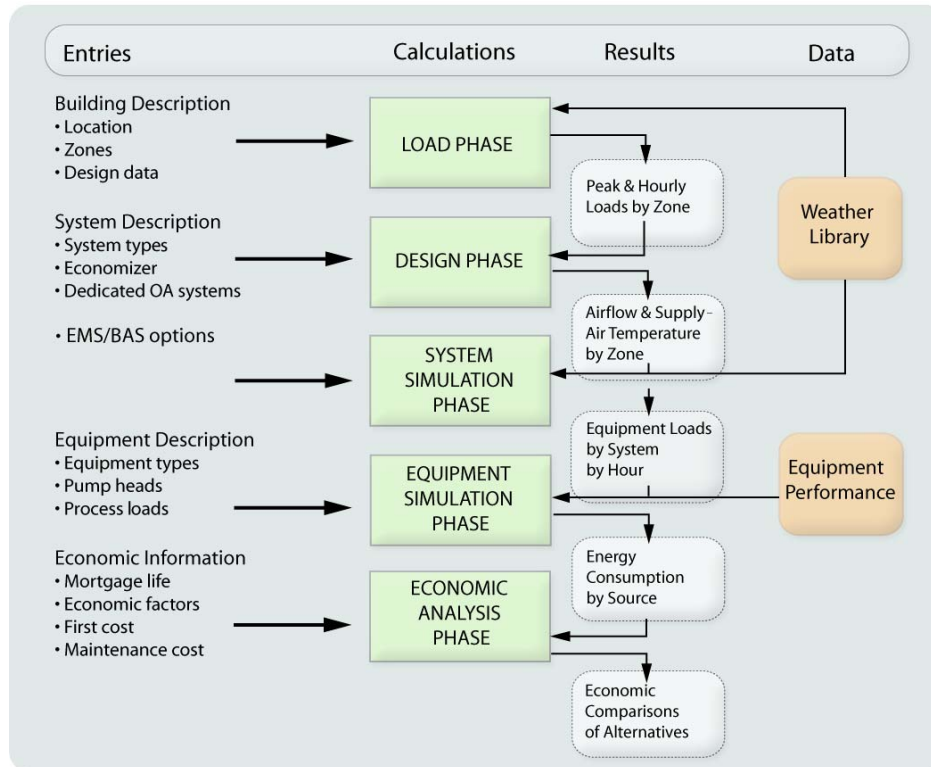


## TRACE™ 700 Load Design

TRACE 700 Load Design is comprised the first two phases (Load and Design) of the TRACE (Trane Air Conditioning Economics) program (Figure 1).

Figure 1. TRACE application flow chart



### Load Phase

The Load phase of the program calculates the peak sensible and latent zone loads, as well as the *block sensible* and *latent* loads for the building. In addition, the hourly sensible and latent loads, including *weather-dependent* loads, are calculated for each zone, based on the weather library.

Loads defined in the calculation are:

#### External Loads

- Wall Load
- Glass Load
- Roof Load
- Floor Load
- Internal Loads
- Lighting Loads
- People Loads
- Miscellaneous Loads

The specific entries required to facilitate these calculations are:

#### External Loads

##### Weather

- Weather Library (geographic location)

- Outdoor Design

#### Solar

- Latitude and Longitude
- Time Zone
- Clearness Number
- Design Month
- Building Orientation

#### Construction

- Roof Heat Transfer Properties
- Roof Area
- Wall Heat Transfer Properties
- Glass U-Value
- Percent Glass
- Glass Shading Coefficient

#### Internal Loads

##### Room Design Temperature (setpoint)

- Summer, Winter

##### Design Values

- Lighting
- People Sensible and Latent Heat
- People Density
- Miscellaneous Sensible and Latent Heat

##### Utilization Schedules

- Lighting
- People
- Miscellaneous

### **Day Calculations**

- Weather data for one day
- Sunrise and sunset time, solar declination angle, degrees equation of time, hour constants

### **Hour Calculations**

- Direction cosines of sun, direct normal solar intensity, sky brightness

### **Zone Calculations**

- Ground brightness, angle of incidence, direct solar radiation, sky diffuse radiation, ground diffuse radiation, total solar radiation
- Wall load
- Transmission and absorption factors of glass
- Glass film coefficient
- Solar heat gain through glass
- Glass load
- Roof load
- Floor load
- Partition load
- Internal loads, people, lights, miscellaneous

## Design Phase

The Design phase of the TRACE program calculates the design supply-air temperatures, heating and cooling capacities, and supply air quantities given the peak load files generated by the Load phase. For applications where the building design parameters are known, you can override the calculation of these values using optional entries to the System phase. This gives you the ability to simulate existing buildings with installed equipment that may not be sized according to the loads calculated in the Load phase.

