TECBLAST Version 1.1 for Windows

(Duct Leakage Test Software)

Software User's Guide
for
Manual Data Entry

The ENERGY CONSERVATORY

DIAGNOSTIC TOOLS TO MEASURE BUILDING PERFORMANCE

TECBLAST™ Version 1.1 for Windows

(Duct Leakage Test Software)

Software User's Guide
for
Manual Data Entry

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Table of Contents

Chapter 1   **Introduction to TECBLAST** (Version 1.1 for Windows)

TECBLAST is The Energy Conservatory's duct airtightness test analysis program for Windows computers. The TECBLAST program is used to calculate, display and store test results from duct airtightness tests using a Minneapolis Duct Blaster®.

TECBLAST Features

- Easy data entry of all test data, building and customer information.
- Calculation and display of duct airtightness test results including estimated leakage rate in CFM, leakage area in square inches, leakage as a percent of system airflow, and estimated annual system efficiency loss from duct leakage.
- Built-in report generator includes a choice of one page easy-to-read homeowner report, or a two page detailed technical report.
- TECBLAST lets you print your company logo directly on the reports for a professional image. Compatible with either BMP or EMF logo file formats.
- On-Screen Help.

Help Buttons

Each screen in the TECBLAST Program contains a **Help** button to provide you with detailed information for that screen. Wherever you see the **Help** button, clicking on it will open a text window. We recommend that you use all the **Help** buttons the first time you run the program. Also, feel free to pick up the phone for some assistance in getting started (612-827-1117).

Installing TECBLAST for Windows

Before starting the install process, make sure you have at least 2 MB of hard drive space available. Place the TECBLAST diskette or CD in the appropriate drive on your computer. From the **Start** button, open the Control Panel.

From the Control Panel window, click on **Add/Remove Programs** and then click on **Install**.

The computer will locate the TECBLAST installation program on the floppy disk or CD and guide you through the remainder of the installation process

Chapter 2   **Starting the TECBLAST Program**

<u>Starting TECBLAST</u>

The TECBLAST program should have been installed using the procedures outlined in *Chapter 1* (Installing TECBLAST for Windows).

To start TECBLAST, click on **Start...Programs...Energy Conservatory...TECBLAST 1.1**.
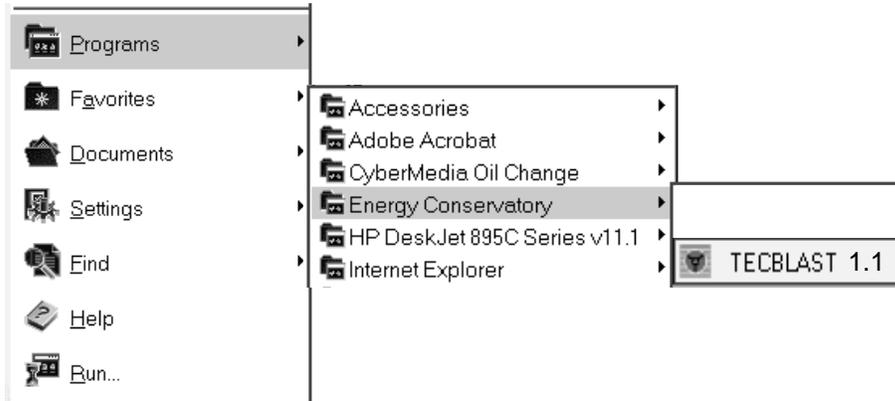
The main TECBLAST screen will now appear, with the Main Menu containing **File**, **Options**, **Goto** and **Help** located in the upper left hand corner.

Figure 2.1: Main TECBLAST Screen

Chapter 3   **Overview of TECBLAST**

Starting a New Test

To start using the TECBLAST program, open the File Menu by clicking on **File** in the Main Menu. The top of the File Menu contains three starting options:
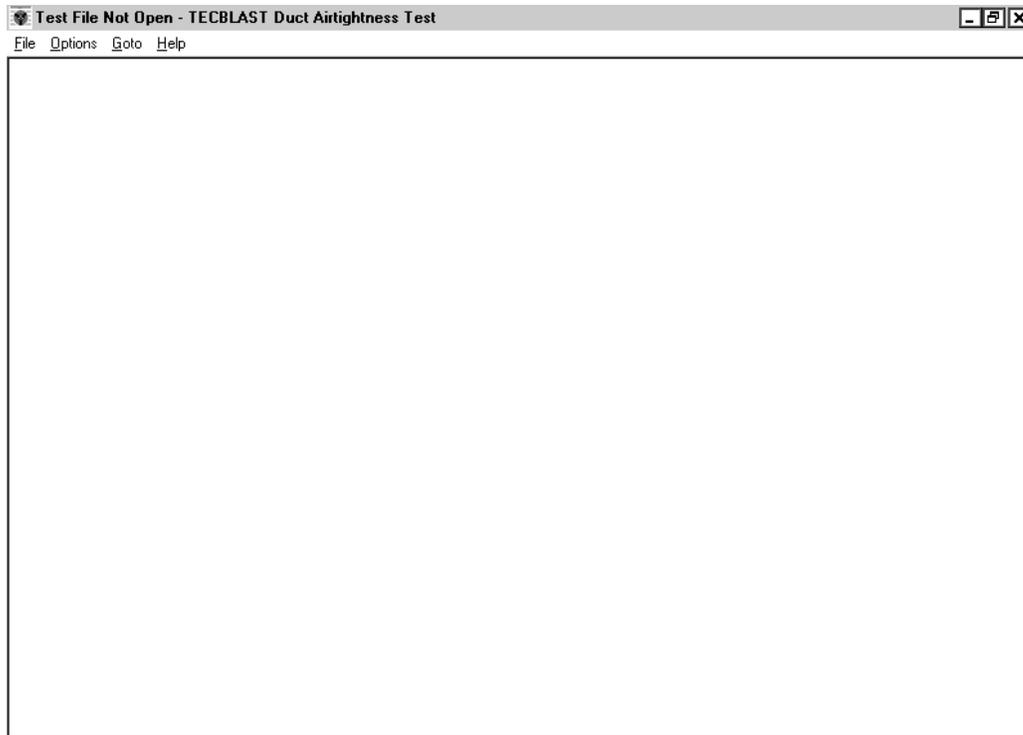
```
New Test
New Test with Custom Configuration...
Retrieve Existing Test...
```

⇒ *New Test*   is selected to begin data entry for a new duct airtightness test using the factory default program settings. Selecting this option automatically loads all factory default settings and takes you to the Customer and Building Info Screen.

⇒ *New Test with Custom Configuration*   is selected to begin data entry for a new duct airtightness test using custom configuration files which you have previously created and saved. Using configuration files is the most efficient way to run TECBLAST. Creating and saving configuration files is discussed in *Chapter 9*. After selecting a configuration file to load, the Customer and Building Info Screen will appear.

⇒ *Retrieve Existing Test*   lets you recall a previously saved duct airtightness test file. After selecting the test file to retrieve, the values from the retrieved file are loaded into the program, and the Customer and Building Info Screen appears. Once a test file is recalled, it may be viewed, edited and re-saved (with the same or a different file name). Refer to *Chapter 7* for more information on retrieving and saving test files.

Menu choices are selected by clicking on the desired option. We recommend that first time users begin by selecting **New Test**. The other starting options should be explored after familiarizing yourself with the TECBLAST program.

Help Buttons

Each screen has its own **Help** button (located in the upper right hand corner) which opens a **Help** window providing useful operating tips and detailed explanations of what information needs to be entered into each field. Be sure to use the **Help** feature the first time you use TECBLAST, and refer to the **Help** buttons whenever you have a question on program operation. To close a **Help** window, click on **Exit Help**.

