

**Getting Started**

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# **TRACE™ 700**

## **Load Express**

**version 6**



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The Trane Air-Conditioning Economics (TRACE™ 700) software, is intended as a design-and-analysis tool to help designers optimize the design of the heating, ventilating, and air-conditioning system based on energy utilization and life-cycle cost. Program accuracy is highly dependent on user-supplied data. It is the user's responsibility to understand how the data entered affects program output, and to understand that any predefined libraries are to be used only as guidelines for entering that data. The calculation results and reports from this program are meant to aid the system designer and are not a substitute for design services, judgment, or experience.

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# 1

## Introduction

Welcome to TRACE™ 700 Load Express—a quick-and-easy software application that calculates cooling loads, heating loads, and airflow capacities using ASHRAE-approved algorithms. Combine the intuitive Microsoft® Windows-based interface with entries geared specifically for small- to medium-sized light commercial buildings, and the result is an incredibly short learning curve. TRACE 700 Load Express lets “rookies” and experienced users alike perform accurate load calculations in minutes.

### What to look for in this manual

The best way to learn TRACE 700 is to try it yourself. Tutorials describe the steps you will use to:

- Work with TRACE 700 project files (Chapter 2)
- Model a building (Chapter 3)
- Describe the air distribution system (Chapters 4–5)

If you purchase the full edition of the TRACE 700 program, additional tutorials illustrate how to:

- Model heating and cooling plants (Chapters 6–7)
- Describe the economic parameters (Chapter 8)
- Work with Alternatives (Chapter 9)

*Note: These tutorials assume that you have a working knowledge of your computer hardware and Windows operating system, and that you have successfully installed TRACE 700.*

### What to look for in online Help

- Detailed descriptions of each entry in the program, including default values, acceptable ranges, and typical values
- Calculation formulas and information used by the program
- Assistance for interpreting calculation results
- Rules that govern the entry process

## How to reach us

Your license agreement (renewable annually) entitles you to continued use of the program, as well as free program and documentation updates. The experienced HVAC engineers and software specialists in our support center will provide you with unlimited software support. Should you need additional help, we also offer regional or on-site training. Call us for details.

Support center hours are from 8:00 a.m. to 5:30 p.m. central time, Monday through Thursday, and from 8:00 a.m. to 5:00 p.m. Friday.

phone • 608-787-3926

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## Want the latest developments?

Visit the Trane Web site at [www.tranecds.com](http://www.tranecds.com).

## Have suggestions?

We recognize the need for continual product improvement. As you use TRACE 700 and discover opportunities to enhance the usability of the product, or if you encounter difficulties, please take a moment to let us know. Fill out the feedback form included in the software package and fax or mail it to us. Or, if you prefer, contact us through any of the methods listed above.

**Tutorial**

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# **Load Express**



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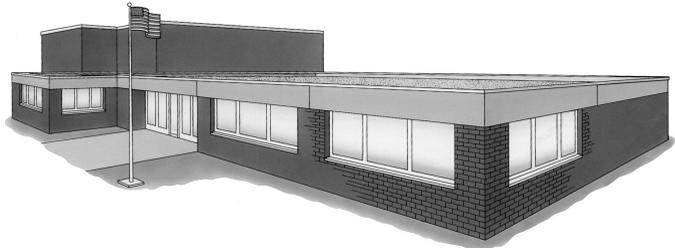
## 2 Working with a Project

The best way to learn TRACE 700 is to try it yourself. Use Chapters 2 through 9 to guide you through basic TRACE 700 skills. During the tutorial, you will create and print a project file for a fictitious Washington Elementary School.

*Note: This tutorial assumes that you have a working knowledge of your computer hardware and Windows operating system, and that you have successfully installed TRACE 700.*

### Scenario

The architect provided a floor plan, descriptions of the construction materials, and other basic design criteria for the fictitious Washington Elementary School. You will finish creating a project file, define the rooms and HVAC systems, and print the results.



**Washington Elementary School**

### Opening an existing project



To begin the tutorial, we will need to open an existing project. Start TRACE 700 Load Express and either click **Open** on the **File** menu or click **Open File** on the toolbar.

Select the LETUTORIAL.TRC project file from the PROJECTS folder and click **OK**. (You will also find COMPLETED\_LETUTORIAL.TRC in the same folder. This is the completed project file for the Washington Elementary School, which is provided so that you can compare your results with ours.)

## Saving a project

TRACE 700 automatically saves the project file as you select Project Navigator commands or switch worksheets, rooms, or components. To preserve this tutorial file, rename it now—before you make any changes. (On the **File** menu, click **Save As** and give the file a different name.)

By default, TRACE 700 will save your project files in the project folder you specified during installation. You can change this default later. Refer to **Setting Preferences** in online Help for additional details.

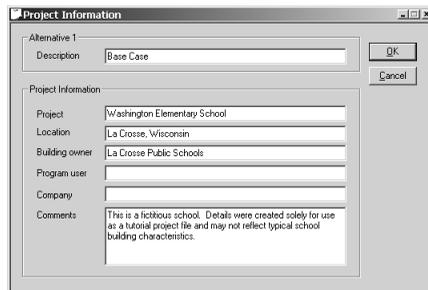
## Entering project information



Entering project information is optional. The **Title Page** report identifies your project with the project information you enter here. It also summarizes the geographical information and other design parameters.

To begin, click **Enter Project Information** in the **Project Navigator** window, click the **Enter Project Information** icon on the toolbar, or click **Enter Project Information** on the **Actions** menu.

- 1 Add a brief description for this project file in the **Comments** section. (You can use the same information as our sample screen shown below, or you can create your own project description.)



The screenshot shows a dialog box titled "Project Information". It has a tab labeled "Alternative 1". The "Description" field contains "Base Case". Below this is a section titled "Project Information" with several fields: "Project" (Washington Elementary School), "Location" (La Crosse, Wisconsin), "Building owner" (La Crosse Public Schools), "Program user", "Company", and "Comments". The "Comments" field contains the text: "This is a fictitious school. Details were created solely for use as a tutorial project file and may not reflect typical school building characteristics." There are "OK" and "Cancel" buttons on the right side of the dialog.

- 2 Click **OK** when finished.

Notice that the project name is displayed to the right of the **Project Navigator** icon.

## Selecting a weather location

Area weather conditions affect the loads in a building. To specify the climate, identify a city location for the building and TRACE 700 will use the weather conditions, time zone, and elevation for that area.

More than 500 U.S. and international weather profiles are predefined in the program. Each profile describes design wet-bulb and dry-bulb temperatures, barometric pressures, wind velocities, ground reflectance, saturation curves, and cloud cover modifiers. TRACE 700 uses this information to determine conduction, solar, infiltration, and outdoor-air loads.



Click **Select Weather Information** in the **Project Navigator** window, click the **Select Weather Information** icon on the toolbar, or click **Select Weather Information** on the **Actions** menu.

TRACE 700 opens the map you chose as default during installation. You can select a different map by clicking **Map** on the **Options** menu. Refer to **Setting Preferences** in online Help for additional information.

- 1 Click *once* on the dark blue area of the map to select the region for La Crosse, Wisconsin.
- 2 Select **La Crosse, Wisconsin** from the list that appears and click **OK**.

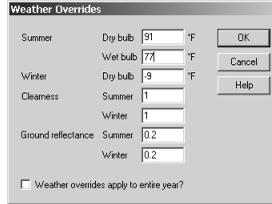
## Creating a new weather profile

There are several ways to create new weather for TRACE 700 to use during the calculation.

### Overriding design conditions

The summer design weather values for each city are based on ASHRAE 2.5% design conditions, when available. If you want to

design your system for other design conditions, you can change the design points in the **Weather Overrides** dialog box.

