



U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

2.3.3 ONSITE METEOROLOGICAL MEASUREMENTS PROGRAM

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of meteorology

Secondary - None

I. AREAS OF REVIEW

Chapter 2 of the SRP discusses the site characteristics and postulated site parameters that could affect the safe design and siting of the plant. The staff reviews information presented by an applicant for a construction permit (CP), operating license (OL), design certification (DC), early site permit (ESP), or combined license (COL) concerning the onsite meteorological monitoring program along with the resulting data. This SRP section applies to reviews performed for each of these types of applications. The review covers the following specific areas:

1. Meteorological instrumentation, including the siting of meteorological towers and sensors, sensor type and performance specifications, methods and equipment for recording sensor output, the quality assurance program for sensors and recorders, data acquisition and reduction procedures, and special considerations for complex terrain sites and sites located in remote harsh environmental regions.

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USNRC STANDARD REVIEW PLAN

This Standard Review Plan, NUREG-0800, has been prepared to establish criteria that the U.S. Nuclear Regulatory Commission staff responsible for the review of applications to construct and operate nuclear power plants intends to use in evaluating whether an applicant/licensee meets the NRC's regulations. The Standard Review Plan is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide an acceptable method of complying with the NRC regulations.

The standard review plan sections are numbered in accordance with corresponding sections in Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)." Not all sections of Regulatory Guide 1.70 have a corresponding review plan section. The SRP sections applicable to a combined license application for a new light-water reactor (LWR) are based on Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)."

These documents are made available to the public as part of the NRC's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Individual sections of NUREG-0800 will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience. Comments may be submitted electronically by email to NRO_SRP@nrc.gov.

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2. The resulting onsite meteorological database, including consideration of the period of record (POR), data recovery, and the amenability and representativeness of the data for use in characterizing atmospheric dispersion conditions within the general site area (typically to include the exclusion area boundary (EAB), outer boundary of the low population zone (LPZ), the hypothetically maximum exposed member of the public, and the plume exposure emergency planning zone).
3. Additional Information for 10 CFR Part 52 Applications: Additional information will be presented dependent on the type of application. For a COL application, the additional information is dependent on whether the application references an ESP, a DC, both, or neither. Information requirements are prescribed within the "Contents of Application" sections of the applicable Subparts to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."
4. Design Certification Applications: For DC applications, the details of the meteorological monitoring program are site-specific and will be addressed by the COL applicant.
5. COL Action Items and Certification Requirements and Restrictions: For a DC application, the review will also address COL action items and requirements and restrictions (such as interface requirements and site parameters).

For a COL application referencing a DC or ESP, a COL applicant must address COL action items (referred to as COL license information in certain DCs) included in the referenced DC or ESP. Additionally, a COL applicant must address requirements and restrictions (such as interface requirements and site parameters) included in the referenced DC.

Review Interfaces

Other SRP sections interface with this section as follows:

1. Data summaries from the pre-operational onsite meteorological monitoring program are presented in Standard Review Plan (SRP) Section 2.3.2, "Local Meteorology" for comparison to data summaries from any earlier onsite monitoring and/or offsite monitoring locations to help establish long-term representativeness of the onsite data.
2. The data collected from the pre-operational onsite meteorological monitoring program are used to generate the short-term (accident release) atmospheric dispersion factors reviewed in SRP Section 2.3.4, "Short term Dispersion Estimates for Accident Releases," for use in the design basis radiological consequences analyses performed in SRP Chapter 15" and for use in the postulated leakage or failure analysis of a waste gas tank release or charcoal delay tank performed in SRP Section 11.3, "Gaseous Waste Management System."
3. The data collected from the pre-operational onsite meteorological monitoring program are used to generate the long-term (routine release) atmospheric dispersion and deposition factors reviewed in SRP Section 2.3.5, "Long-Term Atmospheric Dispersion Estimates for Routine Releases," for use in calculating the estimated gaseous effluent concentrations and annual doses to members of the public from gaseous effluents during normal routine operations and anticipated operational occurrences performed in

SRP Section 11.3, "Gaseous Waste Management System."

4. A review of the adequacy of instrumentation, including the control room displays, to assess conditions at the plant and its environs during and following an accident is performed in SRP Section 7.5, "Information Systems Important to Safety."
5. A review evaluating the capability of the operational meteorological monitoring program to provide the required near real-time meteorological information in the appropriate emergency response facilities for use in dose projections during radiological emergencies is performed in SRP Section 13.3, "Emergency Planning."

The specific acceptance criteria and review procedures are contained in the referenced SRP sections.

II. ACCEPTANCE CRITERIA

Requirements

Acceptance criteria are based on meeting the relevant requirements of the following Commission regulations:

1. For CP, OL, and COL applications, 10 CFR Part 20, "Standards for Protection Against Radiation," (Reference 1), Subpart D with respect to the meteorological data used to demonstrate compliance with dose limits for individual members of the public.
2. For CP applications, 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities" (Reference 2), Paragraph 50.34(a)(1)(ii)(D) with respect to a safety assessment of the site, including consideration of major structures, systems, and components (SSCs) of the facility and site meteorology, to evaluate the offsite radiological consequences at the EAB and outer boundary of the LPZ.
3. For OL applications, 10 CFR 50.34(b)(1) with respect to providing current information in the OL Final Safety Analysis Report (FSAR) on the results of the pre-operational meteorological monitoring program since issuance of the CP related to the site evaluation factors identified in 10 CFR Part 100 (Reference 3).
4. For CP, OL, and COL applications and for ESP applications that contain proposed complete and integrated emergency response plans, 10 CFR 50.47(b)(4), 10 CFR 50.47(b)(8), and 10 CFR 50.47(b)(9), as well as Section IV.E.2 of Appendix E to Part 50 with respect to the onsite meteorological information available for determining the magnitude and continuously assessing the impact of the releases of radioactive materials to the environment during a radiological emergency.
5. For CP, OL, and COL applications, 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," General Design Criterion (GDC) 19, "Control Room," with respect to the meteorological considerations used to evaluate the personnel exposures inside the control room during radiological and airborne hazardous material accident conditions.
6. For CP, OL, ESP, and COL applications, 10 CFR Part 50, Appendix I with respect to meteorological data used in determining compliance with the numerical guides for

