Case Study: Metrology Calibration Laboratory

Optomation Systems Implements SNAP PAC System for Utility Metering Certification Lab

Trusting the Meter

Ever stopped to think about the importance of instrument calibration in our everyday lives? You may not realize it, but we all rely heavily on the readings and measurements provided by everyday equipment that's all around us. Weigh scales in supermarkets, fuel pumps, even gaming machines in casinos all demand perfect, certified calibration, as do the water, gas, and electricity meters for our homes.

The accuracy of this equipment is hugely important to everyday consumers. (After all, no one wants his gas pump to indicate 10 gallons pumped, when it really only dispensed 9.5.) Big business also has a vested interest. Suppliers and manufacturers need accurate scales to ensure that they're sending and receiving the proper amounts of raw materials, while pharmaceutical and food companies need exact measurements of the various ingredients in their batch recipes

And of course the government also takes instrument calibration very seriously, mainly because of taxes. If a gas station or utility company undercharges or overcharges consumers, it makes it more difficult for the government and its agencies to calculate, reconcile, and collect the proper tax. So in every country, a government-controlled metrology laboratory is responsible for the certification of all fiscal-related metering devices.[1]

The master piston

Metrology Laboratories

Metrology is the science of measurement. Although manufacturers are responsible for the production, calibration, and conformity of their equipment, a metrology laboratory must validate the manufacturer's specifications for individual meters and instrumentation. Validation involves the use of special test stations with a dedicated control system along with a real-time database for recording and archiving test results. The control system regulates the test station as it executes very detailed and precise procedures in order to confirm the manufacturer's accuracy and precision specifications as correct. The control system must also maintain detailed records for each individual test it conducts and each meter it evaluates.

1. In the US, this organization is the National Institute of Standards and Technology (NIST). Among other things, NIST supplies industry, academia, and the government with definitive calibration standards for measuring equipment and measuring procedures.

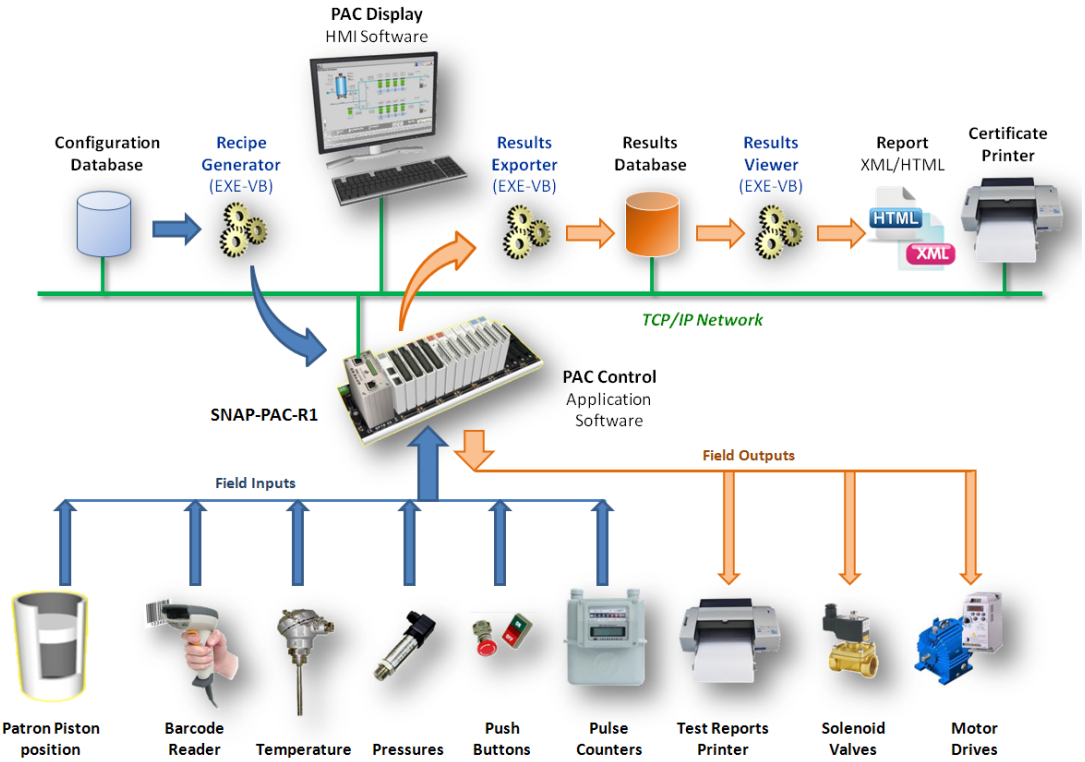
The only approved metrology laboratory for the Madrid Autonomous Region of Spain is the Centro de Laboratorios de Madrid (CLM). The lab certifies almost 250,000 utility meters each year, including 52,000 domestic and industrial gas meters. Its customer base includes corporations, utility service providers, public institutions, service station operators, manufacturers, licensed operators of gaming machines, and even ordinary people who might believe a meter is inaccurate.

