefing of private corporate clients. Assisted in the environmental assessment of fossil facility impact upon local air quality regulations. Performed field measurements of meteorological and air quality parameters using state-of-the-art instrumentation.

EXHIBIT B

I. INTRODUCTION

The purpose of this paper is to substantiate and demonstrate that the atmospheric dispersion model used by Applicants to estimate the mixing and dispersal of radioactive effluents which could be released from the Shearon Harris Nuclear Power Plant (SHNPP) into the air under accidental and routine conditions:

1) represents state-of-the-art atmospheric dispersion modeling for nuclear applications;

2) is consistent with the various NRC Regulatory Guides cited below;

3) is adequate, reasonable, and useful to estimate the relative concentrations of radionuclides, and subsequently, the radiation and inhalation doses which could be observed at SHNPP;

4) accounts for site specific atmospheric factors;

5) contains many conservative factors that significantly reduce the transport, diffusion and depletion of the plume as compared to realistic and actual conditions, thus

assuming very small and incomplete plume dispersion and mixing. (The conservative assumptions embedded in the dispersion modeling methodology result in estimated high relative concentrations and doses. These relative concentrations and doses are much higher than occurrences during realistic and actual conditions, accounting for the SHNPP site specific adverse meteorological conditions); and

6) provides very conservative estimates of ground level relative concentration and radiation and inhalation doses due to the exclusion of the rainout considerations from an atmospheric dispersion model.

II. GENERAL METHODOLOGY

Section 100.11 of 10 C.F.R., entitled "Determination of Exclusion Area, Low Population Zone and Population Center Distance" establishes numerical limits for the individual exposure to a total radiation dose due to an accidental release of radioactive effluents. 1/

Appendix I of 10 C.F.R. Part 50 entitled "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable' for Radioactive Materials in Light-Water-Cooled Nuclear Power Reactor

Effluents" establishes numerical limits for individual exposure to a total radiation dose under routine releases of radioactive effluents. 2/

Compliance with the numerical limits for total radiation dose is accomplished through the implementation of:

1) the necessary design objectives for equipment to control the release of radioactive material in effluents from nuclear plants (10 C.F.R. Part 50.34a) 3/; and

2) management tools that enable both the NRC and the Applicants to estimate the total exposure assuming a particular release rate and the environmental conditions based on on-site observations at SHNPP.

One of the key management tools most commonly used to relate total exposure to the release rate and environmental conditions (often referred to as establishing source-reception relationship) are mathematical dispersion models. These models provide an estimate of the dispersion of the released effluent and of its spatial concentration in the medium under consideration (air, water, soil).

Mathematical dispersion models have been in use in nuclear applications for approximately four decades. In general these models account for the transport, diffusion, and depletion mechanisms involved in dispersion of radioactive materials. The depletion mechanisms generally accounted for in air are: dry and wet deposition and radioactive decay.

Thus, the objective of using dispersion models for atmospheric releases of radioactive effluents, is:

> to provide conservative estimates of relative concentrations under various meteorological conditions for routine and accidental release conditions, with emphasis on accidental release coupled with worst case meteorological conditions.

This objective is further delineated in several of the NRC Regulatory Guides that provide the methodology for atmospheric dispersion and dose assessment.

These include:

1) Regulatory Guide 1.4, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors" 4/;
2) Regulatory Guide 1.24, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Pressurized Water Reactor Radioactive Gas Storage Tank Failure" 5/;
3) Regulatory Guide 1.25, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors" 6/;

4) Regulatory Guide 1.77, "Assumptions Used for Evaluating a Control Rod Ejection Accident for Pressurized Water Reactors" 7/;

5) Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 C.F.R. Part 50, Appendix I" 8/;

6) Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors" 9/;

7) Regulatory Guide 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants" 10/.

