WWW.CHEMICALPROCESSING.COM

CHEMICAL PROCESSING

LEADERSHIP | EXPERTISE | INNOVATION

Predictive Maintenance eHandbook

Improve Your Maintenance Practices

Start ▶

PutmanMedia®

Table of Contents

Ad Index

Don’t Neglect Pressure Gauges

Inadequate attention can make plants vulnerable to mishaps

By Jason Deane, WIKA Instrument

THE SIMPLE pressure gauge is an often-overlooked defense mechanism for preventing accidents. However, in auditing more than 250 plants, WIKA Instrument discovered that up to 25% of all pressure gauges were broken, damaged or misapplied — this represents an average of eight deficient gauges located within 20 feet of each employee.

A failed gauge compromises a plant’s ability to detect a problem before a safety incident occurs. Malfunctioning gauges also can lead to media leaks, fugitive emissions and a fire or explosion, taking a toll on safety and reliability.

Even minor accidents can cause employee injury and lead to downtime. Any accident or leakage also puts staff sent to fix the problem into harm’s way, which, of course, can lead to further employee injury and lost hours.

Many causes contribute to this dangerous situation with gauges. Fortunately, they can be prevented.

CAUSES OF GAUGE FAILURE

Through its evaluation of more than 150,000 gauge installations, WIKA has identified eight common causes of failure. So, let’s look at each, along with the solution.

1. *Vibration.* Many pieces of equipment vibrate. However, excessive vibration can lead to gauge failure and may indicate a problem with a component. Solution: install a gauge that will resist vibration better — i.e., a liquid-filled or direct-drive gauge with only a single moving part.

2. *Pulsation.* A rapidly cycling medium within a pressure system can make a gauge pointer move erratically and eventually can lead to breakdown of internal parts. Solution: install a restrictor and liquid-filled case to dampen pulses on a standard gauge or replace with a direct-drive gauge that lacks gears and linkages.

3. *Temperature.* Extreme temperatures cause sweating and loosening in metal joints and eventually can cause them to crack. Solution: install a gauge with a fully welded diaphragm seal and consider adding an on-board cooling element to combat the highest temperatures.

4. *Overpressure and pressure spikes.* Frequent pegging against the stop pin can bend the gauge pointer and compromise the integrity of the Bourdon tube or sensing element and, ultimately, lead to rupture. Solution: install an overpressure protector to inhibit readings that exceed gauge capacity.

5. *Corrosion.* The highly corrosive media often found in process plants can damage the sensing material in gauges. Solution: install a diaphragm seal that’s constructed from material that will withstand the corrosive.

6. *Clogging.* A medium that contains suspended particles or is viscous or can crystallize can clog the

RELATED CONTENT ON CHEMICALPROCESSING.COM

“Avoid Instrument Issues During Revamps,” www.ChemicalProcessing.com/articles/2011/avoid-instrument-issues-during-revamps/

“Bhopal Leaves a Lasting Legacy,” www.ChemicalProcessing.com/articles/2009/238/

“Repair Your Mechanical Integrity Program,” www.ChemicalProcessing.com/articles/2005/588/

pressure system and make gauge readings unreliable. Solution: install a diaphragm seal with a clog-preventing barrier.

7. *Steam.* Some media produce steam or other vapors that can damage the internal parts of gauges. Solution: install either a mini-siphon with an internal chamber to reduce surges or a full siphon, making sure to include a coil for horizontal applications and a pigtail for vertical ones.

8. *Mishandling and abuse.* Even properly installed gauges will start to malfunction if mistreated over time. Solution: conduct regular safety and maintenance training for all employees who come into contact with or proximity to gauges.

Unfortunately, many plant personnel aren't properly equipped or experienced enough to recognize and address all these problems. That, however, doesn't reduce the importance of doing so.

TACKLING THE PROBLEMS

When beginning to address instrument shortcomings, keep in mind that studies show that fewer than 0.25% of piping components account for greater than 80% of controllable fugitive emissions. Installing gauges with welded diaphragm seals on these components creates a dual containment device, which is required by the U.S. Environmental Protection Agency. This means plants can correct a major source of violations and fines by addressing a very small percentage of connection points. For many facilities, this is an excellent place to start to get meaningful results quickly.

