2.3.3 ONSITE METEOROLOGICAL MEASUREMENTS PROGRAMS

REVIEW RESPONSIBILITIES

Primary- Probabilistic Safety Assessment Branch (SPSB)

Secondary- None

I. AREAS OF REVIEW

This section of the site safety assessment for an early site permit (ESP) application concerns the onsite meteorological measurements programs, including instrumentation and measured data. The review covers the following specific areas:

1. Meteorological instrumentation, including siting of sensors, sensor performance specifications, methods and equipment for recording sensor output, the quality assurance program for sensors and recorders, and data acquisition and reduction procedures.

2. Meteorological data, including consideration of the period of record and amenability of the data for use in characterizing atmospheric dispersion conditions.

3. Additional meteorological measurement requirements for emergency preparedness planning pursuant to 10 CFR 50.47 (Ref. 1) and Appendix E to 10 CFR Part 50 (Ref. 2) are reviewed by SPSB as a secondary review responsibility for Section 13.3 of this review standard.

II. ACCEPTANCE CRITERIA

The acceptance criteria for the onsite meteorological measurement program are based on the relevant requirements of the following regulations:

1. 10 CFR 100.20(c) 100.21(c), and 100.21(d) (Ref. 3) as related to meteorological data collected for use in characterizing meteorological conditions of the site and surrounding area.

2. 10 CFR Part 50, Appendix I (Ref. 4), as related to meteorological data used in determining the compliance with the numerical guides for doses to meet the criterion of "as low as is reasonably achievable."

Specific criteria necessary to meet Part 100 and Appendix I are as follows:

1. The onsite meteorological measurements programs should produce data that describe the meteorological characteristics of the site and its vicinity for the purpose of making

atmospheric dispersion estimates for both postulated accidental and expected routine airborne releases of effluents and for comparison with offsite sources to determine the appropriateness of climatological data used for design considerations. The criteria for an acceptable onsite meteorological measurements program are documented in the Regulatory Position, Section C, of Regulatory Guide 1.23[1] (Ref. 5).

2. For the ESP application, at least one annual cycle of onsite meteorological data should be provided at docketing. (Ref. 6)

Meteorological data should be presented in the form of joint frequency distributions of wind speed and wind direction by atmospheric stability class in the format described in Regulatory Guide 1.23. If a site has a high occurrence of low wind speeds, a finer category breakdown should be used for the lower speeds so data are not clustered in a few categories. A listing of each hour of the hourly-averaged data should be provided on electronic media in the format described in Appendix A to this section of this review standard.

Evidence of how well these data represent long-term conditions at the site should be presented.

III. REVIEW PROCEDURES

1. Meteorological Instrumentation

The basic meteorological parameters measured by instrumentation are reviewed and should include wind direction and wind speed at two levels, ambient air temperature difference between two levels, temperature, and atmospheric moisture (at sites where water vapor is emitted, as from cooling towers or spray ponds).

a. Instrument Siting

Instrument types, heights, and locations are compared generally to the position stated in Regulatory Guide 1.23, Positions C.1 and C.2. Detailed review procedures follow. Information sources such as References 7 and 8 may be used during the review.

(1) Local Exposure of Instruments

The local exposure of the wind and temperature sensors is reviewed to ensure that the measurements will represent the general site area. A determination is made whether the tower which 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 should be

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

unaffected by thermal radiation from the tower itself. No temperature sensors may be mounted directly on stacks or closed towers. Mounting booms for all sensors should be oriented normal to the prevailing wind at the site.

A determination is made whether the terrain at or near the base of the tower will 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 of nearby structures 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 which represent the overall site meteorology without structure interference, the tower position(s) should have been selected with this general objective in mind. Examination of topographical maps, which have been modified to show the likely finished grade of a nuclear power plant or plants of specified type (or falling within a plant parameter envelope [PPE]) that might be constructed on the proposed site, a site visit, and professional judgment on airflow patterns are used to evaluate the representativeness of the measurement location(s).

The planned structure layout of the nuclear power plant or plants of specified type (or falling within a PPE) that might be constructed on the proposed site (to the extent known), including structure heights, is examined to identify potential influence on meteorological measurements. Sensors should be located at least 10 obstruction heights away from an obstruction to minimize the influence of the obstruction on measurements.

b. Meteorological Sensors

The type and performance specifications of the sensors are evaluated. Manufacturers' specifications and analysis, and operating experience for these sensors are considered in evaluation of adequacy with respect to accuracy and the potential for acceptable data recovery. References 8 through 11, as well as operational experience reports contained in research papers that describe sensors, may be used in this evaluation.

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 conditions and the ability of the sensors to withstand corrosion, blowing sand, salt, air pollutants, birds, insects, lightning, icing, and humidity are considered.