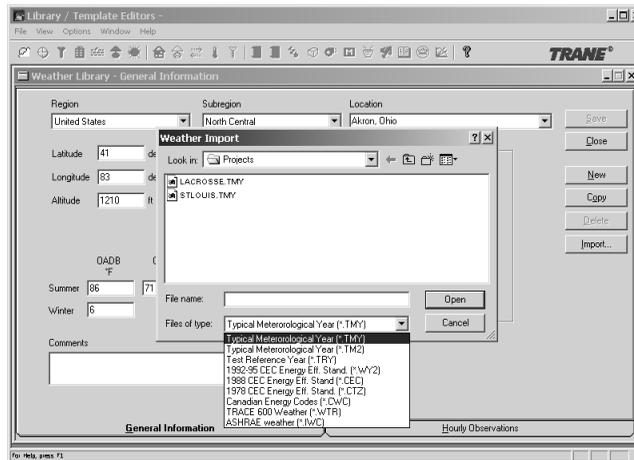


Import...

### Importing a weather profile

If custom weather profiles were created in TRACE 600, the **Weather Library** import feature will bring them into TRACE 700. (Custom Load 700 weather locations can be imported using the *Export/Import Custom Library* feature described in online Help.)

If you have full-year (8,760 hours) analysis weather in one of the accommodated formats, import it into the **Weather Library** as shown. TRACE 700 will create design weather based on the data, and will store a reference to the filename and location of the data file on your computer or network. If you later delete a full-year weather file, e.g., SANFRANCISCO.TMY, you will not be able to use that location until you restore it or re-import it.



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# 3

## Creating Rooms

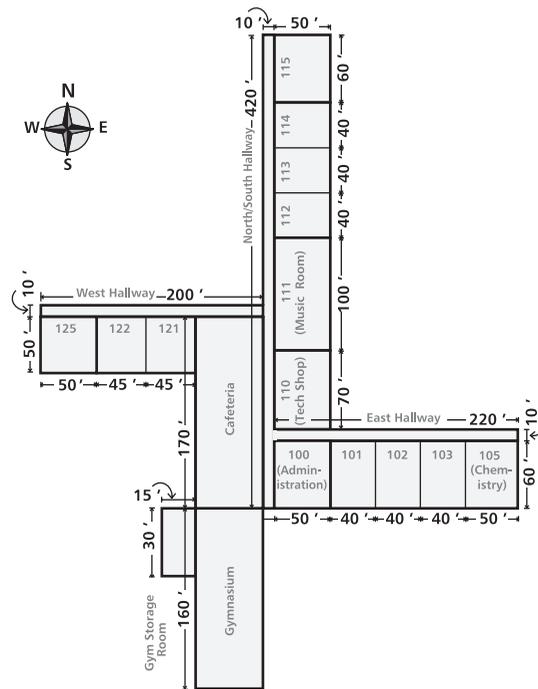
TRACE 700 defines a *room* as the smallest space for which it can calculate a heating or cooling load. The space may be a large, open-plan office that occupies the entire floor of a building, or it may be a conference room separated from adjacent spaces by interior dividers. Commonly, the dimensions of a room are defined by surfaces that contribute to heat-transfer characteristics.

In this chapter, you will learn how to use the **Create Rooms** worksheets to create and define the various small spaces of a building.

Ready to start? Turn the page ...

# Floor plan

Here is the floor plan that the architect provided for Washington Elementary School. The building is laid out in a *plus* shape with three intersecting hallways. We created a project file that uses the architect's naming convention for areas of the building. In TRACE 700, you can use any alphanumeric phrase to name rooms, systems, and zones.



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## Create Rooms window



Click **Create Rooms** in the **Project Navigator** window, click the **Create Rooms** icon on the toolbar, or click **Create Rooms** on the **Actions** menu.

The **Create Rooms** window contains seven tabbed *worksheets*.

Description	Length (ft)	Height (ft)	Direction	% Glass or Qty	Length (ft)	Height (ft)
1	120	10	270	35	0	0
	0	0	0	0	0	0
	0	0	0	0	0	0

Internal loads...			Airflows...		
People	40	sq ft/person	Cfg vent	15	cfm/person
Lighting	2	W/sq ft	Htg vent	15	cfm/person
Misc loads	0.22	W/sq ft	VAV min	0	air changes/hr

The **Single Sheet** worksheet provides a convenient summary of various room attributes. The other six worksheets let you refine the description of the room by entering additional details. To display a specific worksheet, click the associated tab at the bottom of the **Create Rooms** window.

You can quickly model simple projects by entering room information solely on the **Single Sheet** worksheet. Use the entries on the subsequent worksheets to help you model complex projects with extensive details.

The **Create Rooms** worksheets are linked to each other, and editing an entry on one worksheet automatically updates the other worksheets with the same data. For example, if you change the direction of a wall on the **Single Sheet** worksheet, the direction is also changed on the **Walls** worksheet.

The **Room Description** list (located at the top of every worksheet) shows all of the rooms in the project file. You can

switch from room to room by clicking the down arrow at the right of the **Room Description** box and then selecting a room from the list.



To avoid overwriting your original data when exploring *what if* situations, rename the project file *before* you make any changes.

## Apply and Close/Cancel buttons

Simply stated, the **Apply** button stores the current worksheet information in the project file. However, the program also does this automatically whenever you switch between worksheets, rooms, or components (for instance, selecting different walls in the same room).

The **Close/Cancel** button is labeled **Close** when a worksheet is initially displayed, and changes to **Cancel** when you enter or modify room information. Clicking **Cancel** erases any changes you made to the current worksheet and returns the button label to **Close**. Clicking **Close** returns you to the **Project Navigator** window.

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## Single Sheet worksheet

You can quickly define a room using only the **Single Sheet** worksheet to enter data and select templates. This worksheet identifies general information commonly seen on blueprints: floor and roof area, external wall descriptions, amount of glass on walls, internal load conditions, and ventilation requirements.

Templates contain information that can apply to many rooms. Selecting a template *fills in* data on worksheets. You can create and edit templates for use in several projects. Any of these values can be edited, even on a room-by-room basis. Refer to online Help for more information about using templates.

Therefore, on the **Single Sheet** worksheet, type in a few dimensions, specify internal loads and airflow information, select desired templates, and you are done. (For more-accurate calculations, use the other six worksheets to provide more details about the room.)

To get you started, the tutorial project file already contains many of the room descriptions. You can switch to different rooms by clicking the down arrow at the right of the **Room Description** box and selecting a room from the list.



Why are some values red and others black? Red values originate from templates. Overriding a value or selecting a new item from a list changes the value in the field to black. To restore the template value for a numeric field, enter an asterisk (\*). For text fields, select **\*Template**.

### Creating a new room

We will create **Classroom 115** on the **Single Sheet** worksheet.

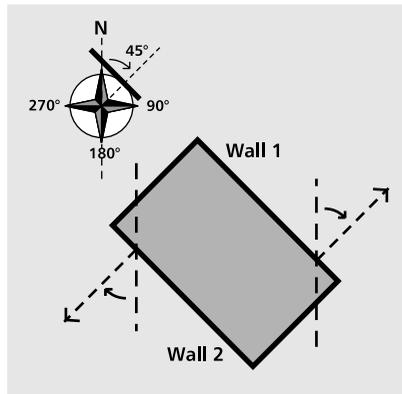
- 1 Click **New Room** and change the room description to **Classroom 115**.
- 2 To save time, use the predefined templates to fill in some of the details. From the **Room Templates** list, select **@Classroom**. The **Room** template is a *main* template that contains references to four other sub-templates: internal loads, airflows, thermostat settings, and construction types.
- 3 The floor plan represents Classroom 115 as 60 feet by 50 feet. Type these dimensions in the **Floor Length** and **Floor Width** boxes.

**Figure 3–1 Wall Direction**

Determine angle from north/  
south axis:

**Wall 1** faces northeast = 45°

**Wall 2** faces southwest = 225°



*Note: The program multiplies these entries together to calculate the area of the room. If the room is not a perfect rectangle, enter the area of the room in one field and enter the numeral 1 in the other. For example, the dimensions of this room could also be entered as 3000 feet by 1 foot and the results would not change.*

- 4 Because the roof on Classroom 115 has the same dimensions as the floor, click the **Equals floor** option button.

