QA/QC REQUIREMENTS FOR METEOROLOGICAL MONITORING

Kolli M. Rao

New York Power Authority

123 Main Street, White Plains,New York 10901

I. Introduction

Quality Assurance and Quality Control (QA/QC) of meteorological monitoring is essentially a new field. Valid meteorological data are the basic requirement for any successful assessment of the consequences of pollutant release, either routine or accidental,into the atmosphere. Without valid meteorological data it is very difficult to provide reliable and useful input to those responsible for minimizing the consequences of an accidental releases not only at nuclear power plants but also other industrial facilities such as chemical plants.

In recent years, the use of meteorological data by the industrial sector has increased many fold. All operating nuclear power plants must maintain and operate meteorological towers capable of providing real time data such as wind speed, wind direction, ambient temperature , as well as a methodology to estimate turbulence so that atmospheric diffusion and transportation of radioactive releases can be estimated during routine operations and accidental releases. Similarly regulatory agencies, at the federal, state and local level that have authority to issue various Clean Air Act permits often require on site meteorological monitoring programs before, during and after the construction of the facility . The purpose of such meteorological data has often been to estimate the maximum ground level concentration and its location from the facility.

The atmospheric and dispersion modeling has many uncertainties. The inherent uncertainties of modeling are mainly due to inadequate model physics, stochastic process of the atmosphere etc.,. In addition to the inherent uncertainties of modeling itself , lack of valid input data for the models is another major uncertainty. Uncertainties in the input variables could be both in the source strength term and meteorological data. Any errors in the input variables could exacerbate the uncertainties already inherent in the model. One way to reduce the uncertainties to propagate into final assessment is to have a reliable valid input data. Since meteorology is one of the critical inputs the necessity to have a valid meteorological data increases many fold.

In addition to source emission data, site specific meteorological data play a major role in determining not only ground level concentrations of pollutants but also their transportation . In the case of nuclear power plants erroneous meteorological data may result in mis-characterization of the meteorological conditions and could affect the recommendations for the protective actions, assessments of plume arrival and transit times etc.,. Even in the case of normal routine releases from the facility erroneous meteorological data may result in improper calculation of dosage levels. Thus the basic requirement to obtain valid site specific meteorological data is to have a good QA/QC program not only to validate the data but also for the monitoring program itself. Filippov (1968) offered a detailed and through discussion of the various possible sources of error, and Lockhart (1985) provided guidance for quality assurance of meteorological monitoring. In this review QA/QC program for meteorological monitoring specifically at nuclear power plants are examined.

II. QA/QC of Meteorological Monitoring Program

The meteorological monitoring program at an operating nuclear power plant is a regulatory requirement and the data are often used for various purposes including estimation of off_site doses for routine radioactive releases and for the emergency planning and response during any " off-normal " releases. In Information Notice No. 84-91, the Nuclear Regulatory Commission identified two major concerns of meteorological monitoring programs at nuclear power reactors. One concern is the availability of sufficient data and the second is the availability of valid data. Lack of proper and adequate operational and maintenance procedures generally would result in poor quality measurements and may even result in not meeting the data availability requirements of Regulatory Guide 1.23 " on site meteorological monitoring program ". Information Notice No.84-91 even identifies inadequate maintenance of ground cover and tree growth as one possible cause of poor quality data.

The QA/QC of the meteorological program itself should be developed to meet the Regulatory Guide 1.23 and 10 CFR 50 Appendix B " Quality Assurance Criteria For Nuclear Power Plants and Fuel Processing Plants". 10 CFR 50 Appendix B delineates a Quality Assurance program in detail for systems and components that prevent or mitigate the consequence of postulated accidents that could cause undue risk to the health and safety of the public.

The QA/QC of the monitoring system should consist of at least the following areas:

1. Project organization
2. Procedures for maintenance
3. Procedures for operation
4. Procedure for installation
5. Document control
6. Audits
7. Non-Conformance and Corrective Actions

Each component of the program is briefly discussed below:

1. Project Organization:

As in any project the management should clearly establish the responsibility for operation and maintenance of the meteorological monitoring system . This should include not only data gathering but also purchasing, calibrations,document control, data analysis and storage.

