

# Port Flow Analyzer v3.0, 3.5, 3.5B, 3.5C

## User's Manual

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\*\*\*\*\* WARNING \*\*\*\*\*

The Port Flow Analyzer makes calculations based on equations and data found in various published and heretofore reliable documents. The program is designed for use by skilled professionals experienced with engines and Tests. The following processes are hazardous, particularly if done by an unskilled or inexperienced user:

- Obtaining data to input to the program
- Interpreting the program's results

Before making measurements of or modifications to any Test, engine or driving situation, DO NOT FAIL TO:

- Regard the safety consequences
- Consult with a skilled and cautious professional
- Read the entire user's manual
- Obey all federal, state & local laws
- Respect the rights and safety of others

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# Chapter 1 Introduction

## 1.1 Overview of Features

The Port Flow Analyzer v3.0 program by Performance Trends, Inc is a software system to help head porters, engine builders, and other flow bench users "streamline" their flow bench testing. The program offers options to record, calculate, save, graph, organize, retrieve, report and analyze flow bench test data. In the Pro version, flow data can be combined with camshaft and engine specifications to make engine horsepower and torque estimates, and intake runner recommendations. The Port Flow Analyzer v3.0 is a unique program which will save test time and improve the analysis of cylinder head flow test data.

### Basic Features:

- Capability to tailor the program to work with standard SuperFlow benches, or custom flow benches
- Reads data directly from SuperFlow FlowCom (tm) or Performance Trends' Electronic Interface.
- User friendly, Windows interface, compatible with Windows 3.1, 95, 98 and NT.
- Can print results using most any Windows compatible printer, many times in color.
- Save nearly unlimited number of tests for recall, comparison and analysis in the future.
- Allows several reporting, averaging and graphing options for analysis.
- Allows you to record at 1 test pressure, but graph and report results at another test pressure.

### Added Features for Pro Version

- You can also record:
  - Additional flow data like CFM variation (useful for identifying "unstable" ports), Swirl and Swirl variation, Tumble and Tumble variation, Port velocities from Pitot tube readings, Barometer, Temperature (even if its not needed for corrections), and Humidity.
  - More Head specs like Intake and Exhaust stem diameter, throat diameter, port shape, seat angle, port volume and more.
  - Over 60 head details like valve spring specs and part #s, valve specs and part #s, seat cutter descriptions, lock descriptions, retainer descriptions, and much more.
- Combine your flow data with simple cam and engine specs for more detailed analysis and engine performance estimates.
- Customize printed reports and especially graphs. You can include comments for each head graphed and tables of the actual data graphed.
- Write ASCII files for importing data into other computer programs.
- Filter (find) past tests based on certain criteria, like Max Int CFM over a certain amount, certain Customer name, etc.
- "History Log", keeps a running log of tests you have recently started new, run, graphed or reported.

Please read Sections 1.2 "Before You Start" and 1.3 "A Word of Caution" before you turn on the computer. Then try running the program following the guidelines in 1.4 "Getting Started" and 1.5 "Example to Get You Going". When you feel a little familiar with the program, take time to read this entire manual. It will show you all the things you can do with this powerful tool.

\* SuperFlow and FlowCom are registered trademarks of SuperFlow Corporation.

**See Appendix 7, 9, 10 for new features added in version 3.5, 3.5B, 3.5C.**

# 1.2 Before You Start

What you will need:

- Windows XP, Vista, Windows 7, Windows 8, Windows 10 computer.
- Printer (optional).

Many terms used by the Port Flow Analyzer and this user's manual are similar to terms used by other publications, i.e. Valve Flow Coef, Valve Area, etc. However, these terms may have different definitions. Therefore, read Chapter 2 to see what these terms mean to the Port Flow Analyzer.

Occasionally it will be necessary to identify "typos" in the manual, known "bugs" and their "fixes", etc. which were not known at the time of publication. These will be identified in a file called README.DOC in the Port Flow Analyzer directory or folder.

To read this file, use Windows Explorer to find the Port Flow Analyzer directory, usually PFA30 under PERFTRNS.PTI. Then double click on README.DOC. Wordpad will display the contents.

You can also read this file by clicking on Help (top of main screen), then Display Readme.doc file.

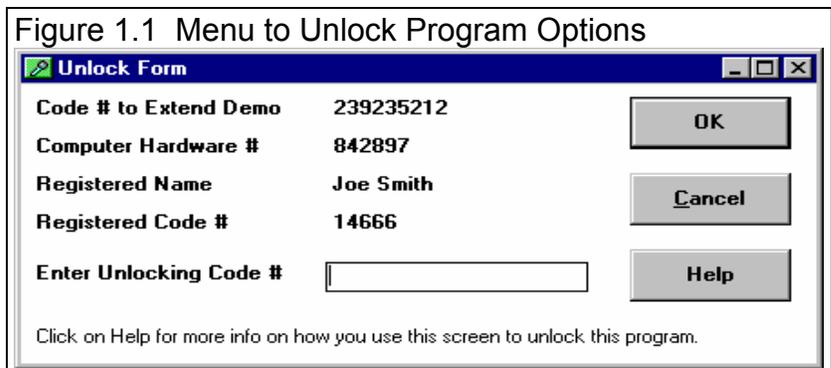
## Unlocking Program Options:

The Port Flow Analyzer is equipped with copy protection. This ensures the legitimate users do not have to cover the costs for unauthorized distribution of the program. When you first receive the program, it is in demo mode. **All features work in Demo mode.** In demo mode you can try either the Basic version, or the full Professional version for ten days. Sometime during those 10 days, you must call Performance Trends to obtain an "Unlocking Code". This Unlocking Code will be for either the Basic version or the Pro Version, which every you have purchased.

Before you call Performance Trends, you should get your registered code number and computer hardware number. These are available by clicking on file in the upper left hand corner of the Main Screen, then clicking on Unlocking Program Options. A screen will appear as shown in Figure 1.1.

Performance Trends will provide you an unlocking code number. Type in the unlocking code number and click on OK. If you typed in the number correctly, you will be given a message that the program is permanently unlocked to either the Basic or Pro mode. The program will only run on this one computer.

If you want to run the program on another computer, you must install it, obtain the computer hardware number and registered code number as shown in Figure 1.1, and call Performance Trends for a new Unlocking Code for that computer. There may be a charge for additional computers.



## 1.3 A Word of Caution

First, before switching from hand recording to computer recording test data, you should be very familiar with the Port Flow Analyzer v3.5 program and your computer in general. See the precautions in Section 2.0 and Example 4.1.

Second, a powerful feature of the Port Flow Analyzer Pro version is its ability to combine flow data and general cam and engine data to make performance projections and recommendations. These projections can be used to judge head/cam combinations, cylinder head modifications, etc.

An engine is a very complex system, which makes exact calculations of all details impossible. Therefore, simplifying assumptions are made to reduce the calculations to a manageable level. See the Assumptions in Appendix 1 and Example 4.4. The user must recognize:

The software cannot predict the safety of an engine modification or running condition. Please read and follow any safety precautions as described in this manual. Also, get "expert" opinions before running your engine at an RPM or torque level higher than what it was originally designed for.

The software cannot make exact predictions of torque and horsepower because:

- Much of the input data to the software are estimated.
- Even if the input data were exactly correct, the simplifying assumptions will limit the accuracy.
- Environmental and engine conditions, fuel, the driving situation, etc. are never constant and repeatable.

The software should be used as a guide to:

- Help understand how cylinder heads interact with other engine components; what parameters are important and what are the tradeoffs.
- Provide general direction for making modifications. This direction should be verified by other sources like known authorities, engine tests, books, etc. Never trust one "single source" if it does not make sense.
- Make you think, not think for you. If unexpected results are obtained, take a minute to:
  - Double check all input data.
  - Refer back to this manual.
  - Ask someone else skilled and experienced in the particular area.
  - Give the retailer or Performance Trends Inc's. Tech Help Line a call for an explanation. (Also, programs are written by people so it's always possible there may be an error in the calculations. Your call may help us correct it.)

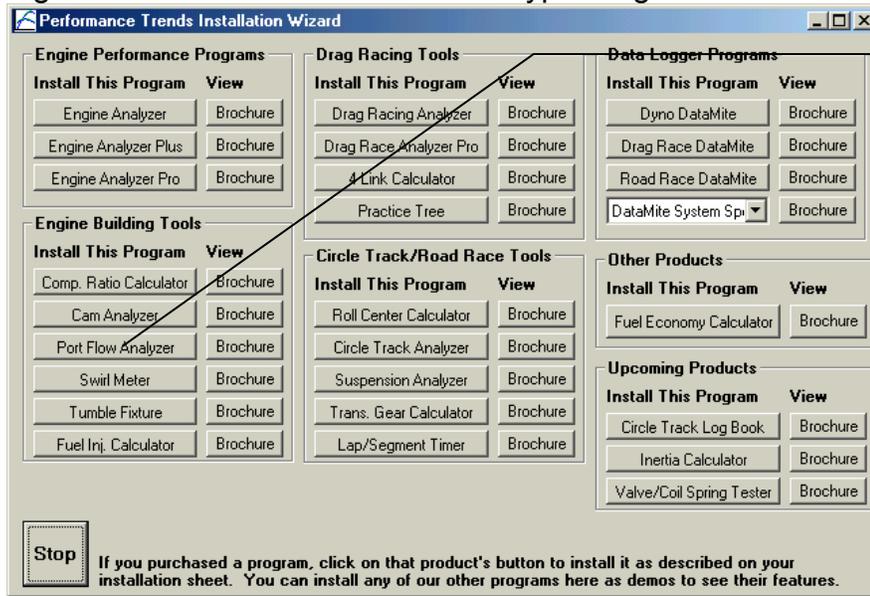
Please also read the Warranty and Warning at the beginning of this manual and on the diskette envelope.

# 1.4 Getting Started (Installation)

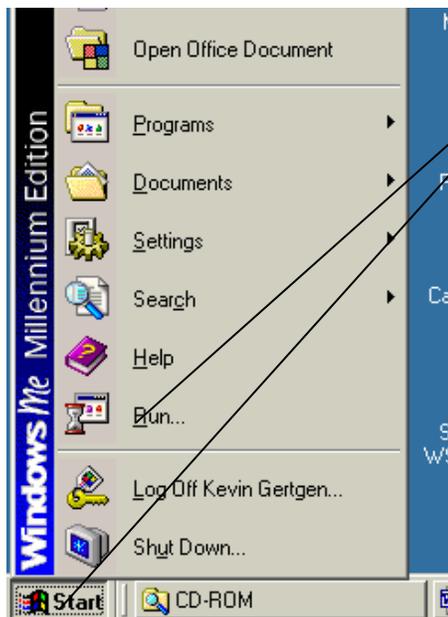
You must install the Port Flow Analyzer from a CD or our website before it will run. To do this from a CD, simply install the CD in your CDRom drive and the Performance Trends Installation Wizard should automatically start, allowing you to install the Port Flow Analyzer and demos of any of our other products.

If the CD does not auto-run, then click on Start, then Run, then Browse and find your CD drive. Then look for SETUP.EXE on the CD and run it to run the Installation Wizard. If you want to bypass the wizard, go into the Programs folder and run the PFA-32.EXE file.

Figure 1.1 B Installation Wizard or Bypassing Installation Wizard



The Installation Wizard will Auto-Start when you insert the program CD. Here's the Port Flow Analyzer button to install this program. You can also install any or all of the other demo programs on the CD. Click on the Brochure button by a particular product for a description with illustrations (a brochure) of that program to be displayed.



To bypass the Installation Wizard, click on Start, then Run, then Browse from the Run screen shown below to find the CDRom, then the Programs folder on the CD, then the PFA-32.exe file in the Programs folder.



## Entering Registered Owner's Name:

The first time you run the Port Flow Analyzer, you will be asked to enter your name as the Registered Owner. During this first session, you can modify it until you are satisfied. Once you accept the name, the computer will generate a Registered Code # based on the name. To be eligible for Tech Help, you will need both your registered name and code #, and to have sent in your registration card. The name you enter should be very similar to the name you enter on the registration card.

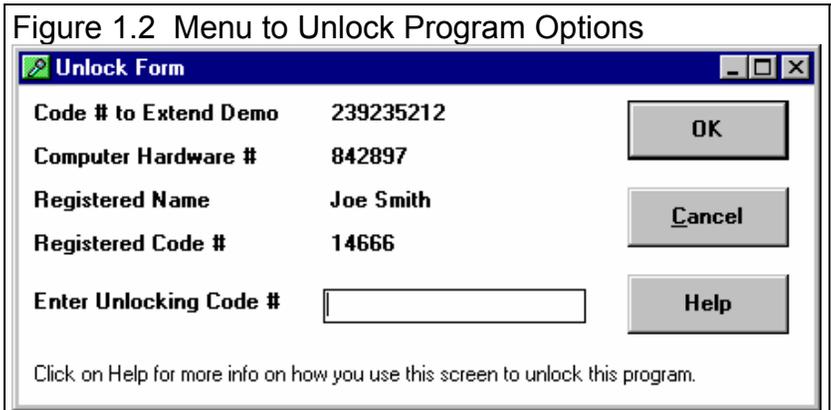
Click on Help, then About Port Flow Analyzer at the Main Screen to review your name and code # .

## Unlocking Program Options:

The Port Flow Analyzer is equipped with copy protection. This ensures that legitimate users do not have to cover the costs for unauthorized distribution of the program. When you first receive the program, it is in demo mode. In demo mode you can try either the Basic version, or the full Professional version for ten days. *All features are working in demo mode.* Sometime during those 10 days, you must call Performance Trends to obtain an "Unlocking Code". This Unlocking Code will be for either the Basic version or the Pro Version, whichever you have purchased.

Before you call Performance Trends, you should get your registered code number and computer hardware number. These are available by clicking on file in the upper left hand corner of the Main Screen, then clicking on Unlocking Program Options. A screen will appear as shown in Figure 1.2.

Performance trends will provide you with an unlocking code number. Type in the unlocking code number and click on OK. If you typed in a number correctly you will be given a message that the program is permanently unlocked to either the Basic or Pro mode. The program will only run on this one computer.

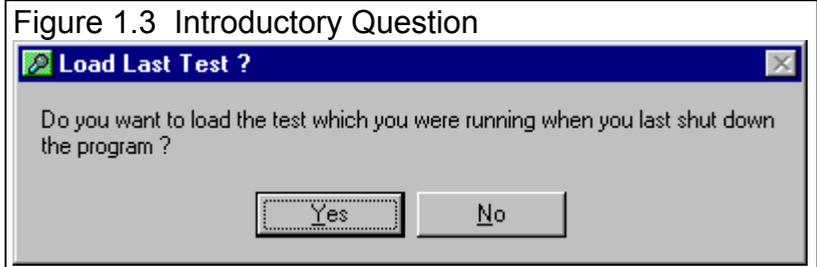


If you want to run the program on another computer, you must install it, obtain the computer hardware number and registered code number as shown in Figure 1.2, and call Performance Trends for a new Unlocking Code for that computer. There may be a charge for additional computers.

# 1.5 Example to Get You Going

To start the Port Flow Analyzer, double click on the desktop Icon called Port Flow Analyzer v3.5. If you don't see a desktop icon, click on Start, then Programs, then Performance Trends, and then Port Flow Analyzer. During startup of the program, you will be given some introductory tips.

One of these "Tips" will ask if the "last test you were running should be loaded". If you have just received the program, this test will be an example test which was loaded at the factory. If you have run the Port Flow Analyzer before, this will be the last test you were working with. If you are just learning the program, it is recommended you answer yes to this question so you have some example data to work with to understand how the program works.



After these brief introduction screens and questions, you will be left at the Main Screen shown below:

Figure 1.4 Main Screen (Pro Version)

Port Flow Analyzer v3.0 Performance Trends [ CHEV194-150 ]

File Graph Report Test Options Head Flow Bench Engine Preferences Help

Exh #3 Int #5 Exh #5 Int #7 Exh #7

Test Comments: EXAMPLE FOR CHEVY HEAD - 600 CFM FLOW BENCH

Help: Click on one of the Tabs here to change to a different cylinder or port. Click on the Head menu command above to change the number of ports to be tested on this head.

	W	CFM
	\$	%
		48.0
		90.6
3	.291	.150 3 19.8 95 141.2
4	.388	.200 4 19.8 54 159.3
5	.485	.250 4 20 57 167.4
6	.582	.300 4 20 61 179.4
7		
8		
9		
10		
11		
12		
13		

Graph showing CFM vs. RPM (0.0 to 0.6) with multiple curves.

Annotations:

- Name of current test you are working with
- Menu Commands
- Click on File, then choose from different Save or Open options
- Click on Unlock Program Options to obtain codes to give to Performance Trends to permanently unlock the program (take out of the 10 day demo)

From this Main Screen, you can:

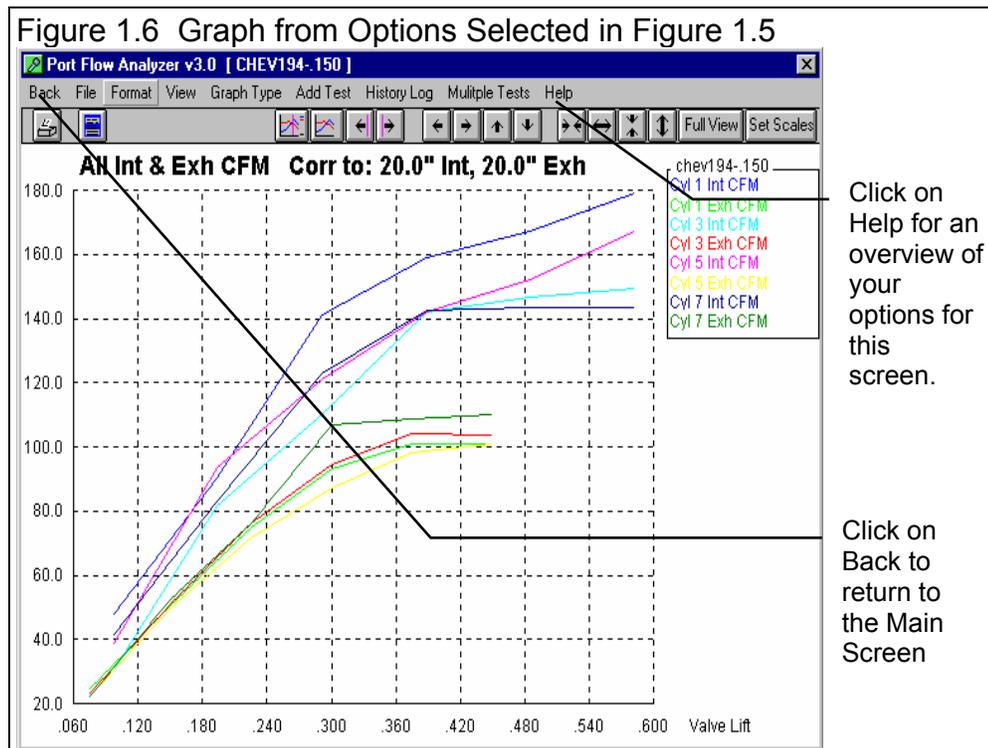
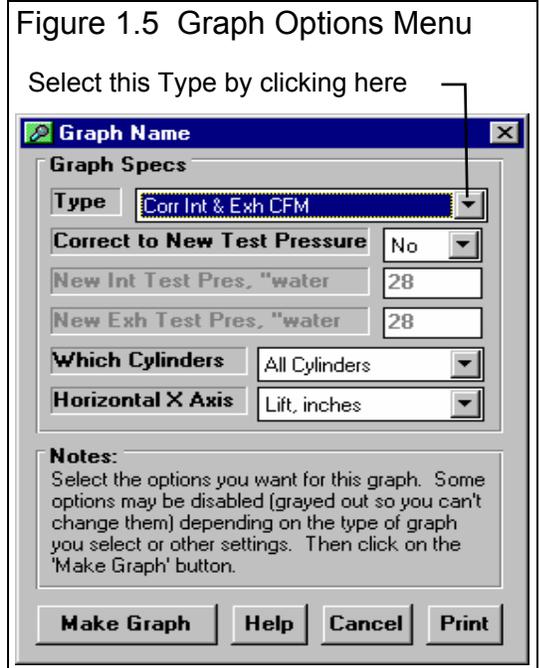
- Choose to review your options by clicking on the menu items at the top of the screen.
- Open or save a file of test results and specs by clicking on File in the upper left corner, and then the Open or Save commands.
- Add, edit or review flow data or test comments for the file you are currently working with.
- Graph or report the test for the file you are currently working with.
- Change the Preferences options to somewhat customize the program for your needs.
- Click on File, then Unlock Program Options to obtain codes to give to Performance Trends to permanently unlock the program (take out of the 10 day demo mode). See Section 1.4.
- Get HELP to explain these options by clicking on Help or pressing <F1>.
- Quit the program by clicking on File, then Exit.

All these options are explained in detail in Chapters 2 and 3.

In the Main Screen's blue title bar you will notice the name of the current test is contained in square brackets [ ] (if you did load in a Flow Test at program startup or opened a file by clicking on File, then Open). The program has several examples of tests saved in the Test Libraries' Example folder right from the factory.

To get started, let's try a couple of Menu commands. Click on the Graph menu command to open up the graph options menu shown in Figure 1.5. That Graph Type shown in Figure 1.5 is for intake and exhaust corrected CFM. If this is not the graph type you see on your computer screen, click on the down arrow to select "Corr Int & Exh CFM".

Click on the Make Graph button to produce the graph shown in Figure 1.6. At the graph screen you have several other options available for changing the graph. These options are available by clicking on the commands in the menu bar or on the buttons at the top of the screen, including the Help command. The Help command at this screen (and most screens) provide a good background on what the various options are. For now, just click on Back at the upper left to return to the Main Screen.

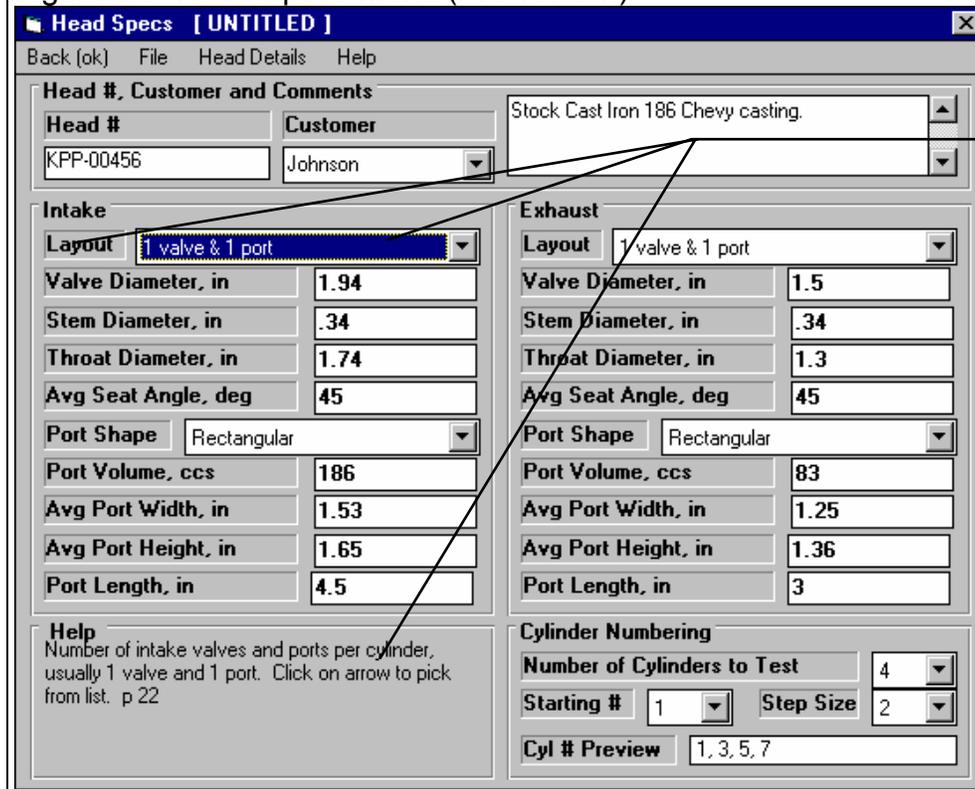


A Test File is made up of the flow data (test pressure, temperatures, valve lifts, etc) and other data like Head Specs, Flow Bench Specs, etc. This is explained in Section 3.6 "Data Libraries". Click on the Head command to obtain a menu as shown in Figure 1.7.

These head specs are used for calculating certain outputs (like valve area, port velocity, etc), and they are useful descriptions to remind you of what this head was in the future.

Many of the input specifications you see in the various menus may not be familiar to you. For a brief definition of the inputs, simply click on the specification name. The definition will appear in the Help frame with a page # in this manual for more info.

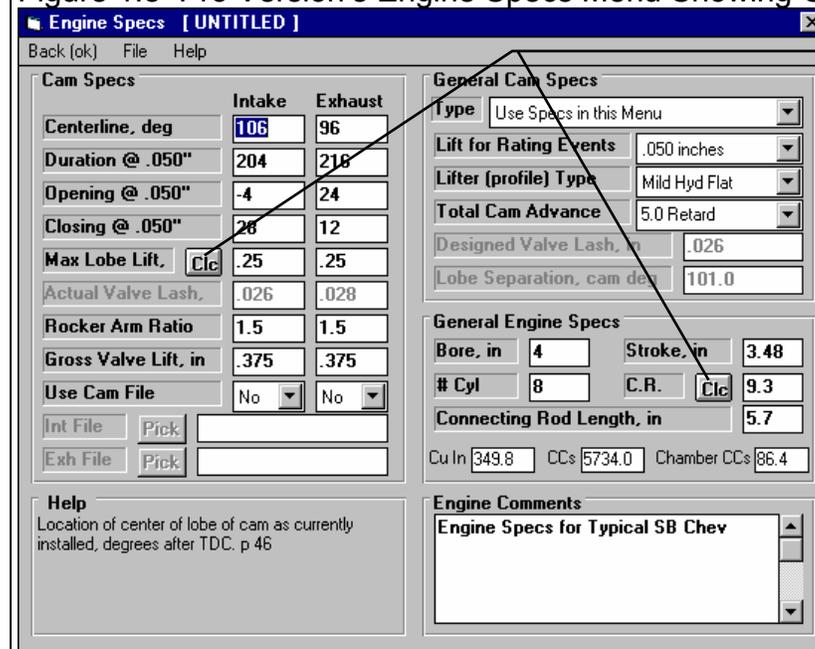
Figure 1.7 Head Specs Menu (Pro version)



Click on most any spec or spec name, and a brief Help description is given here in the Help Frame, with a page # in this manual for additional info.

In the Pro version, some engine specs have "Clc" buttons. One example is Compression Ratio. "Clc" stands for "calculate". For example, if you want to calculate compression ratio from chamber volume, deck height, etc., simply click on the Clc button. The program will display a new menu listing the inputs and the Calc Compression Ratio from these inputs. For further explanation, click on the Help buttons in these menus. To use the Calc Compression Ratio calculated from these inputs, click on the Use Calc Value button. Otherwise click on Cancel to return to the Engine Specs menu with no change to Compression Ratio. Section 2.8, Calculation Menus explains all these calculations.

Figure 1.8 Pro Version's Engine Specs Menu Showing Clc Button



Clc button calculates the value of these specs based on other inputs.

Once you feel comfortable changing specifications in the various menus and making various performance calculations, read Section 3.6 of this manual called Data Libraries to learn how to save a set of flow data or component specifications or recall information which has been previously saved. Then you will know all the basic commands to operate the program. For a more in-depth knowledge of using these commands and an explanation of the results, read this entire manual.

# Chapter 2 Definitions

## 2.0 Basic Program Operation:

Whenever you start the Port Flow Analyzer (Basic or Pro versions), you are brought to a Main Screen which will look like either Figure 2.1 or 2.3. If you have not yet selected a test to work with and have not started a new test, the Main Screen is mostly blank, like Figure 2.1.

If you want to Open a previously saved test, you can click on File in the upper left corner, then click on Open (from all saved tests). You will get a screen as shown in Figure 2.2 where you are presented with a list of saved tests in the Test Library. Some tests are examples provided by Performance Trends. As you run tests yourself and save the results, you will add many more tests to the library. These saved files are useful for making comparisons in the future, and can be used as test patterns (or templates) for new tests (saving you considerable time by not having to type in specs which match a past test).

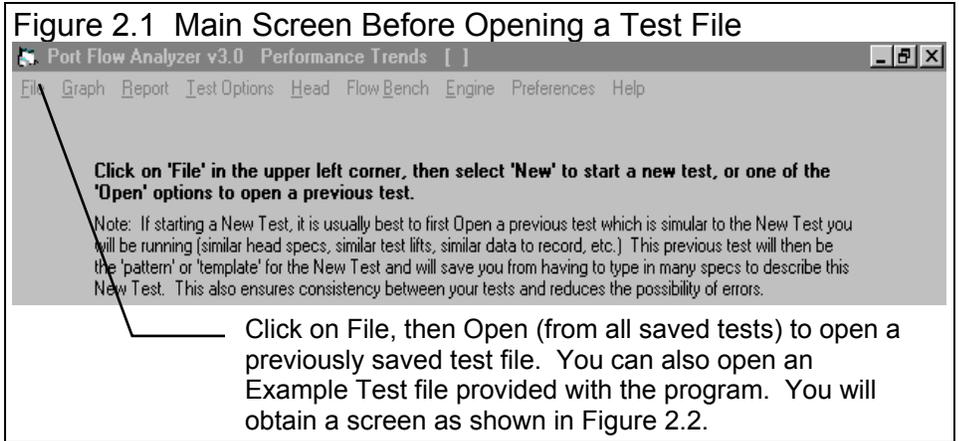
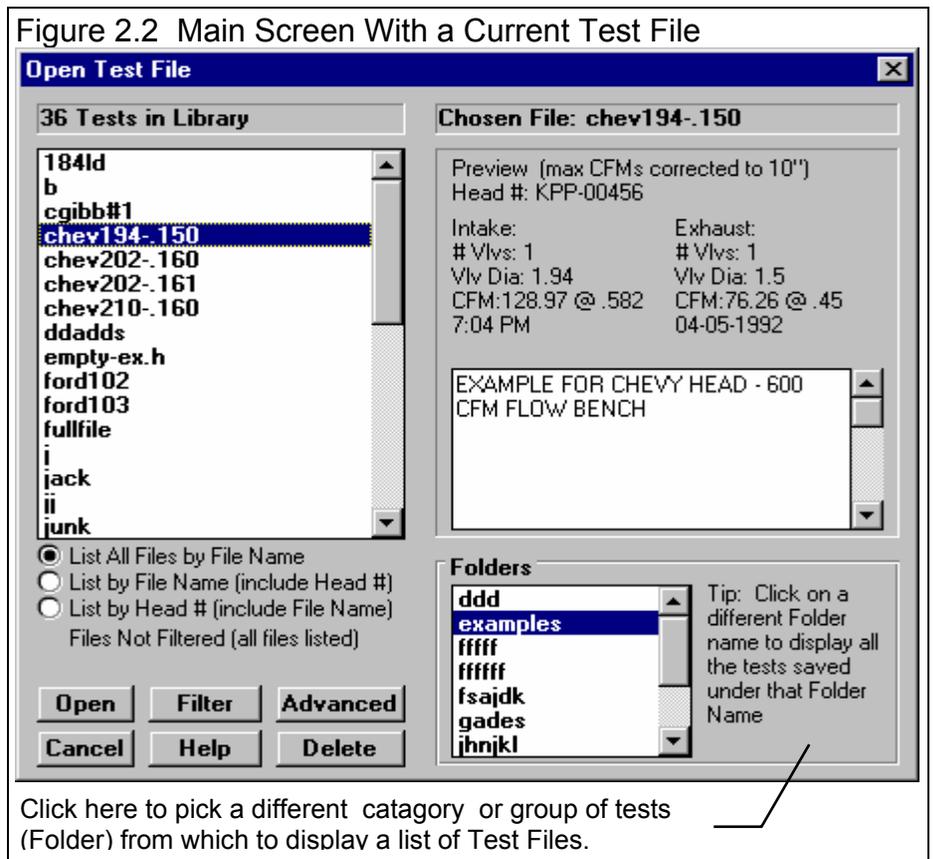


Figure 2.2 shows that the Test Library is divided into sections (called Folders in Figure 2.2) to help organize a large number of tests. For example, all flow tests for the company ABC Engines could be saved under a section name of ABC-ENG. All 4 cylinder Ford tests could be saved under a section name of 4CYL-FORD. This will save considerable time and confusion when trying to locate a particular test in the future. To look in different sections, click on the Folder name from the list shown at the lower right of Figure 2.2. The list of tests will then be updated for that Folder. To pick a test, simply click on it from the list of tests, then click on the Open button. (For those familiar with computers, Folders are actually subdirectories or folders in the PFADAT folder. The Name "Folder" can be changed to something else, like "Customer" used in the DOS v2.1, in the Preferences menu.)



If you *are* working with particular test, the data will be presented as shown in Figure 2.3. Notice in Figure 2.3 that a

**Figure 2.3 Main Screen After Opening a Test File**

Menu Commands of File, Graph, etc. These give you all the options to operate the program and change test data.

Name of Current Test File

Click on these tabs to switch between the different ports on this particular head.

Enter most any test comments here to keep notes about this head or test.

Move the mouse over an area on the screen, and a Help description of that item is given here.

This summary graph shows how CFM from the various ports compares. The CFM for the port you are currently displaying is graphed in color, blue if intake, red if exhaust.

Click on Slide Bars to display more Test Data, which may not be able to fit on the screen.

Click on most any setting in the Test Data grid to enter flow data. You can enter or change most any data by hand except CFM. CFM is calculated from the other data inputs. (Note that in the Test Options menu you can select to enter CFM directly, but this eliminates the other flow data entries like Flow Pressure, Flow Bench Range, etc.)

Click either in the first column (Point column) or top row (with titles of the columns) to open up an Edit menu to insert a row, delete a row, copy down a column, etc.

A summary of critical test settings is given here. Click on a setting to change it (in the case of Leakage air flow for each port), or to bring up the menu where it can be changed.

Point	Lift	L/D	Range	Test Pres \"	Flow Pres %	CFM
1	.097	.050	2	20.3	72	48.0
2	.194	.100	3	20	62	90.6
3	.291	.150	3	19.8	95	141.2
4	.388	.200	4	19.8	54	159.3
5	.485	.250	4	20	57	167.4
6	.582	.300	4	20	61	179.4
7						
8						
9						
10						
11						
12						
13						

current test name is listed at the top in square brackets [ ]. This is the file of cylinder head data, flow data and flow bench specs which are currently saved in the Flow Test Library, and are the data and specs you are currently working with. If you change the flow data or specs, make a graph or report, it is for this test file.

If you click on one of the Menu Commands at the top of the Main Screen, you can be presented with screen of specs, as shown in Figure 2.4. Figure 2.4 discusses some of the commands to enter or change settings at this menu.

Figure 2.4, Explanation of Sections of Typical Menu (Engine Specs menu shown which is only available in the Pro version)

Names of component specs. Click on them for a description in the Help frame in the lower left corner.

Name of component file displayed in this menu (Pro version only).

Standard text entry box where you can type in a number for a spec.

Drop down combo box. For some specs (like Total Cam Advance in these Engine Specs) you can either type something in the box, or click on the arrow button to select a pre-programmed selection. For most others you can only select from a list pre-programmed choices.

Comment text frame to enter a comment to describe these component specs. These comments are saved with the specs in the Component Library, in the case shown here, the Engine Library.

Some specs have a Clc (calculate) button, where you can either enter the specs directly (in this case the compression ratio) or click on the Clc button to calculate it from other inputs.

	Intake	Exhaust
Centerline, deg	107	117
Duration @ .050 "	204	214
Open @ .050 "	-5	44
Close @ .050 "	29	-10
Max Lobe Lift, Clc	.280	.295
Actual Valve Lash,	.026	.028
Rocker Arm Ratio	1.5	1.5
Gross Valve Lift, in	.42	.443
Use Cam File	No	No

Standard menu commands which provide the options for closing this menu (Back), saving or open files of these individuals specs (click on File, then Save or Open), erasing a set of specs (click File, then New, printing this screen (click on File, then Print), etc. See the sections later in this chapter for more details on individual menus.

### Before Running Your First Flow Test:

It is recommend you becoming very familiar with the Port Flow Analyzer before starting "real" tests. Points to consider include:

- Unlike paper Test Data grids, computer data from past tests can be lost if back up copies on external disks are not made. Printing paper reports of a test is another method of "backing up" data. See Appendix 4, Backing Up Data.
- Data for a test can also be lost if the Save command is not used to save data to the Flow Test Library.
- Perform some "parallel" tests using both the computer and recording data by hand. The results should agree within a couple of CFM. If not, the Port Flow Analyzer might not be set up correctly for your flow bench. Also, check the hand calculations to be sure they are being performed in the way the Port Flow Analyzer calculates results. Resolve any problems before switching over to the computer. **Note: Port Flow Analyzer is doing all recommended corrections, which you may not currently be doing by hand. This is a possible reason the Port Flow Analyzer's CFM numbers may not match your hand calculations.**

### Flow Bench Terminology:

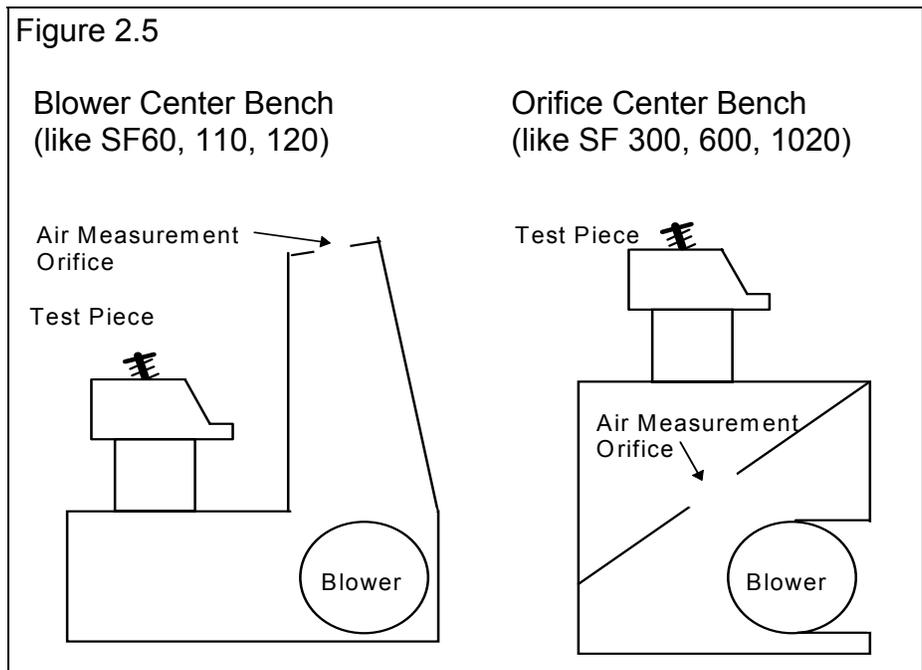
A flow bench is a device which flows air through a test piece at a measured pressure drop and air flow rate. By knowing the pressure drop and air flow rate, the test piece can be rated for flow efficiency and compared with other similar test pieces. For engine components, the higher the flow efficiency, the higher the horsepower potential.

The pressure drop across the test piece is called the test pressure and is abbreviated as Test Pres in this manual and program. Test Pressure is usually measured with a vertical manometer calibrated in inches of water.

The air flow is generally measured by monitoring the pressure drop across one or more flow orifices of known sizes. The pressure drop across these orifices is abbreviated as Flow Pres for flow pressure. Flow Pres is usually measured with an inclined manometer calibrated in % Flow.

The Port Flow Analyzer assumes the test pieces are cylinder heads either with or without other components attached (manifolds, headers, etc). The program can be used for testing other components, however a notation system for organizing the data will have to be developed by the user.

Section 2.6 on Bench Specs goes into more detail on specific flow bench features. Be familiar with the Flow Bench Specs before taking data. The flow bench specs must match those of the particular flow bench being used for the test data to be accurate.



There are 2 basic types of flow benches the Flow Bench Analyzer supports, "blower center" and "orifice center". See Figure 2.5. These types can be either standard as available from a manufacturer like SuperFlow \*, or "custom". The various types of benches are described in more detail in Section 2.6, Bench Specs.

\* SuperFlow, SF 60, SF 110, SF 120, SF 300, SF 600 and SF 1020 are registered trademarks of SuperFlow Corp.

# 2.1 Main Screen (Test Data) Inputs

The Main Screen is shown in Figure 2.6 and is designed to resemble a typical paper data sheet. Like a paper data sheet, you enter valve lifts, range numbers, manometer readings, and temperature readings as needed. The Main Screen is made up of 5 basic sections as shown in Figure 2.6. These are discussed in the next 5 sections. The rest of this section gives an overview of how a Flow Test is organized.

Figure 2.6 Main Screen After Opening a Test File

5) Menu Commands of File, Graph, etc. These give you all the options to operate the program and change test data.

1) Click on these Tabs to switch between the different ports on this particular head.

2) Test & Head Conditions summarizes some critical test specs, and includes a comments section to keep notes about this test.

3) This Summary Graph shows how CFM from the various ports compares. The CFM for the port you are currently displaying is graphed in color, blue if intake, red if exhaust.

4) Click on most any setting in the Test Data grid to enter flow data. You can enter or change most any data by hand except CFM. CFM is calculated from the other data inputs. (Note that in the Test Options menu you can select to enter CFM directly, but this eliminates the other flow data entries like Flow Pressure, Flow Bench Range, etc.)

Point	Lift	L/D	Range	Test Pres "	Flow Pres %	CFM
1	.097	.050	2	20.3	72	48.0
2	.194	.100	3	20	62	90.6
3	.291	.150	3	19.8	95	141.2
4	.388	.200	4	19.8	54	159.3
5	.485	.250	4	20	57	167.4
6	.582	.300	4	20	61	179.4
7						
8						
9						
10						
11						
12						
13						

## 2.1.1 Tabs

A cylinder head's Flow Test is made up of between 2 to 16 Test Data grids for each port, each with a tab as shown in Figure 2.6. If you are testing just 1 cylinder, the flow test will be made up of 1 intake and 1 exhaust Test Data grid. If you are flowing 2 cylinders it is made up of 2 intake and 2 exhaust Test Data grids, and so on. Figure 2.6 shows how a test for 4 cylinders would look. You move to different ports by clicking on the Tabs at the top of the screen.

You set the Number of Cylinders to test and the pattern for the cylinder numbering in the Head Specs menu. You can open the Head Specs menu by clicking on the Head menu command at the top of the Main Screen. See Section 2.4.

## 2.1.2 Head and Test Options

### Valve Description

Describes the number of valves and valve diameter for the port being displayed. Click on this item to display the Head Specs menu where this data is contained.

### Test Time and Date

This records the time and date at the start of the flow test. When a flow test is started with the New Test command (click on File, then click on New Test at the Main Screen), the computer's current time and date are saved as the test time and date. The test time and date can also be changed by clicking on it here at the Main Screen. Only one test time and date is saved for the Flow Test file. If, for example, a note is needed to show some ports were tested on a different day, that must be recorded in the test comments.

### Test Correction Factor

The SuperFlow 110 and 120 bench recommends a calibration test be performed periodically. This is done by flowing a standard size orifice where the head is mounted. By comparing the flow of this orifice with the expected flow, a correction factor is calculated and displayed here. See the Test Correction Factor command in Section 2.10, page 57 and Example 4.2. For other benches, the Test Correction Factor is automatically set to 1.000 (no correction) and is not displayed.

### Bore Adapter

Describes the Bore Adapter diameter used for this test. The Bore Adapter is the cylinder mounted between the head and the flow bench, simulating the engine's bore. The size of bore adapter can have a large effect on the CFM flow. Click on this item to display the Test Options menu where this data is contained.

### Test Pressure

Air flow through the port will vary as the Test Pressure (vertical manometer pressure) changes. For most flow tests, it is best if the Test Pressure is kept constant, however, this is not always easy. For example, you may want to hold 28 inches, but the true reading may be 27.8, or 28.1. Fortunately it is easy to mathematically correct the air flow to a constant Test Pressure. This spec identifies the standard Test Pressure you are trying to maintain on the vertical manometer. CFM will be corrected to this Test Pressure for the current port being displayed. Intake and exhaust ports can be set to different Test Pressures. Click on this item to display the Test Options menu where this data is contained.

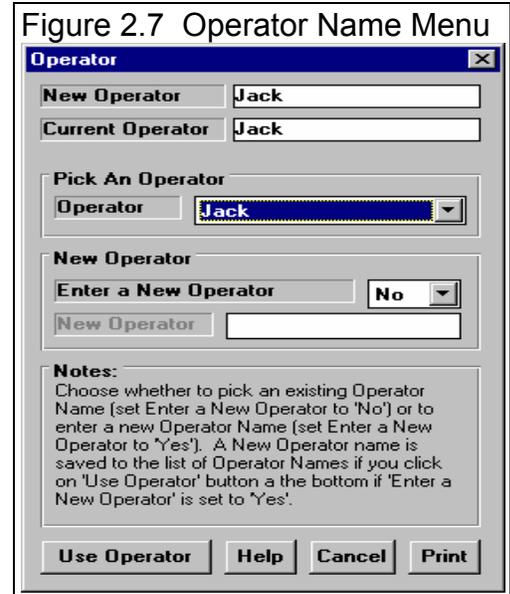
### Leakage

This is the leakage flow through the bench with the valve closed in the port being flowed. Because this flow is not passing through the valve, the Leakage CFM value is subtracted from the calculated flow for each test point. See Examples 4.1 and 4.2 for recording Leakage and how it corrects data. The Leakage CFM can be different for each port. Click on this item for each port to type it in directly. Press <enter> when you are done typing. Although many head porters do not check or record leakage, it is a good practice to develop.

### Test Operator

This is the name of the operator who ran the test. Click on this item for the menu of Figure 2.7 to be displayed, where you can type in a new operator name, or choose from one you have previously entered. It is always recommended you first check the list of existing operators, so you do not end up with several names for the same operator. For example, Bob, Bobby and Robert may all be for the same guy. When you go to look for tests run by Bobby in the future, the search (Filter option) will not show up the tests run by Bob or Robert.

To pick an existing operator name, pick No for Enter a New Operator, then pick from the Operator list. To enter a New Operator name, pick Yes for Enter a New Operator, then type in a New Operator name, which will be added to the list of operator names.



### Test Comments

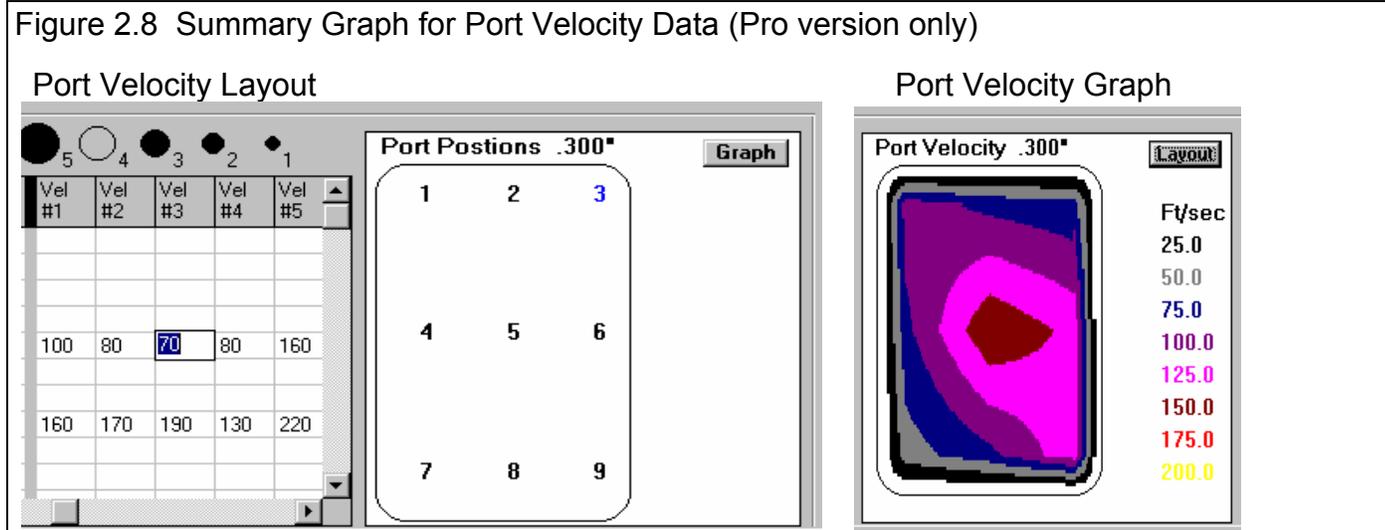
Test comments are for making most any notes about the test, unusual observations, customer requirements, etc. In the Pro version, you can search the Comments for various words. For example, you could search for all the tests which had the word “unstable” or “titanium” in the Test Comments.

### Help

The help frame will describe what ever portion of the screen the mouse has passed over or clicked on. For example, click on a location in the Test Data grid, and a description of what data can be entered in that particular column is given.

## 2.1.3 Summary Graph

The summary graph shows CFM graphed versus valve lift for all the ports on this particular head (Figure 2.6). This is an excellent way to show if the data between the different ports is agreeing well. It does take some time to graph all ports. On slower computers you may want to change the Preference “Main Screen, Other Cyl. Graphs” to No. This will result in faster updating of the Main Screen but graph only the data for the port you are working on.



In the Pro version, if you are working with (clicked on) a column for entering Port Velocity it will show a graph of Port Velocity or a layout diagram so you know where different port points are located. See Figure 2.8.

If you click on the Summary Graph, the Graph Options menu pops up to provide many more graphing options.

### 2.1.4 Test Data Grid

#### Point

The point column simply numbers the rows of data, and is used by the program to identify a row of data for messages. Another feature is if you click on a Point #, the Edit Test Data menu shown in Figure 2.9 pops up, letting you edit the row you clicked on. A similar editing menu is available by clicking on the top row, for editing columns.



#### Lift

This is the valve lift in inches from its seated position. If you have asked for L/D to be displayed (selectable in the Test Options menu), a new L/D value is calculated as each valve lift is entered or changed.

#### L/D

This is the ratio of valve lift divided by valve diameter. For example, if the particular port is an intake port, the valve diameter is specified in the Head Specs menu under Intake Port Specs. As each valve L/D is entered or changed, a new valve lift is calculated. You can ask for this column not to be displayed by selecting the appropriate option in the Test Options menu.

#### Range

This identifies the range number currently being used for measuring the air flow, a number between 1 and 9. The number identifies the Full Scale Flow entered in the Flow Bench Specs menu. For SF 1020 benches, the actual Full Scale Flow in CFM is entered in this column.

Note: If you were using a previous DOS version of Port Flow Analyzer with a "blower centered bench" like a SF 110, this spec has changed. You no longer can enter the numbers of the holes which are open. When your old DOS files are read into this new version, the Range # and possibly the Flow Pres data will be changed to match the new data format, but giving the same CFM as before.

#### Test Pressure

This is the pressure drop measured across the head (port and valve) on the vertical manometer in inches of water, called "test pressure". This value should be kept within .5" of the Test Pressure specified in the Test Options menu and as shown in the Test Notes section.

#### Flow Pressure

This is the pressure drop across the air flow orifices, generally measured with an inclined manometer. For custom benches, the Port Flow Analyzer allows you to use various types of inclined manometer readings. See Inclined Flow Manometer under Bench Specs in Section 2.6 and Appendix 2.

## Test Temp

If Use Temp Correction is set to Yes under Bench Specs (Custom Blower Center bench or SF 60, SF 110, SF 120), this data is the temperature of the air passing through the head in degrees F. For intake flow it is measured after the port. For exhaust it is measured before the port.

If Use Temp Correction is set to No under Bench Specs (Custom Orifice Center bench or SF 300, SF 600, SF 1200, SF 1020), this column will not be present in the Test Data grid unless you specifically request recording temperature in the Test Options.

## Flow Temp

If Use Temp Correction is set to Yes under Bench Specs (Custom Blower Center bench or SF 60, SF 110, SF 120), this column is made available. It is the temperature of the air passing through the air measurement orifices in degrees F. For intake flow it is measured before the orifices. For exhaust it is measured after the orifices.

If Use Temp Correction is set to No under Bench Specs (Custom Orifice Center bench or SF 300, SF 600, SF 1200, SF 1020), this column will not be present in the Test Data grid.

## CFM

Is the air flow in CFM which has been corrected for temperature, leakage and the difference between actual Test Pressure recorded and Standard Test Pressure. This is the only data that you can **NOT** enter directly or modify by clicking on it and typing in a new value (unless you specify “Enter CFM Directly” in the Test Options menu). It is based on the calculations from data in the other columns.

The general sequence of events for the CFM calculation is given below:

1. After each new value is entered, the program checks to see if enough data has been entered to calculate CFM for that row.
2. If enough information is present, the Full Intake Flow or Full Exhaust Flow for the range # identified under Range is determined.
3. The correct fraction of the total flow for the appropriate range is based on Flow Pressure and the Inclined Flow Manometer specs in the Bench Specs menu.
4. If Use Temp Correction is set to No (SF-300, SF-600, etc.), a correction is made for intake and exhaust flow due to any difference between actual Test Pressure and Orifice Std Pres spec in the Bench Specs (typically a very small correction).
5. If Use Temp Correction is Yes (SF-110, SF-60), a correction is made due to temperature differences at the measurement orifices (Flow Temp) and the test piece (Test Temp).
6. A correction is then made for any difference between actual Test Pressure and the Desired Test Pressure shown in the Test Notes and set in the Test Options menu.
7. For the SF 110 bench only, the resultant CFM at this point is multiplied by the Test Correction Factor. See Section 2.10.
8. The Leakage CFM is then subtracted from the previously calculated CFM. This is the value printed in the data column for CFM. It is assumed that the Leakage CFM has already been corrected for the factors mentioned in steps 2-4. See Examples 4.1 and 4.2.

## Stblty +/- % (Pro version only)

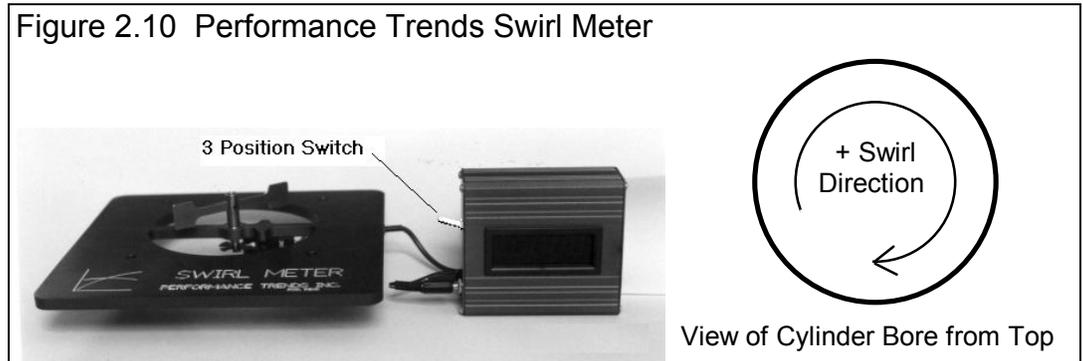
This is a measure of the stability of the Test Pressure for this data point. Many head porters talk about a stable versus an unstable port. This can be based on sound or the “bounce” they see in the test pressure manometer. The Port Flow Analyzer’s definition of Stblty is the percent of Test Pressure “bounce” compared to the total Test Pressure. For example, if you see a 1” bounce in test pressure when you are trying to set 10”, this would be 10% ( $1/10 \times 100\% = 10\%$ ). If you only saw 0.1” of bounce, this would only be 1% Stblty.

