



U.S. NUCLEAR REGULATORY COMMISSION  
**STANDARD REVIEW PLAN**  
OFFICE OF NUCLEAR REACTOR REGULATION

### 2.3.5 LONG-TERM DIFFUSION ESTIMATES

#### REVIEW RESPONSIBILITIES

Primary - ~~Accident Evaluation Branch (AEB)~~ Emergency Preparedness and Radiation Protection Branch (PERB)<sup>1</sup>

Secondary - ~~Effluent Treatment Systems Branch (ETSB)~~  
~~Radiological Assessment Branch (RAB)~~ None<sup>2</sup>

#### I. AREAS OF REVIEW

Information for a construction permit (CP), operating license (OL), combined license (COL), or early site permit review<sup>3</sup> is presented by the applicant and reviewed by the staff concerning 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. Derivation of diffusion parameters.
4. Relative concentration (X/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.<sup>4</sup>

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#### USNRC STANDARD REVIEW PLAN

Standard review plans are prepared for the guidance of the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants. These documents are made available to the public as part of the Commission's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Standard review plans are not substitutes for regulatory guides or the Commission's regulations and compliance with them is not required. The standard review plan sections are keyed to the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants. Not all sections of the Standard Format have a corresponding review plan.

Published standard review plans will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience.

Comments and suggestions for improvement will be considered and should be sent to the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

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~~A secondary review is performed by ETSB and RAB and the results are used by AEB in the overall evaluation of the long-term diffusion estimates. The ETSB reviews the points of routine release of radioactive material to the atmosphere and the characteristics of each release mode. The RAB reviews the locations of potential receptors for dose computations. The results of their analyses are transmitted to AEB for use in its independent review.~~<sup>5</sup>

For a design certification review, values of X/Q should be in the site parameter envelope specified for the standardized design.<sup>6</sup>

### Review Interfaces<sup>7</sup>

The Civil Engineering and Geosciences Branch (ECGB), under SRP Section 2.3.6 (proposed), reviews the adequacy of the site parameter envelope specified in standard design certification applications.<sup>8</sup>

## 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.

The following regulatory guides provide acceptable criteria for complying with this ~~SRP~~ Standard Review Plan (SRP)<sup>9</sup> section:

1. Regulatory Guide 1.109 presents identification criteria to be used for specific receptors of interest.
2. Regulatory Guide 1.111 provides criteria for characterizing atmospheric transport and diffusion conditions for evaluating the consequences of routine releases. Use of the model described in ~~NUREG-0324~~ NUREG/CR-2919<sup>10</sup> is acceptable.
3. Regulatory Guide 1.112 presents identification criteria to be used for release points and release characteristics.

Specifically, for CP, OL, COL, or early site permit reviews,<sup>11</sup> the following information should be provided by the applicant in the safety analysis report (SAR):

1. A description of the atmospheric dispersion models used by the applicant to calculate concentrations in air and amount of material deposited as a result of routine releases of radioactive gases to the atmosphere. The models should be sufficiently documented and substantiated to allow a review of their appropriateness to site, plant, and release characteristics.
2. A discussion of atmospheric diffusion parameters, such as vertical plume spread ( $\sigma_z$ ) as a function of distance and wind speed, related to 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 80 km (50 mi)<sup>12</sup> from the plant.

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 and which are characteristic of annual average atmospheric transport and diffusion conditions in the vicinity of the plant. (See SRP Section 2.3.3 for data acceptability criteria, and see Regulatory Guide 1.23 for data formats.)
4. Relative concentration (X/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.
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.<sup>13</sup>

For a design certification review, the probability distributions for X/Q should be in the site parameter envelope specified for the standardized design.<sup>14</sup>

#### Technical Rationale<sup>15</sup>

The technical rationale for application of the above acceptance criterion is discussed in the following paragraphs:<sup>16</sup>

Compliance with the numerical guides for doses specified in 10 CFR Part 50, Appendix I, requires that the nuclear facility be operated to meet the criterion "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 near a nuclear facility. In addition, 10 CFR 20.1101 states that licensees should, in addition to complying with the limits set forth in 10 CFR Part 20, make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to unrestricted areas, as far below the limits specified in 10 CFR Part 20 as is reasonably achievable. The Commission encourages licensees to operate their facilities in a way that maintains occupational doses and those resulting from the release of radioactive effluents ALARA. 10 CFR Part 50, Appendix I, provides numerical guidance for doses to meet the ALARA criterion.

