1. Enter your company information.

2. Enter your client information.

3. Enter the design temperatures – The indoor design temperatures are normally 70F for the winter and 75F for the summer, however, you may enter other temperatures if needed. The outdoor design temperatures can be found on Table 1 in Manual J or by searching for ‘outdoor design temperatures’ on the internet. Note: the outdoor design temperature for Raleigh, NC is listed as 92F. Experience has shown the temperature regularly reaches the mid 90’s, therefore, I took the liberty to use 95F.

4. Enter the direction house is facing.

5. Enter the heated or cooled area of the house.

6. Select the humidity level for your area.

7. Select the tightness of the construction.

8. Select the number and tightness of fireplaces if any exist. Ventless fireplaces and those obtaining all combustion air from outside are considered tight.

9. Enter the number of occupants in the home. Typically, this is the number of bedrooms plus one.
STEP 2

Overhang characteristics

1. Enter the distance between the top of the windows and the overhang (A) for each corresponding direction. Enter only feet decimally. For example: 6 inches = .5

2. Enter the distance the overhang sticks out from the wall (B) for each corresponding direction. Enter only feet decimally. For example: 1 foot 6 inches = 1.5

3. Enter the total linear feet across the top of all windows under the overhang for each corresponding direction. For example: if there are four windows under an overhang facing east and each is 3’, 4’, 3’ and 5’ across the top, respectively, then you would enter 15.
Is it an overhang or a porch?

If the window is located under a structure that is always totally shaded such as a porch, awning or carport, then it is considered as facing north thus, its area should be included with the north facing windows. In the Sample House Plan the only window facing east is under a covered porch, therefore, its area is added to the North facing windows and there are no east facing windows.

Fenestration (Glass)

1. If the window manufacture’s specs are available, check the box and enter the latitude, U-value and SHGC. (Do not select type of glass if manufacture’s specs are used)
2. Enter the area (sq. Ft.) of all windows facing north. Include any permanently shaded windows, even if facing another direction.
   Enter the area of all remaining windows facing their respective direction.
3. If you did not use manufacture’s specs, select the type of glass from the dropdown.
4. If glass has reflective coating, select YES, otherwise NO
5. Enter area (sq. ft.) of skylight and select type of glass

The total solar gain is the total amount of btuh entering the house through all glass surfaces. It takes into account both radiation and conduction.
Ducts

1. Select location of duct work
2. Select insulation on ducts
3. Select whether ‘sealed’ or ‘unsealed’
4. Enter the ceiling or floor area the ductwork is either above or below. For example: The Sample House is one story and all ductwork is in the attic, laying on a 1768 sq. ft. ceiling. Therefore, enter 1678. If, however, the home is 2 stories (839 sq. ft. on each floor) then only the duct work in the upper ceiling would be exposed to outside conditions. In which case, you would enter 839.
5. Select the attic temperature. **Make your best guess** as this is a function of radiant heat, conduction and attic ventilation.

Load calculation

1. Enter the gross area of all exposed walls* the wall. Gross area is the total area including windows and doors

   \[
   \text{Gross area} = \text{perimeter of house} \times \text{wall height}
   \]
*Exposed wall* means any wall that is exposed to the outdoor conditions. Also includes any wall between a conditioned and unconditioned space. Example: the wall between the house and unheated garage is exposed.

2. Glass 1- Value is entered automatically. Select type of glass
3. Glass 2- Enter the area (sq. ft.) only if there is a significant amount of different glass. For example: one half the house has single glass while the other half is double glass.
4. Skylight- Enter the area (sq. ft.) of skylight and select type of glass.
5. Doors- Enter area of doors and select insulation value. (Note: separate the glass from doors. If a west facing 3’ x 7’ door is half-glass, then enter 11 sq. ft. in the door cell and 10 sq. ft. in Step 2, west facing windows **Sliding glass doors** should be treated as windows
6. Net Wall- Automatically calculated

\[ \text{Net Wall} = \text{Gross wall} - \text{all openings} \]

7. Ceiling- Enter the area of all *exposed* ceilings. The Sample house has 1768 sq. ft. of *exposed* ceiling, If the house were 2 stories (839 sq. ft. on each floor) then it would only have 839 sq. ft. of exposed ceiling