III. ATMOSPHERIC DISPERSION MODEL USED IN ROUTINE AND ACCIDENTAL RELEASE ASSESSMENT.

A. Rationale for Use of Gaussian Model

The Gaussian plume model is the basic, most widely and most commonly used atmospheric dispersion model 11-16/. The Gaussian name has been adopted to emphasize that the plume dispersion in the vertical and horizontal (lateral) directions follows the Gaussian distribution function. The model

formulation is therefore based on the Gaussian equation. Key factors that make the Gaussian dispersion model so versatile in nuclear application are:

1) It approximates the dispersion of windborne pollutants in the atmosphere under various meteorological conditions;

2) It represents a state-of-the-art dispersion modeling technique and methodology, used in air pollution meteorology both for nuclear and non-nuclear applications;

3) The formulation is basic and easily implemented by the user. It is based on fundamental principles of atmospheric physics and represents a solution to the Fickian diffusion equation with constant diffusivity and wind speed. The formulation is also consistent with the random nature of turbulence;

4) It is easy to use in practical applications relating source to receptors under various meteorological conditions, thus making the model's utility quite high;

5) It produces results that agree well with other types of atmospheric dispersion models 17-18/ including the most detailed and complex ones available. Justification

for the extra effort and the potential complications associated with the use of a very complex model is quite questionable due to the small advantage, if any, that a more complex model has over the Gaussian dispersion model;

6) It tends to provide conservative estimates of plume dispersion from low-level or ground-level releases under certain limiting meteorological conditions conducive to high radioactive concentrations, such as stable atmospheric conditions with very light winds.

Because of these key factors, the NRC considers the Gaussian dispersion model to be the most prevalent tool in nuclear applications for estimating relative concentrations of radionuclides and radiation and inhalation doses due to accidental and routine releases. This Gaussian model is an integral part of the dispersion calculation methodology outlined in many NRC Regulatory Guides such as: Regulatory Guides 1.4, 1.24, 1.25, 1.77, 1.09, 1.111, and 1.145 4-10/. In addition, the NRC has developed computer codes that are based on the Gaussian dispersion model, for use by its staff in meteorological evaluation of routine 19/ and accidental releases 20/ from commercial nuclear plants.

Based on the above information and consistent with the recommended NRC approach to dispersion modeling, Applicants have used the Gaussian dispersion model in estimating the relative concentrations of radionuclides under routine and accidental releases. The exact methodology is detailed in NRC Regulatory Guide 1.145 10/ for accidental releases and in Regulatory Guide 1.111 9/ for routine releases.

B. Assumptions and Accuracy of the Gausian Dispersion Model for Nuclear Applications.

The Gaussian dispersion model is based on several assumptions that should be realized by the users of the model. It is imperative to understand these assumptions in order to put in perspective the applicability, capability, and performance of the model for a specific application. Once these assumptions are fully understood, the model may be used in specific applications. The resulting calculated relative concentrations, and subsequently the calculated radiation and inhalation doses, then can be interpreted in order to determine whether a particular plant meets the numerical guidance set up in 10 C.F.R. Part 100.11 1/ and Appendix I to 10 C.F.R. Part 50 2/.

The Gaussian dispersion model incorporates assumptions associated with both its formulation and the augmentation and refinement of its capabilities and performance. Assumptions associated with the model's formulation are:

1) Plume dispersion follows the Gaussian distribution in the horizontal and vertical directions. The plume dispersion in these directions is measured by the horizontal and vertical dispersion parameters (often called coefficients). The dispersion parameters vary with the distance downwind from the source and atmospheric stability 13,16,21/. For a fixed atmospheric stability the dispersion parameters increase with downwind distance. For a fixed distance downwind the horizontal and vertical dispersion parameters attain the largest values under extremely unstable conditions and the smallest values under extremely stable atmospheric conditions. For a ground level release the relative concentration is inversely proportional to the product of the horizontal and vertical dispersion parameters. For example, if the plume spreading in the horizontal and vertical directions decreases by a factor of two and three, respectively, the relative concentration of radionuclides increases by a factor of six;

2) The relative concentration is inversely proportional to the wind speed for a given release height. Thus, if the wind speed is reduced by a factor of two, the relative concentration increases by a factor of two;