Test Station and Certification Procedure

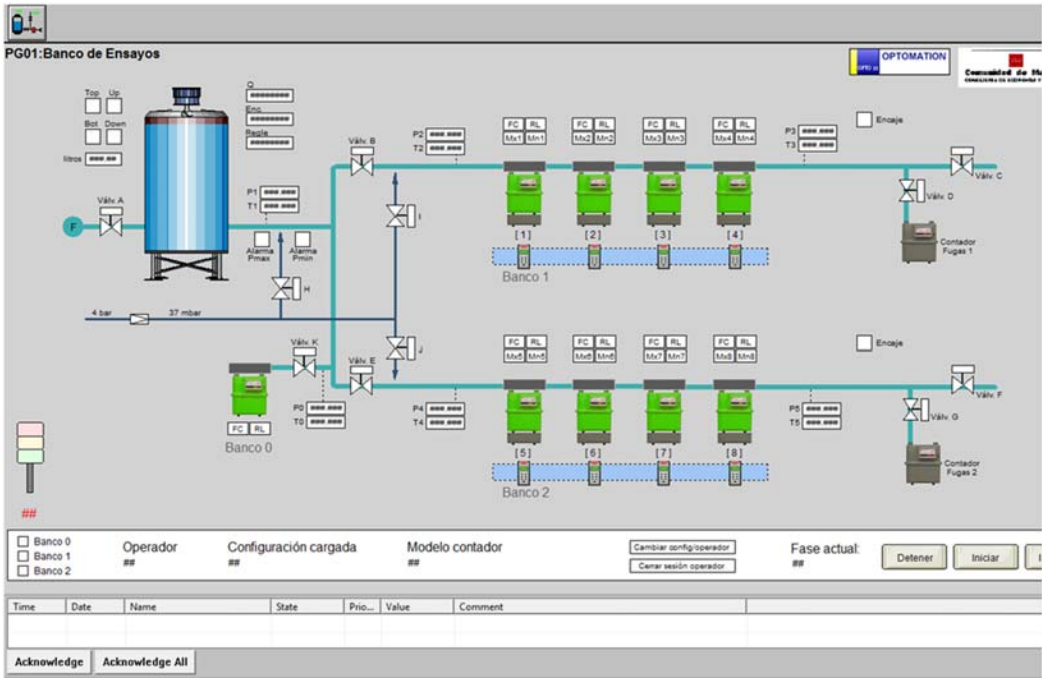
At the CLM, the gas meter test station consists of a precision-engineered master piston that volumetrically displaces a precise quantity of air from a cylinder to eight connected gas meters. It's a simple concept: the same volume of air displaced by the master piston should pass though the meter, with no difference between the two calculated volumes.

Piston movement and all other test station control, measurements, and data acquisition are handled by an Opto 22 SNAP PAC System that features a programmable automation controller and input/output modules as its key components. A variety of I/O modules connect to test station sensors, transducers, actuators, and readers.

- **Voltage output modules** connect to variable speed controllers used to modulate the speed of the motor (that controls the piston) during the test. Digital output modules, meanwhile, control multiple solenoid valves on the test station used for shutting off and venting gas.
- **High-speed digital input modules** count the pulses coming from an optical ruler that emits a low voltage pulse for every micrometer (0.001mm) the piston moves. This way, technicians can be sure exactly how much gas is being pushed through the cylinder to the meters. For verification, the pulses are also counted as the gas passes through the meters.
- A **barcode reader** scans the manufacturer's serial number of each meter. A serial communication module connected to the barcode reader then passes this information to the PAC.



