Nuclear Utility Meteorological Data Users Group
(NUMUG)

Meteorological Monitoring System Survey
(Second Edition)

Syracuse, New York
May 1999

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PREFACE

The Nuclear Utility Meteorological Data Users Group (NUMUG) was founded to provide a forum to address problems and exchange ideas among those collecting and utilizing meteorological data at nuclear power plants and facilities. One of NUMUG's first activities was to compile a data base of meteorological monitoring programs to help focus NUMUG's efforts. The original survey was conducted during 1992 and the results were presented at the Boston NUMUG meeting in 1993.

The second edition of the NUMUG survey was developed by streamlining the original survey and adding some new items, so the second edition should be viewed as a supplement to the original survey and not as a stand-alone document. The second edition of the survey was conducted in late 1997 and early 1998. In addition to the information included in the original survey, additional questions were asked about work practices and Department of Energy (DOE) facilities were added. The work done by Stan Marsh and the team that conducted the original NUMUG survey was invaluable in producing the second edition of the survey. The original survey was an excellent product that made preparation of the second edition of the survey a far easier task.

This report summarizes the second edition of the NUMUG survey.

A project of this scope can not be done alone. Therefore, I would like to thank the many individuals who assisted in developing the survey, responded to the survey, and/or reviewed the results. I would especially like to thank Jeanie Ashe who transferred the information from the survey forms to the spreadsheet file, and Stan Marsh and Doyle Pittman who reviewed the draft report.

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* Note: Appendixes are not included in preprint version of report.

INTRODUCTION

To comply with regulatory and other guidance, nuclear utilities and facility operators develop and operate meteorological monitoring programs using a wide variety of equipment available form numerous vendors. These programs generate the meteorological data bases required for effluent release reports as well as provide real time data for use in emergency response activities and normal plant operations. Because of this freedom of choice, meteorological monitoring programs nationwide can vary both in content and application which can lead to uncertainty in how to comply with requirements as well as inconsistencies in the resulting data bases.

At the inaugural Nuclear Utility Meteorological Data Users Group (NUMUG) meeting in 1991, it was agreed that an inventory would be compiled of meteorological monitoring programs nationwide. The purpose of this effort is twofold:

1) Provide detailed information on compliance with applicable requirements as they pertain to meteorological monitoring at nuclear power plants and facilities.
2) Develop a data base from which an updated industry standard for meteorological monitoring can evolve.

During 1992, a detailed survey was prepared and circulated to all nuclear utilities nationwide and the responses tabulated. The survey responses were compiled into a detailed PC data base and summarized in a report presented at the NUMUG meeting in 1993.

By 1997, a number of factors indicated that it was appropriate to update the original survey.

- Facilities included in the original survey had made numerous changes. It was necessary to update existing information to accurately reflect the current state-of-the-industry.

- The original survey did not address a number of other important aspects (maintenance and calibration, data processing and archiving, and general administrative issues) concerning meteorological activities. This type of information would be helpful in developing a meteorological data collection and processing program.

- The original survey did not include several DOE sites because they are non-utility facilities. However, these sites conduct meteorological monitoring for many of the same applications as commercial nuclear plants. An expanded data base was expected to provide a useful exchange of information about meteorological monitoring programs to both the utility industry and DOE.

Consequently, the NUMUG steering committee conducted a second survey. The second edition of the survey requested most of the information included in the original survey with additional questions about work practices and included DOE facilities. The information was assembled into a Microsoft Excel spreadsheet file for analysis and this summary report was prepared.

SURVEY DESCRIPTION

The NUMUG Meteorological Monitoring System Survey was designed to give a complete picture of the meteorological monitoring systems operating at nuclear power plants and facilities. The second edition of the survey (Appendix A) consisted of six pages of questions in a fill-in or short answer format covering the following areas:

Identification
Unit Information
Site Characteristics
Meteorological Tower Information
Variables Monitored
Meteorological Instrumentation
Recording and Auxiliary Equipment
Off-Site Data Sources
Maintenance and Calibration
Data Processing and Archiving
Administration

The second edition of the NUMUG survey was sent to 82 nuclear plants and DOE facilities in the United States. Completed valid surveys were received from 27 facilities. While this is not as large a response as was hoped, the combination of the original survey and the second edition includes information for 45 different facilities (slightly more than 50 percent of the applicable U. S. Facilities).

Survey Participation	
Number of surveys mailed for U. S. facilities	1992: **54** 1997: **82**
Number of responses to original survey only *	**18**
Number of responses to second survey only	**12**
Number of responses to both surveys	**15**
Total Number of Responses	**45**

* Note: One nuclear plant (Trojan) responded to both surveys, but is included in the composite data base for the original survey only. The plant was decommissioned in late 1992 and the meteorological monitoring program was discontinued.

The following facilities participated in the second edition of the survey.

Power Plants:

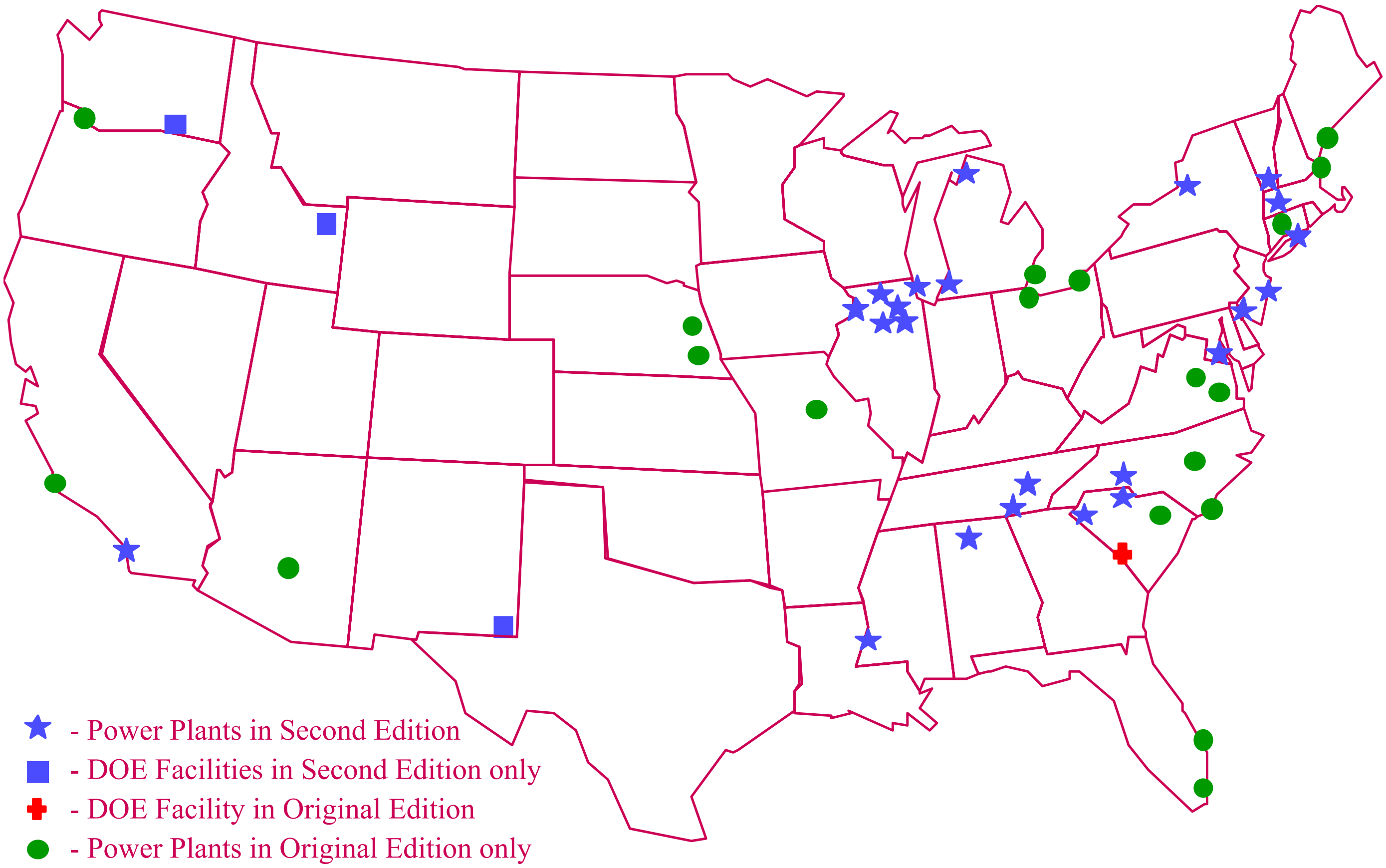
Utility	Facility	Location	Contact
Baltimore Gas & Electric	Calvert Cliffs	Lusby, MD	Richard Stattel
Commonwealth Edison	Braidwood	Braceville. IL	Fred Ost
	Byron	Byron, IL	
	Dresden	Morris, IL	
	LaSalle	Marseilles, IL	
	Quad Cities	Cordova, IL	
	Zion	Zion, IL	
Consumers Energy	Big Rock Point *	Charlevoix. MI	Dennis Kahlbaum
	Palisades	Covert, MI	
Duke Energy	Catawba	York, SC	Marvin Hayden
	McGuire	Huntersville, NC	
	Oconee	Seneca, SC	
Entergy Operations	Grand Gulf	Port Gibson, MS	T. Matson
GPU Nuclear	Oyster Creek	Toms River, NJ	Paul Schwartz
Niagara Mohawk Power	Nine Mile Point	Scriba, NY	Tom Galletta
Northeast Utilities	Haddam Neck *	Haddam Neck, CT	John Leavitt
Public Service Electric & Gas	Salem/Hope Creek	Salem, NJ	Bob Yewdall
Southern California Edison	San Onofre	San Clemente, CA	Stan Marsh
Tennessee Valley Authority	Browns Ferry	Athens, AL	Kenneth Wastrack
	Sequoyah	Soddy-Daily, TN	
	Watts Bar	Spring City, TN	
Vermont Yankee Nuclear Power	Vermont Yankee	Vernon, VT	Brad Harvey
Yankee Atomic Electric	Yankee Rowe *	Rowe, MA	