If the roof area differs from the floor area, enter roof dimensions in the **Roof Length** and **Roof Width** fields. Because the program multiplies these two entries, enter the roof area in one box and the numeral 1 in the other if the roof is not a perfect rectangle.

- 5 Refer to the floor plan and enter the dimensions and direction of the two walls in Classroom 115.

In TRACE 700, create walls to describe exterior surfaces exposed to ambient conditions. Describe interior walls and below-grade walls as *partitions* on the **Partn/Floors** worksheet. Define the direction of the walls as the angle of rotation from due north, as illustrated in page 4–6. Refer to online Help for additional information.

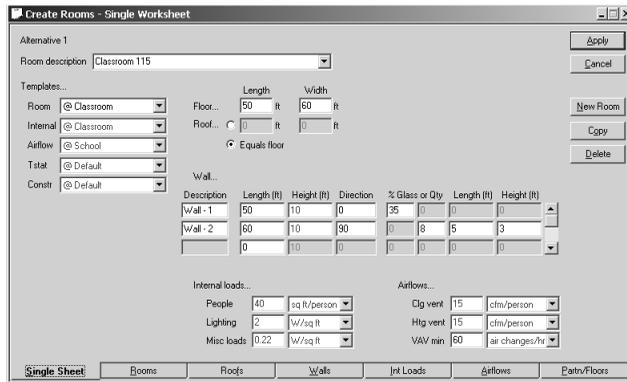
- 6 Describe the glass for each wall. Define the dimensions of the glass by entering either the percentage of total wall area *or* the length and width of a single window and the number of windows to which those dimensions apply.

**TIP**

In TRACE 700, a wall is an exterior surface that is exposed to ambient conditions and contributes to the conduction load for the room. (Use the **Partn/Floors** worksheet to describe interior walls and below-grade walls that separate spaces with significant temperature differences.)

The north wall (Wall 1) is 35 percent glass. The south wall (Wall 2) has eight windows, each 5 feet high by 3 feet wide, totalling 20 percent of the wall area.

- 7 Use the default values for internal loads. (These default values are read from templates.)
- 8 Change the VAV minimum airflow to **60% Cig Airflow** (percent of the design cooling airflow). This is the minimum stop on the VAV box that serves the room.
- 9 Click **Apply** to store the changes. Now, compare your worksheet with ours:



## Copying a room

Making a copy of a room, from either the **Single Sheet** worksheet or the **Rooms** worksheet, can save time. Copying a room copies the entries (on every worksheet) for the current room and creates a new room with identical values. The only thing left for you to do is to rename the room and modify values as appropriate. Copy **Classroom 115** to create **Classroom 105**:

- 1 On the **Single Sheet** worksheet, select **Classroom 115**.
- 2 Click **Copy**.
- 3 Change the room description to **Classroom 105**.
- 4 The only difference between **Classroom 105** and **Classroom 115** is the direction of the walls.

Change the wall information as follows:

	Length	Width	Direction
Wall 1	50 ft	10 ft	180°
Wall 2	60 ft	10 ft	90°

5 Click **Apply** and compare your worksheet with ours:

The screenshot shows the 'Create Rooms - Single Worksheet' dialog box. The 'Room description' is 'Classroom 105'. Under 'Templates...', 'Room' is set to 'Classroom', 'Internal' to 'Classroom', 'Airflow' to 'School', 'Total' to 'Default', and 'Const.' to 'Default'. The 'Length' is 50 ft and 'Width' is 60 ft. The 'Equate floor' checkbox is checked. The 'Wall...' table is as follows:

Description	Length (ft)	Height (ft)	Direction	% Glass or Qty	Length (ft)	Height (ft)
wal - 1	50	10	180	35	0	0
wal - 2	60	10	90	0	3	5
	0	10	0	0	0	0

Internal loads: People (40 sq ft/person), Lighting (2 W/sq ft), Misc loads (0.22 W/sq ft). Airflows: Cfg vent (15 cfm/person), Htg vent (15 cfm/person), VAV min (60 % Cfg Airflow). The 'Single Sheet' tab is active, with other tabs for Rooms, Roofs, Walls, Int Loads, Airflows, and Part/Floors.

## Rooms worksheet

Use the **Rooms** worksheet to provide information about the floor and the thermostat settings for the room. (You can create new rooms from this worksheet also.)

TRACE 700 assumes that the floor described on the **Rooms** worksheet contributes only to the *thermal mass* of the room—not to the conduction load. To model the heat transfer across a floor, use the entries on the **Partn/Floors** worksheet to create an *exposed* or a *slab-on-grade* floor.

We created a room called **Cafeteria** for this project. The cafeteria is not carpeted, nor is there a suspended ceiling to define a plenum. Describe these factors on the **Rooms** worksheet.



TRACE 700 displays a warning message if you enter a value outside the typical range. You can find the typical range and limits for any numeric entry in online Help.

### Editing information on the Rooms worksheet

- 1 Select **Cafeteria** from the **Room description** list.
- 2 Change the **Floor-to-floor** height to **20** feet, and the **Plenum** height to **0** feet.
- 3 Clear the **Carpeted** check box because the room is not carpeted.
- 4 Apply these changes. (The program will warn you that this height *seems unusual*—which is okay for this tutorial.) Now, compare your worksheet with ours.

Alternative 1	
Room description	Cafeteria
Templates...	
Room	@ Classroom
Internal	@ Classroom
Airflow	@ School
Tstat	@ Default
Constr	@ Default
Size...	
Length	50 ft
Width	170 ft
Height...	
Floor to floor	20 ft
Plenum	0 ft
Above ground	ft
Duplicate...	
Floor multiplier	1
Rooms per zone	1
Room mass/avg time lag	None
Slab construction type	4" LW Concrete
Carpeted	<input type="checkbox"/>
Acoustic ceiling resistance	1.786 hr·R <sup>2</sup> ·F/Btu
Design...	
Cooling dry bulb	75 °F
Heating dry bulb	68 °F
Relative humidity	50 %
Thermostat...	
Cooling dirtpoint	90 °F
Heating dirtpoint	65 °F
Cooling schedule	None
Heating schedule	None
Location	Room
Humidity...	
Moisture capacitance	None
Humidistat location	Room

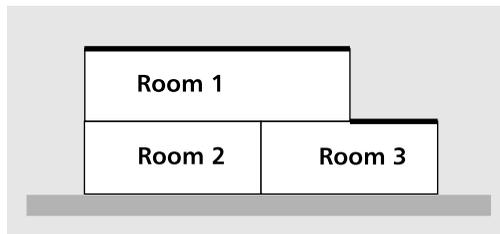
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## Roofs worksheet

Use the **Roofs** worksheet to describe the roof and skylight surfaces.

In TRACE 700, a roof describes external surfaces (including skylights) that are exposed to ambient conditions. It contributes to the conduction and solar radiation loads for a room.

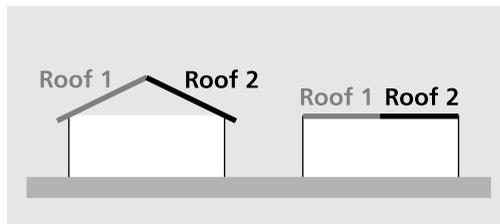
A roof may be pitched or it may only partially cover a room. In these instances, roof area would *not* equal floor area.



**Figure 3-1**  
**Roof Types**

**Room 1:**  
roof = floor  
**Room 2:**  
no roof  
**Room 3:**  
roof  $\neq$  floor

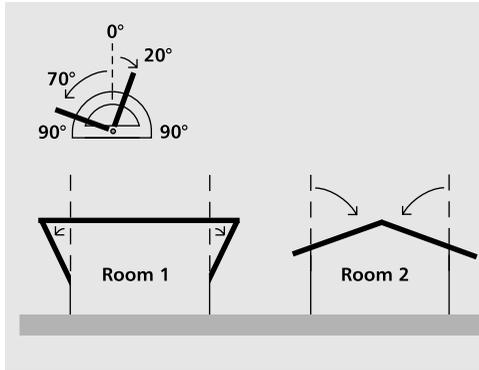
On the **Roofs** worksheet, you can add multiple roofs to a room, describe the construction type of each roof, and specify heat-transfer parameters. Describe multiple roof surfaces when the roof has a pitch (two or more surfaces facing different directions) or when it has two different construction types.