This column is only available if you have selected “Calc from Entries, Include Stability” option for CFM Flow in the Test Options menu. Although you can enter Stblty by hand, it was meant to be recorded electronically with SuperFlow’s FlowCom or Performance Trends’ Electronic Interface. In the Flow Bench Specs menu you can specify from 5 to 50 data points to be

recorded and averaged together for a CFM reading. During these readings, the program calculates some statistics on the stability of the Test Pressure readings. It *tries* to be as accurate at estimating stability if only 5 readings are taken, but it should be obvious to the user that the accuracy and repeatability of the Stability readings improves as you ask for more readings to be taken. Performance Trends recommends you always take at least 10 readings if you are recording Stblty +/- %.

## Swirl (Pro version only)

Swirl is a measure of the motion of the intake air in the cylinder. The correct amount of intake air motion improves combustion and improves burn rate, both of which improve performance. It can be measured on a flow bench using Performance Trends RPM based Swirl Meter. See Figure 2.10. Performance Trends definition of swirl direction is: Clockwise rotation when viewed from the top of the cylinder is positive (+) swirl, counterclockwise is negative (-). See Figure 2.10.



If you have asked to record swirl in the Test Options, this column is made available, but only on the Intake ports (exhaust swirl is meaningless). Record swirl RPM from the Performance Trends Swirl Meter or a swirl reading from a different type of meter. Enter a negative (-) number if the swirl is counterclockwise as viewed from the top of the cylinder.

## Swirl +/-% (Pro version only)

This data is very similar to the Stblty +/- % discussed previously, and is the % variation (“bounce” discussed earlier) in the Swirl reading compared to the average Swirl Reading. If the variation from Max to Min over 10 seconds was 300 RPM and the average Swirl was 3000 RPM, this would be 10%.

This column is only available if you have selected “Record Avg Swirl and Range %” option for Record Swirl in the Test Options menu. Although you can enter Swirl +/- % by hand, it was meant to be recorded electronically with SuperFlow’s FlowCom or Performance Trends’ Electronic Interface. In the Flow Bench Specs menu you can specify from 5 to 50 data points to be recorded and averaged together for a CFM reading. During these readings, the program calculates some statistics on the Swirl readings. It *tries* to be as accurate at estimating Swirl +/- % if only 5 readings are taken, but it should be obvious to the user that the accuracy and repeatability of the Swirl +/- % readings improves as you ask for more readings to be taken. Performance Trends recommends you always take at least 10 readings if you are recording Swirl +/- %.

## Baro Pres (Pro version only)

If you have asked to record Barometer in the Test Options, this column is made available. Record Barometer in inches of Mercury. (This entry is for information only and is not used in the CFM calculation.) If you are using the SuperFlow FlowCom, this reading is provided by the FlowCom.

Background: There are 2 basic types of Barometric Pressure readings:

Corrected Barometer: This reading is what you will hear from most any TV or radio weather report. It is the true barometric pressure *corrected to sea level*. This means, with the current barometric pressure, what would a barometer read as sea level.

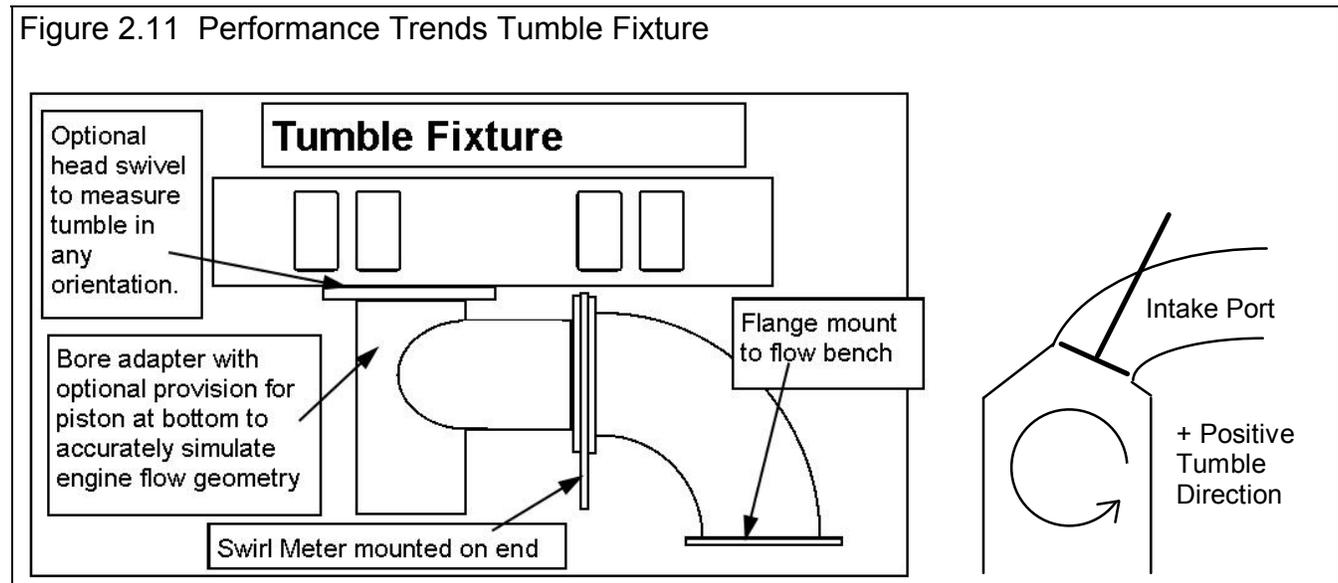
Observed (true) Barometer: This is the actual Barometric Pressure at the barometer instrument, *measuring the actual air pressure at the barometer*. This reading will read *approximately* .1 inches of mercury less than the corrected barometric pressure you will hear from a TV or radio weather report for each 100 feet of elevation.

For this reason, the barometer you see on TV or hear on the radio should be about .1” higher for each 100 feet of elevation at the FlowCom’s barometer or the barometer instrument at your shop. It is not important to the program which barometer you record because it is for your information only. However, to avoid confusion on your part you should be consistent from test to test.

### Reltv Hum or Dew Point (Pro version only)

If you have asked to record Humidity in the Test Options, this column is made available. The title depends on your choice of Relative Humidity or Dew Point in Test Options. Note that this entry is for information only and is not used in the CFM calculation.

### Tumble (Pro version only)



Tumble is a measure of the motion of the intake air in the cylinder. The correct amount of intake air motion improves combustion and improves burn rate, both of which improve performance. It can be measured on a flow bench using Performance Trends RPM based Tumble Meter. Performance Trends’ convention is a negative tumble means the tumble direction is opposite of the direction the intake port would induce. See Figure 2.11.

If you have asked to record Tumble in the Test Options, this column is made available, but only on the Intake ports (exhaust Tumble is meaningless). Record Tumble RPM from the Performance Trends Tumble Meter or a Tumble reading from a different type of meter.

### Tumble +/-% (Pro version only)

This data is very similar to the Stblty +/- % discussed previously, and is the % variation (“bounce” discussed earlier) in the Tumble reading compared to the average Tumble Reading. If the variation from Max to Min over 10 seconds was 300 RPM and the average Tumble was 3000 RPM, this would be 10%.

This column is only available if you have selected “Record Avg Tumble and Range %” option for Record Tumble in the Test Options menu. Although you can enter Tumble +/- % by hand, it was meant to be recorded electronically with SuperFlow’s

FlowCom or Performance Trends' Electronic Interface. In the Flow Bench Specs menu you can specify from 5 to 50 data points to be recorded and averaged together for a CFM reading. During these readings, the program calculates some statistics on the Tumble readings. It *tries* to be as accurate at estimating Tumble +/- % if only 5 readings are taken, but it should be obvious to the user that the accuracy and repeatability of the Tumble +/- % readings improves as you ask for more readings to be taken. Performance Trends recommends you always take at least 10 readings if you are recording Tumble +/- %.

### Vel (Port Velocity) (Pro version only)

These columns are for entering port velocity measurements made with a Pitot (pronounced "pee-toe") tube. These columns are displayed only if you have requested Port Velocity measurements in the Test Options menu. In addition, port velocity measurements are only entered in 1 or 2 rows, rows with lifts specified in the Test Options screen. You must have entered one of these lifts before you can enter port velocity data.

You can enter velocity data either as:

- Pressure in inches of water and have the program convert it to velocity in Ft/Sec. This is probably the most common method if your Pitot tube is connected to a water manometer scaled, for example, from 0 to 30 inches. Note that the data in the table stays in inches of water pressure and is only converted to Ft/Sec when a graph or report is made.
- Velocity in Ft/Sec directly.

## 2.1.5 Main Screen Commands

The next section discusses some of the commands available at the top of the Main Screen. Most will not be discussed here in detail, as they are discussed in other sections of this manual.

### File (see Figure 2.12 for File Options)

#### New (start new test)

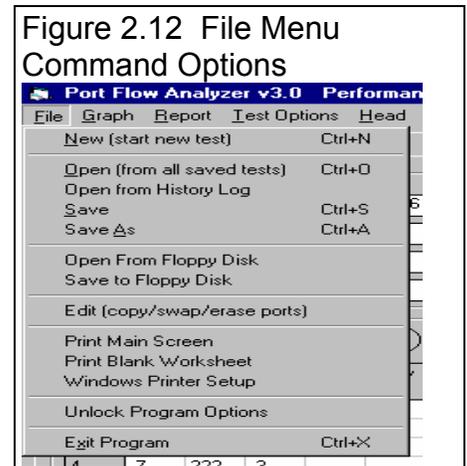
Click on File, then New to start a new test. This process will “walk you through” some critical steps to start with a blank Test Data grid, or to keep certain data from the previous test. Keeping data can save you considerable time since you don’t have to type in information which may be the same as the current test. The New Test command is discussed in full detail in Section 2.9.

#### Open (from all saved tests)

This option presents the Open Test File menu discussed in Section 3.6, Data Libraries. From there you have several options to open a previously saved test file from any place in the Test Library, or from most any place on the computer, including an external disk drive.

#### Open (from History Log) (Pro version only)

This option presents the History Log, a chronological list of test files you have been working with as discussed in Section 3.8. From there you can review a summary of the last 25 to 100 tests, and pick one to open. This method can make it easier to find a file you have just worked with lately, say in the last couple of weeks.



## Save

Select Save if you want to save the current test and any recent changes *to the same name* as you are currently working with. This is the file name shown in square bracket [ ] at the top of the Main Screen.

## Save As

Select Save As if you want to save the current test and any recent changes *to a new name or new folder*. You will be presented with the menu discussed in Section 3.6 where you can change the test name, change the folder you are saving it to, or add a new folder name.

## Open from External Drive

This command provides a simple 1 click command to open a standard Windows “File Open” menu displaying the contents of the disk in the external (CD or USB) Drive. This provides a convenient method for copying files from one computer to another.

## Save to External Drive

This command provides a simple 1 click command to save the current test file to the disk in the external (CD or USB) Drive to the same name as is currently being used. This provides a convenient method for copying files from one computer to another.

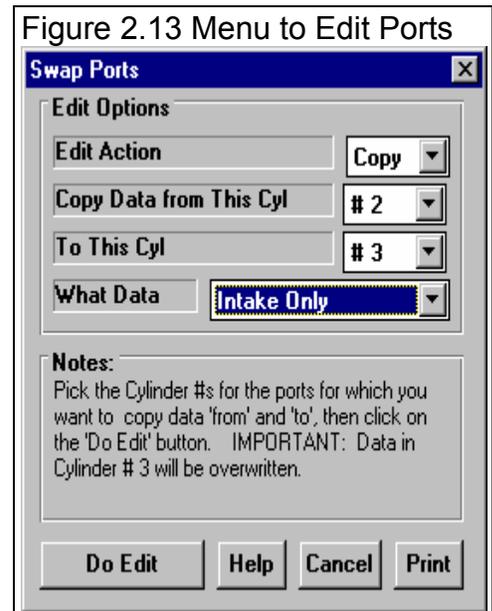
## Edit (copy/swap/erase ports) (Pro version only)

This command will display the menu shown in Figure 2.13. This menu lets you modify Flow Data for an entire port. This can be useful should you find you have mistakenly recorded data for the wrong port, for filling in a new blank port with data from a previously tested port, or completely erasing a port. The process consists of:

- First select the type of 'Edit Action' you want to do.
- Then select which port or ports you want to perform the action on.
- Then select which data (Intake, Exhaust or Intake + Exhaust) you want to edit.
- Then Click on the 'Do Edit' button to perform the edit.

Swapping and Copying are also handy if you want to make a 'stand alone' test of a particular port. Say you were doing several modifications to a particular port. Each modification you simply called a different Cylinder by setting the 'Number of Cylinders to Test' spec in the Head Specs menu to the # of modifications. For example, Cyl #1 could be 'Baseline', Cyl #2 could be '3 angle valve job', etc. Say that the 5th modification was one you wanted to do more analysis on. You could first Save all your modifications as a Test File, like 'ALL-MODS' for future reference.

Then you could 'swap' Cyl #5 with Cyl #1, so Cylinder #5's data (the 5th modification) is in Cylinder #1's location. In Head Specs you could then set 'Number of Cylinders to Test' to just 1, which effectively erases all cylinders higher than the first. Now you could Save THIS file under a new name, like 'BEST-MOD'. This 'BEST-MOD' file of just 1 cylinder can now be combined with Engine Specs for analysis, graphed with other Test Files, etc., just as if the entire head was like the 1 cylinder, the 5th or best modification.



- Print Main Screen
- Print Blank Worksheet
- Windows Printer Setup

The Print Main Screen and Print Blank Worksheet commands simply give you instructions how to do each. These commands were placed under File as many users will look under File to find these print options. The Windows Printer Setup lets you change your Windows default printer, paper orientation, etc for printing reports or graphs in other areas of the program.

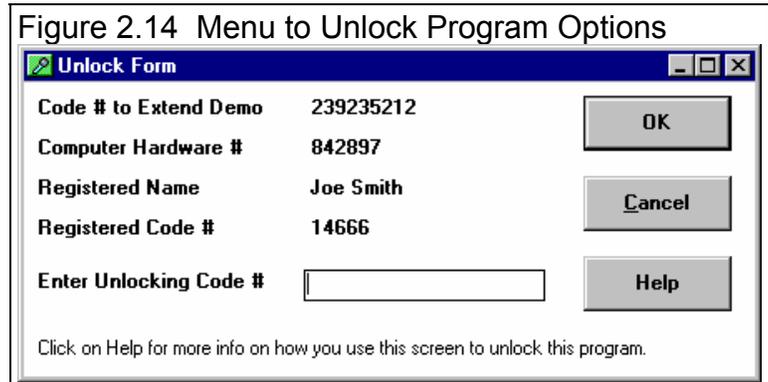
### Unlock Program Options

The Port Flow Analyzer is equipped with copy protection. This ensures that legitimate users do not have to cover the costs for unauthorized distribution of the program. When you first receive the program, it is in demo mode. In demo mode you can try either the Basic version, or the full Professional version for ten days. *All features are working in demo mode.*

Sometime during those 10 days, you must call Performance Trends to obtain an “Unlocking Code”. This Unlocking Code will be for either the Basic version or the Pro Version, whichever you have purchased.

Before you call Performance Trends, you should get your registered code number and computer hardware number. These are available by clicking on File in the upper left hand corner of the Main Screen, then clicking on Unlocking Program Options. A screen will appear as shown in Figure 2.14.

Performance Trends will provide you with an unlocking code number. Type in the unlocking number and click on OK. If you typed in a number correctly you will be given a message that the program is permanently unlocked to either the Basic or Pro mode. The program will only run on this one computer.



If you want to run the program on another computer, you must install it, obtain the computer hardware number and registered code number as shown in Figure 2.14, and call Performance Trends for a new Unlocking Code for that computer. There may be a charge for additional computers.

### Graph

The Graph command lets you graph several different types of data from the current test, either by itself or with data from other tests for comparisons. The Graph options are discussed in detail is Section 3.4, page 85.

### Report

The Report command lets you create reports of several different types of data from the current test, either by itself or with data from other tests (Pro version only) for comparisons. The Report options are discussed in detail is Section 3.1, page 65.

### Test Options

The Test Options command opens up the Test Options menu. There you tell the program what data you want to record (swirl, port velocity, barometer, etc) and other details about the test (like test pressure, bore adapter diameter, etc.). Test Options are discussed in detail in Section 2.3, page 29.

## Head

The Head command opens up the Head Specs menu. There you can describe the head you are testing, like valve size, port volume, etc. In the Pro version, you can also open up the Head Details menu. There you can record over 60 other specs about the head, like valve/spring/locks/retainers details, material type, chamber CCs, etc. Head Specs are discussed in detail in Section 2.4, page 33.

## Flow Bench

The Flow Bench command opens up the Flow Bench Specs menu, where you can describe the Flow Bench you are using.

***The specs in the Flow Bench menu are critical for accurate results. Be sure to read and understand the Flow Bench Specs as discussed in detail in Section 2.6, page 41.***

## Engine (Pro version only)

In the Pro version, the Engine command opens up the Engine Specs menu. There you can briefly describe engine specs to combine with your head flow data for more detailed analysis. Engine Specs are discussed in detail in Section 2.7, page 45.

## Preferences

Preferences let you customize the program for your needs and for your computer and printer. See Section 2.2, page 25.

## Help

Click on Help for several options to help describe your options at the Main Screen, and for other information to help you understand how this program works.

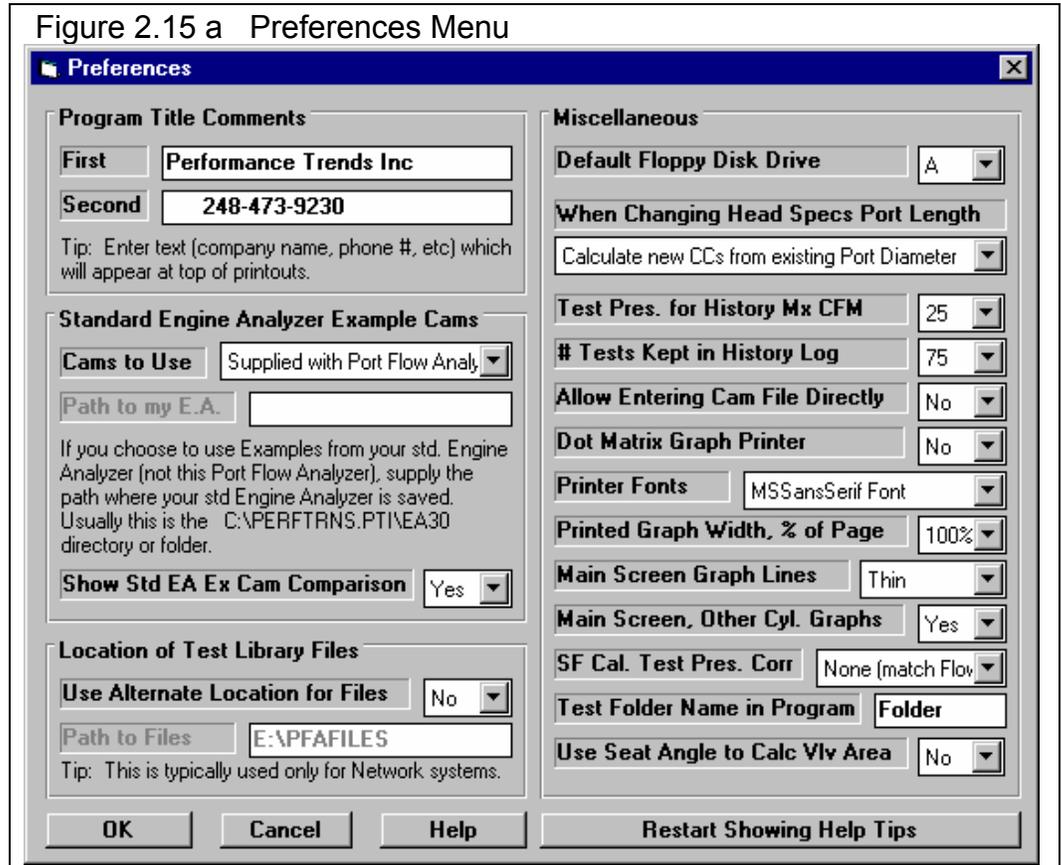


# 2.2 Preferences

Click on the Preferences item in the menu bar at the top of the Main Screen to bring up the Preferences menu shown in Figure 2.15 a. Here you can adjust some program items to personalize the program for your needs. Preferences may also save time by eliminating steps you don't require.

## Program Title Comments

Enter most any text here for the First and Second lines. These 2 lines will appear at the top of printouts and printed graphs. This is a good place for your business name or your personal name. You can change these entries as often as you wish.



## Standard Engine Analyzer Examples (Pro version only)

These specs let you have access to the same Libraries of simple Cam example specs that come with our standard Engine Analyzer program, v3.0 or later. If you choose 'My Engine Analyzer' as the Engine Analyzer to use, you must provide the Path location to your Engine Analyzer. Otherwise, the Port Flow Analyzer uses the library of standard Engine Analyzer examples provided with the Port Flow Analyzer. The major advantage to using examples from *your* standard Engine Analyzer is you can load specs from additional examples you have added and saved.

## Use Alternate Location for Files (Pro version only)

Some users (typically those on a network) may need to store their data files in a location other than in the PFA30 folder (the folder containing the actual Port Flow Analyzer program). For example, you may want to put the files on the E drive so other computers can access them. If so, choose Yes and then the spec Path to Files will be enabled.

*In most all situations (except for network users) it is STRONGLY recommended you keep this marked No.*

*It is also STRONGLY recommended that if you do choose Yes, that you do NOT keep changing this back and forth from No to Yes. This will produce possible errors when saving or opening files. This will be due mostly to saving them in one location and then looking for them in another location.*

### Path to Files (Pro version only)

If you set the previously described Use Alternate Location for Files spec to Yes, this spec becomes enabled. Enter the full path to the new location for the Port Flow Analyzer data files. For example, if you want to store the files on the E drive, enter the path:

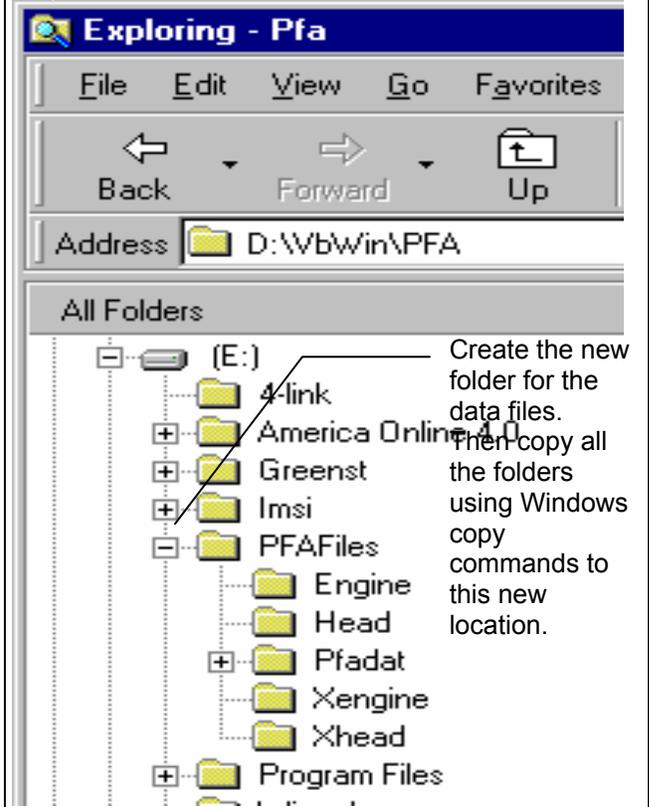
E:\PFAFILES

Either before you make this change in the Preferences menu, or immediately after that change, you must copy all Port Flow Analyzer data folders (directories) and data files to the new location. These folders include:

- Test Library (the PFADAT folder and all subfolders)
- Head Library (HEAD and XHEAD folders)
- Engine Library (ENGINE and XENGINE folders)

Assuming you used the path E:\PFAFILES, you must copy the ENGINE, HEAD, PFADAT, XHEAD, XENGINE folders (and their contents, the data files) to the PFAFILES folder on the E drive. See Figure 2.15 b.

Figure 2.15 b Alternate Path in Windows Explorer



***You must copy all 5 folders listed above and their contents (files) to the new location to avoid errors.***

***It is also STRONGLY recommended that you do NOT keep changing the path. Once you set it, do NOT change it. Constantly changing it will produce possible errors when saving or opening files. This will be due mostly to saving them in one location and then looking for them in another location.***

***If this process seems complicated or you are not familiar with Windows copy commands or folders, DO NOT use this option. Keep the spec Use Alternate Location for Data Files set to No.***

### Default External Disk Drive

Choose the letter of the external disk drive on your computer, usually A . This is the disk drive which will be first opened when using the Save to External Drive or Open from External Drive File commands at the Main Screen.

### Main Screen, Other Cyl. Graphs

Choose Yes to graph all cylinders for the data entered on the Main Screen. This provides an instant review that all data is consistent from point-to-point and cylinder-to-cylinder. Choose No to only graph the data from the current cylinder you are working with. The only real advantage of choosing No is to save time refreshing the Main Screen on slower computers.

## When Changing Head Specs Port Length (Pro version only)

In the Head Specs menu, entries are possible for Port CCs, average Port Diameter and Port Length. As one spec is changed, another is updated to make the 3 specs consistent. Your choice here tells the program which spec, CCs or Diameter, to change when Port Length is changed.

## Test Pres. for History Mx CFM (Pro version only)

The program keeps track of the maximum intake and exhaust CFM for each test. This Max CFM is shown in the History Log, test Preview when Opening Test Files, and can be searched for in the Filter options. Your choice here determines to what Test Pressure to correct this CFM to for reporting. For example, a SuperFlow 110 user may prefer 10" where a SuperFlow 600 user may prefer 25" or 28".

## Show Std EA Exmp Comparison (Pro version only)

Choose Yes and the current specs are shown with the new Example cam specs side by side if you are picking Example cam specs from the Std Engine Analyzer library. This comparison can be useful in preventing mistakes, but some users may want to eliminate this extra step.

## Printer Fonts

Choose which basic type of font to use for printouts. You may not get your choice if your printer does not support that particular font.

## Enter Cam File Directly (Pro version only)

Choose Yes if you want to be able to type in a Cam File path and file name directly (recommended for advanced users only). If 1 character is wrong in the path, you will get error messages. At the time printing, this option was not activated in this version yet.

## # Tests Kept in History Log (Pro version only)

Pick the number of tests which you want the History Log to hold, from 25 to 100.

## Printed Graph Width, % of Page (Pro version only)

Due to the endless combinations of computers, Windows setups and printers, some printed graphs may not fill the page, some may extend off the page. This option lets you expand (% greater than 100) or shrink (% less than 100) the printed graph to better fit the page.

## Main Screen Graph Lines (Pro version only)

This option lets you choose the line thickness of the summary graph of CFM vs valve lift for all the ports on the Main Screen.

## SF Cal. Test Pres. Corr.

SuperFlow 300, 600, 1200 and 1020 benches have an additional, minor correction factor if you flow heads at a different test pressure than what the bench was actually calibrated for at the factory. The FlowCom does not include this correction factor. Select 'Do Correction' if you want your data corrected for this effect (should be more accurate). Select 'None (match FlowCom)' if you want the program to match your FlowCom CFM calculations.

## Graph Dot Matrix Printer Adjustment

Choose Yes if you are getting breaks in the border around printed graphs (usually happens with dot matrix printers).

## Test Folder Name in Program

The Port Flow Analyzer saves tests under different folders (directories) under the main folder PFADAT. Some users may prefer to have the 'Folder' be called 'EngFamily' or 'Customer', depending how they choose to organize their tests. Your entry here of most any text up to 9 characters is what the program will use to call the different folders where test files are stored.

Note: In the DOS version 2.1, these folders were called "customers". If you want to match the wording used in the DOS version 2.1, change this word to Customer.

## Use Seat Angle to Calc Vlv Area (Pro version only)

Select Yes and the Vlv Area in the reports and graphs is calculated based on valve outside diameter, stem diameter, valve seat angle and valve throat diameter. This is a more detailed and accurate way to calculate true geometric valve opening area. Select No and the Vlv Area in the reports and graphs is calculated based on valve outside diameter only. This method is like the method used in Performance Trends' Engine Analyzer programs. Vlv Area is also used to calculate Valve Vel and Flow Coef, and therefore also affects these results. See Figures 3.6, 3.7 and 3.8 in Section 3.1 for more information.

**See Appendix 7, 9, 10 for new features added in version 3.5, 3.5B, 3.5C.**

# 2.3 Test Options

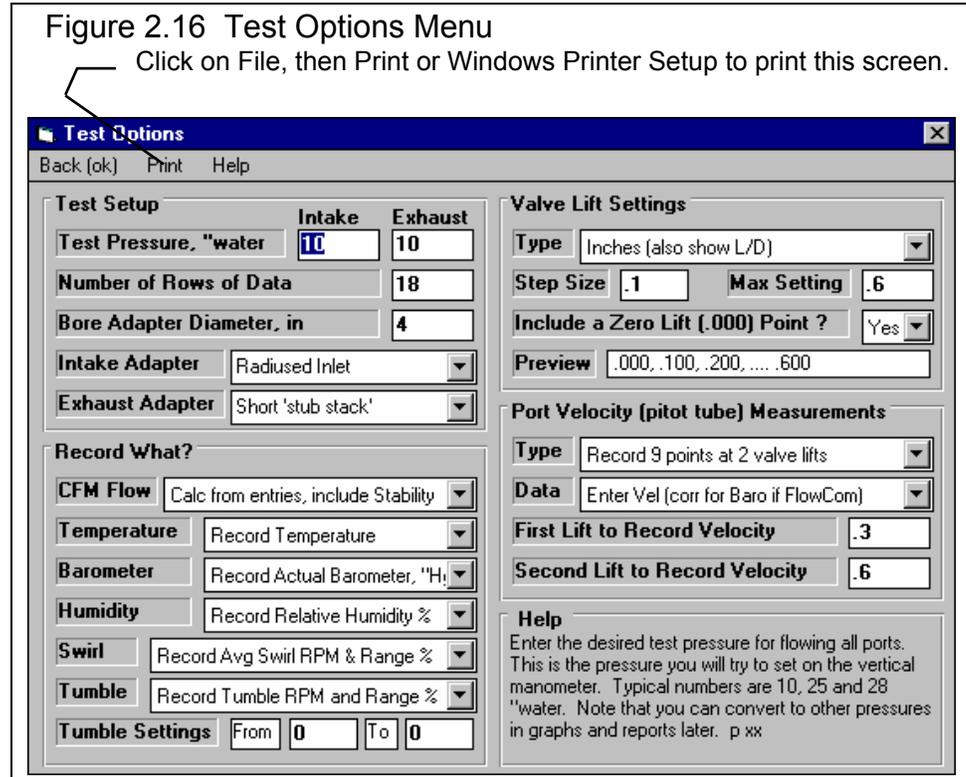
The Test Options determine what data is recorded for a flow test and what test equipment was used which can effect CFM flow.

## Test Pressure, "water

Enter the desired test pressure for flowing all ports. This is the pressure you will try to set on the vertical manometer. Typical numbers are 10, 25 and 28 "water. Note that you can convert to other pressures in graphs and reports later.

## Exhaust Test Pressure, "water

Enter the desired test pressure for flowing all exhaust ports. This is the pressure you will try to set on the vertical manometer. Typical numbers are 10, 25 and 28 "water. Note that you can convert to other pressures in graphs and reports later. Most head porters use the same pressure here as picked for the Intake Test Pressure.



## Number of Rows of Data

Enter the total number of data points you think you will record for the test, usually the number of valve lift settings. (Tip: Enter a number 3 to 5 higher than you think you will need so you can easily add points if you want. There is no problem with having extra blank rows.)

## Bore Adapter Diameter, in

Enter the diameter of the Bore adapter used for the Flow Test, in inches. The diameter of the Bore Adapter you use can significantly affect CFM flow, and potentially stability, swirl and tumble.

## Intake Adapter

Enter a description of the intake adapter, something like None, Radiused Inlet #2, Clay, Dual Plane + Holley 350, etc, or click on the Down Arrow button to pick a standard choice. If you are using Port Flow Analyzer CFM data in our Engine Analyzer programs for head data (not manifold data), it is recommended you use a radiused inlet adapter or clay.

## Exhaust Adapter

Enter a description of the exhaust adapter, something like None, 6" Stub Stack, 1 5/8" header, etc, or click on the Down Arrow button to pick a standard choice. If you are using Port Flow Analyzer CFM data in our Engine Analyzer programs for head data (not exhaust manifold or header data), it is recommended you use a short section of pipe, 6-12 inches long.

## CFM Flow

Click on down arrow button to set the method for entering or measuring CFM flow. This choice together with the Type of Flow Bench specified in the Flow Bench Specs has a large impact on what columns are displayed on the Test Data grid. The option of Entering CFM Directly provides an easy way to create reports and graphs for tests run on other types of flow benches.

## Temperature (Pro version only)

Click on down arrow button if you want to record air temperature, even if it is not required for CFM calculations. This will add a Temp column to the Test Data grid.

## Barometer (Pro version only)

Click on down arrow button if you want to record actual (not corrected like a TV weather report) Barometric Pressure, even if it is not required for CFM calculations. This will add a Baro column to the Test Data grid.

## Humidity (Pro version only)

Click on down arrow button if you want to record humidity, even if it is not required for CFM calculations. This will add a Dew Point or Reltv Hum% column to the Test Data grid.

## Swirl (Pro version only)

Click on down arrow button if you want to record Swirl. This will add a 1 or 2 columns to the Test Data grid.

## Tumble (Pro version only)

Click on down arrow button if you want to record Tumble. This will add 1 or 2 columns to the Test Data grid, depending of the Tumble Settings entered. (This may expand to include the Tumble Settings in future versions.)

## Tumble Settings, From - To (Pro version only)

Enter the starting number for the first tumble setting. For example, if you are recording 4 tumble readings from 0 to 270 degrees of rotation (0, 90, 180 and 270), enter 0 for the 'From' setting. For the To setting, set the final degrees of rotation. In the example of 0, 90, 180, 270 this would be 270. At the time of printing this manual, these options were not yet activated.

## Type

Click on down arrow button to set the method for determining valve lift setting for the flow test. Note that most people use valve lift in inches, not L/D.

## Step Size

Enter the difference between subsequent lifts. The units will be in either Inches or L/D depending on the Type chosen above. If you want to record flow at every tenth of an inch, choose a Type of Inches and enter a Step Size of .1 .

## Max Setting

Enter the highest valve Lift in inches or L/D you want recorded. The units will be in either Inches or L/D depending on the Type chosen above.

## Include a Zero Lift (.000) Point ?

Click on down arrow button to select to include a zero (0) lift point in the data set. Including 0 can be a convenient way to measure and record Leakage at each port.

## Type

Click on down arrow button to set the method for measuring Port Velocities. This will add several columns to the Test Data grid.

## Data

Click on down arrow button to select the type of velocity data and related data you are entering. If you select "Water, then these pressure readings are recorded and will be converted to velocity in Ft/Sec when graphed or reported.

## First Lift to Record Velocity

If you chose a Type above to record port velocities, you can enter the first or lowest valve lift in Inches at which to allow port velocities to be recorded. At the time of printing this manual, you could not specify this Lift as an L/D.

## Second Lift to Record Velocity

If you chose a Type above to record port velocities at 2 valve lifts, you can enter the second valve lift in Inches at which to allow port velocities to be recorded. At the time of printing this manual, you could not specify this Lift as an L/D.

**See Appendix 7, 9, 10 for new features added in version 3.5, 3.5B, 3.5C.**



# 2.4 Cylinder Head(s)

The cylinder Head Specs describe the port geometry and cylinder numbering. In the Basic version, many of the specs shown in Figure 2.17a are not available to keep the program easier to operate.

## Intake Port Specs:

### # Valves/Ports

Identifies if there are 1, 2 or 3 intake valves per cylinder and how many ports there are for this number of intake valves. If 2 or 3 valves are specified, both valves are assumed to be equal size and opened exactly the same. If 2 or 3 ports are specified, the program also assumes all these ports are the same volume and length. If you have 2 or 3 valves per cylinder, and the ports from these valves siamese (run into each other) in the head, specify the number of ports as 1.

### Valve Diameter, in

Identifies the outside (largest) diameter of the head of the intake valve(s) in inches.

### Stem Diameter, in (Pro version only)

The diameter of the stem of the intake valve(s) present in the port in inches.

### Seat Inside Diameter, in (Pro version only)

The smallest diameter of the port in the valve seat area. Usually this is the inside diameter of the valve seat. This spec is used to more accurately calculate the *true* valve opening area. This area is used to calculate and report VlvArea and FlowCoef if Use Seat Angle to Calc Vlv Area is set to Yes in the Preferences menu. See Section 3.1 and Example 4.3.

Figure 2.17a Cylinder Head(s) Menu

Click on File, then:

- New to blank out this menu.
- Open Example to pick an example head provided with the program.
- Save to save these head specs to a name of your choosing.
- Print or Windows Printer Setup to print this screen.

Name of current set of Head Specs (SB-FORD). You give the specs a name when you save them (Pro version only).

Details opens up a new menu for storing more head info.

Head Comments (different than Test Comments) lets you describe the head itself (Pro version only).

## Seat Angle, deg (Pro version only)

The overall angle of the valve seat. For most valves (even multi-angle valve jobs) this is 45 degrees. For multi-angle valve jobs, enter the angle for the middle angle. Some race valves have 30 degree seats which improve low lift flow. This spec is used to more accurately calculate the *true* valve opening area. This area is used to calculate and report VlvArea and FlowCoef if Use Seat Angle to Calc Vlv Area is set to Yes in the Preferences menu. See Section 3.1 and Example 4.3.

## Port Shape (Pro version only)

The setting of this specs determines if the Port Dimensions in this menu are either Diameter or Width & Height. This spec is also used to draw the port when Pitot tube port velocity readings are being recorded or graphed.

## Avg Port Diameter, in (Pro version only)

Identifies the average inside diameter of the intake port(s) over their entire length in the cylinder head. Usually this can be measured at the end of the port which mates to the intake manifold. A more precise way is to calculate the diameter by measuring the port volume and port length. If you know port CCs, enter it in the spec below, first making sure the Port Length is accurate. If you set the number of ports to 2 or 3, this is the diameter of only 1 of these ports. These ports are assumed to be the same length and diameter.

*As you enter Port Diameter (or Port Width and Port Height), or Port CCs, or Port Length, the other related specs are instantly updated to keep all values consistent with each other. The spec "When Changing Head Specs Port Length" in the Preferences menu lets you have some control over what specs get changed and which specs stay constant when changes are made.*

## Avg Port Width, in (Pro version only)

## Avg Port Height, in (Pro version only)

If you have set the Port Shape as Rectangular (not circular), these specs are displayed instead of the single specs of Avg Port Diameter.

## Port Volume, CCs (Pro version only)

Is the volume of the intake port in CCs (cubic centimeters). This value can be input directly (then the Avg Port Diameter changes to match this volume and the Port Length spec). Also, if you enter or change the Avg Port Diameter, this value will be calculated based on that diameter and the current Port Length spec. If you set the number of ports to 2 or 3, this is the Volume of only 1 of these ports. These ports are assumed to be the same length and Volume.

## Port Length, in (Pro version only)

Is the length of the intake port (down the center of the port) from the intake valve to the end of the head port (the start of the intake manifold runner). For many common heads, 4.5"-6" is a typical length. If you change Port Length, either the Port Volume or the Port Diameter (or Width and Height) are updated so these dimensions are all consistent. The Preferences menu's spec When Changing Head Specs Port Length (Section 3.2) lets you select if you rather have the dimension specs or the volume specs changed when Port Length is changed.

## Exhaust Port Specs:

The definitions of the Exhaust Port Specs are identical to those of the Intake Port Specs.

## Cylinder Numbering

These specs are used for cylinder numbering of the cylinder head.

## Number of Cylinders in Test

This identifies the number of cylinders on the head which will be tested. For example, a cylinder head on a V-6 would have three cylinders per head, and an in-line 4 cylinder would have four cylinders per head. The Port Flow Analyzer v3.0 allows up to eight cylinders per head. If you are only going to test 1 cylinder on a head with 4 cylinders, this spec would be set to 1, not 4.

## Starting #

The first or lowest cylinder # for the head.

## Step Size

The difference in cylinder numbers between adjacent cylinders on the same head. For example, for a Chevy V-8 with cylinder numbering of 1, 3, 5, 7 this would be 2. For a Ford V-8 with cylinder numbering of 1, 2, 3, 4 this would be 1.

Tip: Often users may want to run several tests on a single port, with various stages of port modifications. Rather than making several different test files, you can call each modification a separate cylinder. In the Test Comments you can specify that, for example, Cylinder #1 is the Baseline, Cylinder #2 is with a 3 angle valve job, etc.

## Menu Commands

The menu bar at the top provides for several command options, some which are fairly self explanatory:

- Back (ok) returns you to the Main Screen.
- File opens up several typical Windows options, many only available in the Pro version. In the Pro version, you can open and save these Head specs as separate files. This allows you to easily change these specs to match a different head with only a couple of clicks. See Section 3.6, Data Libraries.
  - New will blank out all the Head Specs, Head Comments; and the Head File name will be called “Untitled”.
  - Open Example Head File will open a typical Port Flow Analyzer “File Open” menu, where you can pick a set of example Head Specs loaded by Performance Trends.
  - Open Saved Head File will open a typical Port Flow Analyzer “File Open” menu, where you can pick a set of Head Specs which *you* have saved, using the Save command in this menu.

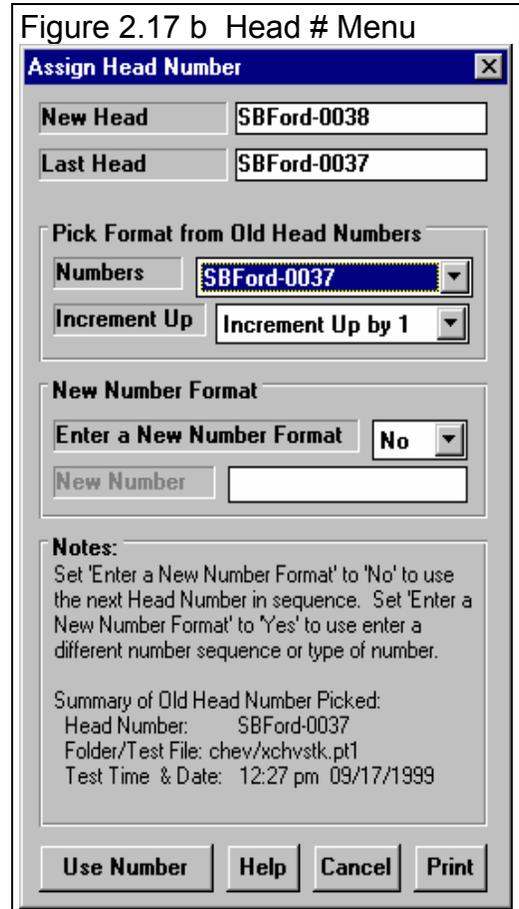
- Save Head File will open a typical Port Flow Analyzer “File Save” menu, where you can save the current set of Head Specs and Head Comments under a name of your choosing. This name then appears at the top of the Head Specs menu. This name should not be confused with the Test File Name which appears at the top of the Main Screen. The Test File includes all the Head Specs and Flow Data, and therefore includes the Head Name.
- Print lets you print this screen.
- Windows Printer Setup lets you change printer selection, paper orientation, etc.
- Head Details (Pro version only) brings up a new menu for you to enter many more detailed head specs. See Section 2.5.
- Help brings up a series of help screens on the Head Specs menu.

### Head # (Pro version only)

Head #s can be critical for shops flowing many heads a year. The program keeps track of #s so you don't assign duplicates or skip #s. Consistency of Head # pattern also makes it easy to find heads in the Test Library. If you click on the Head # spec, the menu of Figure 2.17 b is displayed. This menu lets you pick a new head # 3 different ways.

1. You can start a new Head # format if you select Yes for Enter a New Number Format. For example, say you currently are using 'Johnson0012' as a Head # for 1 customer Johnson. Now you have a new customer Smith and you want to start with #s like 'Smith0000'.
2. You can simple use the last Head # used, incremented up by 1 you select No for Enter a New Number Format.
3. Select No for Enter a New Number Format, then select some other Head # (not the latest Head #) from the Numbers list, and a new Head # will be created from it. This new # will be, either the exact # you picked (typical if you are flowing a head which you have already flowed), or incremented up by 1 if you request it (typical if you are working with a new head but with the same Head # format). This is a list of the last 100 Head #s you have assigned.

For Advanced Users: To delete or change #s in this list, use Wordpad or Notepad and edit the 'Headnum.pti' file in the PFA30 folder, but keep a backup in case you make a mistake.



### Customer (Pro version only)

Click on the down arrow of Customer to be presented with a list of customers you have previously used. You can pick one of these customers, or type in a new one. New ones are saved by the program and added to the list.

For Advanced Users: To delete or change customer names in this list, use Wordpad or Notepad and edit the 'Customer.pti' file in the PFA30 folder, but keep a backup in case you make a mistake.

### Comments (Pro version only)

Type in comments to help describe these cylinder head specs, and the head details if you want. These comments are saved with the Test File, with the Head File if you save the Head File, and can be printed out with the Head Specs when reports are printed.

# 2.5 Cyl. Head Details (Pro version only)

The cylinder Head Details have no effect on any calculations or analysis. They are only saved for information to help describe this head and associated parts. You may want to fill in some, all or none of these specs. You can print out these details with reports and you can search (Filter) test files for specific Head Details. For example, you can filter test files for all tests which had Valve Spring Open Pressure (a Head Detail) greater than 400 pounds. See Section 3.7 on Filtering tests.

## Valve Description

Enter a part # and/or description of the valve, 30 characters max.

## Valve Length, in

Length of the valve in inches

## Installed Height, in

Height of the valve stem above the valve guide once the valve and springs are installed, or some other reference point that you use, in inches.

## Lock Groove, in

Distance down from the valve tip to the top of the first lock groove, in inches.

## Valve Weight, gms

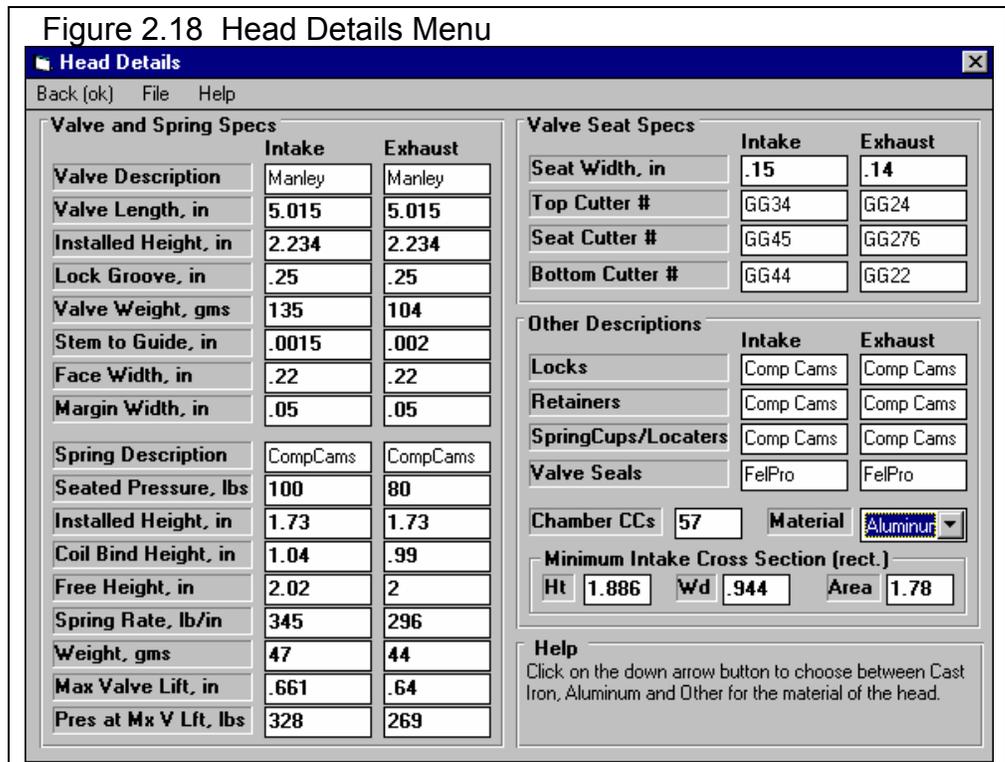
The weight of 1 valve, in grams.

## Stem to Guide, in

The clearance between the valve stem and the valve guide, in inches.

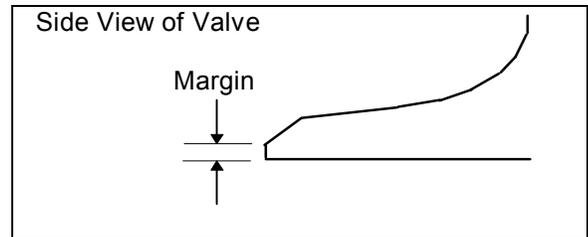
## Face Width, in

The width of the valve face, in inches.



### Margin Width, in

The width of the valve margin, in inches.



### Spring Description

Enter a part # and/or description of the valve spring, 30 characters max.

**Note: For the specs Spring Description, Seated Pressure, Installed Height, Free Height, Spring Rate, Max Valve Lift and Pres at Mx V Lft, if you change one of these specs, it is likely that one or more of these other specs may be updated to keep all these specs consistent.**

### Seated Pressure, lbs

The force exerted by the valve spring when compressed to its installed height, in pounds.

### Installed Height, in

The height of the spring once installed in the head with the retainer and locks, with the valve closed on the seat, in inches.

### Coil Bind Height, in

The height of the spring compressed so there is no space between coils, in inches. Note that this spec is compared to the Max Valve Lift and Installed Height specs. If coil bind is occurring, the Pres at Mx V Lft is calculated and displayed as 99999, indicating a problem.

### Free Height, in

The height of the spring with no weight or load on it, in inches.

### Spring Rate, lb/in

The rate of the spring in pounds per inch (lb/in). This will be calculated from the specs above, or if you enter the spring rate here, the Seated Pressure will be calculated.

### Weight, gms

The weight of the spring(s), in grams.

### Max Valve Lift, in

The maximum lift the anticipated cam and rocker arm ratio will lift the valve, in inches. This will be calculated from the Spring Rate if you enter Pres at Mx V Lft below.

## Pres at Mx V Lft, lbs

The force in pounds (lbs) of the valve spring at the Max Valve Lift entered above. This will be calculated from the Spring Rate if you enter Max Valve Lift above.

If coil bind is detected based on the other input specs, this value is reported as 99999, indicating a problem. The only way to change this from 99999 is by changing the specs which affect coil bind: Coil Bind Height, Installed Height and Max Valve Lift.

## Seat Width, in

The width of the valve seat, in inches.

## Top Cutter #

Enter a part # and/or description (angle, width, etc) of the valve seat cutter for the top of the valve seat, 30 characters max.

## Seat Cutter #

Enter a part # and/or description (angle, width, etc) of the valve seat cutter for the main part of the valve seat, 30 characters max.

## Bottom Cutter #

Enter a part # and/or description (angle, width, etc) of the valve seat cutter for the bottom of the valve seat, 30 characters max.

## Locks

Enter a part # and/or description of the valve locks or keepers, 30 characters max.

## Retainers

Enter a part # and/or description of the valve retainer, 30 characters max.

## Spring Cups/Locators

Enter a part # and/or description of the valve spring cups or locators, 30 characters max.

## Valve Seals

Enter a part # and/or description of the valve seals, 30 characters max.

## Chamber CCs

Enter the CCs of the combustion chamber in cubic centimeters, CCs.

## Ht

Enter the height of the minimum cross-sectional area of the intake port. Area will be calculated based on Port Shape specified in Head Specs. This spec could be Dia if the Port Shape is Round.

## Wd

Enter the width of the minimum cross-sectional area of the intake port. Area will be calculated based on Port Shape specified in Head Specs. This spec will not be shown if the Port Shape is Round.

## Area

Enter the minimum cross-sectional area in sq inches of the intake port. Wd and Ht will be calculated based on proportions of the Port Ht & Wd in Head Specs.

## Material

Click on the down arrow button to choose between Cast Iron, Aluminum and Other for the material of the head.

# 2.6 Flow Bench Specs

The Flow Bench Specs describe the flow bench you are using, and any required specs concerning the electronics which may be recording the data. Flow Bench Specs are critical to accurate data. Therefore, be sure these specs are correct for each test.

## Master Bench Specs

A critical concept for Flow Bench Specs is the idea of the Master Bench Specs. When you run a flow test, you are using a particular flow bench, with certain Flow Bench Specs. When you save the flow test, the program saves a copy of the Flow Bench Specs with the test. Lets call this test "Test110" and assume it was run with a SuperFlow 110 flow bench.

Lets say several months later that you buy a new SF 600 type of bench. (Or you could have changed any Flow Bench spec: different bench, different electronics, different calibrations, etc.) Your current bench specs do not match the specs for "Test110". If you open "Test110", the program installs the SuperFlow 110 bench specs which you used when you ran the test. This lets you accurately calculate CFM and other data just as you did when you first ran the test.

If you go into the Flow Bench Specs menu, you will likely get a message shown in Figure 2.19, saying that the Bench Specs for Test110 do not match your **Master Bench Specs**, the specs for your current SF 600 bench. You may ask "What are **Master Bench Specs**?"

The program keeps track of any changes to Flow Bench Specs, asking you if these changes should only apply to the Flow Bench Specs for a particular flow test, or if these changes represent your actual flow bench, the Master Flow Bench specs. Whenever, you start a new test, either based on a previous test or starting completely blank, the Master Flow Bench Specs are used. Whenever you open an old test file, the bench specs used for that particular test are used.