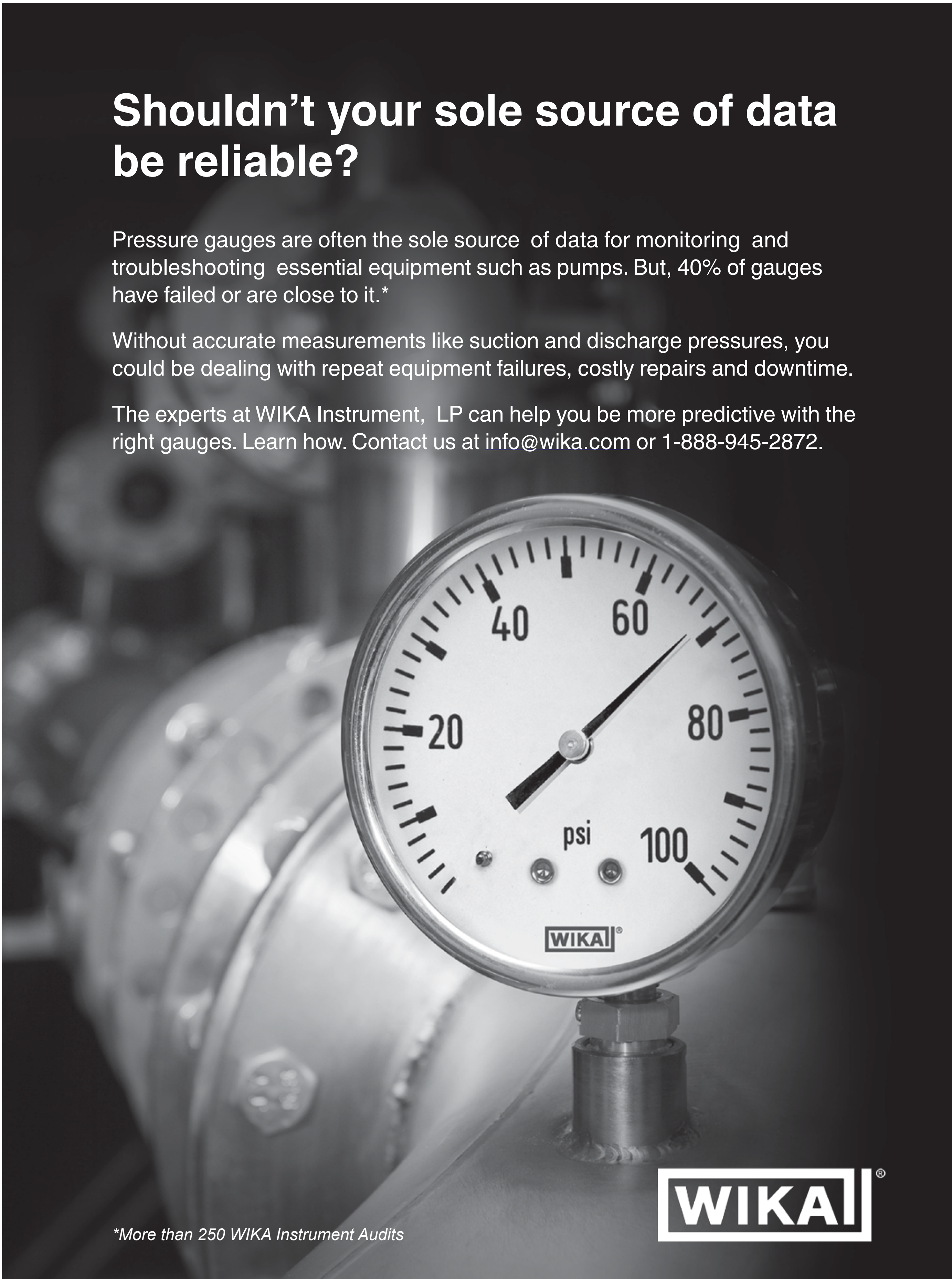
Another fairly straightforward step that's simple to implement but can yield powerful results is standardization of gauges. This reduces the number of replacement parts that must be kept in inventory — and confusion by technicians. In other words, when replacing an old or faulty gauge, employees more likely will select the correct gauge rather than resorting to like and kind replacement. This also helps ensure the storeroom maintains proper inventory, helping cut costs.