design objectives and limiting conditions for operation to meet the requirement that radioactive material in effluents released to unrestricted areas be kept as low as is reasonably achievable (ALARA).

7. For ESP applications, 10 CFR 52.17(a)(1)(ix) with respect to a safety assessment of the site, including consideration of major SSCs of the facility and site meteorology, to evaluate the offsite radiological consequences at the EAB and outer boundary of the LPZ.
8. For COL applications, 10 CFR 52.79(a)(1)(vi) with respect to a safety assessment of the site, including consideration of major SSCs of the facility and site meteorology, to evaluate the offsite radiological consequences at the EAB and outer boundary of the LPZ.
9. For stationary power reactor site applications before January 10, 1997:
 - a. 10 CFR 100.10(c)(2), "Factors to be considered when evaluating sites", with respect to the meteorological conditions at the site and in the surrounding area which should be considered in determining the acceptability of a site for a power reactor.
 - b. 10 CFR Part 100.11(a) with respect to using the meteorological conditions pertinent to the site, along with an assumed fission product release from the core and the expected containment leak rate during postulated accidents, to ensure that prescribed dose limits for the EAB and outer boundary of the LPZ are met.
10. For stationary power reactor site applications on or after January 10, 1997:
 - a. 10 CFR Part 100.20(c)(2) with respect to the meteorological characteristics of the site that are necessary for safety analysis or that may have an impact upon plant design in determining the acceptability of a site for a nuclear power plant.
 - b. 10 CFR Part 100.21(c) with respect to the meteorological data used to evaluate site atmospheric dispersion characteristics and establish dispersion parameters such that (1) radiological effluent release limits associated with normal operation can be met for any individual located off site, and (2) radiological dose consequences of postulated accidents meet prescribed dose limits at the EAB and outer boundary of the LPZ.

SRP Acceptance Criteria

Specific SRP acceptance criteria acceptable to meet the relevant requirements of the U.S. Nuclear Regulatory Commission (NRC) regulations identified above are as follows for the review described in this SRP section. The SRP is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of compliance with the NRC regulations. The staff should review the following information in each application:

1. The pre-operational monitoring program should be described for CP and ESP applications and for COL applications that do not reference an ESP. The operational monitoring program should be described for OL and COL applications and in those ESP

applications that include proposed complete and integrated emergency response plans. The operational monitoring program may be described for ESP applications that include major portions of the emergency response plans. The monitoring program description should include meteorological measurements made at the site (primary and, if applicable, backup towers) and any offsite equipment and instrumentation used by the applicant in their atmospheric dispersion analyses. As a minimum, the description should include:

a. Instrument Siting

- a site map (drawn to scale) that shows plant and True North, the tower's grade elevation, and the tower location with respect to man-made or natural features that may affect onsite meteorological measurements (such as buildings; paved and improved surfaces; cooling towers and ponds; hills; trees; bodies of water)
- distances to nearby obstructions to air flow in each downwind sector
- exposure and orientation of instruments
- lightning protection system

b. Meteorological Sensors

- parameters measured and elevations of measurements
- types of instruments (such as cup, propeller, vane, or sonic anemometers; resistance temperature detectors (RTDs) or thermistor-type temperature sensors; chilled mirror or lithium chloride dew point sensors); however, details regarding makes and model numbers are not necessary
- instrument performance specifications (such as sensor and system accuracies; wind sensor starting thresholds; channel measurement resolutions and ranges)

c. Recording of Meteorological Sensor Output

- data output and recording systems, including (for OL and COL applications) locations of data displays

d. Instrument Surveillance

- summaries of calibration and maintenance procedures and frequencies

e. Data Acquisition and Reduction

- data acquisition and processing procedures, such as data sampling rates, averaging times, and methods for developing data averages (for example, wind speed and direction scalar versus vector averaging) consistent with regulatory and industry guidance and how the data will be used

- data validation procedures, including summary of data validation checks (automated and manual) and data correction or substitution

Guidance on a suitable onsite meteorological monitoring program to provide the required meteorological data is presented in Regulatory Guide (RG) 1.23, "Meteorological Monitoring Programs for Nuclear Power Plants" (Reference 5).

2. Data should include an hour-by-hour listing of the hourly-averaged parameters in the format described in Appendix A to RG 1.23, "Meteorological Monitoring Programs for Nuclear Power Plants." Data recovery should be at least 90 percent on an annual cycle basis for individual variables, as well as for the joint recovery (at each wind measurement level) of concurrent wind speed, wind direction, and atmospheric stability. When an application submittal includes more than one annual cycle of onsite meteorological data, the data recovery objective applies to each annual cycle as well as the composite POR.
 - a. CP applications should include at least one annual cycle (that is, a consecutive 12-month period) of onsite meteorological data. OL applications should include at least two consecutive cycles (and preferably 3 or more whole years, if available), including the most recent one-year period, at the time of application submittal.
 - b. COL applications that do not reference an ESP as well as ESP application submittals should include at least two consecutive annual cycles (that is, a consecutive 24-month period) (and preferably 3 or more whole years, if available), that are no older than 10 years from the date of the application.