* Decommissioned

Department of Energy (DOE) Facilities:

Facility	Location	Contact
Waste Isolation Pilot Plant (WIPP)	Carlsbad, NM	Tim Brown
Savannah River Site	Aiken, SC	Matthew Parker
Idaho National Engineering and Environmental Laboratory (INEEL)	Idaho Falls, ID	David George
Richland Operations Office	Richland, WA	Dana Hoitink

The following map shows the geographical distribution of facilities included in the surveys.



SURVEY RESULTS

Upon receipt of the completed survey, information was extracted and input into a Microsoft Excel spreadsheet file to facilitate analysis. The data summaries are provided in appendix B. A spreadsheet file (NUMUG_97.xls), developed as a companion to this report, contains the survey input data.

Unit Information

The following tables summarize the power plants and DOE facilities that participated in the survey.

Power Plants - Pressurized Water (PWR):

Size (MW)	Plant	Utility	Unit(s)	
<= 500 MW	*San Onofre*	*Southern California Edison*	*1*	*Decommissioned*
	Yankee Rowe	*Yankee Atomic Electric Co.*	*1*	*Decommissioned*
500 < MW <= 1000	Calvert Cliffs	Baltimore Gas & Electric	1, 2	
	Haddam Neck	*Northeast Utilities*	*1*	*Decommissioned*
	Oconee	Duke Energy Corporation	1, 2, 3	
	Palisades	Consumers Energy	1	
> 1000 MW	Braidwood	Commonwealth Edison	1, 2	
	Byron	Commonwealth Edison	1, 2	
	Catawba	Duke Energy Corporation	1, 2	
	McGuire	Duke Energy Corporation	1, 2	
	Salem	Public Service E&G	1, 2	
	San Onofre	Southern California Edison	2, 3	
	Sequoyah	Tennessee Valley Authority	1, 2	
	Watts Bar	Tennessee Valley Authority	1	
	Zion	Commonwealth Edison	1, 2	

Power Plants - Boiling Water (BWR):

Size (MW)	Plant	Utility	Unit(s)	
<= 500 MW	*Big Rock Point*	*Consumers Energy*	*1*	*Decommissioned*
	Dresden	Commonwealth Edison	1	
	Vermont Yankee	Yankee Atomic Electric Co.	1	
500 < MW <= 1000	Dresden	Commonwealth Edison	2, 3	
	Nine Mile Point	Niagara Mohawk	1	
	Oyster Creek	GPU Nuclear	1	
	Quad Cities	Commonwealth Edison	1, 2	
> 1000 MW	Browns Ferry	Tennessee Valley Authority	1, 2, 3	
	Grand Gulf	Entergy Operations, Inc.	1	
	Hope Creek	Public Service E&G	1	
	LaSalle	Commonwealth Edison	1, 2	
	Nine Mile Point	Niagara Mohawk	2	

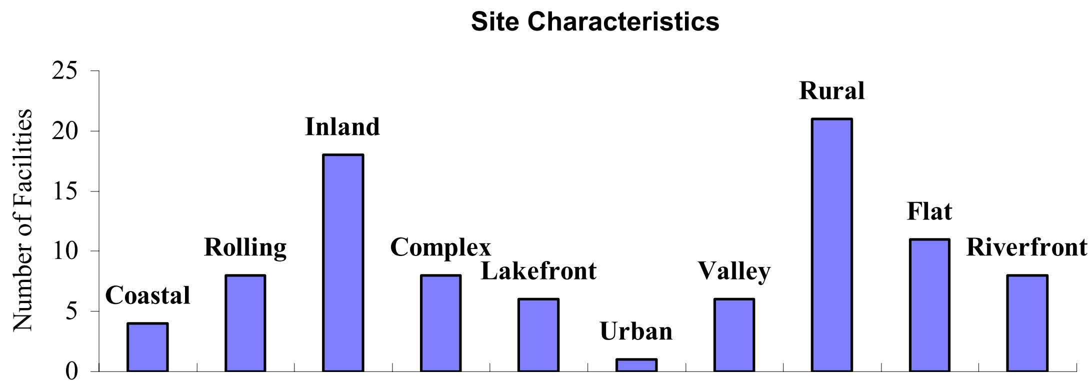
Department of Energy Facilities:

Waste Disposal	Waste Isolation Pilot Plant (WIPP)
Weapons Facility	Savannah River Site
Research Facility	IDAHO National Engineering & Environmental Laboratory
Clean up Site	Richland Operations Office

Site Characteristics

The site characteristics of a nuclear power facility dictate the complexity of its associated meteorological monitoring program. For example, a rural, flat, inland site will need only a simple monitoring program since dispersion conditions will be fairly simple. On the other hand, an urban lakefront site area will have to consider more difficult flow patterns.

The following graph depicts the results (Note: Facilities generally fall into more than one category):



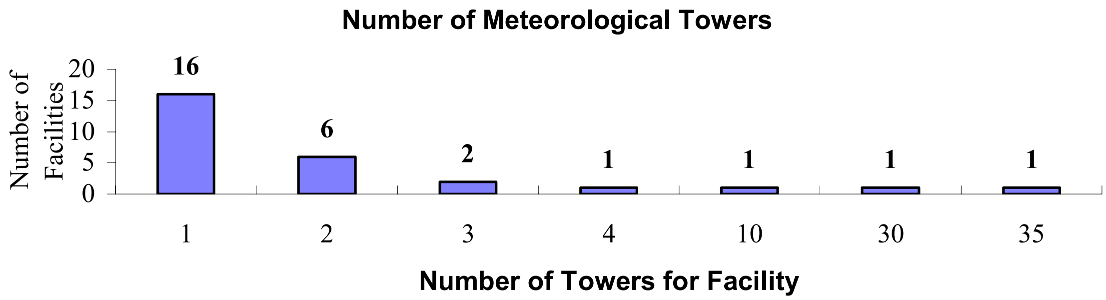
The Inland, Rural, and Flat categories are the most common, but every category is represented at least once.

Meteorological Tower Information

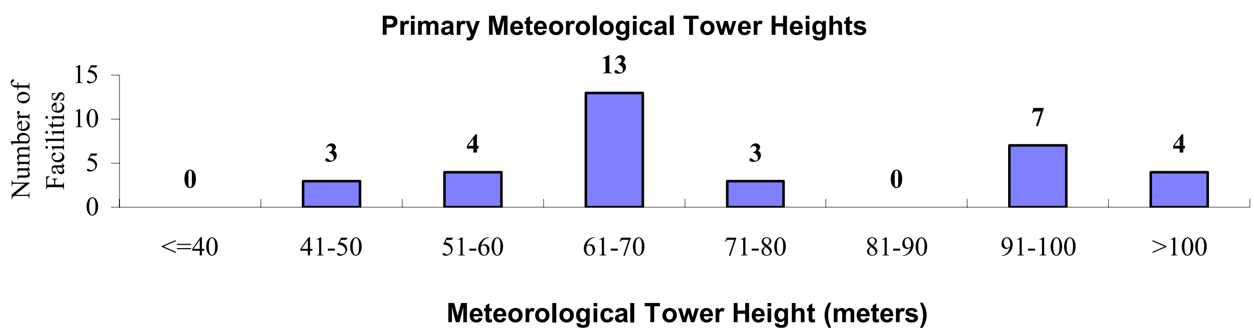
Each facility was asked for information about its meteorological monitoring program. For this purpose, the **primary tower** is the predominant source of information about the site. **Other towers** include all other towers for the site, regardless of function (backup, supplemental, etc.). The survey also, included the specific elevations at which data are collected. Although the 10-meter level was most common, there was wide variability in the specific elevations. The companion spreadsheet file includes the specific elevations that apply to each site.

