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VAV systems and return air balancing

The ability to balance return inlets requires some thought and evaluation.

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When designing a variable air volume (VAV) system, engineers will specify return airflow volumes at the return air inlets. When these return air volumes are associated with variable supply air volumes for a given area, the ability to balance these return inlets requires some thought and evaluation.

The return inlet airflow values shown in Figure 1 are airflows required when the VAV boxes are at maximum cooling and the return fan is operating at maximum design airflow.

The return system is typically balanced when the system (supply VAVs) is set to maximum cooling airflow. This should drive the return fan to its required maximum system airflow. The return air system is then proportionally balanced to obtain the design airflows at each inlet.

The return air system is a pressure dependent system and the main factor affecting the airflow to the individual return inlets is the return fan speed and the amount of airflow and pressure present in the duct system.

The return air system is designed and the ductwork is sized for "maximum" system airflow and the ability of the system to obtain design return airflow at all of the return inlets. The return airflow in the duct and at the inlets changes once the return fan speed is reduced from "maximum" airflow. The return fan speed is typically controlled by tracking the supply fan by an offset speed or airflow value; maintaining a plenum pressure; or maintaining a building pressure. It should be noted that none of these control scenarios are associated with maintaining the design return airflow at the individual return air inlets.

MYTH 1: Return airflow at the inlets changes exactly proportional with respect to a change in return fan speed.

The airflow at the individual inlets will not remain proportionally balanced exactly as the speed of the fan is decreased. If the return fan speed is reduced 25%, the return airflow at each individual inlet is not proportionally reduced exactly 25%. Originally the ductwork was sized for "maximum" airflow and now that the total system airflow has been reduced, it is "oversized" for the reduced airflow. At the reduced fan speed the following properties in the ductwork are reduced: air velocity, friction loss, velocity pressure, and static pressure. It should be noted that the amount of "imbalance" will increase as the return fan speed is further decreased and it is possible that little or no airflow can be measured at a return inlet located a good distance from the return fan.

MYTH 2: The return inlet airflow changes as the associated supply VAV changes in airflow.

The amount of conditioned air supplied by a VAV box into a room will vary from maximum to minimum based on a thermostat setting change, change in occupancy, solar load, equipment operating conditions, etc. The amount of air returned from the room varies gradually as the building load changes

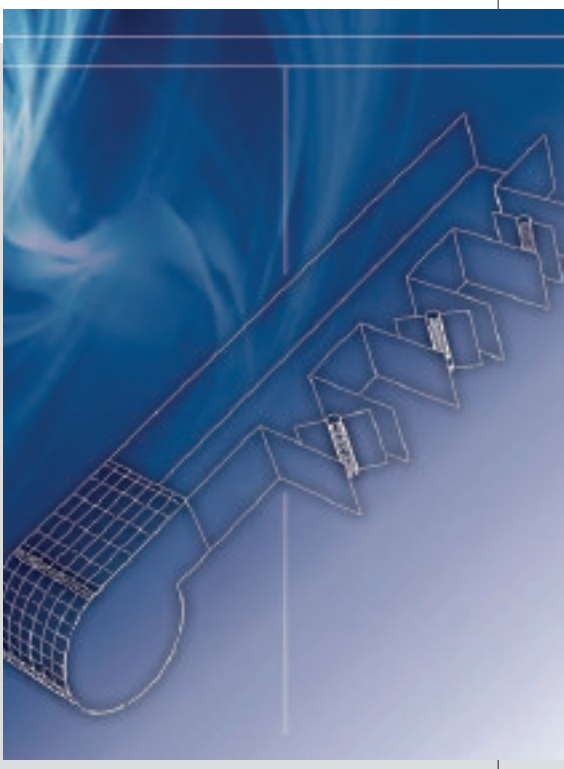

Figure 1: The return inlet airflow values are airflows required when the VAV boxes are at maximum cooling and the return fan is operating at maximum design airflow. Courtesy: Systems Management & Balancing

Once the air handling system is put into operation under DDC, the return airflows originally reported cannot be repeated.

and the return fan speed changes. Therefore, once the system is operating under control, the supply air to return air ratio for given areas is subject to constant change. The supply airflow and return airflow systems are not a closed coupled system.

Once the air handling system is put into operation under direct digital control (DDC), the return airflows originally reported cannot be repeated. In order to repeat airflow measurements at the return inlets, the system must be indexed to the mode that it was operating in during balancing. This operating mode is typically with all supply VAVs indexed to maximum cooling and the return fan at maximum airflow.

If return airflow balancing is required for the VAV system, then an evaluation using these three parameters should be performed on the requirements and approach to performing the air balancing:

1. Is individual airflow at each return inlet critical? Will system or building performance be affected if the airflow at these inlets is not obtained?