If two years of onsite meteorological data are not available at the time the application is filed, a COL or ESP application should include at least one annual cycle of meteorological data collected onsite. The application should also include calculations of (1) the short-term atmospheric dispersion estimates for accident releases discussed in SRP Section 2.3.4, and (2) the long-term atmospheric dispersion and deposition estimates for routine releases discussed in SRP Section 2.3.5 based on the one-year data set. The staff should not make findings until it receives and evaluates a complete 2-year data set and an updated safety analysis report based on the complete 2-year data. The letter informing the applicant that the application has been accepted for docketing should provide instructions to the applicant for completing the meteorological data set. This letter should also instruct the applicant to submit the second year data set, along with: (1) the onsite meteorological monitoring program data summaries reviewed in SRP Section 2.3.2, (2) the short-term atmospheric dispersion estimates reviewed in SRP Section 2.3.4, and (3) the long-term atmospheric dispersion and deposition estimates reviewed in SRP Section 2.3.5 based on the composite 2-year POR.

3. The applicant should identify and justify any deviations from the guidance provided in RG 1.23.

Technical Rationale

The technical rationale for application of these acceptance criteria to the areas of review addressed by this SRP section is discussed in the following paragraphs:

1. For power reactor site applications submitted before January 10, 1997, 10 CFR 100.10(c)(2) states that meteorological conditions at the site and in the surrounding area should be considered in determining the acceptability of a site for a power reactor. Likewise, for power reactor site applications submitted on or after January 10, 1997, 10 CFR 100.20(c)(2) requires consideration of the meteorological characteristics of the site that are necessary for safety analysis or that may have an impact upon plant design in determining the acceptability of a site for a nuclear power plant. With respect to the review under this SRP section, the regulatory requirements to consider meteorological conditions at or near the site of a proposed nuclear power plant are imposed, in part, to provide sufficient meteorological data needed for making atmospheric dispersion estimates for both postulated accidental and expected routine airborne releases of radioactive effluents. Meeting these requirements helps to ensure that these conditions will not compromise the plant's design and operation or the public's safety.
2. For power reactor site applications submitted before January 10, 1997, 10 CFR 100.11(a) specifies the manner in which the EAB, LPZ, and population center distances are determined given a fission product release from the reactor core, an expected leak rate from containment, and pertinent meteorological conditions. Identification of an EAB, LPZ, and population center distance is an integral aspect of the siting criteria for a nuclear power plant. Specified radiation dose guidelines are associated with the EAB and outer boundary of the LPZ. Verification that the proposed nuclear plant meets these radiation dose guidelines is accomplished by calculating expected offsite radiation doses using an assumed inventory of fission products available for release from the containment building, the expected containment leak rate, and site atmospheric dispersion characteristics. Dispersion characteristics are typically determined from meteorological measurements taken at the proposed plant site and, if necessary, other offsite locations.
3. For power reactor site applications submitted on or after January 10, 1997, 10 CFR 100.21(c) requires the evaluation of site atmospheric dispersion characteristics and the establishment of dispersion parameters such that (1) radiological effluent release limits associated with normal operation from the type of facility proposed to be located at the site can be met for any individual located off site, and (2) radiological dose consequences of postulated accidents meet the prescribed dose limits at the EAB and LPZ distances set forth in 10 CFR 50.34(a)(1). The maximum annual average atmospheric dispersion factor (χ/Q value) at or beyond the site boundary and the annual average atmospheric dispersion and deposition factors (χ/Q and D/Q values) at specific locations of potential receptors of interest are a significant input to the assessment performed to demonstrate that radiological effluent release limits associated with normal operation from the type of facility proposed to be located at the site can be met for any individual located off site. Likewise, site atmospheric dispersion characteristics are a necessary input to the assessment demonstrating that the safety features that are to be engineered into the facility, including the plant design features intended to mitigate the radiological consequences of accidents, are adequate to ensure that the offsite radiological consequences of accidents meet specified radiation dose guidelines for the EAB and outer boundary of the LPZ.

4. The GDC set forth in Appendix A to 10 CFR Part 50 establish minimum requirements for the principal design criteria for water-cooled nuclear power plants. Specifically, GDC 19, "Control Room," requires that a control room be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions. Adequate radiation protection must be provided to permit access to and occupancy of the control room for the duration of accident conditions. Atmospheric dispersion estimates are significant inputs in assessments performed to demonstrate compliance with this requirement.
5. 10 CFR 50.47, "Emergency plans," and Appendix E, "Emergency Planning and Preparedness for Production and Utilization Facilities," to 10 CFR Part 50 specify requirements for emergency preparedness planning. Some emergency preparedness planning requirements focus on determining the magnitude, and assessing the impact, of radioactive releases to the environment. Hence, methods, systems, and equipment are required for assessing and monitoring offsite consequences. Meteorological parameters provide an integral part of the data needed to establish atmospheric dispersion factors for assessing offsite doses from airborne releases of radioactive material. Meeting the requirements for measurement of meteorological parameters during an accident or anticipated operational occurrence provides assurance that those personnel responsible for managing the event will be fully informed about the potential consequences of airborne radiological releases.
6. Applicants and licensees generally show compliance with 10 CFR Part 20, Subpart D, "Radiation Dose Limits for Individual Members of the Public," by demonstrating that the annual average concentrations of radioactive material at the boundary of the unrestricted area and at specific defined receptor locations of interest beyond the unrestricted area boundary do not exceed the values specified in Table 2, "Effluent Concentrations" of Appendix B to 10 CFR Part 20. 10 CFR Part 50, Appendix I, provides numerical guidelines for the ALARA criterion concerning radioactive material in light-water-cooled nuclear power reactor effluents. Sections 50.34a and 50.36a contain provisions designed to ensure that releases of radioactive material from nuclear power reactors to unrestricted areas during normal operation, including anticipated operational occurrences, are kept as low as is reasonably achievable. Appendix I provides numerical guidance for this requirement. Meeting the requirements of these regulations provides assurance that radiation doses from normal operation and from anticipated operational occurrences will not result in exposures that could cause measurable damage. Data from the pre-operational onsite meteorological measurements program are used to generate atmospheric dispersion and deposition estimates which are significant inputs to the assessments performed to demonstrate compliance with these requirements.

