Heating exclusively through the ceiling
Heating exclusively through the ceiling

Why use high induction diffusers to heat through the ceilings?

**Induction diffuser**
- Good mixing of the air
- Room air circulation cycle complete
- No stagnant air zone present in the room
- Possibility of reducing the input of fresh air

**Standard diffuser**
- Bad mixing and stratification
- Room air circulation cycle incomplete
- Stagnant air zone present in the room
- Increase of input of fresh air
Why use high induction diffusers to heat through the ceilings?

DAL 358

DAL 359

SAL
In order to heat through the ceiling, you need to respect certain conditions

**2 cases**

- Room with ceiling height of 14 ft. or less
- Room with ceiling height of 14 ft. or more
Heating exclusively through the ceiling

Conditions for heating a room with ceiling heights of 14ft and less

1. **Proper zoning of ventilation units**
Heating exclusively through the ceiling

Proper zoning of ventilation units

Limit central zone /peripheral zone

10 feet
Heating exclusively through the ceiling

Proper zoning of ventilation units

**NOTE:** Energy savings: In unoccupied mode (night) the central unit can be turned off, the peripheral unit will assure maintenance of the temperature and supply of fresh air.

The diffusers in the peripheral zone are connected to the peripheral zone unit.

The diffusers in the central zone are connected to the central zone unit.
Heating exclusively through the ceiling

Proper zoning of ventilation units

The diffusers in the central zone are supplied with tempered or slightly cooled air

The diffusers in the peripheral zone are supplied with hot air

→ Energy Savings
The supply temperature is adapted to each zone ex: It is not necessary to cool the air from the central zone which has been heated in the peripheral zone
Heating exclusively through the ceiling

Conditions for heating a room with ceiling heights of 14ft and less

1. Proper zoning of ventilation units

2. Have a temperature differential of no more than $\Delta+15$ °C at output
Heating exclusively through the ceiling

Supply temperature of diffusers

Maximum temperature differential of Δ+15 °C

Sample with a ceiling at 9 ft

Local = 22°C
Heating exclusively through the ceiling

Supply temperature of diffusers

Simulation DAL 358 DN 600

Temperature difference = + 30 °C

Temperature difference = + 10 °C

→ Maximum supply temperature of 37 °C (98 F) (Difference of 15 °C)

Ex : Set up to avoid : natural gas unit with temperatures + to 55 °C
Heating exclusively through the ceiling

Conditions for heating a room with ceiling heights of 14ft and less

1. Proper zoning of ventilation units
2. Have a temperature differential of no more than $\Delta +15$ °C at supply
3. Ensure VAV boxes are open 100% in heating and size the room using heating parameters for the north
Heating exclusively through the ceiling

Setting of VAV boxes and sizing of installation

**Zone E-S-W:** Sizing of installation in cooling, opening of VAV boxes at 100% in heating: good mixture of air in the room

**Zone Nord:** Determine output in heating and cooling. It is possible the sizing may have to be done in heating
Heating exclusively through the ceiling

Conditions for heating a room with ceiling heights of 14ft and less

1. Proper zoning of ventilation units
2. Have a temperature differential of no more than $\Delta + 15 \, ^\circ C$ at supply
3. Ensure VAV boxes are open 100% in heating and size the room using heating parameters for the north
4. **Place diffusers in the proper location**
Heating exclusively through the ceiling

Location of diffusers

**Objective:** Air speed of 0.15 m/s (30ft/min) @ 0.6 m (2ft) from the floor

→ Validate that the air circulation cycle is complete in the room

NAD Klima has developed a method of determining the location of the diffuser.
Heating exclusively through the ceiling

Location of diffuser

**Objective:** Air speed of 0.15 m/s (30 ft/min) @ 0.6 m (2 ft) from the floor

**NAD Circle:** speed of 0.15 m/s (30 ft/min) @ 4.3 ft from the floor

The NAD circles must overlap the exterior wall by 2 to 3 ft

Sample with a ceiling at 9 ft

speed of 0.15 m/s (30 ft/min)
Conditions for heating a room with ceiling heights of 14ft and less