System architecture



Human-machine interface developed using PAC Display.

- A **local serial printer** is also connected to the PAC via a serial communication module. Test results are printed directly onto paper and saved. This provides a safeguard against any potential tampering or manipulation of the database reports.
- **Temperature input modules** supply both ambient and process temperatures to the PAC. Any slight variation in temperature during testing will affect the measured amount of gas being displaced and this error must be corrected in the software.
- **Current input modules** interface to different pressure transducers in and around the process. The PAC must apply precise corrections for any fluctuation in gas pressure during the test procedure.

During the test, all meter readings (and the discrepancies between them) are recorded, and the test is repeated using five different gas flow rates. Only when all discrepancies are resolved and all test results match will the system certify an individual meter and register it as accurate and calibrated. However, all faulty meter test results are also recorded and saved. The volume is checked for leak detection against three other meters undergoing simultaneous testing (plus a single pre-calibrated meter) in the same pipeline.

Software and Communications

An operator interface created with the PAC Display HMI development software provides security (and evidence of changes to any of the test parameters) by registering all user actions. Real-time graphical representation of the process, test procedures, results, and trend data are also available through PAC Display, and visual alarms are triggered when specified conditions are met or exceeded.

A configuration database maintained on a networked PC contains all the parameters and data used for the test station. This way, the control commands corresponding to the test procedures of each type of meter can be quickly and easily downloaded to the PAC via TCP/IP.

The PAC controller maintains all test data, serial numbers, calculations, and results in its internal memory, backed up by an on-board microSD memory card. At the end of each batch test, all information is automatically uploaded via FTP to a results database on a networked PC.

Hardware and System Integration

Luis Blanco Estrecha, Manager of CLM's Metering Division, says that the laboratory had considered using a PLC-based solution for its test station control. The lab ultimately chose its PAC system because it was better suited for the multiple and varied sensor connections, as well as the complex math calculations that needed to be executed in real time. The PAC system also offered better reporting capabilities and Ethernet connectivity to standard IT packages like Microsoft Office.

Estrecha says system modularity was also very important.

"The Opto 22 hardware is a bit like a Lego construction kit. You only pick the exact modules for the signals and sensors you need. Our test station uses pulse encoders, infrared sensors, reed contacts, proximity switches, pressures, temperatures, bar code readers, servo controllers, and solenoid valves. Whatever we needed, Opto 22 had a suitable module for direct wired connection."

The CLM also recognized they needed the support of a full-service systems integrator.

"The new system needed to be implemented seamlessly in order to avoid any loss in production," Estrecha says. "We were aware of the risk in subcontracting to different companies for hardware, software, and installation requirements, in that when the going got tough, each could have easily claimed that any discovered problem was not within their scope of supply."

Local integrator Optomation Systems not only handled rewiring, commissioning, and database migration, but also supplied the CLM with application software and all replacement hardware.

Estrecha says that from the outset, Optomation Systems took full ownership of all aspects of the project and offered a "one stop shopping" approach that ensured the project's success.

About Opto 22

Opto 22 develops and manufactures hardware and software for applications involving industrial automation and control, remote monitoring, and data acquisition. Opto 22 products use standard, commercially available networking and computer technologies and have an established reputation worldwide for ease-of-use, innovation, quality, and reliability. Opto 22 products are used by automation end-users, OEMs, and information technology and operations personnel in over 10,000 installations worldwide. The company was founded in 1974 and is privately held in Temecula, California, USA. Opto 22 products are available through a global network of distributors and system integrators. For more information, contact Opto 22 headquarters at +1-951-695-3000 or visit www.opto22.com.

About Optomation Systems

Working from its centralized offices in Madrid, Optomation Systems has been the exclusive distributor for Opto 22 for Spain, Portugal, and North Africa since 1996. The company is responsible for the commercialization, distribution, installation, and after-sales support of Opto 22 products in this area.

Optomation has developed a complete support network, including integrators, consultants, and suppliers that offer services, local support, compatible technologies, and products that complement those of Opto 22.

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