Figure 2.19 Typical Note on Master Bench Specs

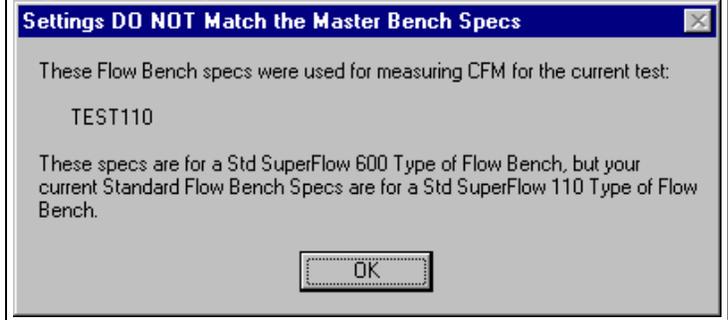
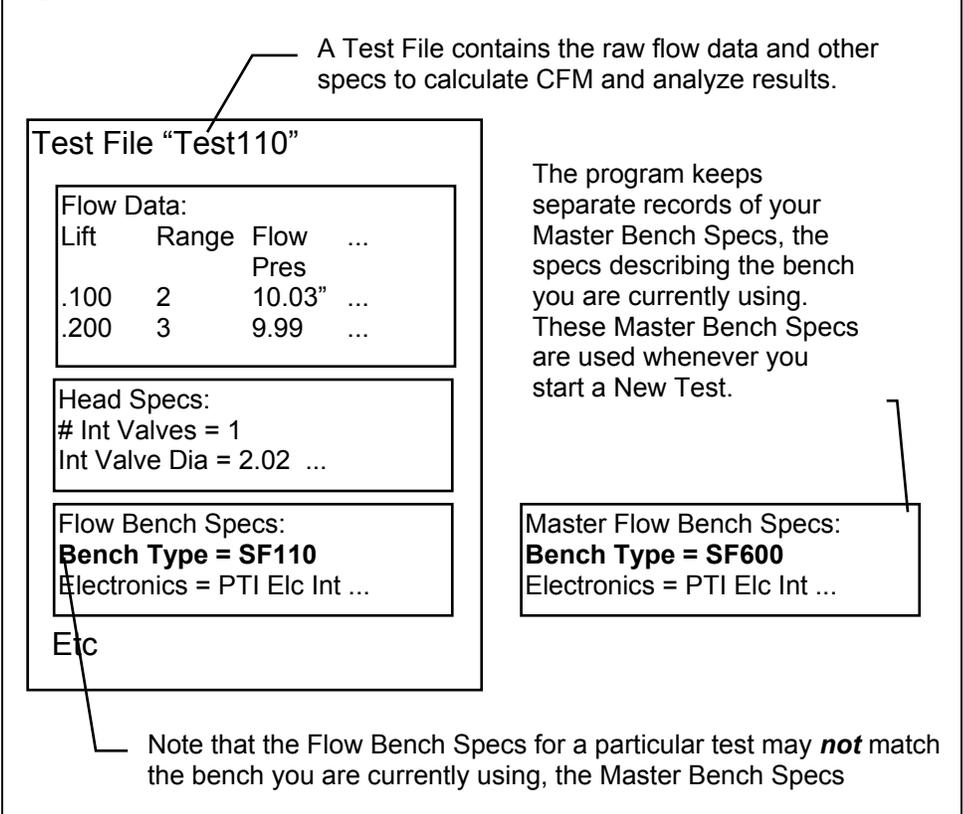


Figure 2.20 Illustration of Master Bench Specs



## General Bench Specs

### Type

Click on the down arrow button to select the type of flow bench you are using. Your choice here will affect which specs are enabled or disabled in this menu.

### Use Temperature Correction

Click on the down arrow button to select whether the CFM flow readings must be corrected for the temperature difference between the cylinder head and the measurement orifices. For custom 'Blower Center' type benches like a SF 110, choose Yes. (For standard SuperFlow benches, this spec is disabled and set to the appropriate setting for that particular bench.)

### Rated Test Pressure, "water

Enter the test pressure at which the measurement flow orifices have been calibrated for. For example, for an SF 600 this would be 25", for an SF 1020 this would be 50". (For standard SuperFlow benches, this spec is disabled and set to the appropriate setting for that particular bench.)

### Inclined Flow Manometer

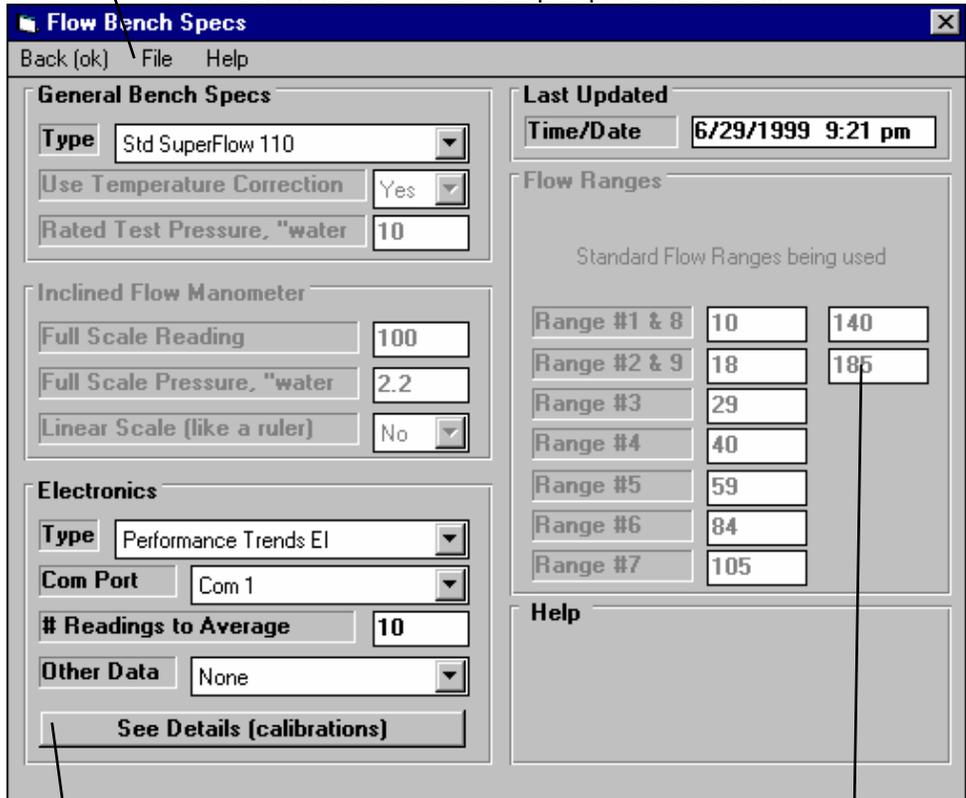
#### Full Scale Reading

The highest reading # on the inclined manometer. Usually this is 100%, but could be something different if the manometer is custom or calibrated in "water. (For standard SuperFlow benches, this spec is disabled and set to the appropriate setting for that particular bench.)

Figure 2.21 Flow Bench Specs Menu

Click on File, then:

- Save as My Master Bench Specs
- Open Master Bench Specs
- Load Typical Flow Ranges (for SF 300 or SF 600 benches)
- Print or Windows Printer Setup to print this screen.



Note how several inputs in this menu, especially for standard SuperFlow benches can be disabled (printed in gray and they can not be changed). Many of these inputs are enabled (printed in black and allowed to be changed) only for Custom benches.

Click here to bring up the Calibration Window for Electronics, discussed in Appendix 5.

## Full Scale Pressure, "water

The actual pressure in inches of water at the Full Scale Reading entered above. (For standard SuperFlow benches, this spec is disabled and set to the appropriate setting for that particular bench.)

## Linear Scale (like a ruler)

Click on the down arrow button to select the type of scale used to mark the inclined manometer. Select Yes if the scale is linear like a standard ruler. Select No if the scale is non linear like a SuperFlow % Flow manometer. (For standard SuperFlow benches, this spec is disabled and set to the appropriate setting for that particular bench.)

## Electronics

### Type

Click on the down arrow button to select the type of electronics you are using to record flow bench readings. Your choice here will affect which specs are enabled or disabled in this section.

### Com Port

Click on the down arrow button to select computer's COM (serial) port # you are using to 'talk' to the electronics. It is most reliable for you to click on the Find button to the right of this entry to have the program automatically check all possible COM ports to find your type of electronics. If it can not be found, you may want to go into the Electronics or FlowCom screen, click on Help, then Troubleshoot and try some of the Troubleshoot options. You can also check the Frequently Asked Questions (FAQ) section of our website under "Support" for the latest info on finding a working COM port on your computer.

Also check Appendix 7, 9, 10 for additional new features added in version 3.5 & 3.5B & 3.5C.

### # Readings to Average

Enter the number of readings you want to be averaged together for a CFM, Swirl and/or Tumble reading. If you enter a lower number the test will be completed faster. A larger number (10 or higher) usually produces more repeatable results, especially if you are recording Test Stability, Swirl +/-% and Tumble +/-%.

### Other Data

Click on the down arrow button to select the type of other data which can be read through the electronics. Click on 'See Details' button to calibrate these sensors (and the flow sensors for non-SuperFlow FlowCom electronics) to the program. See Appendix 5 for more details.

### See Details (calibrations) Button

This button becomes enabled if you have selected the Performance Trends EI for the Type of Electronics, or selected something other than None for Other Data. See Appendix 5 for more details.

## Last Updated

### Time/Date

The time and date when these Flow Bench Specs were last modified. An old date is not necessarily a bad thing. It just means you have been using the same bench for a long time, usually a good thing.

## Flow Ranges

### Range #1-7

Enter the Full Scale flow for Ranges 1 through 7, intake and exhaust. This is the CFM Flow when the inclined flow manometer is at its highest reading, usually 100% Flow. For many types of SuperFlow flow benches, these specs are preloaded by the program and are disabled for you to change. For SuperFlow 300, 600 or 1200, or custom benches, you just enter the CFM values which came with your bench from the factory.

# 2.7 Engine Specs (Pro version only)

The Engine specs describe the engine's size, compression ratio, cam and valve train. These specs are combined with flow data to do more detailed analysis of a head and its performance potential.

Cam and valve train specifications are critical to engine performance; therefore reliable information is necessary. It is recommended that you use specifications given by the cam grinder or engine manufacturer. Actual measurements of cam and valve train specifications can be done, however this can be tricky and therefore is recommended to have someone experienced perform them. Guides for making these measurements are also available from cam grinders and manufacturers of valve train components and are beyond the scope of this User's Manual.

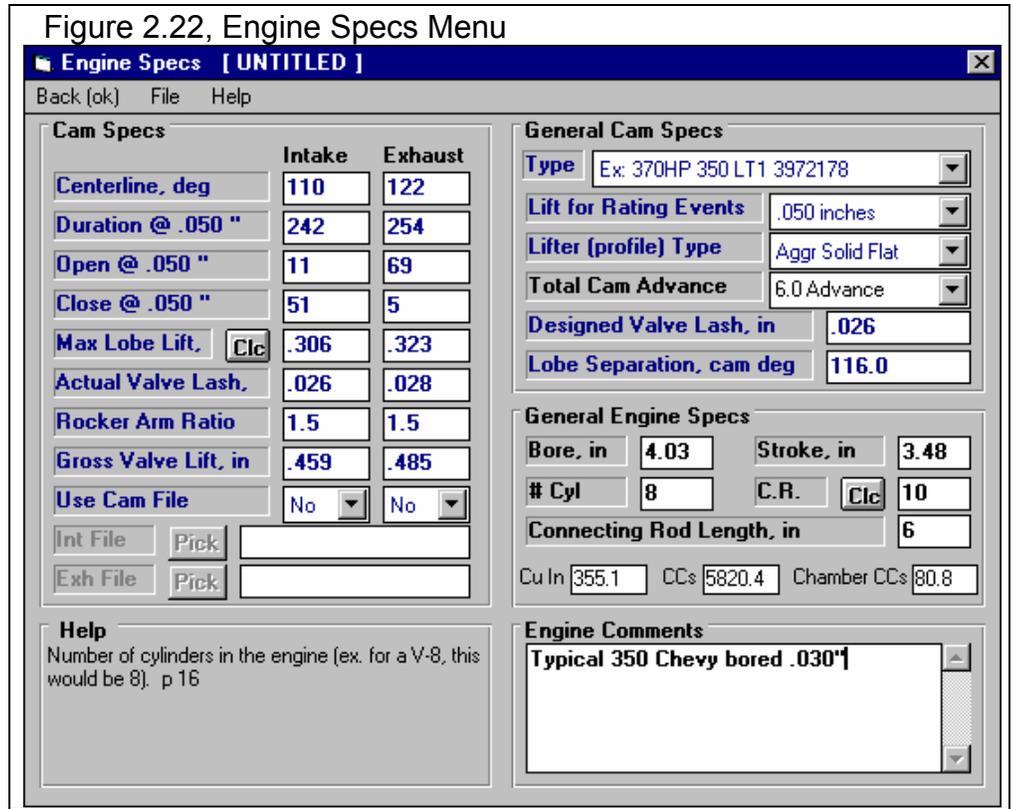


Figure 2.22, Engine Specs Menu

**Important:** The Engine Specs menu's Cam specs update as you change other cam specs. For example, if you change a centerline, the Total Cam Advance number changes to reflect the new centerline.

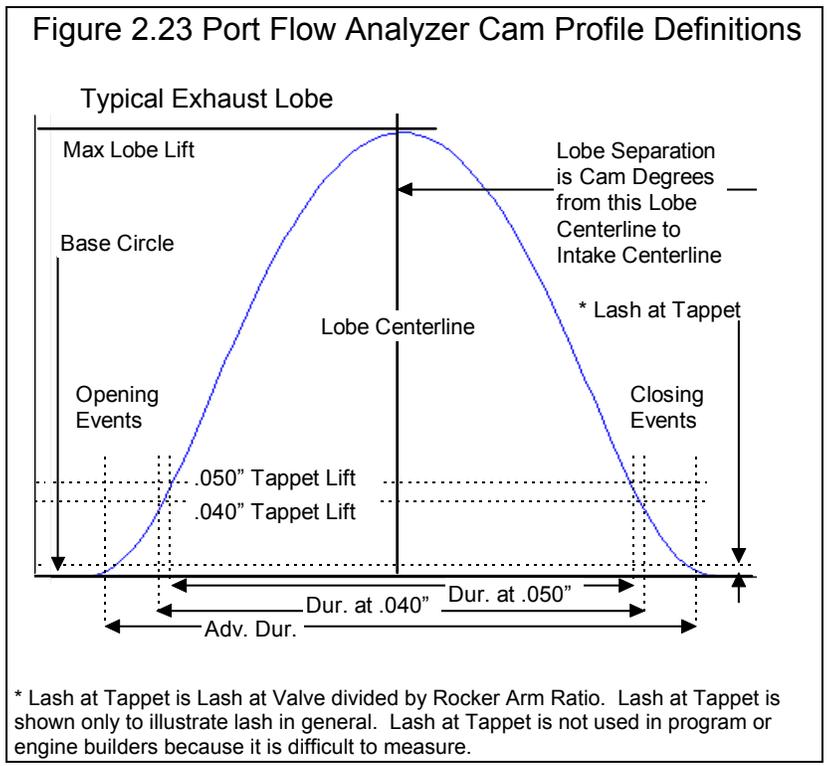


Figure 2.23 Port Flow Analyzer Cam Profile Definitions

## Intake

### Centerline, deg ATDC

Is the location of the maximum lift point on the cam profile. If you are using the program's

standard cam profiles, this is also exactly half way between the open and closing point because the program assumes the same opening and closing profile (a symmetric lobe).

### Duration @ xxx

Is the number of crank degrees where the tappet is lifted to the tappet lift specified as the Lift for Rating Events in the General Cam Specs section above base circle.

### Opening @ xxx

Identifies crankshaft degrees before top dead center where the tappet has been lifted to the Lift for Rating Events above base circle Base Circle on the opening ramp. (Lift for Rating Events is specified in the General Cam Specs section.) This value is generally available on your "cam card" or in cam catalogs. If this event occurs after top dead center, enter a negative value. For example, if it is reported as 4 degrees after top dead center, enter -4.

### Closing @ xxx

Identifies crankshaft degrees before top dead center where the tappet has been lowered to the Lift for Rating Events above base circle Base Circle on the closing ramp. (Lift for Rating Events is specified in the General Cam Specs section.) This value is generally available on your "cam card" or in cam catalogs. It is highly unlikely, but if this event occurs before bottom dead center, enter a negative value. For example, if it is reported as 4 degrees before bottom dead center, enter -4.

### Max Lobe Lift, in

Identifies how high the cam lobe lifts the tappet above Base Circle in inches. If you are given "gross valve lift" by the cam grinder, divide by the rocker arm ratio *assumed by the cam grinder* to obtain gross or maximum tappet lift. This can also be done by clicking on the Clc button to open up a Calculation Menu. See Section 2.8.2.

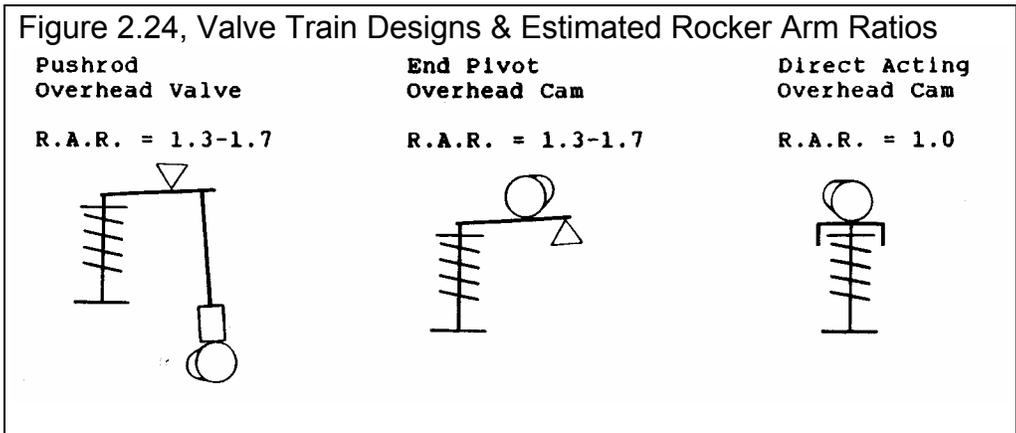
### Actual Lash @ Valve, in

Identifies the lash or clearance in inches between the valve tip and its actuator, generally the rocker arm. If you have specified a hydraulic Lifter (profile) Type, this spec is disabled.

Notes: This spec works with the Designed Valve Lash spec. If you specify an Actual Valve Lash nearly the same as the Designed Valve Lash, the valve will be opened as the cam profile was designed. If you specify a smaller Actual Valve Lash than the Designed Valve Lash, the valve will be opened longer and higher than what the cam was designed for. And vice versa, if you specify a larger Actual Valve Lash than the Designed Valve Lash, the valve will be opened less time and less lift than what the cam was designed for.

### Rocker Arm Ratio

Identifies the ratio between tappet lift and valve lift. Generally rocker arm ratios vary between 1.3 to 2.0. For valve trains with no rocker arms, for example overhead cam



systems with directing acting tappets, enter 1. See Figure 2.24. The Port Flow Analyzer assumes the ratio is constant although actual rocker arm ratios vary slightly with valve lift.

## Gross Intake Valve Lift, in

Is the maximum lift of the valve with NO valve lash (even if it is a mechanical cam with valve lash). Mathematically it is Max Lobe Lift multiplied by rocker arm ratio. This is the standard way most cam grinders rate their cams for valve lift, sometimes called Advertised Lift. This number is calculated from other specs in this menu and can not be entered directly.

**Note: If you are not using (specifying in the program) the same Rocker Arm Ratios as what the cam grinder is assuming, this number will not match the cam grinder's catalog or advertised lift.**

## Use Cam File

Click on the down arrow to pick Yes or No. In this version of the program, No is the only option. Future versions will allow you to read in Cam Files describing the cam profile, degree by degree.

## Exhaust

Centerline, deg ATDC  
Duration @ .050"  
Max Lobe Lift, in  
Actual Lash @ Valve, in  
Rocker Arm Ratio  
Gross Valve Lift  
Use Cam File

Definitions for these specs are the same as for the Intake cam described previously.

## General Cam Specs

### Type

This combo box lets you describe the source of the specs used in this menu:

- You can select the Use Specs in this Menu and enter in most any combination of Cam or Valve Train specs.
- You can pick the Pick an Example option to be presented with a list of Example Cam Specs See Picking Example Cam Specs at the end of this section. It will then display the name of the Example Cam specs you have picked

The Type you choose has a large effect on how this menu looks. If you choose Use Specs Below, all specs will be printed in black, and you can change them to most any number you want. If you have chosen an example, the specs which relate directly to the example will be displayed in blue.

Should you choose to change any of these blue specs, a notice is given that changing any spec related to the example will change the Type from the example name to the general name of Use Specs Below. The example name is a handy reminder of what the specs in this menu represent, so you may not want to change any of these blue spec settings.

## Lift for Rating Events

You can pick the lift from base circle at which cam events are rated from the following:

- .050" which was the method used by all our previous Port Flow Analyzers, and is the way used by most cam grinders for American aftermarket and racing cams.
- .040" or 1 mm which is a common metric method used for motorcycles and foreign cams.
- Seat Timing which is commonly used for Advertised Duration by American cam grinders.

Be sure you are using the correct one, as this will create large errors in the results if you are not.

## Total Cam Advance

This combo box lets you either pick an advance, retard or "straight up" cam timing by clicking on the arrow key, or you can type in an advance or retard in degrees directly. If you just enter a number, a number with a + sign (ex. +4) or a number followed by the letters "adv", the program assumes it is number of degrees of cam advance. If you just enter a number with a - sign (ex. -4) or a number followed by the letters "ret", the program assumes it is number of degrees of cam retard.

Total cam advance is based on the current Intake and Exhaust Centerlines. If the centerlines are equal, Total Advance is set to 0 or straight up by the program. ***This is a major change from the previous DOS versions of Port Flow Analyzer*** where the spec Additional Cam Advance was used. In those versions you could specify opening and closing events which would produce a Total Cam Advance of say 4 degrees, but the Additional Cam Advance could be set to 0. This was confusing to users. This new method of using Total Cam Advance should match cam specs used by most cam grinders.

To change cam timing from how it was ground by the cam grinder you will need special set of timing gears or an offset timing pin, key or bushing. In general, advancing the cam will give more lower end torque while giving up some top end HP; and retarding will give up low end torque to gain top end HP.

## Designed Valve Lash, in

Is the valve lash the cam grinder recommends you use, or what the cam was ground for. If the cam grinder recommends a different lash for the exhaust than the intake, use the intake lash. Also see Actual Lash @ Valve a couple pages back.

## Lifter (profile) Type

This combo box lets you pick the type of lifter and the "steepness" or "aggressiveness" of the cam's profiles. The combinations consist of:

Hyd vs Solid	Hydraulic vs Solid lash adjustment
Flat vs Roller	Aggressiveness or steepness of the profile (Roller being more aggressive)
Mild vs Agr	Aggressiveness or steepness of the profile (Agr being more aggressive)
Invrtd	The most aggressive or steep profile (being more aggressive than Mild or Agr)

The choice of Hydraulic vs Solid is the most important as this dictates the use of a lash setting and whether hydraulic lifter pump up is possible in the Engine Performance Estimate report. The other choices simply determine differences in the steepness of the profile ***for the same Max Lobe Lift.*** Most truly aggressive cams or roller cams have more Max Lobe Lift for a given duration, and milder or hydraulic cams have less Max Lobe Lift.

## Lobe Separation, cam deg

Is the separation between the intake and exhaust centerlines in *cam* (not crankshaft) degrees, and is the standard method used by most cam grinders. This number is calculated from other specs in this menu and can not be entered directly.

## Engine Specs

### Bore, inches

The diameter of the cylinder measured in inches.

### Stroke, inches

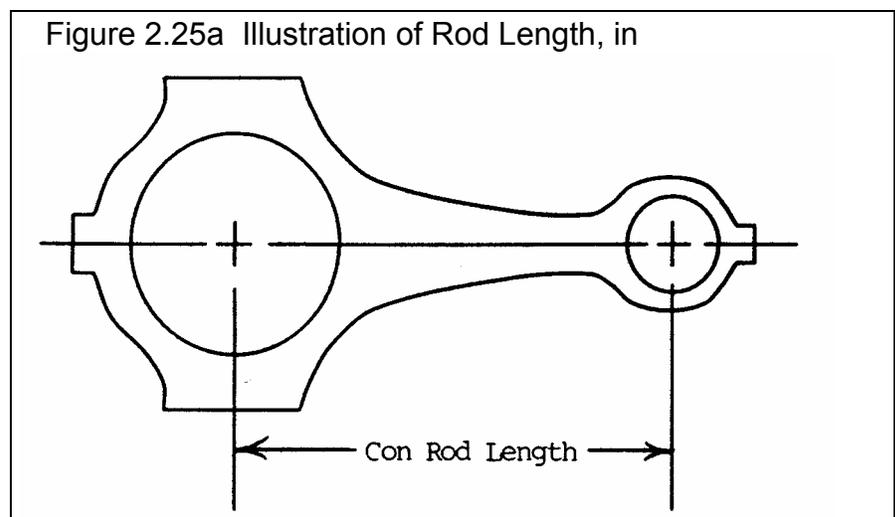
The distance the piston travels from TDC (top dead center) to BDC (bottom dead center) measured in inches.

### # Of Cylinders

The number of cylinders for the engine. For example, for a V-8 this number is 8, for a single cylinder engine this number would be 1.

### Rod Length, in

The distance from the center of the wrist pin bore to the center of the crank journal bore measured in inches.



### C.R. (compression ratio)

The engine's compression ratio based on cylinder clearance volume and total cylinder swept volume (sometimes called *static* compression ratio). Do not use compression ratios which are corrected for cam timing, weather or supercharger boost.

$$\text{Compression Ratio} = \frac{\text{Clearance Volume} + \text{Swept Volume}}{\text{Clearance Volume}}$$

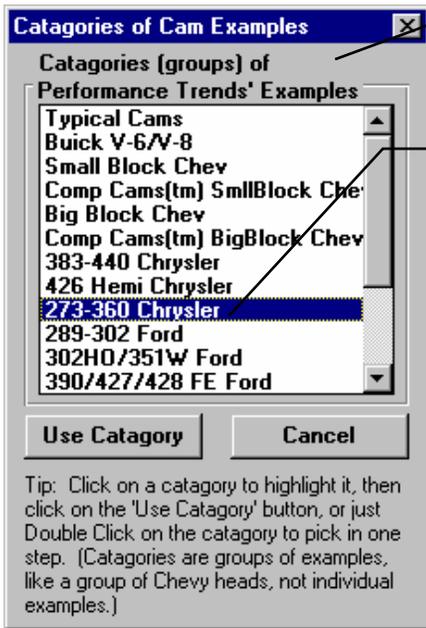
Clearance Volume and Swept Volume must be in the same units, both either CCs or cubic inches. Multiply CCs by .061 to obtain cubic inches, multiply cubic inches by 16.39 to obtain CCs.

Since C. R. has a Clc button, see Section 2.8.1 for calculating Compression Ratio from clearance volume, piston dome volume, deck height and gasket thickness.

### Picking Example Cam Specs

If you click on Type in the General Cam Specs, you can choose the Option of Pick Example Cam. If you do, you will be presented with the screens shown in Figure 2.25 b.

Figure 2.25 b Picking Example Cam Specs



Click on Type in the General Cam Specs, then pick the Pick an Example Cam option to be presented with this menu, a list of categories of cams.

Click on a Category to highlight it, then click on the Use Category button to pick that category.

This screen shows the individual examples of cams that come preloaded with the Port Flow Analyzer Pro version. Click on an example cam to highlight it.

Once highlighted, click on the Pick button to actually load in these example cam specs. Depending on settings in the Preferences menu, you may be shown a comparison of these specs with your current cam specs.

Examples

273-360 Chrysler Cams	Rated Lift	Lifter Profile	Valve Train	Cntr Line	Dur	Lobe Lift	Valve Lash	Rocker Ratio
Stock 68 340 Manual Trans	.050	MHydFlt	P+RA imp	104	216.	.297	na	1.5
Stock 68 340 Manual T(exh)				120	216.	.297	na	1.5
Stock 68 340 Auto Trans	.050	MHydFlt	P+RA imp	104	210	.285	na	1.5
Stock 68 340 Auto Tra(exh)				120	210	.285	na	1.5
<b>B1R SBChrsr WG-1183 HYD</b>	<b>.050</b>	<b>AHydFlt</b>	<b>P+RA prd</b>	<b>105</b>	<b>184</b>	<b>.245</b>	<b>na</b>	<b>1.5</b>
B1R SBChrsr WG-1183 H(exh)				115	194	.265	na	1.5
B1R SBChrsr WG-1184 HYD	.050	AHydFlt	P+RA prd	105	194	.265	na	1.5
B1R SBChrsr WG-1184 H(exh)				115	204	.268	na	1.5
B1R SBChrsr WG-1184 HYD	.050	AHydFlt	P+RA prd	105	194	.265	na	1.5
B1R SBChrsr WG-1184 H(exh)				115	204	.280	na	1.5

Abbreviations: B1R=Blue Racer CC=Comp Cams Lun=Lunati Ms=Motorsports Comp Cams Grinds: DEH=Duel-Energy XR/XE=Extreme-Energy NX=Nitrous-HP

Tip: Click on Example to highlight it, then click on 'Pick' or 'Delete' button. Double click to pick Example in 1 step.

Pick      Cancel      Print

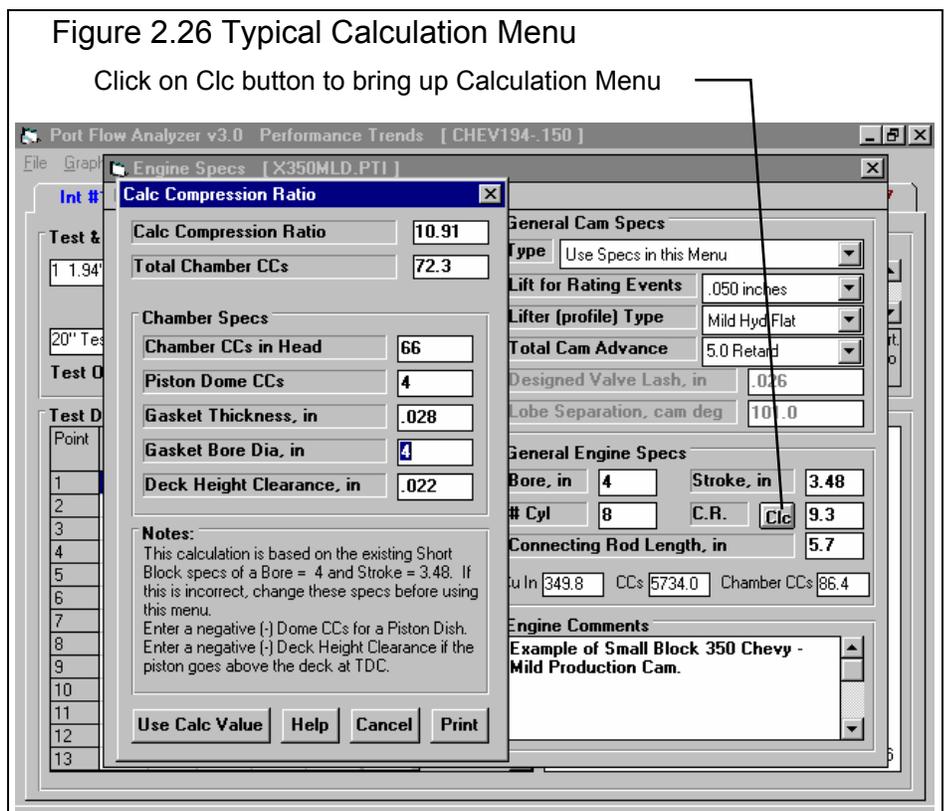
# 2.8 Calculation Menus (Pro version only)

The following section explains the user input for engine specs listed with Clc buttons. These specs are ones where you can simply enter a value, or click on the Clc button and the program will present a menu of inputs which will calculate that particular parameter. These menus are like computer “scratch pads” for calculating specs like Compression Ratio and Max Tappet Lift from other inputs.

Notes:

The starting values in each calculation menu are always blanked out. Once enough specs have been entered, the calculated value(s) at the top of the menu will be displayed. This calculated value(s) will now be updated each time you change a spec. If you want to use this calculated value, click on Use Calc Value. If the calculated value is within expected limits, it will be loaded into the original menu. If you click on Cancel, you will be returned to the original menu with the original value unchanged. If you click on Help, you will be given a general explanation of calculation menus, and a page # in this section for more info about the particular menu you are using.

The input values or calculated values in any calculation menu have NO affect on calculated performance unless you load the Calculated value into the original menu. *If you already know a spec in the form required by the program, then you have no need to use the calculation menu.* For example, if you know the Compression Ratio is 10.3, you have no need to use a calculation menu to calculate Compression Ratio based on Gasket Thickness, Piston Dome CCs, etc.



## 2.8.1 Calc Compression Ratio

Is the Compression Ratio calculated from the following specs and the current cylinder volume (based on the current Bore and Stroke in the Engine menu). Compression Ratio is defined on page 49 under Engine specs. See page 51 for general notes on Calculation Menus and for an example of their use.

The equation for Compression Ratio depends on the cylinder displacement. This displacement is based on the current Bore and Stroke in the Engine menu and is displayed in the Notes section at the bottom of this menu. Make sure these specs match the engine for which you are calculating Compression Ratio before using this menu.

## Chamber Specs

### Chamber CCs in Head

Is the combustion chamber volume in the cylinder head, measured in cubic centimeters. This is the value obtained if the heads are "cc'd".

If you know the entire clearance volume of the cylinder, but do not know Piston Dome CCs, Gasket Thickness or Deck Height Clearance, enter that volume here as Chamber CCs in Head. Then enter 0 for Piston Dome CCs, Gasket Thickness and Deck Height Clearance. The program will calculate compression ratio based on the equation below where Clearance Volume is the Chamber CCs in Head.

$$\text{Compression Ratio} = \frac{\text{Clearance Volume} + \text{Swept Volume}}{\text{Clearance Volume}}$$

### Piston Dome CCs

Is the volume of the "pop up" in the piston measured in cubic centimeters. The "pop up" is the volume of piston material added to the top of a flat top piston. If the piston has a "dish" (depression), enter the dish volume as a negative (-) number.

### Gasket Thickness, in

Is the thickness of the head gasket in inches after it has been "crushed". "Crushed" thickness is after the head bolts have been torqued to spec.

### Gasket Bore Diameter, in

Is the diameter of the bore in the head gasket. A good approximation is to use the same as the Bore in the Engine menu, and this value is loaded in when you first open up this menu. You can change it to most any value you want. (In actual use, gasket bores are usually .030-.100" larger than the cylinder bore.)

### Deck Height Clearance, in

Deck Height Clearance is the distance in inches from the top of the piston to the top of the cylinder block when the piston is at TDC. The top of the cylinder is the deck, or surface to which the head bolts. If the outer edge of the piston travels above the deck, this is called negative deck height and you must enter a negative (-) number.

## 2.8.2 Calc Max Lobe Lift

Is the maximum lobe or tappet lift for the cam. Max Lobe Lift is defined on page 46 in the Engine specs. See page 51 for general notes on Calculation Menus and for an example of their use.

### Advertised Valve Lift, in

The valve lift you see in the cam grinder's ads, catalog or cam card in inches, also called Gross Valve Lift.

### Assumed Rocker Arm Ratio

The Rocker Arm Ratio *assumed* by the cam grinder for the particular engine. This should be stated somewhere in the catalog or on the card. Note that this assumed rocker arm ratio may be different than what you are actually using on the engine. The Notes section displays typical Assumed Rocker Arm Ratios for popular American V-8s.

Figure 2.27 Calc Max Lobe Lift

**Calc Max Lobe Lift, in**

Calc Max Lobe Lift, in:

**Cam Grinder's Specs**

Advertised Valve Lift, in:

Assumed Rocker Arm Ratio:

**Notes:**  
Advertised Valve Lift is gross valve lift from base circle (assuming no lash).  
You must use the Rocker Arm Ratio assumed in the cam grinder's catalog, which may NOT be the Rocker Arm Ratio in the engine. Check with cam grinder, but here are some examples:

1.5	Small Block Chevy
1.7	Big Block Chevy
1.6	289/302/351W Ford
1.73	351C, 351/400M, 429/460 Ford
1.76	352/390/428 Ford
1.5	383/440 Mopar
1.5	273/318/340/360 Mopar
1.6	Oldsmobile V-8
1.5	Pontiac V-8 (sometimes 1.65)
1.55	Buick V-8
1.6	AMC V-8

Use Calc Value   Help   Cancel   Print



# 2.9 New Test Menu:

The New Test command is available by clicking on File at the top, left of the Main Screen, then selecting New Test. You will then be presented with the screen shown in Figure 2.28. Getting a new test started right is probably the *most important step in running a flow test*. (Also see Example 4.1 and 4.2 for more details on the New Test menu.)

When starting a New Test, it is usually best to first Open a previous test which is similar to the New Test you will be running (similar head specs, similar test lifts, similar data to record, etc.) This previous test will then be the 'pattern' or 'template' for the New Test and will save you from having to type in many specs to describe this New Test. This also ensures consistency between your tests and reduces the possibility of errors.

If the current test is not a good 'pattern' for this new test (or if there currently is no test displayed), you can abort starting this new test by clicking on 'Cancel (don't start new test)' at the top of the New Test screen. Then click on 'File' at the top, left of the Main Screen and select one of the 'Open' options to open a past test to serve as a pattern.

If you must start with a blank test (which may be the case when you first get this program), or want to modify some specs from the previous test, click on the 'See Specs' buttons for each category of specs. Click on Help at these menus for more info on how to enter these specs.

When you close out these menus, you are brought back to the New Test screen. Be sure to check the check box at the left for all specs you want to use for your new test. *All* Categories not checked will be blanked out. Blank specs may cause problems with more detailed analysis, and won't allow you to keep track of important details about the head you are testing.

Most specs in these categories can be changed once the test has started with no problems. This includes specs which simply describe the test and head and do not affect any calculations or what is recorded, like Head Details, Test Comments, etc.

Figure 2.28 New Test Menu

4 Critical specs for the new test are listed here at the top.  
Click here to start a New Test based on these settings.

Click here to Check or Uncheck these options. Checking means you want to keep these specs for the new test. Once the new test is started you can then make modifications to these specs if you want.

A summary of the current settings is given here.  
Click on these buttons to see the current settings.  
See Figure 2.29 for an example of Keeping the Test Pattern.

Figure 2.29 Test Pattern Data

Point	Lift	L/D	Range	Test Pres "	Flow Pres %	T
1	.051	.025	1			
2	.101	.050	2			
3	.202	.100	3			
4	.303	.150	4			
5	.404	.200	4			
6	.505	.250	4			
7	.606	.300	4			
8						
9						

Keeping the Test Pattern keeps Valve Lifts, L/Ds and Ranges from Previous Test.

However, specs which DO affect calculations like the Flow Bench Specs, most Test Options specs, Valve Diameters in Head Specs (if L/Ds are being used) are critical to have correct for even the first data point.

Four other critical specs are listed separately at the top:

1. File Name for New Test is the file name the program will create for saving the Flow Data for the new test you are starting. The program fills in a default name of the current test name, but incrementing the last digit in the name by 1. You can change this name to most anything you like. The program will warn you if the name entered is not valid and show you what is wrong.
2. Operator for New Test is the name of the operator for this test. Click on Pick to pick an operator name already used or to enter a new name. The program defaults to the operator of the current test.
3. Head # for New Test is critical for shops who use a head numbering system. Click on Assign to create a new Head # based on the last Head # assigned (incremented up by 1) or to start with a new type of Head #.
4. Folder Name for New Test is the folder in the PFADAT folder where the test will be saved. The program may not be using the name 'folder' for this spec, but whatever word you have assigned in the Preferences menu at the Main Screen. The folder name 'Examples' is reserved for Performance Trends example tests supplied with the program, and can **NOT** be used for your tests.

When you are ready to start the new test, click on 'Start New Test' at the top of the screen. If some critical specs has not been entered, the program will warn you and ask you for it at that time. The program will fill in the Test Time and Date based on the computer's time and date. This can be changed later by clicking on the Test Time/Date at the Main Screen.

Tip: If you are making several small changes to a port, and are not starting with a new head, you might want to simply call every new port modification a new 'Cylinder'. This is done by increasing the 'Number of Cylinders to Test' in the Head Specs menu to as high as 8 if needed.

You can keep track of modifications in the Test Comments, like "Cyl 1 = Baseline, Cyl 2 = 3 angle valve job". This will save considerable time not having to start new tests, and avoids filling the test library with possibly meaningless tests.

However, there are limitations with this method in that you are limited in how you can report, graph or analyze a single cylinder's data.

For modifications which you want to treat separately, you can either:

- Use the Port Edit command (Pro version only) as discussed on page 21 to copy the port to the first position (for example, Cylinder #1). Then change the 'Number of Cylinders to Test' in the Head Specs to 1. This effectively erases all other ports. Then save this single port to a new name.
- Or, perform a completely separate flow test.

**See Appendix 7 for using the new, easy “EZ Start Wizard” feature added in version 3.5.**

## 2.10 Test Correction Factor Menu

This screen lets you calculate a test correction for a SF 110 style of flow bench. The Test Correction can be entered 2 different ways (chosen by 'Data Type').

1. You can enter a number directly, like '1.002'. The number 1.000 will give No correction (uses the Factory calibration).
2. You can install the standard orifice provided with your bench (where the head normally goes) and flow it. Then knowing what the orifice is rated for (usually 153.2 CFM at 10") and what it actually flowed, the program will calculate a new Test Correction.

The procedure for option 2 would be:

1. Open some recent test that you ran on this flow bench, from the Test Library, or start a New Test (as in Example 4.2). This test will be used as a scratch pad to calculate Corr CFM.
2. Install the Std Orifice plate with the 2 holes, one small and one large.
3. Plug the large orifice and check that you are getting from 35 to 55 % Flow reading on the Range 1 (from 3.5 to 5.5 CFM flow on SF110/120) assuming 0 leakage.
4. Open both the Std Orifices and flow them at 10" Test Pressure. Record all the data to calculate CFM, including Range (usually the highest range), Test Pres, Flow Pres, Test Temp and Flow Temp. Valve Lift is not required. You can do this manually or with the FlowCom and record the data in some blank row in the Flow Data grid. Note the Corr CFM obtained.
5. Click on the Test Corr display at the Main Screen and bring up the Test Correction menu (Figure 2.30).
6. Choose Calculate from CFM Flow as the Data Type. Then enter the Corr CFM recorded and the Std Orifice Flow (usually 153.2 CFM). The program will display the new Test Corr. (Note that the New Test Corr is based on the fact that the Measured CFM had the Current Test Corr factored into it. Meas Flow WO Test Corr is displayed also so you can more easily see how the Test Corr is calculated.)
7. If the New Test Corr is close to the Current Test Corr (within 1% or .01), it is recommended you do not use the new one, but keep the old one.

**Figure 2.30 Test Correction Menu**

**Calc Test Correction**

New Test Correction: 1.003

Current Test Correction: 1.021

Meas. Flow WO Test Corr.: 152.8

Current Date/Time: 08/23/99 06:49 pm

**Test Correction Factor Data**

Data Type: Calculate from CFM flow

Test Correction: [ ]

\* Measured Flow, CFM: 156

\*\* Standard Flow, CFM: 153.2

**Notes:**

\* Measured Flow is obtained by flowing the standard orifice provided with your flow bench. It is best to calculate this flow from the Flow Test Data Sheet before entering this menu. This calculated flow will incorporate the current test correction factor of 1.021 which was calculated from a Measured CFM (without a correction factor) of 150.0 and a Std flow of 153.2 CFM on 02/01/99 04:38 pm.

Use Calc Value | Help | Cancel | Print

**See Example 4.2 for more details.**

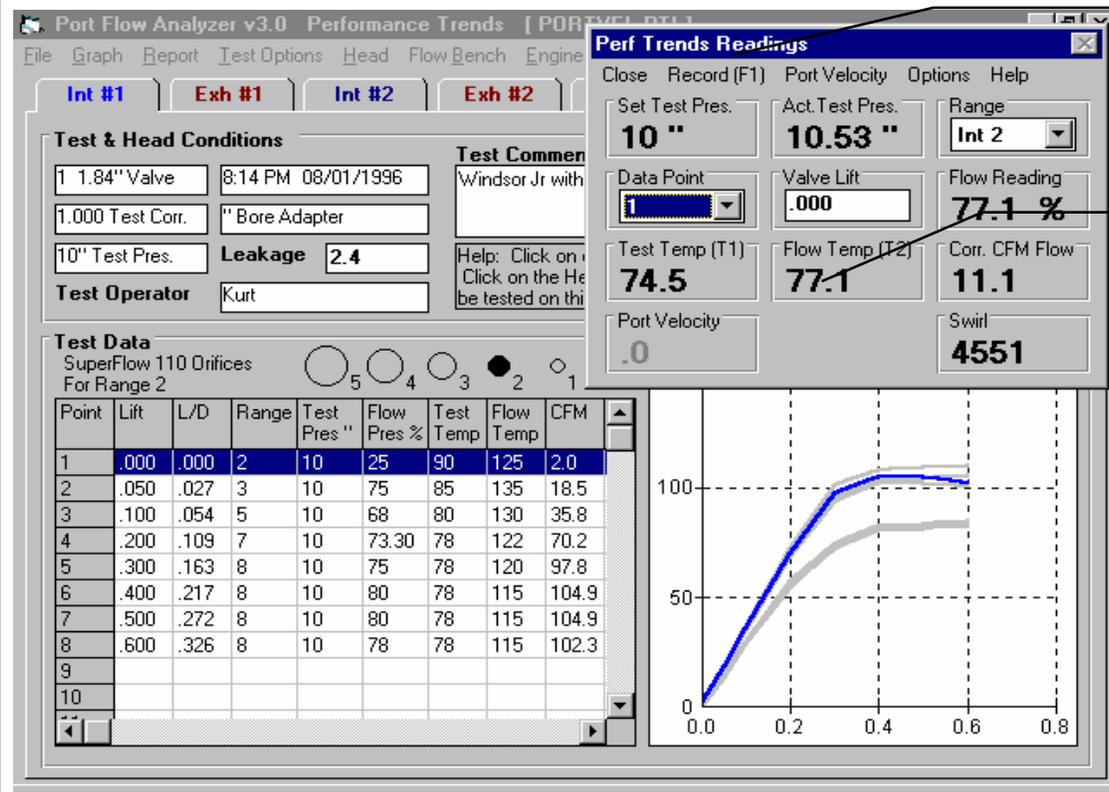
**See Appendix 7, 9, 10 for new features added in version 3.5, 3.5B, 3.5C.**



# 2.11 Recording Data Electronically with SuperFlow FlowCom (tm) or Performance Trends Black Box II:

This screen shows you the readings from the electronic recording device currently connected to your computer, either the SuperFlow FlowCom (tm) or Performance Trends Black Box II. Either of these systems let you automatically record these readings and load them in the Test Data grid. This feature saves considerable time, ensures consistency of readings and improves accuracy. (Also see Example 4.2 for more details.)

Figure 2.31 Screen for Reading Electronics, SF FlowCom or Perf. Trends Black Box II



Menu commands and options are explained later in this section.

The layout and data displayed on this screen depends on your setup in the Test Options menu for data you want to record, and Flow Bench specs for what data is needed to calculate CFM and what additional sensors you

What data is displayed here and can be recorded is determined by settings in the Flow Bench and Test Options screens, and somewhat by available space on the screen. Click on 'Flow Bench' and 'Test Options' at the top of the Main Screen to see these options.

To avoid communications problems with the electronics, you can't type on the Test Data grid when this screen is open. Therefore, you must use commands on this screen to select or change 'Data Points' (which row in the Test Data grid you are recording for), Range, and Valve Lift. Also, you can only close this screen by clicking on 'Close' at the top left corner.

FlowCom is a computer itself, and can calculate and display CFM based on pressures, temperatures, leakage, range, etc. The Port Flow Analyzer reads the pressures, temperatures, barometer (and optional swirl or tumble inputs), but not the FlowCom's calculated CFM. The Port Flow Analyzer program calculates its own CFM based on these raw measurements.

If the Port Flow Analyzer's Leakage, Set (desired) Test Pressure, Flow Range and Flow Direction match the FlowCom's, both will calculate and display the same CFM. If they are NOT the same, but the Port Flow Analyzer's Leakage, Set Test Pressure, Flow Range and Flow Direction **are correct**, the CFM calculated by the **Port Flow Analyzer is correct**. (A note is displayed at the bottom of the FlowCom screen if these specs don't match.)

This is important because it means you do not have to keep adjusting the FlowCom's leakage, range or test pressure to match the flow bench. Just be sure the Port Flow Analyzer screen does match the settings on the flow bench and the Port Flow Analyzer's CFM readings will be correct.

**Note: Check the Preference spec SF Cal. Test Pres. Corr. on page 27 for a setting which may produce an additional small difference between the Port Flow Analyzer's calculated CFM and the FlowCom's.**

The Performance Trends Black Box II does not calculate CFM. Therefore, there are no concerns about the leakage, flow range values, etc matching the Port Flow Analyzer program because the Black Box II does not store any of these values.

***The most critical thing for accurate readings is to check that the manometers and dial thermometers on your flow bench are matching the readings on this screen. If they do not, the electronics may need recalibration. See Appendix 5.***

When taking a reading, the Port Flow Analyzer takes several readings to average together to produce a good, repeatable reading. This is shown in the upper left corner as the 'Set Test Pres' frame changes to 'Reading' x of xx and is displayed in blue. At the same time, it watches the stability of Test Pressure (vertical manometer) and Swirl or Tumble if they are being recorded. The number of readings to average is set in the Flow Bench Specs, from 5 to 50.

When done taking a reading, the data is written to the Test Data grid on the Main Screen and the Test Summary graph is updated. The 'Data Point' indicator and corresponding highlighted bar for the current Row automatically advance by 1. Therefore, try to start recording data at the top of the Test Data grid (Data Point 1) and let the Data Point indicator and current row advance automatically down the grid as you record data.

If you have selected to record Port Velocity (selected in the Test Options) screen, a 'Port Velocity' option is available at the top of the screen. Here you can select to Start or Stop recording Port Velocities.

You can click on the blue bar at the top of this screen and drag this screen to any location on your computer screen and the program will keep it there.

## Menu Commands

### Close

Click this option to close this menu and return to the Main Screen.

### Record (F1)

Click this option or press the <F1> key to start recording data.

## Port Velocity

Click this option to select either to start recording Port Velocity (somewhat rearranges this screen) or to stop recording Port Velocity (returns the screen to recording CFM). This is only displayed when you have requested Port Velocities to be recorded in the Test Options menu.

## Options

### Freeze

Freezes the current readings in this screen.

### Continuous Update

“Un-freezes” the current readings in this screen and returns to continuous updating.

### Re-Zero Pressure Readings

Electronics are prone to minor changes (or drift) over time or through temperature changes, etc. This is most obvious when you have the flow bench turned off, but the updating pressure readings are not reading *exactly* 0.0. Rather than doing a complete calibration of the system, you can simply re-zero the Performance Trends Electronic Interface by clicking on this option. The program will tell you to turn Off the flow bench and wait for all pressures (manometers) to go to zero. Then click a button and the program will reset the zero pressure reading on all 3 pressure sensors. (This command is not available with the SuperFlow FlowCom.)

Note: Because the pressure transducers are so sensitive, the updating display will never read a constant 0 when the flow bench is turned off. However, when they are correctly zeroed, you should see about the same amount of negative readings as positive readings. (Note: The SuperFlow FlowCom is designed to never read negative #s, so this does not apply to it.)

### Eliminate Re-Zero Correction

Click on this option if you want to eliminate any Re-Zeroing effect. The program will now convert voltage from the Performance Trends Electronic Interface exactly as you calibrated it. (This command is not available with the SuperFlow FlowCom.)

### Display ...

These “Display” commands are of little value to the user. There are used primarily by Performance Trends technicians to troubleshoot communications problems.

## Help

Brings up “on screen” help.

## Definition of Data Types Recorded

**Set Test Pres** is the desired reading on the vertical manometer, the pressure drop across the valve and port. This is set in the Test Options menu. When recording data, this changes to 'Reading' x of xx and is displayed in blue.

**Act. Test Pres** is the electronics' current reading of the vertical manometer, the pressure drop across the valve and port.

**Range** is the Flow Bench range #. Click on the down arrow key to select from the current valid ranges for this flow bench (set in the Flow Bench menu). For SuperFlow 1020 benches, this is displayed as the full CFM for the current range.

**Data Point** is the current row in the Test Data grid you are working with. This row will be highlighted in blue. Click on the down arrow key to select the row to work with. The total number of rows is set in the Test Options menu.

**Valve Lift** is the current Valve Lift for the row you are working with. Type in a different valve lift to change it.

**Flow Reading** is the electronic's current reading of the inclined manometer, the pressure drop across the flow measurement orifices in the flow bench.

**Test Temp (T1)** is the air temperature by the head, the lower temperature location on SuperFlow 110 or 120 benches.

**Flow Temp (T2)** is the air temperature by the flow measurement orifices, the upper temperature location on SuperFlow 110 or 120 benches.

**Barometer** is the actual barometric pressure in Inches of Mercury and is available only with the FlowCom. The "corrected" barometric pressure, as reported by radio or TV weather reports, will be higher due to elevation.

**Corr. CFM Flow** is the CFM calculated by the Port Flow Analyzer based on all its current settings. This should match the FlowCom's CFM if all FlowCom and Port Flow Analyzer settings match.

**Port Velocity** for a FlowCom is the reading from the 3rd FlowCom pressure input, usually hooked to a Pitot tube for measuring Port Velocity. The reading can be in Feet/Second or inches of water pressure depending on the 'Port Velocity Data' setting in the Test Options menu. For the Performance Trends Electronic Interface, you must select inches of water pressure for the 'Port Velocity Data' setting in the Test Options menu.

**Swirl** for a FlowCom is the reading from the J1 connection on the FlowCom, usually connected to a Swirl Meter or Tumble Meter. This is only displayed if the 'Swirl' setting in the Test Options menu is set to one of the Record Swirl settings. For the Performance Trends Electronic Interface, this is the signal entering the Auxiliary 0-5 volt jack, if so equipped.

**Tumble** for a Flow is the reading from the J1 connection on the FlowCom, usually connected to a Swirl Meter or Tumble Meter. This is only displayed if the 'Tumble' setting in the Test Options menu is set to one of the Record Tumble settings. For the Performance Trends Electronic Interface, this is the signal entering the Auxiliary 0-5 volt jack, if so equipped.

# Chapter 3 Output

The Port Flow Analyzer provides several ways to view and output the test results, including:

- Reports of tabular data displayed on the screen
- ASCII files for importing results to other software packages (Pro version only)
- High resolution graphs
- Printer output of reports or graphs
- History Log (Pro version only)
- Data Libraries for recording flow test data (or sets of head or engine specs in the Pro version) for later use.

All these topics will be covered in this chapter. Figure 3.1 shows how to reach all these various features.

**See Appendix 7, 9, 10 for new features added in version 3.5, 3.5B, 3.5C.**

Figure 3.1 Various Output Options from the Test Results Screen

Click on File to display several options to Save test files, Open test files which were previously saved, display the History Log, or print information.

Click on Graph to display several Graph Options and produce a high resolution graph.

Click on Report to display several Report Options and produce a tabular report. Once a report is displayed, it can be output as an ASCII file, or printed.

Name of current Test File

Open from Pro version's History Log displays a chronological log of test files you have recently worked with (started new, opened, made graphs or reports of, etc.) Section 3.8.

Saving options to Save a test file are discussed in Section 3.6.

Opening options to open a previously saved test file are discussed in Section 3.6.

Although Print options are limited on the Main Screen, most menus have a Print button to print that menu, or a File command which lists Print options under it. See Section 3.5

	CFM	Swirl
6	63.4	1134
7	132.9	1567
8	185.4	2189
9	218.3	2578
10	236.2	2986
11	245.2	3002



## 3.1 Reports

Click on the Report menu command at the Main Screen to be presented with the Report Options Menu shown in Figure 3.2. The inputs in this menu are described below.

### Type

Several types of reports can be picked by clicking on the down arrow key of this combo box. Depending on your choice, several options in this menu may be enabled or disabled.

### Correct to New Test Pressure

Pick Yes and the report data will be corrected to the test pressures identified by the next one or two specs, New Int Test Pres, " Water and New Exh Test Pres, " Water. Pick No and the data is corrected to the test pressure identified in the test's Test Options menu under Test Pressure. (Note that in the Pro version, the Port Velocities, Swirl and Tumble are corrected in addition to CFM. However, these corrections have not been well proven with years of experience as has the CFM correction.)

For several Report Types, like Engine Performance report, no correction is possible or required and this spec is disabled (printed in gray and you are not allowed to change it).

### New Int Test Pres, " Water

The pressure the *intake* flow or velocity data is corrected to if the previous spec, Correct to New Test Pressure is set to Yes. Note that if you flow a head at 10" and correct to say 28" you may get different results than if you had actually flowed the head at 28". This can be especially true of data other than CFM, like Swirl, Tumble, Stability, and Port Velocity readings.