3) The most widely used Gaussian dispersion model assumes a steady state continuous point source release. The formulation involved does not consider explicitly the temporal (time) variation of the plume dispersion. Further, it assumes instantaneous travel of the plume from the source to a receptor located at a certain distance downwind from the source regardless of the distance between the source, the receptor, and the plume travel time. This means that the model assumes that the plume spreads instantaneously. [If the plume actually travels at the speed of the wind, it is possible to estimate the plume travel time from the release point to a receptor. For example, with a 1.0 mph wind speed it takes the front part of the plume two hours to reach a receptor located 2.0 miles downwind from the release point, assuming that the wind will persist in the same direction for this time duration];

4) The Gausian dispersion model is a straight line model. Since it is not time dependent and assumes instantaneous spread of the plume, it does not account for variations in wind directions with time. The wind variations with time are smoothed and averaged to yield an average wind direction;

5) For routine releases the model incorporates the sector average concept that is based on the assumption that the concentration is uniformly distributed in the lateral direction within a wind sector of 22.5 degrees.

6) The model assumes homogeneous wind field; i.e. wind is invariant with space coordinates (x, y, z).

Assumptions associated with the augmentation and refinement of the Gaussian dispersion model are:

1) Building wake considerations are included in the Gaussian dispersion model to simulate the effect of the wake on low-level releases, such as vent, roof, or ground level releases near large obstructions 4,9,10,22-26/. A building wake adjustment term (or factor) has been included in the model to simulate an increase in the mixing

of the plume in the vicinity of obstructions due to the wake effect. The adjustment term is a function of obstruction height and width. This methodology is the most commonly used in nuclear applications;

2) The values of the horizontal and vertical dispersion parameters used in the Gaussian dispersion model under stable atmospheric conditions are small because they simulate the small spread and growth of the plume as a function of distance downwind under these atmospheric conditions. After a decade of elaborate and extensive field tests, researchers have concluded that the dispersion parameters commonly used 13,21/ to estimate the relative concentration of radionuclides released from low-level or ground-level releases under stable atmospheric conditions and light winds, are consistently smaller than ones derived from field tests 27-33/. The results of field tests show that the relative concentrations estimated

by the Gaussian dispersion model are one to two orders of magnitude higher than the measured values depending on the site specific characteristics. 31-32/ The reason for this large discrepancy is the actual measured large horizontal meander and the large vertical spread of a plume released near the ground, that are not accounted for by the commonly used dispersion parameters. The increase in plume meander and vertical spread are attributed in part to surface roughness and building obstruction effects that are not included in the commonly used dispersion parameters;

3) The current Gaussian dispersion model utilized in nuclear applications for accidental releases include a wind meander adjustment factor in the horizontal dispersion parameter that partially compensates for the meander effect. 10,20/ No adjustment factor is included for the vertical dispersion parameter, that compensates for the observed increase in the vertical

spread of the plume under stable conditions in the wake of buildings;

4) The Gaussian dispersion model applied in nuclear applications allows for plume depletion terms that account for dry and wet deposition on a case by case basis 34-41/. Plume depletion due to dry deposition is attributed to gravitational settling of particles and absorption of gases and aerosols onto ground surfaces. Plume depletion due to wet disposition, often referred to as precipitation scavenging, consists of two removal mechanisms:

   a) rainout which is the wet deposition component due to precipitation in clouds, and

   b) washout, which is the wet deposition component due to precipitation that takes place below clouds.

5) The influence of the wet deposition term that simulates the rainout and washout effects has a small effect on calculated relative concentration within about 30 miles (50 km) around

the release source. Consequently, the effect of wet deposition on radiation and inhalation doses is small especially for long-term/annual average doses 34/. Therefore, the more conservative approach for estimating radiation and inhalation doses ignores the influence of deposition on the relative concentration. This approach is consistent with NRC Regulatory Guide 1.4 4/ that calls for no correction for the depletion of the effluent plume of radioactive iodine due to deposition under accidental release conditions. In the event of routine releases, dry deposition is accounted in the Gaussian dispersion model 9/. Wet deposition, however, is accounted for on a case by case basis, depending on the release height (elevated) and the nature of the precipitation, for the area under consideration. If releases will be elevated and the area has a distinct rainy season corresponding to the grazing season, wet deposition is taken into account 9/.