The entries required for these calculations are as follows:

- Output from Load phase
  - Zone peak loads
  - Building block loads
- Room design conditions
- Outside-air conditions
- Outside-air percentage
- Percentage of internal and wall loads to return air
- System type
- System fan static pressure
- Fan motor efficiency
- Infiltration
- Reheat minimum airflow

The Design phase will first assign the peak or block load calculated by the Load phase to the systems providing cooling. Once the loads have been assigned, the latent and sensible components of the loads are totaled and the sensible heat ratio (SHR) for each system is determined.

Knowing the design room conditions, design outside-air conditions, percent of outside air used for ventilation, and fan heat, the supply-air dry-bulb temperatures for each system are psychrometrically established. Applying this supply-air dry-bulb temperature to each zone, the required peak airflow for each individual zone is determined. For peak-air systems, the system airflow is determined by totaling the zone peak airflows. For block-air systems, the system airflow is based on the block load of the system.

From the earlier psychrometric simulation, the coil-entering and leaving enthalpy conditions can be determined. The program then modifies the enthalpy difference to correct for the design barometric pressure. The modified enthalpy difference is subsequently used to calculate the design cooling capacity.

The design heating capacity for primary systems is calculated by summing the wall, glass, floor, and roof loads plus the ventilation and infiltration loads at the winter design temperature. In addition, mixing and reheat systems will include a reheat load. All internal and solar loads should conservatively be scheduled unavailable when arriving at the final design heating capacity.

### Assignment of Loads

The first step in the design phase is to assign zone sensible loads to the system that will ultimately handle that particular load. The assignment of loads to the return air also takes place. The percentage of lights, wall, and roof loads assigned to return air will reduce the zone sensible load. The system type will determine whether the system space cooling loads are based on the block-system load or the sum-of-the-zone peak loads.

If no skin system is specified, all of the heating and cooling loads are assigned to the primary system.

$$QSYSc =$$

$$QLITEs \times (1-PCLRA) + QPEOPs + QMISCs + QWALLc \times (1-PCWRA) + QGLASSc + QROOFc \times (1-PCRRA) + QFLOORc + QINFc$$

$$QSYSh =$$

$$QWALLh \times (1-PCWRA) + QGLASSh + QROOFh \times (1-PCRRA) + QFLOORh + QINFh$$

Where:

*QSYSc* = system level cooling load

*QSYSh* = system level heating load

*PCLRA* = percent load to return air

*QPEOPs* = people load

*QMISCs* = miscellaeneous load

*QWALL* = wall load

*PCWRA* = percent wall return air

*QGLASS* = glass load

*QROOF* = roof load

*PCRRA* = percent roof return air

*QFLOOR* = floor load

*QINFc* =  $K \times CFMINF \times (SDDb - RMDb_c)$

*QINFh* =  $K \times CFMINF \times (SDDb - RMDb_h)$

*h* = heating

*c* = cooling

If a heating-only skin system is specified, only the wall, glass and floor heating loads are assigned to the skin system, and the remaining heating loads are assigned to the primary system.

If a heating/cooling skin system is specified both the heating and cooling wall, and the glass and roof loads are assigned to the skin system. The remaining loads are assigned to the primary system. Only the primary system may handle latent loads.

### System Cooling Supply-Air Dry Bulb (SADBc)

Once the system loads have been assigned, the psychrometric iteration to find SADBc is performed using the following procedure.

Step A. Calculate the system SHR and the temperature increase due to the supply and return fans.

- Step B. 1. Assume a value for coil leaving dry bulb and then  
2. Determine the cooling supply air dry bulb, SADBc.

Given the SHR line and SADBc, the wet bulb can be taken from the psych chart.