8. The EMS load calculator offers three types of floors:
   a. Floors over crawl space – enter square feet, select insulation
   b. Floors over open area - enter square feet, select insulation
   c. Slab floors – enter **linear feet**, select insulation
9. Infiltration: Enter the cubic feet of the house (area x average ceiling height). The program will calculate the heating and cooling loads due to infiltration based on the tightness selected in Step 1
10. Appliances – A default value of 1200 btuh is programmed into the software. If you wish to change the value, click on the check box next to ‘Enter Value’ and enter a new value. Use this feature if an abnormal number of appliances are present, such as computers and big screen TV’s.
11. Summary – The summary will give the heating and cooling loads.
    Heating Load – Use this load to size the furnace or boiler. Always use the **output** rating.
Cooling Load – The cooling load is divided between sensioble, latent and total loads. The air conditioning equipment chosen must be able to handle all three loads at outdoor design temperatures.

Note: the example below indicates a 1.99-ton AC unit is needed. Typically, a 2-ton AC would be chosen for the job. However, the manufacturer’s specifications indicate their 2-ton unit has a sensible capacity of 18,000 btuh and a latent capacity of 6000 btuh. We may, therefore, need to move up to a 2.5-ton unit to cover both loads. Some, but not all, of the excess latent capacity may be used to make up for the sensible deficient. To properly select equipment a Manual S calculation should be performed.

<table>
<thead>
<tr>
<th>Floor</th>
<th>Over Crawl or Unheated Basement</th>
<th>Open-Balcony House Above Carport</th>
<th>Stab On Grade - enter-linear ft</th>
<th>Infiltration: Enter cubic-ft of building</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>184</td>
<td>141-44</td>
</tr>
</tbody>
</table>

**Summary**

<table>
<thead>
<tr>
<th>Heating Load</th>
<th>Sensible Cooling</th>
<th>Latent Cooling</th>
<th>Total Cooling Load</th>
<th>Nominal Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>37,592</td>
<td>20,232</td>
<td>3,694</td>
<td>23,927</td>
<td>1.99</td>
</tr>
</tbody>
</table>

If the home has a basement and you wish to heat and/or cool the basement with the same unit serving the story above, the program will indicate the total loads for both stories under ‘Summary Including Basement’
What is a basement? A basement is an area that has a floor at least 2 feet below grade. Otherwise, it is simply the first floor and its components should be entered in Steps 1, 2 and 3.

Enter the areas/volume as asked and select insulation.

Note two exceptions:

1. Separate the above grade and below grade wall areas. Remember.
2. Enter the square feet of the basement floor. Note: for slab floors on grade the heat loss is along the perimeter, but for slab floors two feet or deeper below grade, the heat loss is throughout the slab.
Notice in the drawing above, the rooms are drawn as number of rectangles. Also, note we did not complicate our drawing by showing or drawing closets, halls and stairwells even though their areas are included in the drawing.

1. System CFM – Enter the system CFM for cooling and heating (how? See below)
   a. Determine the equipment size from the summary on Step 3
   b. Consult manufacturer’s specs to obtain the CFM
2. Click on + Add Room, then name the room and enter the area of each component in the room.
   Note: only enter areas that are exposed to the outdoor temperature.
   Example 1: BR2 has two walls exposed while BR3 has only one wall exposed.
   Example 2: If there is a conditioned area above a room, then that room has no ceiling.
   Example 3: If there is a conditioned area below a room, then that room has no floor.
   Example 4: Treat a wall between unheated areas, such as house and garage, as outside.
3. Click Save
4. To add next room, click + Add Room and repeat until all rooms are accounted for.
5. After adding all rooms, click ‘Check Calculation When Completed’. If the calculated room-by-room load is within 5% of the whole house load (Step 3) then your entries are considered accurate. If the load is not within 5% then you must re-check your entries. The reason for the inaccuracy is the values entered for each room do not add up to those in Step 3. For example: The area of the walls in Step 3 is 1472 sq. ft. If you were to add up the area of each individual room wall, it should equal 1472 sq. ft. Any other value would indicate a mistake. Ditto for windows, doors, ceilings and floors.
Duct sizing (A Room-by-Room load calculation must be performed before sizing ducts)

Round to Rectangular Conversion Calculator (use only if needed):
The EMS load calculator gives duct sizes in round duct diameters. If you need to convert a round duct to rectangular duct, enter the round duct size into the first cell and the desired size of one side into the second cell (side A). The other side of the rectangular duct will be (B).