Plants that don't have the resources to identify and correct faulty and misapplied pressure measurement instruments can get outside help, such as from WIKA's FAST Team. Any audit team should:

- Visually evaluate the plant's gauge population and look for issues that need to be addressed.
- Diagnose gauges that pose threats and uncover the causes.
- Formulate a strategic plan to address all the discovered issues.
- Audit the storeroom and streamline inventory, reducing redundant part numbers and guesswork.
- Provide dependable processes to prevent misapplying instruments in the future, and coordinate employee-training programs.

Given the complexity of managing the operations of a process plant, it's easy to understand how smaller components such as mechanical pressure instruments can be overlooked. However, using gauges as early warning devices can improve uptime, safety and profits. Money spent on the humble gauge very well could be the best investment a processing plant can make.

JASON DEANE is a senior instrumentation engineer for WIKA Instrument, LP, Lawrenceville, GA. E-mail him at jason.deane@wika.com.


Shouldn't your sole source of data be reliable?
Pressure gauges are often the sole source of data for monitoring and troubleshooting essential equipment such as pumps. But, 40% of gauges have failed or are close to it.*
Without accurate measurements like suction and discharge pressures, you could be dealing with repeat equipment failures, costly repairs and downtime.
The experts at WIKA Instrument, LP can help you be more predictive with the right gauges. Learn how. Contact us at info@wika.com or 1-888-945-2872.
20
40
60
80
100
psi
WIKA
*More than 250 WIKA Instrument Audits
WIKA

Maintenance Gets a Makeover

Asset management software is spurring more proactivity and greater efficiency.

By Seán Ottewell, Editor at Large

UNTIL RECENTLY Nova Chemicals, Calgary, AB, was struggling to process upwards of 20,000 maintenance work orders per year at each of its 11 chemicals and plastics resins manufacturing facilities.

The company was running SAP's enterprise asset management (EAM) software but not using its full functionality. Plant maintenance processes weren't integrated with related EAM processes, leading to inefficiency and a lack of transparency. Reporting and analytics activities were insufficient. What's more, Nova's existing maintenance system couldn't provide a complete view of current and scheduled work, materials and dependencies categorized by plant and department — adding to the challenges of capacity evaluation and prioritization of work orders.

"We needed a solution to help make sure that repair work on our equipment and plants is done correctly and as quickly as possible — at the lowest possible cost," explains Ron Chow, a maintenance and reliability leader at Nova.

Today the situation has changed: the SAP EAM software provides a complete and consolidated view of scheduled maintenance at Nova Chemicals. It facilitates maintenance scheduling, work execution and material availability processes. All key stakeholders can access information relevant to them — for instance, business users can get a daily and weekly view of work scheduled, priorities, resources required, scheduling conflicts and project status — and gain a better understanding of the wide-ranging effects of maintenance operations.

The software has spurred better coordination and integration of maintenance scheduling, enhanced communication between maintenance and operations, and cut the number of unplanned equipment outages. It has directly impacted the bottom line, e.g., reducing by 47% the time spent on reactive, emergency work; increasing by 61% the time spent on proactive, preventative maintenance; and improving maintenance schedule compliance by 22% — in a year-long process that also included a pilot program.

Nova currently is focused on its next step — the integration of data from other processes such as capacity evaluation, additional forecasting and spending analytics, and maintenance cost budgeting.

DATA ISSUES

Retrieving and integrating ever more data into EAM software is posing some increasingly subtle challenges to the broader chemical community.

"The whole chemical industry is focused on data-mining. The Tier 1 companies in particular believe that somewhere inside all that operations data there has got to be information that will help them to better run their business. There is decades-worth of this information available to the larger companies," says John Harrison, Toronto-based senior solutions specialist for SAP. He is responsible for the chemical industry worldwide and has a particular focus on plant maintenance.

