ASHRAE 62.1: Section 6.2
Ventilation Rate Procedure (VRP)

- Prescribes quantity of outdoor air delivered to each zone based
- How to calculate outdoor air flow needed at the system intake
Learning objectives

- Describe the multi-zone calculation process
- Show how TRACE™ determines system level
- Common questions

Example: Two zone office
Calculate required outdoor air intake VAV reheat system

Block airflow: 2560 cfm
VAV diversity factor: 0.8

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ASHRAE Standard 62.1 Variables

Block airflow:
\[ V_{ps} = 2560 \text{ cfm} \]

Zone Airflow Rates

1. Define Zone Level Parameters
   a. Define zone airflow rates and distribution effectiveness
      a. \( R_a \) = Outdoor airflow rate per unit area (Table 6-1)
      b. \( R_p \) = Outdoor airflow rate per person (Table 6-1)
      c. \( E_z \) = Define zone air distribution effectiveness (Table 6-2)
Zone Airflow Rates

1. Define Zone Level Parameters
   a. Define zone airflow rates and distribution effectiveness
      a. \( R_a \) = Outdoor airflow rate per unit area (Table 6-1)
      b. \( R_p \) = Outdoor airflow rate per person (Table 6-1)
      c. \( E_z \) = Define zone air distribution effectiveness (Table 6-2)

2. Calculate Breathing Zone Outdoor Airflow (\( V_{bz} \))
   a. \( V_{bz} = (R_p \times P_z) + (R_a \times A_z) \)
   where \( P_z \) is the number of people and \( A_z \) is the zone area

3. Calculate Zone Outdoor Airflow (\( V_{oz} \))
   a. \( V_{oz} = \frac{V_{bz}}{E_z} \)
Zone Airflow Rates

Calculate \( V_{oz} \) and \( V_{oz} \):

**Zone 1:**
- \( Rp = 5 \text{ cfm/p} \)
- \( Ra = 0.06 \text{ cfm/ft}^2 \)
- \( Pz = 30 \text{ people} \)
- \( Az = 1500 \text{ ft}^2 \)
- \( Ez = 1.0 \) (cooling)

**Zone 2:**
- \( Rp = 5 \text{ cfm/p} \)
- \( Ra = 0.06 \text{ cfm/ft}^2 \)
- \( Pz = 10 \text{ people} \)
- \( Az = 500 \text{ ft}^2 \)
- \( Ez = 1.0 \) (cooling)

ASHRAE Standard 62.1/TRACE demonstration

1. **Area and occupancy ventilation rates:**
   OA required to remove contaminants from people and building materials

2. **Zone level efficiency:**
   Effectiveness of zone level outdoor airflow to dilute indoor contaminants
ASHRAE Standard 62.1/TRACE demonstration

3. Area and occupancy ventilation rates: Select an appropriate standard 62.1 calculation

TRACE™ ASHRAE Standard 62.1 report
Ventilation Parameters

<table>
<thead>
<tr>
<th>System Zone Room</th>
<th>Occupancy Category</th>
<th>Rp cfm/p</th>
<th>Pz People</th>
<th>Ra cfm/ft²</th>
<th>Az ft²</th>
<th>Vbz cfm</th>
<th>Ez cfm</th>
<th>Voz cfm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 1</td>
<td>Zone 2</td>
<td>Office space</td>
<td>5.00</td>
<td>10.00</td>
<td>0.06</td>
<td>500</td>
<td>80</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>Zone 1</td>
<td>Office space</td>
<td>5.00</td>
<td>30.00</td>
<td>0.06</td>
<td>1,500</td>
<td>240</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>VAV reheat</td>
<td>Office space</td>
<td>5.00</td>
<td>40.00</td>
<td>0.06</td>
<td>2,000</td>
<td>320</td>
<td>1.00</td>
</tr>
</tbody>
</table>
4. Determine Zone Primary OA Fraction ($Z_p$) for each zone

$$Z_p = \frac{Voz}{Vpz-min}$$

Where
- $Voz$ = zone outdoor airflow
- $Vpz-min$ = minimum expected zone primary airflow at the design condition analyzed

