Cleaning Up With SPC

Statistical process control is playing a role in a huge environmental project at a nuclear weapon production site

by **Steven S. Prevette**

Statistical process control (SPC) is playing a safety and quality role in what has been called the world's largest environmental cleanup project.

The U.S. Department of Energy's (DOE) Hanford Nuclear Site played a pivotal role in the nation's defense beginning in the 1940s when it was created as part of the Manhattan Project.

After more than 50 years of nuclear weapons production, Hanford, covering 560 square miles in southeastern Washington state, is now focused on three outcomes:

1. Restoring the Columbia River corridor for multiple uses.
2. Transitioning the central plateau to support long-term waste management.
3. Putting DOE assets to work for the future.

The current environmental cleanup mission faces challenges of overlapping technical, political, regulatory and cultural interests. Fluor Hanford, my employer and a prime contractor for the DOE, has the ultimate responsibility for cleaning up a large portion of the site. Our emphasis has to be on safety, quality of work and meeting deadlines. We chose to use SPC to manage our safety and quality information, and progress has been achieved in both injury reduction and process improvement.

What SPC provides

SPC addresses several quality issues including adverse trends and corrective action management. It provides low cost, effective data analysis as required by several government regulations, policies and orders governing Hanford operations.

The advantages of SPC include the following:

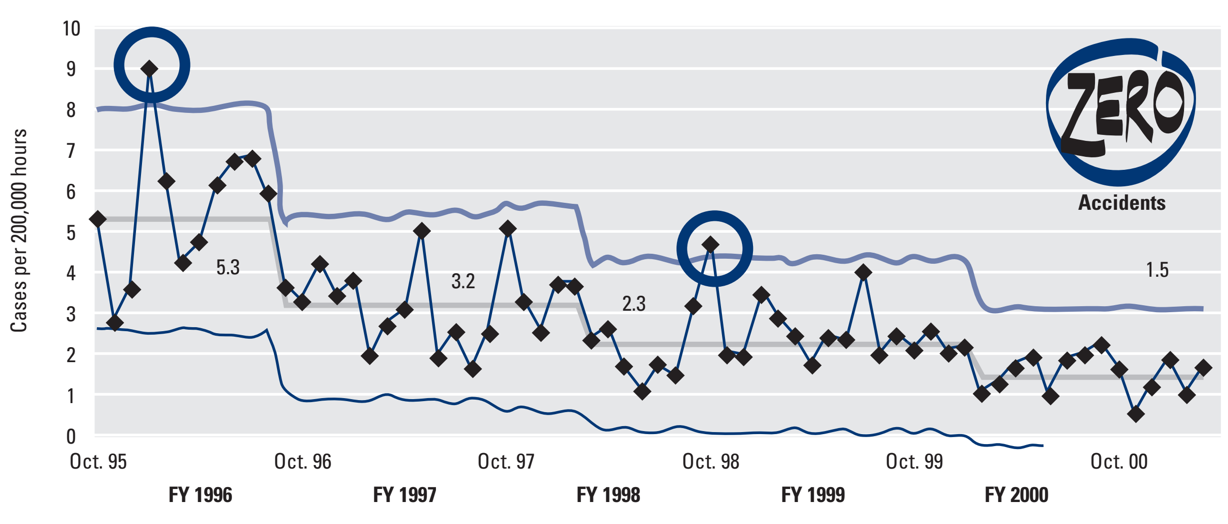
- It is one of the simplest statistical analysis tools for separating signal from noise.
- It plots the actual data in a visual manner.
- Analysis results are replicable by different analysts.
- False alarms and knee-jerk reactions to the latest datum value are minimized.
- Its rules detect both small long-term shifts and large short-term shifts on one chart.
- When it detects a trend, a useful special cause is usually found.
- It minimizes process tampering and wasted action.
- It can be performed without expensive computer software.
- It provides feedback on the impact of actions.

DOE's integrated system

DOE's integrated environment, safety and health (ESH) management system (ISMS)[1] is based on the concept of integrating safety awareness and good practices into all aspects of work.

A basic principle of ISMS is that work should be conducted in a manner that protects the public,

FIGURE 1 Fluor Hanford OSHA Recordable Injury/Illness Rate



OSHA = Occupational Safety and Health Administration worker and environment. Safety is an integral part of each job—not a standalone program.