A dedicated field technician trained in operating and maintaining the meteorological instrumentation should be identified and made responsible for day to day operations of the system.

2. Procedures for maintenance

Maintenance procedures for both routine operation and for emergency operation should be developed for the whole system. This should include not only meteorological sensors but also power supply, data loggers, strip chart recorders, tower and other ancillary equipment. These procedures should clearly identify the frequency of sensor calibration (usually once in six months) and maintenance of calibration certificates for each sensor. No sensor should be installed on the tower unless it is calibrated at least once in six months.

Calibration procedures for all the meteorological parameters monitored should be developed. Sensors should be taken off the tower, reconditioned if necessary, and calibrated. The calibration should be done by accredited laboratory or the sensor manufacturer and the calibrations should be " traceable to National Institute of Standards Technology (NTIS)" .

It is very important for the preventive maintenance program to identify and store the spare parts and spare sensors. All the spare sensors should be properly calibrated before storing.

A preventive maintenance program should also be included with a check list provided to the field technicians to routinely check various parts of the monitoring system.

3. Procedures for operation

Operational procedures for daily operation of the system should also be developed. This should include daily checking of span and zero checks for all sensors, visual inspection of the sensors on the tower and other auxiliary equipment. Check lists should be developed and the site technician should be required to maintain the log of all the daily checks.

4. Procedures for Installation

Procedures should be developed for installation of all the meteorological sensors. This should include pre-installation bench testing of the equipment for its proper function and verifying all the calibration certifications. No sensor should be installed on the tower without proper calibration certification.

5. Document Control

All the operational activities including QA and QC activities should be documented and this is essential to show evidence of data validity. A station log should be maintained and every activity including problems, scheduled calibrations and findings, unscheduled maintenance tests and repairs, audits etc., should be recorded.

Documents such as calibration certificates, data logs, and any pertinent instrument data should be stored in proper storage as long as the sensor is either on tower or in storage.

6. Audits

The system should be audited by an independent auditor such as a corporate QA group or outside contractor at least once in two years for compliance with all the applicable guidelines and administrative and operations procedures . Performance audits establish a quality plan and identify out areas required to get the system " in control". Any audit findings and any recommendations should be communicated to the individual responsible for meteorological programs and to the management.

7. Non-Conformance and Corrective Actions

Procedures and measures should be established to assure that conditions that affect the quality of measurements, such as failures, malfunctions, deficiencies, deviations, defective materials and equipment and any other nonconformance conditions are properly identified and corrected.

III. QA/QC of Meteorological data

It is essential that a meteorological monitoring program provides valid data. Thus QA/QC requirements for validation of the measured data are as important as QA/QC of the meteorological monitoring program itself.

The QA/QC program for valid meteorological data should have

1. Procurement Procedures
2. Data Validation
3. Verification and Validation of computer software

1. Procurement Procedures

Procurement of various sensors that meet the monitoring requirements is very important. The instrument accuracy, minimum threshold value and operational advantage should be considered. The accuracy requirements as stated in Regulatory Guide 1.23 and ANSI/ANS_2.5_1984 (Standards for determining Meteorological Information at Nuclear Power Sites) should be followed as the minimum requirement. The procurement specifications should clearly provide these values and the vendor must provide proof of accuracy limits. It is recommended that a QA organization representative review and sign off all the procurement documents to ensure that the specifications meet the required procedures.

The procurement procedures should also include acceptance criteria when the vendor or manufacturer ships the equipment. This should include verifying calibration certificates, physical damages etc.,.

2. Data Validation

Data validation is the most important aspect of the whole QA/QC program for meteorological monitoring. An excellent handbook is available from the US Environmental Protection Agency " Quality Assurance Handbook for Air Pollution Measurement Systems, Volume

IV--Meteorological Measurements (1989). It is not the intent here to reproduce the data validation techniques contained in the handbook, however some important points are noted below.