The number and type of towers illustrates clear difference between power plants and DOE facilities. Power plant monitoring programs are centered around one particular facility and therefore need only one primary tower and up to three supplemental towers. DOE facilities on the other hand generally cover very large areas with multiple sources that must be considered. In addition, research activities at some DOE sites require detailed knowledge about meteorological conditions. Consequently, DOE facilities generally have multiple meteorological towers.

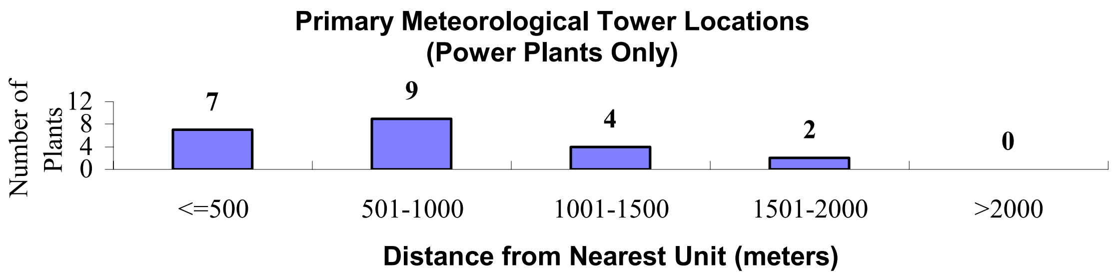
The following graph shows the number of meteorological towers included in the meteorological monitoring programs. As can be seen, most facilities (all power plants) have only one tower while the DOE facilities can have ten or more towers.



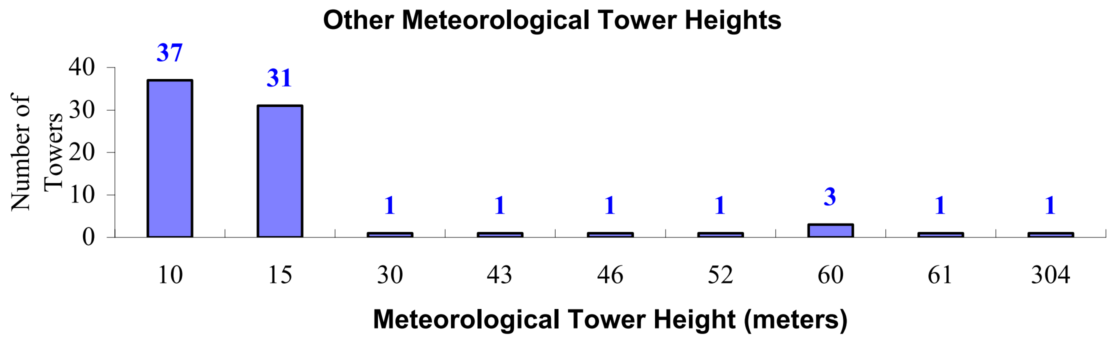
The primary meteorological tower height is dictated by the height of potential emission points and the need to know the dispersion characteristics of the lower portion of the atmosphere containing any effluent. As can be seen on the following graph, the most common tower height is in the 61-70 meter range, with a significant portion in the 91-100 meter range.



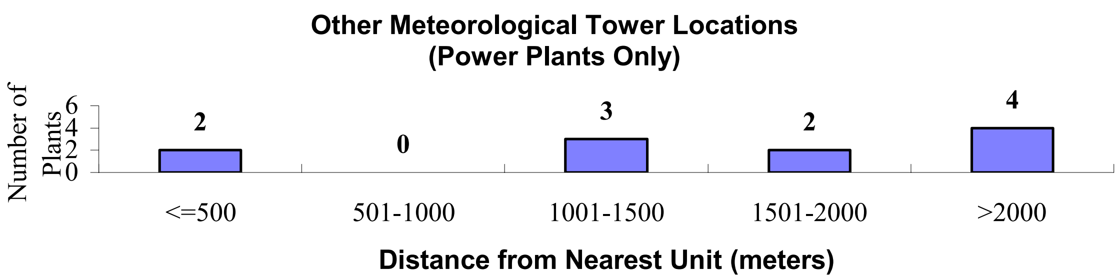
The distance of the primary tower from the emission source is important as well. A tower that is too close may be influenced by the source, while a tower that is too far away may not be representative of conditions at the source. This distance criterion applies only to the power plant sites because multiple sources exist at DOE facilities. The most common distance is in the 501-1000 meter range, but primary towers are within 2000 meters for all facilities.



The heights of other meteorological towers are dictated by the specific functions those towers fulfill. While some of these towers are 30 or more meters tall, the following graph shows that most towers are 10-15 meters tall.

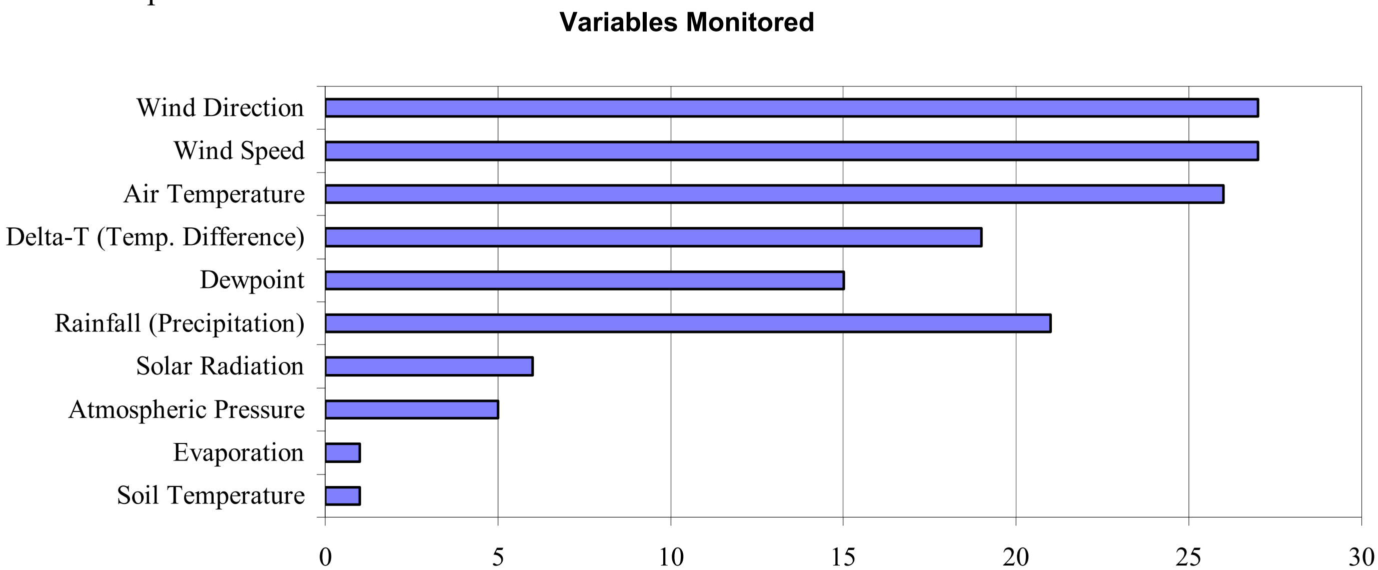


The following graph shows that most other meteorological towers are more than 1000 meters from the nearest unit. Again, the distance information does not apply to DOE facilities.



Variables Monitored

As can be seen in the following graph, all facilities measure wind direction and wind speed. Other variables collected for most of the facilities are air temperature, delta-T (temperature difference), dewpoint and rainfall/precipitation. Lesser numbers of facilities collect solar radiation, atmospheric pressure, evaporation, and soil temperature.