Supply air

Return air

VAV

Exhaust

5. Determine critical zone (zone with maximum $Z_d$)

Critical zone

$Zd = 0.6$

$Zd = 0.2$
### TRACE™ ASHRAE Standard 62.1 report

**Ventilation Calculation for Cooling Design**

<table>
<thead>
<tr>
<th>System Zone Room</th>
<th>Box Type</th>
<th>Vpz cfm</th>
<th>Vfan cfm</th>
<th>Vdz cfm</th>
<th>Vpz-min cfm</th>
<th>Voz-clg cfm</th>
<th>Zd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 2</td>
<td>VAV Reheat</td>
<td>1,500</td>
<td>1,500</td>
<td>1,500</td>
<td>400</td>
<td>80</td>
<td>0.200</td>
</tr>
<tr>
<td>Zone 1</td>
<td>VAV Reheat</td>
<td>1,500</td>
<td>1,500</td>
<td>1,500</td>
<td>400</td>
<td>240</td>
<td>0.600 *</td>
</tr>
<tr>
<td>Alternative 1</td>
<td>VAV Reheat</td>
<td>3,200</td>
<td>2,560</td>
<td>3,200</td>
<td>800</td>
<td>320</td>
<td></td>
</tr>
</tbody>
</table>

Determine uncorrected OA intake (Vou)

\[
V_{ou} = D \sum_{all	ext{ zones}} R_p P_z + \sum_{all	ext{ zones}} R_a A_z,
\]

where \( D \) represents the occupancy diversity within the system

- Assume \( D = 1 \)
- \( V_{ou} = 320 \text{ cfm} \)

 OA

![Diagram of ventilation system]

- \( V_{bz} = 240 \text{ cfm} \)
- \( V_{bz} = 80 \text{ cfm} \)
**TRACE™ ASHRAE Standard 62.1 report**

**System Ventilation Requirements**

<table>
<thead>
<tr>
<th>AHU Location</th>
<th>Description</th>
<th>$\sum V_pz$ (cfm)</th>
<th>Ps (People)</th>
<th>$\sum P_z$ (People)</th>
<th>$D = \frac{\sum P_z}{\sum P_z}$</th>
<th>Vou (cfm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alternative 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System</td>
<td>VAV reheat</td>
<td>Cooling</td>
<td>3,200</td>
<td>40</td>
<td>40</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heating</td>
<td>800</td>
<td>40</td>
<td>40</td>
<td>1.00</td>
</tr>
</tbody>
</table>

4. Determine Average Outdoor Air Fraction ($X_s$)

$$X_s = \frac{V_{ou}}{V_{ps}}$$

where $V_{ps}$ is system primary airflow (VAV block airflow)

- $V_{ou} = 320$ cfm
- $V_{ps} = 2560$ cfm (fan block)
- $X_s = 0.125$
Determine system ventilation efficiency (Ev):

Equation A-1

\[
Ev = 1 + X_s - Z_{d\text{-max}} = 1 + 0.125 - 0.6 = 0.525
\]

Table 6.3 System Ventilation Efficiency

<table>
<thead>
<tr>
<th>Max (Zp)</th>
<th>Ev</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 0.15</td>
<td>1.0</td>
</tr>
<tr>
<td>≤ 0.25</td>
<td>0.9</td>
</tr>
<tr>
<td>≤ 0.35</td>
<td>0.8</td>
</tr>
<tr>
<td>≤ 0.45</td>
<td>0.7</td>
</tr>
<tr>
<td>≤ 0.55</td>
<td>0.6</td>
</tr>
<tr>
<td>&gt; 0.55</td>
<td>Use Appendix A</td>
</tr>
</tbody>
</table>
Find outdoor intake flow (Vot):

\[ Vot = \frac{Vou}{Ev} = \frac{320}{0.525} = 610 \text{ cfm} \]