III. REVIEW PROCEDURES

The reviewer will select material from the procedures described below, as may be appropriate for a particular case.

The procedures outlined below are used to review CP applications, ESP applications, and COL applications that do not reference an ESP to determine whether the scope of the pre-operational and operational phases of the onsite meteorological measurements program for the proposed site meet the acceptance criteria given in Subsection II of this SRP section. For

reviews of OL applications, these procedures are used to verify that the scope of the operational phase of the meteorological measurements program remains valid and that the facility's design specifications are consistent with this scope.

As applicable, reviews of OL, DC, and COL applications include a determination on whether the content of any technical specifications related to the meteorological monitoring program operational phase is acceptable and whether the technical specifications reflect consideration of any identified unique conditions. Note that Generic Technical Specifications typically have an Administrative Controls Section that requires establishing, implementing, and maintaining written procedures covering such programs as the Offsite Dose Calculation Manual (ODCM) which includes the conduct of the radiological environmental monitoring program (REMP). NEI 07-09A, "Generic FSAR Template Guidance for Offsite Dose Calculation Manual (ODCM) Program Description" (Reference 6) provides a complete generic program description for use in developing construction and operating license applications. The operational meteorological monitoring program, including the preparation of an annual meteorological summary, is generally considered part of the REMP as outlined in RG 1.21, "Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste." Therefore, Generic Technical Specifications require written procedures for the operational meteorological monitoring program.

These review procedures are based on the identified SRP acceptance criteria. For deviations from these acceptance criteria, the staff should review an applicant's evaluation of how the proposed alternatives provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

1. Meteorological Instrumentation

The basic meteorological parameters measured by instrumentation should include wind direction and wind speed at two levels, ambient air temperature difference between two levels, ambient air temperature, precipitation (rainfall and liquid equivalent of frozen precipitation), and any other parameters used by the applicant to determine atmospheric stability (or turbulence) for the purposes of atmospheric dispersion and deposition modeling.

For those sites that rely on water evaporation as part of their normal heat sink (such as cooling towers, cooling lakes and ponds, or spray ponds), the pre-operational monitoring program should include atmospheric moisture measurements. Except for passive plants utilizing a passive containment cooling system, sites that rely on water evaporation as part of their ultimate heat sink (such as a mechanical draft cooling tower, a cooling lake with a submerged pond, or spray ponds), both the pre-operational monitoring program and the operational monitoring program should include atmospheric moisture measurements.

A site visit by staff to review the applicant's onsite meteorological measurements program is encouraged. This may be done in coordination with the environmental-related review. The scope of the site visit should include reviewing the siting of the meteorological tower(s), local exposure of instruments, identification of the types of sensors and data recorders installed and their corresponding performance specifications; inspection, calibration, maintenance, corrective action, and data handling procedures; and associated records.

a. Instrument Siting

Instrument types, heights, and locations are compared generally to the positions stated in RG 1.23. Additional information is provided in American National Standards Institute/American Nuclear Society (ANSI/ANS)-3.11-2015 (Reference 7). Detailed review procedures follow.

(1) Local Exposure of Instruments

The local exposure of the wind and temperature sensors is reviewed to ensure that the measurements represent the general site area. A determination is made as to whether the tower that supports the sensors will influence the wind or temperature measurements. Professional experience and studies have shown that wind sensors should be mounted on booms such that the sensors are at least two tower widths away from an open-latticed tower. For temperature sensors, mounting booms need not be as long as those for wind sensors but must be unaffected by thermal radiation from the tower itself. No wind or temperature sensors may be mounted directly on stacks or closed towers. Mounting booms for all sensors should be on the upwind side of the mounting object in areas with a dominant prevailing wind direction. In areas with two distinct prominent wind directions (such as mountain valleys), the sensors should be mounted in a direction perpendicular to the primary two directions to minimize tower interference.

The staff should determine to whether the terrain at or near the base of the tower will unnaturally affect the wind or temperature measurements. Heat reflection characteristics of the surface underlying the meteorological tower (grass, soil, gravel, paving, etc.) are considered to ensure that localized influences on measurements are minimal. The position, size, and materials used in the construction of the instrument shelter and nearby trees and vegetation are also examined for potential localized influence on the measurements.

(2) General Exposure of Instruments

Since the objective of the instrumentation is to provide measurements that represent the overall site meteorology without interference from plant structures and other features, including plant operations, the positions of the primary and, if applicable, backup meteorological towers should have been selected with this general objective in mind. Examination of topographical maps, that have been modified to show the likely finished plant grade, a site visit, and professional judgment on airflow patterns are used to determine and evaluate the representativeness of the pre-operational and, if different, operational phase tower location(s).