However, identifying the most relevant and accurate data on which to build maintenance and repair strategies is a far less straightforward task than it might appear initially — particularly when it comes to smaller chemical companies. "The quality of what they are recording and for how long they have been recording it is a moot point because they

RELATED CONTENT ON CHEMICALPROCESSING.COM

"Benchmarking Bolsters Improvement Efforts," www.ChemicalProcessing.com/articles/2013/benchmarking-bolsters-improvement-efforts/

"Focus on Critical Assets Pays Off," www.ChemicalProcessing.com/articles/2010/022/

"How Many More Months Will It Run?," www.ChemicalProcessing.com/articles/2009/176/

"Make the Most of Historical Process Data," www.ChemicalProcessing.com/articles/2009/091/

might not even be recording their data properly," Harrison notes. This can make a nonsense of the key performance indicators (KPIs) that companies are using, he cautions.

"I have a real concern in general about where data comes from and the calculations being carried out using it. I constantly have to deal with these two questions: 'Are you gathering enough data to generate them?' and 'Are you collecting the correct data?' To me, the bigger problem here is inconsistency in data definitions because these lead to inconsistent and wrong solutions."

He believes the issue of KPI benchmarking and the master definitions needed to do it should have been fixed decades ago. In the meantime, SAP is working with its KPI group, which includes Dow, Nova Chemicals, Celanese and Chevron Orinite, to try to agree on cross-industry definitions.

So far, there's a consensus on definitions for the top 30–40 KPIs such as mean time between failures (MTBF) and mean time to failure (MTTF). However, trying to define "failure" itself triggers huge discussions at maintenance meetings, he says.

Despite this challenge, the integration of business KPIs such as payroll and attendance with maintenance KPIs such as MTBF, MTTF, hour utilization by trade, and equipment vibration trends allows chemical companies to look more deeply into issues of concern. For example, it may explain why one shift experiences more shutdowns than another.

From this sort of work, a third, very important layer is emerging. "Here we are starting to see multiple disciplines of information coming together which can show up, for example, if there are higher failure rates either before or after maintenance staff vacations. Do patterns emerge? This is the sort of information that is now becoming accessible."

At the heart of SAP's efforts in this area is its HANA in-memory computing platform — which the company describes as a breakthrough technology that helps users to dramatically accelerate analytics, business processes and predictive capabilities.

"HANA allows us to analyze large amounts of information from multiple data sources at the same time and this is the future. My belief is that as we have access to more and more business data we can begin to ask some quite odd questions," notes Harrison.

Examples he cites include: Do high (or low) summer temperatures have an impact on plant shutdowns? Does buck fever (deer hunting season) lead to a decrease in production? Why is more electrical tape used by plant technicians in Canada in winter?

"This last turns out to be due to pilfering for use on ice hockey sticks and a company might decide that this is irrelevant, but when you start blending these questions together it gives you a much greater sense of how a plant is operating over time. Of course, you do need a very big database to achieve this."

Chemical companies, especially Tier 1 firms, are very receptive to this line of thinking, Harrison says.

With raw materials' costs rising and selling prices tight, they are desperate to drive out any other costs — and using historical data to identify trends and improve processes to achieve this is proving a popular solution. He currently is working with a number of undisclosed chemical companies in this area.

"The big breakthrough with HANA is being able to ask questions I never thought I could ask before. The other side of this is getting swift answers back. With faster answers, we can do more data blending. The question now is how we use this information."

He believes the future lies in the ability to more rapidly and better process ever more plant data.

The way this data is presented will be important, too. For example, engineers trained in SAP's Visual Enterprise applications, 3D diagrams and animated equipment explosions already have cut many days off large-dollar maintenance project executions. Similarly, the advent of 3D technical documentation from equipment manufacturers will make the whole maintenance experience much simpler — and, he notes, more digestible for new people coming into the industry.

"Overall, we are on the cusp of a radical change of how people understand maintenance and deal with it."