### New Exh Test Pres, " Water

The pressure the *exhaust* flow or velocity data is corrected to if the previous spec, Correct to New Test Pressure is set to Yes. Note that if you flow a head at 10" and correct to say 28" you may get different results than if you had actually flowed the head at 28". This can be especially true of data other than CFM, like Swirl, Tumble, Stability, and Port Velocity readings.

### Which Cylinder(s)

Click on the down arrow key of this combo box. to pick from reporting on:

- All Cylinders tested
- Average of all cylinders tested
- Pick Individual Cylinders (new feature added in version 3.5. See Appendix 7)
- Individual cylinders, which can be picked by the order they were recorded.

If the test file was only for 1 cylinder, or for some reports which require average data like Engine Performance Estimate, this spec will be disabled.



Notes:

- If you pick Average, the average is based on all cylinders with data which is not 0. For example, for 3 cylinders, if cylinder 1 is 20 CFM and cylinder 2 is 24 CFM and cylinder 3 is 0 CFM, the average is 22 CFM  $((20+24)/2)$ , not 14.7 CFM  $((20+24+0)/3)$ .
- If the cylinders are numbered 2, 4, 6 and 8 on the head, and you ask for the 4th cylinder, the report will be for cylinder #8, not cylinder #4.

## Report Types

### Int & Exh Raw Flow Data

This report simply restates the raw data recorded on the Flow Test Data grid for each and every port. See Figure 3.3. If you select this report all specs in the Reports menu are disabled.

Generally, raw data is only useful for finding errors in data which occurred during the flow test. For example, during analysis of data, one data point looks "out of line" from the others. By examining the raw data, you may discover that a Test Temp of 15 was entered when it should have been 115.

You can now go into the Flow Test Data grid screen and change that particular point to 115. Use the Save command to save this corrected data to the Flow Test Library. This ensures that if you open the file again, it will have the correct 115 value, not 15. Now when you make reports or graphs, the Port Flow Analyzer will calculate all results based on the new, correct 115 Test Temp.

See Section 2.1 describing the Main Screen Test Data grid for definitions of the items reported here.

Figure 3.3 Portion of Raw Int & Exh Data Report

Port	Lift	L/D	Range	Test Pres	Flow Pres	Leak CFM	Corr CFM	Swirl
Int #1	.101	.050	2	25.00	93.00	3.0	63.4	1134
Int #1	.202	.100	3	25.00	90.00	3.0	132.9	1567
Int #1	.303	.150	4	25.00	63.00	3.0	185.4	2189
Int #1	.404	.200	4	25.00	74.00	3.0	218.3	2578
Int #1	.505	.250	4	25.00	80.00	3.0	236.2	2986
Int #1	.606	.300	4	25.00	83.00	3.0	245.2	3002
Exh #1	.080	.050	2	30.00	57.00	3.0	36.3	0
Exh #1	.160	.100	3	30.00	53.00	3.0	72.0	0
Exh #1	.240	.150	3	30.00	78.00	3.0	107.4	0
Exh #1	.320	.200	3	30.00	97.00	3.0	134.3	0
Exh #1	.400	.250	4	30.00	52.00	3.0	145.6	0
Exh #1	.480	.300	4	30.00	53.00	3.0	148.4	0
Int #3	.101	.050	2	25.00	80.00	3.0	54.1	1277
Int #3	.202	.100	3	25.00	80.00	3.0	117.8	1537
Int #3	.303	.150	4	25.00	60.00	3.0	176.4	1890
Int #3	.404	.200	4	25.00	72.00	3.0	212.3	2210
Int #3	.505	.250	4	25.00	77.00	3.0	227.2	2546

Summary of Critical specs for this test and head.

Click on Report Types to bring up the Reports Option menu again to change a report option.

Select either Print option to print this report.

### Int & Exh Cyl-Cyl Comparison

This report type compares the average CFM for each port on the head you tested with the average for the entire head. If the same lift point is tested more than once on an individual cylinder, say 2 times, an \*2 will be include with the CFM for that cylinder. See Figure 3.4. (See Appendix 7, 9, 10 for several new features added in version 3.5,3.5B, 3.5C.)

Figure 3.4 Int & Exh Cyl-Cyl Comparison Report

Port	Lift	L/D	Avg CFM	Cyl # 1 CFM	Cyl # 3 CFM	Cyl # 5 CFM	Cyl # 7 CFM
Intake	.101	.050	61.1	67.1	58.1 *2	49.7	72.4
Intake	.202	.100	131.1	140.6	124.7	119.9	139.1
Intake	.303	.150	191.4	196.2	186.7	183.5	199.3
Intake	.404	.200	227.8	231.0	224.7	218.3	237.3
Intake	.505	.250	245.2	250.0	240.5	231.0	259.5
Intake	.606	.300	251.6	259.5	243.6	234.1	269.0
Exhaust	.080	.050	37.4	38.5	37.0	36.3	37.7
Exhaust	.160	.100	76.0	76.2	74.7	75.4	77.7
Exhaust	.240	.150	111.8	113.6	110.6	110.6	112.1
Exhaust	.320	.200	142.1	142.1	143.6	139.1	143.6
Exhaust	.400	.250	155.6	154.1	163.1	148.0	157.1
Exhaust	.480	.300	157.1	157.1	163.1	148.0	160.1
Exhaust	.560	.350	160.1		160.1		

### Int & Exh Calculated Data

This report contains very little data from the Flow Test Data grid. However, it does contain several calculated parameters which will help to rate ports for their design and porting.

#### Port

This column identifies the port type (Int or Exh) and the cylinder # for each data point.

If the report is for an Average of all cylinders across the head, the number listed with “Int” or “Exh” is the number of points averaged together on this head. Only ports with identical lift values are averaged together. For example, if all four intake ports have a lift value of .400”, the identifier would be “Int (4)”. If only one intake port has a lift value of .403”, it would be identified as “Int (1)”.

Note: During averaging, the program will warn that a port has a very low but not exactly 0.0 Corr CFM flow with a lift which is greater than 0, or 0 lift and has significantly different than zero Corr CFM. To continue with averaging at this point, would cause unusual data to be averaged in with the other cylinder's flow, giving unexpected average data. It is best to do a report or graph of all cylinder's data before a report of Average data to check for this. (If a port has **exactly 0.0** CFM or is blank, the program assumes the port has not yet been tested and the data is **not** averaged with other data.)

Figure 3.5 Portion of Int & Exh Calculated Data Report

Report of: Test Time Tested Corr to # Vlvs Vlv Dia Stem Dia Port Area  
 All 4 7:04 PM Int: 25" 28.0" 1 2.02" .34" 2.52 sq in  
 Cylinders 04-05-1992 Exh: 25" 28.0" 1 1.6" .34" 1.70 sq in

Port	Lift	L/D	Corr CFM	VlvArea sq.in.	CFM / sq.in.	FlwArea sq.in	Flow Coef.	Swirl	Valve Velocity	Port Velocity	% Exh/Int
Int #1	.101	.050	67.1	.438	153.32	.460	1.052	1200	368.0	64.0	
Int #1	.202	.100	140.6	.949	148.17	.965	1.017	1658	355.6	134.1	
Int #1	.303	.150	196.2	1.541	127.29	1.346	.873	2317	305.5	187.1	
Int #1	.404	.200	231.0	2.150	107.43	1.585	.737	2728	257.8	220.3	
Int #1	.505	.250	250.0	2.745	91.08	1.715	.625	3160	218.6	238.4	
Int #1	.606	.300	259.5	2.745	94.54	1.780	.649	3177	226.9	247.5	
Exh #1	.080	.050	38.5	.256	150.27	.264	1.031	0	360.6	54.4	57.3
Exh #1	.160	.100	76.2	.526	144.84	.523	.994	0	347.6	107.7	54.2
Exh #1	.240	.150	113.6	.811	140.15	.780	.962	0	336.4	160.7	57.9
Exh #1	.320	.200	142.1	1.139	124.76	.975	.856	0	299.4	200.9	61.5

Note that Flow Coef can be greater than 1.0. This report uses Seat Angle and Throat Diameter to calculate Valve Area (selectable in the Preferences menu.).

Swirl only recorded on Intake side.

Lift

Valve Lift in inches.

L/D

The ratio of valve lift divided by valve diameter.

Corr CFM

Air flow in CFM corrected to the test pressure specified. If the spec Corrected to New Test Pres in the Report Options menu is set to No, flow is corrected to the Intake or Exhaust Test Pressure set in the Test Option menu. If the spec Corrected to New Test Pres is set to Yes, flow is corrected to the specs New Int Test Pressure and New Exh Test Pressure in the Report Options menu.

Vlv Area

This is the geometric valve opening area in square inches. There are 2 ways to calculate geometric valve area:

1. Simple method using the outside diameter of the valve and valve lift, sometimes called the "curtain area". This is the method usually used for port flow analysis because it only requires valve diameter and lift to be calculated. It is also used in our Engine Analyzer programs and the Basic version of Port Flow Analyzer.
2. A more accurate way is to use the valve seat angle, valve stem diameter and inside throat diameter to calculate area. This area is smaller than the simple "curtain area". See Figures 3.6, 3.7 and 3.8.

Figure 3.6 Side View of Valve & Seat Showing Different Opening Areas

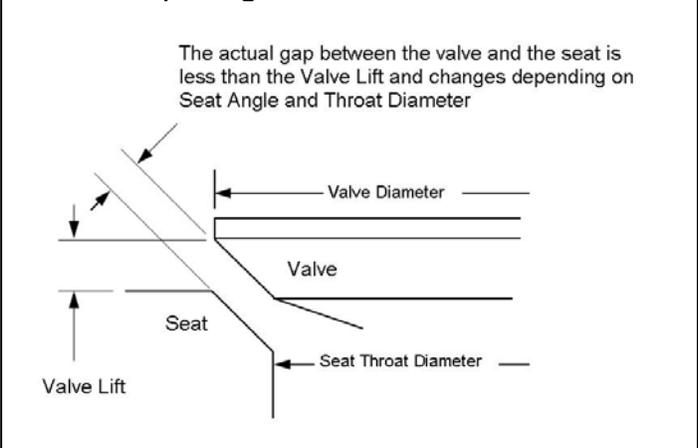


Figure 3.7 Illustration of Using Seat Angle Area vs Standard Curtain Area to Calc. Valve Area

Vlv Area (valve area) is the smaller of the "curtain Area" or Max Valve Area

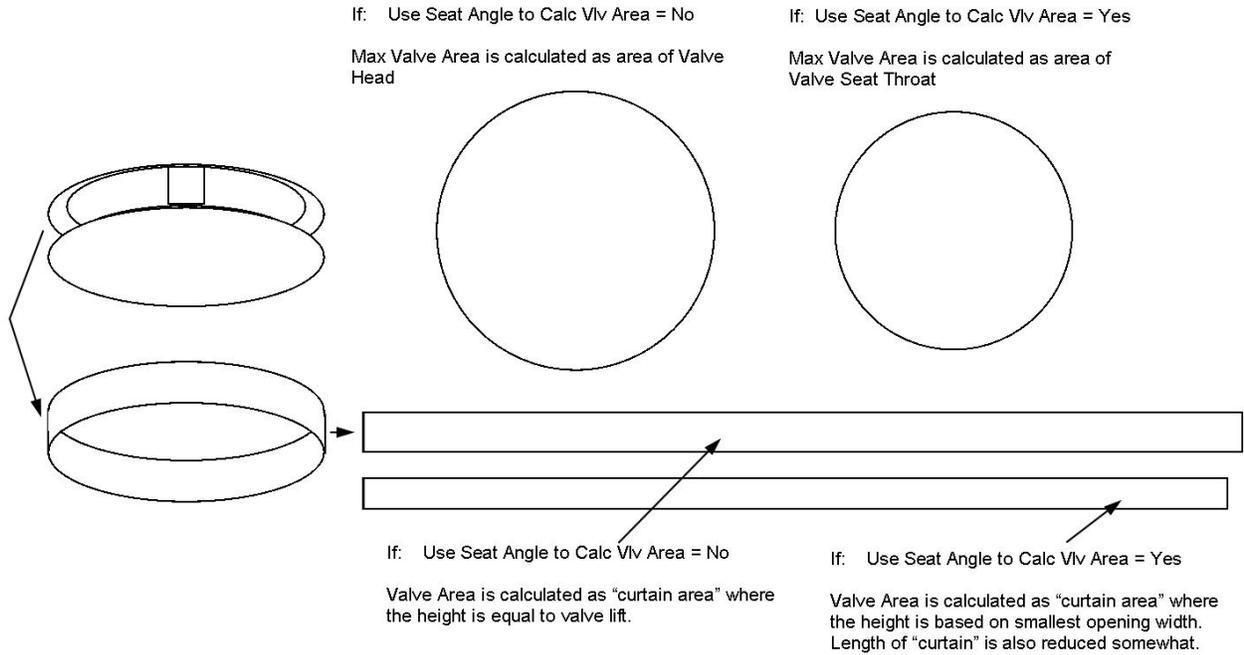
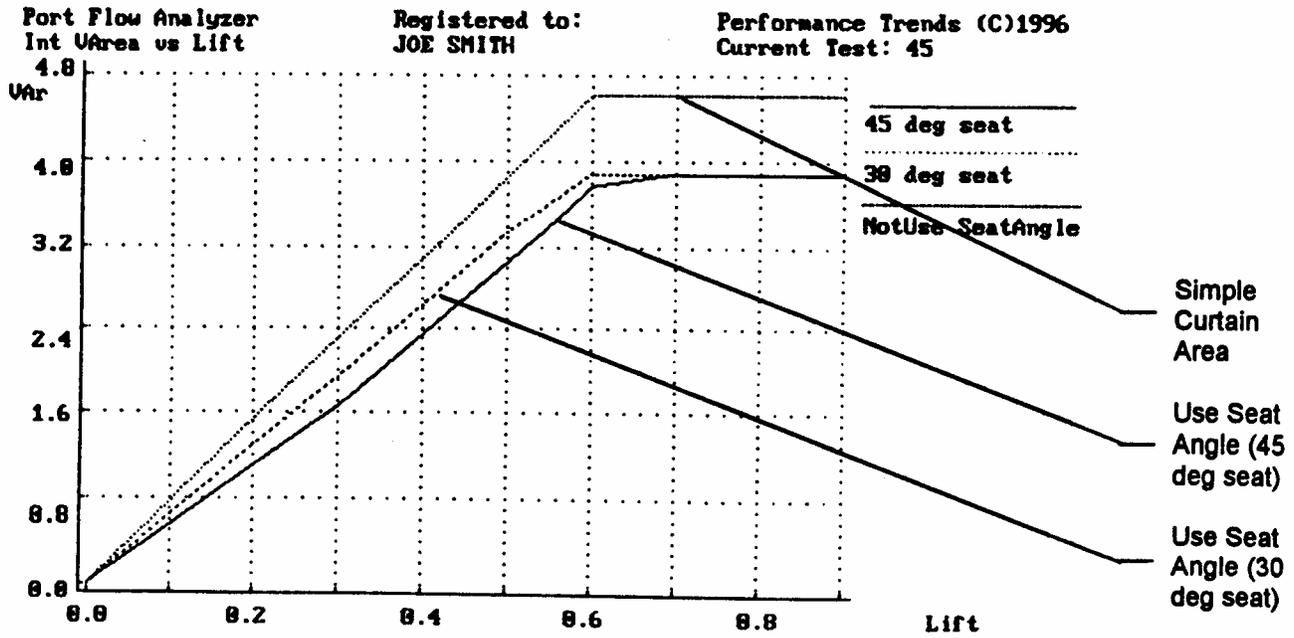


Figure 3.8 Graph of the 2 Valve Area Calculations vs Valve Lift, and 2 Different Seat Angles



In the Pro version, you can select the method used to calculate Valve Area. This is selectable in the Preferences menu (Section 2.2) by the spec "Use Seat Angle to Calc Vlv Area", either Yes or No. Since Valve Area is also used to calculate other outputs like Valve Velocity, CFM/sq in and Flow Coef, this setting also affects these outputs.

## CFM/sq in

Is the Corr CFM divided by the Vlv Area. This can give an idea of how efficiently the port is flowing for a valve of this size at this lift. However, if a port is flowing 50 CFM/sq in at 10" test pressure, it will flow 84 CFM/sq in at 28". See Flow Coef below for a measure of flow efficiency which does not depend on test pressure. With the Pro version, also see Vlv Area to understand the options for calculating Vlv Area, which will affect CFM/sq in.

## FlwArea

This is the opening area of the valve in square inches "as far as the air is concerned". For example, the geometric valve opening area (Vlv Area) may be 2.5 square inches but due to poor design, the air restriction is more like a hole (FlwArea) of 1.5 square inches.

This is really what you are measuring with a flow test. CFM only has meaning when you know what Test Pressure was used. A head that flows 100 CFM at 10" flows 167 CFM at 28". However, the Port Flow Analyzer reports the FlwArea of 1.15 sq in for either 10" or 28" of test pressure.

The difference between Vlv Area and FlwArea is a useful measure of how well a port is flowing *for its size*. Note that at low lifts, it is possible for the FlwArea to actually be larger than Vlv Area. This is especially true if you have set Use Throat Dia to Calc Vlv Area to Yes in the Preferences Menu. That is because that method calculates a smaller Vlv Area for the same valve lift.

## Flow Coef

The flow coefficient is simply the ratio of FlwArea to Vlv Area. For very well designed ports it will be close to 1.0 or higher at low lifts and 0.7 to 0.8 at high lifts, especially if you set Use Seat Angle to Calc Vlv Area to Yes in the Preferences Menu.

The advantage of using Flow Coef is that it does not change significantly with different test pressures. A well designed valve/port will have a flow coefficient of .8 for any valve size or pressure drop. Flow Coefs over 0.8 are highly unlikely at high valve lift. Good valve designs will have Flow Coefs of .6 to .8 at max lift.

Generally, there are higher flow coefficients at low valve lifts because here the valve and seat are the only major restrictions. In addition, the valve and valve seat with a multi-angle valve job closely resembles a free-flowing venturi shape. At higher lifts and air flows, the valve seat and the entire port combine their restrictions, and the Flow Coef drops.

Flow Coef calculated with accurate port dimensions for Throat Area and Seat Angle is the best number to rate the design of a port. You must also set Use Seat Angle to Calc Vlv Area to Yes in the Preferences menu. The best you can hope to achieve for either case is listed in Table 3.1.

<b>Table 3.1 Valve Lift</b>	<b>Best Flow Coef with Use Seat Angle to Calc Vlv Area = Yes</b>	<b>Best Flow Coef with Use Seat Angle to Calc Vlv Area = No</b>
Low Lift (L/D less than .15)	1.20	1.00
Mid Lift (L/D from .15 to .25)	.95	.80
High Lift (L/D over .25)	1.00	.90

## Valve Vel

The valve velocity is the average air speed flowing through the valve opening in feet/sec. Like CFM, the Valve Vel will increase with increasing test pressure. Therefore, only compare Valve Vel between heads with equal corrected test pressures.

Valve Vel can be used to compare valve air flow with port air flow. Generally, port design is most critical where air velocity is high. Thus, at low lift where Valve Vel is high compared to Port Vel, valve and valve seat design is critical. Valve Vel can also be used to compare Pitot Tube air velocity measurements. See Port Vel.

## Port Vel

The port velocity is the average air speed flowing through a port area defined by the Avg Port Diameter (or Avg Port Height and Width) entered in the Head Specs menu. The units are measured in feet/sec. Like Valve Vel, the Port Vel will change with different corrected test pressures. See Valve Vel.

The Port Vel can be used to compare the inertia tuning potential of different port designs. Air at high velocity contains significant inertia; the higher the velocity, the higher the inertia. This inertia can be used to pack more air into the cylinder after the piston has passed BDC but before the intake valve has closed. The same principle applies for scavenging on the exhaust side.

If two ports flow the same CFM for the same test pressure, the one with the higher Port Vel will generally produce more torque (with proper length of runner for tuning). HP potential will depend on cam specs and the designed RPM range of the engine.

## Swirl

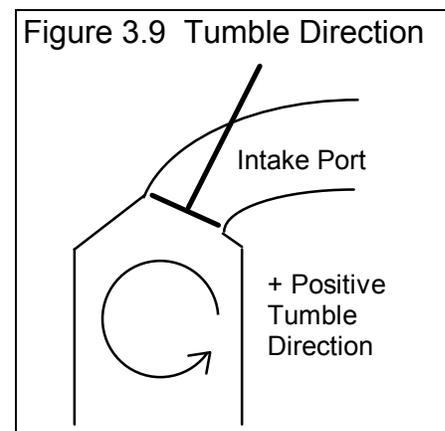
The swirl reading you entered, usually in RPM. Performance Trends' convention is a negative swirl means the swirl direction is counter-clockwise when viewed from the top of the bore. This column is only displayed if you selected to record swirl in the Test Options menu.

**Important:** *Swirl is corrected for any difference in test pressure when swirl was recorded and the test pressure for the report, the same as CFM. Although this correction is approximately correct, its accuracy has not yet been proven over years of experience, like the CFM correction.*

## Tumble

The tumble reading you entered, usually in RPM. Performance Trends' convention is a negative tumble means the tumble direction is opposite of the direction the intake port would induce. See Figure 3.9. This column is only displayed if you selected to record tumble in the Test Options menu.

**Important:** *Tumble is corrected for any difference in test pressure when swirl was recorded and the test pressure for the report, the same as CFM. Although this correction is approximately correct, its accuracy has not yet been proven over years of experience, like the CFM correction.*



### % Exh/Int

This is the percent ratio of the exhaust flow to the intake flow at equal Inches lift or L/D depending on the Valve Lift Settings (Inches or L/D) in the Test Options menu. For example:

Inches are being used for Valve Lift Settings

Int #3 = 121 CrCFM @ .2 inches  
Exh #3 = 88 CrCFM @ .2 inches  
Exh #3 % Exh/Int = 72.7 @ .2 inches

"Rules of thumb" state the exhaust should flow 75% of the intake flow for "non boosted" engines. For supercharged and nitrous oxide engines, the desired percent increases to 85%.. The % Exh/Int **Flow Area** in the Eng Performance Estimate report gives a better indication of this relationship because it also takes the cam profile into account.

### Int & Exh Other Calc Data (Pro version only)

This report contains Lift, L/D and Corr CFM, and information recorded only with the Pro version and not found in other reports. This data includes stability, swirl and swirl stability, and tumble and tumble stability.

Definitions for this data are found in the previous section describing the Int & Exh Calculated Data report, and the definitions for test Stability, swirl stability and tumble stability described in Section 2.1. Note that test Stability, swirl stability and tumble stability are not affected by any correction factor for test pressure. If test stability was 1.5% at 10" it is assumed to be 1.5% at 28". This may not be the case in some situations. Many head porters say a port which is stable at 10" can be *very* unstable at 28".

Figure 3.10 Portion of Int & Exh Other Calc Data Report

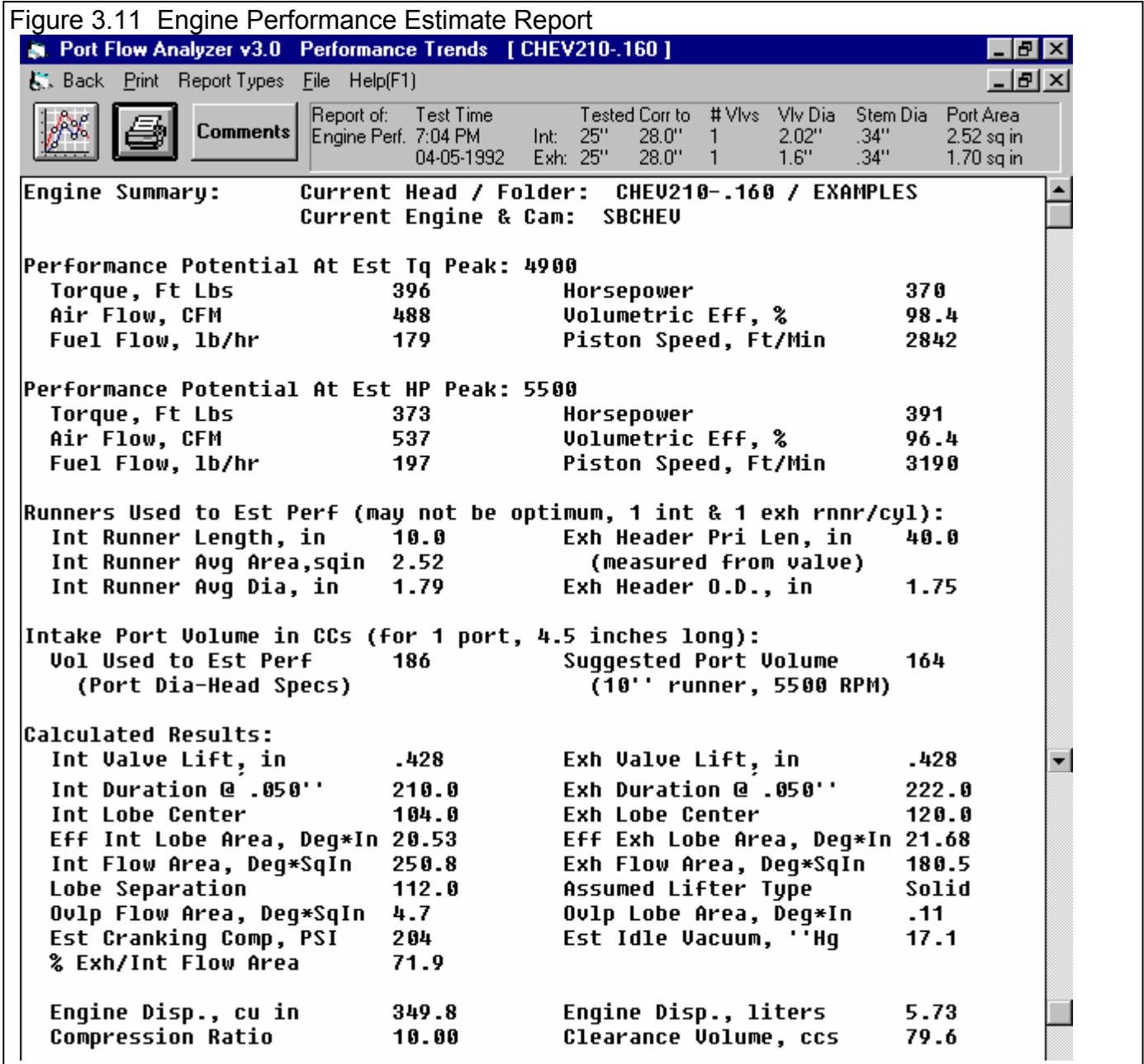
The screenshot shows a software window titled "Port Flow Analyzer v3.0 Performance Trends [ CHEV210-.160 ]". The window contains a menu bar (Back, Print, Report Types, File, Help(F1)), a toolbar with icons for a graph and a printer, and a "Comments" field. Below this is a summary table with columns: Report of: (All 4 Cylinders), Test Time (7:04 PM 04-05-1992), Tested (Int: 25", Exh: 25"), Corr to (28.0", 28.0"), # Vlys (1, 1), Vlv Dia (2.02", 1.6"), Stem Dia (.34", .34"), and Port Area (2.52 sq in, 1.70 sq in). The main data table has columns: Port, Lift, L/D, Corr CFM, Unstbl +/-%, Swirl, Swirl +/-%, Tumble, and Tumble +/-%. The data rows are as follows:

Port	Lift	L/D	Corr CFM	Unstbl +/-%	Swirl	Swirl +/-%	Tumble	Tumble +/-%
Int #1	.101	.050	67.1	63.40	1200	.00	0	.00
Int #1	.202	.100	140.6	132.90	1658	.00	0	.00
Int #1	.303	.150	196.2	185.40	2317	.00	0	.00
Int #1	.404	.200	231.0	218.30	2728	.00	0	.00
Int #1	.505	.250	250.0	236.20	3160	.00	0	.00
Int #1	.606	.300	259.5	245.20	3177	.00	0	.00
Exh #1	.080	.050	38.5	.00	0	.00	0	.00

### Eng. Performance Estimate (Pro version only)

This report will display several calculated parameters describing how the current head's flow data would perform with a given engine. They are based on the flow data for the current Flow Test file and specifications in the current Engine Specs file.

Figure 3.11 Engine Performance Estimate Report



#### Performance Potential At Est Tq Peak: 5300 RPM

The program estimates performance at 2 RPMs, the estimated torque and HP peak RPMs. For example, in the line above, the program estimates the torque peak to occur at 5300 RPM.

The performance calculations are similar to our standard version Engine Analyzer program. However, since there are so few inputs about the engine, the program must make many assumptions. In general, these assumptions assume race engine conditions, like race intake manifold, headers, low friction from accessories, no nitrous oxide, no supercharger, etc. Therefore, performance estimates will be "best case" for non-supercharged gas engines. Your actual performance will likely be less, especially for more street orientated combinations.

Torque, Ft Lbs  
Horsepower

The brake torque and HP at the flywheel for these RPMs, corrected to 29.92 and 60 degrees of dry air.

*Safety Precaution: Even though the engine may be able to flow air and make HP at high RPM, its connecting rods, crank pins, pistons, etc may not be able to withstand the severe stress. The RPMs estimated for the torque and HP peak are based mainly on air flow capabilities only, not stress limits or the possibility of parts breakage. You must judge this limit based on your experience, parts manufacturer's advise and other sources.*

Air Flow CFM

The estimated air flow through the engine for this RPM in standard CFM.

Volumetric Eff, %

The estimated volumetric efficiency for this RPM. Volumetric Efficiency is basically the percent of air which the engine flows compared to how much it could under "perfect", non-supercharged conditions. Naturally aspirated engines with good tuning will achieve volumetric efficiencies well in excess of 100%. See Table 3.2 for typical values.

<b>Table 3.2 Typical Values for Volumetric Efficiency, %</b>	
Engine Description	Volumetric Eff, %
Non-performance American design of the 70s	50-70
Modern production, American and foreign	70-85
"Muscle Car" era performance design, production	75-85
Full race design, naturally aspirated	100-130

Fuel Flow, lb/hr

Fuel Flow assuming gasoline in lb/hr. Multiply this value by .171 to obtain gallons per hour.

Piston Speed, Ft/Min

This is the calculated piston speed in feet per minute at this RPM. Piston speed is used as a comparison of engine speed between engine's with different displacements. See Table 3.3.

<b>Table 3.3 Piston Speeds for Various Types of Engines</b>	
Engine Type	Piston Speed, ft/min at Max HP
Basic Street Automobile	2500-3000
Performance	3000-4000
Race	3500-6000

Engines of different displacements with equal quality and strength reciprocating parts can generally safely rev to the same pistons speed, which may be very different RPMs. For example, for a small, short stroke engine, 3000 ft/min piston speed may come at 7000 RPM. But on a large V-8 with a long stroke, 3000 ft/min may come at 5000 RPM. With equal quality and strength parts, the small engine would not be stressing its rods, pistons, etc at 7000 RPM any more than the larger V-8 at 5000 RPM.

### Runners Used to Est Perf (may not be optimum, 1 int & 1 exh rnnr/cyl):

This section tells you the program's assumptions for typical runners for an engine with these heads and general engine specs. Depending on the RPM you want to tune for, better performance may be obtained with different runner sizes.

If you set # Valves/Cyl to 2 or 3 in the Head Specs Port Layout spec, there are 2 or 3 of these runners per cylinder. If you want to see the size of 1 runner which would feed the 2 valves or 3 valves and give approximately the same performance, multiply the area by 2 and the diameter by 1.414 for 2 valves, and 3 and 1.73 for 3 valves. The length will not change.

### Intake Runner Length, in

Is the length of the intake runner from the valve seat to the first abrupt opening or enlargement. This abrupt opening could be a plenum or an opening to atmosphere. This is always assumed to be 10" in the Port Flow Analyzer.

### Intake Runner Avg Area,sqin

Is the average cross sectional area of the intake runner over its entire length in square inches.

This area is taken from the Intake Port Spec Avg Port Dia (or Width and Height) in the Head Specs menu. By changing this spec, you will likely see a significant effect on the engine performance estimate.

### Intake Runner Avg Dia, in

Is the average diameter of the intake runner over its entire length in inches. See Intake Runner Avg Area,sq in above.

### Exh Header Pri Len, in

Is the length of the exhaust runner from the valve seat to the first abrupt opening or enlargement. The program assumes headers are used and this is the length from the valve seat to the collector. The program estimates length based on the anticipated RPM range of the engine to give good tuning.

### Exh Header O.D., in

Is the outside diameter of the header tubes to the nearest 1/8 inch for 18 gauge tubing (approximately .050" wall). The program estimates O.D. based on the anticipated RPM range of the engine to give good tuning. The I.D. will be approximately .100" smaller than this O.D.

### Intake Port Volume in CCs (for 1 port, 4.5 inches long):

This section tells you the program's assumption for the port volume used to estimate performance, and suggests a port volume for good velocity and tuning. Both volumes are in CCs or cubic centimeters.

For these volumes to be accurate, it is critical that the Port Length spec in the Head Specs menu be correct. This length is reported here in the example line above as 4.5".

If you set # Valves/Cyl to 2 or 3 in the Head Specs' Port Layout spec, there are 2 or 3 of these ports per cylinder and the volumes are for each of these ports. If you want to see the size of 1 port which would feed the 2 or 3 valves and give approximately the same performance, multiply the volumes by 2 or 3.

### Vol Used to Est Perf

Is the volume in CCs calculated from the Head specs of Avg Port Length and Avg Port Dia, in.

### Suggested Port Volume

Is the volume in CCs the program would recommend for good tuning at the estimated HP peak, also assuming a 10" runner length. If the actual engine would peak higher or your would use a longer intake runner, this volume would increase somewhat. For a lower RPM or shorter runner this volume would decrease.

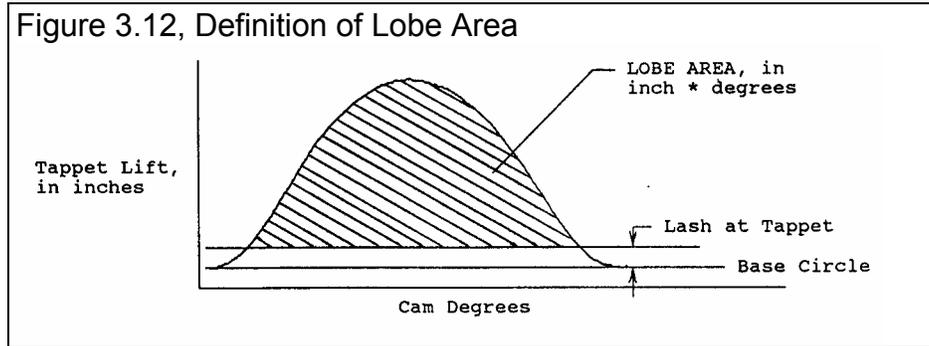
*This recommendation is very general, and much is assumed about other engine specifications.*

### Calculated Results:

Int Valve Lift, in  
Exh Valve Lift, in

Int Duration @ .050"  
Exh Duration @ .050"

Int Lobe Center  
Exh Lobe Center



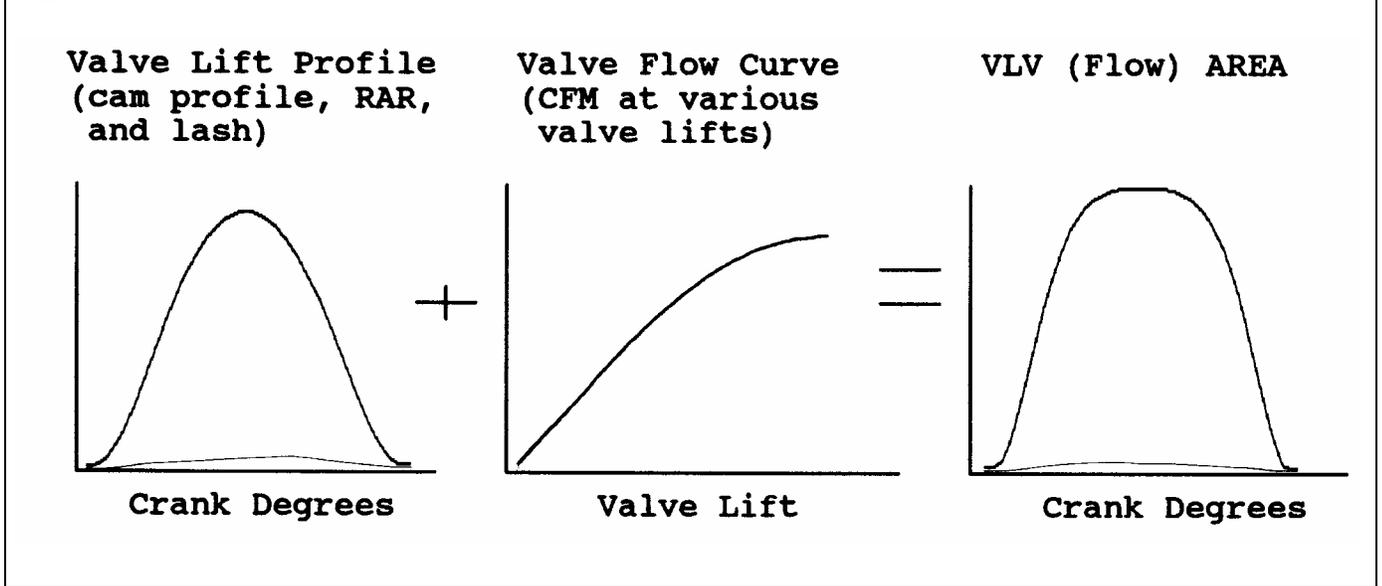
The calculations are simply restating the Calculated Specs from the Engine Specs menu, discussed in Section 2.7.

Int Lobe Area, Deg\*In  
Exh Lobe Area, Deg\*In

Is the estimated area of the cam lift profile measured in tappet lift x cam degrees. See Figure 3.12.

This measurement is usually obtained with computerized cam checkers or when a cam is measured with Performance Trends' Cam Analyzer. This spec lets you see how closely the Port Flow Analyzer's cam profile matches a measured cam profile. See Figure 3.12.

Figure 3.13, Illustration of Flow Area Calculation



Int Flow Area, Deg\*Sqln  
 Exh Flow Area, Deg\*Sqln

Is the valve opening flow area in units of degree-square inches. These units can be illustrated using the example below.

Example: If the Int Flow Area was 200, it could mean that:

- An effective valve flow area of 2 square inches was open for 100 degree of crank rotation. This would be a great flowing head with a very short duration cam.
- An effective valve flow area of 1 square inches was open for 200 degree of crank rotation. This would be a typical head with a typical cam.
- An effective valve flow area of .5 square inches was open for 400 degree of crank rotation. This would be a bad flowing head with a very long duration cam.
- Or any other combination of Flow Area at a particular valve lift x the # degrees at that valve which gives 200.

This value represents the total effective flow area available for the intake and exhaust valves while they are open. It is calculated from the estimated valve lift curve and the measured valve flow curve. See Figure 3.13.

The Flow Area is the most useful measurement for comparing port & cam combinations for air flow capability. Generally: the higher the flow area, the higher the HP capability.

Lobe Separation  
 Lifter Type

Again, these "calculations" are simply restating specs from the Engine Specs menu, discussed in Section 2.7.

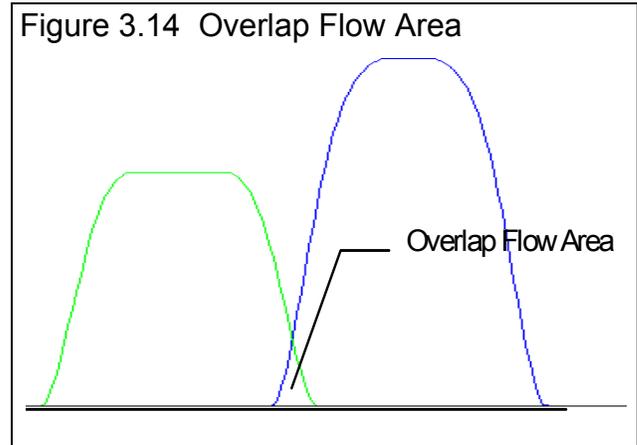
Ovlp Flow Area, DegSqln

Is the same as the Int Flow Area and Exh Flow Area explained earlier, except it is calculating the size hole available for the exhaust to leak into the intake runner. Cams with high overlap and heads with good low-lift flow increase this number.

For race engines, overlap is generally needed for two reasons. First, it provides lower cam acceleration rates to attain the high lifts required for high RPM HP. Second, overlap can also improve performance by allowing for efficient purging of residual exhaust out of the clearance volume during overlap with proper intake and exhaust tuning.

However, at "untuned" RPMs, overlap can increase the potential for intake reversion (reverse air flow up the intake runner from the cylinder) and poor scavenging. High overlap area can also lead to poor fuel economy through "short circuiting" (where intake charge passes through the combustion chamber out the exhaust system without being used).

Since turbocharged engines operate with high pressure and high temperature exhaust, Ovlp Flow Area is best kept to a minimum for turbocharged engines. This is both to reduce reversion (when high pressure exhaust flows backward into the intake) and exhaust temperatures (when "short circuited" fresh charge burns in the exhaust). Generally, cams for supercharged engines are also ground with less Ovlp Flow Area, for similar reasons as turbo cams.



The Ovlp Flow Area is given here to compare overlap areas between different cam profiles, lash settings, and cylinder head flow curves.

### Ovlp Lobe Area, Deg\*In

Is similar to the Int or Exh **Lobe** Area, but is just measured during the overlap period. It is similar to the Ovlp Flow Area shown in Figure 3.14, but the graph would be of the cam profile instead of Flow Area.

### Est Cranking Comp. PSI

Is the estimated cranking compression pressure in pounds per square inch based on compression ratio, estimated intake cam profile and lash. The calculation assumes some heat losses and cylinder leakage. Your actual cranking compression (100-200 RPM) will likely be less due primarily to leakage and heat losses. Higher RPM compression (1000 RPM or higher) would more closely match this value. Est Cranking Comp is reported here simply to show trends.

### Est Idle Vacuum, "Hg

Is the estimated idle vacuum at 1500 RPM, with no load on the engine (no torque converter). The program assumes a constant barometric pressure of 29.92, a low amount of accessory loads, good spark advance and good fuel distribution and mixing. Actual engines will likely develop less vacuum, especially if over-carbureted for example. Use this calculation only for predicting trends between different combinations.

### % Exh/Int Flow Area

This is the percentage ratio of total exhaust flow area to intake flow area. It is calculated as:

$$\% \text{ Exh/Int Flow Area} = \frac{\text{Exh Flow Area, Deg*Sqln}}{\text{Int Flow Area, Deg*Sqln}}$$

"Rules of thumb" state that the exhaust port does not produce significant power losses until the exhaust flow potential falls below 75% of the intake flow potential. For supercharged or nitrous oxide engines this percent should increase to approximately 85%. This number is a more accurate determination of %Exh/Int than the %Exh/Int calculated in the Int & Exh Calc Data report discussed several pages earlier in this section.

### Engine Disp., cu in

Is the engine size (total swept volume) in cubic inches.

### Engine Disp., liters

Is the engine size (total swept volume) in liters. To obtain displacement in CCs, multiply this displacement in liters by 1000. For example a 1.23 liter engine is 1230 CCs.

### Compression Ratio

Again, this "calculation" simply restates this spec from the Engine Specs menu, discussed in Section 2.7.

### Clearance Volume, CCs

Is the total clearance volume (chamber volume in head, gasket volume, piston dome or dish, etc) for this engine displacement, # of Cylinders and Compression Ratio.

### Meas Int & Exh VelData (Pro version only)

This report displays all the port velocity readings (measured with a Pitot tube in the port) with averages. See Figure 3.15.

*These readings are corrected for any difference between the test pressure during the test and the requested test pressure for the report. However, the variation if port velocity across a port is likely to be different, say if you measure at 10" and correct to 28" than if you actually measured port velocities at 28".*

The lifts you record port velocity at is determined by settings in the Test Options menu.

Figure 3.15 Meas Int & Exh VelData Report

	Vel #1	Vel #2	Vel #3	Vel #4	Vel #5	Vel #6	Vel #7	Vel #8	Vel #9	Avg
Int #1 .300" Lift	175	177	107	156	349	262	101	140	178	183
Int #1 .600" Lift	211	264	180	183	248	158	154	224	123	194
Exh #1 .300" Lift	192	262	134	110	117	192	222	142	137	168
Exh #1 .600" Lift	211	246	175	289	192	224	142	147	192	202
Int #2 .300" Lift	105	156	192	222	151	123	86	189	162	154
Int #2 .600" Lift	211	240	197	202	235	158	154	191	207	199
Exh #2 .300" Lift	227	158	90	107	229	175	196	140	129	161
Exh #2 .600" Lift	229	178	202	151	148	191	184	226	229	193
Int #3 .300" Lift	191	154	186	142	137	109	210	229	132	166
Int #3 .600" Lift	211	240	245	191	227	227	192	142	175	206
Exh #3 .300" Lift	177	140	105	183	226	191	203	154	156	171
Exh #3 .600" Lift	229	191	246	191	172	172	184	154	173	190
Int #4 .300" Lift	177	140	229	208	158	181	222	140	120	175
Int #4 .600" Lift	197	224	246	191	254	140	142	145	173	190
Exh #4 .300" Lift	246	158	140	105	142	156	186	191	156	164
Exh #4 .600" Lift	180	229	191	230	191	172	154	177	246	197
Avg Int .300 Lift	162	157	179	182	199	169	155	175	148	169
Avg Int .600 Lift	208	242	217	192	241	171	161	175	169	197
Avg Exh .300 Lift	211	179	117	126	178	179	202	157	145	166
Avg Exh .600 Lift	212	211	203	215	176	190	166	176	210	195

This is the average of all velocity readings on Intake #1 at .300 lift (this row).

These bottom rows are the average of all cylinders, Int or Exh, for the particular lift.

These numbers are the average of all cylinders at all positions, Int or Exh, for the particular lift.

### Compare Heads- CrCFM @ Lift (Pro version only)

The Port Flow Analyzer offers several report types to compare test results between 2 different heads. These comparisons can be at relatively equal valve Lifts or L/Ds. The report title Compare Heads- CrCFM @ Lift will compare Corrected CFMs between 2 heads at approximately the same valve lifts.

The 2 tests or heads which are compared are:

1. The current head.
2. A head or flow test which you will be asked to pick from the Flow Test Library.

There are several "Compare Tests" report types available, some making comparisons at equal valve Lifts and some at equal L/D. (Actually, the Lifts or L/Ds do not have to be exactly equal, but within 5% of each other.)

Only average data for a test is used for comparison. The data from both heads is corrected to the Test Pressure, " Water spec in the Make Reports menu. This ensures you are making comparisons at the same test pressure.

The report is made up of 2 basic sections:

1. The Flow Test Description and Heads Specs. This section lists the folder name, Test Name, date, time, and important head specs for both tests.
2. The actual data with a difference calculation. This is the section with the actual comparison. The data for each head consists of 3 columns:

# Pnts Is the number of data points which made up the average data. For example, if the test had 4 ports flowed and each port had 1 reading at .300" lift, # Pnts would be 4.

Lift L/D Is the valve lift or L/D for the data points.

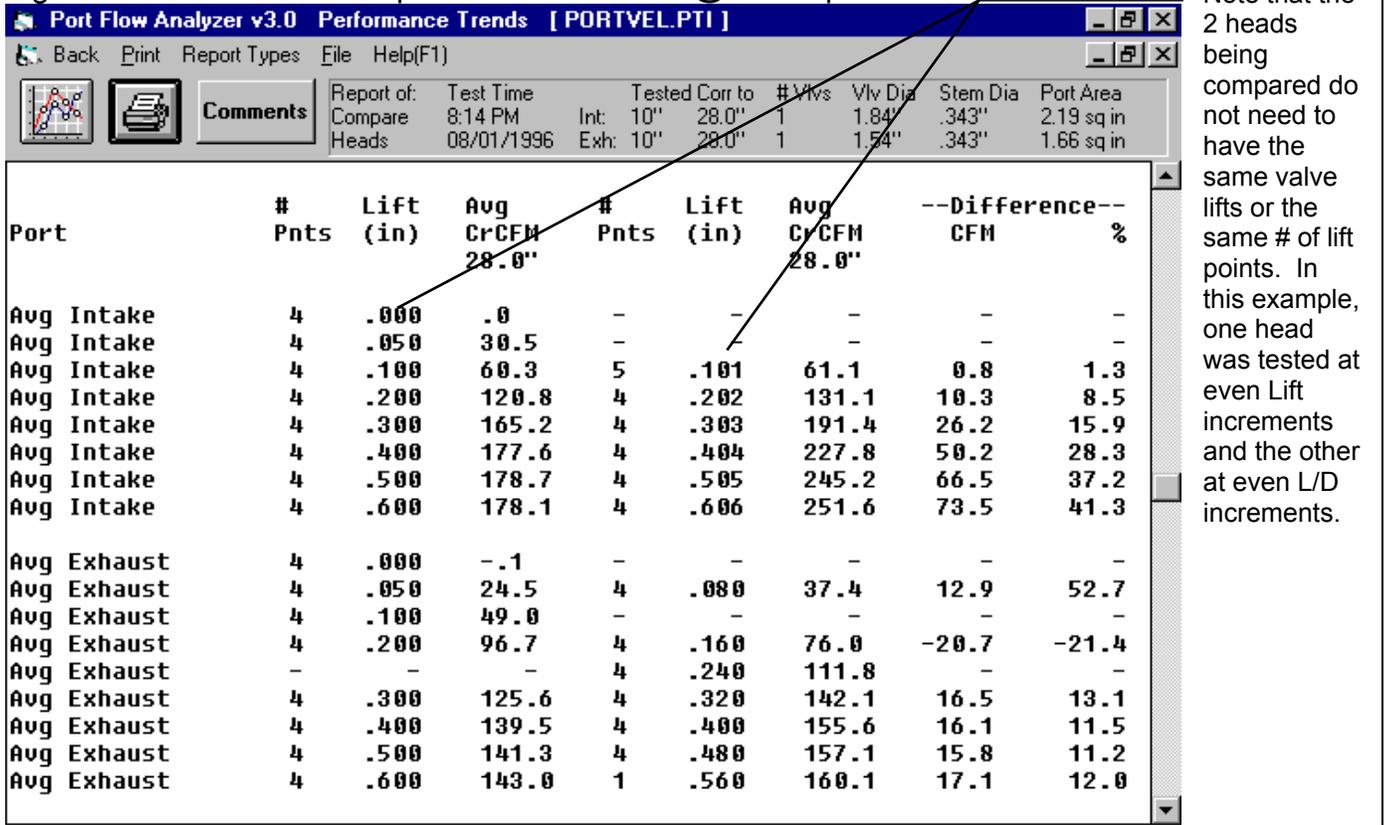
Avg xxx Is the average data being reported (CrCFM, Vlv Area, etc). Definitions for possible data comparisons is given in the Calculated Data report section on page 65.

--Difference--

CFM, Etc, Is the difference between the 2 tests or heads. A negative number means the 2nd head had less CFM, Vlv Area in SqIn, etc. A difference is only calculated when the Lift or L/D between the 2 heads is within 5% of each other.

% Is the difference between the 2 tests or heads in percent. A negative number means the 2nd head had less CFM, Vlv Area in SqIn, etc.

Figure 3.16 Portion of Compare Heads- CrCFM @ Lift Report



See Appendix 7, 9, 10 for new features added in version 3.5, 3.5B, 3.5C.



# 3.2 ASCII Data Files (Pro version only)

You may want to use the results from the Port Flow Analyzer in other software packages. This could be for additional graph capabilities, statistical analysis, data basing, etc. Once you have created a report (as shown in Section 3.1), click on File to write the results to an ASCII file with a name of your choosing. The ASCII File command is possible any time a report is displayed on the screen.

You can only save the results currently displayed on the Report screen. If you want to write an ASCII file of a test file you have previously run, you must open that test file first, then create a report for that test file.

## ASCII File Options

### Comma Separated

Select this option to insert commas between data points. Leave this unchecked for data to be arranged in evenly spaced columns.

### Include Text

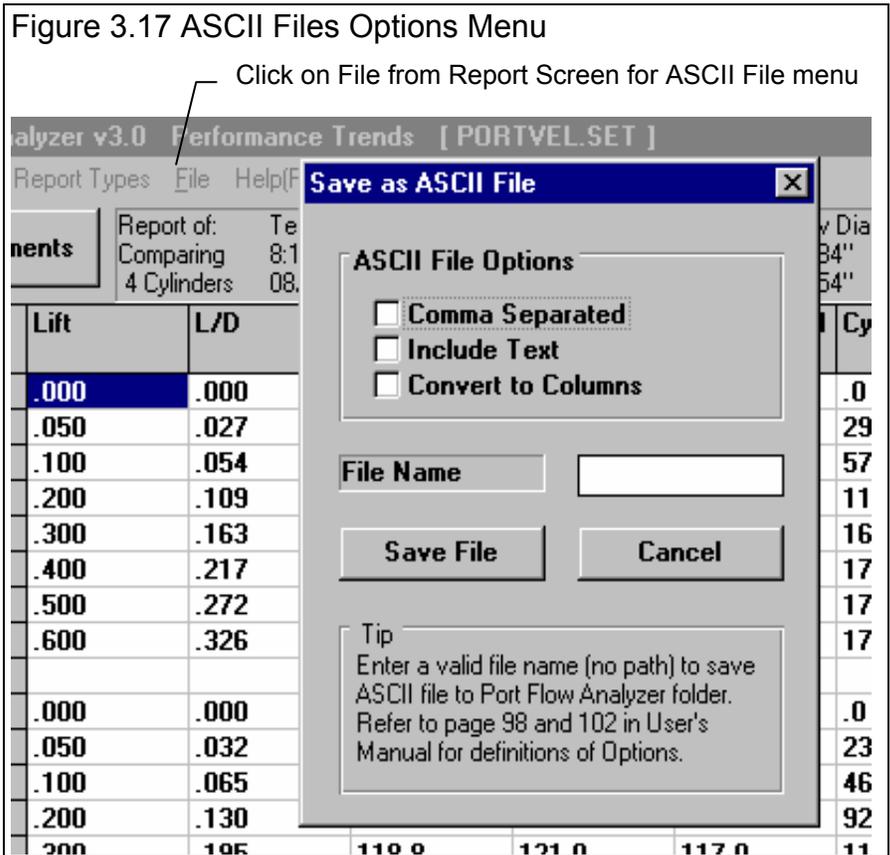
Select this option to strip out all titles and letters, leaving only numbers.

### Convert to Columns

If you do not select this option, data will be written to the file much like it is displayed in the report on the screen. Select this option to have the report turned on its side, that is, the rows will become columns and the columns will become rows.

### File Name

Enter a file name for saving this ASCII file. Checks are made to ensure what you enter is a valid file name and that you are not overwriting an existing file. By default, the file is written to the Port Flow Analyzer folder (directory), the folder which contains the PFA.EXE program file. However, version 3.5 lets you enter the entire path to write this to most any folder or drive on your computer.



- There are certain limitations for file names, like they can not contain certain characters like / \ " : \* . The program will warn you if you use an illegal character.
- The name should not be VERY long (like over 40 characters) or the program may shorten it for you.