**Figure 3-2**  
**1 Room,**  
**2 Roofs...**

Pitched roof  
surfaces that face  
different directions  
Two types of  
construction for the  
roof or skylight

You should identify pitch and direction for each roof, measured in degrees. The default roof pitch is 90°, which is horizontal.



**Figure 3-3**  
**Roof Pitch**

Determine the angle from an axis that is perpendicular to the ground.

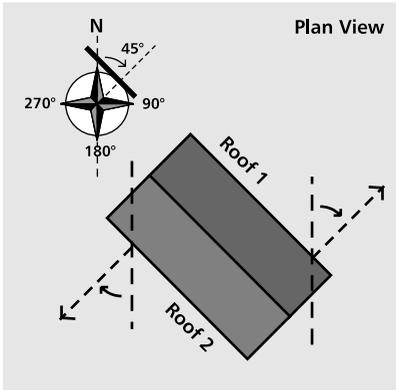
**Room 1:**

Pitched roofs face the ground; pitch =  $-20^\circ$   
Flat roof pitch =  $90^\circ$

**Room 2:**

Pitched roofs face the sky; pitch =  $70^\circ$

Direction is measured as distance (in degrees) from North. This diagram may help you better understand how to enter a value for direction.



**Figure 3-4**  
**Roof Direction**

Determine the angle from the north/south axis.

**Roof 1** faces northeast =  $45^\circ$

**Roof 2** faces southwest =  $225^\circ$

The roof of the Administration room has a pitched roof that slopes down from the cafeteria to the next classroom. We will now model this roof.

## TIP

You can specify only one glass type per roof surface. If a roof consists of two or more types of glass, divide the roof into sections—one for each glass type.

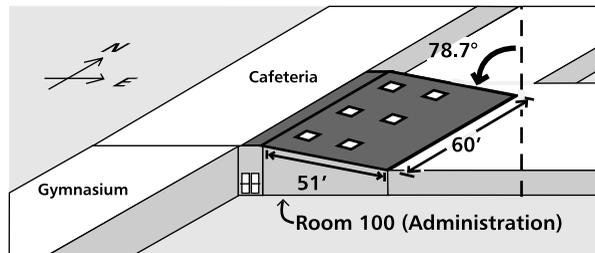
## TIP

Abbreviations commonly used in construction-type definitions include:

Conc = concrete  
Ext = external  
HW = heavyweight  
Ins = insulation  
Int = internal  
LW = lightweight

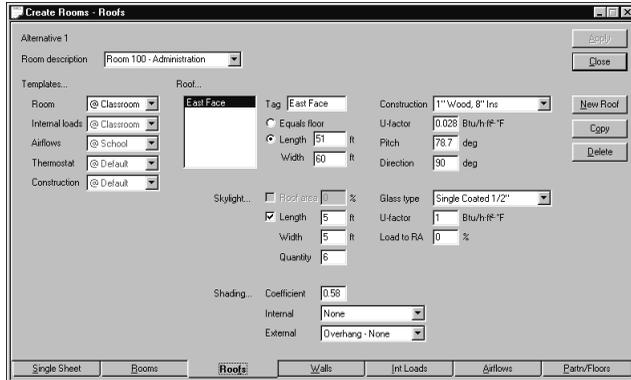
## Describing a pitched roof

- 1 On the **Roofs** worksheet, select **Room 100–Administration**.
- 2 In the **Tag** box, give **Roof-1** a more descriptive name. Half of the pitched roof for this room faces east—name it **East Face**.
- 3 The area of the east-facing roof differs from the floor area. Click the **Length** option button in the **Roof** section to enter the dimensions for this part of the roof. (If the roof is not rectangular, you can enter the total area as one dimension and the numeral 1 as the other.)
- 4 Refer to the illustration below and enter values for dimensions, direction, and pitch. Change the construction type to **1" wood, 8" ins**, and the **U-factor** to **0.028**.



- 5 Describe the skylights either by *percentage of area* or by *dimension*. There are six skylights, each 5 feet by 5 feet—a total of 150 square feet, which is 4.9 percent of the total roof area.

- 6 Select **Single Coated 1/2"** as the glass type. Then apply these changes and compare your worksheet with ours:



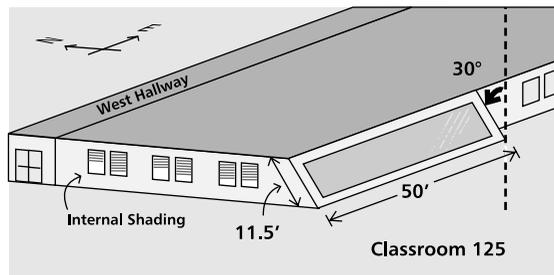
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## Walls worksheet

In TRACE 700, a wall is an *exterior* surface that is exposed to ambient conditions and contributes to the conduction load for the room. (Use the **Partn/Floors** worksheet to describe *interior walls* and *below-grade walls* that separate spaces with significant temperature differences.)

You can enter basic wall information on the **Single Sheet** worksheet. However, if the room has a tilted wall or if the walls are made of more than one construction type, then you should use the **Walls** worksheet to further detail the room description.

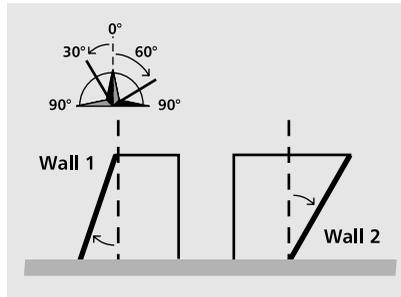
The south wall of Classroom 125 at Washington Elementary School has tinted glass and tilts at a 30° angle.



### Describing a tilted wall

- 1 On the **Walls** worksheet, select **Classroom 125**.
- 2 Create a new wall and name it **South Wall-Tilted**.
- 3 Enter the dimensions and direction of the tilted wall based on the illustration of Classroom 125 above. Use the defaults for the construction type, ground reflectance multiplier, and U-factor.

- Indicate the angle of tilt for the wall. (Refer to online Help for additional information and illustrated explanations of direction and tilt values.)



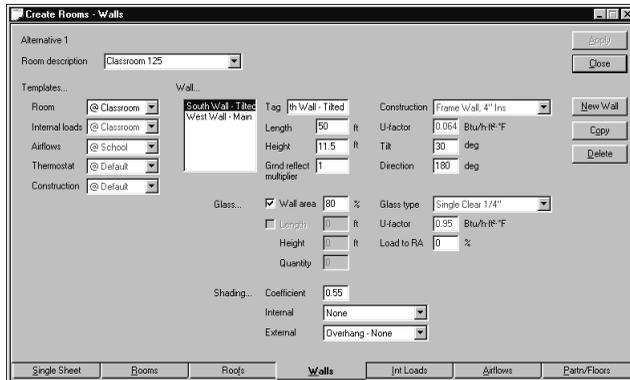
**Figure 3-5 Wall Tilt**

Determine the angle from an axis that is perpendicular to the ground.