Input Screens

The first 2 pages of TECBLAST are input screens where you will enter information about the customer, the building and duct system being tested, and any relevant comments that you would like to save along with the test file. An overview of the 2 screens are shown on the next page. You can click on individual fields to enter information, or use the **Tab** key to quickly move between fields. To clear a screen, click on the **Clear** button at the bottom of each page. When you are finished with a screen, click on the **Next** button to proceed. At any time, you can step back to earlier screens by using the **Previous** button, or use the **Goto** Menu to move to any active screen.

Customer, Building and Comment Screens

Customer and Building Info Screen:
The Customer and Building Info Screen is used to input the name, address, and phone number of the customer for whom the duct test is being performed. In addition, a second set of building address fields can be filled in if the building address is different from the customer address.

Comments Screen:
The Comments Screen is used to enter an unlimited number of lines of comments on the duct system and building being tested. Comments are stored along with the test file and are printed out as part of the Detailed Report.

Test Settings, Graph and Manual Data Entry Screens

After completing the Comments Screen, click on **Next** to move to the Test Settings Screen:

Test Settings Screen:
The Test Settings Screen is used to set the Test Mode, Test Pressure and Test Type, as well as edit the Duct System Parameters. Click on **Next** to move the Test Graph Screen.
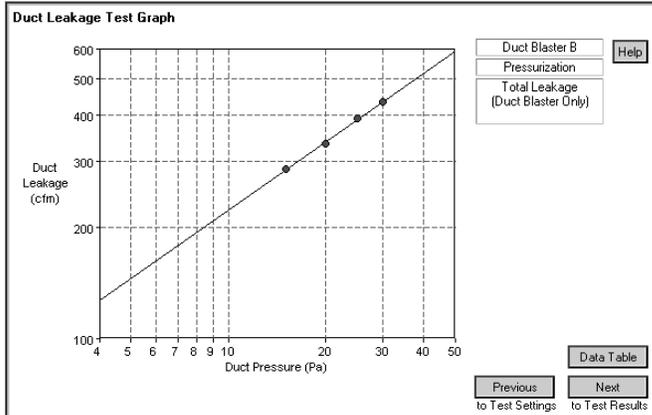
Duct Leakage Test Graph:
  Test data entered into the Data Table are displayed on this screen. To begin entering data, click on the **Data Table** button.

Data Table (Total Leakage Test):
  The Data Table is used to input duct test readings (i.e. duct pressure and fan flow data). The Data Table for the Total Leakage test will allow entry of up to 10 sets of test readings, plus one pre-test and one post-test baseline duct pressure reading. The inclusion of baseline readings in the table allows for quick adjustments to entered test readings for baseline stack and wind effects. After you have entered all data into the table, click on **OK** to return to the Test Graph.

Test Results Screen

Test Results:
  To look at the calculated test results, click on **Next** from the Test Graph Screen. Test results are automatically calculated using all data points displayed on the graph, and values input into the Building and Test Settings Screens.

5

Using the Goto Menu

The **Goto** item in the Main Menu allows you to quickly move to any active screen within the TECBLAST program. Clicking on **Goto** will bring up the following dialogue box.

```
Customer and Building Info...
Comments...
Test Settings...
Test Graph...
Test Results...
```

Simply click on one of the active choices to immediately move to that screen.

Chapter 4 **Editing the Input and Test Settings Screens**

Customer and Building Information Screen

The Customer and Building Information Screen is used to input the name, address and phone number of the customer for whom the duct leakage test is being conducted. You may also input the name of the technician performing the test. In addition, fill in the separate building address fields if the address of the building being tested is different from the customer address. All information entered on this screen is stored in both test and configuration files.

The Customer and Building Information Screen contains two additional fields, Building Floor Area and Air Handler Flow:

Building Floor Area: Enter the floor area of the building in square feet. Include all floors in intentionally conditioned spaces. If you enter a value of 0 (or leave the field blank), Duct Leakage as a Percent of Floor Area will not be calculated.

Air Handler Flow: Enter the estimated total system airflow (in CFM) of the air handler connected to the duct system being tested. Air handler flow can be estimated from the air handler nameplate, using the fan curve and a measurement of the total static pressure, or by directly measuring the airflow using a reasonable flow measuring technique (e.g. Duct Blaster pressure matching method, temperature rise method, TrueFlow plates etc.). For multiple speed systems, use the lowest fan speed unless directed otherwise. If you enter a value of 0 (or leave the field blank), Duct Leakage as a Percent of System Airflow and the Estimated Annual Efficiency Loss from Duct Leakage will not be calculated.

You can click on individual fields to enter information, or use the **Tab** key to quickly move between fields. To clear the Customer and Building Information Screen, click on the **Clear** button. When you are finished entering information, click on **Next** to move to the Comment Screen.

Figure 4.1: Customer and Building Information Screen

Comments Screen

The Comment Screen can be used to enter an unlimited number of lines of comments on the building and duct system being tested. Comments are saved along with the duct leakage test file and can be printed out as part of the detailed test report. Typical comments entered on this screen include client interview information, building and duct system conditions during the test, the location of major air leakage sites etc. To clear the Comments Screen, click on the **Clear** button. When you are finished entering comments, click on **Next** to move to the Test Settings Screen, or **Previous** to move back to the Customer and Building Information Screen.

Note: You can access standard Windows copy and paste commands within the Comments Screen by clicking on the right mouse button. This allows you to easily move text between TECBLAST and other Windows programs such as Microsoft Word.

Test Settings Screen

The Test Settings Screen is used to set up the duct leakage test procedures to be used by the TECBLAST program. You can click on individual fields to enter information, or use the **Tab** key to quickly move between fields. When you are finished selecting test settings, click on **Next** to move to the Test Graph Screen(s), or **Previous** to move back to the Comments Screen.

Figure 4.2: Test Settings Screen
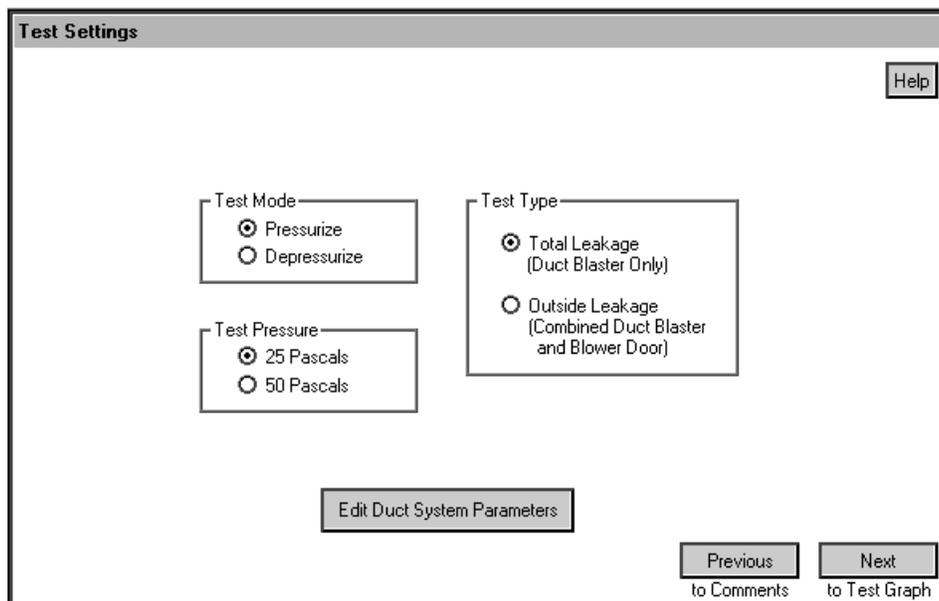
Test Mode

Click on **Pressurize** if the Duct Blaster fan will be blowing air into the duct system, or select **Depressurize** if the Duct Blaster fan will be sucking air out of the duct system.