See Section 3.6 for more details on file names

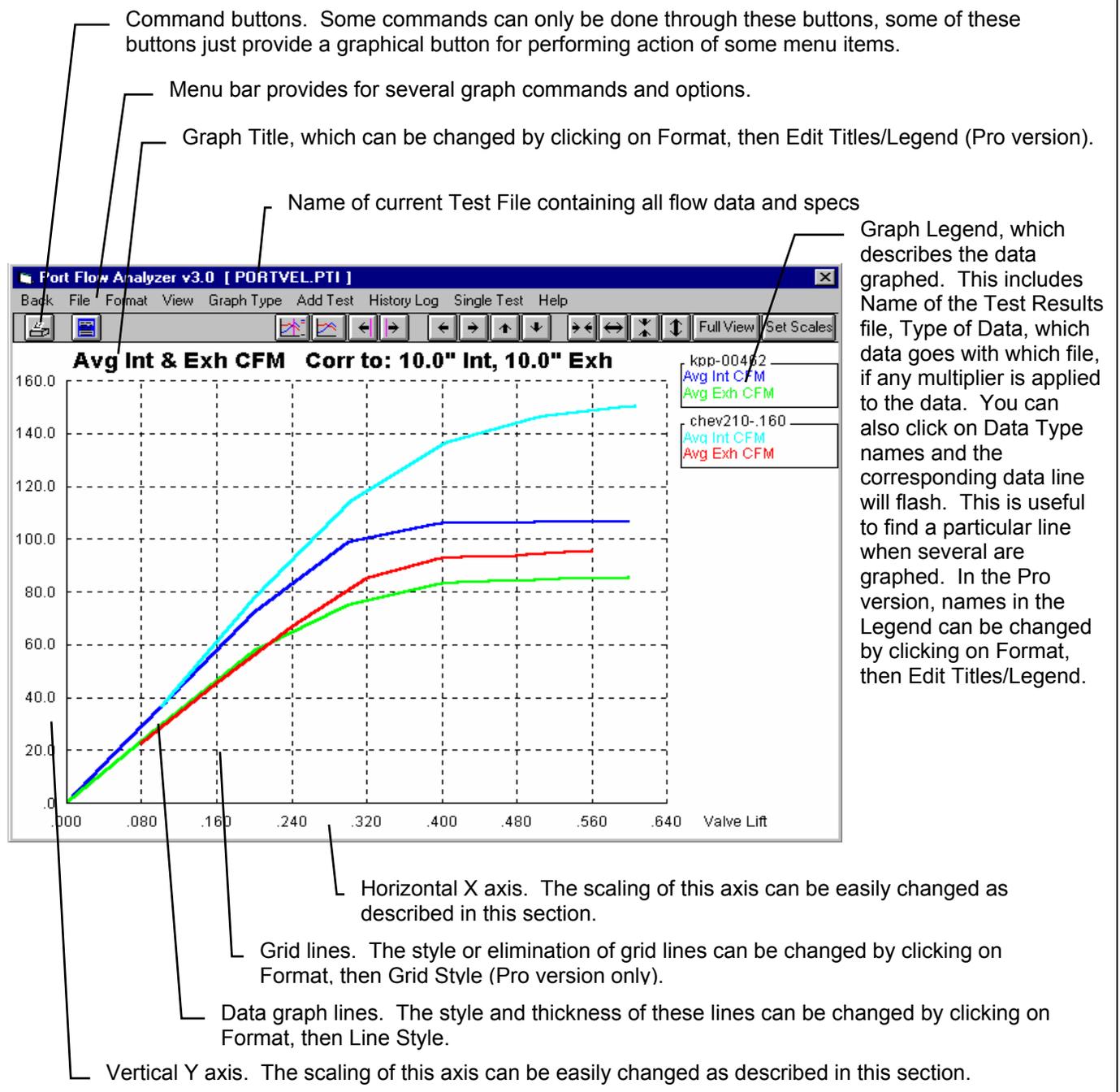
**See Appendix 7, 9, 10 for new features added in version 3.5, 3.5B, 3.5C.**

# 3.4 Graphs

Graphs are obtained by clicking on the Graph menu command at the top of the Main Screen or clicking on the Summary Graph at the Main Screen. Figure 3.18 shows a typical graph and descriptions of some of the basic graph screen items.

**Appendix 9 describes the greatly expanded Graph features in the new Head Porter version.**

Figure 3.18 Primary Graph Screen Items



There are 3 basic types of *test data* which can be graphed:

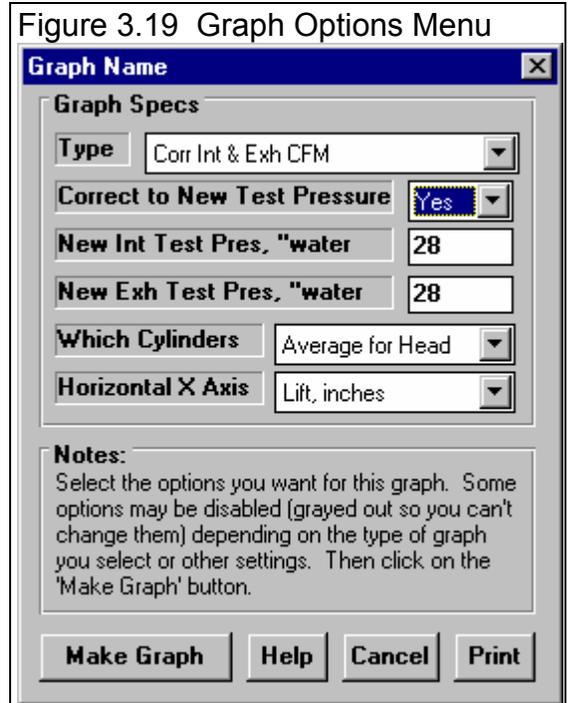
- **Flow Data** like CFM, Swirl, Instability, etc. vs valve lift or L/D.
- **Engine Data** like Valve Lift, Valve Flow Area, etc. vs crank degrees (Pro Version Only).
- **Port Velocity Maps** of port velocity data measured with a Pitot Tube (Pro Version Only).

You determine which type of data you graph by the Graph Type in the Graph Options menu. See Figure 3.19.

### Graph Type

Several types of graphs can be picked by clicking on the down arrow key of this combo box. Depending on your choice, several options in this menu may be enabled or disabled. Table 3.4 lists these various Graph Types.

Table 3.4 Data Types	
Corr Int & Exh CFM	Corr Int CFM
Corr Exh CFM	Calc Int Velocities
Calc Exh Velocities	Intake Swirl
Int Swirl Stab	Intake Tumble
Int Tumble Stab	Int & Exh Flow Coef
Int Flow Coef	Exh Flow Coef
% Exh/Int	Int Stability
Exh Stability	Int & Exh Stability
Int & Exh Flow+Valve Area	Int Flow + Valve Area
Exh Flow + Valve Area	Int & Exh Flow Area+VlvLift
Int Flow Area + Valve Lift	Exh Flow Area + Valve Lift
Overlap Flow + Valve Area	Overlap Flow + Valve Lift
Meas Int Vel (port map)	Meas Exh Vel (port map)



### Correct to New Test Pressure

Pick Yes and the graph data will be corrected to the test pressures identified by the next one or two specs, New Int Test Pres, " Water and New Exh Test Pres, " Water. Pick No and the data is corrected to the test pressure identified in the test's Test Options menu under Test Pressure.

For several Graph Types, like Flow Area, or Flow Coef, no correction is possible or required and this spec is disabled (printed in gray and you are not allowed to change it).

### New Int Test Pres, " Water

The pressure the *intake* flow or velocity data is corrected to if the previous spec, Correct to New Test Pressure is set to Yes. Note that if you flow a head at 10" and correct to say 28" you may get different results than if you had actually flowed the head at 28". This can be especially true of data *other* than CFM, like Swirl, Tumble, Stability, and Port Velocity readings.

## New Exh Test Pres, " Water

The pressure the *exhaust* flow or velocity data is corrected to if the previous spec, Correct to New Test Pressure is set to Yes. Note that if you flow a head at 10" and correct to say 28" you may get different results than if you had actually flowed the head at 28". This can be especially true of data *other* than CFM, like Swirl, Tumble, Stability, and Port Velocity readings.

## Which Cylinder(s)

Click on the down arrow key of this combo box. to pick from Graphing:

- All Cylinders tested
- Average of all cylinders tested
- Individual cylinders, which can be picked by the order they were recorded.

If the test file was only for 1 cylinder, or for some graphs which require average data like Flow Area, this spec will be disabled.

Notes:

- If you pick Average, the average is based on all cylinders with data which is not 0. For example, for 3 cylinders, if cylinder 1 is 20 CFM and cylinder 2 is 24 CFM and cylinder 3 is 0 CFM, the average is 22 CFM  $((20+24)/2)$ , not 14.7 CFM  $((20+24+0)/3)$ .
- If the cylinders are numbered 2, 4, 6 and 8 on the head, and you ask for the 4th cylinder, the graph will be for cylinder #8, not cylinder #4.
- At this time, there is no way to graph the 3rd cylinder from the current test with the 1st cylinder of another test. All cylinders (if you are graphing individual cylinders) must be in the same position.

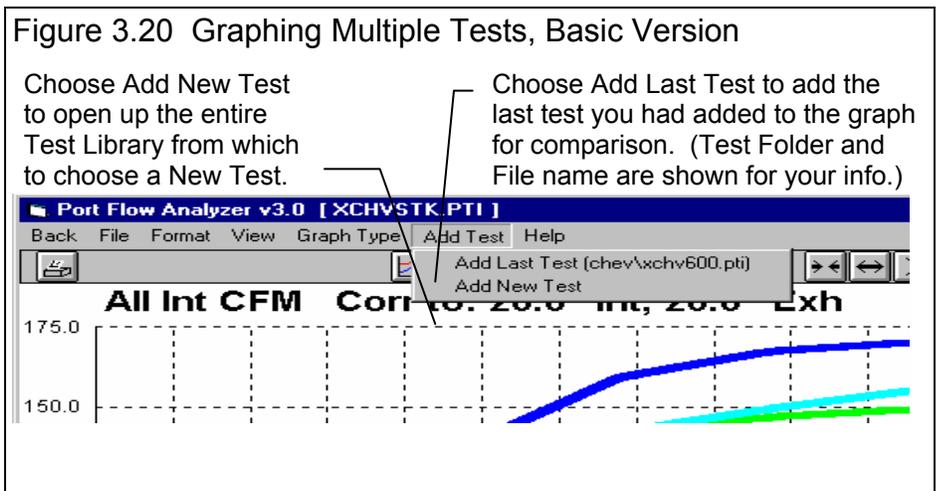
Tip: Although, there is no way to graph the 1st cylinder from the current test with the 3rd cylinder of another test, you can be "creative". If you use the Edit command at the Main Screen on the current test, you can swap, say the 1st and 3rd cylinders. Then you can graph the 1st cylinder from the current test (actually the 3rd cylinder) with the 1st cylinder of another test for comparison. ***Just be sure to swap the 1st and 3rd cylinder back when you are done!***

## Graphs Comparing More Than 1 Test (Basic Version)

There are 3 basic types of *tests* which can be graphed in the Basic version:

- **Current test results.** These are the test results of the test file which you are working with on the Main Screen.
- **Last test results graphed.** These are the test results which you previously included in the graph for comparison. This allows you a way to easily refer back to one particular test for comparison.
- **Add Test** lets you pick any test from the Test Library to compare to the Current test results. This test now becomes the **Last test results graphed.**

In the Basic version, you can only compare 1 additional test to the Current Test. If an additional test is graphed for comparison, the *Add Test* command changes to *Remove Test*. You must first click on Remove Test before the Add Test command reappears so you can add a different test.



### Graphs Comparing More Than 1 Test (Pro Version)

There are 3 basic types of *tests* which can be graphed in the Pro version:

- **Current test results.** These are the test results of the test file which you are working with on the Main Screen.
- **Tests marked in the History Log.** These are the test results which you previously graphed, started new, opened, etc. which you have marked "Yes" to graph in the History Log (see Section 3.8).
- **Add Test** lets you pick any test from the Test Library to add to the top of the History Log, and mark as a test you want to graph. Since it is at the top of the History Log, it should definitely be included in the next graph.

In the Pro version, you can compare data from up to 6 tests, as long as there is room for the Legends (labels) for each graph on the right side of the graph. Usually this ends up being about 24 graph lines, which could be 6 tests with 4 graph lines (for example, Int only for 4 cylinders), or 3 tests with 8 graph lines (for example, Int & Exh for 4 cylinders), etc.

Figure 3.21 History Log (Pro version only See Section 3.8 for more details.)

Click on the History Button or the History menu item to display the History Log.

Click on Single Test to graph only the Current Test.

Click on Add Test to pick a new test to add the graph to the History Log from the entire Test Library.

Choose a 'Graph' option from the menu bar to close the History Log and graph the tests identified by the menu option you pick.

Click in 'Graph?' column to show Yes or remove Yes. Tests marked Yes will be graphed, if there is room (typically not more than 24 graph lines total).

This column shows the Standard name the program will display in graph Legend for this test. Click on the name to change it. Alternate names are possible by clicking on Format, then Edit Titles.

Click and drag slide bar to display entire History Log. Some tests marked Yes may be at the bottom of the Log and not be visible now.

**All Int & Exh CFM Corr to: 25.0" Int, 25.0" Exh**

Test History

Test File and Path	Graph?	Std Graph Title	Save?	Head #	Int Valve	Max Int CFM	T
\examples\chev210-160	Yes	chev210-160			1 at 2.02"	162.6 @ .606	0
\examples\big		kpp-00462			1 at 1.84"	108.9 @ .4	0
\examples\portvel.pti	Yes	kpp-00462			1 at 1.84"	114.5 @ .6	0
\examples\empty-ex.h		empty-ex.h			1 at 2.02"	.0 @ 0	0
\examples\portvel.cor		portvel.cor			1 at 1.84"	114.5 @ .6	8
\examples\chev194-153		kpp-00456			1 at 1.94"	120.5 @ .582	0
\examples\chev194-150		kpp-00456			1 at 1.94"	119.0 @ .582	0
\examples\chev194-150	Yes	kpp-00456			1 at 1.94"	129.0 @ .582	0

Click on 'Graph?' column to select or de-select tests for graphing. Slide button right for more History info. (Max CFMS corr to 10")

## Other Graphing Features

The graph screen has several other features, including:

- Printing
- Cursor to pinpoint the value of a particular point on the graph
- Changing titles and legend names
- Changing the scales

These are discussed in this next section.

## Printing

Figure 3.22 shows the options for printing graphs and how to access these options. Figure 3.23 shows the screen for changing the Windows Printer Setup. Figure 3.24 shows how you can add information to a graph printout by clicking on Format, then Edit Printed Comments and Data Output.

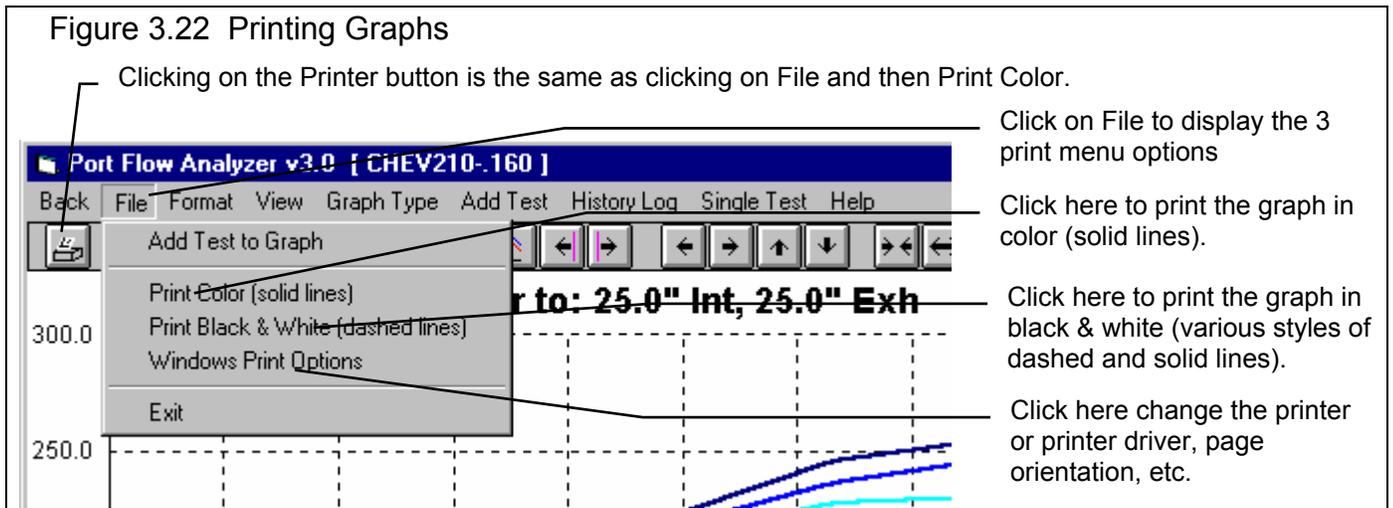


Figure 3.23 Standard Windows Printer Options

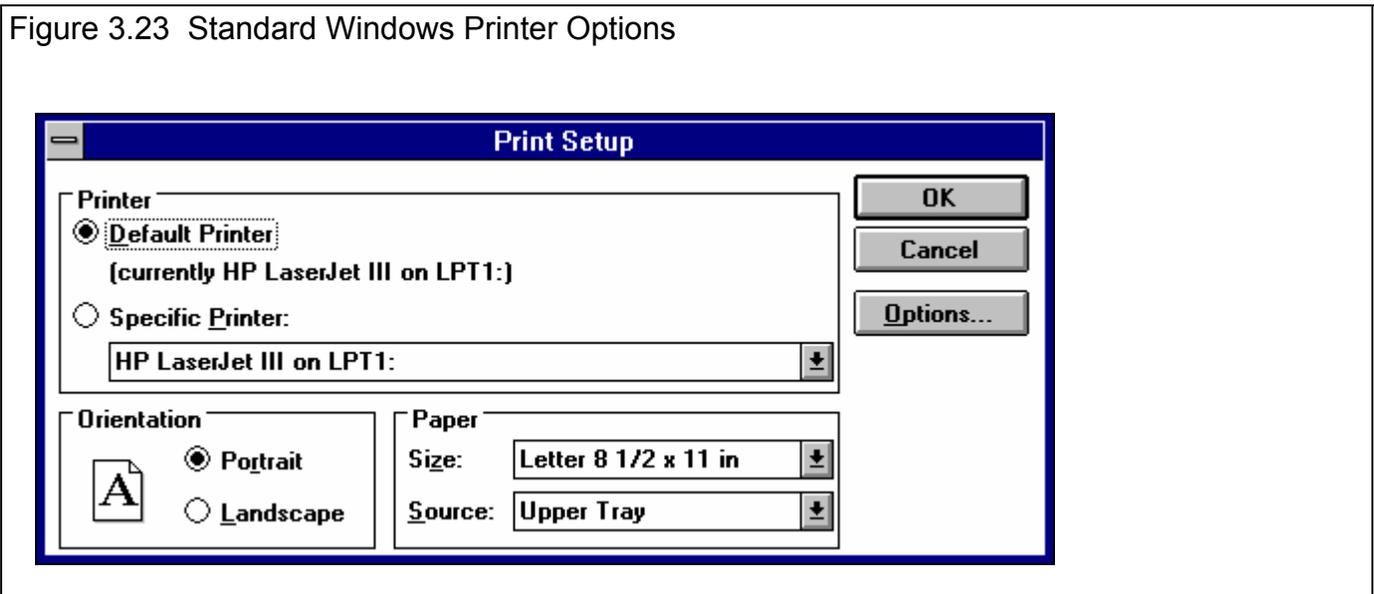


Figure 3.24 Adding Information to a Graph Printout . (Most of these options have no effect on the graph on the screen, only the graph that is printed.)

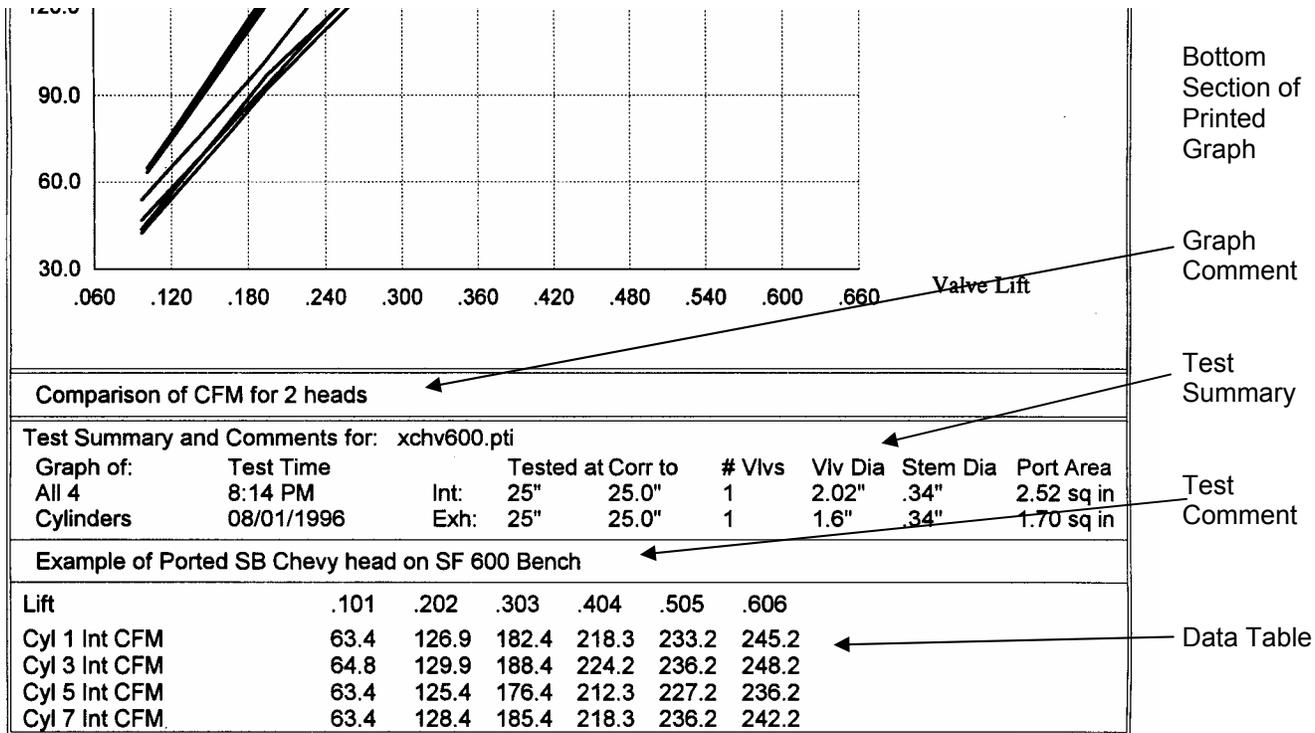
Click on these #s to change which Data Set's (test file's) comments and title you are working with.

Click here to change the Test Comments (comments which appear on the Main Screen). Changes to Data Set 1's comments (the current test) are permanent. Changes to other Data Set's comments are temporary.

This one comment is printed directly under the graph.

The Titles to Use options give you a way to reach the Menu in Figure 3.26 to change the Titles and Legends of the graph.

Check or uncheck these 4 options to determine what gets printed, and what options are enabled and disabled on this screen.

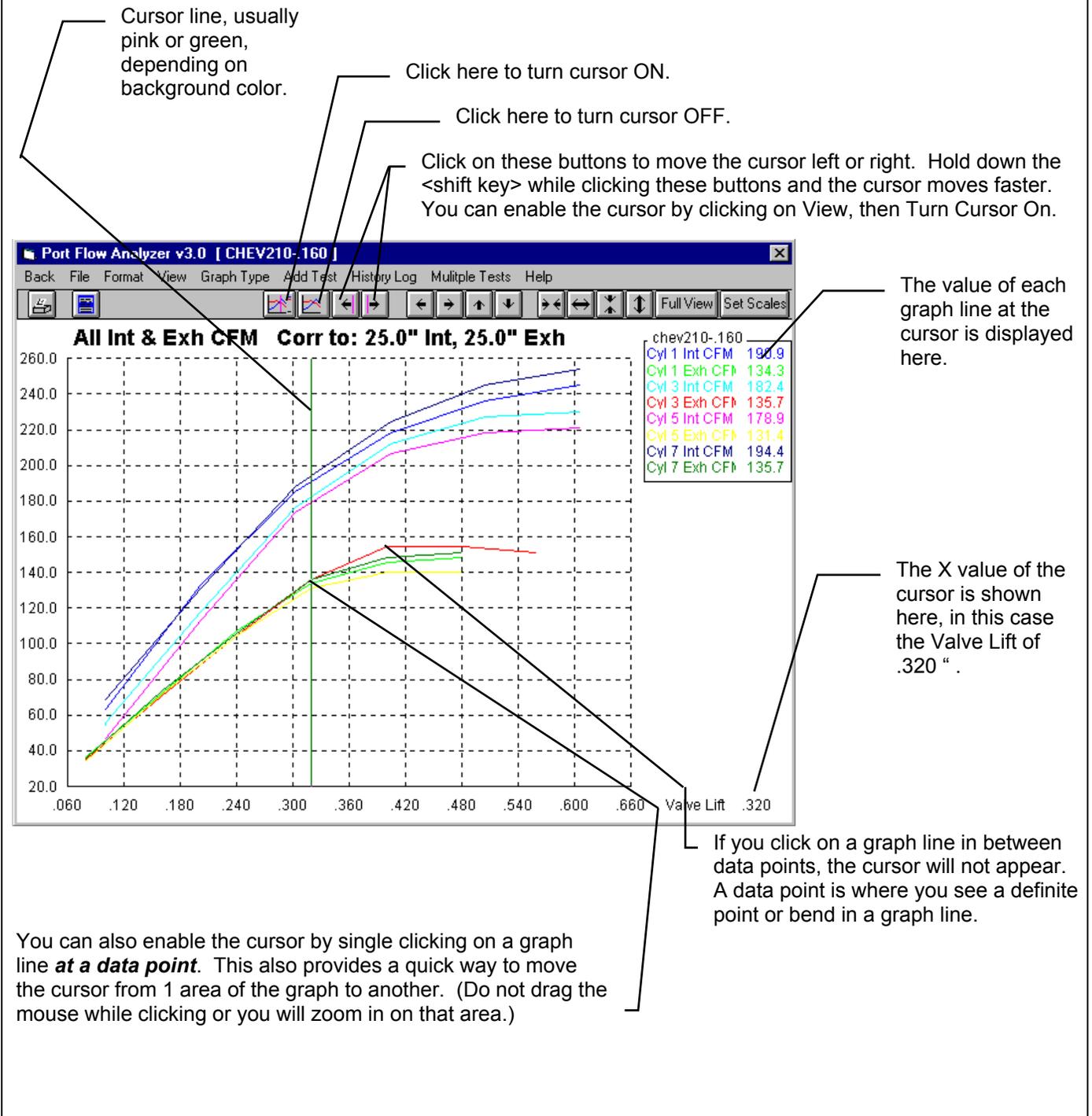


Appendix 9 describes the greatly expanded Graph Print features in the v3.5 B version.

### Cursor

The cursor feature is very useful for determining or comparing the value of the graph lines at various places. See Figure 3.25 for explaining the use of the cursor.

Figure 3.25 Cursor Features and Commands



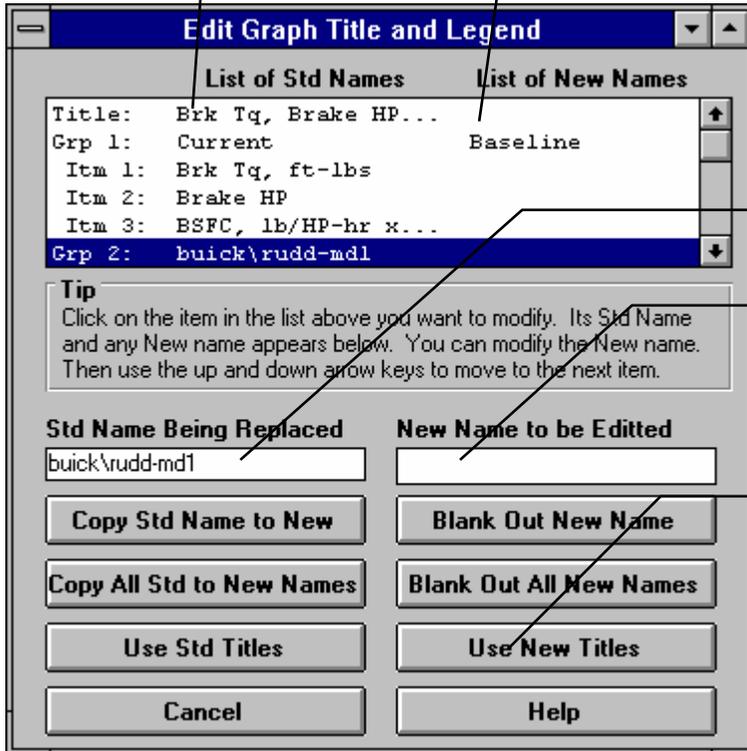
## Changing titles and legend names (Pro version only)

Many times you may want to customize a graph by displaying and printing labels of your choice. Click on Format and then Edit Titles/Legend to bring up the menu shown in Figure 3.26 which will allow you to do this.

Figure 3.26 Menu to Edit Title and Legend

This is the list of Standard names the program uses unless you click on the Use New Titles button below. Select (click on) a Standard name you want to change. The Standard Name appears in the edit box, along with the current New name if there is one. **Once you have selected a name from this list (that row will be highlighted) it is easier to use the up and down arrow keys to select the next item to edit than clicking the item with the mouse.**

This is the list of New names the program will use if you click on Use New Titles. If a title in the List of New Names is blank, the program will use the Standard name.



Standard name from row selected.

New name for you to edit. Other options include clicking on the Copy Std Name to New or Blank Out New Name buttons.

Click here to close this menu and use the New names you have entered. Where New names have been left blank, the Standard name will be used.

### Changing the scales

Many times you may want to change the scale of the X or Y axis. This may be to show an area in more detail or to match the scales of a previous graph. The Pro has several ways to change the scales as shown in Figures 3.27 and 3.28.

Figure 3.27 Changing Scales for the X or Y Axis

Clicking on these buttons shifts the graph left, right, up or down. Hold down the shift key while clicking on them and the graph moves farther each step.

Clicking on these buttons zooms in or zooms out on the graph, either vertically or horizontally. Hold down the shift key while clicking on them and the graph moves farther each step.

Click here to restore "auto-scaling". That is where the computer picks the scale to show all the graph in good detail.

You can use the mouse to outline an area to be zoomed in on. Simply click on the mouse key in the upper left corner of the area, then hold the key down and drag the mouse to the lower right corner of the desired area. A box will be drawn as shown. When you release the mouse key, this area will fill the whole graph. This feature is disabled if the cursor is turned on. Also, start the upper left corner well away from a graph line or the program may turn on the cursor instead.

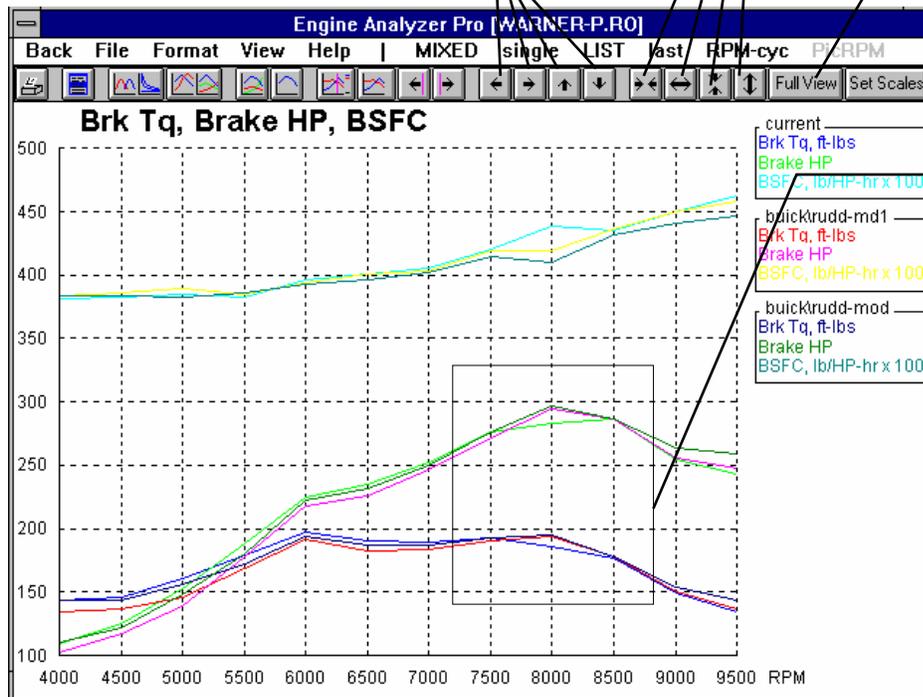


Figure 3.28 Menu to Specify Graph Axes Scales

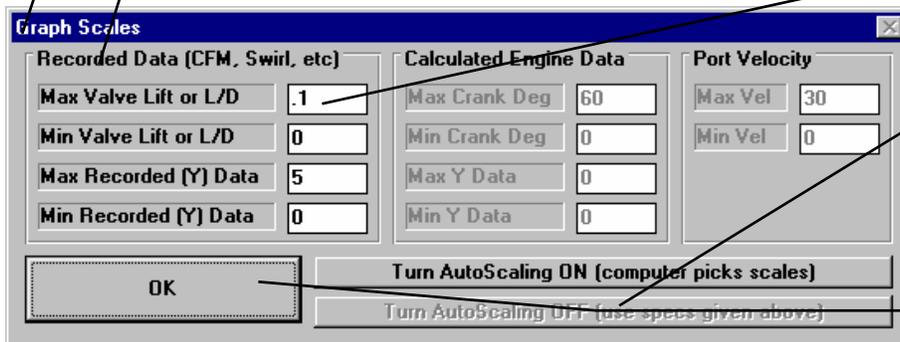
This menu can be obtained 2 ways. You can click on View in the menu bar then Specify Scales (axes), or click on the Set Scales button, the right most button on the graph screen.

Depending on the type of graph data you currently working with, one of these 3 sections will be

The current scale limits are loaded when this menu opens. Change any or all these to most any value you want.

Click the Turn AutoScaling Off button to turn AutoScaling Off to enable changing specs in this menu.

Click on OK to have the graph redrawn to these new scale



### Engine Data Graph Parameters (Pro version only)

This section gives a brief description of all the possible Engine Data which can be graphed.

**Int Valve Lift** The theoretical position of the valve as directed by the cam profile in inches (cam lift x rocker arm ratio - valve lash).

**Int Valve Area** The geometric intake valve opening in square inches based on Int Valve Lift. Geometric valve opening is the actual area, and is defined on pages 68 and 69 as Vlv Area.

**Int Flow Area** The effective intake valve opening in square inches based on Int Valve Lift. Effective valve opening is defined on page 70 as Flw Area and is calculated by:

$$\text{Int Flow Area} = \text{Geometric Area} \times \text{Flow Coef}$$

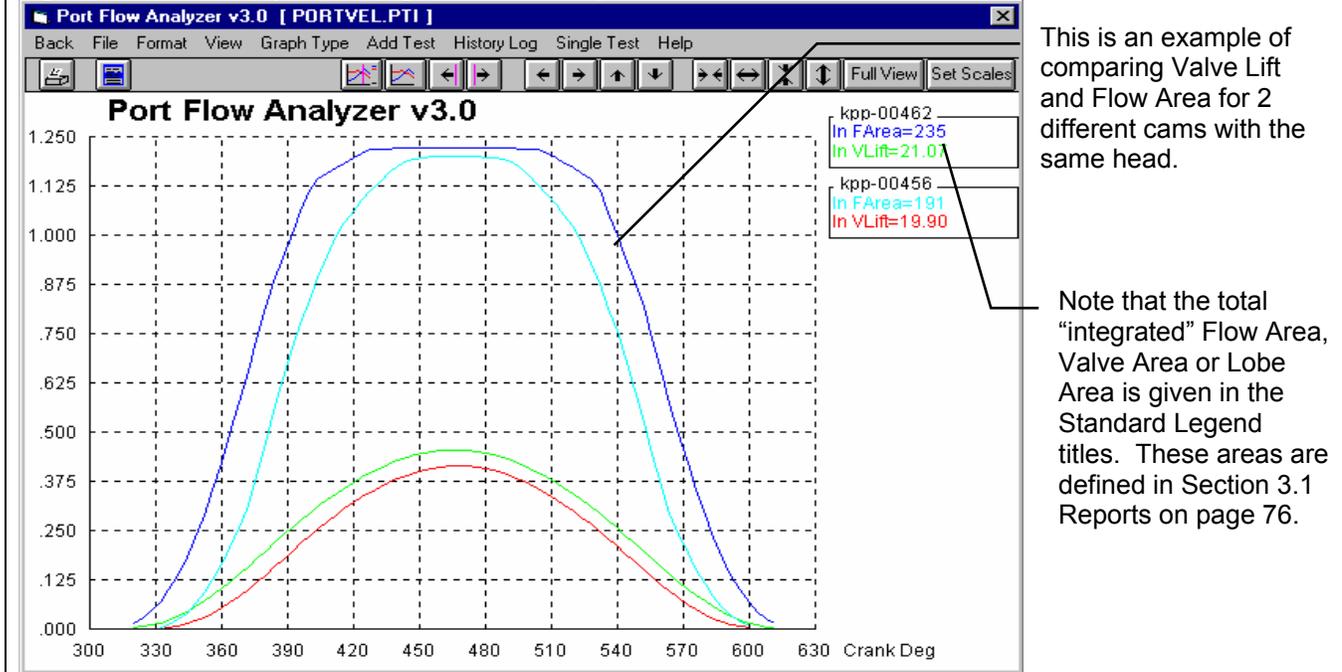
Where Geometric Area and Flow Coef are changing at each lift point. For example, if the valve opening area is 1.5 square inches at .35" of valve lift, and the flow coefficient at .35" is .5, the In Flow Area is .75 square inches at .35" valve lift.

**Exh Valve Lift** See Int Valve Lift above.

**Exh Valve Area** See Int Valve Area above.

**Exh Flow Area** See Int Flow Area above.

Figure 3.29 Example of Engine Data Graph



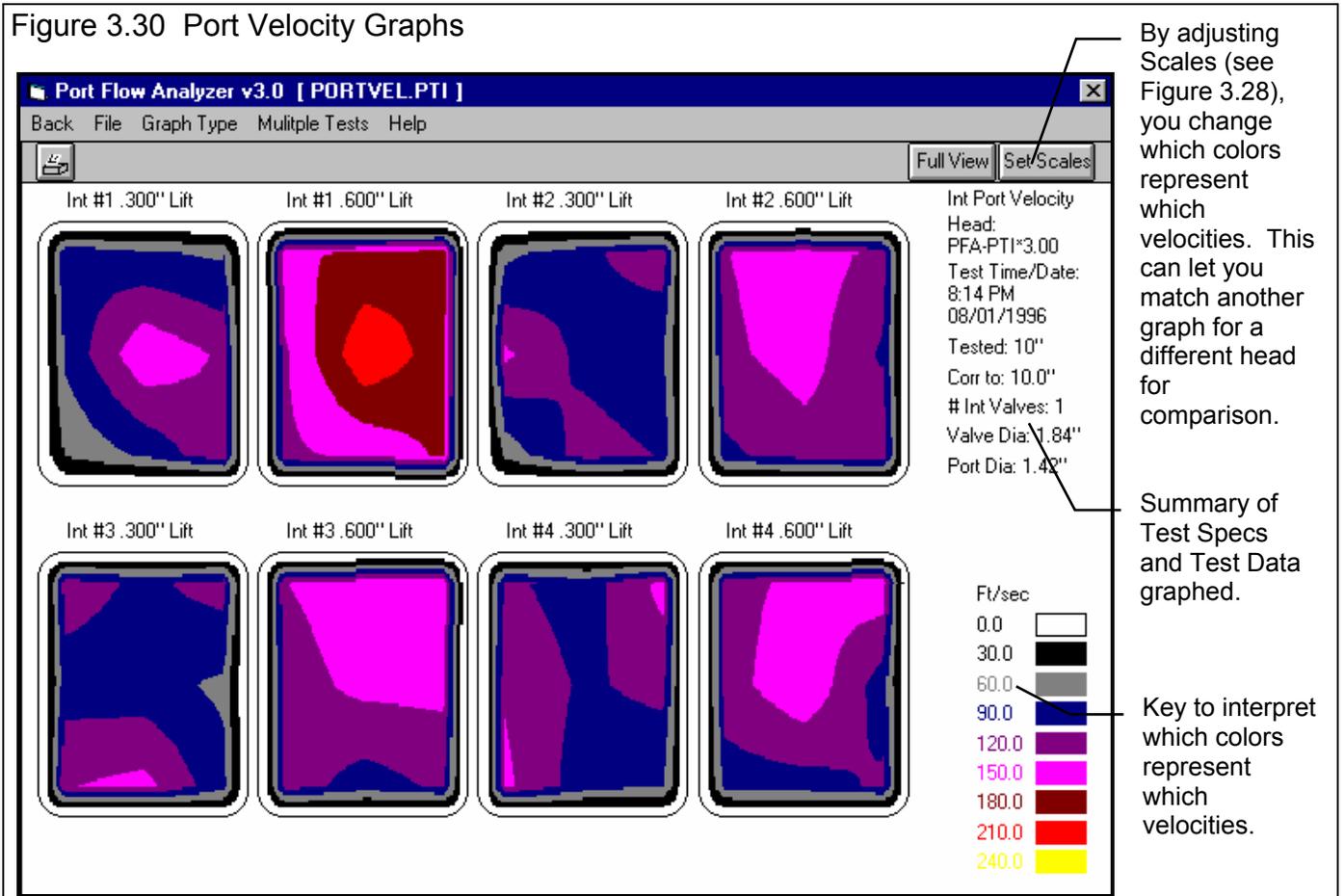
This is an example of comparing Valve Lift and Flow Area for 2 different cams with the same head.

Note that the total "integrated" Flow Area, Valve Area or Lobe Area is given in the Standard Legend titles. These areas are defined in Section 3.1 Reports on page 76.

### Port Velocity Maps (Pro Version only)

Port Velocity Maps are a very special type of graph, and should be discussed separately from the other graph types and features for those graphs. Port Velocity Maps are constructed from the port velocity readings recorded with a Pitot Tube. With Port Velocity Maps, the color indicates the velocity at that particular portion of the port cross section. The velocity indicated by the color is given in the Key in the lower right corner of the graph.

Figure 3.30 Port Velocity Graphs



Appendix 9 describes the greatly expanded Port Velocity Graph features in the new Head Porter version.



# 3.5 Printer Output

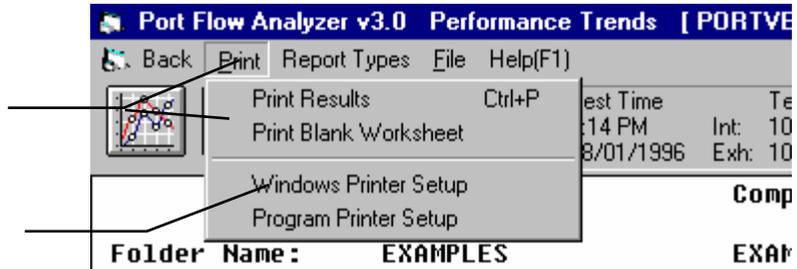
The Port Flow Analyzer can print the tabular test results of a report for a permanent hardcopy by clicking on Print in the menu bar or the Printer icon. The menu of options shown in Figure 3.31 will appear. Check the options you want to use for the printout by clicking on any or all of the Option boxes. All options and buttons are discussed in this section.

**Appendix 9 describes the expanded Print features in the version 3.5 B.**

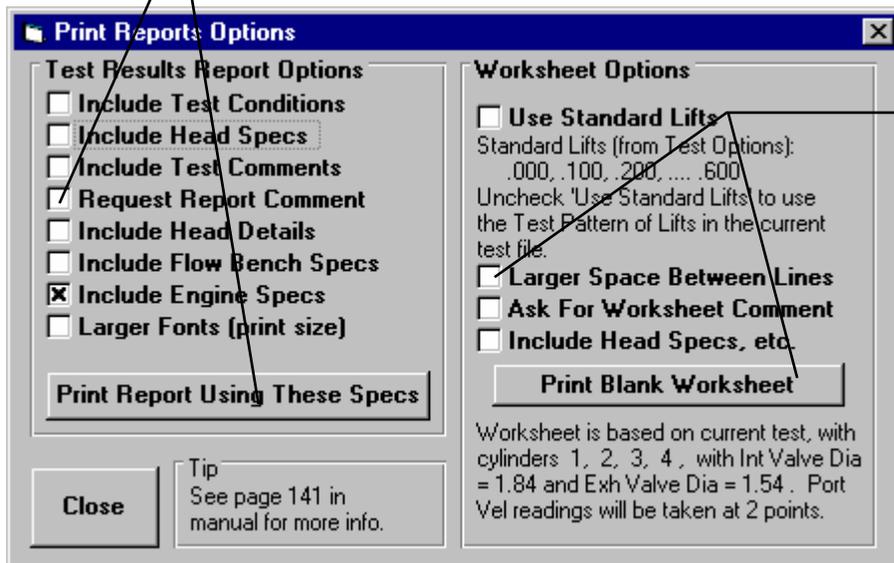
Figure 3.31 Printer Button and Print Menu Command Options - Report Screen

Click on Print or the Printer button (shown hidden here) for the Printout Options menu shown to the right.

This options lets you choose the printer or printer driver being used by Windows and also page orientation.



Check or uncheck these options, then click on this button to print the current report with these options.



Check or uncheck these options, then click on this button to print a blank paper worksheet. This worksheet can be useful for recording data when your flow bench can not be next to your computer.

## Test Results Report Options

- Include Test Options
- Include Head Specs
- Include Head Details Specs (Pro Version Only)
- Include Flow Bench Specs
- Include Engine Specs (Pro Version Only)

Select these options if you want all the specs from these menus printed with the report. This will add 1-2 pages to the printed report. Note that only a few of the Test Options are printed which could affect the test results, not all specs from the Test Options menu.

## Include Test Comments

Select this option if you want all the comments for the Test File printed with the results.

## Request Report Comment

Select this option if you want to be asked for a comment for each particular report you send to the printer. These "report comments" are useful to identify important points for future reference, like modifications, engine results, etc.

## Larger Font (Print Size)

Check this option if your particular printer is printing the results with a small print font. This option will increase the font size for some parts of some reports. Also see Preferences for Selecting Printer Fonts, page 26.

## Worksheet Options

These options let you print a blank paper worksheet. This worksheet can be useful for recording data when your flow bench can not be next to your computer.

## Use Standard Lifts

Check this option to produce a worksheet where the valve lifts (or L/Ds) requested match the specs in the Test Options menu. A summary of these lifts or L/Ds is given below this option. Uncheck this option, and the worksheet will include all lifts (or L/Ds) for the current test file. This also means that the order of the lifts, any extra lift points in some or all ports, etc. will be included in the worksheet.

## Larger Space Between Lines

Select this option if you want more space between lines, so you can write your numbers larger.

## Ask for Worksheet Comment

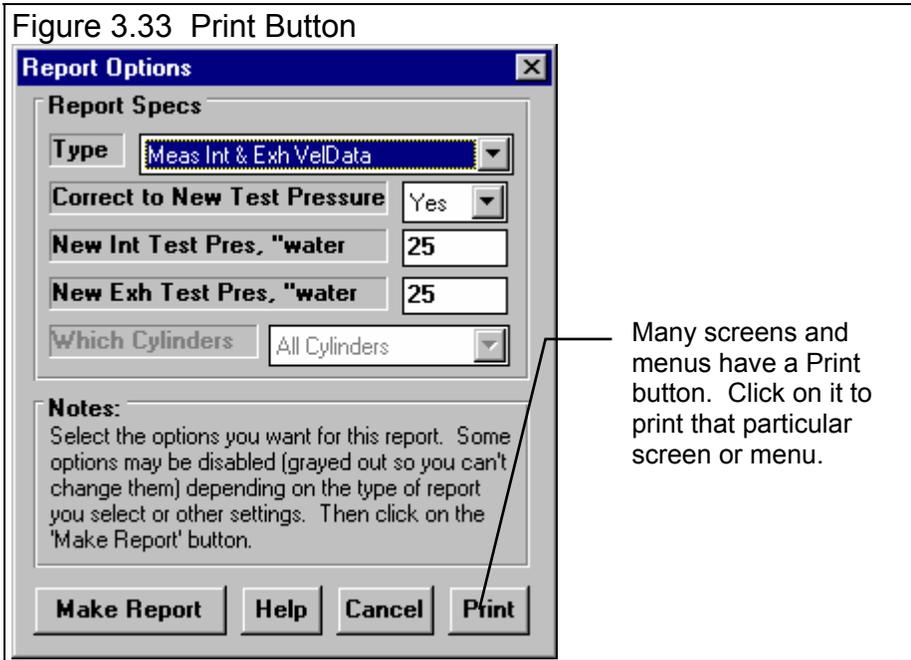
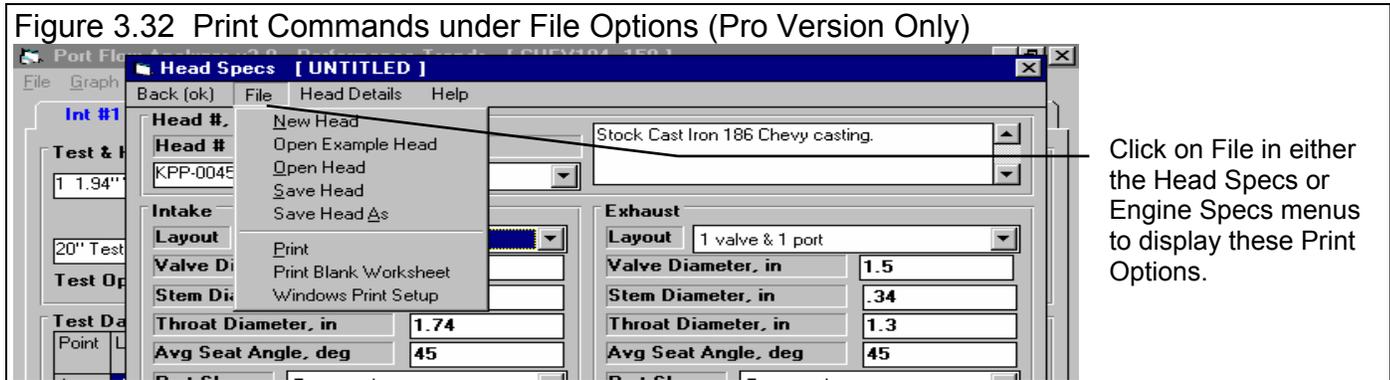
Select this option if you want to be asked for a comment for to be printed at the top of your worksheet.

## Include Head Specs, etc.

Select this option if you want all the specs from the Test Options Menu, Head Menu, Head Details Menu and Engine Specs menu printed with the report with a blank next to them. This will add 1-2 pages to the printed report.

## Other Print Options

Other menus have print menu commands or print buttons as shown in Figures 3.32 and 3.33.





# 3.6 Data Libraries

The Port Flow Analyzer allows you to save a set of Flow Data and related specs (Head Specs, Test Options, etc) to the Test File Library under a name of your choosing. You can then open these test files out of the Test File Library in the future for comparison or modification. The Open window is below with explanations.

Figure 3.34 Test Library Options

Click on File, then Open (from all saved tests) to display Test Library shown here.  
 Click on File, then Save or Save As to save current test and specs to the Test Library.

Total # Tests in Library under this Folder

Name of chosen Test (currently highlighted in Test List)

Click and drag slide bar to view all Tests in list

Preview of Test

Single click on a Test to choose it for preview. Double click to immediately open it.

Tests can be saved under various categories (folders) to help you organize large #s of tests. Click on a different name here and a different list of Test Files will be displayed. The name "Folder" was called "Customer" in the DOS version, but can be changed in the Preferences menu to most any word.

Click here to delete the chosen Test.

Click here to bring up the Filter Options menu where you can select to show only tests which fit certain criteria. See Section 3.7.

Click here to bring up "on screen" help.

Click here to close the Test Library with No changes (without opening a test)

Click here to open the chosen Test

Select one of these options to list the test files alphabetically, either by test file name, or by head #. This option can save you time looking for a particular test file. (Pro Version Only)

Click here to bring up standard Windows File Open screen, to let you open a file in most any folder (directory) and disk drive.

## Open a Test File

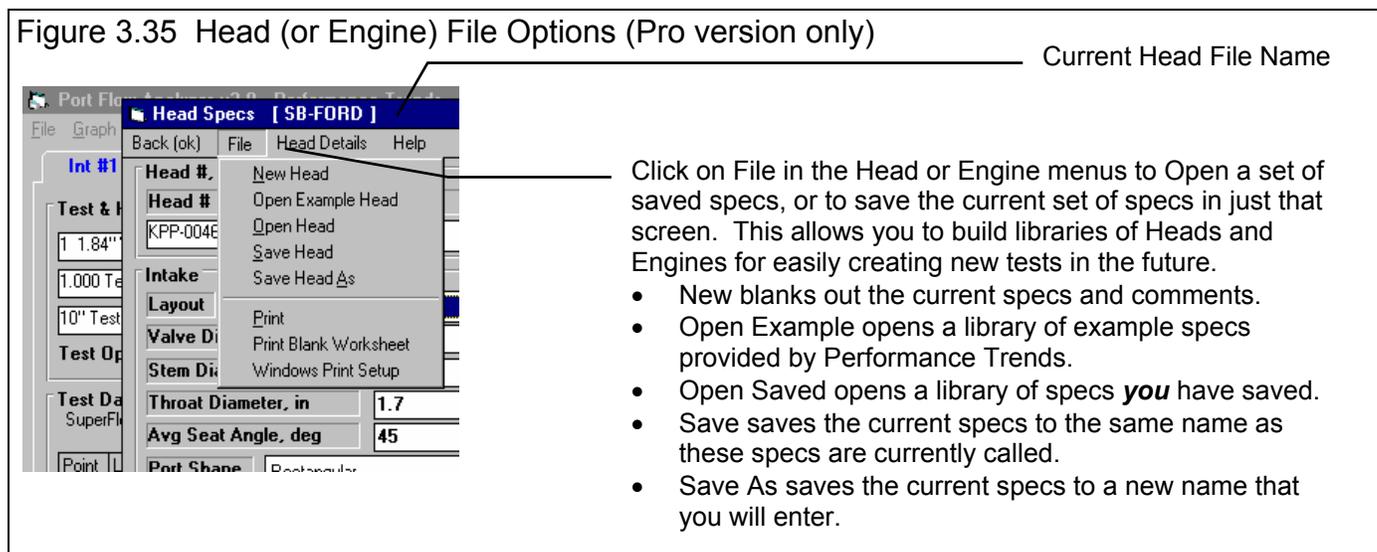
To open a test file saved in the Test Library, click on File at the upper left corner of the Main Screen, then on the Open (from all saved tests). In the Pro version you have an additional option of “Open (from History Log)” which will be discussed in Section 3.8.

You will obtain the window shown on the previous page. Single click on one of the tests in the list, or click and drag the slide button on the right side of the list to display more tests. Once you single click on a test, it is now the Chosen Test File and a preview of the test is given in the Preview section. If the file you chose was not a valid Port Flow Analyzer file (either Windows v3.0 or the older v2.1 for DOS), the program will tell you and you can not choose it.

Once a test has been chosen, you can delete it by clicking on the Delete button, or Open it by clicking on the Open button in this window. You can also click on a different test to Preview it or close this window and return to the Main Screen without choosing a new test file.

