System Analyzer™

Simplified HVAC Energy and Economic Analysis

Version 6

TRANE®

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1 A Brief Introduction

System Analyzer™ is a comparative analysis tool for preliminary evaluations of HVAC systems based on energy and economic performance. Use it to compare virtually any combination of air distribution system(s) and cooling/heating equipment for a specific building type and weather location. Then use the program's professional-looking reports and graphs to help weigh the benefits of prospective system designs.

If you're new to the program, you'll discover that the straightforward, logically organized entries and built-in templates can help even an HVAC novice create a complete analysis in as little as 10 minutes. Experienced users can model more complex HVAC scenarios by customizing the templates and libraries.

Package contents and system requirements

The System Analyzer program includes these components:

■ TRACE™ Family CD-ROM with executable files, online Help— everything you need to install and run the program

■ System Analyzer *Getting Started* manual

Refer to the ReadMe file on the CD-ROM for details about the operating system and hardware that are required to run the program.

What's new

We completely redesigned System Analyzer to integrate it into the TRACE family of HVAC design and analysis tools. The program now uses the same calculation engine as that of our tried-and-true TRACE 700 building load and energy analysis program. This

approach provides two important benefits: Now you can easily import your preliminary System Analyzer evaluations of prospective HVAC designs into TRACE 700 for further refinement and comprehensive analysis. Also, integrating the two programs makes it easier for us to add new features—which means that you can expect more frequent upgrades.

But more importantly, System Analyzer version 6 was developed to better meet your HVAC evaluation needs. Here are a few highlights:

- **Smooth, stable operation.** We changed the programming language to make System Analyzer compatible with the latest Windows operating systems.

- **Streamlined entries.** The redesigned work area and built-in templates make it easy to quickly define a building, weather location, and HVAC systems with as much or as little detail as you want. Collapsible lists in the new "project navigation" pane replace menus, providing instant access to every aspect of the project.

- **Expanded modeling capabilities.** With System Analyzer version 6, you now can model makeup-air units, heating-only airside systems, and a building with *five* (rather than two) thermal zones.

- **Simplified file-sharing.** It's no longer necessary to export information from System Analyzer libraries when sharing your project files with others. Each .sa file contains *all* of the details for a project.

Installing (and uninstalling) System Analyzer

The System Analyzer program must be installed on your hard disk or a LAN drive; you cannot run the program from the CD-ROM. The ReadMe file on the CD-ROM provides step-by-step installation instructions.

Uninstalling the program

If you ever need to remove the System Analyzer program from your computer, use Add or Remove Programs in the Windows

Control Panel. This utility will delete all System Analyzer files—except for those shared by other applications and those that you created (project files and custom definitions of equipment and/or utility companies).

Starting System Analyzer

Start the System Analyzer program just as you would any other Windows program, by doing *one* of the following:

■ Double-click the **System Analyzer** icon on the desktop.

■ On the **Start** menu, point to **Programs** and **C.D.S. Applications**; then click **System Analyzer 6**.

Learning to use System Analyzer

The System Analyzer program was specifically designed so that anyone with a basic knowledge of HVAC systems can easily prepare a design analysis or comparison.

This manual

The *Getting Started* manual will acquaint you with:

■ How the program works (Chapter 2)

■ The *System Analyzer* workspace (Chapter 3)

■ How to create an analysis, step by step (Chapters 4–10)

■ The reports and graphs of the analysis results (Chapters 11–12)

TIP

Tips like this one appear throughout the manual to provide helpful hints and additional insight into how the program works.

Read the manual from cover to cover, or skip directly to Chapter 4 to begin using the program by recreating the sample analysis project.

Online Help

System Analyzer's online Help describes how to perform basic tasks. It also provides detailed information about each program entry. To open online Help, do one of the following:

- On the **Help** menu, click **Contents**.
- Press F1 for the Help topics related to the currently displayed screen.
- Click the **Help** button on the toolbar.

Web resources

Additional sources of information and help are available in the Software area of the Trane Web site. Visit www.tranecds.com for access to our online knowledge base, download center, and training opportunities, and to subscribe for notifications about program updates.

Technical support

Your license agreement (renewed annually) entitles you to continued use of the program, free program upgrades, and the latest documentation. As a Trane C.D.S. customer, you're also eligible for free technical assistance from the experienced HVAC engineers and software specialists in our support center.

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

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Comments?