This approach again allows for a conservative radiation and inhalation doses assessment.

Considering the various assumptions incorporated into the Gaussian dispersion model for nuclear applications, it is apparent that its accuracy is not perfect. Accuracy is a measure of how well model results compare with actual field data. In general the estimated accuracy of the Gaussian dispersion model is 42-44/:

1) Within about a factor of two for real world applications with meteorological parameters reasonably well known and steady and without exceptional circumstances 43/;

2) Larger than a factor of two under exceptional circumstances such as building wakes, varied surfaces and extremely stable conditions.

The estimated accuracy of the Gaussian dispersion model is supported by field studies, in particular, in cases of ground or near ground level releases with building wake effects and stable atmospheric conditions. In such situations, the relative concentration calculated from the Gaussian dispersion model consistently exceeds the actual measured relative concentration by more than a factor of two and often by more than an order of magnitude 31-33/.

IV. CONSERVATISM IN THE SHNPP DISPERSION MODEL

In performing dispersion calculations for postulated accidental and routine releases of radionuclides from SHNPP, Applicants have utilized the Gaussian dispersion model for nuclear applications. The calculated methodology implemented by Applicants is consistent with NRC Regulatory Guides 1.4 4/ and 1.145 10/ for accidental release and NRC Regulatory Guide 1.111 9/ for a routine release of radionuclides.

Based on the discussion presented in Sections II and III, it is evident that the Gaussian dispersion model applied to atmospheric releases of radioactive effluents from the SHNPP:

1) represents state-of-the-art atmospheric dispersion modeling used for nuclear applications;
2) is consistent with the various NRC Regulatory Guides applicable to dispersion calculations 4-10/;
3) is adequate, reasonable, and useful to estimate the relative concentrations of radionuclides and subsequently the radiation and inhalation doses specific to SHNPP.

The dispersion modeling conducted by Applicants for SHNPP accounted for site specific meteorology obtained from the on-site meteorological station. In addition, the containment building cross sectional area was accounted for in the building

wake term of the Gaussian dispersion model. Thus, Applicants' model accounts fully for site specific atmospheric factors.

It is the purpose of this section to demonstrate that the Gaussian dispersion model for SHNPP, used for accidental release calculations, is conservative because of several assumptions included in the calculational methodology.

The assumptions that make the SHNPP Gaussian dispersion model conservative are:

1) The release height is assumed to be at ground level and this is a worst case assumption. In reality the release height for the SHNPP could be more than 150 ft. above the ground even under accidental release conditions: for example, the containment building is about 182 ft. high. Moreover, no consideration is given to the possible rise of the plume due to the release of the energy stored in it. The ground level release assumption coupled with the Gaussian dispersion model implies that the horizontal cross section of the plume containing the plume centerline is at ground level. Since the relative concentration is the highest at the plume centerline for any selected distance downwind from the source and for any

atmospheric conditions it is evident that the ground level release assumption adds conservatism (overestimation) to the calculational methodology of the relative concentrations;

2) The atmospheric conditions assumed in the accidental release calculations for SHNPP (up to eight hours) represent adverse meteorological conditions conducive to extremely high calculated relative concentrations of radionuclides. The atmospheric conditions are: Atmospheric stability G and wind speed of 0.75 mph (0.33 m/sec) which represents the wind instrument lowest detection threshold. As stated in the SHNPP FSAR, §2.3, Table 2.3.6-1C, this combination of meteorological conditions occurred only 4.95% on an annual basis independent of wind direction and on a wind dependent basis only .549% on an annual basis when the wind was blowing from the north (maximum occurrence sector). The atmospheric stabilities commonly used in air pollution meteorology consist of six stability classes A through F, designating A as extremely unstable, B as moderately