If the sensors are new and unique, a meteorological instrumentation expert may need to be consulted.

c. Transmission and Recording of Meteorological Sensor Output

The methods of data transmission and recording (e.g., digital or analog, instantaneous or average, engineering units or raw voltages) and the recording equipment, including performance specifications and location of this equipment, are evaluated. Manufacturers' specifications and operating experience for the transmission and recording systems are considered in evaluation of adequacy with respect to accuracy and data recovery.

The environmental conditions in which the transmission and recording systems are kept are reviewed for adequacy in accordance with the manufacturers' specifications. The ability to obtain a direct readout in situ during routine inspection of systems is checked to ensure that the inspector will be able to relate the output directly to the sensor measurement. Some specific guidelines are contained in Regulatory Guide 1.23, Position C.3. Additional information is provided in Refs. 8 and 12.

The reviewer determines that there are provisions for proper display of measurements of wind direction, wind speed, and vertical temperature difference in the control room during operation of a nuclear power plant or plants of specified type (or falling within a PPE) that might be constructed on the proposed site.

d. Instrumentation Surveillance

The inspection, maintenance, and calibration procedures and their frequency are evaluated. These surveillance procedures and the frequency of attention that the instrumentation systems receive are compared to operating experience at this site and other sites with similar instrumentation with the objective of determining that acceptable data recovery with acceptable accuracy will be obtained throughout the duration of the meteorological program. Regulatory Guide 1.23, Positions C.4 and C.5 describe acceptable accuracy and data recovery rates. Additional information is provided in Refs. 8, 9, and 12.

e. Data Acquisition and Reduction

Procedures, including hardware and software for data acquisition and reduction, are evaluated. Since there are many methods of acquiring data from meteorological measurement systems which are acceptable to the staff, the review procedure varies. The basic components of the program which are reviewed to ascertain the acceptability of data acquisition and reduction are:

(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 time of system outputs for final disposition and accuracy of these data, and

(5) identification and handling of suspect data.

Regulatory Guide 1.23 guidance on accuracy refers to overall system accuracy for time-averaged values. Therefore, the overall system accuracy is evaluated in addition to the component (sensor, recorder, and reduction) 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 (Ref. 13).

2. Meteorological Data Summaries

Annual (i.e., representing the annual cycle) joint frequency distributions of wind direction and wind speed by atmospheric stability class are evaluated for sufficient detail to permit the staff to make an independent determination of the atmospheric dispersion conditions.

The format of the data (joint frequency distributions and hourly averages) is reviewed to ensure that it will be usable by the staff. The formats in Regulatory Guide 1.23 and in Appendix A to this section of this review standard are used for comparison. If a site has a high occurrence of low wind speeds, a finer category breakdown should be used for the lower speeds so data are not clustered in a few categories.

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

Data quality may be checked using the NUREG-0917 (Ref. 14) or similar methodology and/or a computer spreadsheet.

Annual joint frequency distributions for each expected mode of release (i.e., ground level and elevated) are checked for appropriateness of heights of measurements of wind direction, wind speed, and atmospheric stability. Winds at the 10-meter level and the temperature difference (ΔT) between the 10-meter level and the vent height (but no less than 30 m above the lower sensor) are used for vent and penetration releases. Winds from near release height and ΔT between release height and the 10-meter level are used for stack releases.

The climatic representativeness of the joint frequency distribution is checked by comparison with nearby stations which have collected reliable meteorological data over a long period of time (10-20 years). The distributions are compared with sites in similar geographical and topographical locations to ensure that the data are reasonable.

References 8 through 15 are information sources that may be used during the review.

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided in accordance with the requirements of this section of this review standard and that the evaluation supports the following type of concluding statement, to be included in the staff's safety evaluation report:

> As set forth above, the applicant has provided and substantiated information on the meteorological measurements program. The staff has reviewed the available information relative to the onsite meteorological measurements program and the data collected by the program.
>
> Based on [summarize bases for conclusion], the staff concludes that the system provides adequate data to represent onsite meteorological conditions as required by 10 CFR 100.20. The onsite data also provide an acceptable basis for making estimates of atmospheric dispersion for design basis accident and routine releases from a nuclear power plant of type specified by the applicant [or falling within the PPE submitted by the applicant] that might be constructed on the proposed site to meet the requirements of 10 CFR Part 100 and Appendix I to 10 CFR Part 50.

These statements should be preceded by a brief summary description of the onsite meteorological measurements program covering the following items:

1. height and location of meteorological sensors by type,
2. period of data record,
3. data recovery, and
4. meteorological parameters used for atmospheric diffusion estimates.