Wall 1 tilt = 20°

Wall 2 tilts toward ground;  
tilt = -30°

- Glass makes up 80 percent of the tilted wall. Select the **Wall area** check box and enter **80** as the value.
- The tint on this coated glass affects the solar load. Specify a shading coefficient of **0.55**.
- Click **Apply** and compare your worksheet with ours:



**TIP**

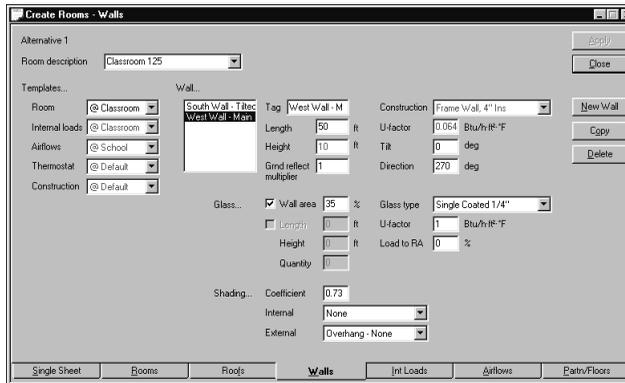
Refer to online Help for definitions and illustrations of internal and external shading. You can customize existing shading types to add new ones of your own.

## Selecting a different glass type

Make sure that **Classroom 125** is still selected on the **Walls** worksheet. Then:

- In the **Wall** box, select **West Wall–Main**.

- 2 Single-coated, 1/4-inch glass makes up 35 percent of this wall. Enter these values.
- 3 Apply the changes and compare your worksheet with ours:



---

## Int (Internal) Loads worksheet

Internal loads (such as the people in a room or heat from lights and office equipment) typically have a significant impact on the cooling load of a room.

Among similar rooms, the various internal loads and their schedules (time periods when the loads are present) are generally the same. Creating and applying an **Internal Load** template will save time by filling in all of the relevant values on the worksheet.

Occasionally, the internal loads vary from the typical values on a template. You may need to edit the **Int Loads** worksheet to more accurately describe the room.

**Room 100–Administration** houses typical office equipment such as copiers and printers. You can apply an existing template with typical office loads and schedules to quickly model the loads, then edit values where needed. After we apply a template, we will add a piece of miscellaneous equipment that is not included in the office template.

### Applying a template and adding miscellaneous equipment

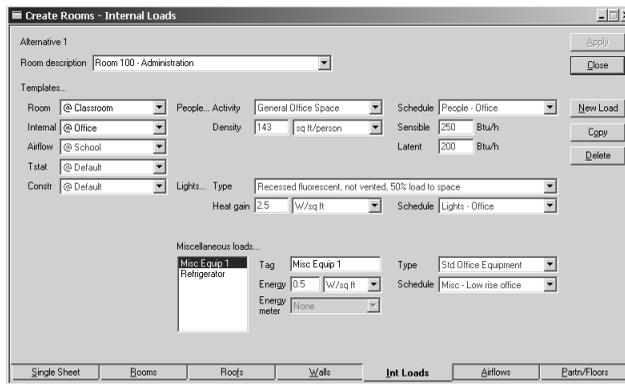
- 1 On the **Int Loads** worksheet, select **Room 100–Administration**.
- 2 Select **@Office** as the template for internal loads. (Notice that all of the red entries change.)
- 3 Click **New Load**. Change the default name (Misc. Load 2) to **Refrigerator**. Assuming that the load is 100 percent sensible, use **Std Office Equipment** as the load type.
- 4 Change the **Energy** value to **300 Btuh**.
- 5 The schedule for the refrigerator differs from that of the standard office equipment. Change the schedule to **Available 100%**.

*Note: Energy-related entries are only available if you purchase and install the full TRACE 700 program rather than the Load Express edition.*



Other values for load type include **Percent of load sensible** and **Radiant fraction**. Use the Library/Template Editors program to view definitions for internal loads in the **Internal and Airflow Loads** Library.

6 Click **Apply** and compare your worksheet with ours:



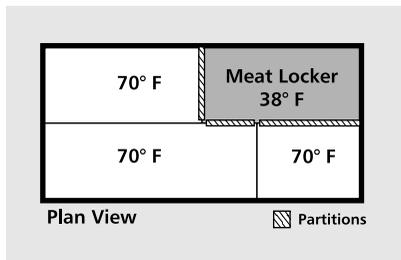


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## Partn/Floors worksheet

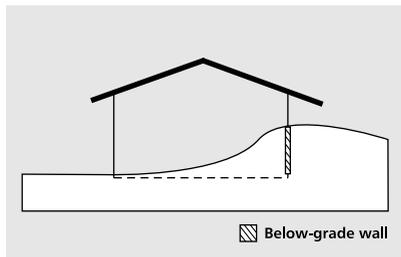
When a surface such as a partition or floor contributes significantly to the room load, you can use the **Partn/Floors** worksheet to describe the parameters that affect the load.

TRACE 700 defines *internal walls* or *below-grade walls* as *partitions*. Partitions separate spaces that have a significant temperature difference, such as a room next to a meat locker or an unconditioned storage area. A partition could also define a below-grade wall. Either way, partitions do not include solar radiation loads—only conduction is considered.



**Figure 3–6 Partitions**

Interior walls that separate spaces with significant temperature differences are modeled as partitions.

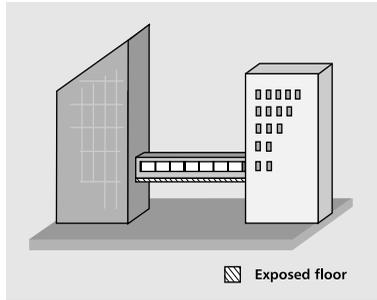


**Figure 3–6 Below grade walls**

Model below-grade walls as partitions because they do not include solar radiation loads.

An *exposed floor* is affected by the ambient environment. It separates the room from an area with a significant temperature

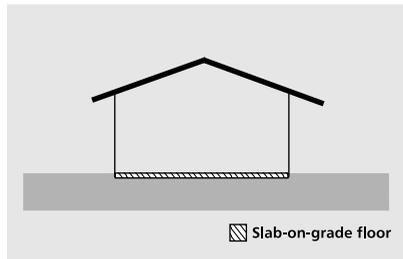
difference, such as a floor above an underground garage or under a breezeway.



**Figure 3-7 Exposed floor**

Floor that is exposed to ambient conditions

A *slab-on-grade floor* accounts for thermal losses through the perimeter edge of the floor slab due to ambient conditions. Slab-on-grade thermal losses are modeled during heating design only.



**Figure 3-8 Slab-on-grade floor**

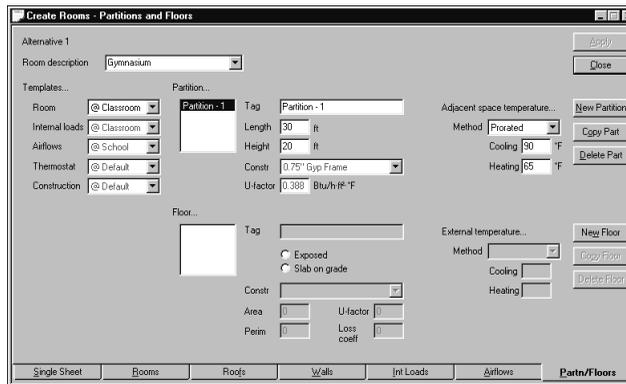
Floor that rests directly on the ground and conducts heat through the perimeter surfaces

A rooftop unit conditions the storage room next to the gymnasium. Although the temperature difference between these two rooms is not significant, we will create a partition between them for this tutorial. (Refer to the floor plan illustrated on page 3-2.)

## Creating a partition

- 1 On the **Partn/Floors** worksheet, select **Gymnasium**.
- 2 Click **New Partition**. If you wish, use the default name assigned by the program (Partition - 1).

- 3 From the floor plan, we know that the room is 30 feet long and 20 feet high. Enter these dimensions.
- 4 Select **Prorated** as the **Method** for the **Adjacent space temperature**. Because the space is not conditioned, temperature in the space varies proportionally to ambient conditions. (Refer to online Help for more information about temperature flags.)
- 5 Enter **90°F** and **65°F** as the temperatures in the adjacent storage room during the cooling season and heating season, respectively.
- 6 Apply the changes and compare your worksheet with ours:



Continue the tutorial in the next chapter, *Creating Airside Systems*.