Test Pressure

Choose a target test pressure of either **25 Pascals** (0.1 inches of water column), or **50 Pascals** (0.2 inches of water column). Choose the Test Pressure that best estimates the average operating pressure in the duct system, or the Test Pressure specified in the testing procedures you are following. The Test Pressure is the pressure in the duct system at which the leakage rate will be measured. Most residential duct testing programs in the United States specify a test pressure of 25 Pascals.

Test Type (select from one of 2 options)

Total Leakage (Duct Blaster Only):   Select the **Total Leakage (Duct Blaster Only)** test if you are using the Duct Blaster by itself to measure all leaks in the duct system, including both leaks to the outside as well as leaks to the inside of the house.

Outside Leakage (Combined Duct Blaster and Blower Door):   This test is selected when you are measuring duct leakage to the outside only, using a test procedure which combines simultaneous operation of a Duct Blaster and Blower Door system. This procedure attempts to eliminate air flow between duct leaks and the inside of the building during the test by equalizing the pressure between the duct system and the building. See your Duct Blaster Operation Manual for more information on this test option.

*Using the **Edit Duct System Parameters** button*

The Duct System Parameters are used by TECBLAST when it calculates the estimated annual system efficiency loss from duct leakage. If you do not wish to estimate an annual system efficiency loss, proceed directly to the Duct Leakage Test Graph Screen by clicking on the **Next** button. To access the parameters, click on the **Edit Duct System Parameters** button located at the bottom of the Test Settings Screen.

Figure 4.3: Duct System Parameters Screen

When first viewing the Duct System Parameters Screen during a new test, all fields are blank. To enter values into each of the fields, you can select the **Use Default Values** button, or you can click or **Tab** through the individual fields to enter the information manually. If any of the fields are left blank, the estimated annual system efficiency loss will not be calculated.

Percentage of Measured Leakage Connected to Outside: When calculating an estimated annual system efficiency loss, TECBLAST considers only outside duct leakage in its estimation model. Enter your best guess as to what percentage of the measured duct leakage is escaping to, or being drawn from, outside the conditioned space of the house. The percentage entered is multiplied by the total measured duct leakage to determine the outside duct leakage rate for the estimation model. **Note:** The default value for this field is 100 percent. In addition, if the Test Type chosen is **Outside Leakage (Combined Duct Blaster and Blower Door)**, this field is fixed at 100%.

TECBLAST uses only outside duct leakage in its estimation model because outside leaks have the largest impact on HVAC system performance. In addition, most residential duct leakage research studies conducted in the U.S. have been performed on houses which contain significant portions of the duct systems in unconditioned zones (e.g. attics, crawlspaces, garages). Much less in known about the system efficiency impacts of duct leakage within the conditioned space of the house.

Average Supply and Return Operating Pressures: Enter your best estimate of the average pressure seen by the majority of the duct leaks in the system under normal operating conditions. Input a separate value for the supply side and return side of the system. **Note:** The default value for these two fields is either 25 Pascals or 50 Pascals, depending on the Test Pressure chosen from the Test Setting Screen.

In order to estimate the impact of duct leakage on the annual system efficiency, we need to make an assumption about the typical pressures acting on these leaks during normal operation. Typically, we assume that the average operating pressure acting on the leaks is the same as the Test Pressure under which the duct leakage test was conducted. TECBLAST allows the user to choose a Test Pressure of either 25 Pascals (0.10 inches of water) or 50 Pascals (0.20 inches of water) on the Test Setting Screen. This assumption can be modified if you have evidence to suggest that a different operating pressure better represents the pressure seen by the predominant duct leaks during normal operation.

For example, if the majority of leaks in the supply duct system are at register boot connections, it might be reasonable to assume that the average operating pressure for the supply leaks is less than 25 Pascals (e.g. 10 or 15 Pascals). If the majority of supply leaks are located at a high pressure location such as a supply plenum, then it might be reasonable to assume that the average pressure seen by the supply leaks is larger than 25 Pascals.

Supply and Return Leakage Splits: The Supply and Return Leakage Splits are the percentage of the measured leakage which is located in that side of the duct system. For example, a Supply Leakage Split of 50 percent means that 50 percent of the measured leakage is in the supply side of the duct system. Input a separate value for the supply side and return side of the system. **Note:** The default values for the Leakage Splits are both 50 percent, meaning that the leakage is divided evenly between the supply and return ductwork.

If you have measured either side of the duct system directly, or have other evidence to suggest that more or less of the measured leakage is in one side of the system, then adjust the Split values accordingly. The Leakage Splits, when added together, should always equal 100 percent.

Leakage Penalties: The Leakage Penalties represent the effective annual energy penalty to the HVAC system for each percent of supply and return air flow that is attributed to leaks. Input a separate value for the supply side and return side of the system.

⇒ **Supply Leakage Penalty**: The default value for the Supply Leakage Penalty is 1.0. A default value of 1.0 means that a measured supply leakage rate of 1 percent (i.e. 1 percent of system airflow) contributes to a 1 percent annual loss to the HVAC system. The default of 1.0 assumes that supply side leaks are direct losses to the outside and are not recaptured back to the house. This number can be adjusted downward to reflect regain of usable energy to the house from duct leaks. For example, during the winter some of the energy lost from supply leaks in a crawlspace will probably be regained back to the house (sometimes one-half or more may be regained). In this case, a Supply Leakage Penalty of less than 1.0 may be appropriate.

⇒ **Return Leakage Penalty:** The default value for the Return Leakage Penalty is 0.5. A default value of 0.5 means that a measured return leakage rate of 1 percent (i.e. 1 percent of system airflow) contributes to a 0.5 percent annual loss to the HVAC system. The default value of 0.5 suggests that on average, return leaks contribute less to energy losses than do supply leaks (which have a default Penalty of 1.0). The Return Leakage Penalty can be adjusted upward from the default value if you have reason to suspect that the measured return leaks contribute significantly more energy loss than on average (e.g. pulling return air from a super heated attic), or can be adjusted downward to represent significantly less energy loss (e.g. pulling return air from a moderate temperature crawl space).

Chapter 5   **Entering Duct Leakage Test Data**

<u>Overview of Duct Leakage Test Graph Screen</u>

Duct test data are entered and displayed from the Duct Leakage Test Graph Screen. The main feature of the Test Graph Screen is a plot of Duct Blaster fan flow (or duct leakage) on the vertical axis versus duct system pressure on the horizontal axis. Test data entered into the Data Table are plotted on the graph, and a best-fit regression line is automatically drawn through the plotted data points.