V. IMPLEMENTATION

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

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

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

VI. REFERENCES

1. 10 CFR 50.47, "Emergency Plans."

2. 10 CFR Part 50, Appendix E, "Emergency Planning and Preparedness for Production and Utilization Facilities."

3. 10 CFR Part 100, Subpart B, “Evaluation Factors for Stationary Power Reactor Site Applications on or after January 10, 1997.”

4. 10 CFR Part 50, Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Condition."

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

6. Regulatory Guide 4.2, "Preparation of Environmental Reports for Nuclear Power Plants."

7. R. C. Hilfiker, "Exposure of Instruments," Chapter in Air Pollution Meteorology Manual, Training Course 411 conducted by USEPA Air Pollution Training Institute, Research Triangle Park, North Carolina, August 1973.

8. U.S. Environmental Protection Agency, “Meteorological Monitoring Guidance for Regulatory Modeling Applications,” EPA-454/R-99-005, February 2000.

9. U.S. Environmental Protection Agency, “Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements,” EPA/600/R-94/038d, March 1995.

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

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

12. American Nuclear Society, “Determining Meteorological Information at Nuclear Facilities,” ANSI/ANS-3.11-2000, February 2000.

13. C. E. P. Brooks and N. Caruthers, "Handbook of Statistical Methods in Meteorology," M.O. 538, Her Majesty's Stationary Office, London (1953).

14. NUREG-0917, “NRC Staff Computer Programs for Use with Meteorological Data,” July 1982.

15. D. A. Mazzarella, "An Inventory of Specifications for Wind Measuring Instruments," Bull. Amer. Meteor. Soc. 53, 860 (1972).

APPENDIX A

RS-002 Section 2.3.3

RECOMMENDED FORMAT FOR HOURLY METEOROLOGICAL DATA TO BE PLACED ON ELECTRONIC MEDIA

When hourly meteorological data are submitted to the NRC, the data may be submitted on mutually-agreed-upon media. The data should be in files that are of a size that are convenient for use and storage. Annual data files are acceptable.

At the beginning of each file, use the first five (5) records to give a file description. Include plant name, location (latitude, longitude), dates of data, information explaining data contained in the "other" fields if they are used, heights of measurements, and any additional information pertinent to identification of the file. Make sure all five records are included, even if some are blank. Format for the first five records will be 160A1. Meteorological data format is (A4, I4, I3, I4, 25F5.1, F5.2, 3F5.1).

All data should be given to the tenth of a unit, except solar radiation, which should be given to a hundredth of a unit. This does not necessarily indicate the accuracy of the data (e.g., wind direction is usually given to the nearest degree). All nines in any field indicate a lost record (99999). All sevens in a wind direction field indicate calm (77777). If there are only two levels of data, use the upper and lower levels. If there is only one level of data, use the upper level.

METEOROLOGICAL DATA ON ELECTRONIC MEDIA

LOCATION:

DATE OF DATA RECORD:

A4	Identifier (can be anything)	
I4	Year	
I3	Julian Day	
I4	Hour (on 24-hour clock)	
		ACCURACY
F5.1	Upper Measurements: Level = _____ meters	_____
F5.1	Wind Direction (degrees)	_____
F5.1	Wind Speed (meter/sec)	_____
F5.1	Sigma Theta (degrees)	_____
F5.1	Ambient Temperature (°C)	_____
F5.1	Moisture: _____	_____
F5.1	Other: _____	_____
F5.1	Intermediate Measurements: Level = _____ meters	_____
F5.1	Wind Direction (degrees)	_____
F5.1	Wind Speed (meters/sec)	_____
F5.1	Sigma Theta (degrees)	_____
F5.1	Ambient Temperature (°C)	_____
F5.1	Moisture: _____	_____
F5.1	Other: _____	_____
F5.1	Lower Measurements: Level = _____ meters	_____
F5.1	Wind Direction (degrees)	_____

METEOROLOGICAL DATA ON ELECTRONIC MEDIA (Continued)

F5.1	Wind Speed (meters/sec)	_____
F5.1	Sigma Theta (degrees)	_____
F5.1	Ambient Temperature (°C)	_____
F5.1	Moisture: _____	_____
F5.1	Other: _____	_____
F5.1	Temp. Diff. (Upper-Lower) (°C/100 meters)	_____
F5.1	Temp. Diff. (Upper-Intermediate) (°C/100 meters)	_____
F5.1	Temp. Diff. (Intermediate-Lower) (°C/100 meters)	_____
F5.1	Precipitation (mm)	_____
F5.1	Solar Radiation (cal/cm^2/min)	_____
F5.1	Visibility (km)	_____
F5.1	Other: _____	_____
F5.1	Other: _____	_____