Data screening and validation could be done both manually and automatically. Meteorological data are generally recorded continuously on a strip charts. However, after the advent of digital data loggers and computers it is a common practice to install data loggers in parallel to the strip chart recorders, thus maintaining a redundant recording of the data.

The data validation generally consists of three steps:

a. if you have redundant recording system compare the recorded values
b. editing or screening of data
c. invalid data what to do with it

a. Comparison of recorded data

The first step in validating the data is to compare the strip chart reading with that of data logger and see whether the data are comparable with in acceptable limits . The data should also be scanned to determine if the recorded values are reasonable and in the proper format. If there is any missing data in the data logger using strip chart recorders fill in the gaps.

b. Editing or screening of data

Methods of editing or screening meteorological data usually involve comparison of the measured value with some expected value or range of values. Data are checked to see if they fall within specified ranges. These ranges are set in advance based on the purpose of monitoring, historical and climatological data and other scientific limitations.

Computer software is presently available to automatically screen the data to see whether the data is within the ranges set in advance. The data logging system will flag such data for an individuals further scrutiny and verification.

c. Invalid data

The most difficult decision is what to do with the invalid data point. It could be deleted from the data base or a proper value could be reconstructed after reviewing all the records. This decision has to be made by the individual who is editing the data and the individual must use the professional judgement based on his knowledge not only of monitoring system but also local climatology.

3. Verification and Validation of Software

If computer software is used to screen and edit the data it is essential that the software should be verified and validated to ensure that the computer code is functioning the way it is supposed to function.

IV. A Case Study:

1. Monitoring System

New York Power Authority maintains and operates a meteorological monitoring net work at its Nuclear Power Plant located at Indian Point in Buchanan, New York.

The meteorological monitoring net work at Indian Point consists of three towers which are located at the plant site. They are situated approximately the same elevation as the plant grade and represents the site meteorological characteristics as closely as possible.

The primary tower is 122 meters in height and has instrumentation at 10,38,60 and 122 meters level. At the 10 meter level there are wind speed and wind direction sensors, ambient temperature sensor and a dew point sensor. At 38 meter level there are wind speed and wind direction sensors. At the 60 meter level there are wind speed and wind direction sensors and a temperature sensor which is used to compute the temperature difference between 60 meters and 10 meters (lower delta t). At the 122 meter level there are wind speed and wind direction sensors and a temperature sensor which is used to compute the temperature difference between 122 meters and 10 meters (upper delta t).

The second tower is the primary backup tower with wind speed and wind direction sensors located at 10 meter level.

The third tower is the standby backup tower. This tower is mounted on the roof of the Emergency Operations Facility (EOF) and has wind speed and wind direction sensors at 10 meter level.

At 122 meter tower site there are two precipitation gauges. The primary gauge is a heated tipping bucket type gauge. There is also a backup dip stick type gauge which is of the standard National Weather Services (NWS) type.

The data is recorded both on continuous trace strip chart analog recorders and a microprocessor data logger. The data logger computes standard deviation (sigma theta), Pasquill category (stability class), and delta temperatures for upper and lower levels and wind data. Fifteen minute and hourly averages are computed and stored in memory. Wind speed, wind direction and stability class data are also transmitted to control room for display and to the emergency operations facility.

2. Operation and Maintenance

The monitoring system must provide real time, valid data that are reliable and representative of site meteorology and meet the regulatory requirements. The regulatory guides require not only 90% data recovery but also specify data accuracy limits.