1. Proper zoning of ventilation units
2. Have a temperature differential of no more than $\Delta + 15\, ^\circ C$ at supply
3. Ensure VAV boxes are open 100% in heating and size the room using heating parameters for the north
4. Place diffusers in the proper location
5. Place thermostats in proper location
Heating exclusively through the ceiling

Location of thermostats

The peripheral zone detects the thermal load:
- In summer: heat radiation from the sun
- In winter: convection from the cold at the window

→ Place the temperature sensor in the peripheral zone within 8 ft from the exterior wall

Note: If it is not possible to install a sensor in the peripheral zone, install a sensor in the return grid, or a ceiling sensor with a 4” long stem (hors jet diffuseur)
Conditions for heating a room with ceiling heights of 14ft and less

1. Proper zoning of ventilation units
2. Have a temperature differential of no more than \( \Delta +15 \, ^\circ\text{C} \) at supply
3. Ensure VAV boxes are open 100\% in heating and size the room using heating parameters for the north
4. Place diffusers in the proper location
5. Place thermostats in proper location
6. Place heating coils in proper location
Heating exclusively through the ceiling

**Location of heating coils**

The heating coil supplies 4 diffusers

The heating coil supplies *only* the diffusers in the peripheral zone

→ The installation must be sized with the air supply in the peripheral zone superior to the central zone
Sample of calculation of the airflow of the diffusers in peripheral and central zone

In order to determine the air flow of each diffuser, you have to divide the room into 2 geometrically equal parts.

The air flow of the diffusers in the central zone correspond to a load factor of 0.8 cfm/ft² for the entire surface of the zone, namely:

- **0.8 cfm/ft² for a room**
- **33 ft * 16.5 ft**

The air flow of the diffusers in the peripheral zone correspond to a load factor of 0.8 cfm/ft² and 1.6 cfm/ft², namely:

- **0.8 cfm/ft² for a room**
- **33 ft * 6.5 ft**
- **1.6 cfm/ft² for a room**
- **33 ft * 10 ft**

Transfer of the air flow for the diffusers in this area in the central zone to the diffusers in the peripheral zone.
Heating exclusively through the ceiling

Sample of calculation of the airflow of the diffusers in peripheral and central zone

<table>
<thead>
<tr>
<th>Diffusers</th>
<th>Airflow per zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central zone</td>
<td>Qv1 = 0,8x33x16,5 = 435 cfm</td>
</tr>
<tr>
<td>Peripheral zone</td>
<td>Qv2 = 0,8x33x6,5 = 172 cfm + Qv3 = 1,6x33x10 = 528 cfm = 700 cfm</td>
</tr>
</tbody>
</table>
Heating exclusively through the ceiling

**Dual duct supply**

In this case the hot air ducts must be connected to the diffusers in the peripheral zone only.
Heating exclusively through the ceiling

Control sequence

Balanced for fresh air, heating and cooling

Balanced for fresh air and cooling
Heating exclusively through the ceiling

Conditions for heating a room with ceiling heights of 14ft and less

1. Proper zoning of ventilation units
2. Have a temperature differential of no more than $\Delta+15$ °C at supply
3. Ensure VAV boxes are open 100% in heating and size the room using heating parameters for the north
4. Place diffusers in the proper location
5. Place thermostats in proper location
6. Place heating coils in proper location
7. Place return grids in proper location
Heating exclusively through the ceiling

Location of return grids

Min 18 °C in winter

Return grids close to windows

→ Capture of heat from the windows in the summer
Heating exclusively through the ceiling

Conditions for heating a room with ceiling heights of 14ft and less

1. Proper zoning of ventilation units
   → Energy savings: the unit prepares the air at a temperature adapted to each zone

2. Have a temperature differential of no more than $\Delta+15 \, ^\circ\text{C}$ at supply
   → Complete air circulation cycle in the room + no stratification

3. Ensure VAV boxes are open 100% in heating and size the room using heating parameters for the north
   → Insure a proper mixture of the air all year around

4. Place diffusers in the proper location
   → Complete air circulation cycle in the room + window coverage

5. Place thermostats in proper location
   → Complete air circulation cycle in the room + window coverage

6. Place heating coils in proper location
   → Supply hot air to the peripheral zone

7. Place return grids in proper location
   → Gather the thermal zone from the windows in the summer
Heating exclusively through the ceiling

