# Monitoring and Controlling Industrial Processes, 2nd Edition

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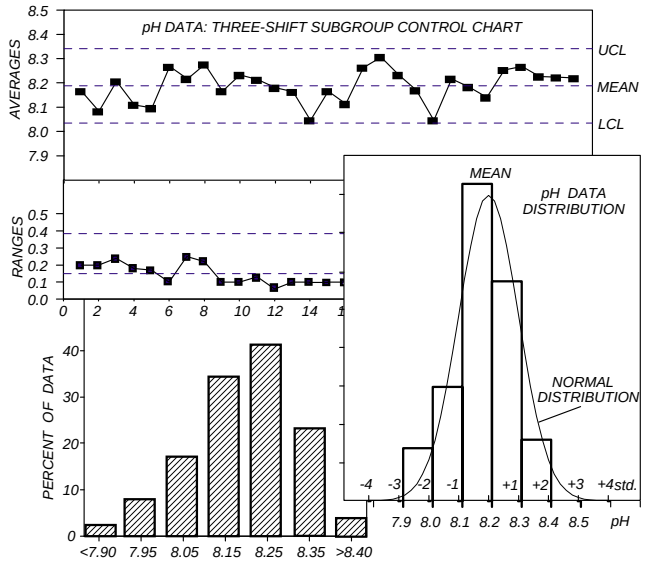
**ISBN 0-9695133-1-3, 96 pages, Cerlox Bound**




As most operating data is used to assess whether or not a plant is operating within specifications, it rarely gets more than one quick look before it is filed and forgotten. Whether we admit it or not, this is a *police action* to provide the proof that analyses were performed and recorded. It does not ensure that their real meaning was determined nor that the consequences of operating outside specification was considered. **What is a specification?** If a few plants appear to operate successfully within a certain regime, that regime tends to become the norm and gets carved into stone as a specification. **Will that spec be correct for all plants?** Not likely. Often the plant tries to tell us something, but we need the tools to listen. If we didn't force them to do so, many plants could never operate within some of their specs. There are some very serious consequences from making them operate this way.

## What happens when things go wrong?

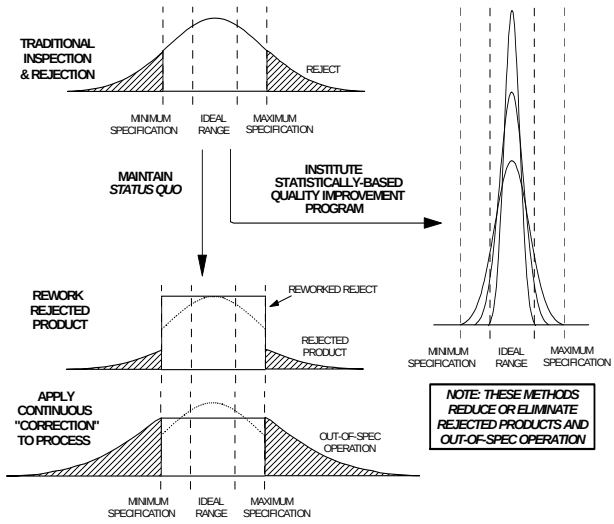
Upsets must be reported to upper management and/or colleagues in a form that shows exactly what is wrong. An off-spec analysis means little without a quantitative measure of its importance in terms that clearly demonstrate how that off-spec parameter will impact upon the short or long-term operation of the plant or process, i.e., it must project the likely cost or downtime. This manual covers four topics:

**The Statistical Nature of Process Data:** All real data has a statistical component to it. How do we see it? How does it complicate control of the process?

**Statistical Process Control:** SPC provides a much improved way to monitor and control plant operations. It is impossible to check or inspect 100% of anything. Rather than take more samples, SPC uses simple statistical techniques to get a better handle on a process and improve both productivity and quality. Coupled with Time-Series Analysis, it provides a powerful arsenal of diagnostic and control tools. SPC techniques are simple to learn and have now been made mandatory for all automotive industry suppliers.

**Time-Series Analysis:** Real plant data exhibits a high degree of randomness. A number of specialized time-series techniques are introduced to check for randomness and trends. They also provide a simple test to confirm the validity of the data.