23.8% OA at cooling design (610 cfm/2560 cfm)

Vot = 610 cfm

TRACE™ ASHRAE Standard 62.1 report
System Ventilation Requirements

<table>
<thead>
<tr>
<th>AHU Location</th>
<th>Description</th>
<th>Xs</th>
<th>Ev</th>
<th>Vot</th>
<th>%OA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 1</td>
<td>VAV reheat</td>
<td>0.125</td>
<td>0.525</td>
<td>610</td>
<td>23.8</td>
</tr>
<tr>
<td></td>
<td>Cooling</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Heating</td>
<td>0.400</td>
<td>0.800</td>
<td>400</td>
<td>50.0</td>
</tr>
</tbody>
</table>
TRACE and ASHRAE Standard 62.1
Common Questions

• Why is my system 100% OA?
• Why does my ASHRAE multi-zone spreadsheet does not match the TRACE 700 output?
• Why does TRACE calculate Zd using Vpz-min?

Resolving 100% OA
• Set Max Vent Allowed (Max Zd) in Create Systems>Advanced
• Increase VAV min in critical zone in Create Rooms>Airflows
ASHTAE Standard 62.1

Lesson 2: Program Methodology

100% OA

### System Ventilation Requirements

<table>
<thead>
<tr>
<th>AHU Location</th>
<th>Description</th>
<th>Vou cfm</th>
<th>Vps cfm</th>
<th>Xs</th>
<th>Ev</th>
<th>Vol cfm</th>
<th>%OA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 2</td>
<td>System - 001</td>
<td>Cooling</td>
<td>460</td>
<td>2,560</td>
<td>0.188</td>
<td>0.186</td>
<td>2,600</td>
</tr>
<tr>
<td></td>
<td>Heating</td>
<td></td>
<td>460</td>
<td>800</td>
<td>0.600</td>
<td>0.600</td>
<td>800</td>
</tr>
</tbody>
</table>

Max Zd = 75%

### System Ventilation Requirements

<table>
<thead>
<tr>
<th>AHU Location</th>
<th>Description</th>
<th>Vou cfm</th>
<th>Vps cfm</th>
<th>Xs</th>
<th>Ev</th>
<th>Vol cfm</th>
<th>%OA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 3</td>
<td>System - 001</td>
<td>Cooling</td>
<td>460</td>
<td>2,560</td>
<td>0.188</td>
<td>0.438</td>
<td>1,097</td>
</tr>
<tr>
<td></td>
<td>Heating</td>
<td></td>
<td>480</td>
<td>933</td>
<td>0.514</td>
<td>0.764</td>
<td>628</td>
</tr>
</tbody>
</table>

Max Zd

**Pros**
- Reduce OA cfm
- Reduced outdoor air cfm
- Reduced ventilation load

**Cons**
- Increased airflows
- Increased minimum stop
- Increased fan power
- Increased reheat loads
Impact of $Z_{d\text{-max}}$ on $V_{ot}$ and $V_{pz\text{-min}}$

Note: These values are for the 2 zone example

TRACE and ASHRAE Standard 62.1
Common Questions

- Why is my system 100% OA?
- **Why does my ASHRAE multi-zone spreadsheet does not match the TRACE 700 output?**
- Why does TRACE calculate $Z_d$ using $V_{pz\text{-min}}$?
### TRACE and ASHRAE Standard 62.1

#### Common Questions

- **Why is my system 100% OA?**
- **Why does my ASHRAE multi-zone spreadsheet does not match the TRACE 700 output?**
- **Why does TRACE calculate Zd using Vpz-min?**
Additional resources

• TRACE™ 700 User’s Manual
• TRACE online (F1) help
• Trane.com/EN
• Trane.com/ContinuingEducation

contact us

phone 608.787.3926
fax 608.787.3005
email cdshelp@trane.com
Web www.tranecds.com