Example: The duct calculator indicates a 16 inch round duct is required, however you need to use a rectangular duct that can be no higher than 8 inches. The resulting size would be 8” x 29.6”

1. ‘Use heating or cooling CFM’ - Select the mode requiring the most CFM
2. Select the duct type.
3. Determine the friction rate (see below for alternative method)

The calculation for determining the friction rate is:

Friction Rate = Available pressure x 100/Total effective length

Available pressure = External pressure of fan (may include air handler casing) minus all air side components (registers, grilles, dampers, filters coils, etc.). All of this data is available from the respective manufacturer’s specifications.

Total effective length = total measured length plus the total equivalent lengths of all fittings and bends.

Measured length = actual measured length from the farthest supply opening to the farthest return opening

Equivalent length = stated length of fittings and turns compared to that of straight duct. A ninety degree round to rectangular floor boot offers as much resistance to the flow of air as 80 feet of straight duct, therefore, it has an equivalent length of 80 feet. ACCA Manual D lists the equivalent lengths of duct components.

Alternative method (Not recommended by ACCA but works on almost all homes)

1. Leave measured length, effective length and available static pressure blank
2. Uncheck ‘calculate friction rate’ and enter .08 as the Friction Rate. For an extremely quiet system, use .05
3. **Room Runs** - It is preferable to size the room runs first. Enter the number of outlets for each room. The calculator will show the room CFM, each outlet CFM, the duct diameter and the velocity of the air. If the velocity is greater than 700 FPM increase the duct by one size.

4. **Supply Trunk Sizing** - After sizing the room runs, size the supply in the following manner:
   a. The first section off the air handler must supply all the equipment CFM (1000 CFM from sample).
   b. After serving the master bedroom, bedroom 2 and bedroom 3 which total 403 CFM, a reduction is made. The new trunk must carry 597 CFM (1000 – 403). Enter 597
   c. After serving the bath, living room and dining room a second reduction is made, The new trunk must carry the remaining 121 CFM. Enter 121

5. **Return Trunk Sizing** – Our example has two returns, each handling 500 CFM. Enter 500 for each reduction.

**Manual S – Equipment Selection**

1. Check ‘Auto Complete’ and the calculated loads will automatically fill in.
2. Enter the altitude above sea level for your area.
3. Select whether your climate is predominantly heating or cooling.
4. **Manufacturer’s equipment specifications**
   
   Using the manufacturer’s specification sheets, enter the equipment manufacturer, model number and btuh output if a furnace or boiler is used for heating. For air conditioners and heat pumps, enter the cooling capacities associated with your area’s outdoor design temperature @ 63-degree wet bulb temperature (63 WB corresponds to 50% RH). Below is an example of a typical performance data sheet for a 2.5-ton heat pump. The highlighted area is ARI’s testing conditions (32,100 btuh total capacity, 78% or 25,000 btuh sensible capacity, therefore leaving 7100 btuh latent capacity.) However, if your area has an outdoor design temperature of 105 degrees, the total capacity of the unit will drop to 30,500 btuh, with 81% or 24,000 btuh sensible and the balance, 5500 btuh latent.
TOTAL CAPACITY with altitude correction is the net capacity of the equipment at your area’s altitude and must be considered when selecting equipment.

Notice the “Cooling cfm (rec.)”. This is the cfm recommended to control humidity in the cooling mode. Using the manufacturer's specs (blower performance chart), enter the external static pressure corresponding to the recommended cfm in the adjacent cell labeled, “Ext. static pressure of blower.” Once the external static pressure is entered, it will automatically be re-entered in the available static pressure section below.

5. In the available static pressure for duct system section, enter the pressure drops caused by each component in the system (coils, registers, dampers, etc.)

*The external static pressure is the pressure the air exerts upon the ductwork as it leaves the air handler. Some manufactures post an external static pressure that allows for a coil and/or filter in place (you must read footnotes to blower performance chart). If the external static pressure includes coils or filters leave the corresponding cells blank.

