

## **Why Test and Balance?**

**By Ron Prager**

Testing and balancing is the final step of commissioning an HVAC system after it is installed. What is testing and balancing? Why is it important? How does it impact the world of the retail facilities manager? These are questions you need to be able to answer and the questions that will be addressed herein.

When an Engineer designs an HVAC system, he follows a specific procedure. First he determines the indoor temperature and humidity levels that will be required to be maintained in the space. Based upon the geographic location, he then determines the outdoor design conditions that occur during the hottest 2% of all days and hours. The Engineer then determines the maximum number of people who will occupy the space simultaneously and the amount of lighting and appliance loads anticipated. From this information and ventilation code requirements, he is able to determine the quantity of outdoor air that must be brought into the space. The Engineer then uses all this information to determine the following:

1. Cooling capacity of the equipment.
2. Volume of air the unit will circulate.
3. Volume of air that will be brought in from outdoors.
4. Volume of air that will be returned from the space.
5. Volume of air that will be exhausted from the space.
6. Temperature and humidity level of air entering the unit.
7. Temperature and humidity level of air leaving the unit.

The Engineer then selects a unit that will meet or exceed the estimated requirements listed above. Next he lays out an air distribution pattern on a ceiling plan of the store. The system is laid out to deliver the capacity of the equipment to the space in the same ratio as heat is being produced in the space. For example, in a store that has a large quantity of south facing glass, the air distribution system needs to be designed to deliver more capacity to this southern exposure than to the northern exposure. Since the temperature and humidity level of the air supplied to all areas served by a particular unit is the same, the cooling or heating capacity delivered to an area is determined by the quantity of air delivered to that area. The engineer selects air outlets (diffusers and registers,) based upon the amount of air each must deliver. This is based on the amount of air he estimates will be required in each area or zone of the building. He sizes the ductwork to deliver the required quantity of air to each outlet.

He records the air quantities being delivered by each outlet as well as the required quantities of outdoor, return, and exhaust air on the mechanical plans. Once the installation of the system is complete, a professional can then test the system to determine what quantities of air are being delivered and balance the system to make certain that the air quantities specified by the Engineer at each outlet are actually being delivered.

The test and balance process (T&B) is simply the way one determines that the system is delivering the design air quantities at the required conditions to each air outlet. It also provides the means to see if the unit is handling the specified total quantities of air, and if the unit is operating according to the manufacturer's specifications. If the system uses condenser water or chilled water, the test and balance process also includes measuring the quantities of water passing through the unit and the temperature of the entering and exiting water.

The importance of a good independent test and balance of each HVAC system cannot be overemphasized. After all, this is the way we measure if the system is performing as designed and specified. The methods used to take the measurements required for test and balance work are complex and subjective and the need for a contractor unrelated to the installing contractor is obvious. The instrumentation used to take measurements is extremely sensitive and expensive and must be calibrated by a laboratory on a regular basis. Therefore, within the HVAC industry test and balance work has become a specialty performed by independent contractors who are usually members of one of two national organizations. These are, "The Associated Air Balance Council," and "The National Environmental Balancing Bureau." After the T&B work has been completed, the independent test and balance contractor issues a certified test and balance report. If the contractor was able to adjust and balance the system so that it met the Engineer's design, all measured air quantities will fall within +/- 10% of the specified air quantities.

If the test and balance contractor cannot get the system to deliver the required design air quantities it usually indicates a problem with either the installation or the design of the system. Often, a test and balance report will show a discrepancy between the measured and design air quantities that will lead to maintenance issues down the road.

- If the T&B report shows that the unit is moving too little air, the facility manager may inherit a unit that freezes up often for no apparent reason.
- If the quantity of outdoor air being introduced is too great, the equipment may never get the store down to the indoor design temperature or the humidity levels in the store may be too high.
- If too little air is exhausted, the front doors will blow open.
- If too little air is exhausted, the doors may be difficult to open and the humidity within the space may become too high.
- If there is insufficient air at the end of a duct run, a fitting room or a stock room may be too warm or too cold.
- If a blower motor is drawing more than it's rated current in order to deliver the specified air quantity, the life of the motor will be reduced significantly and it may cycle off intermittently.

The test and balance report is a report card of the systems performance. Due to its importance, I strongly recommend that the test and balance contractor be hired directly by the retailer rather than being hired by the general contractor or by the HVAC subcontractor. Without questioning the integrity of T&B contractors as a group, there is

always a tendency to overlook issues when the repair of those issues will be the responsibility of the man who is writing your pay check.

The test and balance report is also an important tool when one has issues with a mall based VAV system or a system that utilizes a central chilled water plant or building condenser water. A certified test and balance report can be used to determine if the issue is caused by the tenant's equipment or the landlord's system. These reports can also be used to determine if an issue is caused by poor design or by a poorly installed system. If the system is performing as specified by the engineer and the space is uncomfortable, the Engineer is at fault. If the system cannot perform as specified then either the equipment or the installation is at fault.

Knowing the importance of test and balance, the next step becomes learning how to read a T&B report. We will try to deal with that subject in a future article.