Figure 5.1: Duct Leakage Test Graph Screen
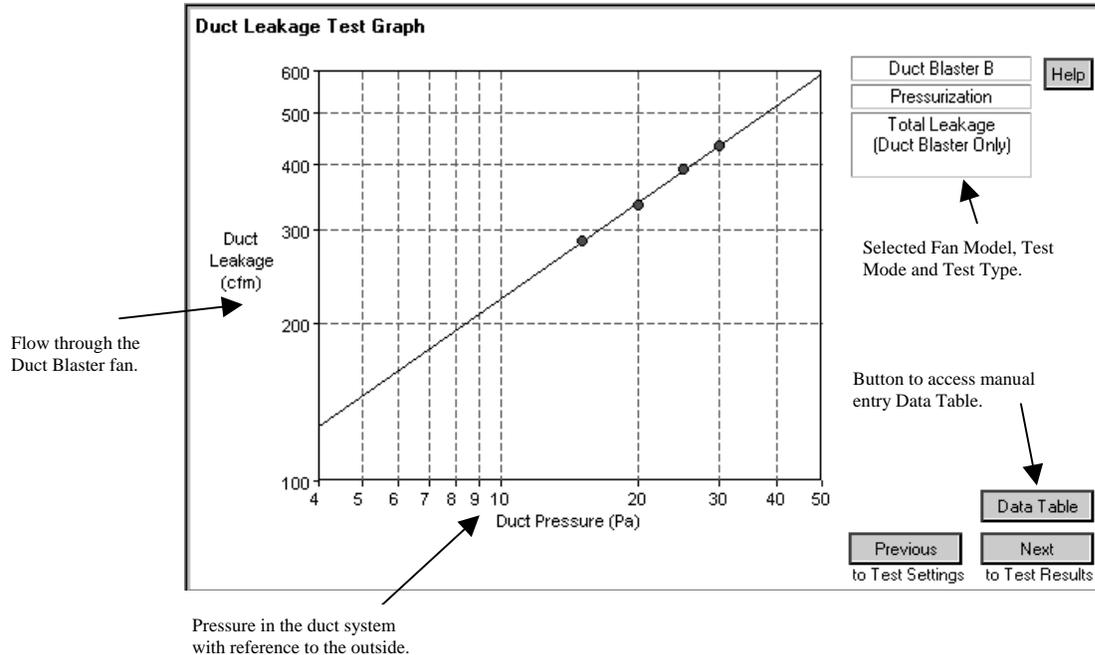
<u>Selecting the Fan Model</u>

Before entering data into the Data Table, select the Duct Blaster fan model being used for the test. To select the fan model, click on **Options** located in the Main TECBLAST Menu. From the Options Menu, select **Fan Info**. In the Fan Information window, select the appropriate fan model (or type), and then click on **OK**. You may also input a fan serial number which will be stored along with the duct leakage test file, and is printed out on the detailed test report. Importantly, if you change the selected fan model while test data are displayed on the graph, the test data will be automatically cleared from the graph and the Data Table.

Note: The Series A Duct Blaster fan has a white fiberglass fan housing and the Series B fan has a black urethane fan housing.

Figure 5.2: Fan Information Window

Entering Test Data into the Data Table

To manually enter test data, first click on the **Data Table** button from the Test Graph Screen. One of two Data Tables will appear, depending on which Test Type has been selected in the Test Settings Screen. You can move through the Tables using the **Tab** key, or by clicking on the individual entry fields.

If "Total Leakage (Duct Blaster Only)" is Selected

The Total Leakage Data Table allows entry of up to 10 sets of duct test readings (arranged in rows), plus one Pre-Test Baseline reading, and one Post-Test Baseline reading.

Figure 5.3: Total Leakage Data Table (Duct Blaster Only)

To begin data entry, you must first input a Pre-Test Baseline reading in Pa. The baseline duct pressure is the pressure between the duct system and the house before the Duct Blaster fan is turned on. The use of baseline duct pressure readings in the Table allows TECBLAST to quickly adjust the test data for any existing duct pressure caused by stack and wind effects.

Note: In many cases, the baseline duct pressure will be very small and you can simply enter 0 into the Pre-Test Baseline field. In addition, if you are using a DG-700 gauge and using the **BASELINE** feature, always enter 0 into this field.

After entering the Pre-Test Baseline reading, enter the test readings. You may input as few as 1 and as many as 10 sets of test readings. For each set of test readings, you must enter the measured duct pressure (in Pa), the fan configuration corresponding to this set of readings (i.e. which flow ring was installed on the fan), and the measured Duct Blaster fan flow used to generate the duct pressure. Fan flow can either be entered directly in CFM (by choosing the **Flow** button in the Flow Data Source field), or by entering the fan pressure signal in Pascals (by choosing the **Fan Pressure** button in the Flow Data Source field). If you enter the fan pressure signal, the flow value will be automatically determined by TECBLAST.

If you input fewer than 10 sets of readings, simply leave the remaining rows empty. The Post-Test Baseline reading is an optional field for those who wish to take a second baseline duct pressure reading following completion of the duct test. If you input a Post-Test Baseline reading, the program will use the average of the Pre and Post Baseline readings in its analysis. If you leave the Post-Test Baseline reading field empty, the program will simply use the Pre-Test reading when adjusting for baseline duct pressure effects.

When you are finished entering test data into the Table, click on **OK** to return to the Test Graph. You can clear the Table at any time by clicking on the **Clear Data** button.

Tips on Using a DG-700 Gauge with the Total Leakage Data Table:

⇒ Be sure you have the gauge set up properly (refer to your Duct Blaster or digital gauge manual). If you have set the gauge up properly, duct pressure readings will be read from Channel A, and Duct Blaster fan flow readings will be read from Channel B.

⇒ If you are using the DG-700's **BASELINE** feature, always enter 0 into the Pre-Test Baseline fields and leave the Post-Test Baseline field blank. Also enter 0 into the Pre-Test Baseline field if you do not take a baseline reading.

⇒ If you are using the DG-700's **PR/ FL@25** feature to conduct a one-point Total Leakage test, always enter the duct pressure as 25 Pa. This is because the **@25** feature automatically adjusts the displayed flow reading to a test pressure of 25 Pa.

⇒ If you are Depressurizing the duct system, enter the duct pressure readings as negative numbers (TECBLAST automatically places a negative sign in the duct pressure entry fields if the Test Mode is set to **Depressurize**).

⇒ If you are Pressurizing the duct system, enter the duct pressure readings as positive numbers.

⇒ Fan pressure readings can be entered as positive or negative numbers.

⇒ If you choose to take and enter a Post-Test Baseline reading, be sure to include the proper sign of the reading.

Tips on Using a DG-3 Gauge with the Total Leakage Data Table:

⇒ Be sure you have the gauge set up properly (refer to your Duct Blaster or digital gauge manual). If you have set the gauge up properly, duct pressure readings will be read from Channel A, and fan flow (or fan pressure) readings will be read from Channel B.

⇒ Be sure the Channel knob is pointing to the correct Channel when taking readings.

⇒ If you take and enter a Pre-Test baseline duct pressure reading, be sure to include the proper sign of the reading. Enter 0 into the Pre-Test Baseline field if you do not take a baseline reading.

⇒ If you are Depressurizing the duct system, enter the duct pressure readings as negative numbers (TECBLAST automatically places a negative sign in the duct pressure entry fields if the Test Mode is set to **Depressurize**).

⇒ If you are Pressurizing the duct system, enter the duct pressure readings as positive numbers.

⇒ Fan pressure readings can be entered as positive or negative numbers.

⇒ If you choose to take and enter a Post-Test baseline reading, be sure to enter the proper sign of the reading

*If "(**Outside Leakage (Combined Duct Blaster and Blower Door)**)" is Selected*

The Outside Leakage Data Table allows for entry of a single set of test readings. The Outside Leakage test measures duct leakage to the outside of the building envelope only, using a procedure which combines simultaneous operation of the Duct Blaster and Blower Door systems. This procedure attempts to eliminate leaks between the duct system and the inside of the building by equalizing the pressure between the duct system and the building. When using this procedure, there are no baseline pressure readings to enter.

Figure 5.4: Data Table for Outside Leakage (Combined Duct Blaster and Blower Door)

For this test procedure, the duct pressure is adjusted at the Blower Door and is determined by measuring either:

⇒ Building pressure with respect to Outside, or
⇒ Building pressure with respect to the space where the ducts are located.