Since its 1995 origin, ISMS has been implemented by DOE across the nation. Its requirements include the use of performance data.

Statistical analysis at Fluor Hanford

The DOE first got interested in performance indicators at the Hanford site around 1993, when a different company had the contract. In 1996, Fluor Hanford was awarded the contract.

I had been hired by a previous contractor to manage implementation of methods using DOE's *Performance Indicators Guidance Document*,[2] which called for SPC and was based on Acheson Duncan's book *Quality Control and Industrial Statistics*.[3] I already was familiar with W. Edwards Deming's management techniques and had been exposed to Duncan's book while an officer in the U.S. Navy.

Since 1993, the use of SPC has expanded beyond maintenance to ESH and quality assurance (QA). When Fluor Hanford assumed responsibility for the project in 1996, the method was codified in the ESH and QA performance indicator plan.

In 1998, much of the plan and supporting training material was placed on the Internet as the *Hanford Trending Primer*.[4] In 1999, Appendix 4 of the plan was published as two formal procedures.

As ISMS was developed and implemented at Fluor Hanford, the existing performance indicator plan and procedures were integrated into it.

These methods have proven to be very successful for Fluor Hanford at the nuclear site. Injuries have been reduced by using control charts and Pareto analyses to focus worker efforts. Figure 1, the Fluor Hanford Occupational Safety and Health Administration recordable injury rate control chart, is an example of the measurable progress achieved.

These reductions in injuries resulted from Pareto chart analyses of injuries by occupation, body part affected and cause of injury. This information allowed Fluor Hanford to focus worker initiatives on reducing the causes and hazards associated with these injuries.

Crisis management has been significantly reduced, as the mechanism focuses efforts onto identifying proper paths for action and minimizing false alarms and incorrect paths. The management style became proactive rather than reactive. Not only does the company now respond to crises properly, but it also can successfully prevent them.

The important principle is to choose one set of criteria and stick to it.

SPC management

The DOE policies on ISMS require goals and objectives to be established for ISMS performance. Fluor Hanford meets these commitments by taking the following steps:

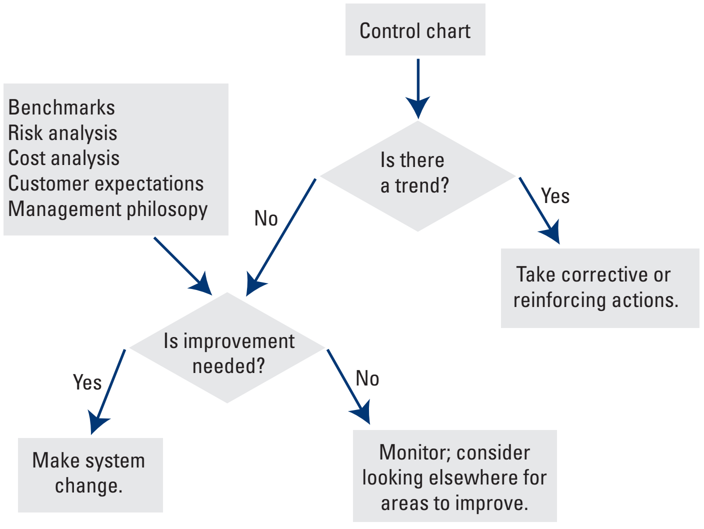
- Perform trending of performance data using SPC charts. Trends are detected through a fixed set of rules.
- If a trend is detected, determine the special cause of the trend. Depending on the cause and the direction, the goal becomes either to reinforce the positive trend, stabilize performance or correct for the adverse trend. A trend in an apparently adverse direction may not actually be adverse. It requires analysis of the cause of the trend to make this distinction.
- If no trend exists, decide if improvement is needed. It may be necessary to gather benchmark data, perform risk analysis, determine customer expectations and determine Fluor Hanford management expectations to make this decision. The goal is then stated as, "Maintain current performance," or "Strive for significant improvement."
- To improve, look at common causes within the system and fundamentally change the system and processes involved.