Meeting the guidance provided in Appendix I to 10 CFR Part 50 provides assurance that the health and safety of facility workers and the public will be protected.<sup>17</sup>

### III. REVIEW PROCEDURES

The reviewer verifies that appropriate atmospheric dispersion models, with adequate onsite meteorological data as input to the models, have been used to calculate relative concentration and relative deposition at appropriate distances and directions from postulated release points during routine airborne releases of radioactive gases.<sup>18</sup>

#### 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 to topography of the site and vicinity, plant configuration, and release characteristics. Additional information for determining model suitability may be found in standard references such as "Meteorology and Atomic Energy - 1968."

The staff performs an independent evaluation of long-term dispersion characteristics. ~~Identification of release points and release characteristics is provided by ETSB. RAB provides the locations of receptors of interest.~~ Release points, release characteristics, and locations of receptors of interest are identified.<sup>19</sup> Each release should be characterized as continuous or intermittent. Using the criteria presented in Regulatory Guide 1.111, each release is classified as completely elevated, partially elevated, or completely ground level. Turbulent mixing of the effluent into the wake of plant structures is considered where appropriate in accordance with Regulatory Guide 1.111.

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, and 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-0324. This model is a straight-line Gaussian model with a specific calculational procedure for estimating X/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-0324.~~ The diffusion model used by the staff is described in NUREG/CR-2919, a user guide for the XOQDOQ Computer Program. This program provides independent meteorological evaluation of routine or anticipated intermittent releases at nuclear power stations.<sup>20</sup>

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

## 2. Atmospheric Diffusion Parameters

The vertical plume spread parameter,  $\sigma_z$ , 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. 10 and 11<sup>21</sup>) may be used to estimate atmospheric stability class or to determine the plume spread parameter directly for unstable and neutral conditions. These alternative classification schemes are reviewed for appropriateness to site, plant, and release characteristics. Standard curves of  $\sigma_z$  with distance are presented in Regulatory Guide 1.111. Modified plume spread parameters may also be considered for unique terrain features such as deserts (see Ref. 13<sup>22</sup>) and large bodies of water (see Ref. 14<sup>23</sup>).

## 3. Meteorological Data

Meteorological data are reviewed for compatibility with the models utilized, representativeness of conditions within the area of interest, and representativeness of annual average meteorological characteristics in the vicinity of the plant. General criteria for collection and presentation of onsite meteorological data are stated in Regulatory Guide 1.23 and in SRP Section 2.3.3, subsection III.2. If adequate onsite meteorological data are not available, the reviewer must assure<sup>24</sup> that adequate conservatism is applied to prevent significant underestimates of airborne concentrations and amount of material deposited.

## 4. Relative Concentrations Used for Routine Releases

The X/Q and D/Q values used for assessment of the consequences of routine radioactive releases are reviewed for appropriateness to site conditions, plant configuration, and release characteristics.

Annual average X/Q and D/Q values are calculated for 16 radial sectors from the site boundary to a distance of ~~50 miles~~ 80 km (50 mi)<sup>25</sup> from the plant, as well as for specific receptor locations. ~~RAB provides the~~ The locations of specific receptors (e.g., site boundary, residence, garden, cow) are identified.<sup>26</sup> Adjustments of the X/Q and D/Q output may be necessary to reflect consideration of unusual site and/or meteorological conditions.

Annual average X/Q and D/Q values at the specified receptor locations and at standard distances in the 16 radial sectors from the site boundary to a distance of ~~50 miles~~ 80 km (50 mi)<sup>27</sup> from the plant are used ~~provided to the RAB~~<sup>28</sup> for the calculation of appropriate doses.

For standard design certification reviews, site-related parameters, including values of X/Q, should be identified in the site parameter envelope. The specified values should be representative of credible, bounding characteristics. The reviewer verifies that the values of X/Q in the site parameter envelope are consistent with the acceptance criteria given in subsection II of this SRP section.

For an application referencing a certified standard design, the reviewer verifies that measured site-related meteorological parameters for the proposed site have been used to derive site-specific X/Q values and that these values are consistent with those identified in the site parameter envelope for the certified design.<sup>29</sup>

For standard design certification reviews under 10 CFR Part 52, the procedures above should be followed, as modified by the procedures in SRP Section 14.3 (proposed), to verify that the design set forth in the standard safety analysis report, including inspections, tests, analysis, and acceptance criteria (ITAAC), site interface requirements and combined license action items, meet the acceptance criteria given in subsection II. SRP Section 14.3 (proposed) contains procedures for the review of certified design material (CDM) for the standard design, including the site parameters, interface criteria, and ITAAC.<sup>30</sup>