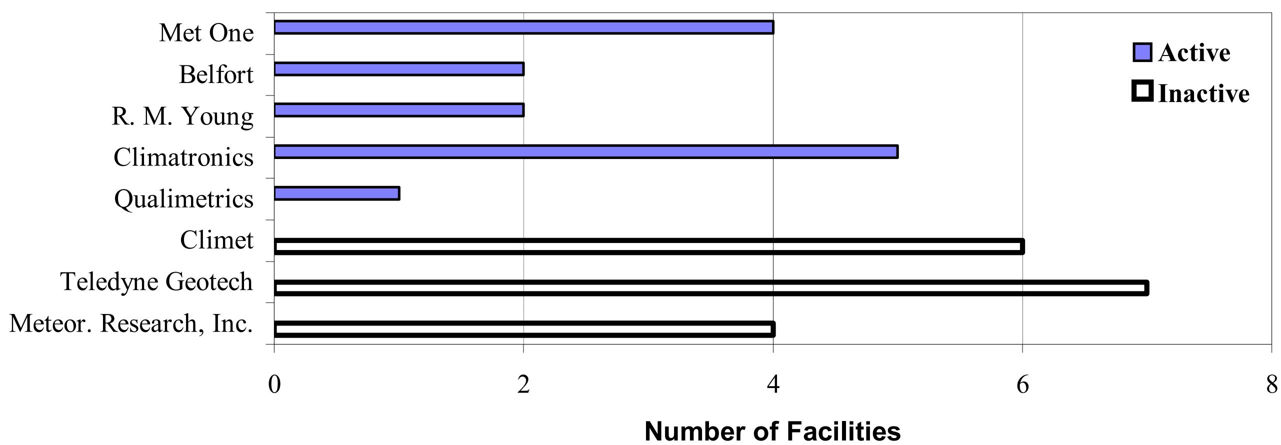
Meteorological Instrumentation

As can be seen in the following graphs, meteorological sensors are available from a large number of vendors. The major active suppliers are Met One, Climatronics, Weed, Protimeter, General Eastern, Belfort, and R.M. Young. Some facilities indicated more than one vendor for particular sensors. This is either a joint product (e.g., MRI/Belfort) or the facility may using items from more than one vendor. Check the companion spreadsheet to determine which applies.

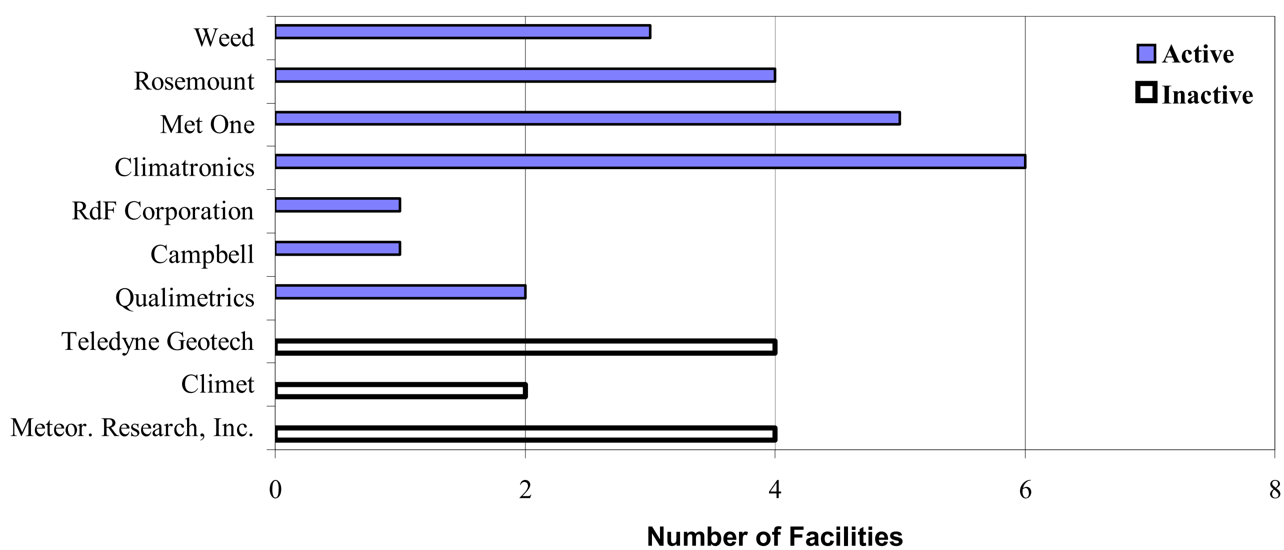
Note: Vendors are identified as "inactive" when the company no longer exists or the company no longer produces meteorological instrumentation. While some vendors are identified as inactive, this can be misleading, since other companies have often obtained the product line and continue to provide technical support.

The following graphs show which vendors provide meteorological sensors for different plants and facilities

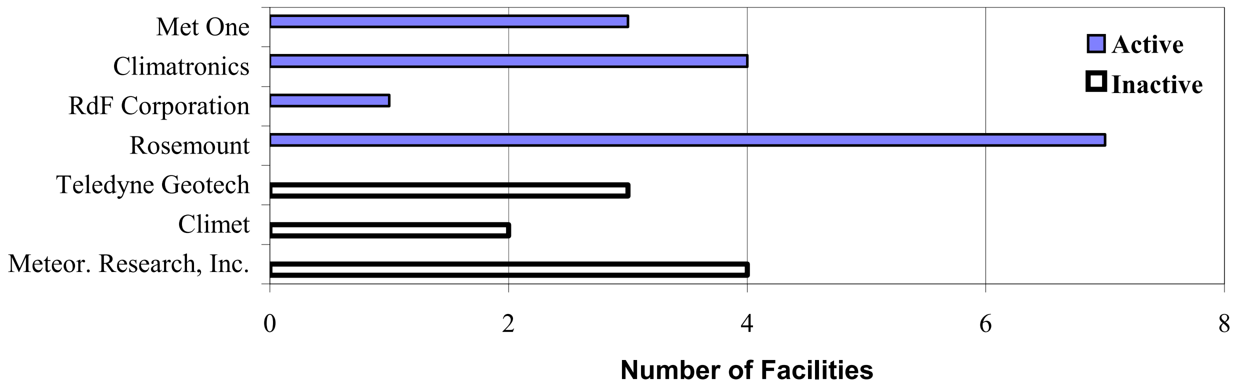
Sensor Manufacturers - Wind Direction/Speed



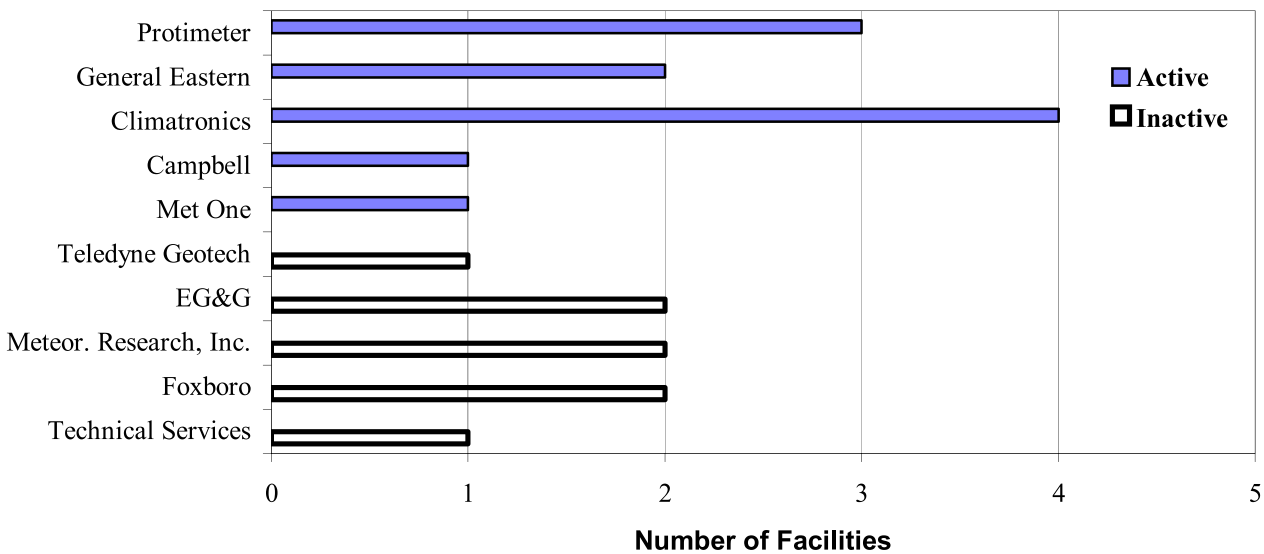
Sensor Manufacturers - Air Temperature



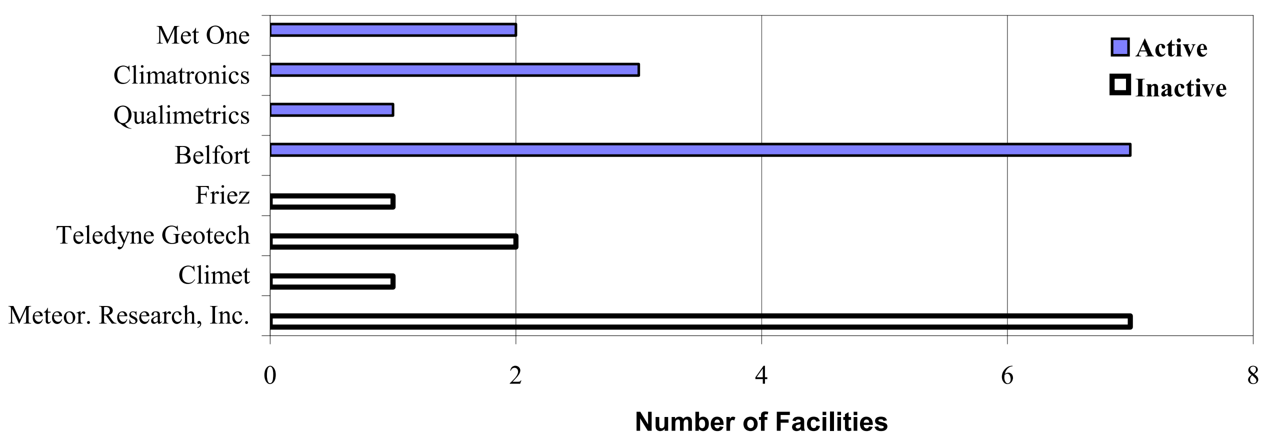
Sensor Manufacturers - Delta-T (Temperature Difference)



