What, When and How Should I Calibrate?

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Calibrating and Testing Control Components on Your Heat Process

You want your processing to be accurate, consistent and reproducible over the long term. You want to be ready when ISO compliance or your customer's quality control calls for proof of the integrity of your operation. So, make sure all your process-critical signals are checked and recorded once or twice per year.

Some -- but not all -- process variables have to be accurate to get the demanded quality, yield, safety and energy efficiency. For optimum cost and efficiency, keep in mind where best to apply your diligence and tight tolerances.

Your Test Equipment List

Must-haves for your test equipment tool kit include the following.

- Precision, multifunction signal source (also called a calibrator). This will put out precise (0.1 percent or better) voltage and current signals that simulate the outputs of various devices such as thermocouples, RTDs and transmitters. Besides simulating these devices, they can measure their outputs and present the indications in engineering units.
- Run-up box. This is a little box with a pair of DC output terminals. It contains a battery, both fine and coarse potentiometers, and a few resistors. You can make one yourself. It is used to inject a signal into an instrument or process to run it up and down for a quick test without involving calibration. You also can buy products with varying levels of price, performance and features ranging from the run-up box to the precision calibrator.
- Precision multimeter.
- Clamp-on ammeter.
- Flashlight, schematics and manuals.
- Clipboard or preprinted forms for your records.
- An adjustable temperature source for calibrating temperature sensors.

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Items to Check and Calibrate

Thermocouple- or RTD-Actuated Temperature Indicators, Recorders or Controllers. Leave the instrument on the bench, switched on and connected to the calibrator using the correct extension cable. With RTD instruments, use copper wire. Wait 10 to 20 min for both to attain room temperature. Inject a minimum of four signals spread through the useable range plus one near your working temperature. Record the indications as found -- and as left if you make any calibration adjustments.

The working environment of an instrument may be a few tens of degrees different from that on the bench. If you suspect that the calibration performed at the two locations do not agree, calibrate first at the working location then on the bench at normal room temperature.

I have dealt in a previous column with the problems of perfectly good instruments and thermocouples combined with mismatched or misconnected thermocouple extension cable. This brings stealthy errors that can come and go within minutes or hours. You may detect these by calibrating on site and injecting the calibration signal into the extension cable at the thermocouple head, having first disconnected the thermocouple.

Say you are calibrating an RTD-actuated instrument on the plant from the sensor location. You are adding (usually three) wires into the circuit that were not there at the bench calibration. If the wires have equal resistance, say as in a three-core copper cable, you will get the same result as a bench calibration. Any unbalance in the sensor wiring can introduce measurement errors. Check the instrument specification for the effects of resistance and resistance unbalance.

Alarm Settings. After you have calibrated your instrument, use your run-up box or calibrator in ramping mode to check where alarms trip in relation to their settings. Check dead zones, too, by approaching slowly from below and above the settings.

Temperature Transmitters and Signal Conditioners. The same principles apply as for indicators. Inject the simulated process signal at the input. You usually will not have an indication. You are looking for a linear DC output (for example, 4 to 20 mA) corresponding to the temperature range of the intended sensor.

Connect your precision multimeter to the output and compare a range of precise input signals with their corresponding analog output signals. Remember that some low cost transmitters and signal conditioners reproduce any input nonlinearity (such as those from thermocouples) at the high level output.

Retransmission Signals. Retransmission signals from controllers, etc., can be treated like outputs from transmitters and signal conditioners, but you have to compare these outputs with the values in the controller that they represent (e.g., process temperature, setpoint, deviation from setpoint or percentage output).

Advanced Features of Calibrators. Some advanced calibrators can:

- Ramp the output up and down at a controlled rate.
- Inject and display an input signal and display the output of the device under test at the same time.
- Capture data in memory for uploading through a PC interface for archiving, printing and analysis. Note that the calibrator cannot see and capture plant instrument indications. You still need to read by eye and write or key them in.
- Calibrate and configure Hart communicating transmitters. These carry a digital signal riding on the analog output signal wires.