TAB Journal

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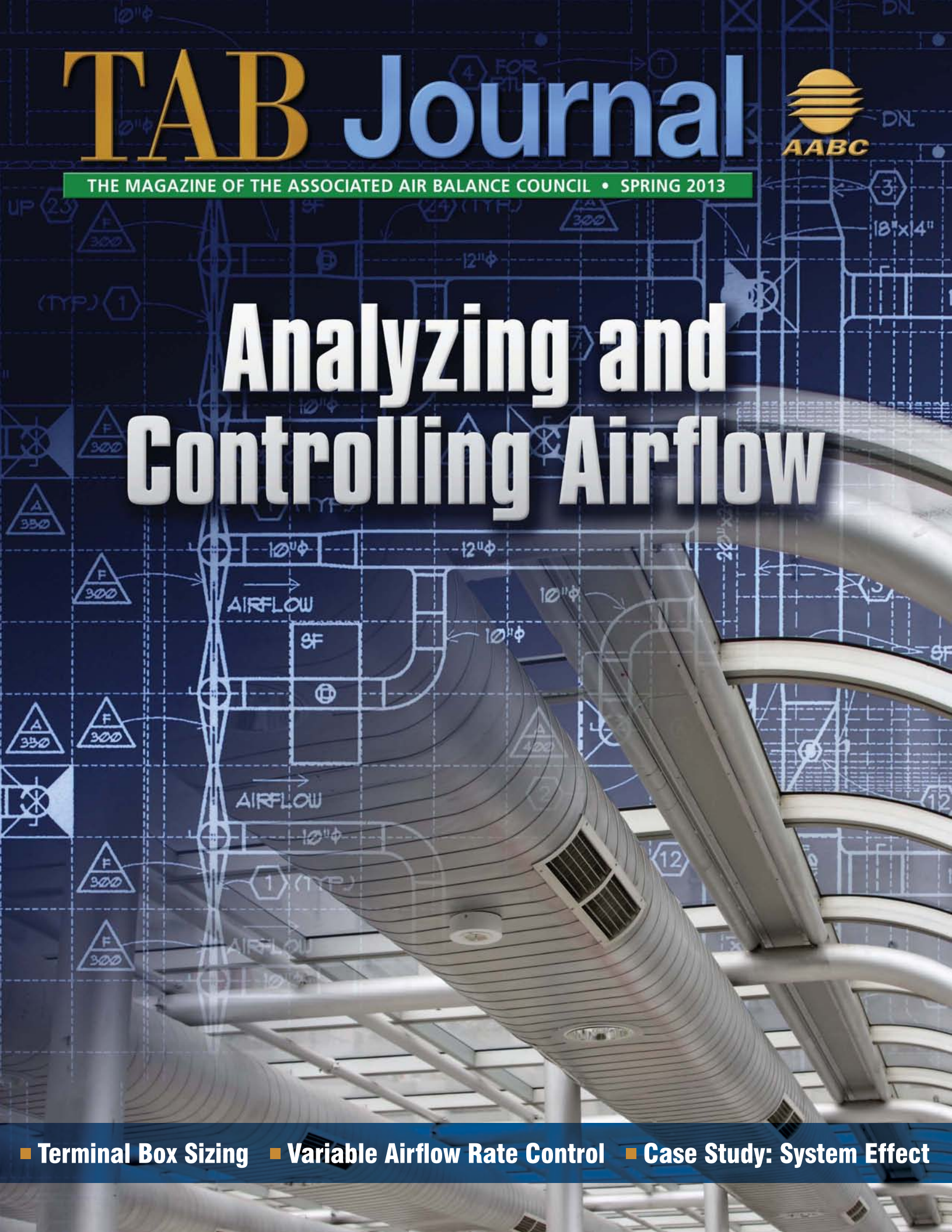
Analyzing and Controlling Airflow



- Terminal Box Sizing
- Variable Airflow Rate Control
- Case Study: System Effect

"Hospitals are especially sensitive to duct leakage because of large airflow rates, room pressurization requirements, and ceiling spaces not normally utilized as return air plenums."

The Importance of Duct Leakage Testing in Hospitals

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The necessity of duct leakage testing is a constant topic of debate, as perspectives on permissible levels of leakage vary. From a test and balance perspective, the hope is that all duct systems are tested for potential leaks. Laboratories and hospitals are especially sensitive to duct leakage because of large airflow rates, room pressurization requirements, and ceiling spaces that are not normally utilized as return air plenums.

Hospital specifications usually state that a medium pressure supply air duct will be tested for leaks. An AABC or SMACNA test standard may not be specified, but there may be at least a short paragraph defining some of the testing parameters. While the specifications might imply that all duct systems will be tested, they are most likely referring only to medium pressure ducts since testing of all duct systems is not typical. The installing contractor has probably not included the cost of sealing all duct systems to AABC or SMACNA leakage standards, which would include the cost of hundreds of duct leakage tests, corrective sealing, and retests.