The proposed layout of plant structures, including structure heights, is examined for potential influence on meteorological measurements. Wind sensors should be located at least 10 obstruction heights away from the obstruction to airflow in order to minimize this influence. In those

situations where one or more natural draft cooling towers are being utilized as the normal plant heat sink, wind sensors can be located closer, but should be at least five times the maximum width of the cooling tower structure from the cooling tower, to preclude the meteorological tower from being located a significant distance from the reactor. The distance is normally acceptable because the rounded and sloping characteristics of a hyperbolic cooling tower are more aerodynamically smooth and streamlined as compared to block-shaped structures and are therefore expected to have shorter building wake effects downwind.

Precipitation gauges should be equipped with a wind deflector shield to improve gauge collection efficiency and may be equipped, where necessary, with heater devices to melt frozen precipitation.

b. Meteorological Sensors

The type and performance specifications of the sensors are evaluated. Manufacturers' specifications and the applicant's operating experience with these sensors are considered in evaluating their adequacy with respect to channel accuracy and the potential for acceptable data recovery.

The suitability of the specific type of sensor for use in the environmental conditions at the site is evaluated. To this end, the range of wind, temperature, and moisture conditions and the ability of the sensors to withstand harsh environments (such as extreme cold/hot, high winds, corrosion, blowing sand or dust, salt, air pollutants, birds or other wildlife, and insects) are considered.

If the instrumentation is new or differs from what is typically used in a meteorological monitoring program (such as SONIC Detection and Ranging (SODAR) measurements), then the application should justify doing so including, but not limited to, how the measurement technology is appropriate and how the resulting data will be used (e.g., input to dispersion models and its compatibility with the model algorithms based on how a particular model was developed). In such cases, meteorological instrumentation and dispersion modeling experts may need to be consulted.

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c. Recording of Meteorological Sensor Output

Information regarding the methods of recording (such as digital or analog; instantaneous or average; engineering units or raw voltages) and the recording equipment, including performance specifications and location of this equipment, is evaluated. Manufacturers' specifications and the applicant's operating experience with the recorders are considered in evaluating their adequacy with respect to system accuracy and the potential for acceptable data recovery.

The controlled environmental conditions in which the sensor processors and recorders are kept (such as the instrument shelter or control room) are reviewed for adequacy in accordance with the manufacturers' specifications. The ability to obtain a direct readout from the recorders in situ during routine inspection of systems is checked to ensure that the inspector will be able to relate the recorder

output directly to the sensor measurement. Some specific criteria are contained in RG 1.23.

d. Instrumentation Surveillance

Information regarding the inspection, maintenance, and calibration procedures and their frequencies is evaluated. RGs 1.21, "Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste," (Reference 8), 1.33, "Quality Assurance Program Requirements (Operation)," (Reference 9), 1.97, "Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants," (Reference 10), and 4.15, "Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination) -- Effluent Streams and the Environment" (Reference 11) discuss the need for procedures and quality assurance requirements for meteorological monitoring programs.

The surveillance procedures and the frequency of attention that the instrumentation systems receive are compared to operating experience at the proposed site and other sites with similar instrumentation with the objective of determining that acceptable data recovery, with acceptable accuracy, might be reasonably expected to be obtained throughout the duration of the operational phase of the onsite meteorological monitoring program. The ability of instrumentation systems to function throughout the course of accidents is also evaluated. Additional information is provided in ANSI/ANS-3.11-2015, EPA-454/R-99-005 (Reference 12) and EPA-454/B-08-002 (Reference 13).

Criteria for acceptable system accuracy and acceptable data recovery are specified in RG 1.23

e. Data Acquisition and Reduction

The methods used for data acquisition, processing, and validation (automated and manual) are evaluated. Since there are many methods of acquiring data from meteorological measurement systems that are acceptable to the staff, the review procedure varies. Information regarding the basic components of the monitoring program which is reviewed to ascertain the acceptability of data acquisition and reduction includes:

- (1) accuracy of direct measurements and their precision,
- (2) accuracy in conversion of direct measurement units to meteorological units,
- (3) adequacy of frequency and mode (instantaneous or average) of sampling,
- (4) averaging times, reporting intervals of system outputs, and averaging methods for consistency with how the data are to be used, and
- (5) identification and handling of suspect data.

Since the accuracy criteria in RG 1.23 refer to overall system accuracy for time-averaged values, the overall system accuracy (sensor, recorder, and data

reduction) is evaluated in addition to checking the component accuracies. The evaluation consists primarily of using statistical procedures for compound errors, based on sensor accuracy, recorder accuracy, conversion of units accuracy, and frequency and mode of sampling (Reference 7).

f. Special Considerations for Complex Terrain and Remote Sites

At some sites, because of complex flow patterns in non-uniform terrain, additional wind and temperature instrumentation and more comprehensive monitoring programs may be necessary. For example, the representation of circulation for a hill-valley complex or a site near a large body of water may need additional measuring locations to determine airflow patterns and spatial variations of atmospheric stability. Occasionally the unique dispersion characteristics of a particular site may also warrant the use of special meteorological instrumentation and/or studies.

At sites located in remote or harsh environments (such as extreme cold/hot, or wet/dry regions), equipment and operating considerations should be taken into account (such as equipment specifications; frequency of maintenance and calibration activities; protective measures to ensure functionality of equipment; approaches for data transmission, recording, and surveillance frequency; methods for atmospheric stability determination) to ensure the capture of valid and useful data. In extreme cold environments, consideration should also be given in determining appropriate measurement heights that take into account the range of meteorological conditions, including the variation and persistence of surface-based temperature inversions over the course of the year.