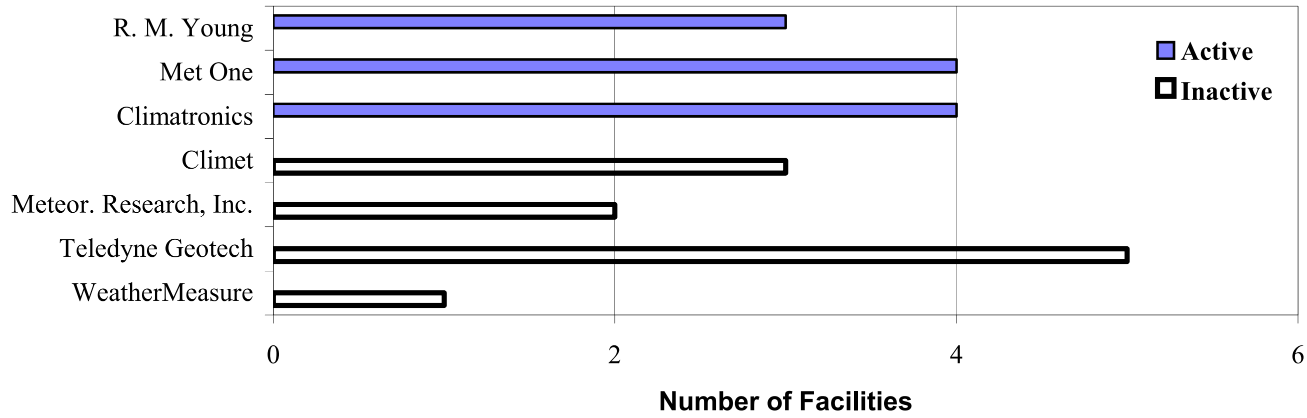
Sensor Manufacturers Humidity/Dewpoint



Sensor Manufacturers - Precipitation



Sensor Manufacturers - Air Temperature Aspirator

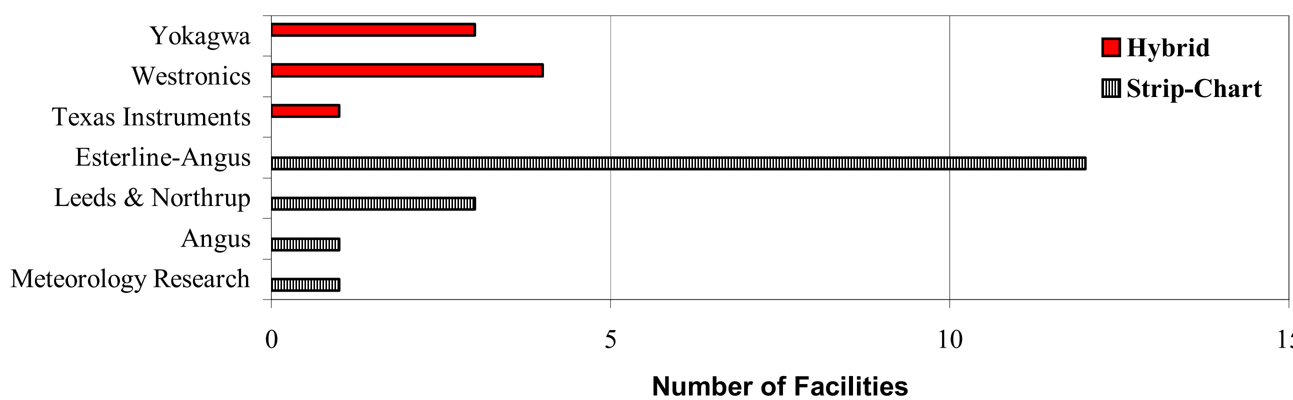


Recording and Auxiliary Equipment

The following graphs provide information about the recording equipment that is used at nuclear facilities to create a record of the data that are collected. Analog recorders produce a continuous chart display while digital recorders sample sensor outputs at specific intervals (ranging from a few seconds to an hour) and produce summary values. The digital record usually serves as the historical data base for a facility, but analog data are useful as backup data to fill-in gaps and to enable analysis of short-term conditions that might not be adequately described in the digital data.

Analog Recorders

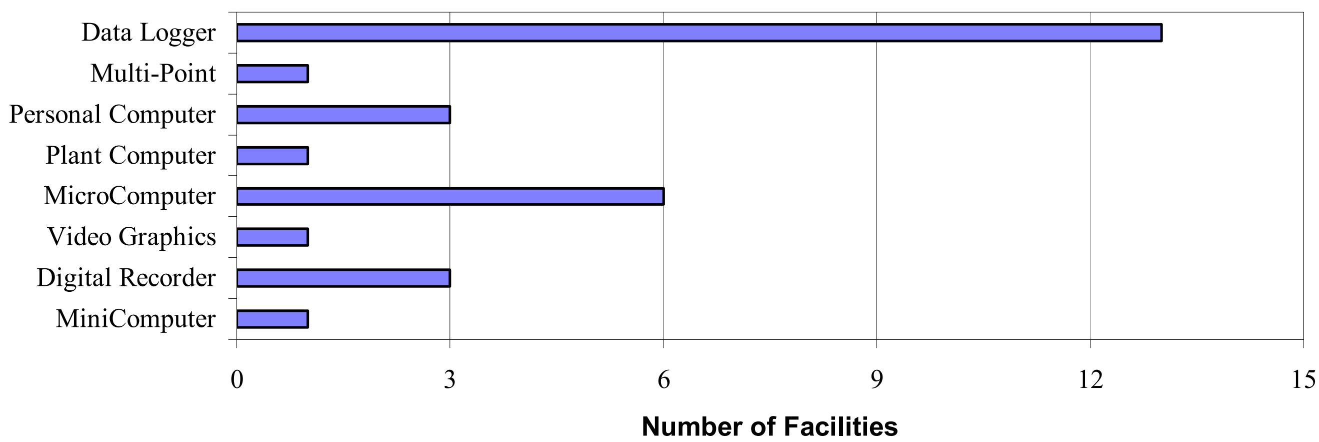
Analog recorders that produce a continuous chart display are of two basic types. A strip-chart recorder outputs a continuous pen trace of the electronic signal received directly from the data source. A hybrid recorder receives a digital signal, performs internal processing, and prints output as a series of closely spaced marks. Both of these types of recorders can include more that one data trace on a single chart.



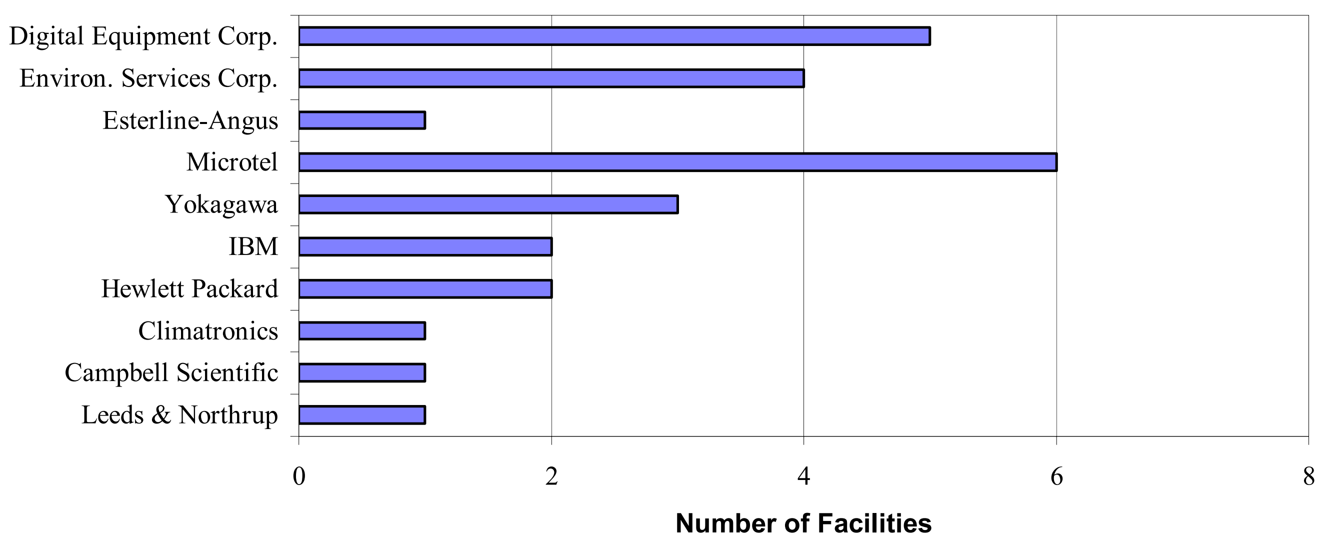
Digital Recorders

Digital recorders widely vary in both type and manufacturers. This probably results from the large number of digital computer vendors and the need for consistency with plant and corporate computing systems.