If you are sure of the test you want to open, you can simply double click on it from the Test List. This opens the test without a preview and closes this menu.

**Note for Pro Version:** You can also save sets of Head or Engine specs to their own separate libraries. This is done very similarly as with the Test Files, except you click on File, then Open from the individual Head or Engine menus. See Figure 3.35.

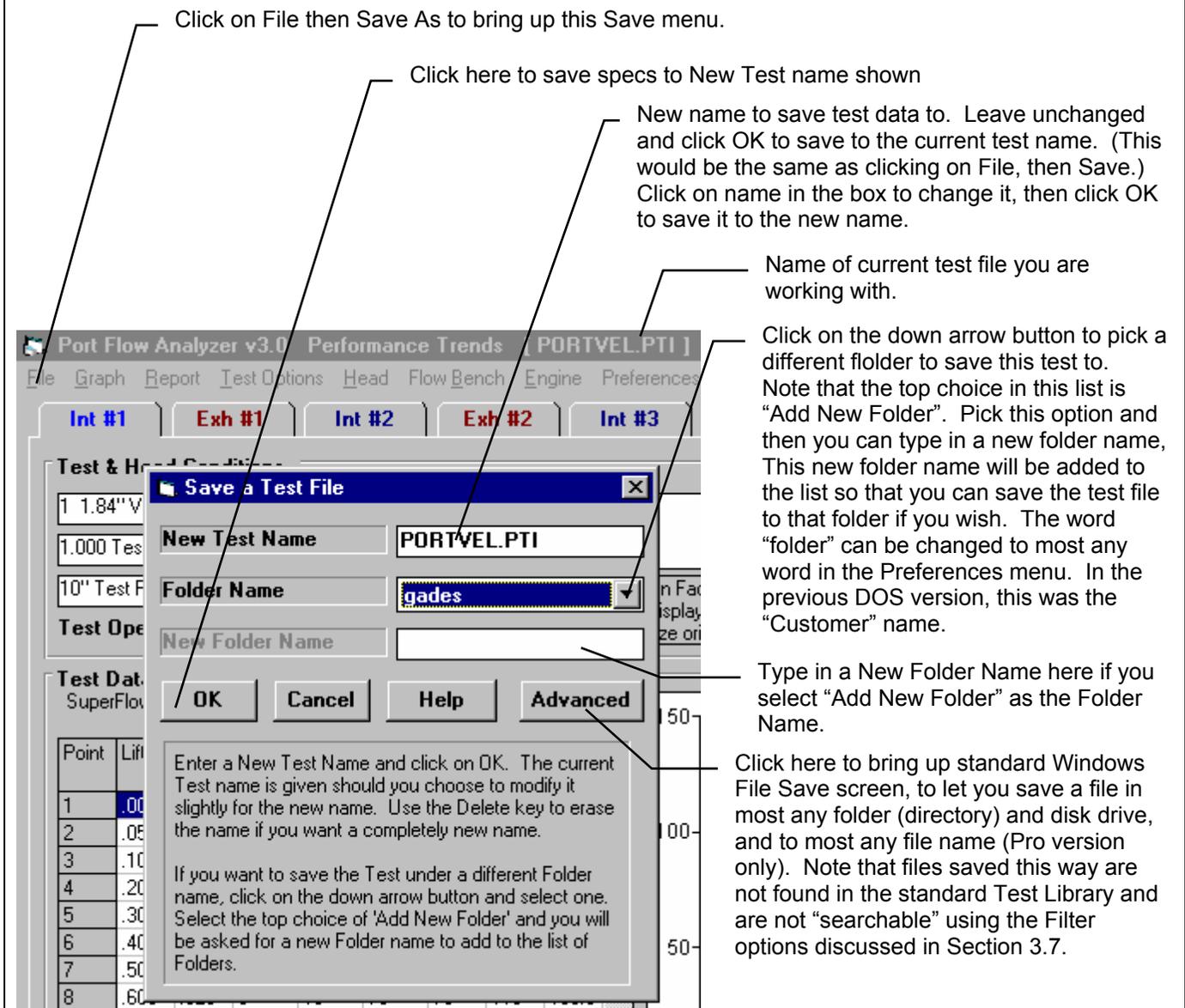


## Save a Test File

Before you discuss saving a test file, it is important for you to understand how the program opens and uses test files. When you open a test from the Test Library, you are only using a *copy* of the test. The original test file is kept in the library.

As you make changes to the test, they are only made to this copy. The original file is not changed. If you want to delete your changes, you can simply open a fresh, unchanged copy of the original test file from the Library. If you want to keep your changes, *you must save them*. This can be done by clicking on File, then Save. You are also asked if you want to save your changes whenever you open a new test, and the program has detected you have made changes to the current file.

Figure 3.36 Saving Test File Options



To save a Test File, you will be presented with the Save Window as shown above. The program suggests a new test name which is the same as the current test name shown at the top of the Main Screen. If you want to save your changes to the same name, simply click on OK. This will update the current test file with your latest changes.

If you want to save the current set of test specs with your changes to a new name (and leave the current test file in the Library unchanged), then click on the suggested file name and modify it as you want. For example, in the window shown above, you may want to add -2 to the current name PORTVEL.PTI to create PORTVEL.P-2 to indicate this is the 2nd revision of PORTVEL.PTI. This is the safest way to make changes, because you can always return to an earlier version and see what you had done.

Certain file names are not acceptable, like names which include the characters: / \ : | < > " \* ? The program will also shorten file names that are VERY long, like over 40 characters.

Test files are saved to folders (directories) you have created in the PFADAT folder (directory) in the PFA30 folder (directory) under Program Files\Performance Trends\Port Flow Analyzer v3.5 folder (directory). You *can* copy Windows Port Flow

Analyzer files from programs on other computers to this folder (directory) and they will be found by the program. The Windows Version 3.5 *will* read files produced with the older DOS v2.1 and Windows v3.0. Just copy them into a folder under the PFADAT folder (other than the Examples folder).

The method of saving Head and Engine files is exactly the same as complete Test Files, except that you access the Save menu by clicking on File at the top of these individual menus, as shown in Figure 3.34. These files are saved to the HEAD and ENGINE folders (subdirectories).

# 3.7 Filter Test Files (Pro Version Only)

The Port Flow Analyzer has a powerful way to search for tests in the Test Library called the Filter Option. Click on the Filter button in the Open Test File menu (Figure 3.34, page 101) to be presented with the screen shown in Figure 3.37 below.

**Figure 3.37 Filter Files Menu**

The screenshot shows the 'Filter Files' dialog box with the following components and callouts:

- Condition 1:** 'List Files If ...' with 'This comment or spec' set to 'Test Comments', 'Has this relationship' set to 'Contains', and 'To what I entered here' set to 'BowTie'. Callout: 'Click on the down arrow button to pick the spec or comment to check for a certain condition "Has this relationship".'
- Condition 2:** 'List Files If ...' with 'This comment or spec' set to 'Customer', 'Has this relationship' set to 'Contains', and 'To what I entered here' set to 'Johnson'. Callout: 'Click on the down arrow button to pick the contion to look for. These change depending on the spec or comment you have chosen.'
- Logic:** Radio buttons for 'And' (selected) and 'Or'. Callout: 'Select And and the Test Files displayed must fit both conditions specified. Select Or and the Test Files displayed can fit either of the conditions specified.'
- Include this condition also:** Checkboxes for the second and third conditions. Callout: 'Type in (or pick from a list for some specs) the condition to look for. The program treats UPPER and lower case letters the same (bowtie = BOWTIE = BowTie). Check here to include a 2nd condition. This enables specs in this section.'
- Buttons:** 'Show only files fitting these conditions', 'Print list of all files fitting these conditions', 'Turn Off Filtering (show all files)', and 'Help'. Callouts: 'Click on this button to return to the File Open menu which will now show all test files.', 'Click on this button to return to the File Open menu which will now only show files which fit the Filter Conditions.', 'Click here to produce a report of all files meeting the Filter conditions IN ALL FOLDERS in the PFADAT folder (the entire Test Library). This way you can avoid looking in each folder separately and can save time.'
- Note:** 'Note: Filtered lists will not include v2.1 files. Click on Help for more info.'

The Filter Feature is very useful for finding a specific test or to find all the tests which meet a certain set of conditions. For example, say you want to find a test that Operator "Jack" ran for Customer "Smith" on a "Big Block Chevy" head. Or, say you are having problems with a certain brand of intake valve seal, where the part # starts with "NAP". Or perhaps you want to find all Small Block Chevy heads that flowed over 200 CFM on the exhaust. In all these cases, the filtering specs would allow you to find the test files.

First you must select the condition you want to look for by clicking on the down arrow button on the 'This comment or spec' box. Your choice of this spec will determine what the 'Has this relationship' options are, and what specs can be entered in the 'To what I enter here' spec.

You can select up to 3 conditions to look for. For the Operator "Jack", Customer "Johnson", "Big Block Chevy" example above, you would need to search for 3 conditions. For the valve seal example, you could just search for 1 condition. You add conditions by checking the 'Include this condition also' box. This enables the other specs for each condition.

If more than 1 condition is being used for the search, you must determine if you want the search to include tests which fit ANY of the conditions (Or) or must match ALL conditions (And). For example, if you are looking for tests run by either Operator Jack or Operator Joe, you would select "Or". If you want Tests which flowed more than 300 CFM on Intake **and** were done since Jan 1999 (the tests must match both conditions), you would select "And".

The 3 command buttons will do the following:

**Show Files Only Fitting These Conditions** will return you to the Open Test File screen. Only files fitting these conditions will be displayed (which may be no files in some situations). You can click on various folders (or whatever name you have given to folders in the Preferences menu at the Main Screen) to see if there are any matches in other folders.

**Turn Off Filtering (show all files)** will return you to the Open Test File screen and now all files will be displayed.

**Print List of All Files Fitting These Conditions** will search through the entire Test Library (all folders in the PFADAT folder) for files matching these conditions and display them in a new screen. From this screen, you can also print the list. This is the quickest way to see which folders may contain test files matching your conditions.

Tip: When looking for a word, the program doesn't care if it is in CAPITAL (upper case) or small (lower case) letters. In Figure 3.37 above you are looking for the word BowTie in the test comments. The program will display all files which have the word "BowTie" or the word "BOWTIE" or the word "bowtie" or the word "BowTIE" anywhere in the comments. The program will **not** find files with the words "Bow Tie" (with a space between Bow and Tie) . Therefore, it may be smarter to just look for the word "bow" to avoid this problem. Note, however, that if you do this, the program will also find tests with the word "elbow" or "crossbow" , for example, in the test comments.

# 3.8 History Log (Pro Version Only)

Click on File, then Open from History Log at the Main Screen to obtain the History Log shown below in Figure 3.38. This screen shows a summary of the results for the last 25-100 tests you have worked with (started new, opened, graphed, etc.) The number of tests in the log (25-100) is selectable in the 'Preferences' menu at the Main Screen. When you work with a new test, it is added to the top of the History Log, and (if the Log is full) the last run drops off the bottom of the list. In the Pro Version, the History Log is an alternate way to Open tests which have been saved to the Test Library. The advantage of the History Log is it lists the tests you most recently worked with at the top.

**See Appendix 7, 9, 10 for new features added in version 3.5, 3.5B, 3.5C.**

**Figure 3.38 History Log and Options**

Click on File, then Open from History Log

Click on Test Title to Open that Test File.

Click in the Save column to enter a Yes or erase a Yes. All tests move to the bottom of the History Log and eventually fall off the list as you work with new tests. However, Tests marked Yes do not fall off the list.

Click and move slide bar down to display all 25-100 tests in the History Log.

Click and move slide bar right to display more columns of test results.

Test File and Path	Graph?	Std Graph Title	Save?	Head #	Int Valve	Max Int CFM	T
\examples\portvel.plh	Yes	kpp-00462		KPP-00462	1 at 1.84"	114.5 @ .6	0
\examples\chev202-.160		chev202-.160			1 at 2.02"	.0 @ 0	0
\examples\chev210-.160		chev210-.160			1 at 2.02"	162.6 @ .606	0
\examples\big		kpp-00462			1 at 1.84"	108.9 @ .4	0
\examples\empty-ex.h		empty-ex.h			1 at 2.02"	.0 @ 0	0
\examples\portvel.cor		portvel.cor			1 at 1.84"	114.5 @ .6	8
\examples\chev194-.153		kpp-00456			1 at 1.94"	120.5 @ .582	0
\examples\chev194-.150		kpp-00456			1 at 1.94"	119.0 @ .582	0
\examples\chev194-.150	Yes	kpp-00456			1 at 1.94"	129.0 @ .582	0

Click on Test Title (1st Column) to Open that test. Click and slide button right for more History info. (Max CFMS corr to 10".)

From this screen you can Open a test file by clicking on the 'Test File and Path' column (first column on the left). If the test file was saved to a standard folder (directory, or whatever you have chosen to call folders in the Preferences menu), the folder name is given first, followed by the test file name.

If a test file has been Opened from or Saved to a non-standard folder (a folder not in the PFADAT folder) using the 'Advanced' function, the entire path is given. If the 'Path and File Name' won't fit, it is shortened and preceded by '...'.

You can choose to Save certain results you believe are special and you may want to recall or graph in the future by clicking on the Save column to insert a Yes there. Tests marked Yes to Save eventually move to the bottom of the History Log, but are never dropped off the list or erased until you again click on the Yes to make it blank.

*Note that just the Test File Name stays in the History Log. Should you delete the file using the Open (from all saved tests) command, the test file will be deleted. When you try to open it or graph it from the History Log, you will get note saying the file can not be found.*

You can print the History Log on a printer by clicking on the 'Print' menu command. Note that the History Log will be most readable when the Page Orientation is in Landscape setting.

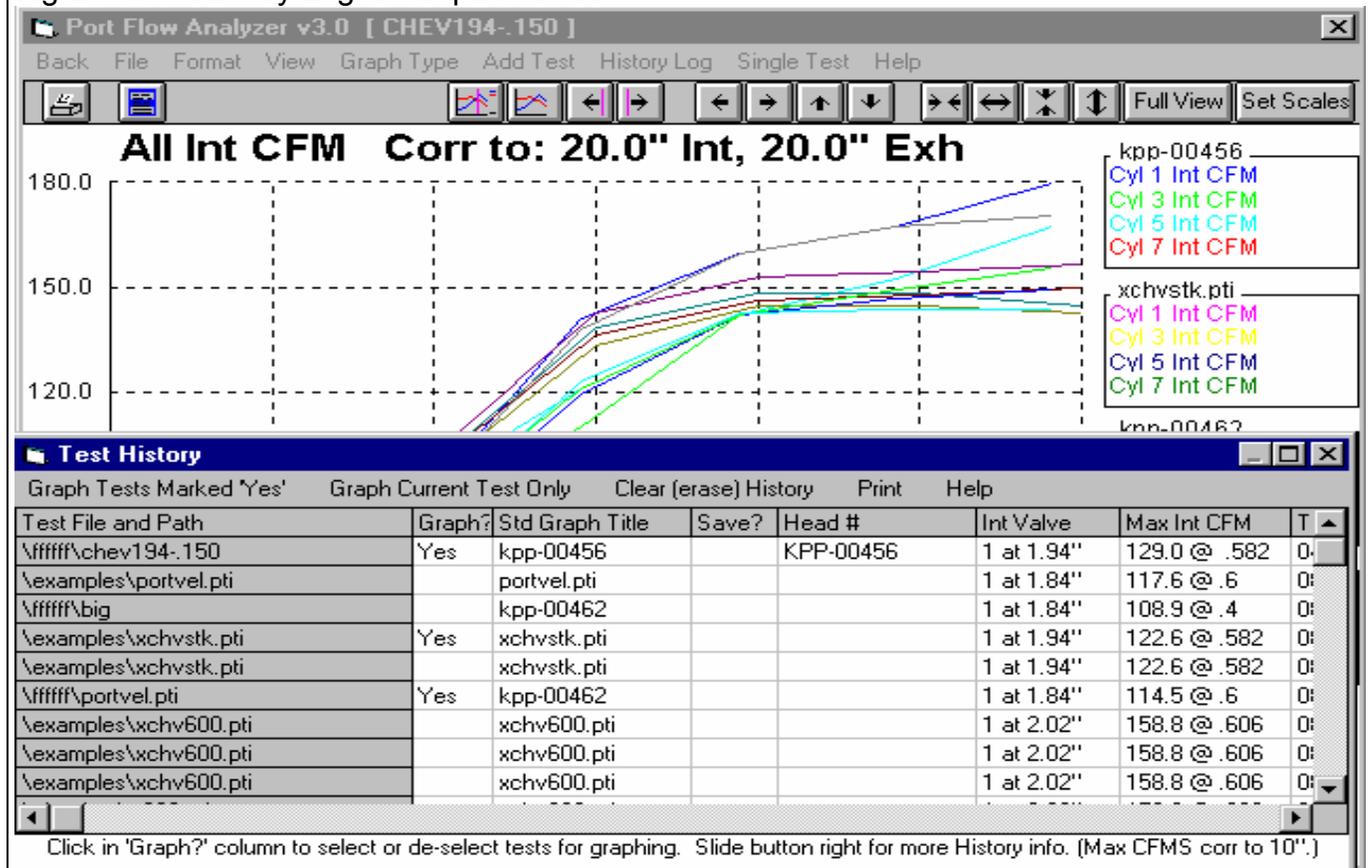
The Max CFMs listed are corrected to whatever test pressure have specified in the 'Preferences' menu. Max CFMs and Valve Diameters are handy to remind you what a test was, and for comparing different tests.

### History Log at Graph Screen

At the Graph Screen, several options are available to graph selected tests from the History Log, and change the Graph Titles. You can obtain the History Log by clicking on the menu command History Log at the top of the Graph Screen. The History Log is how you graph different tests together for comparison. From this screen you can:

- Choose to Graph certain Test Results by clicking on the Graph column to insert a Yes there. Tests marked Yes to Graph will be graphed when you click on the 'Graph Tests Marked 'Yes' '. The first test (usually the current Flow Test you are working with) is always graphed even with no Yes marked. The number of tests actually graphed are limited by available space, usually a limit of about 24 graph lines total.
- Graph only the current test results (the test file at the top of the Log) by clicking on 'Graph Current Test Only'.
- Click on 'Graph Title' to change the Standard Title for this test. The program defaults to putting in the Head # unless it is blank, when it then puts in the test file name. (You can also specify 'Alternate' titles and legend names by clicking on 'Format' at the top of the Graph Screen, then 'Edit Titles/Legends'.)
- Choose to Save certain results you believe are special and you may want to recall or graph in the future. See the Save explanation of the previous page.

Figure 3.39 History Log at Graph Screen



# Chapter 4 Examples

Each example in this chapter becomes progressively more complex, assuming you have performed and understand the preceding example. Section 1.5's example is somewhat more basic than Example 4.1, so it may be a better place to start if Example 4.1 looks complicated.

The results shown in these examples may be somewhat different than what you obtain with your particular version of the program. That is due to minor upgrades in the calculations in later versions.



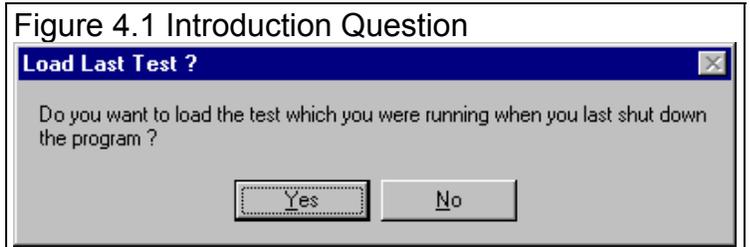
# Example 4.1 Flow Test On a New Type of Head Using a SuperFlow 600\* Flow Bench without Electronics

See Appendix 7 for using the easy “EZ Start Wizard”, added in version 3.5.

This example demonstrates the basic steps for running a flow test. You will use a 2 cylinder Yamaha head and assume that no similar head has been flowed before. Therefore, no similar Test Files are available from the Flow Test Library from which a New Test could be developed. You will be “starting from scratch”.

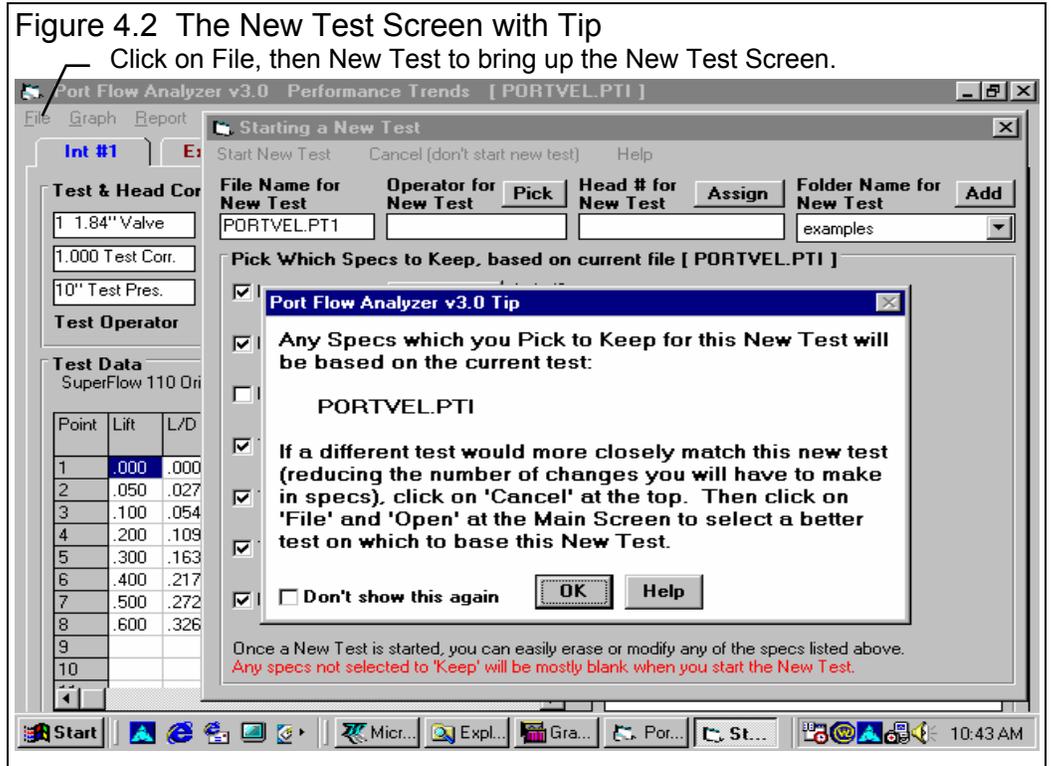
The Port Flow Analyzer has several options for filling in head data on the Test Data grid. The particular steps given below are not the only way to run this flow test.

Start the program by clicking on Start, then Programs, then Perf Trends, then Port Flow Analyzer v3.5, or just double clicking on the desktop Icon. When you enter the Port Flow Analyzer, you may see the question in Figure 4.1. If you answer No, you will start with a blank screen. If you answer Yes, the program will put you back to precisely where you were when you last quit the program. Even though you are starting a New Test, click on Yes to bring up the last test you were working with.



Click on File (upper left corner), then New Test to bring up the New Test screen, which will likely show a Tip message. See

Figure 4.2. As the Tip in Figure 4.2 says, it is always easiest to start with a Flow Test file that is as close as possible to the flow test to be performed. This prevents us from having to make major changes to test information like the Head Specs, Test Options, etc. However, since you have not flowed a head like this one, you can start this test with whatever the Current Test is.



The New Test screen appears as in Figure 4.3. There are 4 critical specs at the top which must be filled out or picked.

If this is the first New Test you have run (you just got the program), you will be given notice that you must also fill out the Master Flow Bench Specs before starting a New Test. To correctly understand the Flow Bench Specs and what the Master Flow Bench Specs are, you will need a little background.

Figure 4.3

4 Critical specs for the new test are listed here at the top.

Click here to start a New Test based on these settings.

Click on these buttons to see the current settings.

Click here to Check or Uncheck these options. Checking means you want to keep these specs for the new test. Once the new test is started you can then make modifications to these specs if you want.

If this is the first time you have started a New Test and you haven't set up any Master Flow Bench specs, the preview will say no Master Bench Specs. You will have to fill out the Bench Specs menu before you can start the New Test.

A summary of the current settings is given here.

### Setting Up Flow Bench Specs for a New Program

A flow test is made up of 4 major parts (6 with Pro version):

- Flow Bench Specs (see Section 2.6)
- Head Specs (see Section 2.4)
- Test Options (see Section 2.3)
- Actual Flow Data (see Section 2.1)
- Head Details (see Section 2.5) (Pro Version Only)
- Engine Specs (see Section 2.7) (Pro Version Only)

Of these, the Flow Bench Specs and the Actual Flow Data are the most important for accurate data. The Actual Flow Data you enter into the Flow Test Data grid are the pressures from the manometers (and temperatures for certain benches). These are obvious to the user since no CFM is calculated without these being entered.

The Flow Bench Specs are stored in a separate menu, but have as much effect on the CFM accuracy as the manometer readings. Once you have set the Bench Specs to match your bench, you will not change them unless the bench or recording electronics change. However, you must initially set them to match your bench.

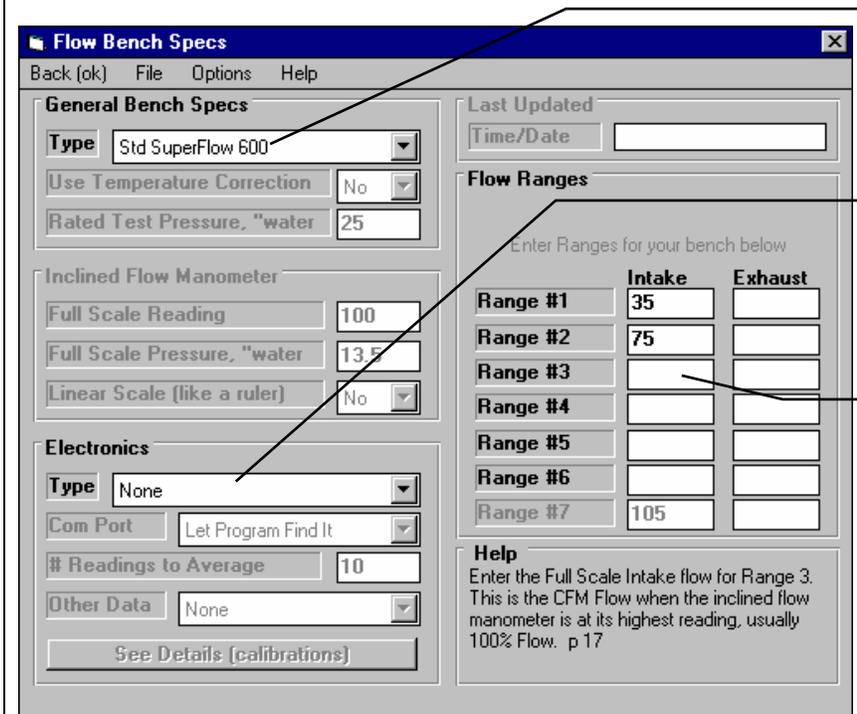
At the New Test screen, you can open up the Flow Bench Specs menu by clicking on the See Specs button next to the Flow Bench option. When you open up the Flow Bench Specs from the New Test screen, the program displays the Master Bench Specs, Figure 4.4.

If the Master Bench Specs are blank:

1. The program will give you tips to first, choose your type of Flow Bench
2. Then depending on the type of bench you picked, it will ask if there are any electronics used for recording data.
3. Then depending on the type of bench you picked, it will ask you to enter in the CFM for the Flow Ranges for your bench. For a SF 600 you are using in this example, this would be the 6 Intake and 6 Exhaust CFMs you got on a calibration card from SuperFlow with your bench.

With the Master Bench Specs filled out, click on Back (OK) at the top left of the Bench Specs screen to return to the New Test Screen.

Figure 4.4 Filling Out Master Bench Specs for First Time



1 Tip messages will first instruct you to pick the general Type of Flow Bench. For this example, we picked a SuperFlow 600.

2 A tip message will instruct you to pick the type of electronics you will be using with the Flow Bench. For this example, we picked None.

3 For a SuperFlow 600 bench, you should fill in the full scale CFM flows for each of the 6 ranges, intake and exhaust.

### Filling Out Other Specs to Start a New Test

If you start with a blank test, or want to modify some specs from the previous test, click on the 'See Specs' buttons for each category of specs. Click on Help at these menus for more info on how to enter these specs.

Since you have not run a Yamaha head before, the head specs currently loaded are probably quite different than the Yamaha you will run. Therefore, you will uncheck the Head Specs option to leave Head Specs blank (for now) with this new test. The same could be said about all other categories of specs. Therefore, you will uncheck all categories except the Flow Bench.

Most specs in these categories *can* be changed once the test has started with no problems, which is what you will do in this example. However, there are four other critical specs listed separately at the top. These *must* be filled out before you can start the new test:

1. File Name for New Test is the file name the program will create for saving the Flow Data for the new test you are starting. The program fills in a default name of the current test name, but incrementing the last digit in the name by 1. You can change this name to most anything you like. The program will warn you if the name entered is not valid and show you what is wrong. **For this example, type in the name: 600CC-4VLV** for this 4 valve Yamaha head.

- Operator for New Test is the name of the operator for this test. Click on Pick to pick an operator name already used or to enter a new name. The program defaults to the operator of the current test. **Through the Operator Menu discussed in Section 2.1, you enter a new Operator name of Jack.**
- Head # for New Test is critical for shops who use a head numbering system. Click on Assign to create a new Head # based on the last Head # assigned (incremented up by 1) or to start with a new type of Head #. **Through the Head # Menu discussed in Section 2.4, you enter a new Head # of TCPerf-0002.**
- Folder Name for New Test is the folder in the PFADAT folder where the test will be saved. The program may not be using the name 'folder' for spec, but whatever word you have assigned in the Preferences menu at the Main Screen. The folder name 'Examples' is reserved for Performance Trends example tests supplied with the program, and can *not* be used for your tests. **By clicking on Add New, you use the new folder of YAMAHA.**

Figure 4.5 New Test Menu for Starting This New Test

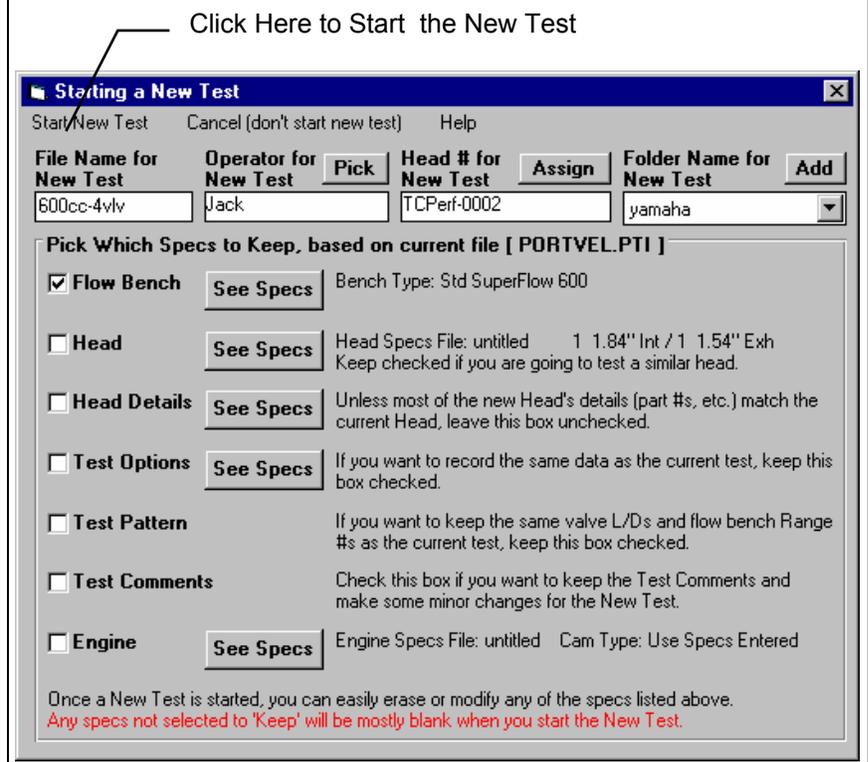
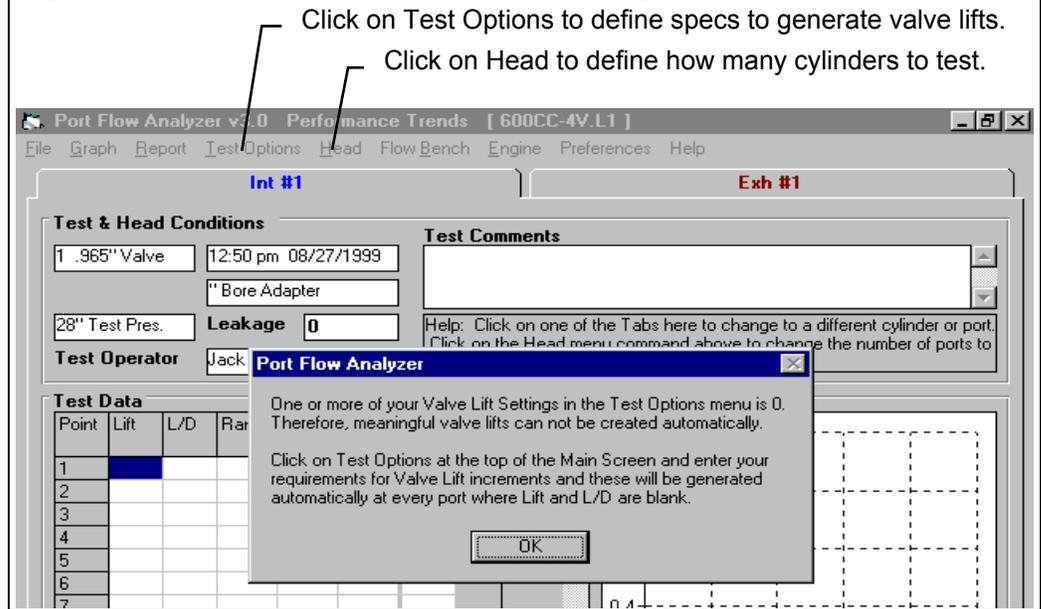


Figure 4.6 Main Screen and Tip after Starting New Test



The New Test screen should now look like Figure 4.5. When you are ready to start the New Test, click on 'Start New Test' at the top of the screen. If some critical specs have not been entered, the program will warn you and ask you for it at that time. These include Intake Valve Diameter, Exhaust Valve Diameter and Test Pressure. The program will fill in the Test Time and Date based on the computer's time and date. This can be changed later by clicking on the Test Time/Date at the Main Screen.

Figure 4.6 shows the Main Screen you get from starting with most menus of options and specs blank. First, there are no valve lifts generated, which Tip message is stating because the specs used to automatically generate lifts in the Test Options menu are blank. Second, you notice that only 1 intake and 1 exhaust tab are shown, but you want to test 2 cylinders. The specs stating how many cylinders to test are contained in the Head Specs menu.

Click on Test Options at the top of the Main Screen to open the Test Options menu (Figure 4.7) There you can fill out any or all the specs which pertain to this test. Click on Head at the top of the Main Screen to open the Head Specs menu (Figure 4.7) to enter specs about this head you are flowing.

Figure 4.7 Filling Test Options and Head Specs Menus

These specs determine what valve lifts are automatically generated by the program. Note the preview shows the pattern of the lifts. The head porter in this example typically tests .025, .050, .100, .150, .200, .250, .300 inches valve lift (not L/D) and then double checks .150 again. The .000 point is also tested to check leakage.

Select None for Port Velocities because we are **not** recording port velocities with a Pitot Tube.

Select "Calculate from data entries" for recording CFM Flow. For this simple test, you select to only record CFM, so other data types are set to "Don't Record".

This is not mandatory, but when all specs and Head Comments are filled in, click on File, then Save As and save these Head Specs to the Head Library with the Head Name "YAM600-4VLV" (Pro version only). This would let you Open a file of these Yamaha head specs some time in the future, saving you from typing them again.

Select the Port Layout, which for this head is 2 intake and 2 exhaust valves, each valve having its own individual port.

Fill in other head specs for more advanced analysis and for documenting this heads specs.

Set this spec to 2 to tell the program you are going to test 2 cylinders on this head.

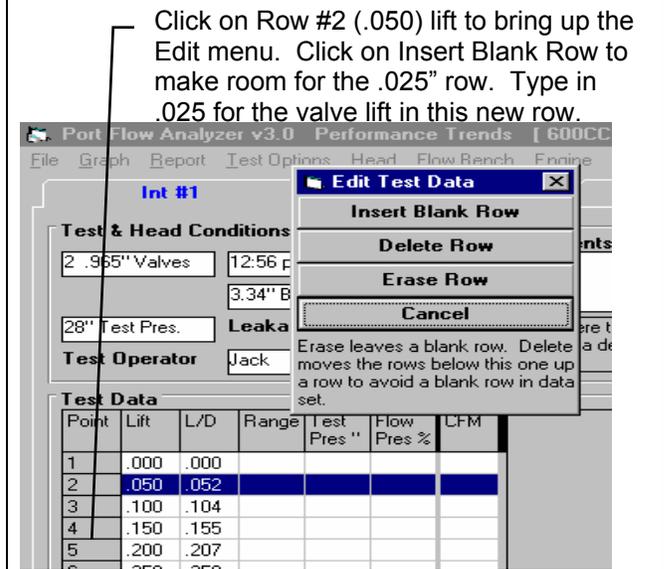
After filling out the Test Options and Head Specs as shown in Figure 4.7, the Main Screen looks more like you are ready to test. Valve lifts and L/Ds are filled in as specified in the Test Options menu. However, the .025 and the recheck of .150 valve lift points are not filled in. You can manually insert a blank row in ahead of the .050 valve lift row as shown in Figure 4.8. Then you can type in the .025" and .150" recheck points.

At the Main Screen, you can also start typing in test comments. For the first comment, you can enter something descriptive like:

Ed's 600 cc Yamaha 4 valve - before porting

Now the Main Screen looks similar to Figure 4.9, so now you can start recording actual flow data.

Figure 4.8 Inserting .025" Lift Point

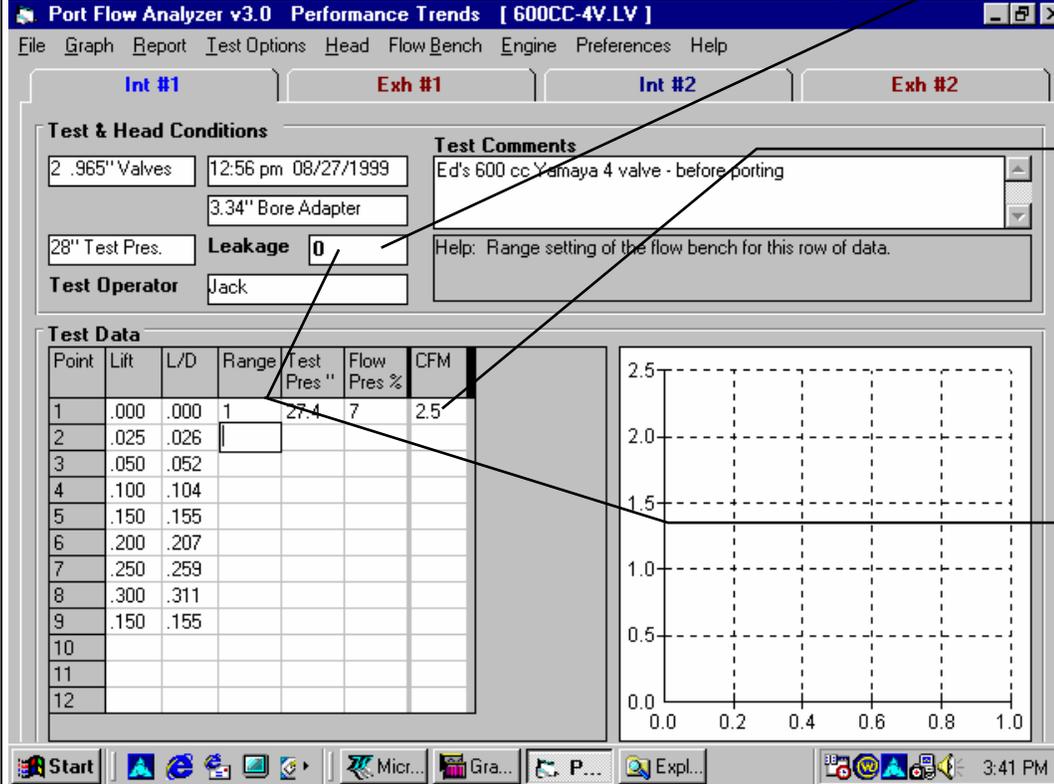


## Recording Flow Data

Set up the bench and head to flow Cylinder #1's intake port. It is necessary to first measure the amount of CFM leakage. (Before checking leakage, be sure that the Leakage value at the Main Screen is set to 0. See Figure 4.9.)

With the intake valve closed and the intake port sealed with tape, start the bench and set approximately 28" water Test Pres. Select the lowest flow range on the bench to measure leakage: Range #1. Enter 1 for Range, and the actual pressures you observe of Test Pres = 27.4" and Flow Pres = 7% as shown in Figure 4.9.

Figure 4.9 Recording Flow at .000 Lift to Determine Leakage



1 Be sure this leakage value is set to 0 before trying to measure Leakage CFM.

Set up the flow bench to record CFM flow at .000 valve lift on the most sensitive range (#1). Type in the Range, Test Pres (vertical manometer) and Flow Pres (inclined manometer %) and the program calculates CFM flow of 2.5 CFM.

Type in 2.5 CFM as the Leakage #. CFM for point 1 (.000 lift) now drops to 0 CFM. This is as it should be, because the 2.5 CFM was not going through the valve because the valve was closed.

This data calculates a leakage of 2.5 CFM. (Note that an accurate leakage CFM can only be calculated when Leakage is set to 0 shown in Figure 4.9. Enter leakage by clicking on Leakage and typing in 2.5. You will notice that the CFM for Point #1 is now 0. This shows the leakage correction is working properly to correct for the 2.5 CFM coming from other sources (not the valve).

Start recording actual flow data at this time. Open the intake valve to .025" as indicated in the Lift column for row 2. Adjust flow to obtain 28" of Test Pres on the vertical manometer. Wait a few seconds to let the Test Pres and Flow Pres on the inclined manometer stabilize.

Enter both Test Pres and Flow Pres as accurately as can be read on the manometer. Although a

setting of 28.0" of Test Pres was desired, it may actually settle out at 28.15". The inclined manometer gives a reading of 48%. Enter these values and the program will calculate a CFM value of 14.7 CFM, which is corrected for leakage and to 28.0" Test Pres. Also note that Point 2 has been graphed on the Summary Graph. See Figure 4.10. Continue setting valve lifts as indicated in the Lift column. For each lift, select the proper flow range and enter the Range, Test Pres and Flow Pres as done before, until there are readings for all Lift points. See Figure 4.10.

### Flow Exhaust Port

With one intake port completed, you can now flow this cylinder's exhaust port. Set up the head and flow bench to flow the exhaust port of #1 cylinder. Advance to the Exh Port Test Data grid for cylinder #1 by clicking on the Tab at the top. See Figure 4.10.

You may notice a short message saying "Saving to Temporary File" appear for about a second. Whenever you change ports, or return from a menu like Head Specs, the program saves a temporary copy of the flow test. Should you loose power, or should the program "bomb", most of your data will be saved. If this happens, when you restart the program the

Figure 4.10 Completed Intake Port

Click on File, then Save to save these test results to the Test File Library.

Click Exh #1 tab to go to next port.

Note that the Summary Graph automatically updates as you enter data.

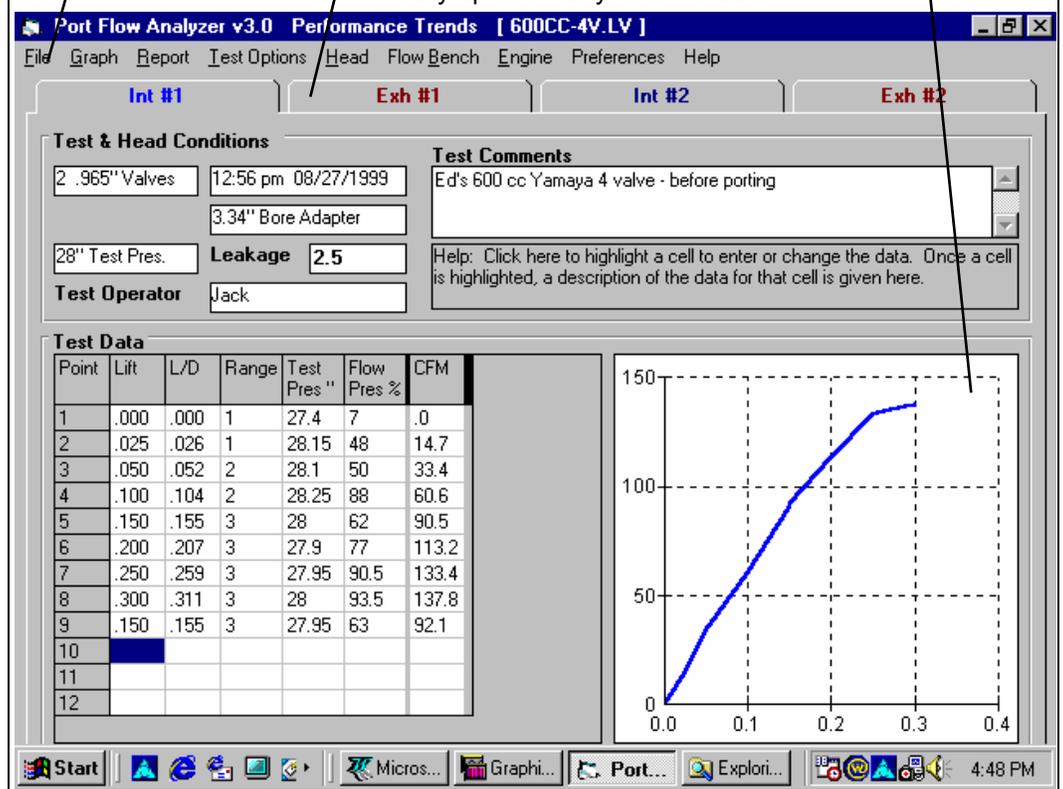
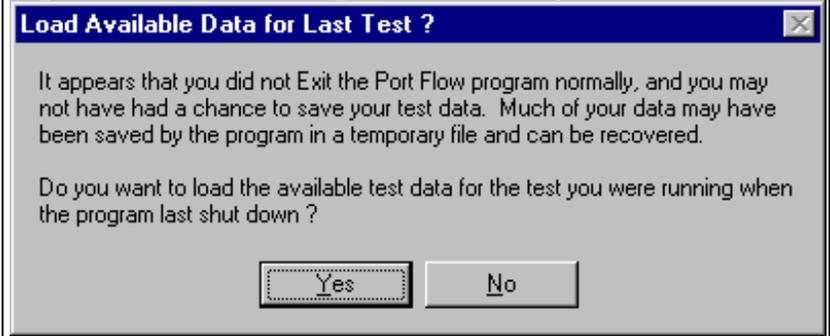


Figure 4.11 Recovering Data at Startup



program will give the message shown in Figure 4.11. If you answer Yes, the program will restore your data up to the point the program last saved it. For added insurance, you can periodically click on File, then Save to permanently save your latest changes to the Test Library while running the flow test.

At the Exhaust Screen, most valve lifts will be generated, but not the .025 and the .150 you added manually for the Intake Port. Add these lift points as done for the Intake Port.

With the exhaust valve closed, the exhaust port sealed with tape, and 0 Leak CFM entered for this port, measure leakage. Enter the 3.0 CFM leakage by clicking on Leakage and typing in 3. Record flow data for the exhaust port by following the steps done on the Intake Port. Generally exhaust ports do not flow as well as intake ports because they are smaller.

With Cylinder #1 completed, you interrupt the flow test for 3 hours for lunch and to do some office paperwork. When you return you make a note of the 3 hr interruption in the by typing in the Comments section something like "Cylinder #2 flowed after 3 hour delay."

Tests are now completed for the intake and exhaust ports for cylinder #1, so set up to flow the intake port of cylinder #2. Advance to the intake port Test Data grid for cylinder #2 by clicking on the Int #2 tab. The Test Data grid is now blank except for the standard valve lifts *and the Range #*. Once cylinder #1 has been flowed, the program assumes the other ports will flow somewhat similar to cylinder #1, and are therefore likely to use the same flow range at the same lifts. You still must manually insert the .025 and .150 valve lifts and run the leakage test.

Follow the same procedure for flowing cylinder #2, Intake and Exhaust as for Cylinder #1. When you are done and the entire cylinder head has been tested, be sure to save the data by clicking on File, the Save. Reports and graphs as shown in Examples 4.3 and 4.4 are now possible.

Note: There are many alternate ways to perform this flow test. For example, flow all the intake ports and then all the exhaust ports. This example is only one suggested method used to illustrate the Port Flow Analyzer's commands and options.

# Example 4.2 Running Flow Test On Type of Head Which Has Been Flowed Before, Using FlowCom

This example is similar to Example 4.1. Therefore, only major differences between the two examples will be discussed in detail. Note, file XFRD185.PTI has been changed to "Example SB Ford SF 110 w Port Velocity" in version 3.5.

This example will demonstrate the basic steps for running a flow test when there *is* a Test File saved which is similar to the test to be performed. You will be testing a small block Ford 302 head, similar to the XFRD185.PTI file saved in the Examples folder of the Flow Test Library. You will flow the head on a SuperFlow 110 bench, using SuperFlow's FlowCom electronics for recording data. The Port Flow Analyzer has several options for filling out the Test Data grid. The particular steps given below are not the only way to run this flow test.

Note: Do not install the head on the bench yet, so you can do a bench calibration. This is discussed later in this chapter.

## Starting a New Test

First, open a Flow Test file which is very similar to the head, flow bench specs and Test Options for this New Test. This can be done by clicking on File, then Open (from all saved tests) at the Main Screen. The Flow Test Library is shown in Figure 4.12 will be displayed.

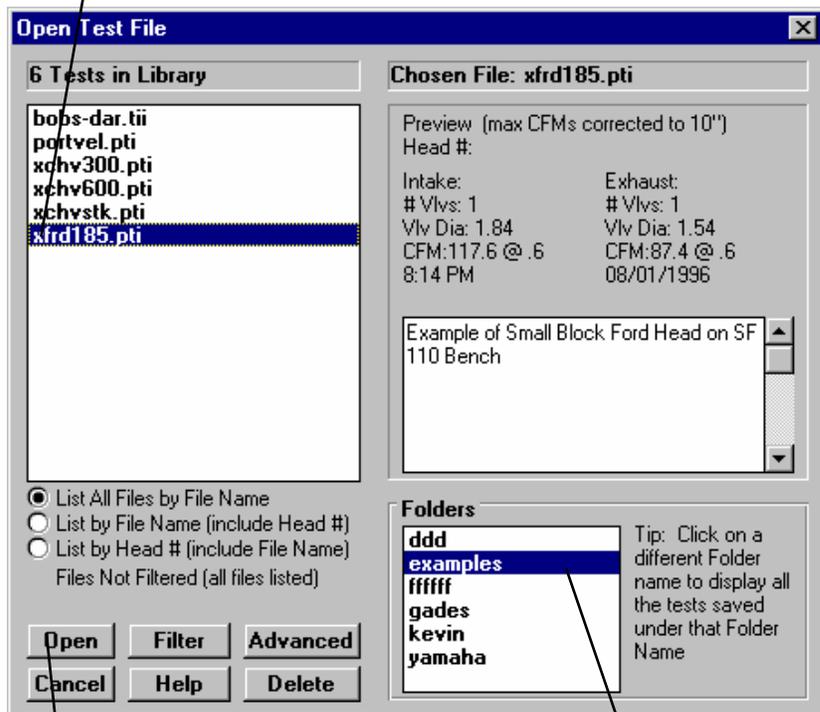
You may first have to switch to the EXAMPLES folder by clicking on EXAMPLES in the list of folders if it was not already highlighted. Then find and click on the XFRD185.PTI test file to obtain the preview. This file contains example flow data from a Ford 302 on a SuperFlow 110 flow bench. Click on the Open button and a copy of this file will be opened to use as the pattern (template) for this New Test.

At the Main Screen, click on File, then New Test to obtain the screen shown in Figure 4.17. You may notice a Tip message when you open the New Test

Screen saying it is best to pattern the New Test after some previous test (Figure 4.13). Since the XFRD185.PTI test file *is* a good pattern (that's why we opened it), simple click on OK to close this Tip message window.

Figure 4.12 Open a Previous, Similar Test File

Second, find the test file and click on it. A preview (summary) of the file is shown to the right.



Third, click on Open to open this test file as the pattern for the New Test. This test file now becomes the current test, the same as if you had simply wanted to look at it, edit it or make a report of it.

First, click on the folder where the test file we will use as a pattern is stored.

At the New Test screen, think about the New Test and the head you are going to flow. Then you must decide how much of the XFRD185.PTI test file you can keep for this new test.

**Flow Bench:** If you were actually doing this example in your shop, your Master Flow Bench specs should already be for a SuperFlow 110.

(If you are simply following this example by going through these steps, your Master Flow Bench may not be a SuperFlow 110. If this is the case, and you want the Master Flow Bench specs to match those of the XFRD185.PTI test, click on 'Cancel (don't start a new test)' at the top of the New Test screen. Then click on Flow Bench at the top of the Main Screen. You should get a message which says the current Flow Bench Specs for XFRD185.PTI does not match your Master Flow Bench specs, which you already know. Click on OK to clear this message, then click on File, then Save as My Master Bench Specs. This will save the Bench Specs for Test File XFRD185.PTI as the Master Bench Specs. Then click on Back (ok) to close the Flow Bench menu. Then click on File, then New Test to return to the New Test screen.)

To tell the program you are using a FlowCom to record the data, select "FlowCom" as the Type in the Electronics section of the Flow Bench specs menu (shown in Figure 4.14). When you are using the FlowCom, it is also critical to have the FlowCom accurately reading the temperatures and pressures. The process of checking and adjusting the electronics to match the manometers and thermometers is called *calibration*. Use the process outlined in the FlowCom instructions from SuperFlow to calibrate the FlowCom. While running the test, you can check the calibration of the FlowCom, which will be discussed later in this example. (If you were using Performance Trends Electronic Interface, you would calibrate the Port Flow Analyzer program following the procedures in Appendix 5.)

