U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 2.3.4 SHORT TERM DIFFUSION ESTIMATES

REVIEW RESPONSIBILITIES

Primary - Site Analysis Branch (SAB)

Secondary - Accident Analysis Branch (AAB)

I. AREAS OF REVIEW

Information is presented by the applicant and reviewed by the staff concerning atmospheric diffusion estimates for accidental releases of effluents to the atmosphere. The review covers the following specific areas:

1. Atmospheric diffusion models to calculate relative concentrations for accidental radioactive and toxic gas release modes as determined by Accident Analysis Branch.

2. Meteorological data summaries used as input to diffusion models.

3. Derivation of diffusion parameters from meteorological data.

4. Probability distributions of relative concentrations.

5. Relative concentrations used for assessment of consequences of radioactive releases for design basis (10 CFR Part 100) accidents, onsite and offsite toxic gas releases, and accidents that result in limited releases of radioactivity.

II. ACCEPTANCE CRITERIA

This section will be acceptable if the applicant has provided conservative estimates of atmospheric diffusion at appropriate distances from the source for postulated accidental releases of radioactive and toxic materials to the atmosphere considering the plant as both a source and a receptor. Guidelines for acceptability of models and conservatism appropriate to design basis calculations are Regulatory Guides 1.3, 1.4, 1.5, 1.23, 1.24, 1.25, and 1.77; National Oceanic and Atmospheric Administration (NOAA) Technical Memorandum ERL ARL-42; standard references such as "Meteorology and Atomic Energy, 1968" and Accident Analysis Branch and Site Analysis Branch positions. Since the staff makes

an independent evaluation of atmospheric diffusion estimates based on data from the onsite meteorological measurements program and other nearby meteorologic data, it is not necessary for the applicant to duplicate the staff's final estimates. However, the applicant's diffusion estimates should reasonably reflect staff positions and state-of-the-art atmospheric diffusion knowledge. Specifically the following information is required:

1. The atmospheric diffusion models used by the applicant to calculate relative concentrations resulting from accidental airborne releases of radioactive and toxic gases must be documented in detail and substantiated so that the staff can evaluate their appropriateness to site and plant characteristics.

2. Meteorological data summaries to be used as input to the diffusion models must be presented in joint frequency distribution form. These summaries must have been generated from the best available annual periods of data on record and contain data acceptable to the staff which represent appropriate hourly values of wind direction, wind speed, and atmospheric stability for each mode of accidental release.

3. The atmospheric fiffusion parameters, such as lateral and vertical plume spread (σ_y and σ_z) as a function of distance and windspeed, must be related to measured meteorological parameters and substantiated as to their validity and degree of conservatism for use in estimating the consequences of accidents within the range of distances which are of interest for the plant.

4. Cumulative frequency distributions of relative concentrations (X/Q) based on mode of release over appropriate time periods and on the aforementioned atmospheric diffusion models, meteorological data summaries, and atmospheric diffusion parameters must be presented for appropriate distances such as the site boundary distance and the outer boundary of the low population zone as specified in Section 2.3.4.2 of the "Standard Format and Contents of Safety Analysis Reports for Nuclear Power Plants," Revision 2. The methods of generating these distributions must be adequately described.

5 Relative concentrations used for assessment of consequences of radioactive releases for design basis (10 CFR Part 100) accidents, for onsite and offsite releases of toxic gases, and for radioactive releases resulting from other accidents must be presented.

III. REVIEW PROCEDURES

1. Atmospheric Diffusion Models

The applicant's diffusion models are compared to the general Gaussian models which are contained in Regulatory Guides 1.3 and 1.4 for elevated releases and ground level releases with a wake correction (see also Reference 3). The suitability of the models for mode of release, plant configuration, and site topography are reviewed. Accident Analysis Branch defines the modes of release and accidents to be considered.

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A determination is made as to whether the release should be considered as an elevated point source or a ground level point source with a volumetric correction for turbulent mixing in the wake of buildings. Generally the release is considered to be elevated if the release point is at least twice as high as nearby solid structures. Otherwise, a ground level volumetric release formulation is usually used. The volumetric correction is usually based on 1/2 the minimum cross-sectional area of the structure from which the effluent is released.

Most accidental releases are considered as continuous releases (i.e., >5 minutes duration). However, in some instances, usually with explosions resulting in the release of toxic chemicals, the releases may be considered as instantaneous (puffs). For puff releases, instantaneous point source Gaussian diffusion equations are used with a correction for initial source volume (Ref. 10).