As important as it is for a medium pressure supply air duct to be reasonably free of leaks, it is absolutely essential that exhaust air systems be as leak-free as possible. If value engineering must cut costs, the low pressure supply air duct downstream of the zone volume control unit could be sealed, as could return air duct run-outs, and neither would need to be leak tested. However, the return air mains and all duct work in a shaft or chase should be independently tested and certified.

Some justifications for "airtight" exhaust duct systems include the following:

- Energy: Unlike supply and return air leakage, which remains within the building envelope, all exhaust air leakage is wasted to the outside, so additional make up air is required to compensate, and it needs to be conditioned if outside air is not at a favorable temperature. The increased motor energy needed for the exhaust fans to transfer the wasted air is continuous for the life of the building.
- The exhaust fans are usually limited in additional capacity.
- The duct may be extensive in distribution and have a long route to the roof, resulting in a high ratio of duct material and joints to airflow rate.
- A duct run-out may extend 40 feet to pick up 50 CFM from a janitor's closet or a remote restroom. Any leakage will bite into that 50 CFM requirement very quickly, making even 45 CFM unobtainable.
- Exhaust systems serve nuclear medicine rooms, patient isolation rooms, and small inlets such as patient room toilets. Many of those rooms are annually re-certified for room air change rates and negative pressurization, all based on adequate exhaust airflow.
- Much of the duct will be over hard-lid ceilings and not accessible for re-sealing at the time of TAB, especially during occupancy.
- The design engineering firm, hospital owner, or state health department might refuse to accept a TAB report showing deficient exhaust airflow rates.

The end result of not testing duct systems could be exhaust fans operating at maximum capability, providing 120% of the design intent, with exhaust inlet terminals proportionately balanced at 80% of the design intent. This is all too common in hospitals.

HVAC air conveyance systems are generally not meant to be absolutely air tight, unlike water pipes. However, sealed ductwork will not be sealed tight enough unless it is leak tested, the leaks are found and re-sealed, and then re-tested.

A long horizontal duct run serving patient room toilets is normally tested before the individual drops to the exhaust registers are installed. The contractor should seal all drops down to and including the register can (from the inside if a hard-lid ceiling is in place) before final trim installation. The TAB agency should confirm that this has been done. It does not require significant effort to compare a summary of capture hood readings with a traverse of the branch duct in order to verify that the drops have been sealed appropriately.

Let's consider a worse, but common case of high ratio of duct material and joints to airflow rate. If a six-inch by four-inch duct extends 40 feet to pick up 50 CFM, the AABC recommendation of 1% maximum rate will allow only 0.5 CFM leakage or 1.0 CFM at 2% maximum. This is not easily obtained, except if a six-inch diameter sheet metal pipe is used.

The SMACNA leakage standard in this example is at the other extreme: a 40-foot long, six-inch by four-inch Class 2 (inches WC) duct is 66.7 square feet of material, which results in 25 CFM allowable leakage for Seal Class C, which will kill our 50 CFM at the inlet.

If a six-inch diameter pipe is installed, the SMACNA allowance is 11.8 CFM, which is better but still registers almost 24% of the desired airflow at the inlet. Actual field leak tests will be on larger duct sections where the ratio of duct material relative to the airflow rate decreases, making the SMACNA allowance more acceptable. This example illustrates how small leakage rates will have adverse affects on exhaust air systems and why it is difficult to obtain the elusive 50 CFM requirement on that remote exhaust inlet.

Success was recorded in balancing hospital exhaust systems when all exhaust ductwork was tested according to the SMACNA standard. The preference is a flat 2% leakage maximum based on total scheduled airflow of the fan, across the entire exhaust duct system at 2" WC test pressure. Admittedly, this is difficult and expensive to achieve with rectangular/flanged ductwork. Whichever standard the specifying engineer prefers, the expectation is that all exhaust ductwork be tested independently.

During the initial project meeting, the TAB agency should insist at a minimum that all exhaust ductwork have certified leakage tests along with medium pressure supply air duct and duct concealed in chases. It is better to make duct leakage a priority at the very beginning of the project, not during actual TAB when the owner is anxious to move into a new hospital and there is a financial penalty if the facility is not opened on the scheduled date.

A commissioning agent might not address this issue up front. The contractor might obtain a change order if the specification is not clear. The contractor should not have to provide something for free, and perhaps none of the other bidding mechanical contractors included extended duct testing.

Clearly, there is a need for certified independent duct leakage testing of hospital exhaust systems. The extensive ducted distribution system, which conveys a relatively small total airflow rate to the fan, is especially susceptible to adverse affects of duct leakage. The fan might be capable of compensating for leakage, but it will lead to additional energy costs for the motor load and increased volume of conditioned make up air every day for the life of the system. Any other fix will be costly in additional construction or duct sealing within a finished building and have a high risk of delayed occupancy.

"The extensive ducted distribution system ... is especially susceptible to adverse affects of duct leakage."