RS-002, "PROCESSING APPLICATIONS FOR EARLY SITE PERMITS"

ATTACHMENT 2

2.3.5 LONG-TERM DIFFUSION ESTIMATES

REVIEW RESPONSIBILITIES

Primary - Probabilistic Safety Assessment Branch (SPSB)

Secondary - Emergency Preparedness and Plant Support Branch (IEPB)

I. AREAS OF REVIEW

This section of the site safety assessment for an early site permit (ESP) application concerns atmospheric diffusion estimates for routine releases of effluents to the atmosphere. The review covers the following specific areas:

1. Atmospheric dispersion models to calculate concentrations in air and amount of material deposited as a result of routine releases of radioactive material to the atmosphere.

2. Meteorological data used as input to diffusion models.

3. Specification of diffusion parameters.

4. Relative concentration (χ/Q) and relative deposition (D/Q) values used for assessment of consequences of routine airborne radioactive releases.

5. Points of routine release of radioactive material to the atmosphere, the characteristics of each release mode, and the location of potential receptors for dose computations (if available at the ESP stage). Bounding values for these parameters may be provided at the ESP stage. In such a case, the applicant will need to confirm at the combined license (COL) stage that the parameters provided at the ESP stage bound the actual values provided at the COL stage, and that the calculational methodology used for the confirmation is consistent with that employed at the ESP stage.

To assist in demonstrating compliance with 10 CFR 100.21(c)(1) (Ref.1), annual average χ/Q and D/Q values at standard distances in the 16 radial sectors from the site boundary to a distance of 50 miles from the proposed site of the nuclear power plant or plants are provided to the IEPB for calculation of doses. Calculations for specific receptor locations such as the limiting residence, cow, garden, etc., will be evaluated at the combined license (COL) stage. However, to the extent bounding evaluations are provided in ESP applications, a secondary review is performed by IEPB and the results are used by SPSB in the overall evaluation of the long-term diffusion estimates. The IEPB reviews the points of routine release of radioactive material to the atmosphere, the characteristics of each release mode, and locations of potential receptors for dose computations. (If the applicant provides bounding values for these parameters as discussed above, these values are reviewed.) The results of their analyses are

transmitted to SPSB for use in its review of diffusion estimates. In such a case, the applicant will need to confirm at the combined license (COL) stage that the values provided at the ESP stage bound the actual values provided at the COL stage, and that the calculational methodology used for the confirmation is consistent with that employed at the ESP stage. For ESP applications that do not provide a full evaluation of atmospheric transport and diffusion of routine releases, those portions not addressed at the ESP stage will be evaluated at the COL stage.

II. ACCEPTANCE CRITERIA

Characterization of atmospheric transport and diffusion conditions is necessary for estimating the radiological consequences of routine releases of radioactive materials to the atmosphere to demonstrate compliance with the numerical guides for doses contained in 10 CFR Part 50, Appendix I (Ref. 2).

The following regulatory guides provide acceptable criteria for complying with this review standard section:

1. Regulatory Guide 1.109 (Ref. 3) presents identification criteria to be used for specific receptors of interest (applicable at the ESP stage to the extent the applicant provides receptors of interest).

2. Regulatory Guide 1.111 (Ref. 4) describes acceptable methods for characterizing atmospheric transport and diffusion conditions for evaluating the consequences of routine releases. Use of the model described in NUREG/CR-2919 (Ref. 5) is acceptable.

3. Regulatory Guide 1.112 (Ref. 6) presents identification criteria to be used for release points and release characteristics (applicable at the ESP stage to the extent the applicant provides release points and release characteristics).

Specifically, the following information should be provided by the applicant in the safety assessment:

1. A description of the atmospheric dispersion models used to calculate concentrations in air and the amount of material deposited as a result of routine releases of radioactive material to the atmosphere. The models should be sufficiently documented and substantiated to allow a review of their appropriateness for site characteristics, plant characteristics (to the extent known), and release characteristics.

2. A discussion of the relationship between atmospheric diffusion parameters, such as vertical plume spread (σ_z), and measured meteorological parameters. Use of these parameters should be substantiated as to their appropriateness for use in estimating the consequences of routine releases from the site boundary to a radius of 50 miles from the plant site.

3. Meteorological data used as input to the dispersion models. Data used for this evaluation should represent hourly average values of wind speed, wind direction, and atmospheric stability which are appropriate for each mode of release. The data should

reflect atmospheric transport and diffusion conditions in the vicinity of the site throughout the course of a year. (See Section 2.3.3 of this review standard for data acceptability criteria, and see Regulatory Guide 1.23[1] (Ref. 7) for data formats.)