Types



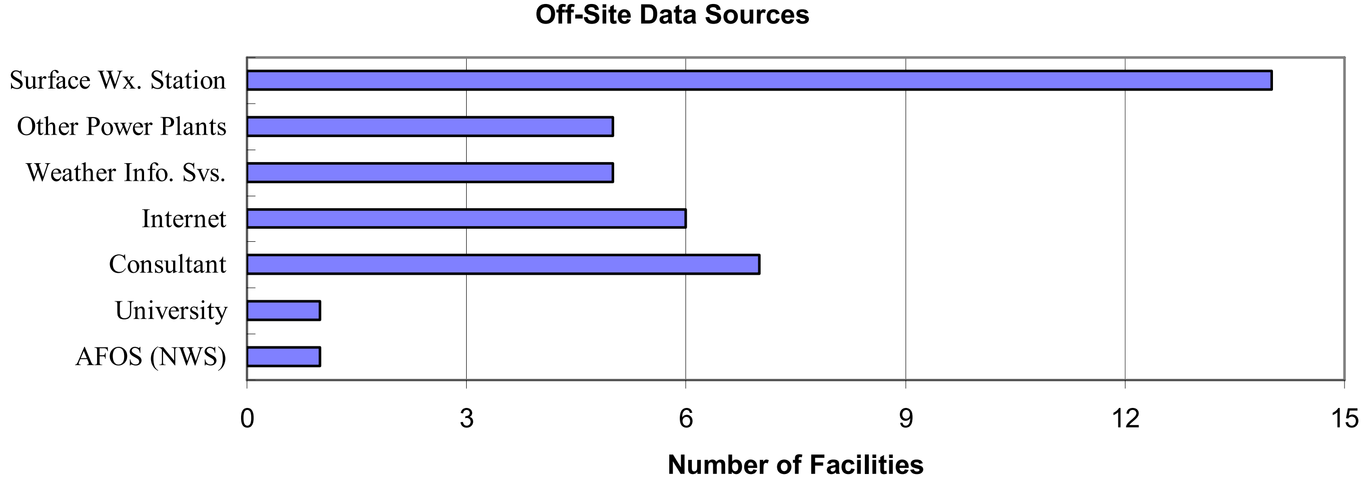
Manufacturers



Auxiliary equipment common to most facilities includes communications equipment to relay the observed data to various users and backup power supplies to help minimize periods of lost data. The types of equipment widely vary, so the information is not summarized in this report. The companion spreadsheet file lists the specific equipment that is used at each site.

Off-Site Data Sources

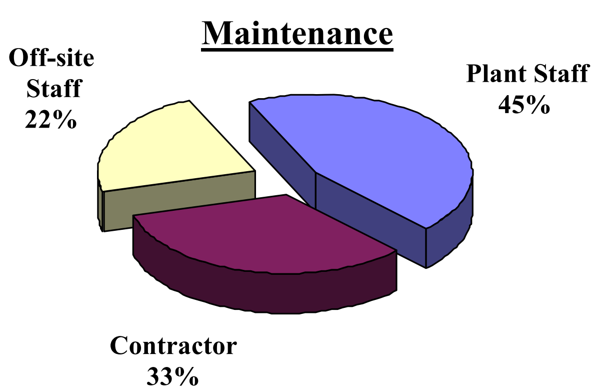
Off-Site data sources are specifically used for supplemental or backup data and not just for general weather information. By far the most common is data from surface weather stations (NWS, FAA, etc.). However, other sources of data are common.

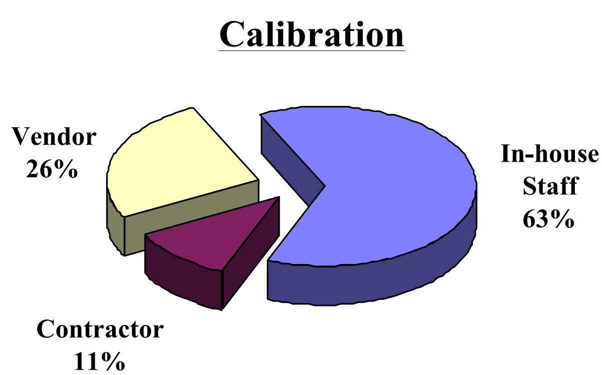


Maintenance and Calibration

Maintenance and calibration of a meteorological monitoring system is critical to obtaining good data that are suitable for the applications at the particular site and that can be compared with data from other locations.

Maintenance and calibration services can be obtained from several different sources. As can be seen in the following graphics; maintenance support is most common from plant staffs, but both off-site staffs and contractors provide significant levels of support. For calibration services, in-house staff is more common than vendor and contractor support combined.