unstable, C as slightly unstable, D as neutral, E as slightly stable, and F as moderately stable. These six atmospheric stability classes have been in use since Pasquill 13/ set up the stability classification scheme. Gifford 45/ shows in his review of the different diffusion typing schemes that state-of-the-art atmospheric stability schemes are based on six or less classes. The same six stability classes also are included in NRC Regulatory Guide 1.4 4/. In the early seventies the NRC introduced a seventh stability class and labeled it G. This stability class represents extremely stable conditions with the horizontal dispersion parameter being 2/3 of that under the F stability and the vertical dispersion parameter being 3/5 of that under F stability 10/, for any distance downwind from the source. This means that under the same wind speed conditions the relative concentration for G stability is 2.5 times higher than the one for F stability. Moreover the shift from the small wind speed of 1.0 m/sec used in NRC Regulatory Guide 1.4 4/ to 0.335 m/sec used with

the G stability makes the relative concentration for F stability exceed the one for G stability by a factor of about 7.5 (2.5 x 1/0.335). Thus it is quite clear that the G stability and light wind speed assumption coupled with the ground level release assumption further increase the conservatism of the Gaussian dispersion model for SHNPP. These conditions assume an extremely restricted dispersion of the plume both in the horizontal and vertical directions;

3) As discussed in Section IV(2) above, conditions with G or F stability the light wind speed coupled with a wind direction persisting for an extended period of time are unlikely 3/. The Gaussian dispersion model for SHNPP assumes the existence of wind persistence under G stability and 0.75 mph wind speed for accidental release. If the wind persists in one direction, it will take the plume about 1.75 hours to first reach the SHNPP site boundary (about 7000 ft. from the plant). Since it is unlikely for the wind to persist in one wind direction under the assumed atmospheric

stability and wind conditions, the wind persistence assumption coupled with G stability and light winds further increases the model's conservatism. The conservatism is because the plume is restricted to a single direction while it undergoes very limited spread;

4) The classification of atmospheric stability for SHNPP is based on the $\Delta T/\Delta z$ scheme (often called delta-T) 46/. This scheme provides a mechanism for estimating atmospheric stability based on the measured changes in ambient temperature with height. The delta-T scheme is considered reasonable for estimating atmospheric stability in the vertical and subsequently for determining the appropriate vertical dispersion parameter. It is well known that the use of the delta-T scheme for estimating the dispersion of a plume both in the horizontal and vertical directions is deficient under certain meteorological situations such as stable atmospheric conditions and light winds. This is because the mechanisms that govern the plume dispersion in the horizontal are not necessarily coupled

to the ones that govern plume dispersion in the vertical. Results of field test studies conducted under stable atmospheric conditions and light winds reveal that the delta-T stability classification scheme provides overly conservative estimates of the relative concentrations of radionuclides 27-33/. This overconservatism is due to the failure of the delta-T scheme to account for the large horizontal meander of the plume under such conditions. Results of field tests show that for topography similar to the SHNPP site the calculated relative concentration using the Gaussian dispersion model exceeds the measured relative concentrations by factors that range between 20 to 40 under stable atmospheric conditions and light winds 31/. Incorporation of the wind meander adjustment factor 10/ discussed in Section IIIB closes the gap between the calculated and measured relative concentration. Still, on the average, the calculated relative concentrations are overpredicted by about a factor of two 33/. Thus the use of the delta-T atmospheric stability scheme coupled with

the wind meander factor provided by NRC Regulatory Guide 1.145 10/ adds additional conservatism to the Gaussian dispersion model for SHNPP;

5) The Gaussian dispersion model for SHNPP incorporates building wake considerations in accordance with the discussion in Section IIIB and consistent with the methodology outlined in NRC Regulatory Guides 1.11 9/ and 1.145 10/. The building wake factor depends on the dimensions of the building under consideration. In the case of SHNPP the smallest cross sectional area of the reactor containment building is used. The building wake factor contains a consideration of the fraction of the cross sectional area over which the plume is dispersed by the wake. This consideration is measured by the inclusion of the parameter c 22/, $1/2 \leq c \leq 2$. In nuclear applications the parameter c is assigned the value 1/2 on grounds of conservatism 23/.