4. Relative concentration (χ/Q) and relative deposition (D/Q) values used for assessment of consequences of routine radioactive gas releases as described in Section 2.3.5.2 of Regulatory Guide 1.70 (Ref. 8).

5. Points of routine release of radioactive material to the atmosphere, the characteristics of each release mode, and the location of potential receptors for dose computations (if available at the ESP stage). Bounding values for these parameters may be provided at the ESP stage. In such a case, the applicant will need to confirm at the combined license (COL) stage that the parameters provided at the ESP stage bound the actual values provided at the COL stage, and that the calculational methodology used for the confirmation is consistent with that employed at the ESP stage.

A licensee can use the numerical guides for doses specified in 10 CFR Part 50, Appendix I, to meet the requirement in 10 CFR 50.34a(a) that the nuclear facility be operated to keep levels of radioactive effluents to unrestricted areas “as low as is reasonably achievable” (ALARA).

10 CFR 20.1301 establishes radiation dose limits to individual members of the public from radioactive effluents in unrestricted areas. In addition, 10 CFR 20.1101 states that licensees shall, in addition to complying with the limits set forth in 10 CFR Part 20, use procedures and engineering controls to achieve doses to members of the public that are ALARA. 10 CFR Part 50, Appendix I, provides numerical guidance for doses to meet the ALARA criterion.

III. REVIEW PROCEDURES

1. Atmospheric Dispersion Models

The applicant's models are compared to the general modeling criteria presented in Regulatory Guide 1.111. The models should be suitable for the topography of the site and vicinity, plant configuration (to the extent known), and release characteristics. Additional information for determining model suitability may be found in standard references such as "Meteorology and Atomic Energy - 1968" (Ref. 9) and “Atmospheric Science and Power Production” (Ref. 10).

The staff performs an independent evaluation of long-term dispersion characteristics. To the extent release points, release characteristics, and locations of interest are identified in the ESP application, they are confirmed by IEPB. Using the criteria presented in Regulatory Guide 1.111, each release is classified as completely elevated or completely ground level. Turbulent mixing of the effluent into the wake of plant

[1] References in Regulatory Guide 1.23 to Appendix D to 10 CFR Part 50 should be read as references to 10 CFR Part 51. For ESP applications, references in Regulatory Guide 1.23 to 10 CFR 100.10 should be read as references to 10 CFR 100.20.

structures is considered where appropriate and feasible given information available about plant design in accordance with Regulatory Guide 1.111.

To the extent relevant and sufficient evaluations are provided in ESP applications on plant design at the ESP stage, any releases characterized as partially elevated or intermittent should be evaluated. Conclusions of these evaluations will be subject to confirmation by the applicant at the COL stage that the parameters provided at the ESP stage remain valid (i.e., they bound the values provided at the COL stage). The staff review at the COL stage will verify that the calculational methodology used for this confirmation is consistent with that employed at the ESP stage. For ESP applications that do not provide a full evaluation of atmospheric transport and diffusion of routine releases, those aspects not addressed at the ESP stage will be evaluated at the COL stage.

Topographic characteristics in the vicinity of the site are examined for restrictions of horizontal and/or vertical plume spread, channeling or other changes in airflow trajectories, or other unusual conditions affecting atmospheric transport and diffusion between the source and receptors of interest. Examples of conditions where modifications to standard approaches may be necessary are narrow, deep valleys; land-sea (lake) breeze regimes; and low-level subsidence inversions of temperature. "Fumigation" may be a concern for infrequent releases of short duration from elevated sources.

The standard diffusion model used by the staff is described in NUREG/CR-2919 (Ref. 11). This model is a straight-line Gaussian model with a specific calculational procedure for estimating χ/Q values for intermittent releases. Modifications to the straight-line model to consider the effects of variations in space and time in airflow are also described in NUREG/CR-2919.

For unusual topographic and meteorological conditions, a variable trajectory model may be used on a case-by-case basis.

2. Atmospheric Diffusion Parameters

The specification of the vertical diffusion parameter, σ_z, as a function of distance and atmospheric stability, is reviewed. Atmospheric stability should be defined by measurement of vertical temperature gradient, particularly during stable conditions. Other classification schemes (e.g., Refs. 12 and 13) may be used to estimate atmospheric stability class or to determine the diffusion parameter directly for unstable and neutral conditions. If used, these alternative classification schemes are reviewed for appropriateness to site characteristics, plant characteristics (to the extent known), and release characteristics. Standard curves of σ_z as a function of distance are presented in Regulatory Guide 1.111. Modified diffusion parameters may also be considered for proposed sites in or near unique terrain features such as deserts (see Ref. 14) and large bodies of water (see Ref. 15).

