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Correct use of the fan curve

Because of the combination of spiraling construction costs, increasing costs of borrowed money, increasing energy costs, and the ever-widening gap between energy supply and demand, the need for more careful attention to the fine tuning of a building HVAC system is rapidly being recognized by both system designers and owners. The efforts at what has come to be called TBA, testing, balancing, and adjusting, are required in new systems at the time of start-up, because the systems currently being designed are less forgiving of maladjustment than those designed in the past, and in existing systems as the first and fundamental step in the retrofit process, whether that process be for the purpose of upgrading (modernizing) an existing system or for instigating an energy management program.

Determine air flow quantities

This chapter addresses only one small part of the system testing problem, but a vitally important part: determining air flow quantities. Much has been published and discussed in open forum on this topic. However, there still appears to be a fundamental misunderstanding on the part of many practitioners. In the vast majority of installations, *the measurement of the pressure rise across the fan, used in conjunction with the published fan curve, cannot be utilized to determine system air quantities.*

The problem is fundamentally that the configuration of the installation differs from that in which the fan was tested and the resulting curve developed. Even with the efforts made in recent years to address the impact upon installation configurations vis-a-vis test configurations, such as system-effect factors, *the fan pressure rise is a totally unreliable metering device.*

Likewise, pressure differential readings across other system restrictions provide, at best, a rough approximation of system flow rate. The reason is similar to that regarding the fan curve: Pressure differentials for such devices as filters and coils are determined by laboratory testing under ideal conditions, wherein the velocity profile across the face of the device is totally uniform. However, in the vast majority of installations, this uniformity is not achieved. Changes in direction, separations, fan inlet or outlet flow patterns are all contributors to the nonuniform velocity profiles.

The only method that provides a reasonable degree of accuracy, then, in determining flow rate in the air delivery system is measuring the velocity or flow rate in the system ductwork at points at which adequate velocity is available for velocity pressure measurements and at which a reasonably flat velocity profile exists. The less consistent the velocity profile, the more points must be measured in the traverse, and the lower the accuracy. It has been said that the majority of air-distribution systems designed to date are actually not balanceable within a reasonable degree of accuracy. If this statement is accepted, the responsibility must be borne by the system designers! In turn, their reason for designing essentially unbalanceable systems has been a lack of understanding of the methods and techniques required for achieving the fine-tuning adjustments.

Correct duct design important

With the foregoing concepts in mind, a fundamental step in the design of any air-distribution system should be to design air metering sections into the air conduit or ducting system. These can vary from flow nozzles to built-in

traverse devices to simple sections of straight ductwork of adequate velocity (1500 to 2000 fpm) with gradual inlet and outlet sections. This approach to designing air flow test sections into the system can usually be achieved at no increase in construction cost. It will then provide the ready capability of balancing and adjusting, and reduce man-hours required to accomplish fine tuning.

To summarize, the primary considerations in designing a balanceable air system are:

- Installation of the fan or fan unit in such a way as to achieve the least possible pressure loss resulting from the fan match to delivery system (system effect).
- Routing and sizing sections in each main and branch so that highly accurate flow measurements can be made, preferably by Pitot tube traverse.
- Providing dampers for regulating the flow in each main and branch. The dampers

should be mounted in the ductwork. Dependence upon dampers in the terminal devices (grilles or diffusers) is not recommended.

- Attention to the design of the return air or outdoor air intake systems. They are as important as the supply systems.

Once the designer has provided in the system the capability of determining the volumetric flow rate at a point or at points that can be summarized, the published fan curve becomes an immediately useful tool. The initial premise was that the fan could *not* be used for determining the flow rate from a field measurement of the pressure rise. However, once the flow rate is determined, the published curve can be referred to directly to determine the *actual* operating point, in identifying both total pressure and horsepower. This is the subtle but all-important issue in comprehending the significance of curves published for the use of the systems adjustment technician.