Why Are Heat Loss and Heat Gain Calculations Important for HVAC Equipment Selection

Achieving occupant satisfaction is the principal goal of any HVAC design. Primary factors impacting occupant satisfaction include: filtration, temperature and humidity control, air motion in the room, adequate ventilation, interior zoning needs and energy efficient operation. Occupant satisfaction is maximized when the heating and cooling system and equipment are the correct type and size and the air distribution system is properly designed and installed.

For residential applications, ACCA's Manual J, Eighth Edition (MJ8) is the only procedure recognized by the American National Standards Institute (ANSI) and specifically required by residential building codes. Load calculations not based on actual construction details, nor founded on relevant physical laws and engineering principles, are unlikely to result in correct equipment sizing.

Problems With Oversized Equipment

Oversized equipment results in marginal part load temperature control. While the temperature control at the home’s centralized thermostat may be satisfactory, equipment cycling may cause noticeable temperature swings between rooms and larger temperature differences between floors. Oversized equipment may cause degraded humidity control and increase the potential for mold growth, allergic reactions and respiratory problems. In these unfavorable conditions, occupants may experience additional discomfort and dissatisfaction. Other negative effects are higher installed costs, increased operating expenses, and increased maintenance costs. Furthermore, oversized equipment generally requires larger ducts, poses additional requirements on the power grid and may lead to more service calls.

Reasons For Oversized Equipment

Three main reasons for oversized equipment are: (1) a guess is made on the load; (2) mistakes are made in the load calculation; (3) the equipment is selected for either unusual/extreme conditions such as abnormal temperatures or unusual occupancy loads (i.e. gatherings/parties). Other reasons include the use of inappropriate and inadequate “rules of thumb” such as ‘500ft²/ton’, ‘400 CFM/ton’, or ‘total cooling capacity = 1.3 x sensible cooling capacity’. Furthermore, seemingly trivial mistakes such as ignoring building efficiency upgrades and assuming that the original design and installation are correct, all contribute towards inappropriate equipment sizing.

Manual J® Verification

While it is not practical to verify every aspect of a submitted Manual J calculation, it is a good practice to review key elements that indicate general integrity of the calculations i.e. the contractor has made a good faith effort to provide reasonably accurate loads.

Items to Verify

The key load elements, grouped in roughly decreasing levels of impact on the overall contribution to the loads, are:

<table>
<thead>
<tr>
<th>HIGH</th>
<th>MEDIUM</th>
<th>LOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔️ Design Temperatures (Indoor and Outdoor)</td>
<td>✔️ Small Skylights</td>
<td>✔️ Appropriately Insulated Floors</td>
</tr>
<tr>
<td>✔️ Windows, Glass Doors and Large Skylights (shading, overhangs, etc.)</td>
<td>✔️ Infiltration</td>
<td>✔️ Appropriately Insulated Walls</td>
</tr>
<tr>
<td>✔️ Ducts (location, leakage and duct wall R-values)</td>
<td>✔️ Ventilation</td>
<td>✔️ Internal Gains</td>
</tr>
<tr>
<td>✔️ Ceilings under an attic (R-values, roof material, roof color)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

It is also worth noting some unusual items that also contribute to the load. These include:

- Hot Tubs
- Whirlpool Tubs
- Three-season Porches

A Note on Understanding the Design Process

Manual J allows contractors to perform a load calculation on a residential building/home. Apart from the load calculation being performed, the ducts must be sized and the correct size equipment must be selected. ANSI-recognized ACCA Manual D® for duct sizing and ACCA Manual S® for residential equipment selection provide guidance here.
# KEY ITEM CHECK QUESTIONS TO ASK CIRCLE ANSWER*

## 1 DESIGN TEMPERATURES
- **Indoor Design Temperatures**
  - Is the indoor design temperature for Heating: per Local Code OR 70°F (21°C) at 30% RH? YES NO ——
  - Is the indoor design temperature for Cooling: per Local Code OR 75°F (24°C) at 50% RH? (or 55% for humid climate, 45% for dry climate?) YES NO ——
- **Outdoor Design Temperatures**
  - Is the outdoor design temperature per Table 1 of MJ8 or Local Code? YES NO ——

