



## Ceiling Displacement Diffusers

---

**Dan Int-Hout**  
**Chief Engineer**  
**12/20/2010**

## OVERVIEW

The Patented Krueger TAD (Total Air Diffuser) was offered to the market in 1985. At the time it offered a radical solution to the problem of supplying air at relatively high quantities with minimal induction, a characteristic desired for many specialized applications, most importantly where fume hoods are present. Many tests were conducted to confirm the claims that the diffuser minimized entrained contaminants, provided minimal disturbance at the face of a fume hood, and worked well in many situations requiring a ceiling supply, displacement-type air delivery system. Ceiling displacement air delivery systems are typically utilized when room processes need to keep airborne contaminants to as low a level as possible. While laminar flow systems are used in clean rooms, they require very high airflows, and are often uncomfortable. Ceiling displacement systems can be operated at much lower airflow levels and at higher comfort levels.

The only complaint of the TAD was of the projection of the diffuser into the room at the ceiling. This came primarily from architects, but is necessary for the high degree of control offered by this configuration. Attempts have been made to develop a flush face diffuser both by Krueger and others in the diffuser industry. While several manufacturers have made many different approaches, all exhibit some limitations.

The most serious potential application problem is a high sensitivity to inlet conditions. While the TAD employs a deep back pan and internal baffles to minimize this effect, the currently available competitive flush face designs are much more sensitive to inlet conditions. With tight ceiling plenum spaces, this can be a serious limitation.

Secondly, the radial face of the TAD allows a true radial pattern. This is required if entrainment (and subsequent draft and temperature variation) is to be minimized. In the past, all available flush or semi-flush faced types have a multi-jet, rather than a radial displacement pattern. This results in induction, potential contaminant injection, and uneven room air velocities and temperatures. Flush face designs therefore all provided a compromise. After 8 months of development Krueger has finally developed a design of a non-intrusive radial flow ceiling displacement diffuser that overcomes these limitations, the RadiaFlo Critical Environment Diffuser.

All radial flow diffusers have operational limitations (as do all diffusers). Radial flow diffusers are limited in terms of room-diffuser delta-t and max/min flow rates. The TAD, with the curved blades and round shape has the broadest range of performance in terms of both flow and delta-t, and its ability to maintain a radial flow pattern over a range of flows. Flush face designs are often more limited due to the compromises made in attempting to achieve radial flow from a flat surface.

The interaction of supply and induced airflows at the surface of a perforated metal face is very complex. A jet of air issuing from a hole in a flat surface tends to entrain air from the surrounding space. Once the jet becomes even slightly less than perpendicular to the surface, it tends to follow the surface, due to an effect often called the Coanda effect. This is due to the fact that any jet has negative static pressure. When near a surface, it therefore tends to adhere to that surface. The TAD maintains many jets, all perpendicular to the curved surface. A flush face diffuser will attempt to provide horizontal airflow at the edges, and vertical airflow in the center, and is by the nature of the physics involved, an unstable flow pattern. This results in an increased sensitivity to delta-t (and the effect of negative buoyancy) and flow. The new RadiaFlo diffuser has a complex, convex (non-intrusive) shape that is able to maintain a true radial pattern without the diffuser projecting into the room,

Why is radial flow / ceiling displacement important? Again, the objective is to minimize induction. When there is induction, the jet entrains particulate contaminants from surrounding areas, and changes in temperature. A true radial pattern will have nearly constant temperatures and will not contain any entrained particles from the surrounding spaces. When the air pattern has several 'lobes', the air varies in

---

### Krueger Corporate Headquarters

1401 N. Plano Rd. • Richardson, TX 75081

Phone: (972) 680-9136 | Fax: (972) 497-0450 | E-Mail: [kruegerinfo@krueger-hvac.com](mailto:kruegerinfo@krueger-hvac.com)

[www.krueger-hvac.com](http://www.krueger-hvac.com)

temperature and entrained contaminants. With a VAV fume hood application, as the airflow varies, this pattern changes. This results in varying space temperatures and localized velocities, often resulting in unstable hood face velocity control.

#### **SUMMARY**

In short, the proven Total Air Diffuser, and its new cousin, the RadiaFlo, offer the least compromise, most stable air delivery, proven, and lowest entrained contaminants of any design of radial flow diffusers, assuring optimal performance of laboratories with VAV hoods and other critical environments, and minimum contamination of the areas served by the diffuser. It allows great installation flexibility by being the least sensitive design to inlet conditions, and has the broadest operating range in terms of VAV airflow and varying supply-room temperature differences, of all the choices for radial flow ceiling displacement air delivery systems.

With either diffuser, non-inductive air can be provided at high flow rates into a critical environment, assuring occupant safety and minimal contamination of operations taking place in that environment.

---

#### **Krueger Corporate Headquarters**

1401 N. Plano Rd. • Richardson, TX 75081

Phone: (972) 680-9136 | Fax: (972) 497-0450 | E-Mail: [kruegerinfo@krueger-hvac.com](mailto:kruegerinfo@krueger-hvac.com)

[www.krueger-hvac.com](http://www.krueger-hvac.com)