We are committed to continually improving our HVAC design and analysis tools. As you use System Analyzer and discover opportunities to improve its usability, or if you encounter difficulties, please take a moment to let us know by e-mail, fax, or phone.

2 How System Analyzer Works

Key concepts

Alternatives

An **alternative** represents a particular combination of building and/or HVAC system characteristics. System Analyzer lets you define and compare up to four alternatives within the same project.

Systems and plants

Airside system represents the arrangement of air paths that carry air to and from the building zones. The program can model 17 types of airside systems in three categories: constant volume, variable volume, and heating only.

Plant refers to the mechanical equipment that conditions (heats, cools), filters, and/or moves air, usually to keep occupants comfortable. Examples include packaged air conditioners, air handlers, chillers, boilers, and auxiliary equipment, such as pumps and cooling towers.

Libraries and templates

Libraries provide the attributes of commonly used construction materials, equipment, base utilities, weather, and scheduling—all of which the System Analyzer program uses to calculate building loads and equipment energy consumption. Much of the information in these libraries reflects the design parameters published in the *ASHRAE Handbook–Fundamentals* and similar industry references.

Note: The program includes a separate Library/Template Editors utility that helps you customize the libraries of building schedules, utility rates, and cooling, heating, and thermal storage equipment. See online Help for more information.

Each *building type, airside system type,* and *plant type* serves as a **template** that provides nearly all of the information necessary to complete a preliminary performance analysis. You can rely on the default values in the template or change them to more closely match a prospective or existing design.

What the program does

System Analyzer automates four sets of calculations, which simulate building and equipment cooling and heating loads to predict the energy consumption and life-cycle costs of the HVAC system.

■ Building cooling and heating loads based on local weather

■ Equipment cooling and heating loads

■ Energy consumed by the HVAC system

■ Costs of owning and operating the HVAC system

To complete these calculations, the program uses information about the building, its location (weather), and the HVAC systems under consideration. Most of this information is provided automatically when you identify the geographic location, building type, and system type.

Here's a brief explanation of the program's methodology.

Weather

System Analyzer predicts the effect of typical weather on building loads by simulating the operation of the building and its services for a " reduced" year. In other words, for each month of a year, the program calculates the " actual" energy consumption during three 24-hour day types—Weekday, Saturday, and Sunday—and then

multiplies each result by the number of occurrences of that day type (Figure 2-1).

Figure 2-1 Basis for calculating monthly energy consumption

MARCH						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
			1 Weekday	2 Weekday	3 Weekday	4 Saturday
5 Sunday	6 Weekday	7 Weekday	8 Weekday	9 Weekday	10 Weekday	11 Saturday
12 Sunday	13 Weekday	14 Weekday	15 Weekday	16 Weekday	17 Weekday	18 Saturday
19 Sunday	20 Weekday	21 Weekday	22 Weekday	23 Weekday	24 Weekday	25 Saturday
26 Sunday	27 Weekday	28 Weekday	29 Weekday	30 Weekday	31 Weekday	

Example:
March energy consumption = (Weekday × 23) + (Saturday × 4) + (Sunday × 4)

The program's "weather" library contains weather profiles (Figure 2-2) for many geographic locations. Each weather profile includes dry-bulb and wet-bulb temperatures, enthalpies, air pressures, solar radiation, and cloud cover for the seasons in that location. System Analyzer uses:

■ "Typical" weather (historical temperatures) to calculate the Weekday, Saturday, and Sunday *energy consumption* for each month

Figure 2-2 July temperature profile for San Francisco
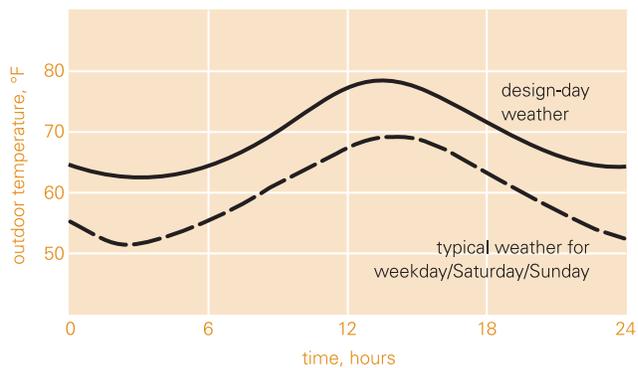
■ "Design" weather (ASHRAE 2.5%, worst-case temperatures)—along with a cooling design day type—to calculate each month's peak *energy demand*

Building loads

Because it's a comparative analysis tool for *preliminary* evaluations, the System Analyzer program generalizes the load characteristics of a building. It treats all buildings, regardless of type or size, as rectangular and divided into five thermal zones— four along the perimeter and one in the interior (Figure 2-3). The depth of each perimeter zone equals the distance between the exterior wall and the interior zone.