15

The Blower Door fan should be adjusted to achieve a building pressure equal to the Test Pressure selected in the Test Settings Screen (e.g. 25 or 50 Pascals). Enter the measured building pressure (from the Blower Door) into the Duct Pressure field in the Table.

Note: If you are depressurizing the building and duct system, enter the duct pressure reading as a negative number (TECBLAST automatically places a negative sign in the duct pressure entry field when the Test Mode is set to **Depressurize**).

While the Blower Door is running, the Duct Blaster fan is used to equalize (or zero out) the pressure between the duct system and the building. The fan configuration and fan flow (or fan pressure) needed to create zero pressure difference between the duct system and the building (while the Blower Door is running) should be entered into the remaining fields in the Table.

Fan flow can either be entered directly in CFM (by choosing the **Flow** button in the Flow Data Source field), or by entering the fan pressure signal in Pascals (by choosing the **Fan Pressure** button in the Flow Data Source field). If you enter the fan pressure signal, the flow value will be automatically determined by TECBLAST

Chapter 6   **Viewing Test Results**

Once the test data have been manually entered into the Data Table, test results are automatically calculated using all data points displayed on the graph, and values input into the building and duct system parameter fields. To view the Test Results Screen, click on **Next** from the Test Graph Screen.

Figure 6.1: Test Results Screen

<u>Overview of Test Results Screen</u>

Measured Duct Leakage

Test Type: This is the Test Type selected on the Test Settings Screen.

Test Pressure: This is the Test Pressure selected from the Test Settings Screen. The Test Pressure is the pressure in the duct system at which the duct leakage rate was measured.

Leakage Rate: This is the measured duct leakage (in Cubic Feet per Minute) at the specified Test Pressure.

Leakage Area: Once you have quantified the leakage rate, it is possible to calculate a Leakage Area of the duct system in square inches. The Leakage Area estimate is a useful way to visualize the physical size of all cumulative leaks in the duct system. The Leakage Area is defined in TECBLAST as the size of a sharp edged orifice which would leak at the same flow rate as the measured leakage, if the orifice were subjected to the Test Pressure.

$$\Rightarrow \quad \text{Leakage Area (sq in)} \ = \ \frac{\text{Duct System Leakage Rate (CFM)}}{1.06 \ \text{x} \ (\text{Test Pressure})^{0.5}}$$

Leakage Parameters

Leakage as a Percent of System Airflow: This is the measured duct leakage rate, divided by the Air Handler Flow entered in the Customer and Building Info Screen.

⇒   Leakage as % of System Flow = (Leakage Rate (CFM) / Air Handler Flow (CFM)) x 100

Leakage as a Percent of Floor Area: This is the measured duct leakage rate, divided by the Building Floor Area entered in the Customer and Building Info Screen.

⇒   Leakage as % of Floor Area = (Leakage Rate (CFM) / Floor Area (sq ft)) x 100

Annual System Efficiency Loss: TECBLAST uses a simple model for estimating an annual HVAC system efficiency loss from the measured duct leakage rate. The annual loss estimate can be applied separately to both heating and cooling modes of operation. The loss estimate uses the measured leakage rate, entered Duct System Parameters from the Test Settings Screen, along with a number of assumptions about the operating characteristics of the HVAC system. Refer to Appendix E in the Duct Blaster Operation Manual for more information on how this estimate is calculated.

Notes on Estimated Annual System Efficiency Loss:

⇒   Because duct leakage loss calculations are extremely complex, this estimation technique should be used with caution and should be viewed only as a rough estimate of the magnitude of losses possible.

⇒   The duct leakage loss estimates do not include many important but complex impacts on system efficiency including latent load impacts, heat pump strip heating impacts, conduction losses, increases in infiltration from dominant duct leakage, or interactions of leakage on mechanical operating efficiencies, all of which can be significant depending on the type and location of the system being tested.

⇒   We do not recommend that this simple model be used for research purposes, program design studies or program impact evaluations. More sophisticated duct leakage loss models are available and better suited to those needs. Listed below are three references to other duct leakage loss models:

ASHRAE Standard 152-2004, Method of Test for Determining the Design and Seasonal Efficiencies of Residential Thermal Distribution Systems, ASHRAE, Atlanta GA, December 2004.

"Development of a Practical Method for Estimating the Thermal Efficiency of Residential Forced-Air Distribution Systems', EPRI, Palo Alto CA, January 1997.

"Improvements to ASHRAE Standard 152P", Paul Francisco and Larry Palmiter, Ecotope, Seattle WA, June 1999.

Leakage Split

Supply Side: This is the estimated amount of leakage (expressed in CFM and square inches) in the supply side of the duct system. The supply side leakage is calculated by multiplying the measured total duct leakage rate and leakage area by the Supply Leakage Split value entered in the Duct System Parameters Screen.

Return Side: This is the estimated amount of leakage (expressed in CFM and square inches) in the return side of the duct system. The return side leakage is calculated by multiplying the measured total duct leakage rate and leakage area by the Return Leakage Split value entered in the Duct System Parameters Screen.

Duct Leakage Curve

Flow Coefficient (C) and Exponent (n):   Once the test data has been entered into the Data Table and plotted on the Test Graph, a "best-fit" regression line (called the Duct Leakage Curve) is drawn through the plotted data. The Duct Leakage Curve can be used to estimate the leakage rate of the duct system at any pressure. If you conduct a single point test, TECBLAST assumes an exponent (n) of 0.60 in its calculation procedures.

The Duct Leakage Curve is defined by the variables Coefficient (C) and Exponent (n) in the following equation:

$$Q = C \times P^n$$
where:
Q is airflow into (or out of) the duct system (in CFM).
C is the Coefficient.
P is the pressure difference between inside and outside of the duct system
n is the Exponent.

Correlation Coefficient: The correlation coefficient is a measure of how well the collected test data fit onto the "best-fit" Duct Leakage Curve. The closer all data points are to being exactly on the Duct Leakage Curve, the larger the calculated correlation coefficient (**note**: the largest possible value for the correlation coefficient is 1.0). Under most operating conditions, the correlation coefficient will be at least 0.99 or higher.

Testing in very windy weather can sometimes cause the correlation coefficient to be less than 0.99. In this case, you may want to repeat the test and increase the number of data points

Chapter 7 **Saving and Retrieving Duct Leakage Test Files**

Saving Duct Leakage Test Files

Test files can be saved at any time by selecting **File** from the Main TECBLAST Menu, and then clicking on **Save Current Test File** which appears in the File Menu.

```
Save Configuration File...
Save Current Test File...
```
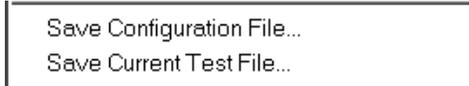
Saved duct leakage test files contain all information entered into the Customer and Building Screen, the Comment and Test Setting Screens, as well as all test data shown on the Graph. When saving a test file, you will need to enter a file name in the file saving browser that appears on screen. You may also choose a different destination folder for the saved file by clicking on the **Save in** window. Once you have chosen a file name and destination, click on **Save**.