2. Can the return airflow be proportioned by area or floor (in lieu of individual inlets) and satisfy the system/ building requirements? Are balancing dampers located in the key areas to allow this to happen?

3. If return airflow balancing is critical for the system/building operation, then the system should be made pressure independent and the use of VAV boxes on the return air system should be employed. |cse|

Table 1: Air properties

Duct size	36 x 24 in.	36 x 24 in.	36 x 24 in.
Air volume	7500 cfm	5000 cfm	2500 cfm
Air velocity	1250 fpm	833 fpm	417 fpm
Duct friction loss	0.07 in. / 100 ft	0.035 in. / 100 ft	0.01 in. / 100 ft
Static pressure	1.5 in.	0.67 in.	0.17 in.
Velocity pressure	0.097 in.	0.043 in.	0.011 in.

Table 1 displays the anticipated properties of air in a section of ductwork for a return air system at reduced fan speeds. Courtesy: Systems Management & Balancing

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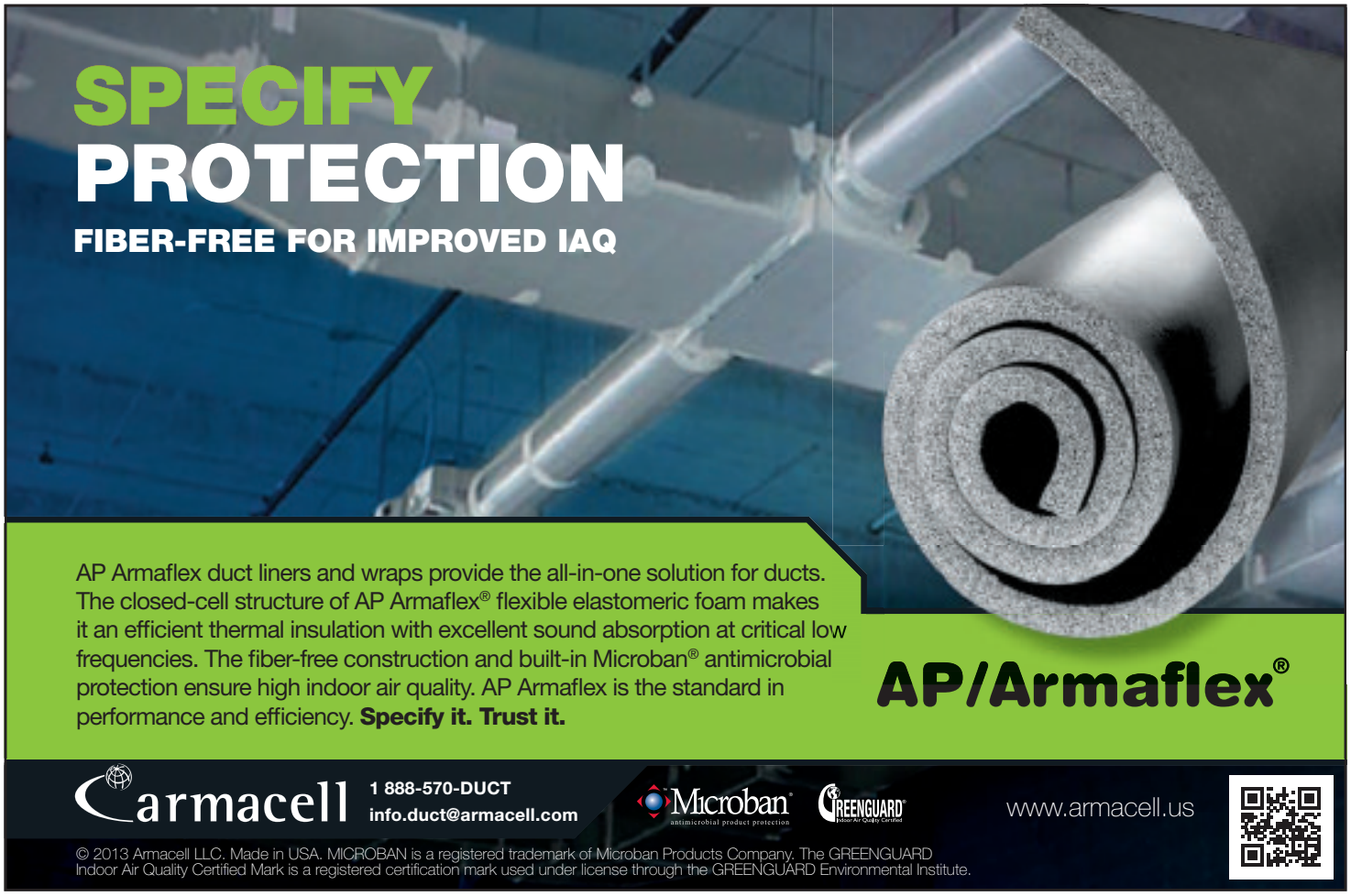

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