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## 4 Creating Airside Systems



When you describe the airside system that will condition the air in your building, TRACE 700 can help you determine design information such as coil and fan capacities, room airflows, and design temperatures.

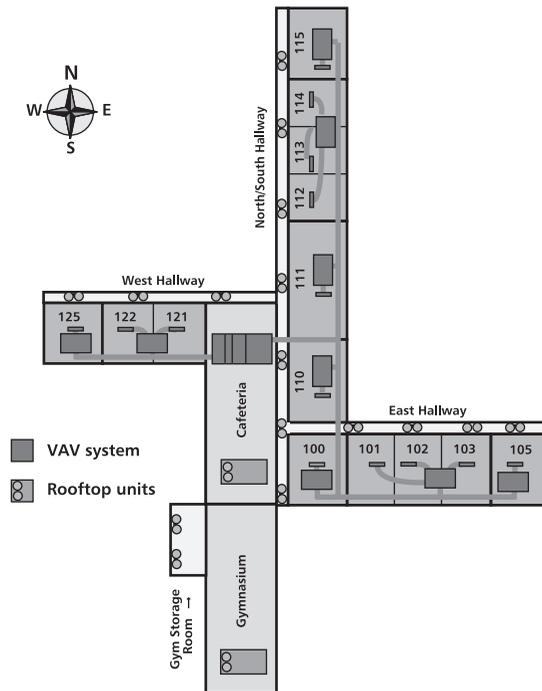
An *airside system* in TRACE 700 refers to the method for distributing conditioned air to spaces—air handlers, unit ventilators, fan coils, and unit heaters, among others. The system type you select loosely describes the components of the system (coils, fans, and air paths). The system type also defines how the program should size components.

---

## System plan

Take another look at Washington Elementary School represented on page 3–2. We reviewed the floor plan and chose three systems that are common in school buildings. We will use:

- A single-zone rooftop system (with two units) for the gymnasium, cafeteria area, hallways, and storage room.
- A VAV system for the classrooms and administration area



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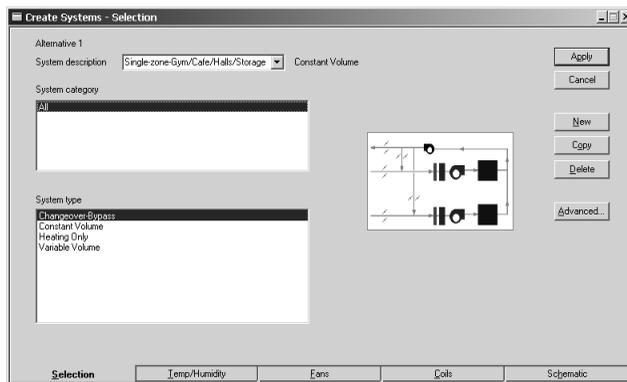
## Create Systems window



Click **Create Systems** in the **Project Navigator** window, click the **Create Systems** icon on the toolbar, or click **Create Systems** on the **Actions** menu.

The **Create Systems** window is comprised of five worksheets. You can create systems and select a system type using only the first worksheet, which is called **Selection**. The program requires only the system type to calculate system design information. It can use the default values (from the subsequent worksheets) to calculate coil loads and airflows.

Each worksheet has a **System description** box that lists every system in your project (similar to the **Room description** box in the **Create Rooms** window). The system type is identified next to this box.



---

## Selection worksheet

Use the **Selection** worksheet to add, copy, and delete systems, to give them unique names (descriptions), and to select the system type.

TRACE 700 Load Express models 4 types of airside systems. The bottom box lists the system types.

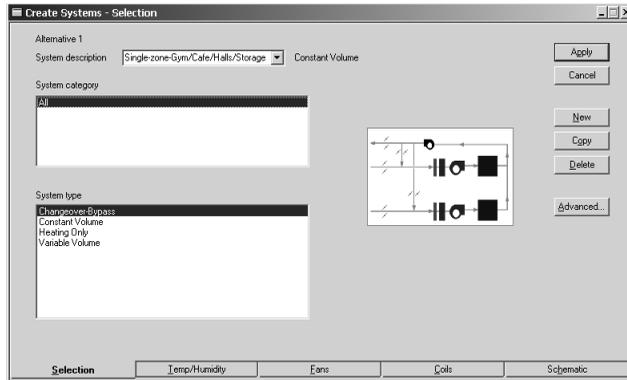
The schematic diagram on the right side of the worksheet illustrates the system type. (The **Schematic** worksheet shows a larger, more detailed drawing that labels the coils and fans.)

One of the systems in this project was created in advance. In this exercise, we will create one new system and then change the system name for easy identification.

### Creating a new system

- 1 Click **New**.
- 2 Change the **System description** to **Single-zone-Gym/Cafe/Halls/Storage**.
- 3 Pick **Constant Volume** as the **System type**.
- 4 Click **Apply** to store your changes. The program does this automatically whenever you switch between worksheets, rooms, or components (for instance, selecting different walls in

the same room), but it never hurts to do it yourself more frequently! Now, compare your worksheet with ours.



As in the **Create Rooms** window, the **Copy** button duplicates the entries (on every worksheet) for the current system and creates a new system with identical values.

Now, finish describing the constant-volume unit.

# Temp/Humidity worksheet



Entering the same value for both the minimum and maximum values limits the supply-air temperature to that value.

TRACE 700 calculates an appropriate design airflow for each room and a supply-air temperature based on the room loads.

If you prefer, you can limit the range for minimum and maximum design-air temperatures on the **Temp/Humidity** worksheet. You can also decide to include minimum humidity levels when sizing a humidification sub-system.

## Changing air temperatures in the system

- 1 In the **System description** box, select **VAV-Classrooms**.
- 2 Specify **60°F** and **55°F**, respectively, as the **Cooling supply** maximum and minimum **Design Air Temperatures**.

The program will return the best supply-air temperature *within the range you specified*, not necessarily the best altogether. You may not achieve your design objective if your range is too narrow.

- 3 To size the humidification sub-system, change the **Minimum room relative humidity** to **30%**. (TRACE 700 uses this value to determine the amount of mechanical humidification needed.)
- 4 Click **Apply** to save your changes and then compare your worksheet with ours:

Alternative 1  
System description: VAV - Classrooms Variable Volume

Design Air Temperature

Cooling supply Max 60 °F Min 55 °F

Leaving cooling coil Max °F Min °F

Heating supply Max °F Min °F

Supply duct temperature difference 0 °F

Reheat temperature difference 0 °F

Direct/Indirect Dehumidification Methods (System Simulation only)

Type: None

Maximum room relative humidity 30 %

Main cooling coil minimum allowable leaving (when throttling a chilled water coil downward during dehumidification or "wild coil" mode) 0 °F

Variable Fan Speed for capacity control (System Simulation only)

Number of fan speeds: None

Percent airflow at low speed 0 %

Percent airflow at medium speed 0 %

Humidification

Design humidity ratio difference 0 grams

Minimum room relative humidity 30 %

Selection Temp/Humidity Fans Coils Schematic

---

## Fans worksheet

The entries on the **Fans** worksheet let you define the fans in the system and also indicate their static pressure.

Click **Overrides** to review the default values for fan efficiencies. The default values are acceptable for many projects. Should your project have special considerations, or if you are modeling an existing system, you may prefer to change the values on this worksheet.

### Specifying fans

TRACE 700 uses the fan static pressures from the **Static Pressure** column to estimate the amount of fan heat added to the air stream. (Leaving the static pressure field zero will omit fan heat from the design calculations.)

For most system types, the main cooling supply fan is the *primary* fan of the system (that is, the supply fan in a central-station air handler).



Entries for fans that do not apply to the system type are unavailable.

To more accurately predict the load for the gymnasium, cafeteria, halls, and storage, we will adjust the cooling supply value to account for added fan heat.