In addition, field studies 26,30,32/ show that the existing approach to building wake effect, as incorporated in the Gaussian dispersion model, tends to underestimate

the effect of the wake on the spread of the plume in the vicinity of buildings at nuclear power plant sites. This causes the Gaussian dispersion model to overpredict the relative concentrations. Van der Hoven 32/ states that the present building wake factor accounted for in the Gaussian dispersion model used for accidental release conditions 4,10/, which is the model used for SHNPP, is hardly sufficient to allow for the factor of ten or more which represents the ratio between the measured to calculated vertical dispersion parameters under stable atmospheric conditions and lightwinds.

These points clearly demonstrate that the Gaussian dispersion model for SHNPP contains another conservative element based on assumptions embodied in the building wake factor incorporated in the model. This conservatism in the building wake factor should result in an over-prediction of the relative concentrations for SHNPP as compared to what actually will be measured in reality;

6) The Gaussian dispersion model for SHNPP does not include a wet deposition term that accounts for the rainout and/or washout of portions of the plume under accidental and routine releases. As explained in Section IIIB the exclusion of the wet deposition term from the calculations:

-- is consistent with the NRC approach outlined in Regulatory Guide and 1.4 4/.

-- provides more conservative estimates of ground level relative concentrations and subsequently of radiation and inhalation doses.

The inclusion of the wet deposition term in the Gaussian dispersion model for SHNPP would have a small effect on the relative concentrations under normal precipitation events (about 0.10 inch/hr) and is well within the realm of accuracy of the Gaussian dispersion model. Plume depletion due to wet deposition under severe thunderstorm with a rainfall of about 1.0 inch/hr is estimated to be about 50 to 70 percent. This corresponds to a reduction in the relative concentration without the wet

deposition term, by a factor of about two to three. The net result is a corresponding reduction in the radiation and inhalation doses.

Applying mass conservation principles to the radioactive plume it is logical to assume that the amount of radioactive material depleted from the plume in the air will be deposited onto soil, other surfaces, vegetation, and water bodies. Thus, the portion of radioactive material that has been depleted from the plume and deposited onto various surfaces will be accounted for in the ingestion pathways. The exclusion of the wet deposition term in the Gaussian dispersion model for SHNPP is consistent with other conservative elements built into the model, as applied to airborne atmospheric releases under accidental conditions, since radiation and inhalation doses are of more concern than ingestion dose and since radioactive material that has been deposited on surfaces can be contained better than radioactive material in air, (food chain can be better controlled).

This discussion clearly shows that the exclusion of the wet deposition term from the Gaussian dispersion model for SHNPP adds more conservatism to the model.

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1. 10 C.F.R. Part 100.11, "Determination of Exclusion Area, Low Population Zone and Population Center Distance."

2. 10 C.F.R. Part 50, Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable' for Radioactive Materials in Light-Water-Cooled Nuclear Power Reactor Effluents."

3. 10 C.F.R. Part 50.34a.

4. U.S. Atomic Energy Commission Regulatory Guide 1.4, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors," Revision 2, June 1974.

5. U.S. Atomic Energy Commission, Regulatory Guide 1.24, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Pressurized Water Reactor Radioactive Gas Storage Tank Failure," March 1972.

6. U.S. Atomic Energy Commission, Regulatory Guide 1.25, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors," March 1972.

7. U.S. Atomic Energy Commission, Regulatory Guide 1.77, "Assumptions Used for Evaluating a Control Rod Ejection Accident for Pressurized Water Reactors," May 1974.

8. 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 C.F.R. Part 50, Appendix I, October 1977.

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22. Gifford, F. A., "Atmospheric Dispersion Calculations Using the Generalized Gaussian Plume Model, Nuclear Safety," Volume 2, pp. 56-59, 1960.

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