Data Center Ventilation Design

Improving Performance and Reducing Energy Use

Data centers have ever-increasing cooling requirements with current trends in intensification of cooling loads from 100 W/ft² to over 500 W/ft². Coupled with this is also a demand for larger data centers, with greater energy efficiency in mission critical roles.

RWDI offers specialty consulting, measurement and modeling services to help achieve suitable air distribution, temperatures and energy performance. This can include full data center modeling as well as detailed analysis of air distribution components. Our experience in data centers is enhanced by our work in other ventilation environments with special requirements. Operating rooms, clean rooms and patient isolation rooms all have unique airflow requirements to support their technical function. These spaces too need well-distributed air supply, and can have large local heat loads. RWDI can assist at the concept, schematic and detailed design phase. We can also assist with post-occupancy verification.

Guidance and Calculations (Conceptual Support)

- Air supply arrangements to avoid problems of poor flow distribution and adverse pressure effects for air shafts and ducted supply systems
- Underfloor plenum characteristics – avoid dead spots
- Concepts of hot aisle or cold aisle containment
- Return-air plenum design - more uniform draw at ceiling
- Novel ideas to save capital and operating costs
- Avoidance of wind pressure effects on the building causing pressure problems inside
- Location of sensors for control of outdoor air
- Mitigation of noise and vibration
- Mitigation of re-entrainment of pollutants
- Reduce contamination of intake air with hot exhaust

CFD Computer Modeling (Proof of Concepts)

- Steady-state flow and heat transfer modeling – RANS methods
- Unsteady flow and heat transfer modeling – LES (Large Eddy Simulation) methods

On-site Measurements

- Verify performance of installed systems
- Guide commissioning and balancing
- Identify source of problems of air distribution, pressures and temperatures in existing facilities

SAMPLE PROJECT LISTING

- Data Center, Laird Drive, Toronto, ON - Regulatory Air Quality Studies
- Laika Data Center, Portland, OR - Ventilation Studies
- Royal Bank Data Center, Guelph, ON - Noise and Air Quality Studies
- Taxation Data Center, Toronto, ON - Snow Studies
- EMC Data Center, Durham, NC - Lab Ventilation Performance
- British Petroleum Data Center, Houston, TX - Design review of underfloor plenum
Laika Data Center
Portland, OR, USA

The data center houses render racks, storage racks and miscellaneous racks. The proposed ventilation system consisted of Computer Room Air Conditioners (CRAC’s) located along the perimeter of the Data Centre which supply cool air into a raised floor plenum. Supplemental cooling was provided by overhead units.

RWDI helped with the design of the underfloor plenum using CFD computer modeling. Predictions of room-air temperature distributions in the data center were assessed for normal operating conditions and also during hypothetical ventilation equipment failures.

EMC Data Center
Durham, NC, USA

RWDI provided consulting advice and CFD modeling to evaluate the ventilation performance within the large Lab/ Data Centre spaces. The work included a study of the airflow distribution from roof-top Air Handling Units into supply air shafts. Turning vanes and perforated plates were used to redistribute the flow uniformly into the underfloor plenum. The air speed and static pressure distributions were determined in the plenum to highlight areas requiring improvement. The supply flow rates through perforated floor tiles was evaluated for initial and future load cases. Air speed and temperature distributions were predicted in the Lab/ Data Centre rooms with an open cold aisle and hot aisle configuration. A preliminary feasibility assessment of the benefits of hot-aisle containment was conducted.
British Petroleum (BP) Data Center
Houston, TX, USA

The substantial cooling loads for this proposed data center provided a significant challenge to the design team. The underfloor supply air plenum had perimeter CRAC units supply in excess of 600,000 cfm of air. Hot aisle containment strategies were used with a draw through a ceiling return plenum.

RWDI’s work first assisted in the design of the underfloor plenum to promote even distribution of supply air, accounting for obstructions in the plenum and low-pressure drop porous tiles. Then the CFD modeling quantified the performance of partial and full containment strategies and impacts of hot air leakage into the room.

Data Center Generator Room Study
Southeast USA

RWDI conducted CFD modeling to quantify the increased temperature at the generator room supply intake, due to contamination from the cooling fan exhaust. Radiator cooling exhaust plumes can bend over at relatively low wind speeds. These conditions present a risk for hot air re-entrainment into the intake louvers, and thus increased inlet temperatures especially during the summer season. Placement of Intake louvers and radiator cooling exhausts is critical to minimize the re-entrainment potential.

Additional modeling was conducted to quantify the temperature profile within a typical generator room. This information was used by the design team to determine potential risk for overheating.