MAINTENANCE TRACKING

Asset availability is the key issue for the chemical industry, asserts Kim Custeau, Burlington, ON-based director of product marketing for asset management solutions for Invensys. "Customers need to schedule resources appropriately. This includes labor utilization, materials sourcing and so forth. Basically, you need everything in the right place at the right time to carry out the maintenance or repair job. So, supply chain connectivity is crucial — from the personnel right down to those 60-cent gaskets," she explains (Figure 1).

Her group particularly focuses on Tier 2 companies, where tight margins are forcing greater proactivity in areas such as maintenance tracking.

"Take predictive maintenance, for example. The guide book tells you that a particular piece of equipment might need maintenance every 30 days. What it often won't tell you is that the same asset might work very differently in locations with different climate conditions," she notes.

More than 25% of maintenance done today is unnecessary and can introduce additional failure risks, Custeau points out. Fortunately, use of both condition-based maintenance and a reliability-centered model for operations and maintenance can ward off unneeded maintenance.

BROAD CONNECTIVITY

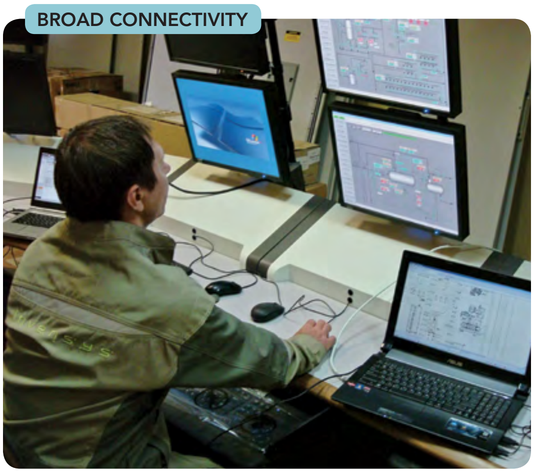


Figure 1. Accessability to the entire supply chain can provide significant benefits. *Source: Invensys.*

To address such challenges, Invensys developed Avantis Condition Manager, part of its InFusion enterprise control system. The system also provides early failure detection to increase asset availability, reduce costs and avoid unnecessary downtime. Invensys's own figures suggest that plants on average lose 5% of their production due to unplanned outages.

Like Harrison, Custeau also is concerned about the nomenclature used: "People are starting to look at how maintenance data is put onto their systems and the nomenclature that is used alongside it. This is a big issue, so Invensys systems have a lot of pull-down menus which make use of specific nomenclature. However, people still want to have the ability to use freehand text; so one of our key challenges is to encourage companies to change their approach and be more systematic in the way that they do this." Invensys is partnering with niche maintenance consultants who are experts in culture change to help its users do just that.

ACHIEVING SAVINGS

Fertilizer manufacturer CF Industries, Deerfield, IL, has standardized on Avantis.PRO software as its core platform for collection and storage of data on maintenance, repair and operations (MRO) activities. The company also uses Avantis.DSS decision support software to analyze the data for continuous process improvement, and has supplemented its system through adoption of standard catalog descriptions and categories for all MRO items.

This system is designed to automate maintenance planning and tracking activities on nearly 50,000 assets, including vessels, pumps, rotating equipment and electrical motors. It also helps manage and analyze MRO inventory and procurement for more than 60,000 inventory items in the four CF Industries manufacturing locations.

"Avantis.DSS software takes data from available Microsoft documents, such as Excel, and makes useful information out if it, which enables us to monitor assets and optimize efficiency. Data analysis that took two weeks is now done in ten minutes, which opens up new doors for improvement," notes Dave Wiedenfeld, group project leader, IT.

The software has proven particularly beneficial in analyzing and improving inventory and spending activities. It has contributed to reducing inventory by several million dollars and to savings of approximately $2 million through improved sourcing and contract negotiations.

"For now, we can actually ensure that maintenance materials and services we need are there when we need them, know what it costs to maintain the plant, and know the best way to maintain it based on history. This puts us way ahead of the game," Wiedenfeld adds.

WHAT'S AHEAD

Mobility will play an important role in the future, Custeau believes. "The maintenance person will take a mobile device of choice and be dispatched to where needed — while having full access to all the information on the office desktop. People expect instantaneous access to all their information, especially the new folks coming in the industry now. So our emphasis is very much on mobility and providing the access to information that they need," she concludes.