**Advanced Presentation Techniques:** Any data that is collected is of little value unless it can be prepared for presentation in a format that enables the decision makers to see its meaning within the context of the operation and make the decisions necessary to keep the plant running at peak efficiency or, if necessary, shut it down to make corrections. This requires developing a variety of graphical and tabular methods to support the work that must be done. Most of these can be accomplished with a spreadsheet such as Excel. The difference between a mediocre graph and a meaningful graph is the ability to go beyond the default settings. A number of simple methods will be demonstrated.




**This manual is relevant to all field personnel who collect or use data.** It demonstrates simple methods to extract relevant information hidden within data, not to make anyone into a computer-dependent statistician. Most of the techniques can be accomplished with paper and pencil. They show how to make plant data talk and tell more about the plant's operation. It also includes lots of ideas for troubleshooting. Believe it or not; all this extra capability can be achieved by doing less, not more work. This means extra time to think or take on additional systems or clients.

## Learning Objectives

Those who purchase this manual will be better able to understand the processes they monitor by learning how to work with the statistical nature of their data to get better control and detect potential upsets that could result in lost production or deratings and believe it or not, this can be achieved by doing less work. They will learn how to set quantifiable objectives that can increase productivity and reliability as well as some interesting troubleshooting and priority-setting techniques. Above all, they will learn how to get their message over to others who can act to get things changed.

## Who will gain the most from this manual?

This is no requirement for a mathematical or statistical background. It helps to have some basic knowledge of the common computer programs used to report and analyze data such as Microsoft Office. This is a practical manual for people who collect and use plant data. It is particularly valuable to those listed below:

- Field staff can get a better handle on their clients. When you have several dozen, you can only spend so much time on each. You have to assess more information in less time.

- Plant operators and laboratories produce the primary data. Can you really learn more from data taken Monday, Wednesday and Friday on days than taking it every shift.

- Formulators must produce products with batch-to-batch consistency. As a bonus, implementation of components of this course form part of ISO-9000 certification.

- Analytical chemists whether they be students starting in the field or highly experienced laboratory supervisors.

- R&D labs have months to simulate what happens over years in the field. You need something more sensitive to catch those small trends before they catch you with a product recall.

## Who Has Attended Our Courses?

Marvin Silbert and Associates have used the material in this manual as the basis for training courses. People have come from major electrical utilities, semi-conductor manufacturing, water treatment chemical vendors, equipment manufacturing, nuclear energy, pulp & paper, iron & steel, petrochemical plants and water purification companies. They have come from Bahrain, Brazil, Canada, Ireland, Kuwait, Germany, Oman, Saudi Arabia, Singapore, Syria, USA and the UK.

## Ordering Information

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**Why do we need to look deeper?** A generalized look at the need for good monitoring and control, difficulties with sampling a real system, course objectives.

**Data formats:** Starting with a table of numbers and proceeding through a number of simple graphical techniques that can make the trends within the data more visible. Scatter plots, runs charts, fitting mathematical formulae to data, histograms and the application of 3D and multi-variable plots. How do conventional graphing techniques lead to poor control. How can we improve upon them?

**Data distributions:** Applications of the Normal, Poisson and Binomial distributions, methods for reporting and how they are used to compare data using graphical techniques, confidence intervals and analysis of variance.

**Medians & percentiles:** Application of frequency distributions for QA applications, comparisons using box-and-whisker plots.

**Time-series analysis:** Simple test procedures to check for randomness, trends and periodicity. Is it possible to detect falsified data?

**Statistical process control:** Statistical control, Type I and II errors, process capability, capability ratios for objective comparison against specifications, $\underline{x}$ & R, median and CuSum control charts, subgroups and moving averages, attributes, c, u, p and np control charts, what to do with bad data.

**The electronic log sheet:** Utilizing spreadsheet programs to custom design reporting systems using standard off-the-shelf field software. Integrating drawings and spreadsheet graphics into reports to make them more effective.

**Applications in the field:** Cost, reliability, availability, sensitivity, servicing and calibration of instruments vs. manual sampling, monitoring controlled systems, steady state, batch and varying processes, relationships among parameters.

**Applying quality methods:** Establishing a QA program, cause-and-effect analysis using Ishikawa diagrams, priority setting with Pareto charts

**Preparing the report:** How do we make those trends show up? How can we convert that off-spec analysis from a simple value into a meaningful terms related to operating costs or production time? How do we add that professionalism we need to the appearance of those spreadsheet graphs and then integrate them into the report? Do we present our slides as those all-too-common one-liner PowerPoint slide shows or do we give them the panache that makes our points stand out