Figure 7.1: File Saving Browser
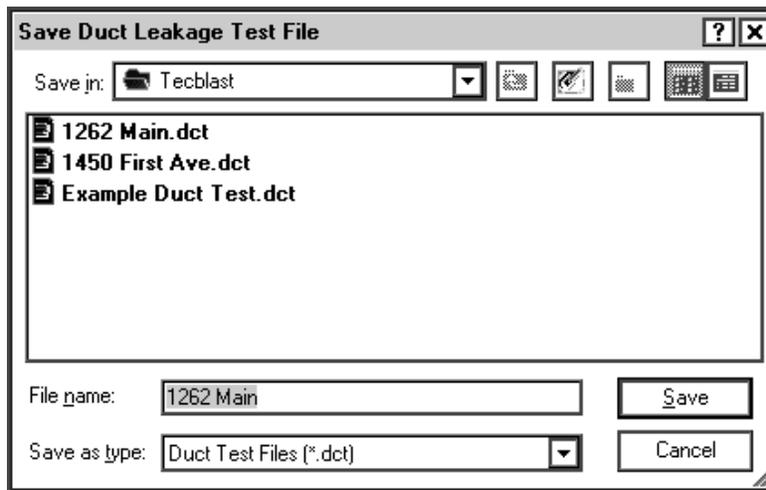
Note: All duct leakage test files are automatically given a *.dct* extension.

Retrieving Duct Leakage Test Files

To retrieve a previously saved duct leakage test file for viewing, editing or printing, first select **File** from the Main TECBLAST Menu, and then click on **Retrieve Existing Test** which appears in the File Menu.

```
New Test
New Test with Custom Configuration...
Retrieve Existing Test...
```
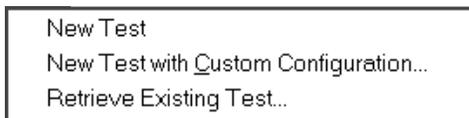
After selecting the "Retrieve" option, a file browser will appear on screen which lists all the duct leakage (*.dct)* test files contained in the default folder. To select a file, click on the file name from the list and then click on **Open**. Once the file has been selected, the file information is loaded into the TECBLAST program and the Customer and Building Info Screen appears. To change the folder being listed, click on the **Look in** window.

20

Figure 7.2: File Retrieving Browser
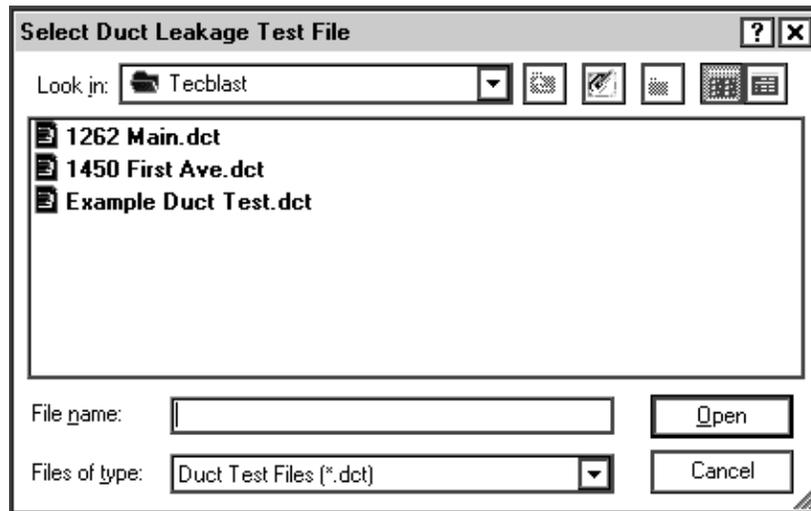
Retrieving a Previous Test as the Starting Point for a New Test

If you want to repeat a test of a duct system that you have previously tested, it is very convenient to start by retrieving the old test. Choose **Retrieve Existing Test** from the File menu and select the old duct leakage test file. As you go through the data entry screens, check for any information that has changed since the old test was performed.

The data on the graph can be cleared by clicking on the **Clear Data** button from the Data Table window. Use of the **Clear Data** button will not affect the original duct leakage test file stored on your computer. When you are done, save your new test using a new file name.

Format of Saved Building Test Files

All duct leakage test files (.dct) are space delimited ASCII text files. The format for saved test files is shown in Figure 7.3 below.

Figure 7.3: Format of Saved Test Files

```
TECBLAST Version: ――――――――    Software Version
Building_Address:
Building_Address_Line2:
Building_City:
Building_State:
Building_Zip:
Floor:
System_Airflow:
Test_Date:                      Customer and
Technician:                     Building Info
Name:
Address:
Address_Line2:
City:
State:
Zip:
Phone:
Fax:      ――――――――――――
Avg_Supply_Oper_Pressure:
Avg_Return_Oper_Pressure:
Supply_Leakage_Split:           Duct System
Return_Leakage_Split:           Parameters
Supply_Leakage_Penalty:
Return_Leakage_Penalty:
Percentage_Outside_Leakage:
Business:
B_Address:
B_Address_Line2:
B_City:                         Business Info
B_State:
B_Zip:
B_Phone:
B_Fax
Comments:
                                Comments

Manual_Entry_Data_0:
Manual_Entry_Data_1:
Manual_Entry_Data_2:
Manual_Entry_Data_3:            Data Table Entries
Manual_Entry_Data_4:
(repeats through Data_10)
Build_Test_Mode: P
Duct_Reference_Pressure: 25     Test Settings
Duct_Test_Type: 1
```

```
Station_count:
Complete_test:
Data_pt_0:
Data_pt_1:
Data_pt_2:
Data_pt_3:                                Test Data¹
Data_pt_4:
Data_pt_5:
(repeats through Data_pt_10)
Duct_Leakage:
Duct_Leakage_Error:
Duct_Leakage_Area:
Duct_Leakage_AsPercentOf_Floor_Area:
Duct_Leakage_AsPercentOf_System_Airflow:
Annual_Duct_System_Efficiency_Loss:
Supply_Side_Leakage:
Supply_Side_Leakage_Area:              Calculated Test Results
Return_Side_Leakage:
Return_Side_Leakage_Area:
C:
C_err:
n:
n_err:
r:
Build_Fan_Model: 3
Fan_Calib_DBA_Ring0:
Fan_Calib_DBA_Ring1:
Fan_Calib_DBA_Ring2:
Fan_Calib_DBA_Ring3:
Fan_Calib_DBA_Ring4:
Fan_Calib_DBA_Ring5:
Fan_Calib_DBB_Ring0:                      Fan Info
Fan_Calib_DBB_Ring1:
Fan_Calib_DBB_Ring2:
Fan_Calib_DBB_Ring3:
Fan_Calib_DBB_Ring4:
Fan_Calib_DBB_Ring5:
```

Test Data [1]

Calculated Test Results

Fan Info

---

[1] Columns from left to right: Fan Configuration (-1 = baseline reading), Target Duct Pressure, Duct Pressure Reading, Fan Pressure Reading, Calculated Flow in CFM, Standard Deviation of the Duct Pressure Reading, Standard Deviation of the Fan Flow Reading.

Chapter 8   **Printing Test Reports**

Printing and Preview Options

Report printing and previewing options are available by clicking on **File** in the Main Menu.

```
Print Customer Report...
Print Detailed Report...
Print Graph...

Preview Customer Report
Preview Detailed Report
Preview Graph
```
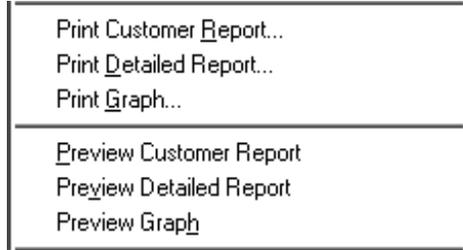
TECBLAST includes a choice of two pre-formatted reports; a one page Customer Report, and a 2 page Detailed Report. In addition, the Test Graph can be printed separately. **Note:** The actual length of the Detailed Report depends on the number of lines of comments entered, and the number of data points collected during the test.

The Customer Report contains the basic test results and a simplified description of how to interpret the test results. Detailed Reports contain a complete listing of the duct leakage test data, the test results, as well as any comments input into the Comment Screen.

