

Low-Pressure Generator Makes Cleanrooms Cleaner

Originating Technology/ NASA Contribution

Scientists at NASA's Kennedy Space Center work in cleanrooms: laboratories with high degrees of cleanliness provided by strict control of particles such as dust, lint, or human skin. They are contaminant-free facilities, where the air is repeatedly filtered, and surfaces are smooth to prevent particles from getting lodged. Technicians working in these environments wear specially

designed cleanroom "bunny suits" and booties over their street clothes, as well as gloves and face masks to avoid any contamination that may be imparted from the outside world. Even normal paper is not allowed in cleanrooms—only cleanroom low-particulate paper. These are sensitive environments where precision work, like the production of silicon chips or hard disk drives, is performed.

Often in cleanrooms, positive air pressure is used to force particles outside of the isolated area. The air pres-

sure in the Kennedy cleanrooms is monitored using high-accuracy, low-differential pressure transducers that require periodic calibration. Calibration of the transducers is a tricky business. In prior years, the analysis was performed by sending the transducers to the Kennedy Standards Laboratory, where a very expensive cross-floated, labor-intensive, dead-weight test was conducted.

In the early 1990s, scientists at Kennedy determined to develop a technique and find equipment to perform qualification testing on new low-differential pressure transducers in an accurate, cost-effective manner onsite, without requiring an environmentally controlled room. They decided to use the highly accurate, cost-effective Setra Model C264 as the test transducer.

For qualification testing of the Setra, though, a portable, lower-cost calibrator was needed that could control the differential pressure to a high degree of resolution and transfer the accuracy of the Standards Laboratory testing to the qualification testing. The researchers decided that, to generate the low-differential pressure setpoints needed for qualification testing, very small gas volume changes could be made against the test article, and a corresponding pressure change would be detected by a pressure standard. This allowed the researchers to recreate cleanroom air pressure settings without the use of a cleanroom.

Thus was born the low-differential pressure generator. In 1993, a prototype was developed using a pair of PVC tanks, a volume controller, and a 1-pound-per-square-inch pressure standard. By 1995, the prototype was perfected into the unit that is still used today.



Setra Systems, Inc., has produced the first portable, low-pressure calibration system capable of performing in situ calibrations of high accuracy, very low-differential pressure transducers.

Partnership

As with so many NASA-inspired inventions, the scientists were in need of a new piece of equipment, so they built it themselves. Stephen Stout and Richard Deyoe of Kennedy were the two principal researchers on this project and they, with Greg Hall, patented it as the Low Differential Pressure Generator in 1997.

Ironically, personnel at [Setra Systems, Inc.](#), the Boxborough, Massachusetts company whose original Model C264 pressure transducer had been tested, came across the new technology in 2002, while conducting a search for the same type of equipment that the staff at Kennedy had wanted. The new low-pressure generator



was described in an article in NASA Tech Briefs. Setra was seeking a pressure-generation method that would isolate the differential pressure sensors from environmental noise during the calibration procedure, a problem that was discovered while working with pharmaceutical manufacturers attempting to certify critical air handling processes.

Setra then contacted Kennedy's Technology Transfer Office to obtain rights to the patent, and the NASA office facilitated the paperwork and provided them exclusive rights to the technology.

Product Outcome

Setra, known for its simplicity of design, high accuracy, exceptional long-term stability, and competitive pricing, incorporated the NASA technology into its Micro-Cal Low Pressure Calibrator, and now offers this unit among its product line.

Technicians have just one portable unit, instead of having multiple components, like the pressure indicator, pressure generator, and data logger to carry to calibration sites. The unit is battery powered, with compact size and a lightweight case that can be carried to cramped, remote locations, even up stairs or ladders. It is a significant improvement over the expensive primary pressure standards that the transducers had to be tested against. Additionally, it boasts superb pressure-reading accuracy, as well as fast, stable, repeatable, and accurate pressure generation. The user can also select or configure pressure generation profiles.

It offers calibration data storage with download capability, data and process security, dual reference pressure sensors to cover a wide range of test pressures at the highest accuracy possible, and calibration times as fast as 5 minutes per unit, which generate significant laboratory cost savings. It also has a simple personal digital

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assistant user interface. Most attractive, even with all of these added features, it is almost half the cost of a laboratory benchtop calibrator.

Most manufacturers of low-pressure calibrators do not use true low-range reference pressure sensors. Instead, they use higher-range sensors and attempt to achieve high accuracy at lower pressures through intricate microprocessor correction. The resulting higher levels of noise and instability limit the ultimate accuracy available. Setra uses patented stretched diaphragm, capacitive sensor technology for highest output at the lowest pressures.

Another area where typical low-pressure calibrators fall short is generating a stable, repetitive, and accurate test pressure. Most companies use micro-solenoid pressure generation and regulation, a technique that applies small pressure pulses to the positive and negative pressure test volumes to regulate the test pressure. During active pressure regulation, this system generates pneumatic noise. Setra uses NASA's low-differential pressure-generation technology that produces maximum pressure-setting sensitivity with minimum noise.

The pressure generation is accomplished using a piston/cylinder arrangement, whereby the differential pressure sensor under test has both high- and low-pressure ports connected to the cylinder in a push/pull configuration. As the stepper motor-driven piston advances in the cylinder, it applies positive pressure to the high port of the test pressure sensor and negative pressure to the low port. The resulting pressure-generation system is sealed and immune to the outside environmental noise and has twice the sensitivity as a single-sided piston and cylinder.

Setra has automated the patented NASA Low Pressure Generator using micro-stepping motors and true low-pressure reference transducer feedback. This combination has produced the first portable, low-pressure calibration system capable of performing in situ calibrations of high accuracy, very low-differential pressure transducers. ❖

Micro-Cal™ is a trademark of Setra Systems, Inc.