Conditions for heating a room with ceiling heights of 14ft and more

1. Having a temperature differential of no more than $\Delta+15$ °C at supply
Heating exclusively through the ceiling

Difference in temperature of maximum $\Delta + 15 \, ^\circ C$ at supply

Example SAL eccentric rollers in heating

Example SAL eccentric rollers in isotherm

→ Reduce difference in temperature in heating: the air flow will have a larger vertical penetration
→ Nad diffusers allow for the seasonal adjustment of the diffusion pattern:
Long vertical projection in heating (to the floor) and horizontal projection in cooling
OR adjusting the system in heating and cooling.
Heating exclusively through the ceiling

Conditions for heating a room with ceiling heights of 14ft and more

1. Have a temperature differential of no more than $\Delta + 15^\circ C$ at supply

2. Using the proper diffuser with adapted control
   
   2.1. Nozzle roller diffusers: RRA and SAL.
Heating exclusively through the ceiling

Nozzle roller diffusers: RRA and SAL.

NAD KLIMA has developed a nozzle roller which increases vertical projection.

1st. case: the air flow of the nozzle is localized in an unoccupied zone: The difference in air flow speed at the floor does not create any discomfort.
Example: along the windows in an entrance hall, No specific air management.

2nd. case: the air flow of the nozzle is localized in an occupied zone: The difference in air flow speed at the floor does create discomfort.

Air management with air flow transfer: see next slide.
Heating exclusively through the ceiling

Nozzle roller diffusers: RRA and SAL: seasonal transfer of air volume

Peripheral area nozzle roller

Central area eccentric roller

6000 cfm
Heating exclusively through the ceiling

Nozzle roller diffusers: RRA and SAL: seasonal transfer of air volume

Winter: 5000 cfm
1000 cfm
Transfer of 1000 cfm

Mid season: 4000 cfm
2000 cfm
Transfer of 1000 cfm

Summer: 3000 cfm
3000 cfm
Transfer of 2000 cfm

6000 cfm
Heating exclusively through the ceiling

Nozzle roller diffusers: RRA and SAL: seasonal transfer of air volume
6000 cfm

Diffusers and ducts conceived for 5000 cfm

Diffusers and ducts conceived for 3000 cfm
Heating exclusively through the ceiling

Nozzle roller diffusers: RRA and SAL.
The SAL
Audi Sherbrooke
Heating exclusively through the ceiling

Nozzle roller diffusers: RRA and SAL.
The RRA
Produits BRP, Valcourt
Heating exclusively through the ceiling

Conditions for heating a room with ceiling heights of 14ft and more

1. Have a temperature differential of no more than $\Delta+15 \, ^\circ C$ at supply

2. Using the proper diffuser with adapted control
   
   2.1. Nozzle roller diffusers: RRA and SAL.

   2.2. Adjustable pattern diffusers: WKD, LDI, VLV, VLD
Heating exclusively through the ceiling

Adjustable pattern diffusers: WKD, LDI, VLV, VLD

VLD
Heating and cooling

Essais de diffusion d'air
Diffuseur industriel
VLD DN315

Sherbrooke, 2014
Heating exclusively through the ceiling

Adjustable pattern diffusers: WKD, LDI, VLV, VLD

Adjustment of the diffusion pattern from **vertical to horizontal**: 

The jet is adaptable according to the season

Manual or motorized versions of the following diffusers are available
Heating exclusively through the ceiling

Adjustable pattern diffusers: WKD, LDI, VLV, VLD

WKD
Simons, Edmonton
Adjustable pattern diffusers: WKD, LDI, VLV, VLD

The functioning of the WKD

**Heating**
- **Nozzle: Position 1**
  - Stable vertical air flow with large penetration.
- **Nozzle: Position 2**
  - Vertical air flow with helical effect.

