Better Ceiling Containment Yields Best Efficiency

Airflow Management and Containment

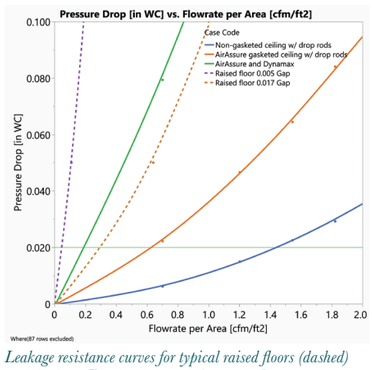
In a typical air-cooled data center, airflow management is about delivering cool air to the IT equipment and returning warm air to the computer room air handler (CRAH). Cooling is most efficient when hot and cold airstreams are separated to prevent mixing, thereby improving predictability and control. Recognized in modern design, the containment of hot and cold air is one of the most promising energy-efficiency measures available to both new and legacy data centers.

Hot Aisle Containment (HAC) is a popular strategy where cold air is supplied to the room and passed through the IT equipment before returning to the CRAH. Ideally, the air supplied by the CRAH is in balance with the air demanded by the IT equipment so that conditioned air passes once through the racks. In the real world, some amount of air bypasses the IT equipment or recirculates through due to leakage in containment structures. The result is elevated fan power and reduced chiller efficiency.

Containment Aisles, Raised Floors… Do Not Forget the Ceilings

Much attention is given to reduce leakage in containment aisles and raised floors. These components are known sources of fugitive leaks and distributed leaks that contribute to bypass losses. Raised floors form a supply plenum and help to direct airflow to the IT equipment.

The discipline given to sealing raised floors and racks should also be applied to ceilings. Ceilings form a return air plenum and, more importantly, separate the warm return air from the conditioned room. Gaps around the tiles and drop rod penetrations allow conditioned air to bypass the IT equipment. The bypassed air must be made up by increasing cool air supply from the CRAH, thereby consuming more energy.

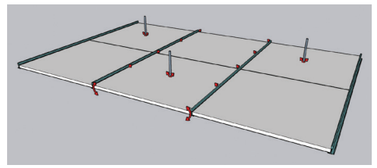


Leakage resistance curves for typical raised floors (dashed) and AirAssure™ ceiling tile with DynaMax® suspension grid (solid green).

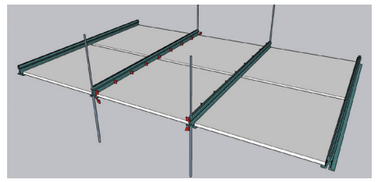
Typical ceiling systems have leakage rates far larger than raised floor systems. At a differential pressure of 0.02 in WC, a raised floor system may leak about 0.05 to 0.30 cfm/SF. A non-gasketed ceiling with typical drop rod penetrations will leak about 1.44 cfm/SF. When AirAssure™ ceiling tile is combined with DynaMax® structural grid, leakage reduces to about 0.19 cfm/SF and becomes comparable to raised floor and containment wall systems.

AirAssure Tile + DynaMax Grid: The Best Solution

AirAssure Ceiling Tiles with DynaMax structural grid is an engineered solution designed for data centers. AirAssure tiles feature a factory-applied gasket that reduces ceiling leakage at the tile edges. DynaMax structural grid eliminates drop rod ceiling penetrations. Paired together, the system reduces bypass leakage down to levels of the best raised floor systems. The Armstrong ceiling solution delivers accessibility and containment that improves cooling efficiency and saves fan energy.



Typical non-gasketed tile with tee-bar grid and drop rod penetrations. Leakage rate may be 1.44 cfm/SF at 0.02 in WC.

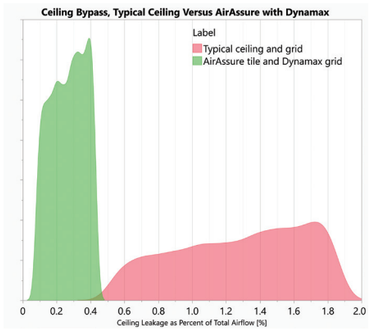


AirAssure gasketed tile with DynaMax grid reduces leakage at the tile perimeter and eliminates leakage around drop rods. Leakage rate may be 0.19 cfm/SF at 0.02 in WC.

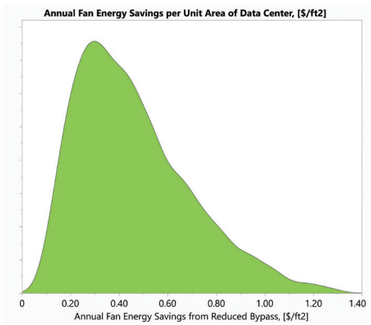
Controlling Costs Means Controlling Leakage

To illustrate the impact of ceiling leakage and its effect on operating energy, one-dimensional calculations were made for a 25,600 SF data hall. This used on-slab, hot aisle containment and included an IT cooling load of 13.2 MW. Supply air temperature was fixed at 65 F and hot aisle temperature was fixed at 82 F.

System static pressure across the fan was varied from 1 to 4 in WC. The pressure difference across the ceiling plane was varied from 0.01 to 0.08 in WC. The cost of electricity was varied from 0.08 to 0.17 $/kWh.



Typical high leakage suspended ceilings may have bypass leakage rates of 0.4 to 2.0% for total HVAC system flow (right distribution). Low leakage AirAssure with DynaMax ceilings reduce that bypass leakage to below 0.5% of total HVAC system flow (left distribution).



Depending on operating conditions and local electricity costs, fan energy savings can range from 0.42 $/SF (median) to 1.30 $/SF (maximum) in this 25,600 SF example.

Heat balance and airflow calculations were solved to satisfy the governing equations for 4000 random combinations of parameters. The resulting charts clearly show the effects of changing from a typical (high leakage) ceiling to the (low leakage) AirAssure with DynaMax system.

Summary

Ceiling and grid systems form return air plenums in data centers and separate cold supply air from warm return air. Leaks across this containment plane contribute to bypass losses, increased fan energy, and increased operating cost. The use of AirAssure gasketed ceiling tiles with DynaMax structural grid reduces leakage rates equal to the best sealed raised floor systems.

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