

Field Validation (Air Balancing) of Critical Spaces

(A-3)

We offer these white papers as a contribution to the growth of our industry. These ideas may or may not apply to a specific project. Please contact us for detailed recommendations.

Field balancing of critical or validated air systems normally have different goals and procedures than more conventional systems.

Often field balancing of critical projects proceed as scheduled but sometimes surprises occur.

Example-- many critical systems will include measuring devices of varying characteristics, sophistication and accuracy. Often Included in critical applications are comfort applications, which can be balanced with simple measuring devices and procedures. Some terminal devices are often required to be responsible to maintain very accurate air flow and /or pressure balances in critical spaces. There are many types of measuring devices for both general and critical applications. Among the choices are static pressure sensors for room applications (which filter any room currents) and duct static pressure devices (installed perpendicular to the velocity flow). Velocity pressure devices include a standard pitot tube, an enhanced pitot tube which amplifies the signal, a "fiecheimer" design which also compensates for yawed flow, total pressure tubes with "keil" shrouds (which also deal with yawed flow) and orifice plates.

Rating of air flow and pressure devices

Most air flow sensors are tested using some form of repeatable laboratory conditions where the air flow past a typical sensor is varied and the resultant sensor output is recorded and graphed. This simple method of rating is easily related to normal field conditions. Some manufacturers test and rate for skewed or yawed flow. In general skewed flow is hard to accurately transfer to field conditions because it often includes significant and hard to repeat turbulence as well as uneven velocity profiles across the duct. In spite of this inaccuracy skewed data is useful because it does indicates the general amount of error that may be present in the field.

Flow Coefficient K

Most differential pressure sensors are rated by a simple formula. V (velocity) = $K \sqrt{\Delta P}$ where the velocity is the velocity in the duct, the ΔP is the output of the sensor and K is a flow coefficient related to the design of the sensor. This formula is a large simplification of the basic flow formula $V = 1096 C_d C_v \phi \sqrt{\Delta P / \rho}$ These individual

coefficients consider density, approach and discharge conditions. While a single K factor is easier to use it does sacrifice accuracy. A simple K assumes a constant density, constant approach and discharge conditions. These and other factors will vary within a single installation. Nevertheless K factors are easily recognized, commonly used and applied in spite of their inherent errors --- 4005 for relating velocity pressure and velocity in a duct---, 1096 for a standard pitot tube. K factors for various intermediate sensor designs are specific to the individual design and normally lie somewhere between these two numbers.

Guidelines for field balancing terminal devices serving critical areas

The entire system should be initially set up as a constant volume system where the fan is locked at a certain speed so the entire system (and each terminal device) will have a constant volume and pressure. The analog signal from the building computer to each transducer/ damper should be fixed to set each damper flow rate to about the desired value. The entire system is now stable and is operating about where it should be.

The actual flow rate should be measured by a pitot tube (or equivalent) for each damper/air flow station, and the installation specific K factor (for the individual damper flow station) is established and applied to the general factory developed k factor. The general performance rating of the damper/air flow station is now established. The transmitter should then be re-spanned (at the computer) so the transmitter output is about mid range (50%) of the full span. With a mid span output the transmitter output should be very repetitive.

With the general calibration finished for each box the calibration should be repeated to fine tune the correction factor and the transmitter output. A simple spread sheet can be developed to compare the rough data with the fine tuned data and retained for future reference. With this thorough approach we have seen accuracies of +/- 3% in the field.

We do not recommend that a system be balanced in the VAV mode. The performances of the individual terminal devices are moving too much to develop any repeatable reference data.