USING STATISTICAL CONTROL CHARTS IN SUPPORT OF A METEOROLOGICAL QUALITY ASSURANCE PROGRAM

Paul E. Schwartz
GPU Nuclear Corporation
Oyster Creek Nuclear Generating Station
U.S. Route 9
Forked River, N.J. 08731
(609) 971-4034

ABSTRACT

To better support routine and non-routine aspects of the commercial operating nuclear facility, General Public Utilities (GPU) Nuclear has upgraded its meteorological monitoring system at both their Oyster Creek and Three Mile Island ear facilities. Part of this upgrade includes a more comprehensive quality assurance program that assists the individual in flagging questionable data and helps to determine reasons for data trends and relationships. One method used by GPU to discover how much variability in a process is due to random variation and how much is due to unique events and individual actions in order to determine whether a process is in statistical control, is with the use of a statistical control chart series. By determining the intra-level difference in a variety of meteorological parameters, monthly control charts can be developed and analyzed for the development of trends due to site specific phenomena or system malfunctions. Other methods of quality assurance that are less sophisticated are also utilized as a first attempt to determine potential problems with particular sensors. Through the ongoing process of investigating flagged data, GPU Nuclear has become more familiar with the peculiarities of site meteorology and ensures the believability of real-time data for possible use in emergency dose assessment as well as routine endeavors.

INTRODUCTION

Since the early 1980's the Nuclear Regulatory Commissions (NRC) requirements for meteorological data monitoring and reduction have become increasingly more stringent. The requirements state that the monitoring system must provide real-time, meteorological data that are reliable and representative of site meteorology. To go one step further, the data must be tied to a comprehensive air transport and diffusion model so that estimates of the dispersion in the atmosphere can be monitored on a 15-minute basis. If the meteorological data base is incomplete or does not meet NRC recommendations, calculated dose assessment could be in error by orders of magnitude. Ensuring the quality of the meteorological data is the subject of this paper.

GPU Nuclear currently operates three meteorological towers. There are two that are operated for the Oyster Creek Nuclear Generating Station (OCNGS) in New Jersey and one for Three Mile Island (TMI) Unit 1. TMI is located near Harrisburg in south central Pennsylvania; Oyster Creek is located in southern New Jersey approximately 10 kilometers from the Atlantic Ocean. It is the latter site that the subject of this report is based on. The main tower at Oyster Creek contains three levels of instrumentation that measure horizontal wind speed, direction, temperature and delta temperature. A second. and smaller tower is located to the northwest (approximately 11 kilometers inland). These two towers are part of the ocean breeze monitoring network (Table 1), which was established in the fall of 1986 as a result of both a field study[1] in 1985 and an analysis of 5 years of meteorological data. The inland site helps delineate the western edge of the ocean breeze front, a thermally-induced phenomenon that occurs roughly 15-20 times during the late spring through early autumn season.

METEOROLOGICAL QUALITY ASSURANCE TECHNIQUES

In the mid-1980's, GPU Nuclear took over the duties of routine data collection from consultants. This also included the daily review of the data. There are programs set up that provide daily output of the 15-minute data. This information is taken by the meteorologist (or his designee) and reviewed. Although this professional review will catch most errors, it is unlikely to catch all of them. More importantly, there remained in the data questionable conditions, relationships and trends that may pass by the eyes of even a trained meteorologist.

Identification of these trends can be accomplished at both the same instrument level and between different heights. On a monthly basis, the NRC's 'QA' computer code[2] will flag any peculiarities it sees between different instrument levels. This code is executed on a PC and is designed to flag conditions such as large jumps in stability class over a one hour period, stability class remaining constant over a prolong period of time, high wind speed under stable conditions and large wind differences between sensors at the upper and lower tower levels. This program is utilized once a month for the primary and secondary systems at Oyster Creek and Three Mile Island. Data that are flagged during this process will possibly indicate deteriorating instrumentation. More likely, the flagged conditions are caused by unexpected but valid micrometeorological conditions. This is especially true of the same problem occurs with the primary and secondary systems. This process allows the site to become more familiar with the peculiarities of site meteorology and ensure the believability of real-time data for use in routine and non-routine dose assessment.

A more important check in the quality assurance process is the comparison of intra-level sensors. Values from instruments at the same level should read about the same, or at least within the calibration accuracy of the equipment. That is, if the calibration accuracy of the wind speed is 0.5 miles per hour, then the primary and secondary sensors should not differ by more than 1.0 miles per hour (since one sensor may read 0.5 mph low and the other read 0.5 mph high).