If a site is located such that the horizontal (or vertical) plume spread via diffusion is restricted by topography (or unusual meteorological conditions), the models are examined for appropriate modification. Some of these conditions are narrow, deep valleys, "fumigation" from elevated sources, and low level subsidence inversions of temperature in the vertical direction.

2. Meteorological Data Summaries

The data summaries in joint frequency distribution form are reviewed for compatability of data with the models utilized in the section above. General criteria are stated in Regulatory Guide 1.23 and in III.2 of Standard Review Plan 2.3.3.

3. Atmospheric Diffusion Parameters

Horizontal and vertical plume spread parameters, σ_y and σ_z, as functions of distance and atmospheric stability are reviewed. The current procedure is to relate $\sigma_y(X)$ and $\sigma_z(X)$ to vertical temperature difference classes as stated in Table 1 of Regulatory Guide 1.23. Departures from this procedure are reviewed for adequate justification. Such departures may be appropriate in the case of unusual sites (e.g., valley or coastal). The curves of σ_y and σ_z with distance, which appear in "Meteorology and Atomic Energy - 1968" are usually acceptable with the addition of a G stability class.

In instances when a puff diffusion equation is used, $\sigma_x = \sigma_y$ is usually a good assumption.

4. Cumulative Frequency Distributions of X/Q

A check is made of the cumulative frequency distributions for inclusion of pertinent modes and time periods of release, and adequacy of input data in accordance with the guidelines set forth in Section 2.3.4.2 of the Standard Format. The methods used to generate these distributions are reviewed for adequacy and conservatism.

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5. Relative Concentrations Used for Accidents

The X/Q values used for assessment of consequences of radioactive releases for design basis accidents, for onsite and offsite releases of toxic gases, and for radioactive releases resulting from other accidents are reviewed for appropriateness and completeness of information.

An independent calculation of the probability distributions of X/Q is made for pertinent distances (usually the exclusion area boundary and the low population zone outer boundary, LPZ) using the computer program CHI/Q (Ref. 11) and the joint frequency distribution data for input. The most restrictive annual average X/Q values are also computed at the site boundary and the LPZ using the same program and input data. For assessment of the consequences of design basis accident releases, the value of X/Q at the "5% level" (value which is exceeded 5% of the time) is evaluated at the exclusion bourdary and the LPZ. These values are assumed to represent conditions for a two-hour period. X/Q values for time periods greater than two hours are estimated for the LPZ distance by assuming a logarithmic relationship between the "two-hour" value and the annual average value.

Conservative (5%) values of X/Q from appropriate models for appropriate time intervals and distances are transmitted to AAB for dose assessment of design basis accidents.

For assessment of other accidents, the median (50%) values of X/Q for appropriate time intervals and distances (usually the site boundary) are evaluated and transmitted to AAB.

X/Q values based on site-specific meteorological data are calculated, as needed, for control room dose calculations and onsite and offsite releases of toxic gases. These estimates are made on a case-by-case basis since the mode of release and, therefore, the diffusion models vary.

IV. EVALUATION FINDINGS

The reviewer verifies that adequately conservative atmospheric diffusion models, with adequate onsite meteorological data as input to the models, have been used to calculate relative concentrations at appropriate distances and directions from postulated release points during accidental airborne releases of potentially hazardous materials. If adequate onsite meteorological data are not available for the construction permit review, the reviewer must assure that adequate conservatism has been applied to the calculated relative concentrations for accidental airborne effluent releases based on available data.

The reviewer's evaluation must support the following type of concluding statement, to be used in the staff's safety evaluation report:

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"Conservative assessments of post-accident atmospheric diffusion conditions have been made by the staff from the applicant's meteorological data and appropriate diffusion models."

The input to the safety evaluation report will also include a brief summary of the relative concentrations (X/Q) calculated by the staff, reference to diffusion models used, and a comparison between the values computed by the staff and the applicant.

V. REFERENCES

1. Regulatory Guide 1.3, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss-of-Coolant Accident for Boiling Water Reactors."

2. Regulatory Guide 1.4, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss-of-Coolant Accident for Pressurized Water Reactors."

3. Regulatory Guide 1.5, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Steam Line Break Accident for Boiling Water Reactors."

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

5. Regulatory Guide 1.24, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Pressurized Water Reactor Gas Storage Tank Failure."

6. 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."

7. Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," Revision 2.

8. Regulatory Guide 1.77, "Assumptions Used for Evaluating a Control Rod Ejection Accident for Pressurized Water Reactors."

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

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

11. J. F. Sagendorf, "A Program for Evaluating Atmospheric Dispersion From A Nuclear Power Station," Technical Memorandum ERL ARL-42, National Oceanic and Atmospheric Administration (1974).

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