- 1 On the **Fans** worksheet, select **Single-zone–Gym/Cafe/Halls/Storage** in the **System description** box.
- 2 Enter the **Static Pressure** for each fan. Use **2.5** in. wg for the primary fan and **1.0** in. wg for the return fan.
- 3 Click **Apply** to save your changes and compare your worksheet with ours:

*Note: Energy-related information such as the fan type, schedule, and full-load energy rate are unnecessary for load design*

calculations. Consequently, these entries are only available if you purchased and installed the full TRACE 700 program.

**Create Systems - Fan Overrides**

Alternative 1

System description:  Changeover-Bypass

Fan cycling schedule:

	Type	Static Pressure (in. wg)	Full Load Energy Rate	Full Load Energy Rate Units	Schedule
Primary	None	2.5	0	kW/Cfm	Available (100%)
Secondary	None	0	0	kW/Cfm	Available (100%)
Return	None	1	0	kW/Cfm	Available (100%)
System exhaust	None	0	0	kW/Cfm	Available (100%)
Room exhaust	None	0	0	kW/Cfm	Available (100%)
Optional ventilation	None	0	0	kW/Cfm	Available (100%)
Auxiliary	None	0	0	kW/Cfm	Available (100%)

Note: Only static pressure entries are needed for Load Express.

## Coils worksheet

The values on the **Coils** worksheet affect the sizing of cooling and heating coils.

Review the default values for the coil properties on the **Coils** worksheet. The default values are acceptable for many projects, especially if you are using occupancy and internal-load schedules. You may decide to change the values on this worksheet to refine your calculations, or to model existing buildings.

*Note: The ability to change coil capacities and schedules is not available for TRACE 700 Load Express.*

Alternative 1  
System description: Single-zone-Gym/Cafe/Halls/Storage Changeover-Bypass

Apply  
Close

Capacity Overrides

	Capacity	Capacity Units	Schedule
Main cooling	100	% of Design Cooling Capacity	Available (100%)
Auxiliary cooling		% of Design Cooling Capacity	Available (100%)
Main heating	100	% of Design Capacity	Available (100%)
Auxiliary heating		% of Design Capacity	Available (100%)
Preheat	100	% of Design Capacity	Available (100%)
Reheat	100	% of Design Capacity	Available (100%)
Humidification	100	% of Design Capacity	Available (100%)

Diversity

People 100 %  
Lights 100 %  
Misc loads 100 %

Note: The coil capacity fields are not available for Load Express.

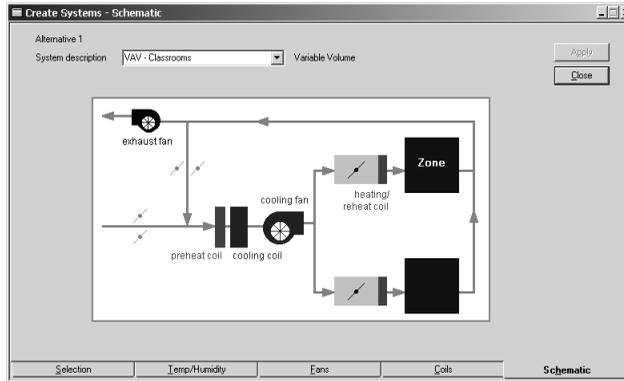
Selection Temp/Humidity Fans Coils Schematic

## Schematic worksheet

The **Schematic** worksheet illustrates and labels the major components of the airside system. This worksheet cannot be edited—it is provided for your convenience. (You may find this illustration useful when you are interpreting design information from calculation results.)



When TRACE 700 calculates system design information, it sizes both a return fan and an exhaust fan, regardless of what is represented on the schematic.



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## 5 Assigning Zones and Rooms



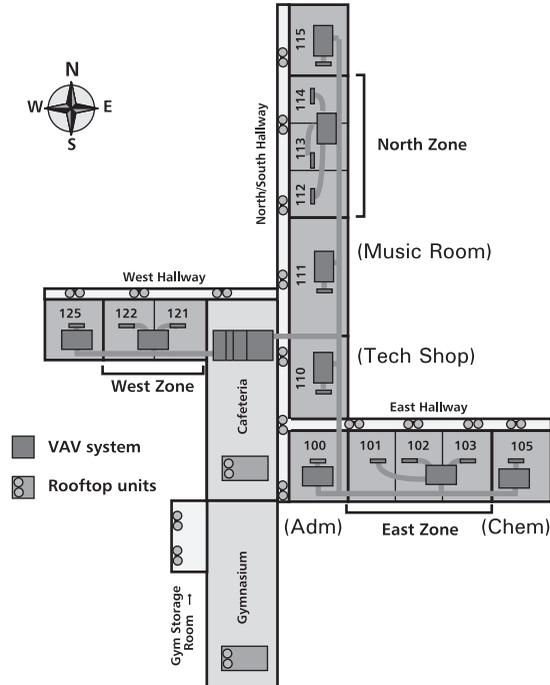
TRACE 700 calculates system design information such as airflows, coil loads, and fan sizes for the HVAC systems, and then uses the design to simulate a year of operation. To do so, you must assign the rooms either directly or indirectly to a system.

Rooms can be grouped into *zones* to determine design loads at a higher level. In a VAV system, for example, a terminal box is frequently designed to serve a group of similar rooms. By grouping these rooms into a zone, the program can calculate the design airflow for each room as well as the design capacity of a heating coil within the terminal box.

Zones are optional. TRACE 700 can calculate design information if only the rooms are assigned to systems, or if both rooms and zones are assigned to systems. (A room assigned directly to a system becomes a zone.) Rooms and zones will now be organized for the systems at Washington Elementary School.

## System and zone plan

As you look again at the Washington Elementary School floor plan, remember that we chose two systems for the building in Chapter 4. Now we will decide how each system will distribute air and identify groups of rooms as zones.



### The VAV system

Ideally, each VAV terminal box in a VAV system serves only one room. However, to reduce costs, many VAV systems often use one terminal box to serve a group of similar rooms.

TRACE 700 can calculate design information (for example, design airflows and heating-coil capacities) at the zone, room, or system level. The system type determines which level to use.

The VAV system uses terminal boxes to serve zones and rooms. Notice on the floor plan that adjacent classrooms (which have similar loads) are grouped into zones.

The administration room, music room, technical shop, and the end rooms each have a terminal box assigned directly to them.

### **The single-zone system**

The single-zone system will serve the gymnasium, cafeteria, hallways, and gym storage, and each room will need a rooftop unit. These spaces are not grouped, but are left as individual rooms served by dedicated systems.

# Assign Rooms to Systems window



Click **Assign Rooms to Systems** in the **Project Navigator** window, click the **Assign Rooms to Systems** icon on the toolbar, or click **Assign Rooms to Systems** on the **Actions** menu.

The **Unassigned Rooms** box on the **Assign Zones and Rooms** worksheet lists the rooms not currently assigned to a system—assigning a room or zone to a system means that the system serves that room or zone.

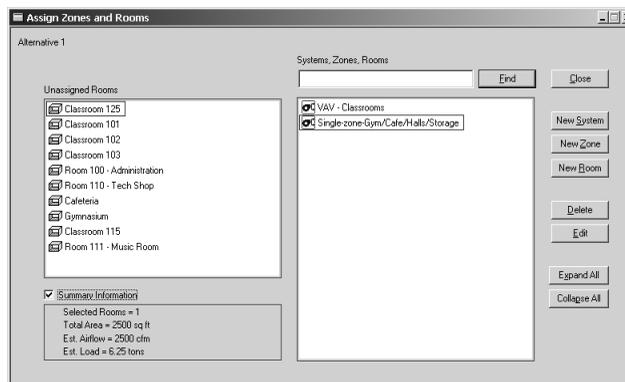


Double-click the system and zone icons to expand or collapse the tree. When a system or zone is *collapsed*, there is a red outline around the associated icon if a room is attached.

The **Systems, Zones, Rooms** box allows arranging and viewing hierarchical relationships using a *tree* metaphor. Each branch from the system shows the rooms and zones it serves. (The rooms and systems are listed in the order that they were created.)