The control chart methodology

The methodology for SPC at Fluor Hanford uses a list of popular criteria for control chart signals. Any of the following signals is acted on as a trend:

- One point outside the control limits.
- Two out of three points that are two standard deviations above or below average.
- Four out of five points that are one standard deviation above or below average.
- Seven points in a row that are all above or below average.

FIGURE 2 Flowchart of the Improvement Process



- Ten out of 11 points in a row that are all above or below average.
- Seven points in a row all increasing or decreasing.

This list was developed from Duncan's book[5] and DOE Standard 1048-92. Other lists exist (examples include Donald J. Wheeler's series of SPC books published by SPC Press in Knoxville, TN), but the important principle is to choose one set of criteria and stick to it. Do not change from seven in a row above average to eight points in a row midstream simply to avoid declaring a trend you do not want to declare.

Fluor Hanford declares a trend on a performance chart to be adverse if it is statistically significant (using SPC criteria), if it is in the opposite direction from improvement and if review of the causes leads the owning management to declare it adverse.

The following actions are taken in response to an adverse trend:

- Report it to appropriate levels of management.
- Determine if it is a deficiency (corrective action management).
- Do Price-Anderson Amendment Act (PAAA) screening if necessary.
- Perform causal analysis.
- Take corrective actions.
- Monitor for effect of actions through future updates on the charts.
- Consider publishing a "lessons learned."

It is important to note that Fluor Hanford treats performance measurement results as a corrective action management issue only if they involve an adverse trend. In those cases where performance is stable but needs improvement, classical corrective action management will have little effect. This is because too often only a few anecdotes or the most recent results and symptoms are investigated.

Moving a stable system toward improvement requires a change to the system. No amount of tampering with recent results or performing root cause investigations on individual results will cause improvement. It is necessary to look at the common causes of the results over a long period of time—usually years of data.

Histograms and Pareto charts can help assist in finding common causes of stable but stagnant performance. You should use these tools only after SPC data determines performance is indeed stable.

Additional quality tools such as Ishikawa diagrams (fishbone diagrams), flowcharting, assessments and observations can assist in determining process changes needed. There is a common lament that we should be fixing recurring deficiencies. But if these deficiencies are the result of a stable system, the only solution that will have an effect is to change the system.

> **Good SPC analysis will quickly get to the root of a flawed measure and point out how to improve it.**

Work planning and employee involvement

No number of wall charts will lead to an improvement unless someone takes action. Management should take the lead and allocate resources, but the major source of improvement ideas will be the employees within the system. The work to improve the system will also be performed by these employees. The key is this SPC methodology makes it easier to focus employee involvement on areas ripe for improvement.

The DOE has instituted a program named Enhanced Work Planning to help focus worker efforts to improve operations and maintenance performance. Multidisciplinary teams are used to plan work and determine improvements.

This performance indicator process can be a key up-front task to determine areas for improvement and provide detailed information on how to achieve it. After the improvement is implemented, the performance indicator helps show the result of the improvement.

The flowchart in Figure 2 (p. 105) forms a cycle. After making the system change or taking an action, continue to update the control chart and determine any effects.

Fluor Hanford found the use of the measure is more important than what is measured. Good SPC analysis will quickly get to the root of a flawed measure and point out how to improve it. Less time is wasted in deciding what to measure. Instead, we get out in the field and start showing progress.

We have used SPC to great benefit to reduce injury and illness rates, gain credibility in corrective action trending and reduce the number and severity of environment, safety and health, and quality crises during the environmental cleanup project at the DOE's Hanford Nuclear site.

NOTE

Additional information on the Hanford Nuclear Site can be found at www.hanford.gov.

REFERENCES

1. *An Introduction to ISM*, U.S. Department of Energy, DOE Policy 450.5 "Line Environment, Safety and Health Oversight" at http://tis-nt.eh.doe.gov/ism/intro.html.
2. *Performance Indicators Guidance Document*, U.S. Department of Energy, DOE-STD-1048-92, December 1992.
3. Acheson Duncan, *Quality Control and Industrial Statistics* (Toronto: Irwin Publishing, 1986).
4. *Hanford Trending Primer*, www.hanford.gov/safety/vpp/trend.htm.
5. Acheson Duncan, *Quality Control and Industrial Statistics* (see reference 3).

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