HVAC & the Energy Code
Manuals J and S in the IECC

John Umphress
July 16, 2018
Manual J is a procedure for calculating building heating and cooling loads based on detailed inputs and conditions.

Manual S is a procedure for selecting appropriate equipment based on accurately calculated loads.
Heating/cooling calculations have been required by the energy code for more than two decades – but seldom enforced.

Earlier codes required systems be sized per Manual J – but Manual J is a load calculation procedure.


What about Manual D? (More on this later)
• What value is a mechanical system that doesn’t address the loads and keep occupants comfortable?

• Oversized systems
  – contribute to peak electricity demand
  – Don’t deliver rated efficiencies due to short-cycling
  – Can have a shorter service life
  – Do a poor job of handling latent loads in humid climates
Need for mechanical cooling

AUSTIN – July 20

Air Temperature $T$ (F)

Dewpoint $T_d$ (C)

Dewpoint $T_d$ (F)

Relative Humidity (%)

© 2008 Eric A. Schiff

Summer AM

Summer PM

Comfort Zone
Hours at temperature – Austin, Texas


[Graph showing hours at temperature for Austin, Texas over the years 2008 to 2011.]
• With advances in code and cooling system efficiency, Austin Energy now requires one-half the energy to cool the same square footage compared to a decade ago

• Comparison between peak demand in 2017 and previous peak in 2011
  – Customers (meters) increased 10%
  – Peak demand only increased .5%

• Some of that demand reduction resulted from demand management, improvements in existing buildings and distributed solar
• Required . . .
  – Grasp of construction concepts
  – Accurate information from architect, designer, specifier (is it code compliant?)
  – Appropriate/accurate design temperatures for location
  – Reviewers that can review quickly
  – Contractors that actually install equipment based on plans and specs
  – Knowledgeable 3rd party testing contractors
Elements that influence loads, performance

- Construction inputs: surface area, R-values (assemblies), shading, added loads (fireplace, appliances, occupants)
- Fenestration U-value and SHGC, orientation
- Roof material, roof color and radiant barrier
- Construction types (tight, average, etc.)
- Air handler location, duct layout/insulation
- With introduction of high efficacy lighting, cooling loads have decreased, heating loads have increased slightly
“Air conditioning” is all about “air”
- How much
- Where it goes (based on room loads)
- How well it’s distributed
- How much heat it gains (or loses)

Code only addresses how much air is lost from the system

Austin’s energy code requires +/- 20% of design air flow for each supply register, +/- 10% for system
Elements of good air distribution

- Central location of air handler
- Good plenum/duct design and construction
- Optimal air velocity at supply terminals
- Returns sized for air flow
- Low pressure drop/high MERV filter
- Unobstructed pathways for return air (RAPS, return ducts, jump-over ducts)
- Bedrooms (closed doorways) are a challenge to air movement, comfort
- Use Manual D!
Other reasons “air” can’t be ignored
Don’t ignore duct loads

• Manual J calculates duct loss and gains from both leakage and thermal transfer, but uses an ASHRAE standard more suitable for metal ducts.

• Duct screen inputs are not shown on Manual J report – have to deduce them from resulting loads.

• Watch for duct location, duct insulation, roof RB, roof cladding.

• “Extremely “ or “notably” sealed should be selected.

• Duct loads should not exceed 10 - 12% of total loads.
Recognizing problems

- Manual J reports can often reveal either climate-inappropriate design or code violations.
- Certain values will be the norm for your climate, building types – with a little experience you can spot the errors easily.
- Watch for “fudging” of values to falsely boost loads.
- Sometimes folks just get it wrong.
- Consider offering corrections a teaching opportunity.
Design should match climate

Test for Adequate Exposure Diversity

Hourly Glazing Load

Maximum hourly glazing load exceeds average by 75.0%.

Zone does not have adequate exposure diversity (AED), based on AED limit of 30%.

AED excursion: 3585 Btuh (PFG - ALP)
Problems Here . . .

Duct loss too high!

Gain from glazing is commonly 30 – 40% of sensible gain, not 13%

So is ventilation!
Errors add up . . .

## System 1 001 Summary Loads

<table>
<thead>
<tr>
<th>Component Description</th>
<th>Area Quan</th>
<th>Sen Loss</th>
<th>Lat Gain</th>
<th>Sen Gain</th>
<th>Total Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Res Glass: Glazing-Residential glazing, u-value 0.17, SHGC 0.3</td>
<td>569.2</td>
<td>4,055</td>
<td>0</td>
<td>9,798</td>
<td>9,798</td>
</tr>
<tr>
<td>13C-50cw: Wall-Block, framing with R-13 in 2 x 4 stud cavity, R-5 board insulation, open core, wood studs</td>
<td>4061.3</td>
<td>10,404</td>
<td>0</td>
<td>4,803</td>
<td>4,803</td>
</tr>
<tr>
<td>13BA-05cw: Wall-Block, framing with R-11 in 2 x 4 stud cavity, filled core, wood studs</td>
<td>1019</td>
<td>3,766</td>
<td>0</td>
<td>1,855</td>
<td>1,855</td>
</tr>
</tbody>
</table>

Subtotals for structure:
- People: 24
- Equipment: 162
- Lighting: 3670
- Ductwork: 23,853
- Infiltration: Winter CFM: 0, Summer CFM: 0
- Ventilation: Winter CFM: 400, Summer CFM: 0

System 1 001 Load Totals:
- 60,163
- 13,832
- 59,280
- 73,112

## Check Figures
- Supply CFM: 2,293
- Square ft. of Room Area: 4,645
- Volume (ft³) of Cond. Space: 50,268
- CFM Per Square ft.: 0.494
- Square ft. Per Ton: 762

## System Loads
- Total Heating Required Including Ventilation Air: 60,163 Btuh
- Total Sensible Gain: 59,280 Btuh
- Total Latent Gain: 13,832 Btuh
- Total Cooling Required Including Ventilation Air: 73,112 Btuh
• Accurate load calculations require accurate data inputs – GIGO!
• Review for accuracy – learn to spot errors
• Think of HVAC from a performance perspective, not as a building component – everything else is essentially static
• Air flow is critical – begins with building design
• Design and install systems with an eye toward maximum performance
• At final, test or commission to ensure that performance is realized