The **Summary Information** check box can help you decide how to group your rooms and zones. When the box is checked, TRACE 700 displays estimated airflow and cooling load values for any highlighted rooms. These estimates are based on common industry measurements: 1 cfm/sq ft and 400 sq ft/ton.

You may find the **Summary Information** box very useful. However, it does slow the program down somewhat. For best performance, check the box only when you need it.



## New, Delete, Edit, and Close buttons

New systems, zones, and rooms can be created using this worksheet—the **Create Rooms** and **Create Systems** windows are then used to further define them. To add a new system, zone, or room, click the appropriate button on the right-hand side of the **Assign Zones and Rooms** worksheet.

The **Delete** button will delete a room, system, or zone *completely*. You can only delete a zone or system if it does not contain any rooms or zones.

When a room or system is selected, clicking **Edit** will open either the **Create Rooms** window or the **Create Systems** window. (Double-clicking a room or system also opens the associated windows.) When a zone is selected, clicking **Edit** lets you change the name of the zone.

Clicking **Close** will return you to the **Project Navigator** window.

---

## Assigning a room to a system

Look at the **VAV-Classroom** system tree. (Double-click the icon if room or zone icons are not currently displayed below the system icon.)

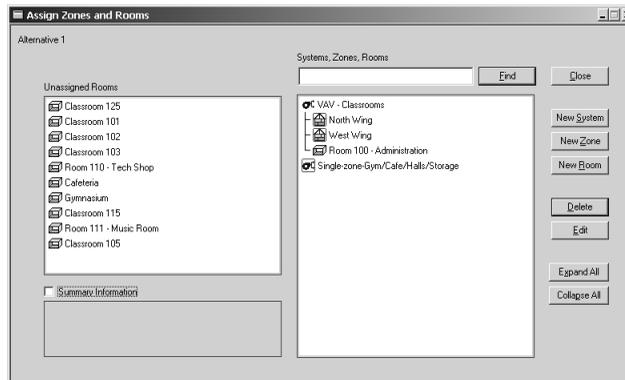
The system serves the West Wing zone (Classrooms 121 and 122) and the North Wing zone (Classrooms 112, 113, and 114). Notice that the system also serves the Tech Shop, Classroom 125, Classroom 111, and the music room as separate comfort spaces.

Add **Room 100-Administration** to the system, remembering not to group it in a zone.

### Assigning a room directly to the system

- 1 Select the **Room 100-Administration** icon.
- 2 Drag the room icon to the icon labeled **VAV-Classrooms** and *drop* it (release the mouse button). The room moves to the system tree. The branch lines indicate that the system directly serves this room.

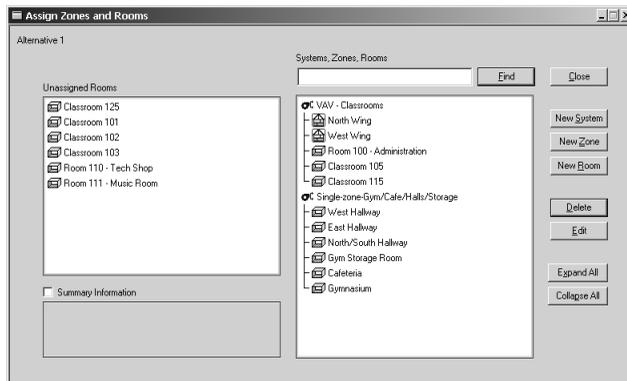
Now, compare your screen with ours ...



## Selecting and assigning non-sequential rooms

Like many other Windows programs, you can select multiple, non-sequential items by pressing the CTRL key as you select each item. Use the gymnasium, cafeteria, hallways, and gym storage room as an example. Try it now:

- 1 Select **Cafeteria**.
- 2 Press and hold the CTRL key, then click **Gymnasium**. Continue holding the CTRL Key and click the hallways and gym storage room until all are selected.
- 3 In one move, drag the selected rooms to the **Single-zone-Gym/Cafe/Halls/Storage** system and release them.
- 4 Repeat steps 2 and 3 to assign Classrooms 105 and 115 to the **VAV-Classrooms** system. Then compare your screen to ours:



---

## Creating a zone within a system

We created the West Wing zone for you; now you will create the East Wing zone.

Creating zones is optional. TRACE 700 can calculate design information for individual rooms assigned to systems, or for both rooms and zones assigned to systems.

### Creating a new zone

- 1 On the **Assign Zones and Rooms** worksheet, select the icon labeled **VAV-Classrooms** system.
- 2 Click **New Zone**. Notice that a new zone icon was added to the system tree.

### Changing the name of the zone

- 1 Click **New Zone** and then click **Edit**.
- 2 Change the zone description to **East Wing** and click **OK**.

## Assigning rooms to a zone

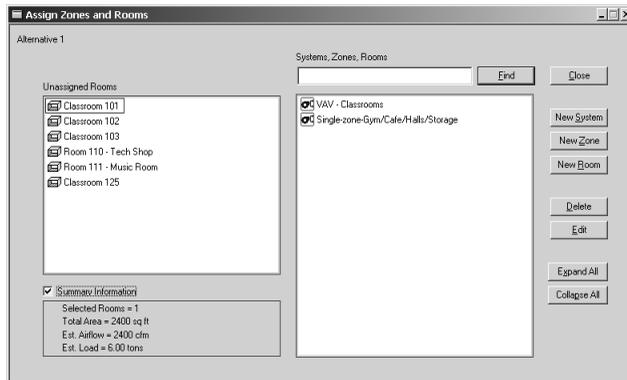


Selecting the **Summary Information** check box estimates airflow and cooling loads for all highlighted rooms.

Now that you have created the East Wing zone, you can assign rooms to it. The **Summary Information** box shows the estimated airflow and cooling load values and can help you determine which rooms to zone together. This can be especially helpful when the system sizes are predetermined. (For example, you may already know that your project will have eight 20-ton rooftop units and you must combine rooms accordingly.)

### Viewing estimated airflow and load values

- 1 Select any room or group of rooms from a list.
- 2 Click the **Summary Information** check box.



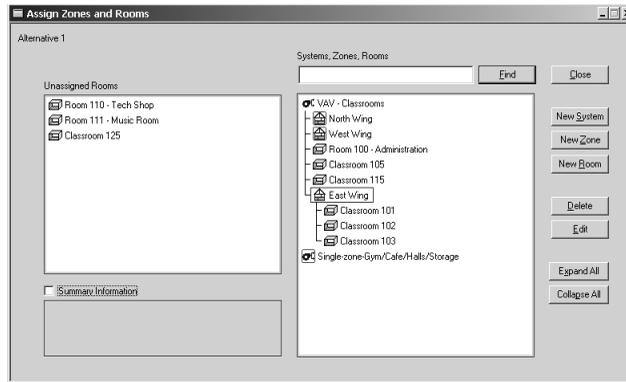
TRACE 700 calculates the total area from the dimensions you entered in the **Create Rooms** window. The program uses these common industry measurements to estimate airflow and cooling load values:

airflow = 1 cfm/sq ft *and* cooling load = 400 sq ft/ton

### Selecting and assigning sequential rooms

Like many other Windows programs, you can select multiple items in a sequence by using the **SHIFT** key with the mouse. To assign Classrooms 101, 102, and 103 to the East Wing zone:

- 1 Select **Classroom 101** (the first in the sequential list of rooms to include).
- 2 Hold down the **SHIFT** key and click **Classroom 103** to select it plus all of the rooms between **Classroom 101** and **Classroom 103**.
- 3 Drag the selected rooms to the **East Wing** zone and drop them directly on that icon. Now, compare your screen with ours:



- 4 Complete the room assignments by dragging the three remaining rooms to the system icon labeled **VAV-Classrooms**. Then click **Close** to return to the **Project Navigator** window.

You have now entered enough information to calculate the design heating and cooling loads for Washington Elementary School.