**Cooling**
- **Nozzle: Position 3**
  - Horizontal helical air flow with relatively low impact.
- **Nozzle: Position 4**
  - Horizontal air flow (without influence from the ceiling) with maximum horizontal reach and elevated primary induction.
Heating exclusively through the ceiling

Adjustable pattern diffusers: WKD, LDI, VLV, VLD

LDI
Centre de foires, Sherbrooke
Heating exclusively through the ceiling

The functioning of the LDI in different operation modes

**Blades:**

**Vertical position**
Constant vertical flow with large penetration.

**Blades:**

**Diagonally variable position**
Air flow with helical effect.
Heating exclusively through the ceiling

Adjustable pattern diffusers: WKD, LDI, VLV, VLD

VLV
Usine Kraft, Montréal
Heating exclusively through the ceiling

The functioning of the VLD / VLV in different operation modes

Blades: Open position
Downward air flow

Blades: Closed position
Sideways air flow
Heating exclusively through the ceiling

Conditions for heating a room with ceiling heights of 14ft and more

1. Have a temperature differential of no more than $\Delta + 15 \, ^\circ C$ at supply

2. Using the proper diffuser with adapted control

   2.1. Nozzle roller diffusers: RRA and SAL.

   2.2. Adjustable pattern diffusers: WKD, LDI, VLV, VLD

   2.3. High induction duct diffusers: customized perforations: FDD, RDD
High induction duct diffusers: FDD, RDD

1st. case: The duct diffuser can be configured to obtain a high velocity air jet at the floor level in an unoccupied zone: The difference in speeds of the air jets at the floor level between the heating and cooling does not create any discomfort No adjustment necessary

2nd. case: The duct diffuser can not be configured to avoid the occupied zone: The difference in air speed at the floor level creates discomfort: Control with a dual sensor thermostat
Heating exclusively through the ceiling

High induction duct diffusers: FDD, RDD : dual sensor control

**Night mode**
- During the night, a temperature of 18°C is requested.

**Schema 1**
- Average Temp. < 22 °C
- Temp increases in ceiling

**Schema 2**
- Average Temp. > 22 °C
- Temp increases in ceiling

**Schema 3**
- Temperature standardisation happens quickly
- Ex: height = 35 feet
  - Morning: 15 min for ΔT = 4°C
  - Daytime: 3 min for ΔT = 1°C

**Schema 4**
- Heating stops
- Destratification of the room

**In the morning, a request for 22°C is carried out**
- Average Temp. < 22 °C
- Temp increases in ceiling

**Ex:**
- Height = 35 feet
  - Morning: 15 min for ΔT = 4°C
  - Daytime: 3 min for ΔT = 1°C

After heating has stopped
Heating exclusively through the ceiling

RDD
Centre de foires de Sherbrooke
Heating exclusively through the ceiling

Sample plan: plumbing layout
Heating exclusively through the ceiling

EXAMPLE OF DESIGN : 7 points to improve
EXAMPLE OF DESIGN: 7 points to improve: modify

1: location of thermostat
4: distance of diffuser from the window
2: location of heating coil
5: zoning of units
3: location of return grids
6: output of 4 diffusers
7: deletion of heating by water

5: Only 1 unit
ADVANTAGES OF HEATING THROUGH THE CEILING WITH HIGH INDUCTION DIFFUSERS

- Savings in construction costs
  → Elimination of hot water or electric baseboards and or Radiant Ceiling Heating Systems (Plumbing, electrical, thermostats, sensors etc)

→ High induction diffusers: reduction of half the number of diffusers required compared to traditional diffusers.

→ Possibility of reducing the quantity of air introduced into the central zones by interpreting the volume of inducted air flow by the diffusers as the volume of recirculated air (in Quebec: 45 l/s/person in accordance with the regulation of the air quality of the workplace, chap S 2-1,r,11 chart 2 of annex B)
ADVANTAGES OF HEATING THROUGH THE CEILING WITH HIGH INDUCTION DIFFUSERS

- **Energy savings**

  → Reduction of 25% of the quantity of fresh air by using high induction diffusers

  → Energy savings through destratification

  → Reduction of the electrical power and consumption of central units
ADVANTAGES OF HEATING THROUGH THE CEILING WITH HIGH INDUCTION DIFFUSERS

- **Reduction in operating costs**

→ Elimination of hot water or electric baseboards:
  Reduction of insurance premiums by half
  - Hot water baseboards: reduction of the risk of water leakage (Contamination of the walls)

→ Reduction of 95 % of noise and discomfort complaints (Including air speeds and temperature variations)

→ Increased physical space through the elimination of baseboards
NAD Klima

144, rue Léger, Sherbrooke (Qué.) J1L 1L9
819 780-0111

nadklima.com