#### IV. EVALUATION FINDINGS

~~The reviewer verifies that appropriate atmospheric dispersion models, with adequate onsite meteorological data as input to the models, have been used to calculate relative concentration and relative deposition at appropriate distances and directions from postulated release points during routine airborne releases of radioactive gases.<sup>31</sup> The input to the Safety Evaluation Report will also include a summary of the relative concentration (X/Q) and relative deposition (D/Q) calculated by the staff, reference to diffusion models used, and a comparison between the values computed by the staff and the applicant.<sup>32</sup> For a CP, OL, COL, or early site permit, the~~<sup>33</sup> reviewer's evaluation must support the following type of concluding statement, to be included in the staff's safety evaluation report (SER):<sup>34</sup>

Based on the meteorological data provided by the applicant and an atmospheric dispersion model that is appropriate for the characteristics of the site and release points, the staff concludes that representative atmospheric transport and diffusion conditions have been calculated for the locations of potential receptors. The characterization of atmospheric transport and diffusion conditions satisfies the criteria described in Regulatory Guide 1.111 and are appropriate for the evaluation to demonstrate compliance with the numerical guides for doses contained in 10 CFR Part 50, Appendix I.

For an application referencing a certified plant design, the reviewer's evaluation must also support a concluding statement similar to the following:

Measured meteorological parameters for the proposed site are consistent with those identified in the envelope of site-related meteorological parameters provided in standard plant design documents.<sup>35</sup>

Input to the SER will summarize the relative concentration (X/Q) and relative deposition (D/Q) calculated by the staff, reference diffusion models used, and compare values computed by the staff and the applicant.<sup>36</sup>

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.

For design certification reviews, the findings will also summarize, to the extent that the review is not discussed in other safety evaluation report sections, the staff's evaluation of inspections, tests, analyses, and acceptance criteria (ITAAC), including design acceptance criteria (DAC), site interface requirements, and combined license action items that are relevant to this SRP section.<sup>37</sup>

## V. IMPLEMENTATION

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

This SRP section will be used by the staff when performing safety evaluations of license applications submitted by applicants pursuant to 10 CFR 50 or 10 CFR 52.<sup>38</sup> 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.

The provisions of this SRP section apply to reviews of applications docketed six months or more after the date of issuance of this SRP section.<sup>39</sup>

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 20, "Standards for Protection Against Radiation."<sup>40</sup>
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. Regulatory Guide 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents From Light-Water-Cooled Reactors."
6. ~~NUREG-0324, "XOQDOQ Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations" (DRAFT), September 1977.~~
6. NUREG/CR-2919, "XOQDOQ Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations" (September 1982).<sup>41</sup>

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. 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).
11. F. O. 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).
12. G. R. Yanskey, E. H. Markee, and A. P. Richter, "Climatology of the National Reactor Testing Station," IDO-12048, Idaho Operations Office, USAEC (1966).
13. 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).

**SRP Draft Section 2.3.5**  
Attachment A - Proposed Changes in Order of Occurrence

Item numbers in the following table correspond to superscript numbers in the redline/strikeout copy of the draft SRP section.

Item	Source	Description
1.	Current PRB name and abbreviation	Changed PRB to Emergency Preparedness and Radiation Protection Branch (PERB).
2.	Current PRB abbreviation	Specified that PERB has assumed review responsibilities of the secondary review branches.
3.	SRP-UDP format item	Added reference to various types of review per 10 CFR Part 52.
4.	SRP-UDP format item	Moved information specified in REVIEW PROCEDURES to AREAS OF REVIEW.
5.	Current PRB review responsibility	Specified that PERB has review responsibilities for these areas.
6.	Integrated Impact No. 240	Identified site parameter envelope for standard design certification review.
7.	SRP-UDP format item	Added "Review Interfaces" to AREAS OF REVIEW.
8.	Integrated Impact 240	Included a review interface to new SRP section 2.3.6 for review of DC site parameter envelope.
9.	Editorial	Provided abbreviation for Standard Review Plan.
10.	Integrated Impact No. 241	Replaced reference to NUREG-0324 with NUREG/CR-2919.
11.	SRP-UDP format item	Added reference to various types of review per 10 CFR Part 52.
12.	SRP-UDP format item	Converted 50 miles to 80 km (50 mi).
13.	SRP-UDP format item	Moved information specified in REVIEW PROCEDURES to ACCEPTANCE CRITERIA.
14.	Integrated Impact No. 240	Identified site parameter envelope needed for standard design certification review.
15.	SRP-UDP format item, develop technical rationale	Added "Technical Rationale" to ACCEPTANCE CRITERIA to describe the basis for referencing 10 CFR Part 50, Appendix I.
16.	SRP-UDP format item, develop technical rationale	Added lead-in sentence for "Technical Rationale."
17.	SRP-UDP format item, develop technical rationale	Added technical rationale for Appendix I, 10 CFR Part 50.
18.	Editorial	Moved paragraph from EVALUATION FINDINGS to REVIEW PROCEDURES.

