MAINTENANCE & ASSET MANAGEMENT

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Turbine and Generator Overhaul IN SEVEN WEEKS

RELIABILITY *What Is It?*

Asset Management BASICS

WHAT IS WRONG *with Process Measurements?*

Plant-wide Measurement Quality Assurance

What is Wrong with Process Measurements and What Can Be Done about It?

According to field studies, faulty measurements are very common in industrial processes. Below you will find some do-it-yourself tips on how to detect errors in measurements, as well as information on new tools and services for assuring a plant-wide measurement quality.

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Based on the studies I have done during seven years on measurement quality in the process industry, I am confident of making the following statement for the persons responsible for an industrial process: "**You cannot utilize the full potential of your process because your process measurements cannot be trusted.**"

You might know it from the last raw material balance sheet or energy report you went through. At first glance everything seems to be in order, but on closer inspection there is a gap here and a gap there. Something is missing or something seems to be too much – the figures just do not seem to add up. You might also know it based on your last visit to the control room. Some of the values you were looking through may not seem to make any sense.

Perhaps the flow measurement you were trying to follow had shown exactly the same value for the last two weeks, or maybe there were 100 tons going into a reactor but only 90 coming out, or a particular process was running with 102 % efficiency. Perhaps you have no trust in the measurements because of the last revision for a major heat exchanger you ordered had no effect; the problem was elsewhere and the revision was a waste of money.

If you cannot trust your measurements you have to play for safety when making decisions. As a result Your company loses money, you miss your bonuses.

Does this sound true – at least some of it? The stories above are all examples from real life that I have faced while doing the analysis work. Luckily, there are things you can do yourself and new tools and services available that can help you to get your measure-

FIGURE 1. *Faulty temperature measurement caused significant error in steam invoicing and efficiency monitoring, but was observed neither in calibration nor by operators.*

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ments in order and start focusing on running the process to its full potential.

Case Power Plant

The conventional power plant is a good example of a process that is measured and controlled by hundreds of measurements mainly for flow, temperature and pressure. The situation is similar for almost all industrial processes – and decision-making is based on these measurements.

Decisions like control set points, maintenance work and investments are justified by performance indicators, which are calculated from the measurements.

The problem is that at any given moment a large number of these measurements have significant errors in them and this causes uncertainty, waste of time and worst of all, bad decisions.

The measurement problems are usually recognized, but not handled in a proper way. The responsibility for the measurement quality work is given to the automation department and the management assumes that things are taken care of.

Due to lack of resources and tools the automation people are often forced to perform only calendar-based maintenance routines to the most critical measurements, without much attention to the system as a whole. Why doesn't it work then? There are two major issues:

1. The calendar based work quality is inefficient and passive when sudden changes occur.
2. The majority of the measurements are not included in the calendar based maintenance routines due to a lack of resources.

A simple example of the challenge with normal quality assurance (QA) is shown in **FIGURE 1**. A faulty temperature measurement caused a huge error in steam invoicing. The measurement was used for the density compensating of the flow meter. The error was not noticed in calibration because the error didn't occur during the calibration. Nor did the operators react to it, because the measurement itself didn't cause problems for the process control.

Detecting the faulty measurements – do it yourself

The good news is that the modern automation system gives us the possibility to look for measurement errors. The reason for this is that measurement information is saved over a long period of time and almost all the meters in the system are correlated. This is good news, because inconsistencies between the unrelated measurements can be detected by analyzing the system as a whole. Here are a few tips on how you can detect faults in the measurement system yourself.

FOLLOW THE VARIANCE IN EACH OF THE MEASUREMENTS

There are certain measurement errors that you see by just looking at the trends. One of the easiest and also most effective procedures is to do variance detection for measurements. A measurement is surely unreliable if it shows a constant value for hours in a row other than zero.

When you have 300-or-so measurements you cannot naturally do this by hand. But checking that the variance and the value are between sensible limits is easy enough for nearly any automation system. Perhaps you pay an engineering student to build you an Excel-macro to do the job.

FOLLOW THE BALANCE ERROR

Practically all measurement systems are built redundantly. This means that if you lose one meter, you can calculate the value some other way. The easiest way of doing this is through material and energy balances. The great thing is that you can use these balances to follow the consistency of your measurement system.

But a word of warning: This method does not work if there are calculated measurements in the balance. I have encountered this situation more than a few times. I have seen that someone has already calculated the last measurement to even up the possible errors in the others.

EDUCATE YOUR AUTOMATION WORKERS

A study on human errors affecting the measurement quality, based on the vast on-site calibration information we have, gave stunning results. Without even taking installation effect into consideration one-in-five measurements had more than two percent – often a lot more – uncertainty in the measurement that was due to human error.