In the past, differences in the primary and secondary readings were determined using joint-frequency distribution tables on a monthly basis. The idea is to ensure that the data from the primary and secondary sensors does not drift apart. This could be an indicator of long term problems such as instrument bearing malfunctions or temperature aspirator problems. Technology at GPU with regard to computers has gone to the point that variability in such a process can be determined using a statistical control chart. A control chart is a run chart with statistically determined upper and lower control limits drawn on either side of the process average. It is an analytical statistic method used when analyzing over time. These limits are calculated by running a process untouched, taking samples, and plugging the sample averages into the appropriate formula. At this point the sample averages can be plotted onto a chart to determine whether any of the points fall between or outside the limits or form unlikely patterns. Any process with points outside the limits are said to be "out of control" . To relate this to our meteorological quality assurance process, the data from the primary and secondary instrumentation are input on a monthly basis and the difference between the primary and secondary sensors are calculated. For each meteorological parameter (such as horizontal wind speed at a particular level), a control chart is developed (Figure 1) and analyzed. The fluctuation of the points within the limits results from variation built into the

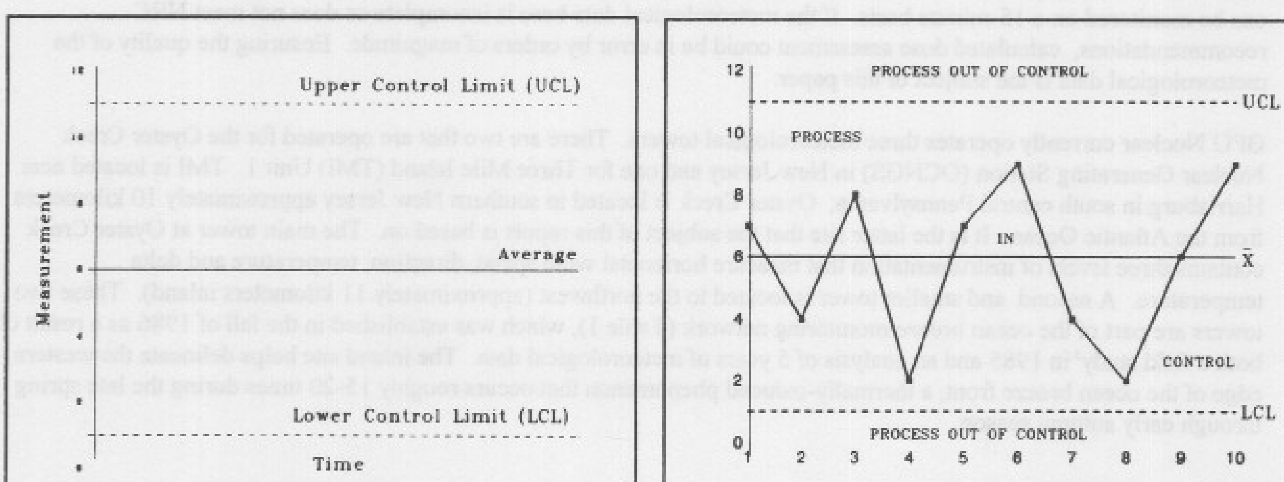

FIGURE 1: The process Control Chart describing (a) control limits and (b) a sample of a control chart plot

process. This results from common causes within the system (design, choice of machine or preventative maintenance), and can only be affected by changing the physical system, which, obviously is not done. However, any points that lie outside the upper or lower control limits result from special causes, such as human error, unplanned events or freak occurrences). In the case of meteorological quality assurance, examples such as frozen sensors or tower maintenance calibrations can be flagged with this process. These are causes that are not part of the way that the process normally operates. They must be eliminated from the database before the control chart can be used as a monitoring tool. Once this is done, the process would essentially be "in control" and samples can be taken at regular intervals to make sure that the process does not fundamentally change. Sometimes large differences between the primary and secondary occur, but these are valid, nevertheless, taking into account meteorology. One example is that wind direction differences can be as large as 45 degrees with wind speeds less than 3 miles per hour. At this stage, the trained meteorologist will attest to these differences as being a result of light or variable winds, usually associated at the center of high pressure and occasionally during weak frontal passages.

SUMMARY

To better support GPU Nuclear, a sophisticated method of quality assurance has been established. This includes a completely automated data collection and reduction system and a comprehensive quality assurance program. With the use of both PC-based and mainframe statistics and graphics, a daily and monthly analysis of the meteorological data, including inter and intra-level comparisons will lead to the flagging of suspect data. The use of analytical statistics to determine special cause problems provide GPU Nuclear and the meteorological industry with the most sophisticated method of quality control designed to ensure believability of data. This, in turn, will lead to the most accurate assessment of routine and non-routine dose that is so valuable to the operation of the nuclear facility.

REFERENCES

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3. P. Schwartz, "A Meteorological Monitoring and Quality Assurance System In Support Of Emergency Preparedness", Paper presented at the Emergency Planning and Technologies Conference, American Nuclear Society, Charleston, South Carolina, September 1988.

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TABLE 1: Meteorological Monitoring Locations and Measurements at TMI and OCNGS. [The "A" sensors at TMI and OCNGS have power supplies independent of the "B" sensors].

Height (feet)	Parameter Measured	OCNGS Tower A Sensor	OCNGS Tower B Sensor	Pinelands Inland Site	Three Mile Island A Sensor	Three Mile Island B Sensor
380	Wind Speed	X	X			
	Wind Direction	X	X			
	Temperature	X	X			
	Delta Temperature	X	X			
150	Wind Speed	X			X	
	Wind Direction	X			X	
	Temperature	X			X	X
	Delta Temperature	X			X	X
	Dew Point System				X	X
100	Wind Speed				X	X
	Wind Direction				X	X
33	Wind Speed	X	X	X		
	Wind Direction	X	X	X		
	Temperature	X	X	X	X	X
Ground	Rainfall	X			X	