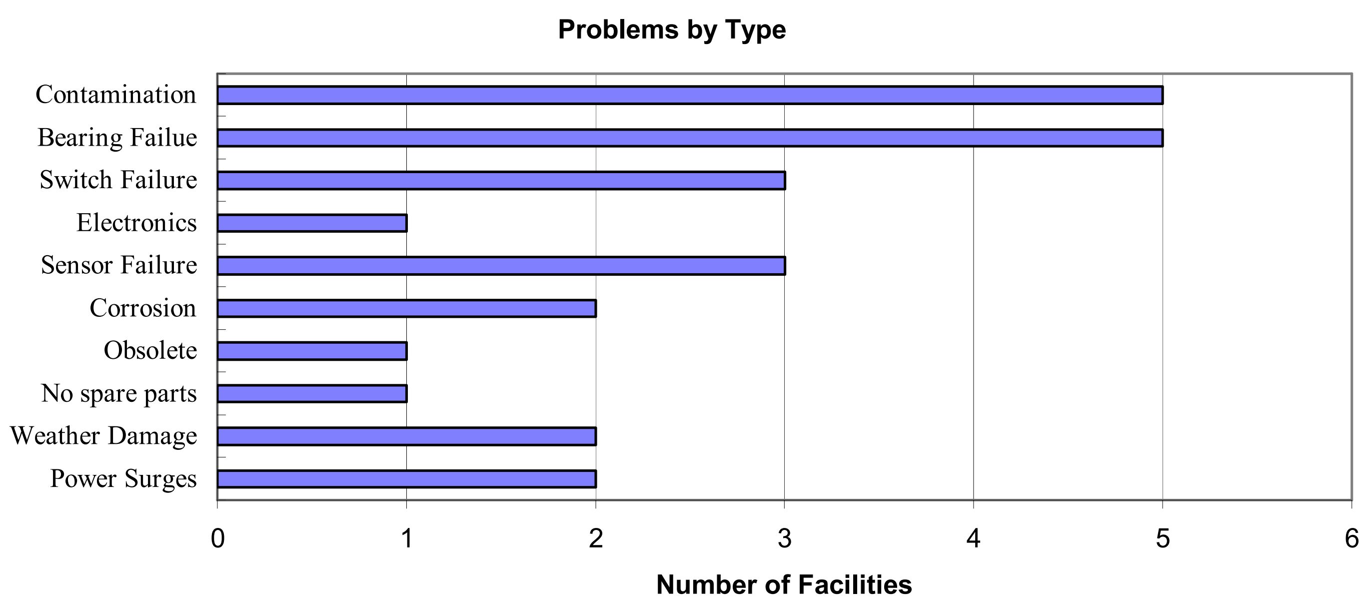


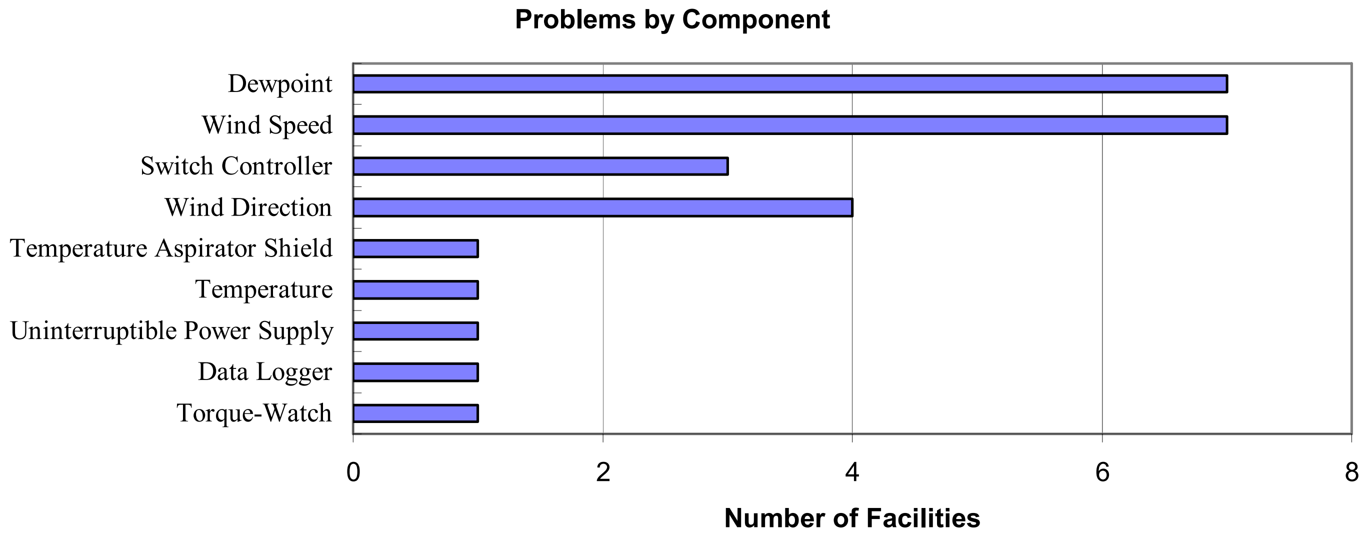
In addition to identifying who performs maintenance and calibration activities, the survey also inquired about calibration practices for various system sensors and components. Specifically, information was requested about the calibration frequency, the type of calibration(s) performed, and the calibration standards. In the vast majority of cases, the calibration frequency is either three months or six months, the type of calibration is either an in-place calibration or an exchange with a calibrated component, and the standard is traceable to a National Institute of Standards and Technology (NIST) or factory standard. The companion spreadsheet file lists the specific information for each site.

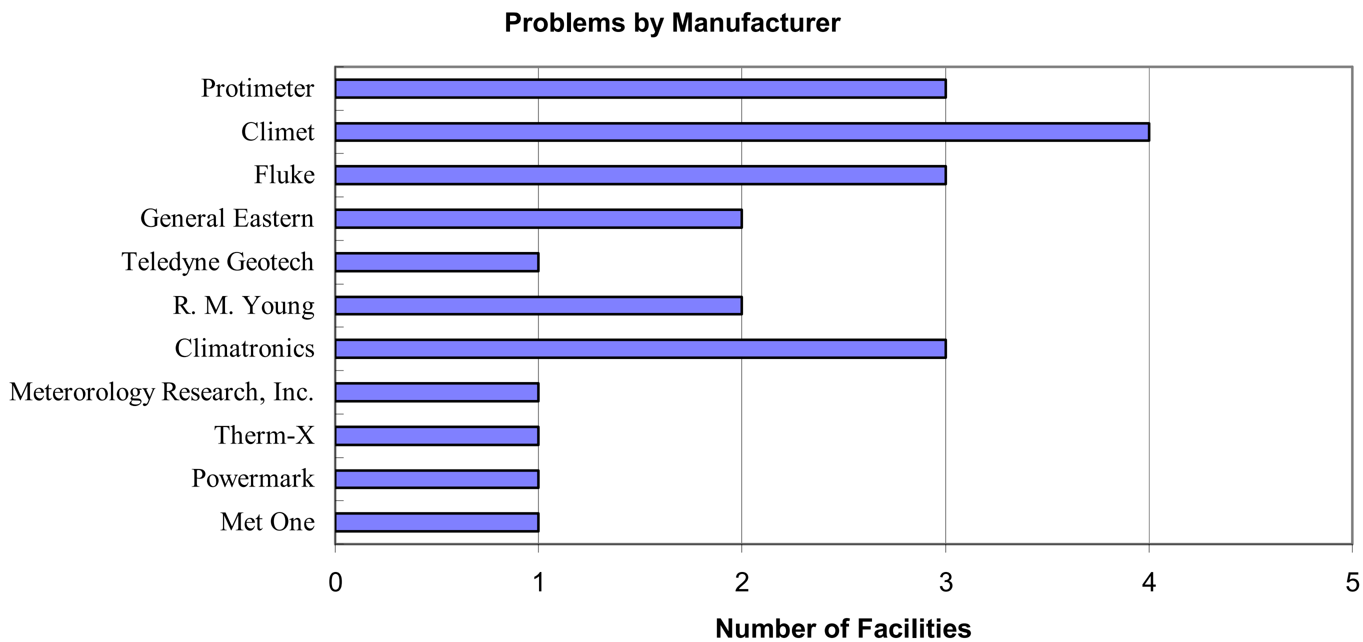
The survey also asked facilities to identify which components in the meteorological monitoring system result in the most maintenance/calibration and/or data recovery problems. This information is useful to other facilities to help avoid components that create problems, aid in concentrating maintenance effort on likely problem areas, and assist in developing solutions to common problems among facilities.

The following graphs summarize problems cited by survey respondents according to the type of problem, the affected components, and the manufacturers.

Caution
Information concerning problems should be interpreted with care because of the relatively small total number of problems actually listed. A relatively minor problem at one or a few facilities included in the survey may look much more significant than is really the case for the nuclear industry as a whole.



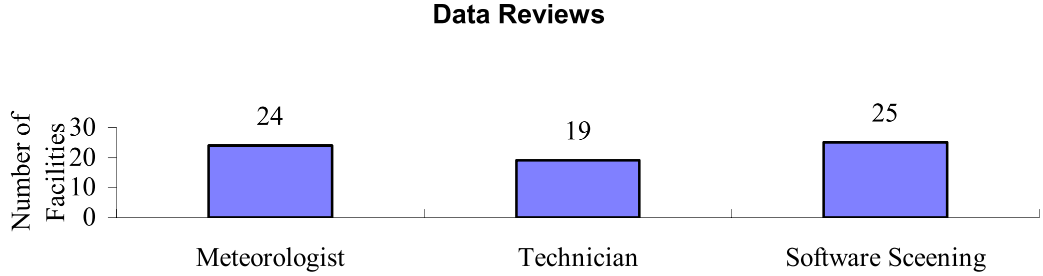




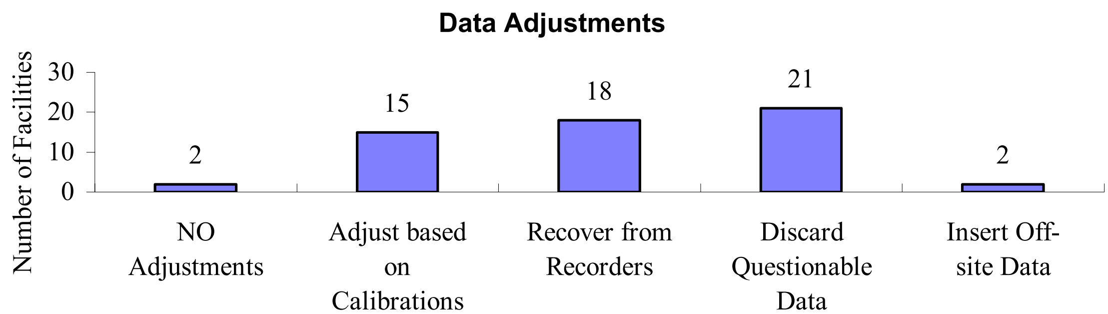
Data Processing and Archiving

Once the meteorological data are collected, a data processing and archiving process confirms the adequacy of the data and archives the data for future access. The survey requested information about several aspects of this process.