2. Meteorological Data

The annual (representing one or more continuous 12-month cycles) joint frequency distributions of wind direction and wind speed by atmospheric stability that are reviewed in SRP Section 2.3.2 are also evaluated in this SRP section to ensure they contain sufficient detail to permit the staff to make an independent determination of the atmospheric dispersion and deposition conditions.

The formats of the joint frequency distributions and hourly data are reviewed to ensure that they will be usable by the staff to review the atmospheric dispersion and deposition analyses performed in SRP sections 2.3.4 and 2.3.5. The formats in RG 1.23 are used for comparison. If a site has a high occurrence of low wind speeds (for example, the wind speed is less than 2 meters per second the majority of the time), a finer wind speed category breakdown should be used for the lower speeds so data are not clustered in a few categories.

"Calm" wind conditions (defined as wind speeds less than the starting speed of the anemometer or vane, whichever is higher) are checked for reasonableness. They should be identified in the joint frequency distributions as a separate wind speed class, without directional assignment for each atmospheric stability class.

Data quality should be checked using the methodology in NUREG-0917 (Reference 14) or similar approaches.

COL applicants referencing a standard design should choose meteorological measurement heights appropriate for the probable atmospheric release heights. As an example, a third measurement height above 60 meters may be implemented in situations where the stack releases exceed 85 meters or higher. Annual joint frequency distributions for each expected mode of release (ground level and elevated) are checked for appropriateness of the measurement heights for wind direction, wind speed, and atmospheric stability. Winds at the 10-meter level and the temperature difference (ΔT) between the vent height and the 10-meter level are used for vent and containment penetration or leakage releases. Winds from near release height and ΔT between release height and the 10-meter level are used for stack releases.

ANSI/ANS-3.11-2015, EPA-454/R-99-005, and EPA-454/B-08-002 are sources of information that can be used during the review.

3. Review Procedures Specific to 10 CFR Part 52 Application Type

a. Early Site Permit Reviews

Subpart A to 10 CFR Part 52 specifies the requirements and procedures applicable to the Commission's review of an ESP application for approval of a proposed site. Information required in an ESP application includes a description of the site characteristics and design parameters of the proposed site. The scope and level of detail for the review of this information parallels that used for a CP review.

In the absence of certain circumstances, such as a compliance or adequate protection issue, 10 CFR 52.39, "Finality of early site permit determinations," precludes the staff from imposing new site characteristics, design parameters, or terms and conditions on the early site permit at the COL stage. Accordingly, the reviewer should ensure that all physical attributes of the site that could affect the design basis of SSCs important to safety are reflected in the site characteristics, design parameters, or terms and conditions of the early site permit.

b. Standard Design Certification Reviews

DC applications do not contain general descriptions of site characteristics because this information is site-specific and will be addressed by ESP and COL applicants. However, pursuant to 10 CFR 52.47(a)(1), a DC applicant must provide site parameters postulated for the design.

There are no postulated site parameters related to the onsite meteorological measurements program for a DC related to this SRP section. The DC application review under this SRP section should confirm the inclusion of a COL action item relating to the need to establish an onsite meteorological monitoring program.

c. Combined License Reviews

For a COL application referencing a certified standard design, the staff reviews the application to ensure that sufficient information is presented to demonstrate that the characteristics of the site fall within the site parameters specified in the DC rule. Since there are no site parameters related to the onsite meteorological

measurements program included in the DC, this demonstration is not applicable for this SRP section.

For a COL application referencing an ESP and DC, the staff reviews the application to ensure that the applicant provides sufficient information to demonstrate that the design of the facility falls within the site characteristics and design parameters specified in the early site permit as applicable to this SRP section.

In addition, long-term environmental changes and changes to the region resulting from human or natural causes may have introduced changes to the site characteristics that could be relevant to the design basis. In the absence of certain circumstances, such as a compliance or adequate protection issue, 10 CFR 52.39 precludes the staff from imposing new site characteristics, design parameters, or terms and conditions on the early site permit at the COL stage. Consequently, a COL application referencing an ESP need not include a re-investigation of the site characteristics that have previously been accepted in the referenced ESP. However, in accordance with 10 CFR 52.6, "Completeness and Accuracy of Information," the applicant or licensee is responsible for identifying changes of which it is aware, which could satisfy the criteria specified in 10 CFR 52.39. Information provided by the applicant in accordance with 10 CFR 52.6(b) will be addressed by the staff during the review of a COL application referencing an ESP or a DC.

For a COL application referencing either an ESP or DC or both, the staff should review the corresponding sections of the ESP and DC FSER to ensure that any early site permit conditions, restrictions to the DC, or COL action items identified in the respective FSERs are appropriately handled in the COL application.

IV. EVALUATION FINDINGS

The review should document the staff's evaluation of the pre-operational and/or operational phases of the onsite meteorological monitoring program and the resulting database from the pre-operational phase against the relevant regulatory criteria. The evaluation should support the staff's conclusions as to whether the regulations are met. The reviewer should state what was done to evaluate the applicant's safety analysis report. The staff's evaluation may include verification that the applicant followed applicable regulatory guidance, performance of independent calculations, and/or validation of appropriate assumptions. The reviewer may state that certain information provided by the applicant was not considered essential to the staff's review and was not reviewed by the staff. While the reviewer may summarize or quote the information offered by the applicant in support of its application, the reviewer should clearly articulate the bases for the staff's conclusions.