This means that when you buy and get 20 new meters installed in your process, on average four of them will measure faulty due to problems in scaling, signal processing or excessive filtering. To avoid these mistakes the workers should be sufficiently aware of how the physical process, measurements and decisions are connected.

Detecting the faulty measurements – tools and services

While there are several things you can do yourself, there are also tools and services available to help systematically detect the faults. One of the tools Indmeas has developed is the balance-based "10-spot-criteria" –analysis (**FIGURE 2**). This on-line tool calculates the "degree of unreliability" by following ten different quality criteria for each measurement.

Examples of the criteria used are the long time correlation between measurements

TIPS:
Detect the faulty measurements – do it yourself!

› Follow the variance in each of the measurements

› Follow the balance error

› Educate your automation workers

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CLASS	Tag	Position	Unit	Nom	Mean	10-spot-CRITERIA	DEGREE OF UNRELIABILITY
CRITICAL	DISTRICT HEATING return temp	2NL02G901	C	49	45.2		
	DH Flow	2NM02G901	m³/h	2000	1598.0		
	Fuel Coal	2NG01G901	ton/h	18	16.9		
	Feed Water Temperature	2NW01G901	C	225	228.9		
	Feed Water Valve - pressure dif	2BN01G901	bar	2	0.2		
?	Flue gas CO	2RA01G901	ppm	-	-		
	Main Steam Flow	2NR01G901	ton/h	550	530.0		

FIGURE 2. *The quality analysis tool helps the maintenance work to pick up likely faulty measurements from hundreds of different signals.*

and balance errors. The degree of unreliability is calculated as the sum of these different quality criteria violated. This way erroneous measurements stand out and maintenance efforts can be directed faster and more effectively.

Fixing the faults

Naturally there needs to be a way of verifying and correcting the suspected measurement errors. Using only the mathematics to determine and correct the errors would soon lead to a system, which has absolutely no touch to reality.

There are several ways to verify the measurement values in a metrologically rigorous way. For flow measurements, which have been one of the difficult measurements to confirm, an accredited on-site calibration method based on tracers has been developed with a minimum calibration uncertainty of ±0.5 %.

Using an on-site method the meter does not need to be removed or process stopped during calibration. The calibration carried out on-line is essential because the possible systematic error in the measured value always depends on the site-specific circumstances.

Flow profiles, fluid properties, physical properties of surroundings and installation effects all give their share to the total measurement error. Even the human effects in the signal processing can be controlled by this method.

It is continuous work – but pays off

Indmeas has used these two technologies – calculated error estimates and on-site calibrations – as a systematic approach to validate process measurements in Northern Europe. The results have been remarkably good.

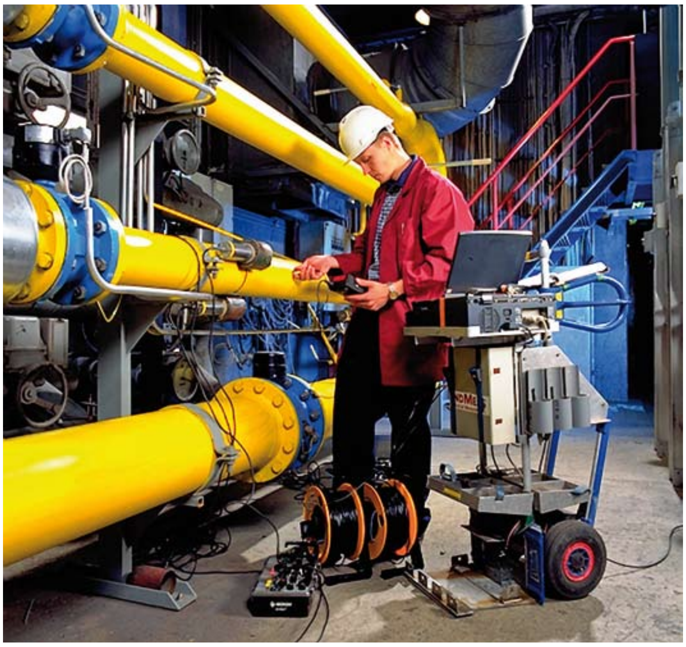

FIGURE 3. *Flow meter calibration with tracer technique on a natural gas line.*

Typically the weighted average error of measurement in energy balance is around 3 %, but with the systematic approach it has been lowered and kept within about 1 %. This improvement in plant-wide measurement quality gives significant advantages in improving operational economics. ■