Step C. Calculate cooling coil airflow. The coil airflow may be a sum-of-the-peaks airflow, or a block airflow.

Step D. Determine the temperature increase due to the return-air loads and return-air fan. Use only block return-air loads.

Step E. Determine the return-air temperature.

Step F. Determine the return/outside air mixture condition.  
Note that  $RACFM = \text{Coil CFM} - OACFM$ .

Step G. Determine the coil-entering condition. For draw-through fan configurations, the coil-entering condition is the same as the return/outside air mix. For blow-through fan configurations, the supply fan heat must be added first.

Step H. Determine the new coil-leaving condition.

Follow the coil line from the coil-entering condition down to the previous assumption for CLDB.

If the difference between the humidity ratios is less than one percent, the iteration stops. Otherwise, follow the coil line down to where it intersects the SHR line (for draw through) or to where it intersect the SHR line minus fan heat (for blow through). Restart the iteration at Step B2.

When cooling supply-air dry bulb is entered, the psychrometric iteration will calculate the room humidity ratio at which the psychrometric iteration of the TRACE program converges.

### **Zone Airflows and Heating Supply-Air Dry Bulb (SADBh)**

After the cooling supply-air dry bulb temperature has been determined for the system, the program calculates the cooling airflow for each zone served by that system. This airflow calculation is based on the peak sensible loads of the zone, as previously calculated and assigned.

Once the zone cooling airflows have been determined for both the primary and skin system, the heating supply-air dry bulb temperature (SADBh) can be calculated.

When system types FC or VTCV are used as skin systems, skin SADBh is initially calculated using the total skin winter design load (QSKINh) and the sum of the skin cooling zone airflows.

If, however, the skin SADBh calculated is greater than the skin SADBh input by the user, or is greater than 125°F, the final SADBh value will be reset to the lower value between the 125°F and user input skin SADBh. If the calculated value of skin SADBh is overridden by the user, the design skin system SADBh must be recalculated.

The zone skin cooling airflows are then recalculated.

For primary systems, the heating supply-air temperature is initially based on the

worst case zone (assuming 20 percent over-design) and the zone cooling airflow.

If, however, the calculated value of SADBh is greater than the system SADBh entered or is above 125° F, the final value will be reset to the lower value, either 125° F or the SADBh entry.

Once the system heating supply-air dry bulb is known, temporary values of zone heating airflows are calculated.

At this point, both a "heating" and "cooling" airflow is known for all zones. Zones which are *heating only* have final zone airflow set to the heating airflow value.

Zones which are *heating/cooling* have final zone airflow set to the larger of the cooling and heating airflow value.

*Note:* All airflows are calculated on a basis of standard airflow unless specified otherwise in the Load Parameters dialog box.

### **System Airflows**

For *peak-air systems*, the fan airflow is the sum of the airflows of the zones served by that system.

For *block-air systems*, the fan airflow is based on the system block sensible load.

### **System Cooling Capacity**

Next, the design capacity is determined from the coil-entering and the coil-leaving condition.

Once the humidity ratios are adjusted for altitude corrections, the return and outdoor air mixture enthalpy and coil-leaving enthalpy are calculated. The cooling capacity is then calculated.

For the double-duct, multizone and bypass multizone systems, the coil airflow is increased by five percent to account for damper leakage. The ventilation load is included in the overall cooling capacity.

### **System Heating Capacity**

The heating capacity requirement is calculated for skin systems. Repeat this process for primary systems.

### **Design Calculation Summary**

- Assign Loads
- Read Building and Zone Peak Loads
- Assign Loads to Zones
- Assign Zone Loads to System
- Determine System Cooling SADB
- Read Input File
- System Sensible Heat Ratio
- Fan Heat
- Cooling Supply-Air Dry Bulb and Supply-Air Humidity Ratio
- Determine Zone Airflows
- Supply-Air Dry-Bulb Heating

- Zone Heating Airflow
- Zone Airflow, System Airflow, Outside Airflow
- Zone Output
- Determine System Capacity
- Supply-Air Dry Bulb if blow-through or Coil-Leaving Dry Bulb if draw-through
- Return-Air Dry Bulb and Return-Air Humidity Ratio
- Return and Outside Air; Coil-Leaving Enthalpy
- Design Cooling Capacity and Design Heating Capacity
- System Output