Figure 2-3 Typical building in System Analyzer (plan view)

System Analyzer divides each building into five thermal zones
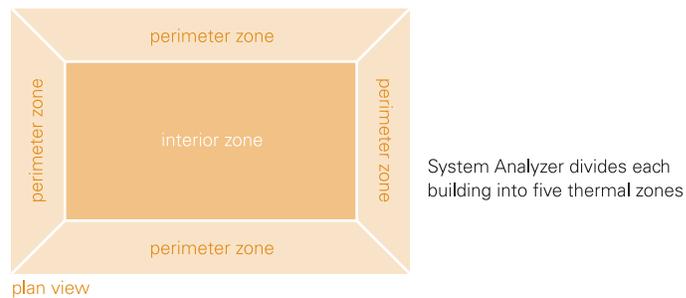
Calculations performed during this simulation define the building cooling and heating loads at design conditions based on the weather location and the description of the building. This description includes the type of building, its layout and construction, and the utilization schedules for occupancy, lights, and miscellaneous loads. (Much of this information is provided when you select a building type. See Chapter 5 or online Help for more information.)

Loads in each zone are calculated independently and without thermal interaction between zones. It's also assumed that all internal loads and ventilation are evenly distributed throughout the building.

Airside systems

To simulate operation of the airside systems in the building, the program performs calculations that determine the equipment loads for air-moving, cooling, and heating based on the heat gains and losses determined during the building load simulation.

System Analyzer then combines the resulting 24-hour building load profiles for each month with coil and fan capacities to determine the effect on the HVAC system and to calculate required airflows.

Cooling and heating plants

The objective of the plant simulation is to predict how much energy the cooling, heating, and air-handling equipment will consume each month of the year. To accomplish this, the program relies on the "equipment" library for performance information (full-load consumption rates, percentage of power consumed, and curves for unloading and ambient relief) about each piece of equipment in the system. The building load profiles generated during the airside system simulation provide the hourly demands for cooling, heating, and airflows.

The program also adjusts equipment performance based on the ambient wet-bulb and dry-bulb temperatures in the weather profile.

Economic performance

System Analyzer's economic simulation automates life-cycle cost calculations to enable decision-making based on financial criteria, such as simple payback period, yearly net present value of cash flows, internal rate of return, and summation of discounted cash flows.

Monthly utility costs are calculated by applying the utility rates (that you define) to the energy consumption and demand values that were calculated during the "plant" simulation. Installed cost, maintenance expense, and other economic factors are applied to project the life-cycle cost for the proposed design.

alternatives, and to change information that's common to all alternatives (weather location and economic parameters). A ▶ points to the current alternative.

*Note: System Analyzer displays a list of recently opened files when you start the program. Click a listed file to open it, or use the **File** menu to locate some other existing project or to create a new one.*

■ The **Alternative** list helps you move between "worksheets" to provide details about the building, airside systems, cooling and heating plants, utilities, and HVAC costs for a particular alternative. Clicking an item in this list displays the corresponding worksheet in the adjacent pane. A ▶ points to the worksheet that's currently displayed.

■ The **Reports** list provides links to the input and output reports for the project. (Some reports only become available after the program completes the analysis calculations.) "Input" reports summarize the data that were used to complete the calculations. "Output" reports show the results of those calculations. A ▶ points to the report that's currently displayed in the adjacent window.

Project details pane

The "project details" pane on the right side of the screen displays the details for the current alternative, worksheet, or report. Default values are provided for most worksheet entries, based on the type of building, airside system, or plant that was selected. Most entries can be edited.

Links at the bottom of this pane let you move to the next worksheet (or report) or return to the previous one.

Menus and toolbar

Menus across the top of the main System Analyzer window organize the commands that help you manage and work with your analysis projects. A **toolbar** directly below the menus provides one-click access to the most commonly used commands. (See Figure 3-1, p. 3–1.)

Color cues

As you work with System Analyzer, you'll notice that some worksheet entries appear in a pale yellow box (Figure 3-2). The values displayed in these entries come from one of the program's libraries of predefined equipment, construction materials, utilities, weather, and schedules. In some cases, you can change the displayed value. A "restore library values" link lets you reset the entry to the original default value.

