CONTINUOUS DUCT APPLICATIONS

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OVERVIEW

With the introduction of the DMG (Duct Mounted Grille) and the new DMD (Duct Mounted Drum Louver) questions are arising regarding optimal applications of a series of grilles, registers or diffusers located along a length of duct. The ASHRAE handbook does not really give advice in this application, nor does any manufacturer's 'engineering section'. In fact, the SMACNA design guide appears to argue against what follows. There is proven experience, however, which can assist in the design.

In the 70's, Owens Corning offered an undampered continuous diffuser which was a part of the ceiling grid, and which was designed to utilize a 5-sided ductboard plenum, and was used in very long runs. One successful project had continuous diffusers over 200 feet in length, end fed. In developing this product, many tests were conducted to determine optimum installation parameters. The successful design requires that with a constant diameter duct, as velocity pressure decreases, as air is lost through grilles/diffusers, the static pressure drop due to duct friction will decrease as well, and actual static will increase slightly. In a good design, static pressure will be minimum at a point 2/3 of the way along the duct.

In many ways, this diffuser / duct application is no different than a series of grilles located along a length of spiral duct, and the lessons learned can be applied equally well. Several rules were learned in the quest to achieve constant delivery along the entire duct run:

- The larger the supply duct, the better. Minimum diameter was found to be a function of desired length, not flow rate (although the fixed 2-slot diffuser limited flow rate as well). Duct velocities should never exceed 1000 fpm.
- A constant duct diameter was required, to achieve the required static regain. Stepping the duct to maintain duct velocity was not only counter-productive, but also resulted in less than optimal supply distribution.
- Required inlet pressures are very low. In most cases, less than 0.2 in. Ps is required (when properly ducted). The major source of noise was found to be the pressure reducing/balancing dampers required at the supply inlet to the large duct.
- Friction in the supply duct was beneficial. The fiberglass duct board's rough surface allowed smaller duct diameters than a smooth sheet metal duct.
- The air had to be turned to get supply perpendicular to the duct run. If not turned properly, air tended to pile up in the room at the end opposite the supply inlet.
- As there is some temperature rise on long runs due to thermal losses through the duct, it may be beneficial to size the duct slightly smaller than optimal, which will result in more airflow at the far end than at the supply, which will allow a continuous btuh/ft, rather than cfm /ft supply flow.

For duct mounted spiral duct / grille applications this has several implications. When properly sized (ie: large enough) the DMG's scoop damper will not really be needed. As a result of static regain, undampered airflow will be essentially constant, but discharge throw will be at a slight angle. The vertical blades in the grille can be adjusted after installation to account for this, but there will be some increase in noise level from this adjustment. We have estimated this increase to be no more than 5NC, and for there to be a slight (10%) increase in total pressure. (As the duct velocities should be low, velocity pressure will be low, and most of the increase will be in terms of static pressure). If duct velocities are higher, or duct pressures vary (often the result of stepping down the duct size) some dampering will be required, further increasing the sound produced. The DMG catalog data therefore is based on 880-grille data +5 NC and 10% total pressure, and will be a conservative estimate for most applications.

Many applications of a spiral duct mounted grille will be near the ceiling. If within 1 diameter, the discharge air pattern will likely attach itself to that surface, and the grille will exhibit a characteristic grille throw pattern (which is shown in the DMG performance data). When the duct is further that 1 duct diameter from an adjacent surface, the grille will have a 'free jet' pattern. Testing shows that this will result in a 30% decrease in throw.

When duct mounted linear diffusers are used in a length of continuous duct, similar rules apply. Ducts should not be stepped down, and if sufficiently large, air discharged will be at a relatively continuous rate. There will be some sideways deflection in the direction of airflow, except at the end of the run.

In conclusion, maintaining a constant diameter (as large as practical) will result in the optimum application of grilles and diffusers along the run. This would appear to not agree with SAMCNA design guidelines, which argues for maintaining a constant duct velocity. This approach is valid for master / sub duct applications, but not optimal for a series of outlets along a duct.

Slight increases in grille sound levels will result from optimizing discharge angles. The data provided for the DMG grille will probably be conservative, if the duct is large enough, and doesn't step down. (In many cases, the cost of the step-down transition is more than the cost of 20 feet of straight duct. Typically, a constant diameter run of spiral is the same cost as one that is stepped.)

For duct-mounted linear diffusers again a constant diameter duct is an optimal design. There will be some directionality to the jets that cannot be avoided. (Effective turning vanes have been engineered in the past, but never employed because of cost). When properly sized, scoops and balancing dampers are not required.