The reviewer verifies that the applicant has provided sufficient information and that the review and calculations (if applicable) support conclusions of the following type to be included in the staff's safety evaluation report. The reviewer also states the bases for those conclusions.

1. Construction Permit, Operating License, and Combined License Reviews

The following are example statements that should be preceded by a summary of the pre-operational and/or operational phases of the onsite meteorological monitoring

program for the proposed plant site:

As set forth above, the applicant has presented and substantiated information pertaining to the pre-operational and/or operational phases of the onsite meteorological monitoring program and the resulting database. The staff has reviewed the information provided and, for the reasons given above, concludes that the onsite meteorological monitoring program and the resulting database are acceptable and meet the requirements of 10 CFR 100.10 [or 10 CFR 100.20 and 10 CFR 100.21 for stationary power reactor site applications after January 10, 1997] with respect to determining the acceptability of the site.

The staff finds that the onsite meteorological data also provide an acceptable basis for making estimates of atmospheric dispersion for design basis accidents and atmospheric dispersion and deposition for routine releases from the plant to meet the requirements of 10 CFR 100.11 [or 10 CFR 100.20 and 10 CFR 100.21 for stationary power reactor site applications after January 10, 1997], GDC 19, 10 CFR Part 20, and Appendix I to 10 CFR Part 50. Finally, the instrumentation provided for measurement of meteorological parameters during the course of accidents is sufficient to provide reasonable prediction of atmospheric dispersion and deposition of airborne radioactive materials in accordance with Appendix E to 10 CFR Part 50.

2. Early Site Permit Reviews

The following are example statements that should be preceded by a summary of the pre-operational phase of the onsite meteorological monitoring program used for the proposed plant site:

As set forth above, the applicant has presented and substantiated information pertaining to the pre-operational phase of the onsite meteorological monitoring program and the resulting database. The staff has reviewed the information provided and, for the reasons given above, concludes that the pre-operational onsite meteorological monitoring program provides adequate data to represent onsite meteorological conditions as required by 10 CFR 100.20 and 10 CFR 100.21. The onsite meteorological data also provide an acceptable basis for (1) making estimates of atmospheric dispersion for design basis accidents and atmospheric dispersion and deposition for routine releases from a nuclear power plant or plants that might be constructed on the proposed site and (2) meeting the requirements of 10 CFR Part 20, 10 CFR Part 100, and Appendix I to 10 CFR Part 50.

If the ESP application contains proposed complete and integrated emergency response plans, add the following:

Finally, for the operational phase, the instrumentation proposed for measurement of meteorological parameters during the course of accidents is sufficient to provide reasonable prediction of atmospheric dispersion and deposition of airborne radioactive materials in accordance

with Appendix E to 10 CFR Part 50.

3. Design Certification Reviews

There are no postulated site parameters or design characteristics for a DC related to this SRP section. The onsite meteorological monitoring program is site-specific and will be addressed by the COL applicant.

V. IMPLEMENTATION

The staff will use this SRP section in performing safety evaluations of DC applications and license applications submitted by applicants pursuant to 10 CFR Part 50 or 10 CFR Part 52. Except when the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the staff will use the method described herein to evaluate conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications submitted six months or more after the date of issuance of this SRP section, unless superseded by a later revision.

VI. REFERENCES

1. U.S. *Code of Federal Regulations*, "Standards for Protection Against Radiation," Part 20, Title 10, "Energy."
2. U.S. *Code of Federal Regulations*, "Domestic Licensing of Production and Utilization Facilities," Part 50, Title 10, "Energy."
3. U.S. *Code of Federal Regulations*, "Reactor Site Criteria," Part 100, Title 10, "Energy."
4. U.S. *Code of Federal Regulations*, "Licenses, Certifications, and Approvals for Nuclear Power Plants," Part 52. Title 10, "Energy."
5. U.S. Nuclear Regulatory Commission, "Meteorological Monitoring Programs for Nuclear Power Plants," Revision 1. Regulatory Guide 1.23, March 2007.
6. Nuclear Energy Institute, NEI 07-09A, "Generic FSAR Template Guidance for Offsite Dose Calculation Manual (ODCM) Program Description," Revision 0, March 2009. ADAMS Accession No. ML091050234).
7. American National Standards Institute/American Nuclear Society, "Determining Meteorological Information at Nuclear Facilities," ANSI/ANS-3.11-2015, 2015.
8. U.S. Nuclear Regulatory Commission, "Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste," Revision 2. Regulatory Guide 1.21, June 2009.
9. U.S. Nuclear Regulatory Commission, "Quality Assurance Program Requirements (Operation)," Revision 3, Regulatory Guide 1.33, June 2013.

10. U.S. Nuclear Regulatory Commission. "Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants," Revision 4, Regulatory Guide 1.97, June 2006.
11. U.S. Nuclear Regulatory Commission, "Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination) – Effluent Streams and the Environment," Revision 2, Regulatory Guide 4.15, July 2007.
12. U.S. Environmental Protection Agency, "Meteorological Monitoring Guidance for Regulatory Modeling Applications," EPA-454/R-99-005, February 2000.
13. U.S. Environmental Protection Agency, "Quality Assurance Handbook for Air Pollution Measurement Systems," Vol. IV: Meteorological Measurements, EPA-454/B-08-002, March 2008.
14. U.S. Nuclear Regulatory Commission, "Nuclear Regulatory Commission Staff Computer Programs for Use with Meteorological Data," NUREG-0917, July 1982.