Figure 4.13

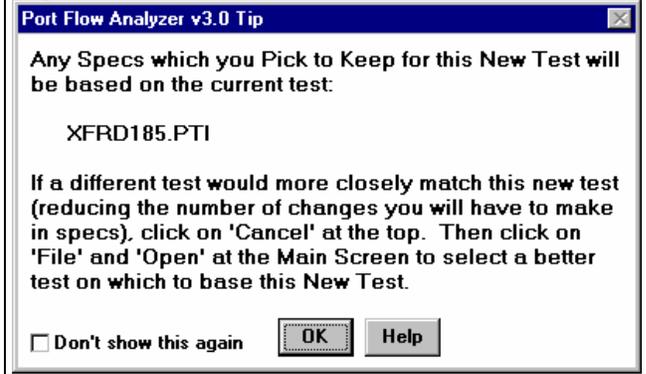
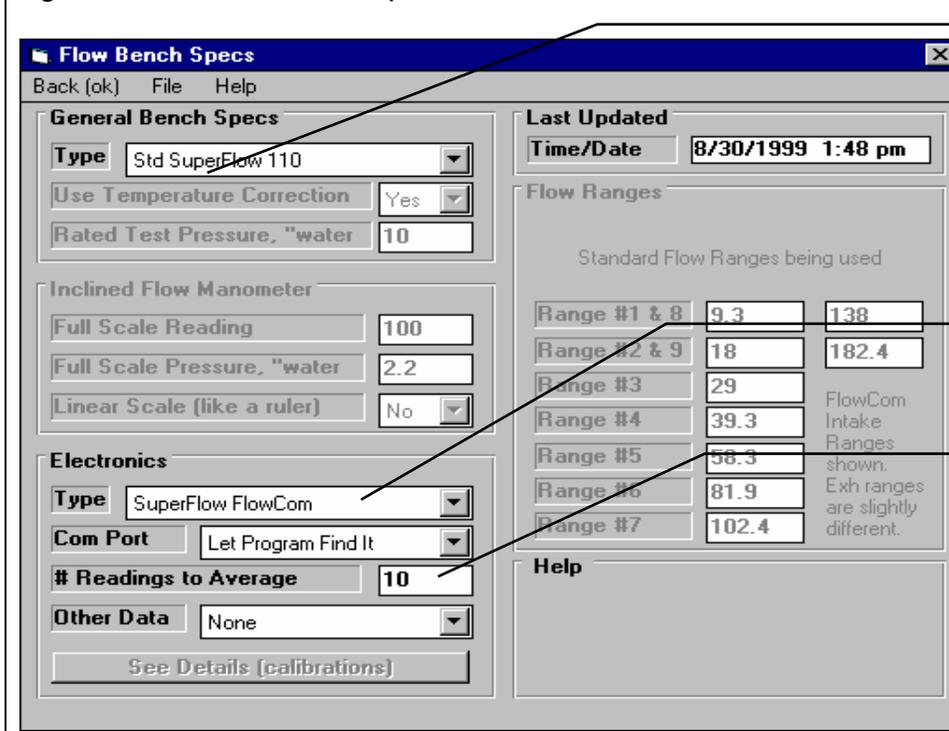


Figure 4.14 Flow Bench Specs



For a SuperFlow 110, the settings are quite simple. Simply select Std SuperFlow 110 as the Type and most other specs are disabled because the program knows what the settings should be.

Select SuperFlow FlowCom for the Type of Electronics.

Set # Readings to 10, which is a good compromise between accuracy and program speed. If you select to also record test "Stability", you may want to increase this # to 15 to 25 readings for a better reading of "Unstbl +/-%". See Figure 4.16.

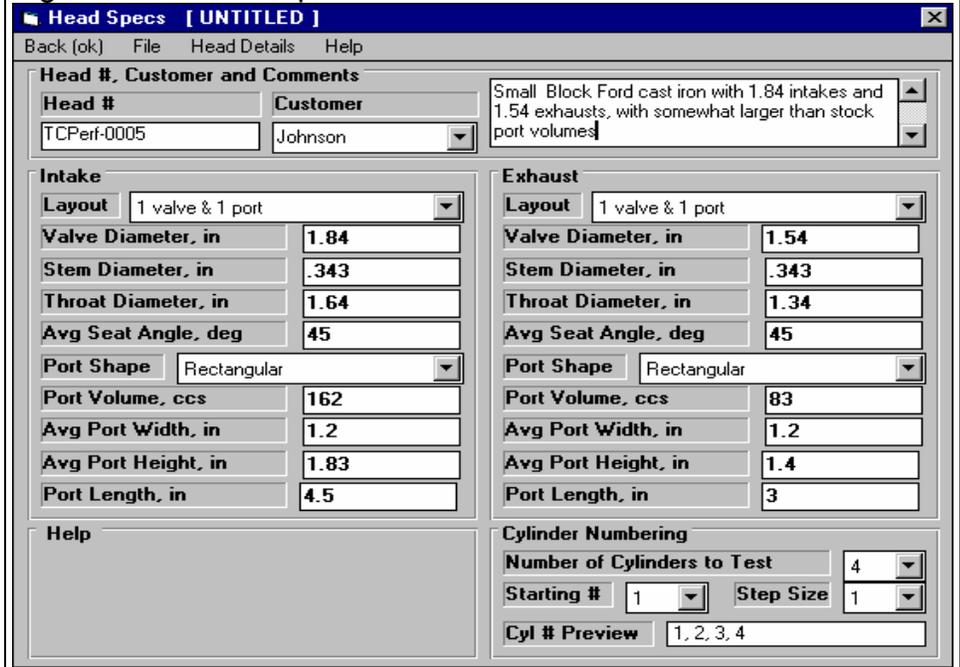
**Head:** Since the head being tested is so similar to the head you are starting with, changes to the Head Specs should be few if any. Click on the See Specs button by Head Specs. The cylinder head you will flow is a Ford small block V-8 head with 1.84"

diameter intake valves and 1.54" diameter exhaust valves. Stem diameters are 5/16" (.343"). Cylinder numbering is 1 2 3 4 and all cylinders will be tested.

Intake port dimensions are approximately 4.5" long and 162 CCs. Exhaust port dimensions are 1.2" wide x 1.4" high by about 3" in length. You estimate both ports to be rectangular in shape. For these port specs, when you type in a Port CCs, Width, Height or Length, one or more of the other specs are recalculated to keep these specs consistent with each other. All you need to do is type in the specs you know, and the other specs are calculated for you.

Fill in other head specs you know, like Head #, Customer name, and any comments which are particular to this head. Completely filling out these specs will make your past tests a valuable reference in the future. Your Head specs menu should now look like Figure 4.15.

Figure 4.15 Head Specs for the New Test



Fill in other head specs you know, like Head #, Customer name, and any comments which are particular to this head. Completely filling out these specs will make your past tests a valuable reference in the future. Your Head specs menu should now look like Figure 4.15.

**Head Details:** For users of the Pro version, click on the See Specs button by Head Details. Check if any of these entries match the parts or components used for this new head. Lets say in this case, very few entries match the new head. Click on Back (ok) to return to the New Test screen. Keep the Head Details option unchecked, which will blank out all Head Details once you start the New Test.

Note that specs for any category which is unchecked (indicating the specs will be blanked out) will not be blanked out until you actually start the New Test. This way you can view the specs with the See Specs button and decide if you want to keep them or blank them out.

**Test Options:** Click on the See Specs button by Test Options. Since the test to be run is so similar to the test data you are starting with, changes should be few if any. Figure 4.16 shows a Test Options

Figure 4.16 Test Options for the New Test

Most specs can be used "as is" from the XFRD 185 PTI test

Select to record port velocities at .600" lift. Also, select to have velocity corrected for the barometer reading, standard with the FlowCom.

The CFM Flow options include recording test Stability, (Unstbl +/-%) which is useful, especially when using the FlowCom.

Select to record Barometer also, since the port velocities will be corrected for Barometer.

menu for the conditions described below:

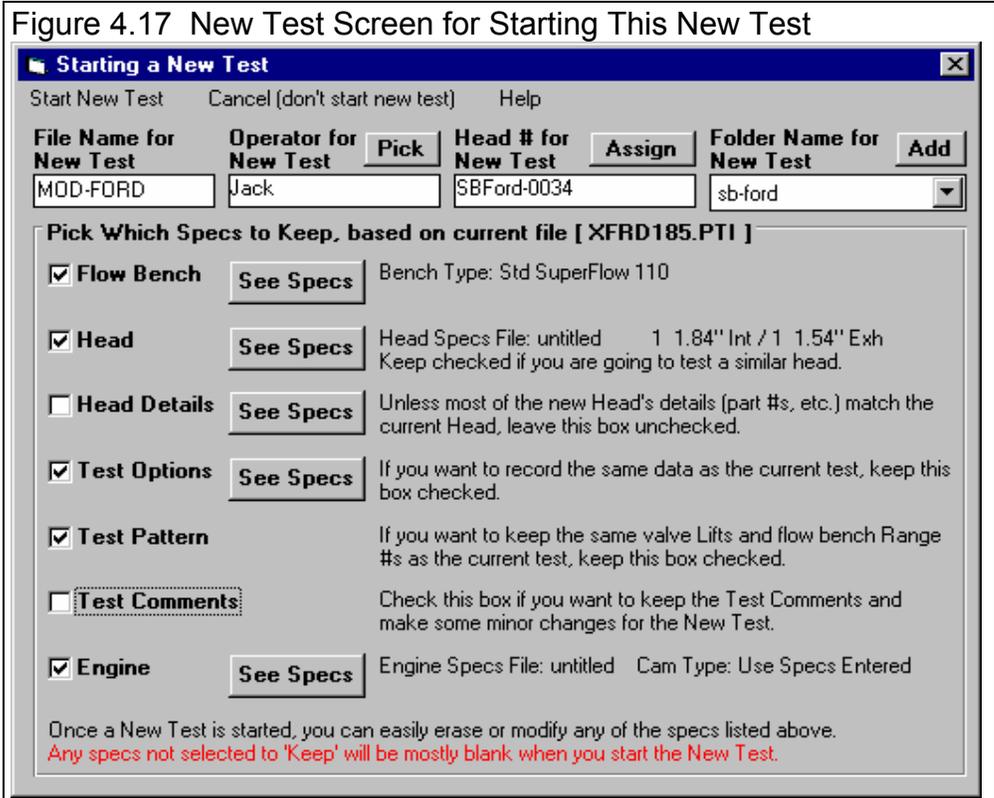
- These flow tests are run at lift increments of .000 .050 .100 .200 .300 .400 .500 .600 . (All these lift points will be generated by the settings in the Test Options menu, except .050". This will be discussed under Test Pattern.)
- The .000 Lift point is used to check leakage.
- Test pressure is held to 10" water for intake and exhaust.
- You *are* recording port velocities with a Pitot tube at .600" lift only, so set the Port Velocity spec Type to "Record 9 points at 1 lift" and First Lift to Record Velocity to .600.
- The FlowCom has a barometer sensor which reads pressure directly, not pressure corrected to sea level. This barometric pressure can be used to improve the accuracy of the port velocity readings. Therefore, for the Data spec, pick "Enter Vel (corr for Baro if FlowCom)".
- Also, select to Record Barometer so you will know in the future what the barometric pressure was.

**Test Pattern:** The Test Pattern is the valve lifts and/or L/Ds, the order of the valve lifts and any repeats, and the flow bench ranges. Check this box to keep the same pattern. For this example, checking Test Pattern will add the .050" lift point (all others would have been created by the Test Options Valve Lift specs), and keep the Flow Bench Ranges from the XFRD185.PTI test.

**Test Comment:** If the XFRD185.PTI test had many detailed comments, you may want to keep them if they also applied to this New Test. Then you could always make minor adjustments to them once the test started. However, since the XFRD185.PTI test's comments are very brief, you uncheck Test Comments to blank them out when you start the New Test.

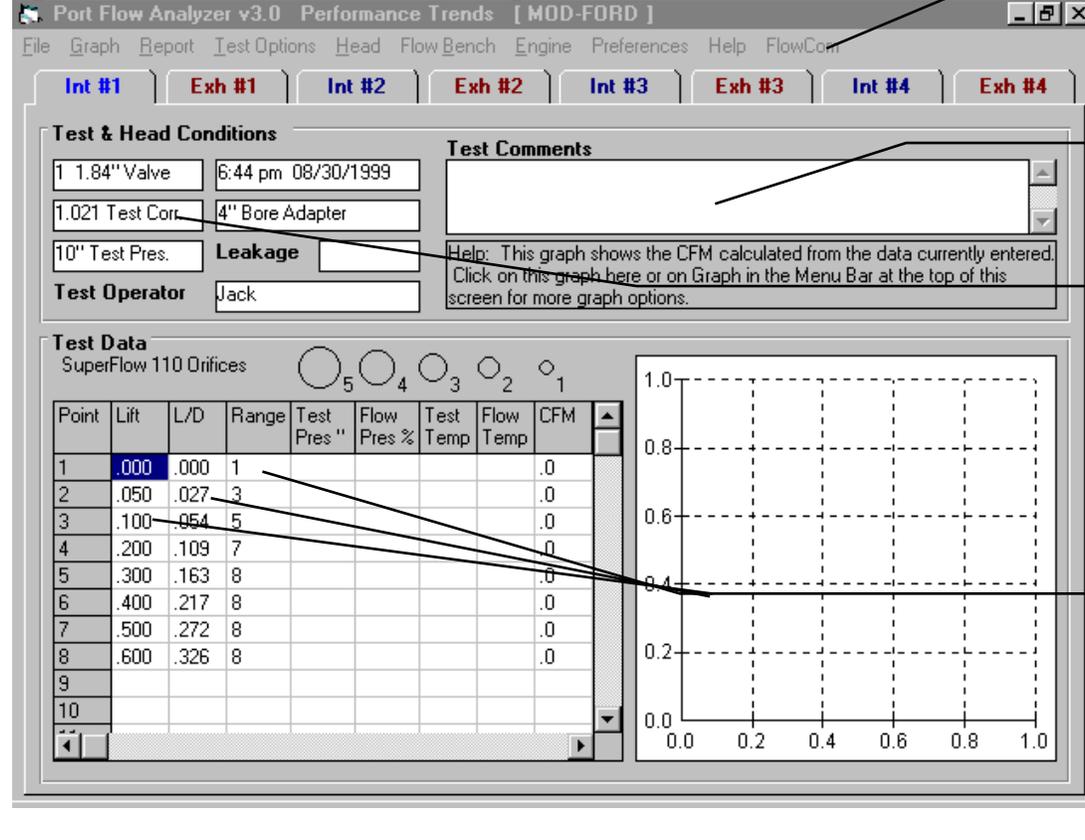
**Engine:** The Engine Specs will provide necessary engine dimensions for more detailed analysis. It may be convenient to keep the same Engine Specs so a direct comparison can be made between the XFRD185.PTI test and this New Test. If the Engine Specs are the same, the only difference should be due to the cylinder head specs and flow data. Therefore, keep the Engine Specs checked to keep them the same.

**Top 4 Specs:** Now, fill out the 4 critical specs listed at the top of the New Test Screen as described in Example 4.1. For File Name, the program took the XFRD185.PTI and changed the last letter I to the number 1. However, this name is not very descriptive, **so you type in the name to MOD-FORD.** Click on Pick to pick the Operator name of **Jack** used in Example 4.1. Pick a new Head # pattern as discussed in Section 2.4 of **SBFord-0034.** If the XFRD185.PTI file had not been opened from the EXAMPLES folder, but instead from, say, the SB-FORD folder, you could use that same folder for this new test. However, the program does not let you save New Tests to the EXAMPLES folder (to prevent you from changing example tests provided by Performance Trends). Therefore, click on the Add button and enter the folder name of **SB-FORD.**



Now, the New Test screen should look like Figure 4.17. Click on 'Start New Test' at the top of the screen. The program will fill in the Test Time and Date based on the computer's time and date. (If your computer clock is not correct, or for most any other reason, this time and date can be changed later by clicking on the Test Time/Date at the Main Screen.) You will be returned to the Main Screen, which should now look like Figure 4.18.

Figure 4.18 Main Screen for Starting New Test



Click on FlowCom to bring up FlowCom screen showing FlowCom readings.

Notice that Test Comments have been blanked out.

Click here to bring up the Test Correction Menu.

Keeping the Test Pattern keeps Valve Lift and L/D, and Range.

## Recording Data

SuperFlow recommends calculating a Test Correction for the SF 110 bench occasionally, as discussed in Section 2.10, on page 57. The start of a new test is a good time to do it. Install the test orifice supplied by SuperFlow on the bench with just the small hole open (plug the big hole). SuperFlow says you should get from 3.5 to 5.5 CFM with just the small hole open.

Start the bench and set the Flow Bench Range to 1 and the flow direction to Intake. Follow the exact procedure as described on page 57. Set the Leakage value on the Main Screen to 0.

*You will use this New Test's Test Data screen to calculate flow for the orifice plate. Once you have calculated a new Test Correction Factor, you will erase any data you recorded. You are simply using the Test Data screen as a "scratch pad".*

To record data accurately, click on FlowCom at the top of the Main Screen to open up the FlowCom screen. When the bench is reading about 10" Test Pres and with the Range set to Range 1 on the flow bench and on the FlowCom screen, click on Record or press <F1> to record CFM flow. The FlowCom will take the 10 readings as you have directed in the Flow Bench Specs, fill in the 1st row in the Test Data grid with the readings, and calculate 4.8 CFM. Since this is within the 3.5 to 5.5 CFM range, you can go to the next step. Nothing is done with this 4.8 CFM reading. See Figure 4.19.

Figure 4.19 Obtaining Test Correction Factor Data with FlowCom

### Determine Flow with Small Orifice Open

The screenshot shows the 'FlowCom: SF110' window with the following settings: Set Test Pres. 10", Act. Test Pres. 9.89, Range Int 3, Data Point 2, Valve Lift .050, Flow Reading 16.4%, Test Temp (T1) 73.4, Flow Temp (T2) 92.4, Corr. CFM Flow 4.8, Port Velocity 0.0, Barometer 29.52". The 'Test Data' table is as follows:

Point	Lift	L/D	Range	Test Pres "	Flow Pres %	Test Temp	Flow Temp	CFM
1	.000	.000	1	9.89	47.3	73	92	4.8
2	.050	.027	3					.0
3	.100	.054	5					.0
4	.200	.109	7					.0
5	.300	.163	8					.0
6	.400	.217	8					.0
7	.500	.272	8					.0
8	.600	.326	8					.0
9								
10								

Set Leakage to 0

Set 10" test pressure on vertical manometer with Range #1. (Note that this FlowCom screen shows readings for 2nd row. The FlowCom screen automatically advances to the next row after recording data.

Click on Record or press <F1> to record CFM with the small orifice open.

4.8 CFM recorded for the small hole only. This verifies there are few if any leaks as 4.5 CFM is the number you should get for the small hole.

### Determine Flow with Both Orifice Holes Open

The screenshot shows the 'FlowCom: SF110' window with the following settings: Set Test Pres. 10", Act. Test Pres. 10.04, Range Int 9, Data Point 1, Valve Lift .000, Flow Reading 84.7%, Test Temp (T1) 73.8, Flow Temp (T2) 110.3, Corr. CFM Flow 151.6, Port Velocity 0.0, Barometer 29.52". The 'Test Data' table is as follows:

Point	Lift	L/D	Range	Test Pres "	Flow Pres %	Test Temp	Flow Temp	CFM
1	.000	.000	9	10.04	84.7	73	110	151.6
2	.050	.027	3					.0
3	.100	.054	5					.0
4	.200	.109	7					.0
5	.300	.163	8					.0
6	.400	.217	8					.0
7	.500	.272	8					.0
8	.600	.326	8					.0
9								
10								

Set a higher range to record about 150 CFM flow

Adjust Test Pressure to get about 10"

Click on Record or press <F1> to record 151.6 CFM

Click on Close to return to Main Screen.

Now you need to obtain the flow reading with both holes of the orifice open. Open both the big and small holes of the orifice plate. Set the Range to Range 9 on both the flow bench and on the FlowCom screen. When readings have stabilized, record the flow reading.

The old Test Correction was 1.021. For the new test, you obtained 151.6 CFM with the test orifices which SuperFlow rates at 153.2 CFM. Close the FlowCom screen and click on the Test Corr box to bring up the Test Correction calculation screen shown in Figure 4.20. Type in your results of 151.6 with a standard orifice plate rated at 153.2. This gives a new Test Correction of 1.032. This means the program will increase all CFM data 3.2% because the bench appears to be reading about 3.2% too low.

Note that the math here is not straightforward, because the 151.6 CFM reading was calculated using a Test Correction of 1.021. Without this correction, the CFM flow would have been 148.5 CFM ( $153.2/148.5 = 1.032$ ). See Figure 4.20.

Click on the Use Calc Value at the bottom of the Test Correction menu to load in this Test Correction. The program asks if 1.032 should be saved as the Test Correction for the Master Flow Bench specs also. Answer Yes, which means for all New Tests, 1.032 will be used until you go through the procedure again. Notice that the 151.6 CFM you recorded changes to 153.2 CFM with the new Test Correction of 1.032. This shows the Test Correction is working correctly because 153.2 CFM is what SuperFlow says the orifice should flow.

The Test Correction should always be between .900 and 1.100 and **should not change much from time to time**. If it was unusually high or low, or very different from the previous Test Correction, the program would warn you to check for errors. Performance Trends suggests not to overdo recalculating the Test Correction factor. Checking the Test Correction every 5 to 10 tests is about right. If the Test Corr stays pretty constant, you have a good flow bench and are probably doing things correctly. If the Test Correction changes a lot from check to check, you probably have a problem with the bench (intermittent leaks), are misunderstanding the procedure, or a not doing things the same from check to check.

Figure 4.20 Calculating Test Correction Factor

Click on Test Corr box to open Calc Test Correction menu.

Select this option to type in CFM readings

Type in the CFM flow you obtained with the orifice plate.

Click on Use Calc Value button to use the new Test Correction.

Click on Yes to keep this Test Correction with the Master Bench Specs.

Now remove the orifice plate and install the head on the bench with the correct bore adapter to flow Cylinder #1's intake port. (Be sure to record the bore adapter diameter in the Test Options menu.) It is necessary to first measure the CFM leakage.

Perform the check just as done for the orifice plate: set leakage to zero, close the valve and close off the port with tape, record flow with the FlowCom at Range 1, close FlowCom screen and type in the Leakage flow recorded of 2.2 CFM. As in Example 4.1, after entering 2.2 CFM Leakage, the CFM for Row 1 goes to zero. This shows the leakage correction factor is working properly.

Remove the tape from the port and open the FlowCom screen again. Since the first row at .000 valve lift has been filled in with the Leakage data, select Data Point #2 from the FlowCom screen. Notice that row #2 is now highlighted in the Test Data grid and the valve lift and Range from row #2 are filled in on the FlowCom screen. All you have to do is set the valve lift, set the Range and readjust flow control to maintain approximately 10" Test Pres. When this has been done, click on the Record command or press <F1>. The program will take 10 readings, average them, calculate CFM and fill the results in the Test Data grid, and advance to the next row. If the head being tested flows significantly different than the old head, you may need to change the Range on the FlowCom screen as needed.

Figure 4.21 Recording Data with FlowCom

After reopening the FlowCom screen after entering the Leakage #, click on Data Point #2 to advance to Row #2, .050" valve lift.

Note that Valve Lift & Range #s are loaded from the data already entered for this row in the Test Data grid.

All you need to do is set Test Pressure to about 10", set the range on the flow bench, and then press <F1> to record data.

The program points out settings not the same between the Port Flow Analyzer and FlowCom. These differences may not be important. See Tips on this page.

Tips using FlowCom:

The FlowCom can also calculate CFM based on readings which you must "type" into it. Typing into the FlowCom (basically pressing buttons like a hand calculator) is cumbersome and really is not even necessary. The Port Flow Analyzer is really only using the FlowCom to read pressures, temperatures, barometer and possibly swirl or tumble. It does not use the FlowCom's Range settings, leakage #, test pressure or flow direction (except for SF 1020 benches). Therefore, you do not need to make any changes to the FlowCom during the running of a test. The program is notifying you of difference between the FlowCom settings and the program settings mostly to explain why the FlowCom's CFM may not match what the program is calculating. **If the program's entries and flow bench specs are correct, then the CFM recorded by the program is correct.**

### Tips using FlowCom, cont:

Although many FlowCom settings are not critical, *the calibrations of the pressure and temperature sensors are critical.* Whenever you are recording data, double check that the manometers and dial thermometers are agreeing with the readings in the Port Flow Analyzer program. Pressures are more critical and should agree within 0.2 “ for Test Pressure and within 1% for Flow Pressure. Temperatures should agree within 3-5 degrees. If you are noticing difference greater than this, recalibrate your FlowCom following SuperFlow’s recommendations.

### Recording Port Velocity Data

After you have recorded CFM data at .600 Lift, the program will ask “Record Pitot Tube Velocities for .600 Valve Lift?” (Figure 4.22) because you selected to record Port Velocities at just .600 valve lift in the Test Options menu. Click on Yes and the FlowCom screen and the Main Screen will

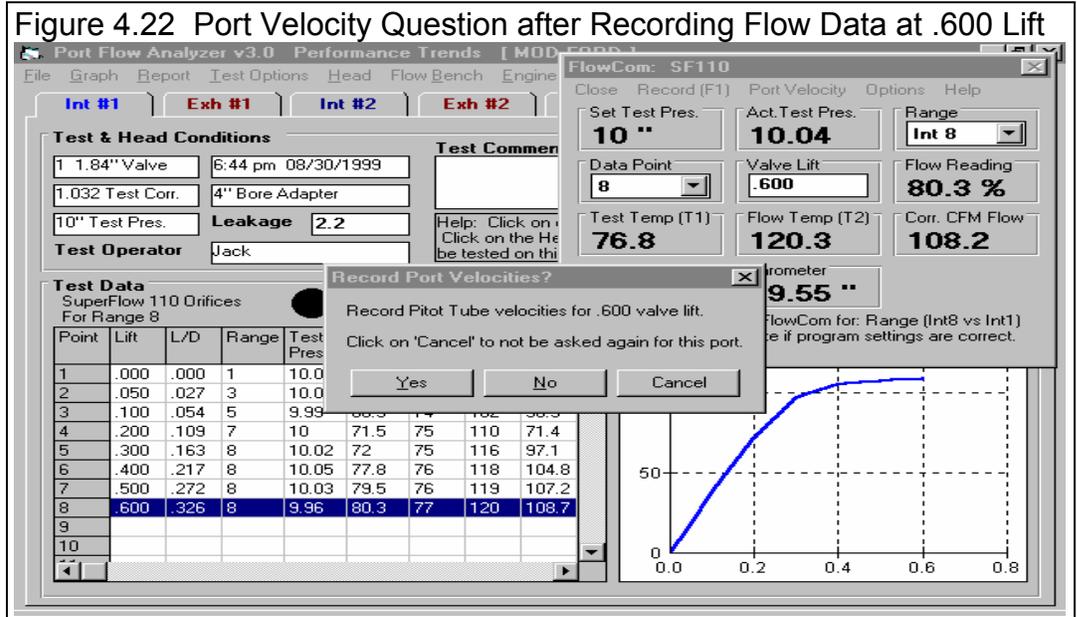
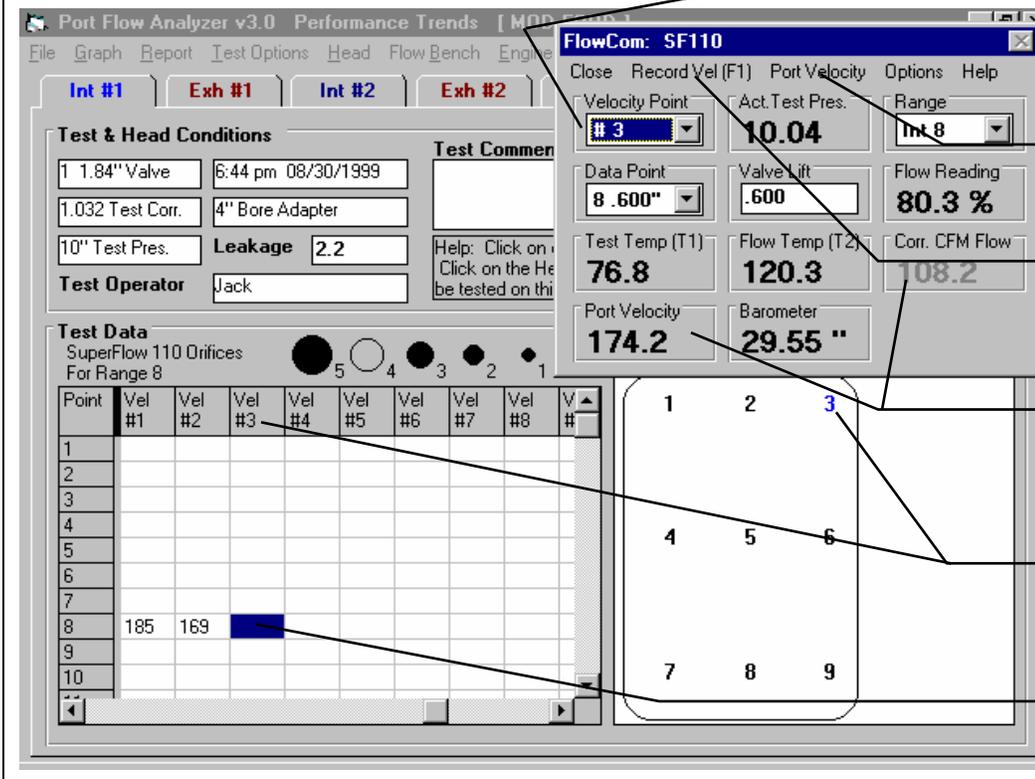


Figure 4.23 Recording Port Velocity (Pitot Tube) Data with FlowCom



Select which Velocity Point (Port Locations 1-9) here. When recording, this advances automatically.

Click here to start or stop recording port velocity readings.

Press <F1> to record port velocity when you have the pitot tube in the proper port location.

Port Velocity displayed in black, CFM in gray when recording port velocity.

Port Locations 1-9 shown in Port Layout diagram and at top of each column.

Velocities are entered automatically into the Test Data grid.

be somewhat rearranged to record Port Velocity readings. See Figure 4.23.

Position your Pitot tube in each of the 9 port locations indicated on the screen. While holding the Pitot Tube, press the <F1> key (easier than clicking on RecordVel). The computer will take 3 readings to average together as the port velocity for that port location. The average velocity will be loaded into the Test Data grid, and the data point will be advanced to the next location. When all 9 points have been recorded, the FlowCom screen will be converted back to that used for recording CFM flow.

## Remaining Ports

Now set up the head and flow bench to flow the exhaust port of #1 cylinder. Advance to Exhaust Port #1 in the program by closing the FlowCom screen and clicking on the "Exh #1" tab at the top of the Main Screen. The exhaust data pattern remaining from the XFRD185.PTI file is shown. Measure leakage and then record data with the FlowCom as done for the intake port.

When you have set and recorded CFM data for .600" lift, then record Pitot tube velocities as done with the intake port.

Continue flowing the remaining ports using the old data from the XFRD185.PTI file as the pattern.

After flowing the entire cylinder head, be sure to save your test file by clicking on File at the top, left of the Main Screen, then clicking on Save. Reports and graphs as shown in Examples 4.3 and 4.4 are now possible.

Note: There are many alternate ways to perform this flow test. For example, flow all the intake ports and then all the exhaust ports. This example is only one method used to illustrate the Port Flow Analyzer's commands and options.

# Example 4.3 Analyzing Cylinder Head Performance

The Port Flow Analyzer provides the user with a number of methods for comparing cylinder head performance, especially the Pro version. Cylinder heads designed to operate on the same engine can be compared as well as cylinder heads from different engine designs. This example assumes the user has already input the data and two Test Files exist, XCHV600.PTI and XCHVSTK.PTI which come with the Port Flow Analyzer program in the Examples folder.

Note: Files XCHV600.PTI and XCHVSTK.PTI have been changed to “Example SB Chevy on SF 600” and “Example SB Chevy Stock” in version 3.5.

XCHVSTK.PTI is a basically stock head with 1.94/1.50 valves, flowed at 20" test pressure (before porting). XCHV600.PTI is a test of the same head with major porting and 2.02/1.60 valves installed, flowed at 25" test pressure (after porting).

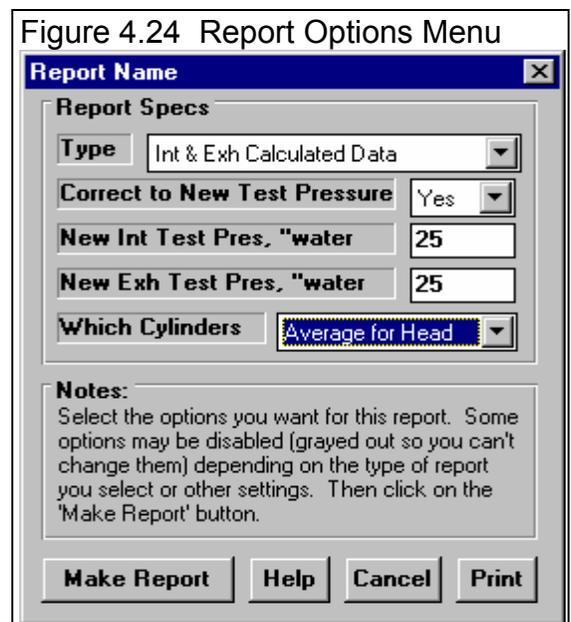
At the Main Screen, click on File, then Open (from all saved tests) to open the Flow Test Library. Open a copy of the XCHVSTK.PTI data from the Examples folder. The program will return you to the Main Screen.

## Calculated Data Reports

Select Reports from the Main Screen to obtain the Reports Options menu. Click on the down arrow key for “Types” of reports to open a list of Report Types. Before you do comparisons, it may be best to look at a report of *Calculated* results for 1 head. Select the Report Type of Int & Exh Calculated Results. Set the other report options as shown in Figure 4.24. These settings will produce a report of Intake and Exhaust Calculated Data, averaging all ports together, where the intake and exhaust results are both corrected to a test pressure of 25 “.

Trends to look for in calculated results, in reference to Figure 4.25 include:

- Corr CFM increases as valve Lift increases.
- VlvArea (valve area) increases with valve lift up to a point, then "tops out" at an L/D of .25 (valve lift equal to 1/4 of the valve's diameter). That is because now the limiting area is the valve throat area which does not increase with valve Lift.
- FlwArea (flow area) increases as CrCFM increases. The better flowing the head, the higher the FlwArea.
- Flow Coef or Flow Coefficient is an efficiency rating of the port and valve at each lift. The higher the Flow Coefficient, the higher the flow for the size of the valve or Vlv Area. A Flow Coef of 1.000 indicates the valve and port are very well designed for the size of the valve. A Flow Coef of .4 to .5 indicates the port and valve have a good amount of untapped potential. See Section 3.1 on Reports.



**Note:** As mentioned in Section 3.1, the setting of Use Seat Angle to Calc Vlv Area in the Preferences menu has a large effect on the VlvArea and Flow Coef calculation. In these examples, this spec is set to No to be consistent with the Basic version of Port Flow Analyzer and our Engine Analyzer programs.

Figure 4.25 Report of Int & Exh Calculated Results Averaged Across All Ports

The Port Type (Int vs Exh) and the number of data points averaged together are shown here.

Click on Report Types to open up the Reports Options menu.

This section shows a summary of critical specs for this head and test.

Port	Lift	L/D	Corr CFM	VlvArea sq.in.	CFM / sq.in.	FlwArea sq.in	Flow Coef.	Valve Velocity	Port Velocity	% Exh/Int
Int, 4 points	.097	.050	46.5	.591	78.62	.337	.571	188.7	44.3	
Int, 4 points	.194	.100	95.5	1.182	80.74	.693	.586	193.8	91.0	
Int, 4 points	.291	.150	140.1	1.774	79.02	1.018	.574	189.6	133.7	
Int, 4 points	.388	.200	163.8	2.365	69.25	1.189	.503	166.2	156.2	
Int, 4 points	.485	.250	169.7	2.865	59.23	1.232	.430	142.1	161.8	
Int, 4 points	.582	.300	173.0	2.865	60.38	1.256	.438	144.9	165.0	
Exh, 4 points	.075	.050	25.9	.353	73.23	.188	.532	175.7	36.6	55.7
Exh, 4 points	.150	.100	57.1	.707	80.83	.415	.587	194.0	80.8	59.9
Exh, 4 points	.225	.150	83.5	1.060	78.71	.606	.572	188.9	118.0	59.6
Exh, 4 points	.300	.200	106.7	1.414	75.49	.775	.548	181.2	150.9	65.2
Exh, 4 points	.375	.250	115.2	1.676	68.73	.837	.499	165.0	162.9	67.9
Exh, 4 points	.450	.300	116.1	1.676	69.28	.843	.503	166.3	164.2	67.1

- Flow Coef for most all ports is generally highest at low lifts and steadily drops as lift increases to an L/D of .25. At L/D greater than .25 Flow Coef may start to increase again. (Occasionally, Flow Coef may drop at very low lifts, L/D less than .05.)
- Since these heads are stock, the somewhat poor Flow Coefs being in the range of .4 to .6 is to be expected and *does* indicated that there is potential for a large improvement with porting.
- The %E/I should generally be between 60% and 90% for most all lifts. This head shows a range from 55% to 65% which is somewhat lower than expected. However, remember that this simple calculation does not consider the cam profile, which has a lot to do with what the engine actually “sees”. See the more accurate % Exh/Int calculation based on cam profile discussed in Section 3.1, page 78 and in Example 4.4.

### Comparison Reports (Pro version only)

Click on the Report Types menu command shown in Figure 4.25. to open the Report Options menu to select a new Report Type. This time select Compare Tests - CrCFM @Lift. This report will compare the CFM of the Current Test XCHVSTK.PTI with the CFM of another test you can pick from the library at approximately equal valve Lifts (Figure 4.26).

At the Report Options menu, notice that the Which Cylinders spec is disabled. That’s because comparison reports always compare the Average data for all cylinders. Intake and Exhaust Test Pressure are being used in the menu for making the report, because all comparison reports correct the data to this Test Pressure to ensure you are making valid comparisons. In this example, one test was recorded at 20" and one was recorded at 25". Both tests will be corrected to 25" for the comparison report as shown in Figure 4.26.

Figure 4.26 Report Options Menu

**Report Name**

**Report Specs**

Type: Compare Heads - CrCFM @Lift

Correct to New Test Pressure: Yes

New Int Test Pres, "water": 25

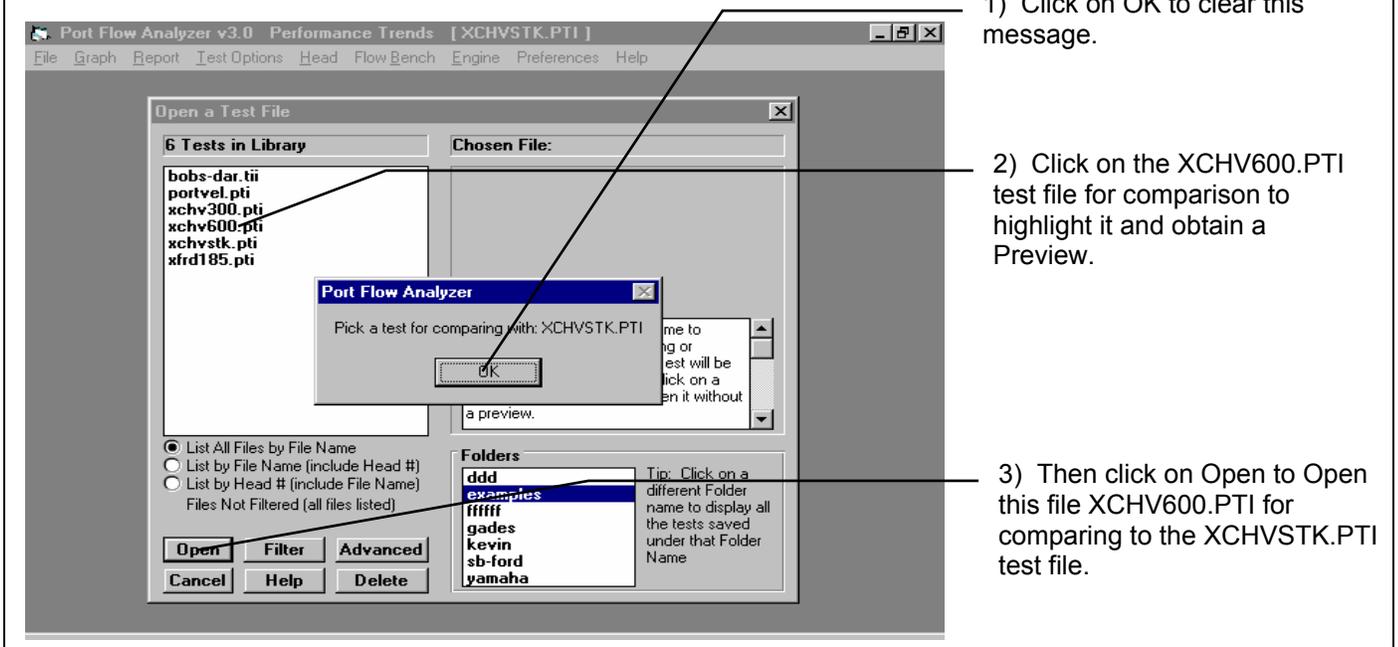
New Exh Test Pres, "water": 25

Which Cylinders: All Cylinders

**Notes:**  
Select the options you want for this report. Some options may be disabled (grayed out so you can't change them) depending on the type of report you select or other settings. Then click on the 'Make Report' button.

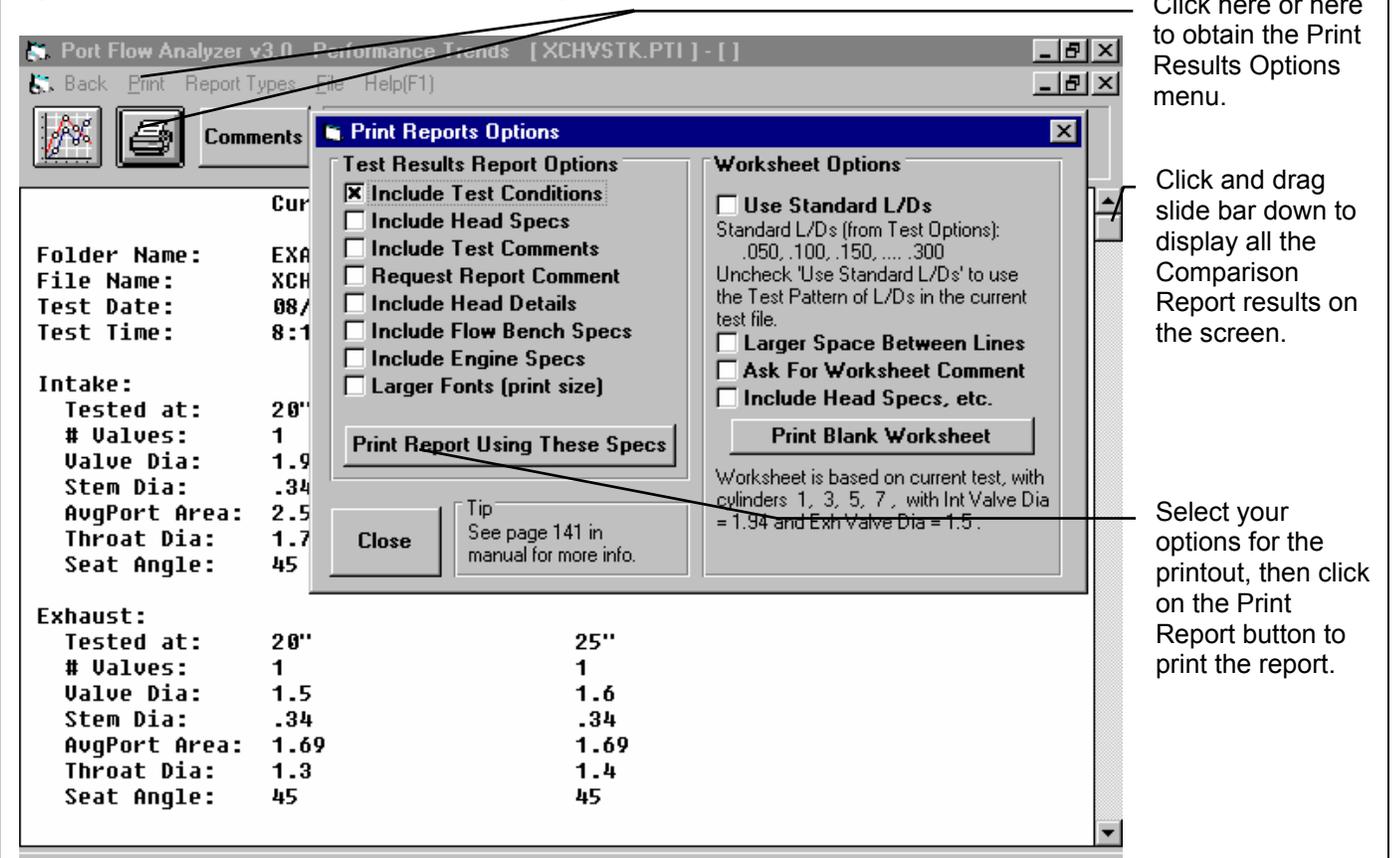
Make Report Help Cancel Print

Figure 4.27 Picking a Test File for Comparison



Click on the Make Report button in the Report Options menu. You will be shown the Flow Test Library where you can pick the test to compare with the current test. You highlight XCHV600.PTI and click on the Open button. See Figure 4.27.

Figure 4.28 Comparison Report Displayed with Printer Menu



When the report is completed, you are presented with a screen similar to Figure 4.28. Figure 4.28 also shows the Printer menu, which is obtained by clicking on the Printer menu command or the Printer button.. With options selected in the Printer menu, you will obtain the printed report shown in Figure 4.29.

Figure 4.29 Printout of the Compare Tests - CrCFM @ Lift Report

Port Flow Analyzer v3.0		Your name / company name can		This Report Printed:				
Test: XCHVSTK.PTI		go here. See Preferences.		3:19 pm 11-09-02				
Folder: examples		Performance Trends (C) 1999		Page: 1				
Report Comparing 2 Heads								
	Current Test			Comparison Test				
Folder Name:	examples			examples				
File Name:	XCHVSTK.PTI			XCHV600.PTI				
Test Date:	08/01/1996			08/01/1996				
Test Time:	8:14 PM			8:14 PM				
<b>Intake:</b>								
Tested at:	20"			25"				
# Valves:	1			1				
Valve Dia:	1.94			2.02				
Stem Dia:	.34			.34				
AvgPort Area:	2.52			2.52				
Throat Dia:	1.74			1.82				
Seat Angle:	45			45				
<b>Exhaust:</b>								
Tested at:	20"			25"				
# Valves:	1			1				
Valve Dia:	1.5			1.6				
Stem Dia:	.34			.34				
AvgPort Area:	1.69			1.69				
Throat Dia:	1.3			1.4				
Seat Angle:	45			45				
Port	# Pnts	Lift (in)	Avg CrCFM 20.0"	# Pnts	Lift (in)	Avg CrCFM 20.0"	--Difference-- CFM	%
Avg Intake	4	.097	41.8	4	.101	57.0	15.2	36.4
Avg Intake	4	.194	85.8	4	.202	114.1	28.3	33.0
Avg Intake	4	.291	126.0	4	.303	163.8	37.8	30.0
Avg Intake	4	.388	147.2	4	.404	195.2	48.0	32.6
Avg Intake	4	.485	152.5	4	.505	208.6	56.1	36.8
Avg Intake	4	.582	155.5	4	.606	217.3	61.8	39.7
Avg Exhaust	4	.075	23.0	4	.080	34.8	11.8	51.3
Avg Exhaust	4	.150	50.9	4	.160	70.6	19.7	38.7
Avg Exhaust	4	.225	74.3	4	.240	103.7	29.4	39.6
Avg Exhaust	4	.300	95.1	4	.320	131.8	36.7	38.6
Avg Exhaust	4	.375	102.6	4	.400	144.3	41.7	40.6
Avg Exhaust	4	.450	103.5	4	.480	145.7	42.2	40.8

**NOTE: Version 3.5 has greatly expanded the ability to compare individual ports on one head or between different heads in reports. Check "Cyl-Cyl Comparison Reports" in Appendix 7.**

**V3.5 B also has advanced Head Porter graph features. See Appendix 9.**

### Graphs

One way to check data for possible testing errors or port flow problems is to graph all cylinder's flow data together. This is done in the small Summary Graph at the Main Screen. You can also produce a larger version of this graph by clicking on Graph at the top of the Main Screen. You will open the Graph Options menu shown in Figure 4.30. Select the Graph Type of Corr Int & Exh CFM, Correct to New Test Pres to No, Which Cylinders to All Cylinders, and Horizontal X Axis to Lift, inches. You should obtain a graph as shown in Figure 4.31.

Figure 4.31 points out a couple of things:

- Most all port's flow curves are relatively smooth and show CFM always increasing with increasing lift. This indicates no *major* errors in entering the data.
- Cylinder #1's intake flows much better than the others intakes, which may be indicating some type of test error.
  - First, examine the raw data from cylinder #1. For example, perhaps an incorrect Leak CFM was entered for this cylinder.
  - You may want to repeat this test on cylinder #1. Perhaps a leak developed during the test, after Leak CFM was measured.
  - If you then believe cylinder #1 flows significantly better than the other cylinders, examine #1 intake port. You may see what makes it better and incorporate that characteristic into the other ports.
- Cylinder #7's exhaust has a sharp bend at .300" Lift, again indicating a possible test error. You may want to double check this point.

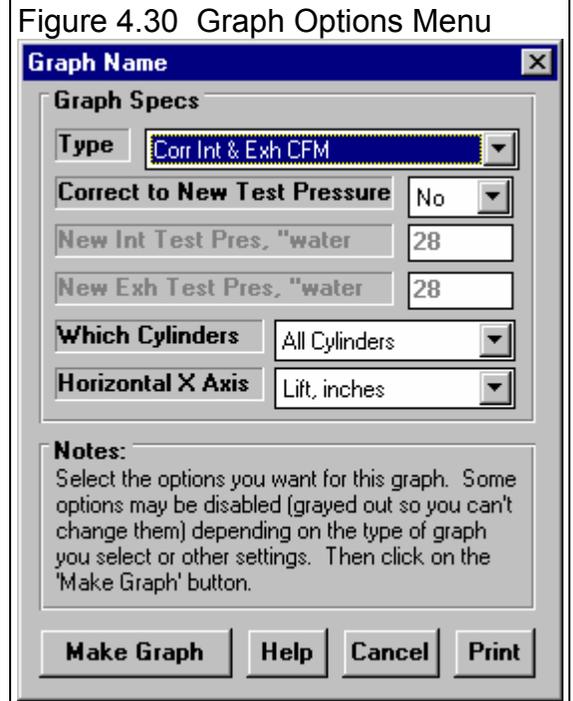
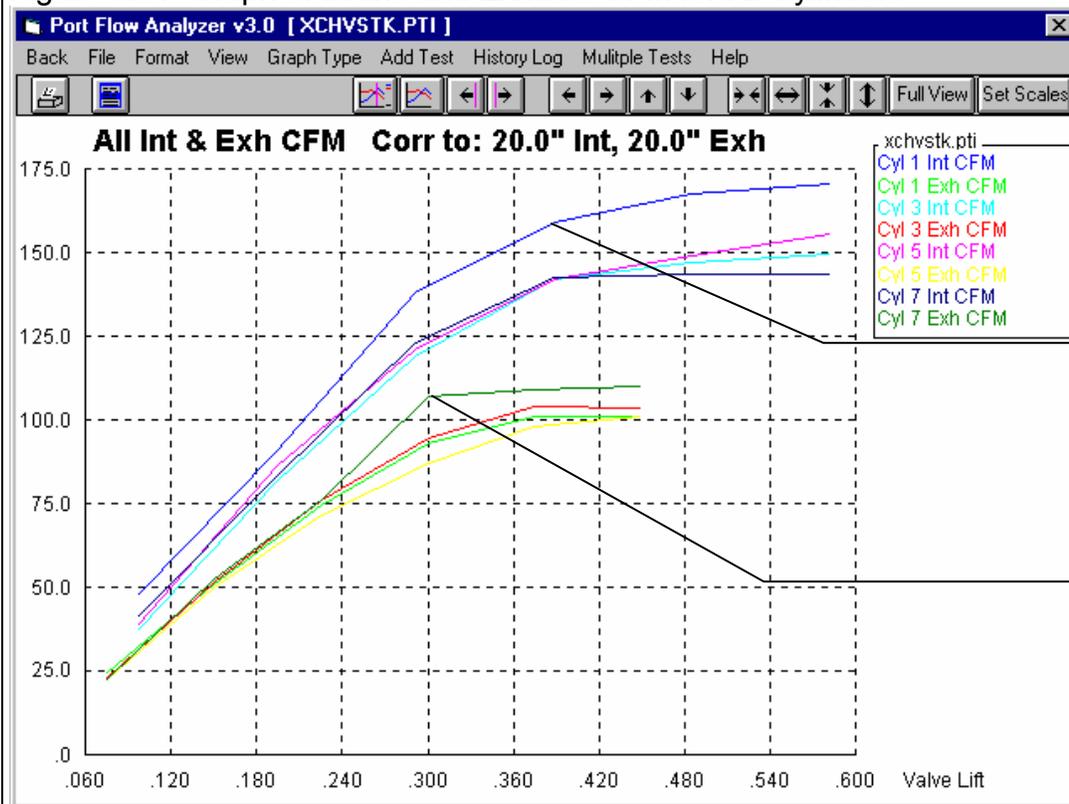


Figure 4.31 Graph of Intake and Exhaust CFM for All Cylinders



Note that Cylinder #1's Intake flow is significantly higher than the other cylinders at most all points.

Note the sharp bend in the Exhaust flow curve for Cylinder #7 at .300 lift.

Figure 4.32 Adding a Test to the Graph for Comparison

The screenshot shows the 'Open Test File' dialog box in Port Flow Analyzer v3.0. The dialog is titled 'Open Test File' and has a 'Chosen File: xchv600.pti'. It features a list of '6 Tests in Library' with 'xchv600.pti' highlighted. Below the list are radio buttons for 'List All Files by File Name', 'List by File Name (include Head #)', and 'List by Head # (include File Name)'. There are also buttons for 'Open', 'Filter', 'Advanced', 'Cancel', 'Help', and 'Delete'. A 'Preview' section shows intake and exhaust data for the selected file. A 'Folders' list includes 'ddd', 'examples', 'fffff', 'gades', 'kevin', 'sb-ford', and 'yamaha'. The background shows a graph with 'Valve Lift' on the x-axis (0.060 to 0.600) and CFM on the y-axis (0 to 175.0).

Click on Add Test to open the Open Test File screen to add another test to the graph.

Find the test you want to include in the graph and click on it to highlight it. You may need to search in different Folders.

After you have clicked on (highlighted) a test, click on the Open button to add it to the graph.

The Port Flow Analyzer also provides the user with the option of graphing data from 2 different heads on the same graph, called Multiple Tests graphs. From the Graph Screen, click on Add Graph to obtain the File Open screen for the entire Flow Test Library. Find the XCHV600.PTI test file in the Examples folder and click on it. This will add this test to the graph. (In the Pro version, you may also get some additional tests added, which were in the History Log and marked "Yes" to graph. If this is the case, click on History Log at the top of the Graph screen, and "un-mark" all tests other than XCHV600.PTI and the current test XCHVSTK.PTI for graphing.)