3. Meteorological Data

Meteorological data are reviewed for compatibility with the models used, representativeness of conditions within the area of interest, and representativeness of annual average meteorological characteristics in the vicinity of the site. General guidelines for collection and presentation of onsite meteorological data are stated in Regulatory Guide 1.23 and in Section 2.3.3 of this review standard, subsection III.2.

4. Relative Concentrations Used for Routine Releases

The relative concentration (χ/Q) and relative deposition (D/Q) values used for assessment of the consequences of routine radioactive releases are reviewed for appropriateness to site conditions, plant configuration (to the extent known), and release characteristics.

Annual average χ/Q and D/Q values are calculated for 16 radial sectors from the site boundary to a distance of 50 miles. To the extent relevant and sufficient evaluations are provided in ESP applications, values are also reviewed for specific receptor locations. IEPB confirms the locations of specific receptors (e.g., site boundary, residence, garden, cow). Adjustments of the χ/Q and D/Q values may be necessary to account for unusual site and/or meteorological conditions.

The following information is provided to the IEPB for the calculation of appropriate doses: (1) annual average χ/Q and D/Q values at standard distances in the 16 radial sectors from the site boundary to a distance of 50 miles, and (2) values for the locations of specific receptors (to the extent relevant and sufficient evaluations are provided in the ESP application).

IV. EVALUATION FINDINGS

The reviewer verifies that appropriate atmospheric dispersion models and meteorological data have been used to calculate relative concentration and relative deposition at appropriate distances and directions from postulated release points for evaluation of routine airborne releases of radioactive material. The reviewer's evaluation should support the following type of concluding statement, to be included in the staff's safety evaluation report:

> As set forth above, the applicant has provided meteorological data and an atmospheric dispersion model that are appropriate for the characteristics of the site and release points. Therefore, the staff concludes that representative atmospheric transport and diffusion conditions have been calculated for 16 radial sectors from the site boundary to a distance of 50 miles and [to the extent relevant and sufficient evaluations are provided in ESP applications] for the specific receptor locations. Therefore, the information required to address 10 CFR 100.21(c)(1) has been provided. Based on [summarize bases for conclusion], the characterization of atmospheric transport and diffusion conditions is appropriate for demonstration of compliance with the numerical guides for doses contained in 10 CFR Part 50, Appendix I.

[If not provided at the ESP stage:] Atmospheric transport and diffusion from specific release points having specific release characteristics, as well as specific locations of receptors of interest, will be evaluated at the combined license (COL) stage.

Any deviation from the acceptance criteria should be explained by a statement that the applicant has provided an alternative approach that the staff has reviewed and found to be acceptable.

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this section of this review standard.

This section will be used by the staff when performing safety evaluations of ESP applications submitted by applicants pursuant to 10 CFR Part 52. Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

Implementation schedules for conformance of parts of the method discussed herein are contained in the referenced regulatory guides and NUREGs.

VI. REFERENCES

1. 10 CFR Part 100, Subpart B, "Evaluation Factors for Stationary Power Reactor Site Applications on or after January 10, 1997."

2. 10 CFR 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 Material in Light-Water-Cooled Nuclear Power Reactor Effluents."

3. 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."

4. Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents In Routine Releases From Light-Water-Cooled Reactors."

5. NUREG/CR-2919, "XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations" (September 1982).

6. Regulatory Guide 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Reactors."

7. Regulatory Guide 1.23, "Onsite Meteorological Programs."

8. Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants."

9. D. H. Slade (ed.), "Meteorology and Atomic Energy - 1968," TID-24190, Division of Technical Information, USAEC (1968).

10. Darryl Randerson (ed.), “Atmospheric Science and Power Production,” DOE/TIC-27601, U.S. Department of Energy (1984).

11. NUREG/CR-2919, “XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations,” September 1982.

12. S. R. Hanna, G. A. Briggs, J. Deardorff, B. A. Egan, F.A. Gifford, and F. Pasquill, "AMS Workshop on Stability Classification Schemes and Sigma Curves--Summary of Recommendations," Bulletin of the American Meteorological Society, Vol. 58, No. 12 (December 1977).

13. F. 0. Hoffman (General Chairman), "Proceedings of a Workshop on the Evaluation of Modes Used for the Environmental Assessment of Radionuclide Releases," CONF-770901, Oak Ridge National Laboratory (April 1978).

14. G. R. Yanskey, E. H. Markee, and A. P. Richter, "Climatography of the National Reactor Testing Station," IDO-12048, Idaho Operations Office, USAEC (1966).

15. R. P. Hosker, Jr., "A Comparison of Estimation Procedures for Over-Water Plume Dispersion." Paper Presented at the Symposium on Atmospheric Diffusion and Air Pollution in Santa Barbara, California, American Meteorological Society (September 9-13, 1974).