## 2 WINDOWS & GLASS DOORS
- **U-values and SHGC values**
  - Are the SHGC and U-values reasonable for the window types and frame constructions? (see Table 2 of MJ8) YES NO ——
- **Shading Adjustments**
  - Have window shading (curtains, drapes, insect screens, tinting, etc.) adjustments been made? YES NO ——
- **Overhang Adjustments**
  - Have roof overhang adjustments been made? YES NO ——
- **Total Area**
  - Is the total area for the windows & glass doors roughly equal to the area shown on the drawing plans? YES NO ——
- **Exposure Directions**
  - Do the exposure directions [North (N), North-East (NE), etc.] appear correct? YES NO ——

## 3 SKYLIGHTS
- **U-values and SHGC values**
  - Are the SHGC and U-values appropriate for the skylight types and frame constructions? (see Table 2 of MJ8) YES NO N/A
- **Shading Adjustments**
  - Have adjustments been made for drapes, tinting and reflective coatings? YES NO N/A
- **Total Area**
  - Is the total area for the skylights roughly equal to the area shown on the drawing plans? YES NO N/A
- **Exposure Directions**
  - Do the exposure directions [North (N), North-East (NE), etc.] appear correct? YES NO N/A

## 4 DOORS | WOOD, METAL
- **None**
  — — — —

## 5 WALLS | ABOVE GRADE, BELOW GRADE
- **Insulation**
  - Are correct wall insulation R-values taken into account when the wall loads are calculated? YES NO ——
- **Total Area**
  - Is the total area for the walls equal to the area shown on the drawing plans? YES NO ——

## 6 CEILINGS
- **Insulation**
  - Is correct ceiling insulation R-value taken into account when the ceiling load is calculated? YES NO N/A
- **Radiant Barrier**
  - If applicable, does the load calculation take credit for a radiant barrier? YES NO N/A
- **Roof color and material**
  - Is correct roof color and material taken into account when the ceiling load is calculated? YES NO ——
- **Total Area**
  - Is the total area for the ceilings equal to the area shown on the drawing plans? YES NO ——

## 7 FLOORS
- **Insulation**
  - Is the floor insulation and type of construction representative of what is built/planned? YES NO ——

## 8 INfiltrATION
- **Envelope Tightness**
  - Is the listed envelope tightness (tight, semi-tight, average, semi-loose, loose) appropriate? YES NO ——
- **Above grade volume**
  - Is the total above grade volume equal to what is shown on the drawing plans? YES NO ——

## 9 INTERNAL GAINS
- **Appliances**
  - Are the appliance gains 1200 Btuh, 2400 Btuh or a value recommended by MJ8? YES NO ——
- **Occupants**
  - Is Maximum Number of Occupants = Number of Bedrooms + 1? YES NO ——
  - Is Btuh (sensible) = 230 x Number of Occupants? YES NO ——
  - Is Btuh (latent) = 200 x Number of Occupants? YES NO ——

## 10 DUCTS
- **Duct Location**
  - If located in an unconditioned space, are the ducts insulated (appropriate R-value)? YES NO N/A
- **Duct Tightness**
  - Is the duct tightness category ‘average sealed’ or higher (i.e. notably sealed, extremely sealed)? YES NO ——

## 11 VENTILATION
- **Intermittent Fans**
  - Are intermittent bathroom and kitchen fans excluded from the infiltration calculations? YES NO N/A
- **Continuous Exhaust Fans**
  - Are dedicated exhaust fans (continuous) included in the calculations? YES NO N/A
- **Heat Recovery Equipment**
  - Are the heat recovery equipment and/or a ventilating dehumidifier included in the calculations (if applicable)? YES NO N/A

*Questions should be answered “YES” (where applicable) to achieve representative load calculations.