**SRP Draft Section 2.3.5**  
Attachment A - Proposed Changes in Order of Occurrence

Item	Source	Description
19.	Current PRB review responsibility	Specified that PERB has review responsibilities for these areas.
20.	Integrated Impact No. 241	Replaced reference to NUREG-0324 with NUREG/CR-2919.
21.	Editorial	Revised reference numbers.
22.	Editorial	Revised reference number.
23.	Editorial	Revised reference number.
24.	Editorial	Changed assure to ensure.
25.	SRP-UDP format item	Converted 50 miles to 80 km (50 mi).
26.	Current PRB review responsibility	Specified that PERB has review responsibilities for these areas.
27.	SRP-UDP format item	Converted 50 miles to 80 km (50 mi).
28.	Current PRB review responsibility	Specified that PERB has review responsibilities for these areas.
29.	Integrated Impact No. 240	Described manner in which the meteorological parameter envelope is used for a COL review that references a standard design certification.
30.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard paragraph to address application of Review Procedures in design certification reviews.
31.	Editorial	Moved sentence from EVALUATION FINDINGS to REVIEW PROCEDURES.
32.	Editorial	Moved sentence to a logical location in EVALUATION FINDINGS.
33.	SRP-UDP format item	Added reference to various types of review per 10 CFR Part 52.
34.	Editorial	Provided abbreviation for safety evaluation report.
35.	Integrated Impact No. 240	Added requirement for a statement regarding the site parameter envelope to EVALUATION FINDINGS.
36.	Editorial	Moved sentence to a logical location in EVALUATION FINDINGS.
37.	SRP-UDP Format Item, Implement 10 CFR 52 Related Changes	To address design certification reviews a new paragraph was added to the end of the Evaluation Findings. This paragraph addresses design certification specific items including ITAAC, DAC, site interface requirements, and combined license action items.

**SRP Draft Section 2.3.5**  
Attachment A - Proposed Changes in Order of Occurrence

<b>Item</b>	<b>Source</b>	<b>Description</b>
38.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard sentence to address application of the SRP section to reviews of applications filed under 10 CFR Part 52, as well as Part 50.
39.	SRP-UDP Guidance	Added standard paragraph to indicate applicability of this section to reviews of future applications.
40.	SRP-UDP format item	Added 10 CFR Part 20 to REFERENCES.
41.	Integrated Impact No. 241	Replaced NUREG-0324 with NUREG/CR-2919 in REFERENCES.

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**SRP Draft Section 2.3.5**  
Attachment B - Cross Reference of Integrated Impacts

<b>Integrated Impact No.</b>	<b>Issue</b>	<b>SRP Subsections Affected</b>
240	Modify SRP Section 2.3.5 to require inclusion of site parameter envelopes in applications for standard design certification and manufacturing licenses (as per 10 CFR Part 52). For applications referencing a standard plant design, compare requirements specified in the site parameter envelope with measured conditions.	<p>Subsection I, AREAS OF REVIEW, second paragraph.</p> <p>Subsection I, REVIEW INTERFACES</p> <p>Subsection II, ACCEPTANCE CRITERIA, fourth paragraph.</p> <p>Subsection III, REVIEW PROCEDURES, subsection III.4.</p> <p>Subsection IV, EVALUATION FINDINGS, second paragraph.</p>
241	Modify ACCEPTANCE CRITERIA and REVIEW PROCEDURES of SRP Section 2.3.5 to replace reference to NUREG-0324 with reference to NUREG/CR-2919.	<p>Subsection II, ACCEPTANCE CRITERIA, second paragraph, Section 2.</p> <p>Subsection III, REVIEW PROCEDURES, subsection III.1, fourth paragraph.</p> <p>Subsection VI, REFERENCES, Reference 6.</p>
1177	Revise the Acceptance Criteria, Review Procedures, and Evaluation Findings as necessary to incorporate the guidance of the proposed draft Regulatory Guide ES 926-4 (second proposed revision 1 to RG 1.23).	No changes to SRP at this time, pending final issue of the RG.