In order to achieve the above goal, we have developed Administrative procedures which delineate organizational responsibilities and Operational Manual which delineates procedures for operation and maintenance of the meteorological system. The operational manual specifically addresses the following:

a. Operation of Meteorological Monitoring System

b. Routine Maintenance and Repairs

c. Calibration

d. Modification of the Meteorological System

e. Activity Near Meteorological Tower

f. Acceptance Testing and Purchases

g. Receipt and Shipping of Sensors and other Material

h. Storage of Sensors and other Materials

i. Records

j. Monthly Reports

The system is operated and maintained by an Environmental Engineer who is totally responsible for meteorological monitoring alone. The Environmental Engineer has background in not only meteorological instrumentation but also electronics.

a. Operation of Meteorological monitoring system

The Environmental Engineer performs the daily, weekly and periodic checks and logs in the station log book. As part of the system operation he identifies the calibrations, maintenance and repairs necessary to ensure proper system operation and ensures that these are implemented as needed in accordance with site policies and procedures.

b. Routine Maintenance and Repairs

The Environmental Engineer performs routine operating instrument maintenance as outlined in the operation manual. When maintenance and/or repair is necessary, the Environmental Engineer prepares and submits the Work request, as appropriate. All the maintenance and repair activities are documented in the site log book and in the monthly meteorology report.

Any monitoring equipment that is repaired must be calibrated before placed back in service.

c. Calibration

All meteorological sensors are calibrated semiannually, as per specific calibration techniques in the Operation Manual. A schedule for the meteorological tower instrumentation is maintained by the Performance and Reliability Group.

Calibration of all sensors is performed by the vendor at the vendor's facility in accordance with their calibration procedures. The calibration data sheets, which are returned with the calibrated instrument, are reviewed by the Environmental Engineer and if acceptable, are maintained on file at the meteorological building.

The Environmental Engineer upon receipt of the sensors from the vendor, will examine the calibration certificate and supporting data before accepting the sensors and having them installed.

d. Modification of the Meteorological System

No modification to the meteorological monitoring system configuration or the program should be made without prior approval of the authorized personal. Modifications and material substitutions will be performed according to site specific procedures.

e. Activity Near The Meteorological Tower

Any planned construction of a building, or storage of equipment planned near the meteorological tower shall be reviewed to ensure that the activity does not affect the meteorological monitoring. The evaluation will be submitted to Plant Operating Review Committee for review.

f. Acceptance Testing and Purchases

Following any necessary QC inspection all instrumentation and accompanying paper work is checked by the Environmental Engineer. All materials required for the operation of the meteorological system will be purchased according to site procurement procedures.

g. Receipt and Shipping of Sensors and other Materials

Shipping and receiving of sensors and other supplies related to the meteorological system are handled through the warehouse.

h. Storage of Sensors and other Materials

The sensors, transmitters and other components used for meteorological monitoring are specific in nature and are stored at the onsite meteorological building. All spare transmitters, translators and electronics parts are also stored in dust free, air tight plastic bags with a desiccant.

i. Records

Calibration records and certificates, records of missing data and a log book documenting daily activities at the site are kept on file in a fireproof file cabinet.

Copies of the Operational Manual, all Procedures are maintained in the meteorological monitoring building.

j. Monthly Reports

The Environmental Engineer prepares monthly status report in the format specified in the Operational Manual.

3. Audits

The site QA/QC department audits the meteorological monitoring program once in a year. The object of the audit is to assure that the program for measuring site meteorological conditions is effective in complying with regulatory requirements and to verify that the monitoring tower and data acquisition equipment are being maintained and tested in accordance with the requirements, commitments, procedures and guidelines developed by the authority.

The authority QA/QC department also audits the vendor's calibration facilities, instrumentation and procedures to assure that the calibrations are being performed in accordance with the approved calibration procedures. These audits generally occur once every two years.

REFERENCES:

1. Lockhart, T.J., "Quality assurance of Meteorological Measurements," Quality Assurance for Environmental Measurements, ASTM STP 867, J.K.Taylor and T.W.Stanley, Eds., American Society of Testing and Materials, Philadelphia, 1985,pp 253-259

2. Filippov, V.V., " Quality Control Procedures for Meteorological Data, WMO, World Weather Watch Planning Report No.26, 1968.

3. Quality Assurance Handbook for Air Pollution Measurement Systems, Vol.IV - Meteorological Measurements, EPA-600/4-82-060, Office of Research and Development, US. Environmental Protection Agency, Washington,DC, 1982