PAPERWORK REDUCTION ACT

This Standard Review Plan contains voluntary information collections covered by 10 CFR Parts 50, 52, and Part 100 that are subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et seq.). These information collections were approved by the Office of Management and Budget (OMB), under control numbers 3150-0011, 3150-0151, and 3150-0093, respectively. Send comments regarding this information collection to the Information Services Branch, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by e-mail to Infocollects.Resource@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0011, 3150-0151, and 3150-0093) Office of Management and Budget, Washington, DC 20503.

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SRP Section 2.3.3 Description of Changes

Section 2.3.3 “Onsite Meteorological Measurements Program”

This SRP revision affirms the technical accuracy and adequacy of the guidance previously provided in Revision 3, March 2007 of this SRP (ADAMS Accession No. ML063600394). This revision captures lessons learned from the staff’s review of DC, ESP, and COL applications received during the previous decade.

Changes were made to update the text with editorial and clarifying statements, including utilizing consistent terminology within this SRP section and planned updates within the other SRP 2.3 sections. For example, the term “atmospheric diffusion” was replaced with “atmospheric dispersion” because atmospheric dispersion is generally recognized as having two components: transport and diffusion. The term “atmospheric stability class” was also replaced with “atmospheric stability” due to the recognition that newer atmospheric dispersion models may be using direct measurements of atmospheric turbulence instead of classifying atmospheric stability into seven distinct classes as is currently discussed in RG 1.23, Revision 1 and associated atmospheric dispersion models. Previous SRP standard boiler-plate statements that are not applicable to this SRP section were also eliminated.

Other changes incorporated in this revision include the following:

I. AREAS OF REVIEW

- a. Clarified the description of the instrumentation review to include the siting of meteorological towers and special considerations for sites located in remote harsh environmental regions.
- b. Clarified the description of the resulting onsite meteorological database to include consideration of data recovery and the representativeness of the data for use in characterizing atmospheric dispersion conditions.
- c. Added the review of COL action items and requirements and restrictions for DC applications. Also added that COL applicants referencing a DC should address action items and requirements and restrictions included in the reference DC.

II. ACCEPTANCE CRITERIA

- a. Reordered and clarified the links to applicable regulations and their subparts as a function of application type.
- b. Reorganized the description of the pre-operational monitoring program under subheadings of instrument siting, meteorological sensors, recording of meteorological sensor output, instrument surveillance, and data acquisition and reduction. Also clarified the information to be provided.
- c. Added a data recovery rate goal of 90 percent consistent with RG 1.23, Revision 1, and clarified its applicability.
- d. Eliminated the need to review evidence of how well the onsite meteorological data represent long-term conditions (this will be moved to SRP Section 2.3.2).

- e. Clarified the amount of meteorological data to be provided as a function of the type of application (to be consistent with RG 1.23).
- f. Clarified the SAR sections which should be updated resulting from a submittal of additional onsite meteorological data.

III. REVIEW PROCEDURES

- a. Added that the Generic Technical Specifications typically require written procedures for the operational meteorological monitoring program.
- b. Expanded the basic meteorological parameters to include any parameters used by the applicant to determine atmospheric stability (turbulence) for the purposes of atmospheric dispersion and deposition modeling.
- c. Specified when atmospheric moisture measurements should be taken.
- d. Recommended a site visit to review the applicant's onsite meteorological measurements program.
- e. Clarified the criteria for siting wind sensors in the vicinity of natural draft cooling towers.
- f. Added the use of wind deflector shields and heater devices for precipitation gauges.
- g. Discussed the need for sensors to withstand harsh environments, as applicable.
- h. Added that procedural and quality assurance requirements for meteorological monitoring programs are discussed in RGs 1.21, 1.33, 1.97, and 4.15.
- i. Added a discussion about choosing appropriate measurement heights.
- j. Eliminated the need to check the climatic representativeness of the joint frequency distributions.
- k. Added that a COL action item establishing an onsite meteorological monitoring program should be included in DC applications.

IV. EVALUATION FINDINGS

- a. Updated with editorial changes.

V. IMPLEMENTATION

- a. No changes.

VI. REFERENCES

- a. Listed regulations by overall title of the regulation instead of separate listings for each pertinent subpart.
- b. Removed the following reference:
 - i. Darryl Randerson (ed.), “Atmospheric Science and Power Production,” DOE/TIC-27601, U.S. Department of Energy (1984).
- c. Added the following references:
 - i. U.S. Nuclear Regulatory Commission, “Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste,” Revision 2, Regulatory Guide 1.21, June 2009.
 - ii. U.S. Nuclear Regulatory Commission, “Quality Assurance Program Requirements (Operation),” Revision 3, Regulatory Guide 1.33, June 2013.
 - iii. U.S. Nuclear Regulatory Commission, “Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants,” Revision 4, Regulatory Guide 1.97, June 2006.
 - iv. U.S. Nuclear Regulatory Commission, “Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination) – Effluent streams and the Environment,” Revision 2, Regulatory Guide 4.15, July 2007.
- d. Updated the following references:
 - i. U.S. Nuclear Regulatory Commission, “Meteorological Monitoring Programs for Nuclear Power Plants,” Revision 1. Regulatory Guide 1.23.
 - ii. American National Standards Institute/American Nuclear Society, “Determining Meteorological Information at Nuclear Facilities,” ANSI/ANS-3.11-2015, 2015.
 - iii. U.S. Environmental Protection Agency, “Quality Assurance Handbook for Air Pollution Measurement Systems,” Vol. IV: Meteorological Measurements EPA-454/B-08-002, March 2008.