If you do not know the pressure drops of the registers and grilles. The generic pressure drop exerted by registers and grilles is about .03. Therefore, enter .03 in the cell next to registers and .03 in the cell next to grilles.

Other- enter manufactures stated pressure drop of any other items in the system. (electric strips, dampers etc.) these may be added together and entered as one total. *Available static pressure for duct (per 100 feet) - In order to assure the correct system cfm, the ductwork must be sized based in this static pressure. *Once the available static pressure is known, it must be adjusted according to the ductwork’s measured and equivalent lengths. This adjustment is commonly referred to as the friction rate. The friction rate is the pressure used on duct calculators and friction charts FR= (Adj. SP x 100)/total effective length This calculation is automatically made on the duct sizing tab.
Supplemental heat needed for heat pump. From the manufactures specs enter the heat pump’s capacity at 47 degrees F and 17 degrees F. The program will calculate the amount of supplemental heat needed expressed in both BTUH and KW.

<table>
<thead>
<tr>
<th>Heating CFM</th>
<th>Cooling CFM (recommended)</th>
<th>External Static Pressure of Blower</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Energy cost/ ROI

1. Enter the heating and cooling degree days (obtain from the maps below)

System 1

1. Enter the SEER of the air conditioner and the cost per KWHR. Example entry: if a KWHR costs 14 cents, enter .14
2. Under Heating, select type of heating system.
3. Enter the efficiency and fuel cost
   a. For furnaces and boilers enter the AFUE and cost per therm, 100 CCF or gallon
   b. For heat pumps enter the HSPF and cost [per KWHR
   c. For electric heat enter 1.00 and cost per KWHR

System 2

4. Enter the SEER of the air conditioner and the cost per KWHR. Example entry: if a KWHR costs 14 cents, enter .14
5. Under Heating, select type of heating system.
6. Enter the efficiency and fuel cost
   d. For furnaces and boilers enter the AFUE and cost per therm, 100 CCF or gallon
   e. For heat pumps enter the HSPF and cost [per KWHR
   f. For electric heat enter 1.00 and cost per KWHR

Payback and ROI

1. Enter the cost of the new or more efficient system and the cost of the less efficient system and any rebates.
# EMS HVAC Load Calculator

## Energy Cost Analysis

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Loss</td>
<td>37,592.10</td>
<td>Heating Degree Days</td>
<td>3226</td>
</tr>
<tr>
<td>Heat Gain</td>
<td>23,926.81</td>
<td>Cooling Degree Days</td>
<td>1840</td>
</tr>
<tr>
<td>Summer Design Temp</td>
<td>95</td>
<td>Summer Design Temp Diff</td>
<td>20</td>
</tr>
<tr>
<td>Winter Design Temp</td>
<td>20</td>
<td>Winter Design Temp Diff</td>
<td>50</td>
</tr>
</tbody>
</table>

### System #1 (Old or less efficient system)

<table>
<thead>
<tr>
<th></th>
<th>Efficiency</th>
<th>Fuel Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Conditioning</td>
<td>14</td>
<td>276.73</td>
</tr>
<tr>
<td>Heating</td>
<td>8</td>
<td>706.01</td>
</tr>
<tr>
<td>Heat Pump</td>
<td>8</td>
<td>706.01</td>
</tr>
</tbody>
</table>

Total annual operating cost of system 1: $982.74

### System #2 (Old or less efficient system)

<table>
<thead>
<tr>
<th></th>
<th>Efficiency</th>
<th>Fuel Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Conditioning</td>
<td>16</td>
<td>215.23</td>
</tr>
<tr>
<td>Heating</td>
<td>10</td>
<td>564.81</td>
</tr>
<tr>
<td>Heat Pump</td>
<td>10</td>
<td>564.81</td>
</tr>
</tbody>
</table>

Total annual operating cost of system 2: $780.04

---

# PAYBACK AND ROI

- **Cost of new or more efficient system**: $7230.00
- **Cost of less efficient system**: $6290.00
- **Rebates or credits**: $0
- **Additional Investment**: $940.00

**Yearly Savings**: $202.70

**Payback (Years)**: 4.64

**Return on Investment (ROI)**: 21.56