The Test Graph is similar to the graph of fan flow (or leakage) vs. duct pressure from the Test Graph Screen. It can be used to visually estimate the relationship between duct leakage and duct pressure.

The printing and preview functions within TECBLAST utilize the Windows printer drivers and configuration options currently installed in your computer. Windows printer setup options can be accessed by clicking on   **Start**....**Settings**....**Printers**.

Putting Your Business Name and Logo at the Top of the Reports

The name, address and phone number for your business can be placed at the top of the first page of all printed reports by completing the Business Info window. To access the Business Info window, click on **Options** in the Main Menu, and then click on **Business Info** from the Options Menu. Information entered in the Business Info window is saved as part of the data files.

Figure 8.1: Business Information Window

Business Info	

Name:
Address:
Address Line 2:
City:
State/Province:
ZIP/Postal Code:
Phone:
Fax:

Help

Clear   Cancel   OK

To insert a logo at the top of the printed reports, simply place an electronic image of your logo in the working directory of the TECBLAST program. The image file must be named "reportlogo", and the file format must be either a Windows Bitmap File (*.bmp* extension) or a Windows Enhanced Meta File (*.emf* extension). The default working directory for TECBLAST is *C:/Program Files/Energy Conservatory/TECBLAST 1.1*. If you chose a custom install directory for TECBLAST during program installation, you will need to place the image file in that directory.

If a *reportlogo.bmp* or *reportlogo.emf* file is found by TECBLAST, the image is automatically placed in the upper left hand corner of the printed reports. The image is placed in a 2" wide by 1" high box, and TECBLAST sizes the image (using its saved aspect ratio) to maximize its size within the box. Because TECBLAST uses a 2" wide by 1" high image box, images saved with a 2 to 1 width to height ratio will completely fill the image box. Images saved with any other aspect ratio will only completely fill the image box in one dimension.

Figure 8.2: Top of Customer Report with Business Name and Logo

DUCT LEAKAGE TEST RESULTS

Wilson's Consulting Services
566 Birch Street
Minneapolis, MN 54666
Phone: 612-333-3333

Logo Image Box

Date of Test: 3-12-99   Test File: examplemanual

Test Performed For: Tom Jones
2345 First Ave.
Minneapolis, Mn 55533
Phone 612-566-6000

Figure 8.3: Sample Customer Report (without Logo)

DUCT LEAKAGE TEST RESULTS

Jim's Heating and Air
4555 Second Street
Phoenix, AZ 55555
Phone: 602-999-9999
Fax: 602-333-3333

Date of Test: 8-30-99   Test File: Example Duct Test

Test Performed For: Robert Vincent
1507 Center Ave.
Phoenix, AZ 88557
Phone 602-822-1111
Fax 602-822-1000

Test Results

1. Test Type: **Total Leakage**
(Duct Blaster Only)

2. Test Pressure: **25.0 Pa**

3. Measured Duct Leakage: **389.2 CFM (73.4 sq. in.)**

4. Duct Leakage as a Percent of System Airflow: **24.3 %**

5. Duct Leakage as a Percent of House Floor Area: **13.9 %**

Estimated Efficiency Loss from Duct Leakage:

1. Annual System Efficiency Loss: **19.5 % ***

2. Estimated Impact on Equipment Efficiency Rating:

Air Conditioner SEER		Heat Pump HPSF		Furnace AFUE	
Rated	Actual	Rated	Actual	Rated	Actual
16.0	12.9	8.0	6.4	95.0	76.5
14.0	11.3	7.5	6.0	90.0	72.4
12.0	9.7	7.0	5.6	85.0	68.4
10.0	8.0	6.5	5.2	80.0	64.4
8.0	6.4	6.0	4.8	75.0	60.4

Additional Information

Duct leakage is often one of the largest sources of energy loss in a house. Leaky supply ductwork causes expensive conditioned air to be lost before it can be delivered to the house, forcing your system to run longer to keep you comfortable.

Leaky ductwork can seriously degrade indoor air quality by pulling pollutants and irritants directly into your house. Leaky return ductwork can also pull moisture into your home, making it feel uncomfortable even when the air conditioning is running.

* The estimated efficiency loss from duct leakage is based on many assumptions. Actual efficiency losses may differ significantly from this estimate.

Figure 8.4: Sample Detailed Report (without logo)

DUCT LEAKAGE TEST

Jim's Heating and Air
4555 Second Street
Phoenix, AZ 55555
Phone: 602-999-9999
Fax: 602-333-3333

Date of Test: 8-30-99   Technician: Bill Smith
Test File: Example Duct Test

Customer: Robert Vincent   Building Address:
             1507 Center Ave.
             Phoenix, AZ 88557
             Phone: 602-822-1111
             Fax: 602-822-1000

Test Results

1. Measured Duct Leakage: **389.2 CFM / 73.4 sq. in. (+/- 0.7 %)**

2. Duct Leakage as a Percent of System Airflow: **24.3 %**

3. Duct Leakage as a Percent of House Floor Area: **13.9 %**

4. Leakage Split: Supply Side: **233.5 CFM / 44.1 sq. in.**
                                      Return Side: **155.7 CFM / 29.4 sq. in.**

5. Duct Leakage Curve: Flow Coefficient (C): **54.2 (+/- 9.0 %)**
                                       Exponent (n):   **0.613 (+/- 0.028 %)**
                              Correlation Coefficient: **0.99786**

6 Test Settings: Test Mode: **Pressurization**
                                     Test Pressure: **25.0 Pa**
                                        Equipment: **Series B Minneapolis Duct Blaster, S/N 1344**
                                        Test Type: **Total Leakage**
                                                       (Duct Blaster Only)

Estimated Efficiency Loss from Duct Leakage:

1. Annual System Efficiency Loss: **19.5 %**

Building and System Parameters:

              Floor Area: **2800 sq. ft.**   Average Supply Operating Pressure: **25.0 Pa**
          System Airflow: **1600 CFM**   Average Return Operating Pressure: **25.0 Pa**
      Supply Leakage Split: **60 %**   Supply Leakage Penalty: **1.0**
      Return Leakage Split: **40 %**   Return Leakage Penalty: **0.5**

        Percentage of Measured Leakage Connected to Outside: **100% (389.2 CFM)**

27

DUCT LEAKAGE TEST Page 2

Date of Test: 8-30-99 Test File: Example Duct Test

Data Points - Data Entered Manually:

Duct Pressure (Pa)	Fan Pressure (Pa)	Fan Flow (CFM)	% Error	Fan Configuration
0.0	n/a			
30.0	30.0	434	-0.2	Ring 1
25.0	90.0	393	1.0	Ring 1
20.0	65.0	334	-1.6	Ring 1
15.0	48.0	287	0.8	Ring 1

Comments

Master Bedroom will not cool during hottest weather.

Platform return appears to be drawing in air from attic through wet wall.

Insulation fibers found in return platform.

The Data Page table contains the following information:

Duct Pressure: The duct pressure reading at which leakage measurements were conducted, including the pre and post test baseline measurements. Baseline duct pressure measurements correspond to Fan Pressure readings of "n/a". Duct pressure data in the table are not adjusted for measured baseline pressures.

Fan Pressure: Fan pressure measurements for each duct pressure.

Fan Flow (CFM): Calculated air flow (or leakage) through the Duct Blaster fan, based on the measured fan pressure and the calibration formula for the fan.

% Error: The % Error column is the % difference between the fan flow listed in the table and the flows calculated by the computer using the "best fit" Duct Leakage Curve.

Fan Configuration: The configuration of the fan (i.e. which low-flow ring was installed) when the fan pressure reading was collected.