Savor Statistics

It can help you uncover important insights from your data

By Dirk Willard, Contributing Editor

WHAT IS the probability that a pump failure will ruin your Christmas? If we assume all pumps operate in series, like lights on a Christmas tree, and two pumps of fifty fail in a typical year, the probability of failure is 2/365 per day. The probability that all pumps will operate simultaneously is $(1-2/365)^{50}$ or about 76%. Don't plan a long trip to the Bahamas.

Now, suppose you install spare pumps that can be switched in easily and reliably. Let's disregard poor suction connections, unreliable heat tracing, blocked strainers, switchgear problems, etc., and presume the spares are well maintained. Now, the probability of a single pump shutting down the plant is only $(1-0.0003)^{50}$ — effectively zero. Take that vacation! This example illustrates the value of a fundamental understanding of statistics.

Let's start with the basics: sampling. It's easy to trip up on the terminology: replicates, variants, and specimens mean the same thing: repeated tests under the same conditions. You want enough replicates per test to compare them among themselves and to identify systemic failures in testing. If there is a high risk of loss of the specimen, use 4–5 as a minimum; 3 is minimum for cross-comparison. When in uncharted territory, do screening experiments to bolster your familiarity and to improve efficiency of testing. Examining whether all the samples collected belong in the same population is called analysis of variance (ANOVA). Use the F distribution at a 95% confidence interval to compare sample averages of variants and X distribution to check for normality. You can use process data for analysis but you can't check for systemic problems or detect interdependence between data points. Bored?

Consider the permutation. Suppose you are trying to figure out the load on a manual vent system involving six tanks. Let's assume initially that flows are equal. You know that if more than three flows occur at the same time the vent will reach a choked condition. How many triplets are there? In statistics this is: ${}_6P_3 = 6!/[(6-3)!3!] = 20$. While it's unlikely that all flows are equal, now you know you have twenty different combinations to model to decide which triplet is the worst case.

Lastly, let's look at regression analysis. An equation that varies a property with temperature and pressure is convenient in process modeling. Regression equations can emulate pump curves or control valves in a simulation. In fitting a curve you have several choices: 1) use a global equation to fit the entire curve, perhaps badly; 2) fit the curve in parts; 3) linearize the curve using 1/X forms or logarithms; or 4) use a generic polynomial fit. The last option generally isn't recommended unless the curve is boxed in — a good example of a boxed-in curve is one that has a 0–100% abscissa, which is typical for a control valve. Only interpolate polynomials, never extrapolate them. A global equation sometimes is chosen, despite a poor fit, because it can be hard to easily switch the regression equation in a model. This was a common problem with old distributed-control-system program languages.

How do you know if your regression equation is valid? The simplest tool is the Z-score. Let's say you have 20 data points you want to develop for a regression equation. First, you want to examine for any deviations, assuming your points are independent, free of systemic error and fit a normal distribution. Before moving on to the Z-score, ensure all of your points represent averages; ideally, each point should be based on the same number of replicates. Next, calculate the Z-score: $Z = (y - \text{Y-bar})/\sigma$ where Y-bar is the average of all points: $\text{Y-bar} = \Sigma y/N$, where N is the number of points; and σ is the standard deviation: $\sigma = [\Sigma(y - \text{Y-bar})^2/(N-1)]^{1/2}$ (for a small sample). So, if an observed value (y) is 4, and σ is 0.521 with an average of 2.33, then the Z-score for the observed value is $Z = (4-2.33)/0.521 = 3.2$. Because 99.7% of data in a normal distribution should have a Z-score within ±3, this point is suspicious; scrutinize it and, if appropriate, toss it out as an outlier. Also investigate borderline values, i.e., >±2.75. Plot the Zs to look for systemic problems, e.g., more than 4 points in sequence on the same side of the average shows interdependence. Outlier elimination only can be done once. In the 1980s it was discovered that a famous petroleum oil property regression from the 1940s was purged of outliers over and over again. It was discarded and a professor was discredited.