Blue text identifies commands and hyperlinks. (An underline appears under the text when you point to it.)

Aqua bars with headings divide worksheets into groups of related entries.

Dimmed entries cannot be edited.

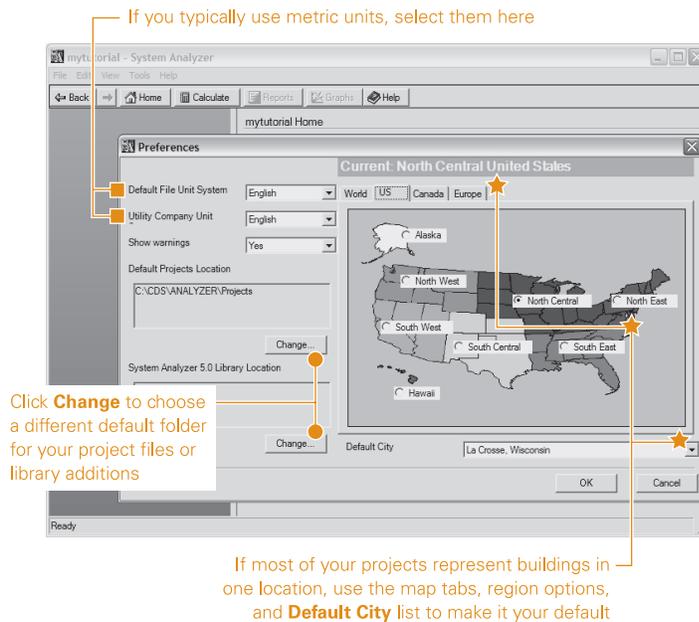**Figure 3-2 Colors identify links and library values**
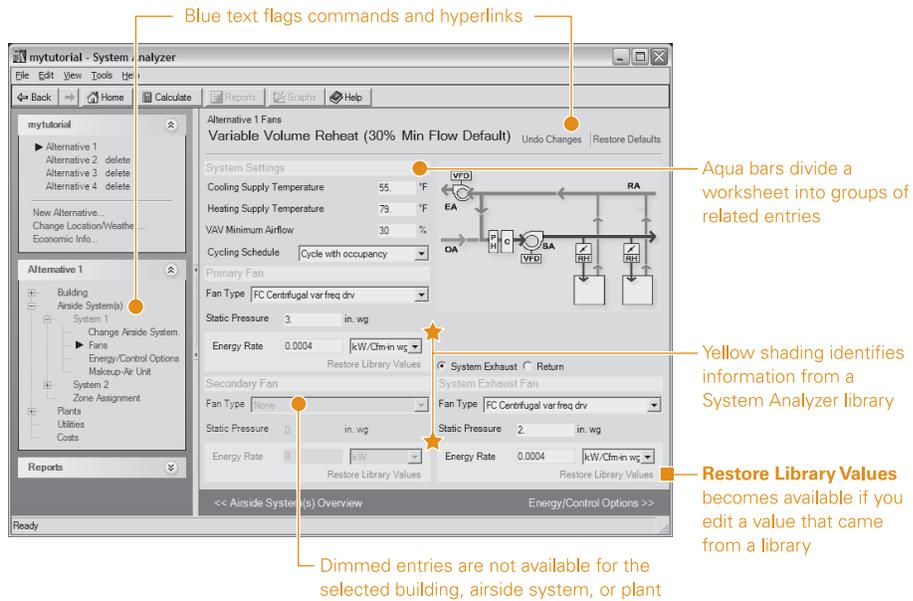
Setting preferences

Preferences are options that let you "tell" the program how you want it to work. Your choices remain in effect until you change them. In the case of System Analyzer (Figure 3-3), you can choose English I-P or metric SI units of measure, a default city for weather, and file locations for projects and libraries.

To review and/or change your preferences, open the **Tools** menu and click **Preferences**.

Figure 3-3 Preferences dialog box

If you typically use metric units, select them here

Click **Change** to choose a different default folder for your project files or library additions

If most of your projects represent buildings in one location, use the map tabs, region options, and **Default City** list to make it your default

Values selected in the **Preferences** dialog box become the defaults for all new System Analyzer project files, and will remain in effect until you change them. (You can change this information for an individual project when you create a new file or edit an existing one. See online Help for more information.)