Chapter 9   **Creating and Using Configuration Files**
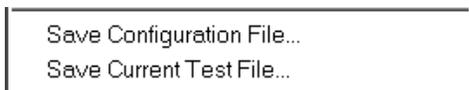
What is a Configuration File?

There can be a significant amount of data entry required in filling out all of the screens of TECBLAST. A configuration file is a place to save test settings, customer and building information, and comments that you routinely use so they can be quickly loaded into the program. The configuration file can then be used as a shortcut for speeding up data entry for future tests. A configuration file looks just like a duct leakage test file, except that no test data (i.e. duct pressure and fan flow readings) are stored in configuration files.2

How to Create a Configuration File

Before creating a configuration file, first be sure to save any current test data loaded into TECBLAST by using the **Save Current Test File** option from the File Menu.

Now select the **New Test** option from the File Menu. Proceed through the Customer and Building, Comments, and Test Settings Screens, filling in only the information which will be always be the same for your testing. For example, on the Customer and Building Info Screen you would not want to fill in the customer name but you probably would fill out the technician name. If there are any "standard" comments which you would like to have on all tests, type them in on the Comments Screen at this time. On the Test Settings Screen, choose the settings you wish to save. Finally, open the Business and Fan Info windows (found in the Options Menu) and complete the appropriate fields.

When you have finished entering information and settings that you wish to save, select **Save Configuration File** from the File Menu.

```
Save Configuration File...
Save Current Test File...
```

When saving a configuration file, you will need to enter a file name in the file saving browser that appears on screen. You may also choose a different destination folder for the saved file by clicking on the **Save in** window. Once you have chosen a configuration file name and destination, click on **Save**.

Note: All configuration files created in TECBLAST are automatically given a *.cfd* extension.
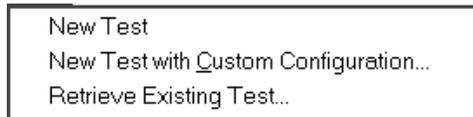
---

2 Information entered using the Options Menu (e.g. Business and Fan Info Screens) are also stored when a configuration file is created.

Figure 9.1: Configuration File Saving Browser
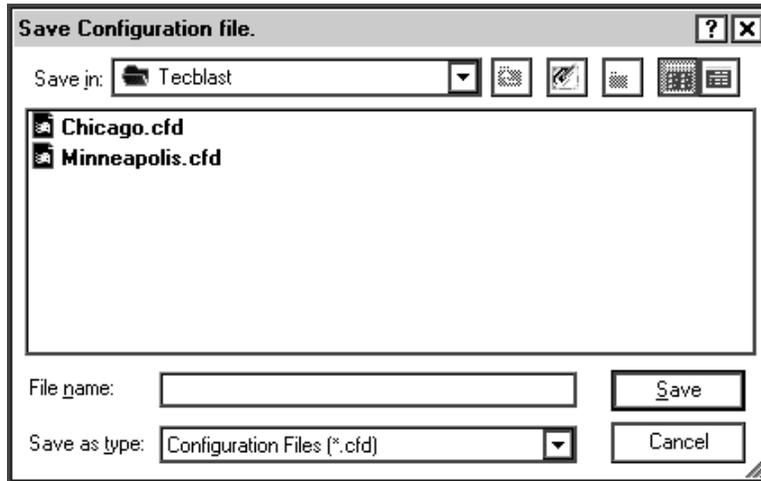
How to Use Configuration Files

To use a configuration file when conducting a new test, click on **New Test with Custom Configuration** from the File Menu.

After selecting the "Custom Configuration" option, a file browser will appear on screen which lists all the configuration (*.cfd)* files contained in the default folder. To select a file, click on the file name from the list and then click on **Open**. Once the configuration file has been selected, the file information is loaded into the TECBLAST program and the Customer and Building Info Screen appears. To change the folder being listed, click on the **Look in** window.

Figure 9.2: Configuration File Retrieving Browser
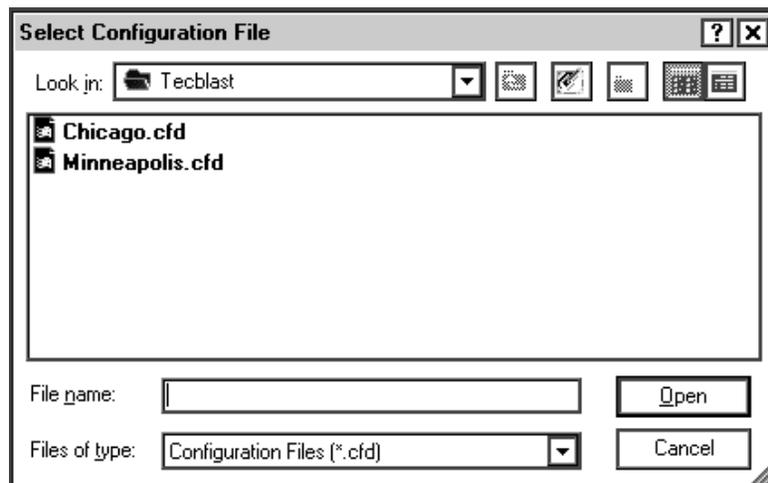
After loading the selected configuration file, complete the remaining data entry fields and proceed with the test. Importantly, you are not "locked into" the entries which were loaded from your configuration file. You can always edit all data entry fields during the test.

Some users may wish to create custom configuration files for a variety of testing situations they frequently encounter. For example, a user may have separate configuration files for each city where they frequently test. Configurations can also be created which are specific to:

> test location
> duct system type
> fan model and serial number
> technician

Keep in mind that the Comments Screen can be a particularly useful part of custom configuration files by containing "boiler plate" comments which you would like to print out (or edit) for all tests.

Note: Because configuration files are so useful, we recommend that everyone create at least one configuration file and call it "*default*". This file should contain your most frequently used settings and information. When you start a new test using **New Test with Custom Configuration**, the program will automatically highlight the *default* file (if it exists) in the file selection browser, so all you need to do is click on **Open**.

Chapter 10   **Entering Custom Fan Calibration Parameters**

The TECBLAST program comes installed with factory default fan calibration parameters for both Series A and B Duct Blaster fans.[3] The fan calibration parameters are used by the program to convert the measured fan pressure in Pascals to airflow in Cubic Feet per Minute.

If your Duct Blaster fan was <u>custom calibrated</u> by The Energy Conservatory, you can input your custom calibration parameters directly into the TECBLAST program in lieu of the factory default values. To enter custom fan calibration parameters, first open the Fan Information window by clicking on **Options...Fan Info** from the Main TECBLAST Menu.

Figure 11.1: Fan Information Window

From the Fan Information window, select the appropriate fan model, and then click on the **Enter Custom Calibration** button to open the Fan Calibration Parameter Window.

Figure 11.2: Fan Calibration Parameter Window

---

[3]   Series A Duct Blaster fans have a white fiberglass fan housing, and Series B fans have a black ABS fan housing.

The Fan Calibration Parameter window shows the calibration parameters being used by the program for the currently selected fan type. There is a unique set of parameters for each of the flow ring configurations used with the fan. The individual calibration parameters can be selected for editing by using the **Tab** key, or by clicking on the input fields. Whenever you input a custom calibration parameter, the new value shown in the field will be displayed in red, rather than black for the default values. You can easily return all calibration parameters to the factory default values by clicking on **Set to Defaults**. The currently entered fan calibration parameters are stored as part of the data file.

Note: Most users should never have to edit fan calibration parameters. The default fan calibration parameters which come with the TECBLAST program should work fine for all standard Series A and B Minneapolis Duct Blaster fans. This feature is necessary only if you receive custom calibration parameters for your fan from The Energy Conservatory.