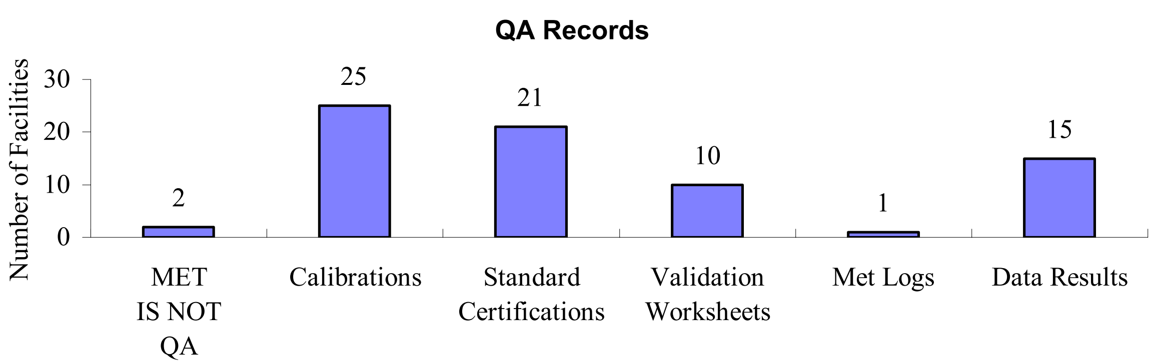
Data reviews generally consist of software screening with meteorologist/technician reviews. For most facilities that use screening software to perform data validation, the software was custom-developed, but there are a few cases where commercially available software is used. Approximately 60 percent of the data validation software run on mainframe computers, with the remainder on personal computers.



While a copy of the raw data as collected should be retained, most facilities perform some adjustments to create the final data set. Data adjustments are generally made based on calibration results, to recover missing data from data recorders, and discard questionable data. A couple of facilities also insert off-site data to replace missing data.



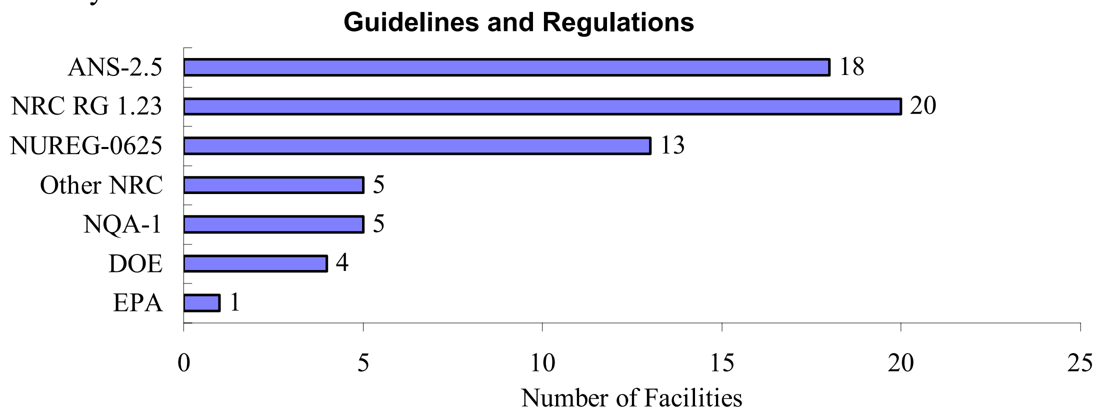
Quality assurance (QA) records document the adequacy of the meteorological monitoring program and the data that is produced. Except for two facilities that do not include meteorological monitoring in the QA program, all facilities treat some meteorological monitoring records as QA records. In most cases, the specific records document calibrations, but records are also maintained concerning standards certifications and data validation. Most plants also retain data results as QA records as well.



Administration

The survey also requested several items of administrative information.

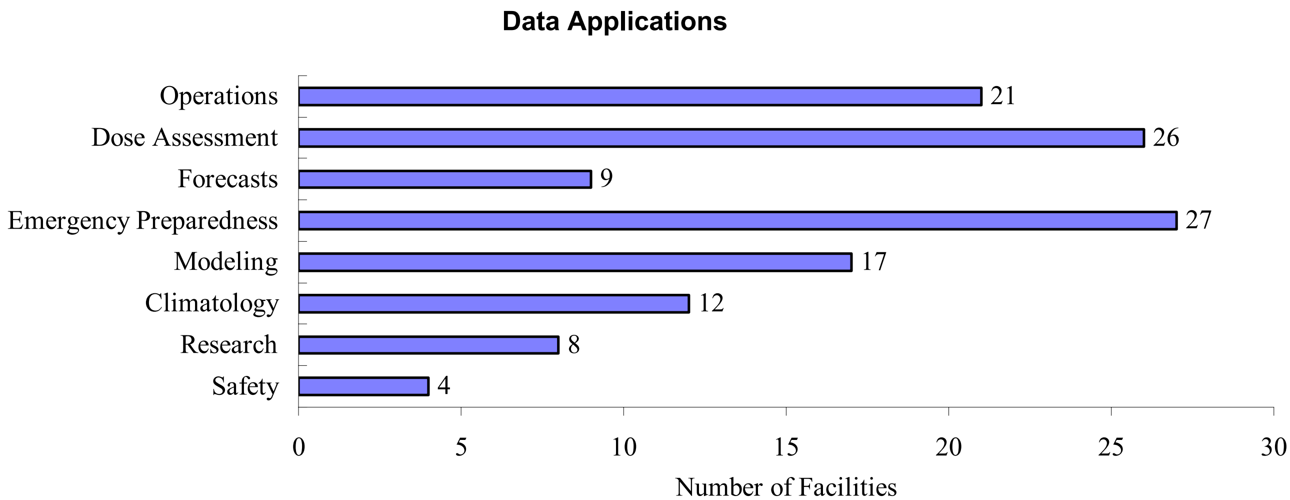
The following graphs identifies the Guidelines and Regulations that meteorological monitoring programs are intended to satisfy:

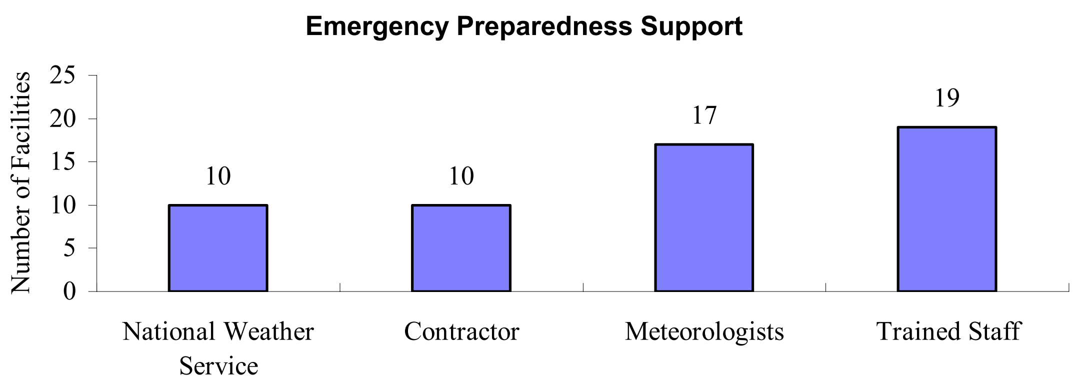


ANS-2.5	*Standard for Determining Meteorological Information at Nuclear Power Sites (to be replaced by ANS-3.11)*
NRC RG 1.23	*Onsite Meteorological Programs*
NUREG-0654	*Criteria for Preparations and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants*
Other NRC	*One or more of the following:* *RG-1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents form Light-Water-Cooled Nuclear Power Plants"* *RG-1.97, "Instrumentation for Light-Water-Cooled Nuclear Power Plant and Environs Conditions During and Following an Accident"* *RG-1.101, "Emergency Planning and preparedness for Nuclear Power Reactors"* *NUREG-0800, "Standard Review Plan"*
NQA-1	*Quality Assurance Requirements for Nuclear Facility Applications*
DOE	*One or more of the following:* *DOE Order 5480, "Environment, Safety and Health"* *DOE/EH-0173T, "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance"*
EPA	*EPA-600/14-82-060, "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV. Meteorological Measurements"*

In addition, virtually all of the power plants are also required to perform 10 CFR 50.59 reviews (i.e., safety assessments) whenever there are revisions to the parts of the meteorological monitoring program that is described in the Final Safety Analysis Report (FSAR).

The following graph shows the types of applications that use the meteorological data collected for each facility and the types of meteorological support that are included in the Emergency Preparedness Programs.





Finally, over 75 percent of the facilities identified significant upgrades/changes in the last three years or expected in the next two years. The companion spreadsheet file describes these upgrades/changes.

USING THE NUMUG DATA BASE

The NUMUG Meteorological Monitoring System Data Base is a resource tool for operators of nuclear meteorological monitoring programs. The information included in the data base can be used to:

- Design a new system or upgrade an existing system.
- Determine the best equipment for a particular site.
- Compare experiences with other operators concerning particular equipment.
- Compare monitoring programs for similar sites.

In a typical application, the program operator can use the data base to identify facilities with similar characteristics. This information can be used to help determine the best approach for accomplishing monitoring objectives based on program requirements, system features, operational experience, and historical problems.