Figure 4.33 Comparison Graph of Current Test XCHVSTK.PTI with XCHV600.PTI, All Cylinders

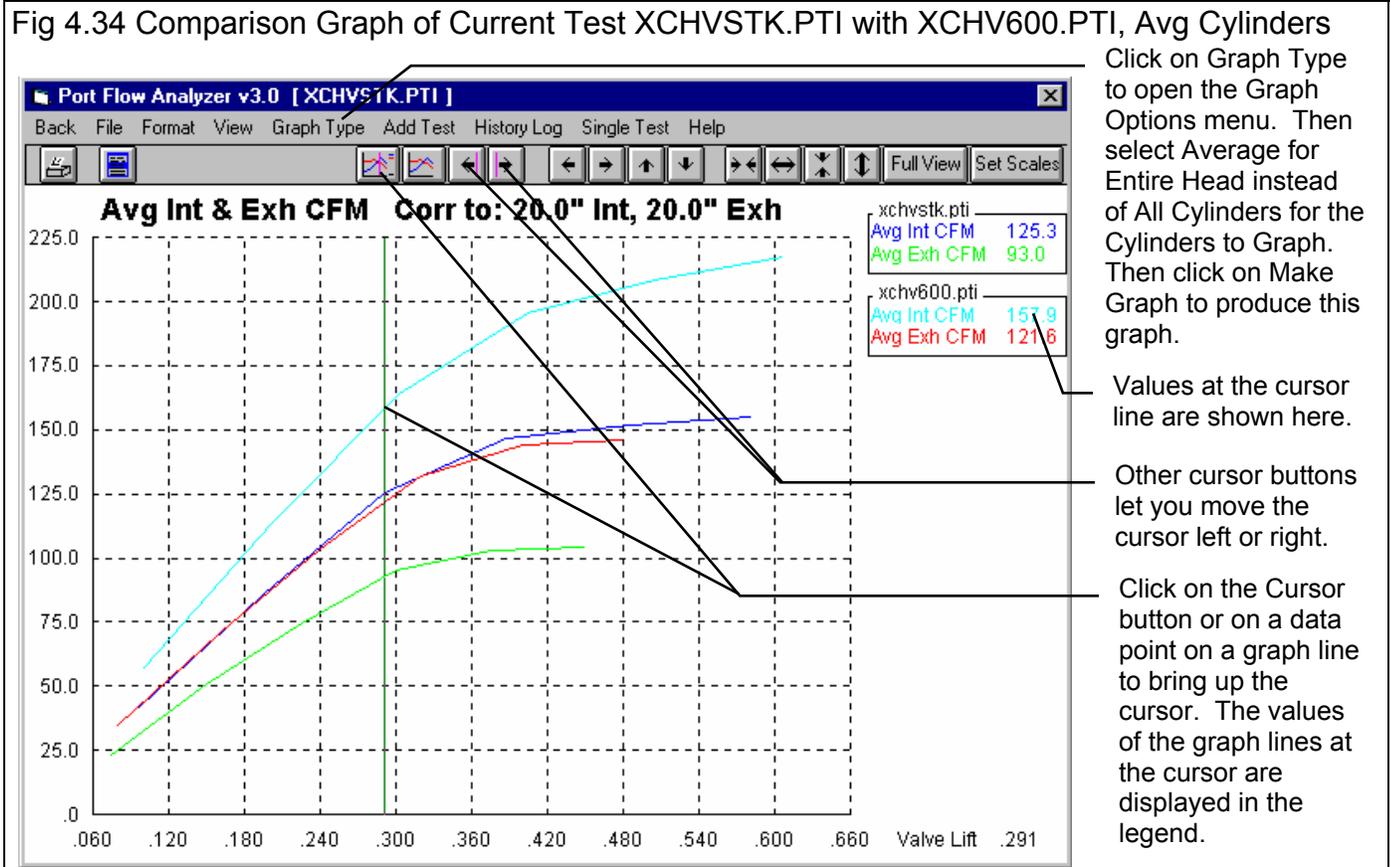
The screenshot shows a comparison graph in Port Flow Analyzer v3.0. The graph is titled 'All Int & Exh CFM Corr to: 20.0" Int, 20.0" Exh'. The x-axis is 'Valve Lift' (0.060 to 0.660) and the y-axis is 'All Int & Exh CFM' (0 to 225.0). The legend shows data for two tests: 'xchvstk.pti' and 'xchv600.pti', each with 7 cylinders (Cyl 1 Int CFM, Cyl 1 Exh CFM, Cyl 3 Int CFM, Cyl 3 Exh CFM, Cyl 5 Int CFM, Cyl 5 Exh CFM, Cyl 7 Int CFM, Cyl 7 Exh CFM). The graph shows that the 'xchv600.pti' test generally has higher CFM values than the 'xchvstk.pti' test across the range of valve lifts.

Because you did not ask to correct to a new test pressure, all tests are corrected to the test pressure of the Current Test.

Notice that all the cylinders for the added test are now included in the Legend.

The graph can appear quite cluttered, especially in black & white.

You can see that Figure 4.33 looks quite cluttered. If you click on Graph Type to open the Graph Options menu, you can change the Cylinders to Graph from All Cylinders to *Average for Head*. This will produce the graph of Figure 4.34, where you can more easily see that both the intake and exhaust of the XCHV600.PTI head flow much better than the XCHVSTK.PTI head. The exhaust on the modified port flows as well as the intake on the stock port.



Click on Graph Type to open the Graph Options menu. Then select Average for Entire Head instead of All Cylinders for the Cylinders to Graph. Then click on Make Graph to produce this graph.

Values at the cursor line are shown here.

Other cursor buttons let you move the cursor left or right.

Click on the Cursor button or on a data point on a graph line to bring up the cursor. The values of the graph lines at the cursor are displayed in the legend.

**NOTE: Version 3.5 has greatly expanded the ability to compare individual ports on one head or between different heads in graphs. Check Appendix 7.**

### Engine Graphs (Pro Version Only)

Another feature in the Pro version of Port Flow Analyzer is the ability to combine the head's flow curve with a cam profile for even more in-depth analysis. After all, how a head flows at a particular lift is only important for the amount of time the cam holds the valve at that lift. For example, how a head flows at .700" lift is not important if the cam only lifts the valve to .550" lift.

First, set the current Engine Specs to match an engine and cam you want to investigate. Click on Engine at the top of the Main Screen to obtain the Engine Specs menu shown in Figure 4.35. The Port Flow Analyzer provides several ways to fill in these cam and engine specs. You can:

- Enter or change any of these specs individually
- Click on the Cam Type combo box and pick an Example Cam to fill in most of the cam specs with one of the hundreds of example cams provided with the program
- Or click on File, then Open Example Engine (provided by Performance Trends) or Open Saved Engine (an engine which you have previously saved).

For this example, click on File, then Open Example Engine, then find the X350MOD.PTI engine file and open it. These specs represent a 350 Chevy with 230 duration cam with 105 lobe centers. Then click on Back (ok) to close the Engine Specs menu and return to the Main Screen. At the Main Screen, click on File, then Save to save the X350MOD.PTI engine specs to the XCHVSTK.PTI test file.

Next, Open the XCHV600.PTI test file by clicking on File, then Open (from all saved tests) at the Main Screen. Back at the Main Screen, click on Engine to open up the Engine Specs screen for this test file. Again, open the example engine file X350MOD.PTI, then click on Back (ok) to return to the Main Screen. Then save this file with these same engine specs.

Now you know that the 2 heads (test files) you want to compare are combined with the exact same engine specs. Any difference you see now in engine analysis will be due only to the head differences.

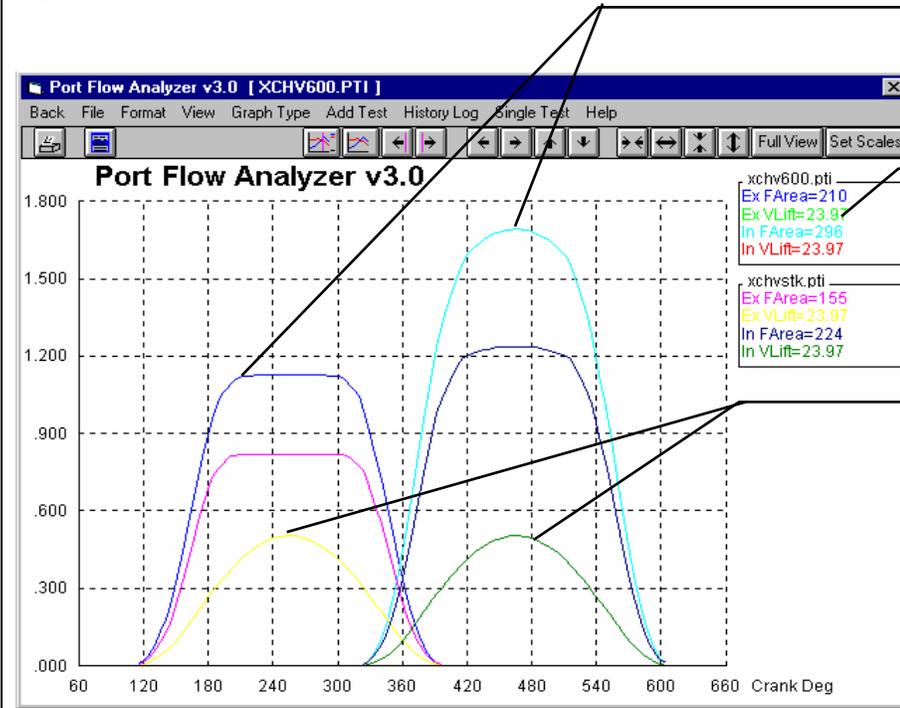
At the Main Screen, click on Graph, then select the Graph Type of "Int & Exh Flow Area+VlvLift". Then click on Make Graph to produce a graph similar to that shown in Figure 4.36.

Figure 4.35 Engine Specs Menu

Click on File, the Open Example Engine to find and open the X350MOD.PTI engine file.

Click here and pick the "Pick Example Cam" to load in cam specs from hundreds of example cams provided with the program.

Figure 4.36 Valve Lift and Flow Area Graphs



The XCHV600.PTI test shows significantly higher Flow Area, especially at higher valve lifts.

The Legend includes the total Flow Area and Lobe Area for all Flow Area and Valve Lift graphs. See Section 3.1, Engine Performance Estimate report for an explanation of these areas.

The Valve Lift graphs are directly on top of each other for the 2 tests. This confirms the both test files are using the exact same set of Cam Specs.

Notice in the graph legend the numbers labeled IFAr and EFAr. This is the Intake and Exhaust Flow Areas graphed. These will match the flow areas given in Eng. Performance Estimate reports as discussed in Example 4.4. Table 4.1 shows a comparison of the 2 heads with this particular cam.

**Table 4.1 Flow Area Comparison of 2 Heads**

<b>Test (head)</b>	<b>XCHVSTK.PTI</b>	<b>XCHV600.PTI</b>	<b>Improvement</b>
IFAr	224	296	32%
EF Ar	155	210	35%
% Exh/Int	69%	71%	2%

Table 4.1 shows that with this cam, the heads flow 32% better on the intake and 35% better on the exhaust. The % Exh/Int has also increased from 69% to 71%. If you did this same comparison with a different cam, the results would be different. For example, if you specified a larger exhaust cam lobe or rocker arm ratio, the % Exh/Int would increase.



# Example 4.4 Engine Performance Estimate Report (Pro version only)

The Pro version of Port Flow Analyzer provides an engine performance prediction function allowing the user to compare cylinder head, camshaft, and other variables on predicted torque, horsepower, idle vacuum, etc. The Eng. Performance Estimate reports are made at the estimated torque peak and horsepower peak RPMs. The following example will demonstrate how this predictive feature can be used to evaluate cylinder head and camshaft modifications on engine performance.

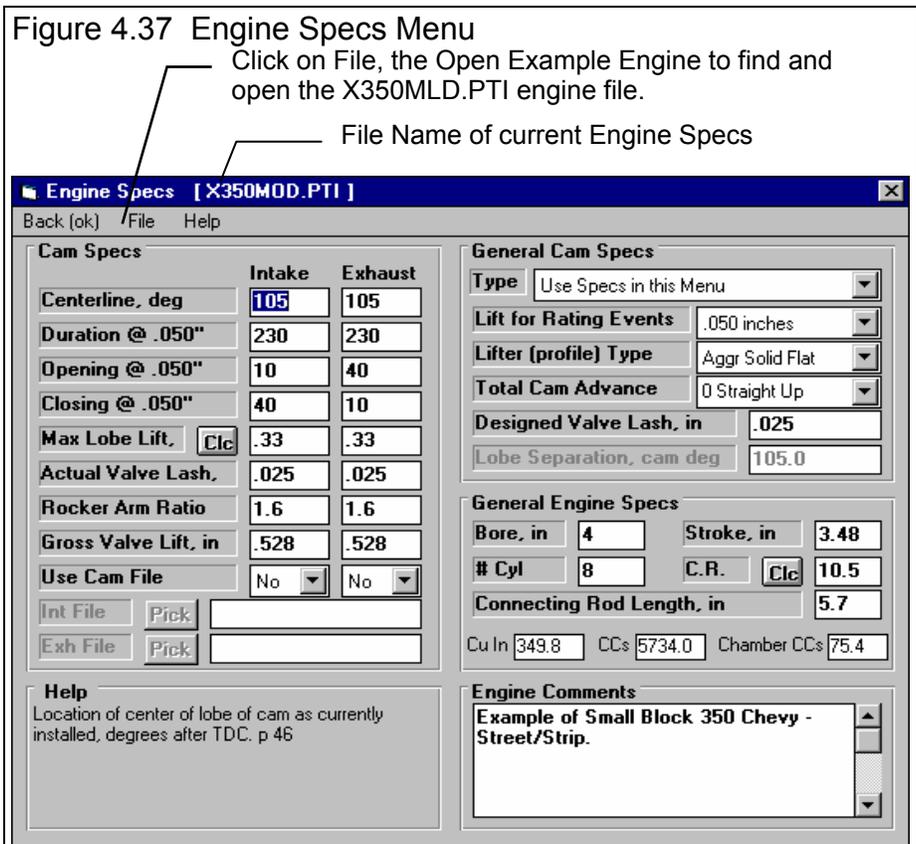
*Note: Performance Trends Engine Analyzer programs (standard and Pro versions) can do much more detailed and accurate estimates of engine performance. The calculations done in the Port Flow Analyzer are rather simplistic compared to these more detailed programs.*

This example will assume your customer has a 350 Chevy (750 CFM carb, single plane manifold with a mild cam) which sees some drag strip use, but is primarily for the street. His current heads are the XCHVSTK.PTI heads in the Flow Test Library. You have just finished installing 2.02/1.60 valves, porting and flowing these heads. These are the XCHV600.PTI heads in the Test File Library. You want to estimate a HP potential improvement and determine if the current cam is sufficient.

At the Main Screen, click on File, then Open (from all saved tests) to open the XCHVSTK.PTI test file from the Examples folder. Back at the Main Screen, click on Engine to open the Engine Specs menu. At the Engine Specs menu, click on File, then Open Example Engine to open the X350MLD.PTI engine file. The program displays the Example Engine Library provided with the program by Performance Trends. These files represent different engine/camshaft combinations which have been created with the Port Flow Analyzer. You can also add other combos to a similar library called Saved Engines. Click on X350MLD.PTI and then click on the Open button.

The program will return you to the Engine Specs menu so you can see the specs for this file. Also note that the Current Engine is X350MLD.PTI at the top of this menu. While reviewing the Engine Specs data file for X350MLD.PTI, you see it is a 4.00 x 3.48 350 CID V-8 with 9.3 compression, and a very mild cam. (The MLD in X350MLD.PTI stands for mild cam.) Return to the Main Screen by clicking on Back (ok) at the top left of the menu or pressing the <Exc> key. (This is very similar to what was done in Example 4.3 to make Engine Graphs.)

By opening the XCHVSTK.PTI Flow Test and the X350MLD.PTI Engine Specs file, you have basically "installed" the XCHVSTK.PTI heads on the X350MLD.PTI engine.



At the Main Screen, select the Make Reports option, and pick the Report Type of Eng. Performance Estimate. All other Make Reports specs are now disabled as they have no affect on the report. Click on the Make Report button to make the report.

The calculated results are displayed on the computer screen, and you can click on the slide bar buttons on the right to display all the results on the screen. See Figure 4.38. Figure 4.39 is a printed hardcopy of this report obtained by clicking on the Print command or Printer button at top of the Reports screen. Important values are summarized in Table 4.2 in Column A. Major points illustrated by Figure 4.39 include:

- The report indicates a stock torque peak of 376 ft lbs at 3600 RPM and a stock HP peak of 285 HP at 4600 RPM. (These figures may look high, but the Port Flow Analyzer is basically assuming a "race engine" condition. This is the engine's potential with open race headers, race intake, 29.92 barometer and 60 deg F correction factor, high octane fuel and optimum spark advance, minimum accessories, etc.)
- At the HP peak RPM of 4600, the piston speed is a relatively "low stress" 2668 ft/minute.
- For this low revving engine combination, the program used an intake runner with 1.79" diameter runners on the intake (10" long). This diameter is not necessarily optimum, but is the Avg Port Dia in the XCHVSTK.PTI head specs. The program chose to use 1.5" headers with 52.2" primaries (as measured from the intake valve). These are the runner specs which produced the estimated torque and HP. Much more detailed simulations are available with the Performance Trends line of Engine Analyzer programs.
- The program recommends a much smaller intake port volume of 137 CCs versus the existing 186 CCs. (This will change with a different selection of cam, or different intake than what the program is assuming, or heads with different flow capabilities.)
- An estimated idle vacuum of 14.6 " Mercury. Although his engine may actually idle at a different vacuum, this number is useful to judge any change in idle vacuum from changes in head flow or cam specs.
- The total % Exh/Int Flow Area for these heads with this cam is a very acceptable 75.8 %.

Figure 4.38 Engine Performance Estimate Report

Click here to print report.

Click and slide this button down to see all of the report.

Section describing estimated torque peak.

Section describing estimate HP peak.

Report of:	Test Time	Tested at	Corr to	# Vlvs	Vlv Dia	Stem Dia	Port Area
Engine Perf.	8:14 PM	Int: 20"	25.0"	1	1.94"	.34"	2.52 sq in
	08/01/1996	Exh: 20"	25.0"	1	1.5"	.34"	1.70 sq in

**Engine Summary:** Current Head / Folder: XCHUSTK.PTI / EXAMPLES  
Current Engine & Cam: X350MLD.PTI

**Performance Potential At Est Tq Peak: 3600**

Torque, Ft Lbs	376	Horsepower	258
Air Flow, CFM	337	Volumetric Eff, %	92.5
Fuel Flow, lb/hr	124	Piston Speed, Ft/Min	2088

**Performance Potential At Est HP Peak: 4600**

Torque, Ft Lbs	325	Horsepower	285
Air Flow, CFM	403	Volumetric Eff, %	86.5
Fuel Flow, lb/hr	148	Piston Speed, Ft/Min	2668

**Runners Used to Est Perf (may not be optimum, 1 int & 1 exh rnr/cyl):**

Int Runner Length, in	10.0	Exh Header Pri Len, in	52.2
Int Runner Avg Area, sqin	2.52	(measured from valve)	
Int Runner Avg Dia, in	1.79	Exh Header O.D., in	1.50

**Intake Port Volume in CCs (for 1 port, 4.5 inches long):**

Vol Used to Est Perf	186	Suggested Port Volume	137
(Port Dia-Head Specs)		(10" runner, 4600 RPM)	

**Calculated Results:**

Int Valve Lift, in	.375	Exh Valve Lift, in	.375
Int Duration @ .050"	204.0	Exh Duration @ .050"	216.0

Figure 4.39 Printout of Eng. Perf. Estimate Report (original XCHVSTK.PTI heads, mild cam)

Port Flow Analyzer v3.0 Test: XCHVSTK.PTI Folder: CHEV		Performance Trends (C) 1999 Your name / company name can go here. See Preferences.		This Report Printed: 9:49 am 09-09-99 Page: 1			
Head #: Customer: Johnson Operator:		Bore Adapter Diameter: " Int Port Adapter: Exh Port Adapter:					
Report of:	Test Time	Tested at	Corr to	# Vlvs	Vlv Dia	Stem Dia	Port Area
Engine Performance	8:14 PM 08/01/1996	Int: 20" Exh: 20"	25.0" 25.0"	1 1	1.94" 1.5"	.34" .34"	2.52 sq in 1.70 sq in
Engine Summary:		Current Head / Folder: XCHVSTK.PTI / CHEV Current Engine & Cam: X350MLD.PTI					
Performance Potential At Est Tq Peak: 3600							
Torque, Ft Lbs	376	Horsepower	258				
Air Flow, CFM	337	Volumetric Eff, %	92.5				
Fuel Flow, lb/hr	124	Piston Speed, Ft/Min	2088				
Performance Potential At Est HP Peak: 4600							
Torque, Ft Lbs	325	Horsepower	285				
Air Flow, CFM	403	Volumetric Eff, %	86.5				
Fuel Flow, lb/hr	148	Piston Speed, Ft/Min	2668				
Runners Used to Est Perf (may not be optimum, 1 int & 1 exh rnr/cyl):							
Int Runner Length, in	10.0	Exh Header Pri Len, in	52.2				
Int Runner Avg Area, sqin	2.52	(measured from valve)					
Int Runner Avg Dia, in	1.79	Exh Header O.D., in	1.50				
Intake Port Volume in CCs (for 1 port, 4.5 inches long):							
Vol Used to Est Perf	186	Suggested Port Volume	137				
(Port Dia-Head Specs)		(10" runner, 4600 RPM)					
Calculated Results:							
Int Valve Lift, in	.375	Exh Valve Lift, in	.375				
Int Duration @ .050"	204.0	Exh Duration @ .050"	216.0				
Int Lobe Center	106.0	Exh Lobe Center	96.0				
Eff Int Lobe Area, Deg*In	18.02	Eff Exh Lobe Area, Deg*In	19.07				
Int Flow Area, Deg*SqIn	181.4	Exh Flow Area, Deg*SqIn	137.6				
Lobe Separation	101.0	Lifter Type	HydFlat				
Ovlp Flow Area, Deg*SqIn	7.5	Ovlp Lobe Area, Deg*In	.22				
Est Cranking Comp, PSI	183	Est Idle Vacuum, "Hg	14.6				
% Exh/Int Flow Area	75.8						
Engine Disp., cu in	349.8	Engine Disp., liters	5.73				
Compression Ratio	9.30	Clearance Volume, ccs	86.3				
Engine File: X350MLD.PTI							
Engine Comments: Example of Small Block 350 Chevy - Mild Production Cam.							
Detailed Cam Specs	Intake	Exhaust	General Cam Specs				
Centerline, deg ATDC	106	96	Type:	Use Specs in this Menu			
Duration @ .050"	204	216	Rated Valve Lift:	.050 inches			
Opening @ .050"	-4	24	Profile Type:	Mild Hyd Flat			
Closing @ .050"	28	12	Total Cam Advance	5.0 Retard			
Max Lobe Lift, in	.25	.25	Designed Valve Lash, in	.026			
Actual Valve Lash, in	.026	.028	Lobe Separation, cam deg	101.0			
Rocker Arm Ratio	1.5	1.5	General Engine Specs				
Gross Valve Lift, in	.375	.375	Bore, in	4			
			Stroke, in	3.48			
			# Cyl	8			
			C.R.	9.3			
			Connecting Rod Length, in	5.7			

Figure 4.40 Printout of Eng. Perf. Estimate Report (ported XCHV600.PTI heads, mild cam)

Port Flow Analyzer v3.0		Performance Trends (C) 1999		This Report Printed:			
Test: XCHV600.PTI		Your name / company name can		9:50 am 09-09-99			
Folder: CHEV		go here. See Preferences.		Page: 1			
Head #:		Bore Adapter Diameter: "					
Customer: Johnson		Int Port Adapter:					
Operator:		Exh Port Adapter:					
Report of:	Test Time	Tested at	Corr to	# Vlvs	Vlv Dia	Stem Dia	Port Area
Engine Performance	8:14 PM	Int: 25"	25.0"	1	2.02"	.34"	2.52 sq in
	08/01/1996	Exh: 25"	25.0"	1	1.6"	.34"	1.70 sq in
Engine Summary:		Current Head / Folder: XCHV600.PTI / CHEV					
		Current Engine & Cam: X350MLD.PTI					
Performance Potential At Est Tq Peak: 4600							
Torque, Ft Lbs	392	Horsepower	343				
Air Flow, CFM	458	Volumetric Eff, %	98.4				
Fuel Flow, lb/hr	168	Piston Speed, Ft/Min	2668				
Performance Potential At Est HP Peak: 5400							
Torque, Ft Lbs	368	Horsepower	378				
Air Flow, CFM	530	Volumetric Eff, %	97.0				
Fuel Flow, lb/hr	194	Piston Speed, Ft/Min	3132				
Runners Used to Est Perf (may not be optimum, 1 int & 1 exh rnr/cyl):							
Int Runner Length, in	10.0	Exh Header Pri Len, in	37.9				
Int Runner Avg Area, sqin	2.52	(measured from valve)					
Int Runner Avg Dia, in	1.79	Exh Header O.D., in	1.75				
Intake Port Volume in CCs (for 1 port, 4.5 inches long):							
Vol Used to Est Perf	186	Suggested Port Volume	161				
(Port Dia-Head Specs)		(10" runner, 5400 RPM)					
Calculated Results:							
Int Valve Lift, in	.375	Exh Valve Lift, in	.375				
Int Duration @ .050"	204.0	Exh Duration @ .050"	216.0				
Int Lobe Center	106.0	Exh Lobe Center	96.0				
Eff Int Lobe Area, Deg*In	18.02	Eff Exh Lobe Area, Deg*In	19.07				
Int Flow Area, Deg*SqIn	233.5	Exh Flow Area, Deg*SqIn	184.0				
Lobe Separation	101.0	Lifter Type	HydFlat				
Ovlp Flow Area, Deg*SqIn	10.2	Ovlp Lobe Area, Deg*In	.22				
Est Cranking Comp, PSI	183	Est Idle Vacuum, "Hg	13.0				
% Exh/Int Flow Area	78.8						
Engine Disp., cu in	349.8	Engine Disp., liters	5.73				
Compression Ratio	9.30	Clearance Volume, ccs	86.3				
Engine File: X350MLD.PTI							
Engine Comments:							
Example of Small Block 350 Chevy - Mild Production Cam.							
Detailed Cam Specs	Intake	Exhaust	General Cam Specs				
Centerline, deg ATDC	106	96	Type:	Use Specs in this Menu			
Duration @ .050"	204	216	Rated Valve Lift:	.050 inches			
Opening @ .050"	-4	24	Profile Type:	Mild Hyd Flat			
Closing @ .050"	28	12	Total Cam Advance	5.0 Retard			
Max Lobe Lift, in	.25	.25	Designed Valve Lash, in	.026			
Actual Valve Lash, in	.026	.028	Lobe Separation, cam deg	101.0			
Rocker Arm Ratio	1.5	1.5	General Engine Specs				
Gross Valve Lift, in	.375	.375	Bore, in	4			
			Stroke, in	3.48			
			# Cyl	8			
			C.R.	9.3			
			Connecting Rod Length, in	5.7			

Return to the Main Screen by clicking on Back (ok) and open the XCHV600.PTI flow test file. Go into the Engine Specs and open the X350MLD.PTI engine file, then click on Back (ok) to return to the Main Screen. Click on Reports and make another Eng. Performance Estimate report. These calculations will be for the same short block (Engine Specs) with the new ported heads with larger valves. A summary of important parameters is given in Table 4.2 in Column B.

Table 4.2 shows a torque increase of 16 ft lb, and a HP increase of nearly 100 HP. Although you (the head porter) think this is quite good, the customer seems disappointed. So you run another report, this time with a bigger cam.

You return to the Main Screen and go into the Engine Specs menu and open the X350MOD.PTI Example engine file. This has a much larger, solid cam and slightly higher compression ratio. You make another Eng. Performance Estimate report, which is summarized in column C in Table 4.2.

With the cam and compression change, you show the customer the heads have the potential of nearly 500 HP at 6500 RPM. *However, you caution him that revving the engine to 6500 increases the stress on the rods and pistons. Piston speed has increased from the stock 2668 at the HP peak to 3770 ft/min. If he were to rev this new, proposed engine to 6500 or beyond, he will need "race engine" quality internal engine parts.*

**Table 4.2 Comparison of Performance Potential of Different Combos**

Heads	XCHVSTK.PTI (A)	XCHV600.PTI (B)	XCHV600.PTI (C)
Cam/Eng	XCHVMLD.PTI	XCHVMLD.PTI	XCHVMOD.PTI
Peak Torque	376	392	430
Peak Tq RPM	3600	4600	5100
Peak HP	285	378	486
Peak HP RPM	4600	5400	6500
Piston Speed	2668	3132	3770
Rec Int Port CCs	137	161	193
Idle Vac	14.6	13.0	14.1
% Exh/Int	75.8	78.8	71.0

Additional points shown in Table 4.2 include:

- The recommended Intake Port Volume increased with an increase in head flow potential and cam size. The higher the engine's operating RPM range, the larger the required port volume.
- Idle vacuum dropped about 1.5" with the better flowing XCHV600.PTI heads with larger valves. However, the X350MOD.PTI engine with higher compression and wider lobe centerlines increased the idle vacuum back to about 14".
- The % Exh/Int flow area remained in an acceptable range of around 75% for all combinations. The last combo showed only 71.0% which is slightly less than recommended "rule of thumb" 75%. The X350MOD.PTI cam may require a couple degrees more exhaust duration or higher exhaust rocker arm ratio to obtain the desired 75%. (If this engine was going to use nitrous oxide or be supercharged, you would want to shoot for 85% Exh/Int.)



# Appendix 1: Accuracy and Assumptions

## Assumptions:

The following paragraphs list some of the major assumptions made by the Port Flow Analyzer. These assumptions will help you understand the calculations and limitations of the program. Other assumptions are listed in this manual and can be located through the Index under Assumptions:

Measurement orifices for custom benches are "sharp edged" orifices whose flow is proportional to the square of the pressure drop (Flow Pressure).

The flow through the cylinder head's port and valve is proportional to the square of the pressure drop (Test Pressure), similar to a "sharp edged" orifice.

Eng. Performance Estimates in the Pro version are based on numerous assumptions and should be only used for comparisons. Your actual engine performance may differ significantly. The Port Flow Analyzer assumes "race engine" conditions, so its estimates may be higher than your engine. Performance Trends' Engine Analyzer programs can provide more accurate estimates of engine performance. See Example 4.4.

## Accuracy:

There are many types of calculations being performed by the Port Flow Analyzer. The accuracy of two major types is discussed below.

### CFM Measurements:

CFM measurements are based on the process for calculating CFM outlined on page 17 under CFM. Since the computer's calculations are the same as calculations done by hand, you may be surprised to find that the Port Flow Analyzer will probably improve CFM measurements calculated by hand. These accuracy improvements come from:

- Correcting for small errors in maintaining Test Pressure.
- Reducing "round off" errors.
- Ensuring that all calculations are performed exactly the same way and proper way for each data point.
- Recording data electronically with SuperFlow's FlowCom (tm) or Performance Trends Electronic Interface can significantly improve accuracy and repeatability (and save time). One reason is because the Port Flow Analyzer takes several readings to average together for the final, recorded reading. This improves accuracy, especially for reading "bouncing" manometers. The electronics also have greater reading resolution, where they can read the difference between 70.1% vs 70.2% Flow Pressure. The human eye can not see differences that small.

Although, the procedures listed above (except for those concerning electronics) can all be done with hand calculations, by making these steps automatic and easy, they are more likely to actually happen all the time.

Any errors in Flow Bench Specs, and Flow Pressure, Test Pressure, Flow Temperature, Test Temperature, Leak CFM measurements (or Test Correction Factor for SF 110 benches) entered into the program will result in errors in CFM calculations. All measurements have small measurement errors associated with them. The more measurements which enter into a calculation, the more likely chance for significant errors. However, some measurements are more important than others. For example, a 5 degree error in temperature is not as important as a 5% error in Flow Pressure.

In general, the accuracy of production flow benches (with "flowed" measurement orifices) near their maximum flow rate should be within 3% of true CFM. At low flow rates, the accuracy will be worse. Custom flow benches can give very *repeatable* numbers. However, unless they are calibrated carefully, their *accuracy* is likely to be worse than production flow benches. See Appendix 2 and Appendix 3 for tips to minimize measurement errors.

### Report of Eng. Performance Potential:

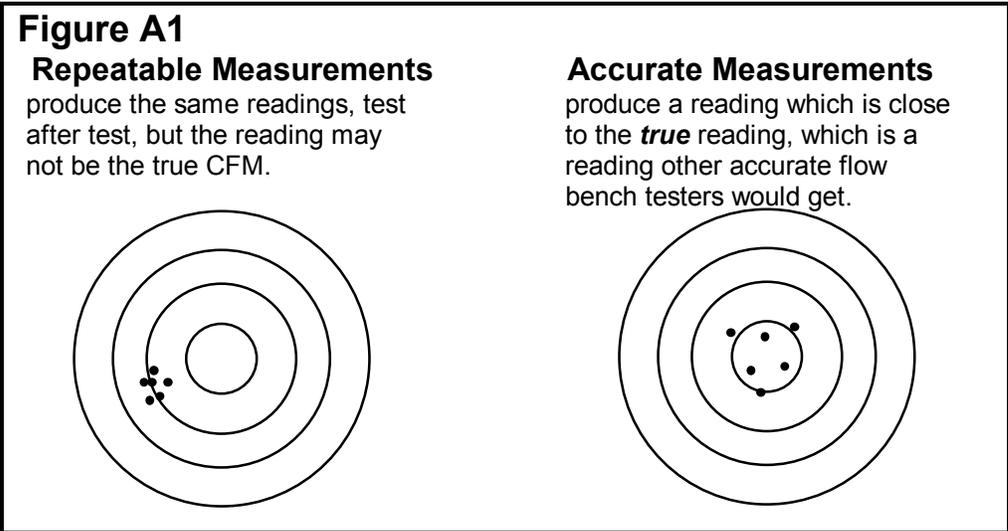
This report is meant only as a guide to show general trends for various combinations of head flow, cam specs and engine specs. Section 1.3 A Word of Caution, 3.1 Reports and Example 4.4 describe the limitations of these calculations.

## Repeatability:

The difference between *repeatability* and *accuracy* is a concept few people understand. Graphically, accuracy and repeatability is shown in Figure A.1. Think of the flow bench as an "archer" which is trying to hit the "bulls eye" or the true CFM measurement. Let's say the true CFM was 150 CFM, but one flow bench always comes up with values between 142 to 143 CFM. This flow bench is not very accurate, but is very repeatable (only a 1 CFM spread in data). Another flow bench comes up with measurements which vary from 145 to 155 CFM, which average out to the true 150 CFM. This flow bench with the 10 CFM spread in data is not nearly as repeatable as the first, but is more accurate.

Ideally, you want both a repeatable and accurate flow bench, but this is not always possible. When are accurate measurements and repeatable measurements most desirable?

- If you very accurately want to determine if a modification (for example, changing the "short side radius" of a port) has improved the flow, the repeatable flow bench is the one to use.
- If you want flow numbers to use in a magazine article, for other people to compare their flow numbers with, you are better off with the accurate flow bench.
- If you want flow numbers to use in an engine simulation computer program, you are better off with the accurate flow bench.



The concepts of repeatability and accuracy are further examined in Appendix 3.

# Appendix 2: Calibrating a Custom Flow Bench

The Port Flow Analyzer can be configured to work with custom flow benches. The program works best if the bench measures air flow by measuring the pressure drop across an orifice, like typical SuperFlow benches. The custom bench can be either Orifice Center like a SuperFlow 300 or 600, or Blower Center like a SuperFlow 110. See Section 2.0, page 12, for Orifice Center vs Blower Center flow bench definitions.

You can also use an air measurement which reads in CFM directly and set the Test Option of CFM Flow to "Enter CFM Directly". For other types of benches (Pitot tube, laminar air flow, etc), contact Performance Trends for details.

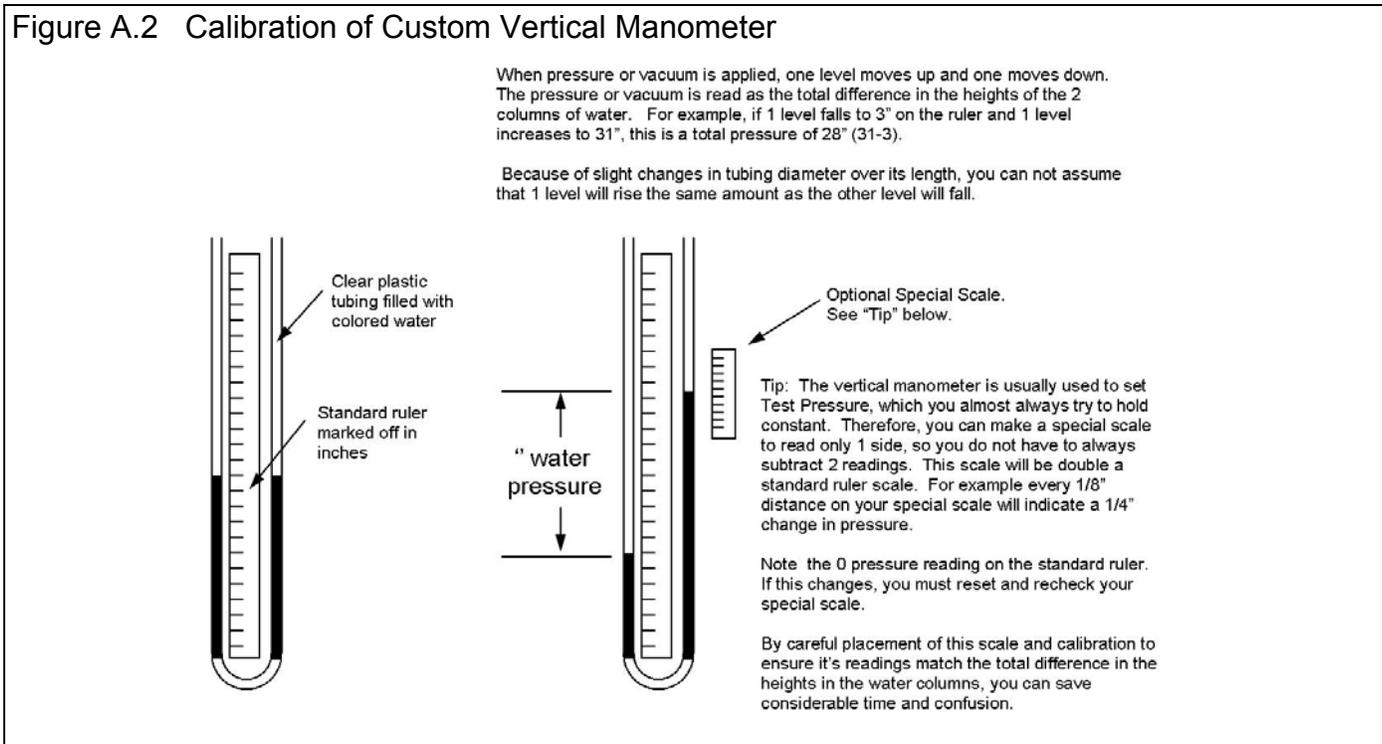
## Manometers

The manometers to measure pressure are critical for accurate air flow measurements. Dwyer Instruments (Michigan City, Indiana at 219-879-8000) is a good source if you purchase manometers. This appendix also discusses "home made" manometers.

### Vertical manometer to measure Test Pressure

Purchased vertical manometers are usually calibrated in inches of water and can be used directly. Home made vertical manometers are easy to construct as shown in Figure A.2. You can use a standard ruler or yardstick if the fluid is water. Other fluids require different scales.

Note: Home made manometers are easy to over-pressure and blow the water out, requiring refilling. Also, the water can get into your bench causing problems.



### Inclined manometer to measure Flow Pressure

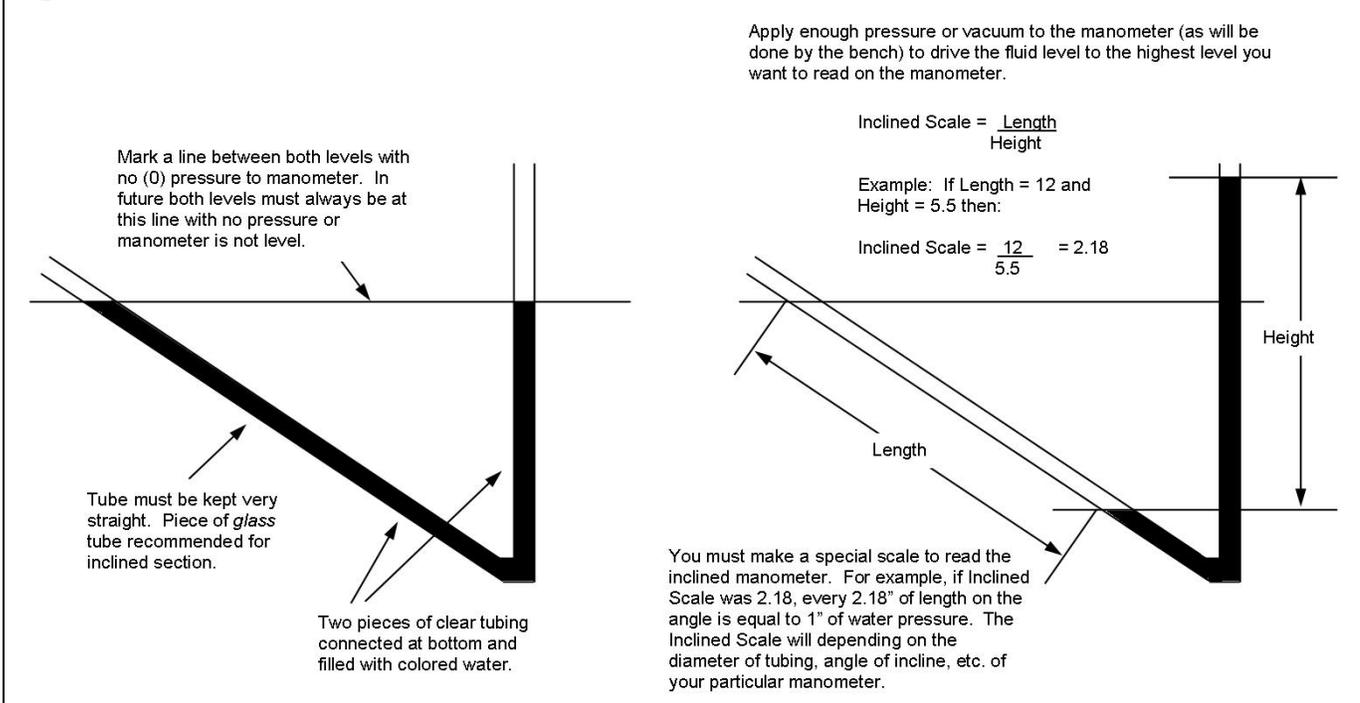
The inclined manometer is not as simple. Because it is on an angle, you can **not** use a standard ruler for the scale without some modification.

You can use a standard Dwyer #244 or #246 manometer calibrated in inches of water. In the Flow Bench Specs menu, first specify the bench Type is Custom. Then set up the 3 Bench Specs in the program as follows:

Dwyer Part #	#244 (0-4")	#246 (0-6")
Flow Bench Specs for Inclined Flow Manometer:		
Full Scale Reading	4	6
Full Scale Pressure	4	6
Linear Scale (like a ruler)	1	1

If you are using a home made inclined manometer, you must calibrate it as shown in Figure A.3.

#### Figure A.3 Calibration of Custom Inclined Manometer



## Calibrate Custom Bench's Flow Ranges:

To calibrate the bench, you must make some calibration, sharp-edged orifice plates. These will be installed where the head is usually installed. Ideally you will make 1 plate close to 85% of the maximum flow for each range, however you may get by with 1 orifice to cover 2 ranges. Use Table A.1 for estimating the size of the orifice needed for each range:

**Table A1: Calibration Orifice Diameter to give about 85% of Full Scale Flow at Specified CFM**

Full Scale CFM	2" water	4" water	6" water	8" water	10" water	12" water	14" water
50	1.5	1.125	1.125	1.125	1	1	.875
100	2.125	1.75	1.625	1.5	1.375	1.375	1.25
150	2.625	2.25	2	1.875	1.75	1.625	1.625
200	3	2.5	2.25	2.125	2	1.875	1.875
300	3.625	3.125	2.75	2.625	2.5	2.375	2.25
400	4.25	3.625	3.25	3	2.875	2.75	2.625
500	4.75	4	3.625	3.375	3.125	3	2.875
600	5.25	4.375	4	3.625	3.5	3.375	3.25
800	6	5	4.625	4.25	4	3.875	3.75
1000	6.75	5.625	5.125	4.75	4.5	4.25	4.125
1500	8.25	6.875	6.25	5.875	5.5	5.25	5.125

For example, assume:

- Your inclined manometer for reading Flow Pres has a Full Scale of 6".
- You estimate that Range #3 will flow 300 CFM at your desired test pressure of 28".

Table A.1 says you should make a 2.75" diameter orifice plate to calibrate Range 3.

The process of calibrating each range consists of:

1. Install the orifice plate where the head is installed.
2. Select the range on the bench you want to calibrate and for flow in the Intake direction.
3. Set the test pressure you will set for most of your flow tests, like 28". This will be recorded on the vertical manometer and is the pressure across the test orifice installed where the head is normally installed.
4. Exactly record all data requested on the following Calibration Test Data sheet.
5. Repeat steps 2-4 for the exhaust direction.
6. Repeat steps 1-5 for all flow ranges on the bench.

Send the Test Data sheets to Performance Trends with \$20 and Performance Trends will return a Calibration sheet with information to load into the Port Flow Analyzer's Bench Specs menu.

**NOTE: Version 3.5 has built in Calibration feature to automatically calibrate custom flow benches and Performance Trends' EZ Flow system. Check Appendix 7.**

Performance Trends' Bench Calibration Test Data Sheet:

1 Range #	2 Int/ Exh	3 Test Pres "H2O	4 Flow Pres "H2O	5 Test Temp degF	6 Flow Temp degF	7 Calibration Orifice, dia "	8 Flow Orifice, dia "
_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____
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_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____

- 1 Bench flow range #
- 2 Intake or exhaust direction
- 3 Vertical manometer reading (reading should be close to standard test pressure, like 28", 25" or 10")
- 4 Inclined manometer reading. This must be accurately calibrated in inches of water. See Figure A.3.
- 5 Record for Blower Center benches only. Air temperature at calibration orifice where head is usually installed.
- 6 Record for Blower Center benches only. Air temperature at air flow orifices.
- 7 The diameter of the Calibration Orifice installed where the head is normally installed.
- 8 If possible, give the number and diameter of the flow orifice(s) inside the bench for this range.

Send data to Performance Trends with \$20 for analysis and Calibrated Full Scale CFM for each range of the bench. These #s can then be entered into the Bench Specs menu of your program.

# Appendix 3: Tips for Accurate Flow Testing

The following notes give tips for improving the accuracy and repeatability of your flow test results:

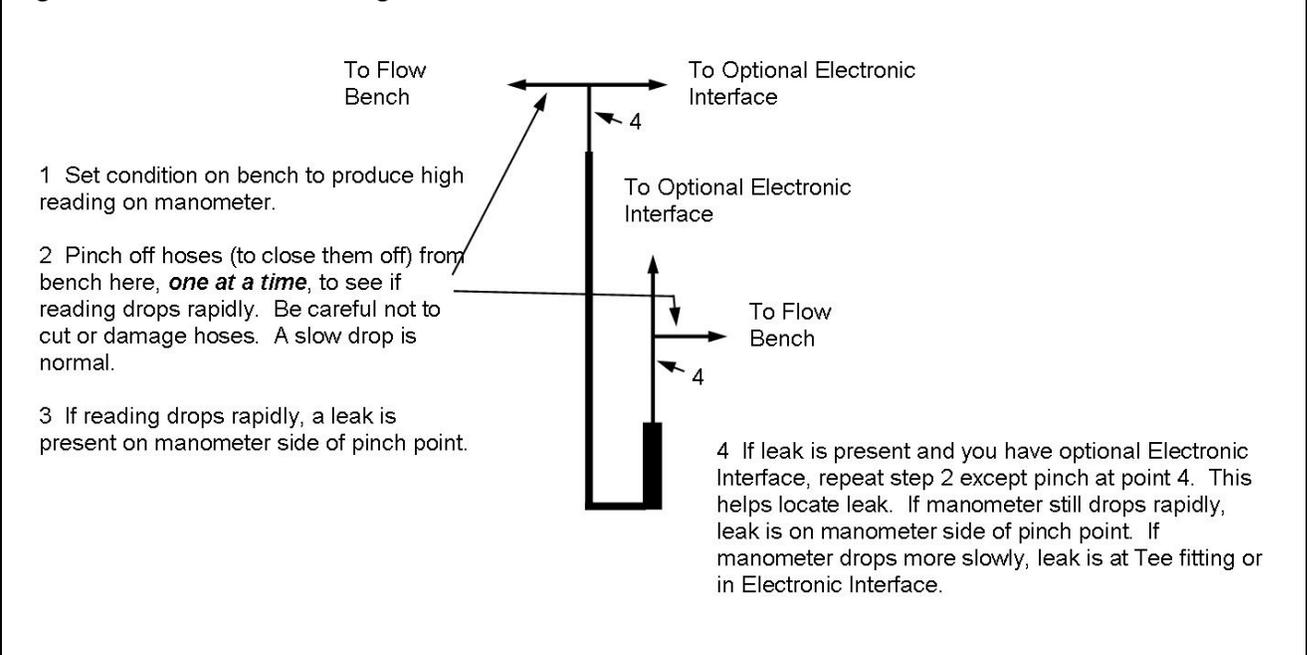
CFM measurements from "sharp edged" orifices are not accurate at low flow pressures (Flow Pres). For example, for a flow manometer calibrated in "Flow %", an eighth inch distance at low flows may be the difference between 20 and 25% Flow. However, at the high end of the scale, an eighth of an inch is the difference between 98 and 98.5% Flow. An eighth inch reading error at the low end may result in  $5/20 = 25\%$  error. However at the high end this same reading error would only be  $.5/98 = 0.5\%$  error. When possible, select a flow range to keep the Flow Pres at the high end of the manometer scale.

Since the Leak CFM is usually small, the Flow Pres may be very low on the Flow (inclined) manometer. Therefore, the Leak CFM measured may not be accurate, and may actually contribute more to an error than neglecting it. For example, the leakage is actually 2 CFM, but you measure it incorrectly as 5 CFM. Using 5 as Leak CFM will cause more error in the final CFM calculation than using 0 for Leak CFM. To accurately measure Leak CFM, first minimize all leaks for all your flow tests, but continue to measure Leak CFM. A Leak CFM which varies more than 2 CFM from port to port may indicate this problem. If this is the case, you may be better off to always check leakage only to find a major problem, but use the same Leak CFM for all tests.

Leaks in the pressure lines to the manometers (and electronics) can cause significant errors. See Figure A.4 for a simple leak check method.

Temperature readouts on SuperFlow 60, 110 and 120 benches can be checked by noting that the 2 temperatures agree within a couple degrees when the bench has been off for more than 1 hour.

Figure A.4 Leak Checking Manometers



## Weather Corrections:

Weather significantly affects engine power so it seems natural that one should correct port flow for weather changes. However, engine power depends on the *mass* of air which flows through it, like lbs/minute. Weather dramatically affects air density, which affects *mass* flow. Head flow in CFM is a *volume* flow, which does not depend on density.

Minor weather correction, for factors other than air density, have been developed for flow bench results. Performance Trends is still investigating the reliability of these corrections.

Notes:

The reason flow benches with air flow measurement orifices require only minor weather corrections, is the cylinder head behaves much like a measurement orifice. If humidity goes up, both the cylinder head and measurement orifice "see" air with more humidity. Both restrictions react in the same way to the increased humidity, so measurement errors tend to cancel out. However, when the air passing through the test piece is not the same as that passing through the measurement orifices, errors can occur. That is why a temperature correction is needed for blower center benches like a SuperFlow 110 bench.

If an air measurement system other than an orifice is used (laminar air flow element, hot wire anemometer, etc), weather corrections become important. That is because the air measurement system will not react to weather changes in the same way as the head restriction.

Performance Trends basically agrees with SuperFlow's analysis of flow bench data, which states that weather corrections are not required for most situations.

## Flow Bench Calibration:

The best check of a flow bench's accuracy and repeatability is to flow one or more calibration orifices of a certain size. For example, perform a flow test at 10" Test Pressure on a thin steel plate with a 1.5" hole, rather than a cylinder head. Use the Port Flow Analyzer to obtain an intake and exhaust CFM. Make all measurements as done for a port, including Leak CFM.

Now you want to compare the measured flow to what you should obtain. One way to estimate what CFM you should measure is to flow the orifice plate on a known, accurate flow bench. Another is to calculate what theoretically should flow through the plate, as shown with the equation below:

The equation to estimate flow through a sharp edged orifice is:

$$\text{CFM flow} = 13.29 \times \text{Diameter}^2 \times \sqrt{\text{Test Pressure, " water}}$$

For the example above, with 10" test pressure across a 1.5" hole:

$$\text{CFM flow} = 13.29 \times 1.5^2 \times \sqrt{10} = 95 \text{ CFM}$$

If the bench is operating properly, you should measure very close to 95 CFM. Some difference between the intake and exhaust CFM should be expected. However, large differences (15% or more, like the Intake direction measures 90 CFM and the Exhaust direction measures 120 CFM), double check the Flow Bench Specs in the program. Other possible problems include:

- Leaks in the manometer pressure lines
- Leaks within the flow bench not accurately accounted for when you measure the Leak CFM
- A calibration orifice with a sharp edge on one side and rounded edge on the other. If you flip the orifice over, and the difference between intake and exhaust reverses, make both edges of the calibration orifice the same.

Some flow bench manufacturers recommend to use this check to obtain a correction factor for the bench. For example, if the bench above would measure 90 CFM instead of the expected 95 CFM, you should increase all measurements by  $5/90 * 100\%$  or 5.5%. See Section 2.10, page 57 on the Test Correction Factor for correcting Blower Center benches like the SF 110.

Performance Trends believes that you should not make a significant correction like this based on only one measurement at one flow. Performance Trends does recommend keeping a record of these calibration checks and perhaps using more than one size of orifice. Only after a long history shows the bench to be consistently off, for example low by 5.5%, should a correction factor be used.

This version of the Port Flow Analyzer allows for a Test Correction Factor on the SuperFlow 110 and 120 benches *only*. To make a correction you must change the CFM flow ratings of all orifices in the Flow Bench Specs. Also see Appendix 2.

Here is an Example showing correcting Full Intake Flow, CFM for calibration test data:

If a good history shows the bench reads 135 CFM when it should read 129 CFM, the correction factor would be:

$$\frac{\text{True CFM}}{\text{Measured CFM}} \times \text{Full Scale CFM} = \text{Corrected Full Scale CFM}$$

Where:

- True CFM is what you calculate should pass through the calibration orifice
- Measured CFM is a good average over many calibration tests of the CFM the bench actually measures
- Full Scale CFM are the Full Intake or Full Exhaust Flow, both intake and exhaust, currently in the Flow Bench Specs for all orifices used
- Corrected Full Scale CFM are the new flows to enter which should make your calibration tests match the orifices calibration flow, and your flow tests more accurate

For example, Full Intake Flow for Range #3 is 150 CFM. Your calibration tests consistently read 135 CFM for a calibration orifice which should flow 129 CFM:

$$\frac{129}{135} \times 150 \text{ CFM} = 143.3$$

Change Full Intake Flow for Range #3 to 143.3 in the Bench Specs menu. Use the same calculation technique to correct all orifice flows in the Flow Bench Specs, both intake and exhaust.

To check that you have performed the calculations correctly, perform the calibration test again. You now measure 130 CFM, which is very close to the "True CFM" of 129. Therefore, you did the calculation correctly.



# Appendix 4 Backing Up Data

Backing up data means to make more than one copy of the data which can be used or referred to at a later date. This may be needed in the event one copy becomes lost or erased, or you need room in the Flow Test Library. Backing up data can take 2 basic forms:

- Paper Reports
- Copying files with Windows copy commands

Other than making Paper Reports, backing up data requires knowledge of Windows File Manager (3.1) or Windows Explorer (95, 98, NT) commands. Unless you are experienced with Windows commands, have someone experienced with Windows assist you to prevent losing data.

## Paper Reports:

If you already keep written copies of all flow tests you perform, you already understand this form of backing up data. When you finish a flow test, simply print out an Int & Exh Raw Flow Data report. In the Print options menu, be sure to check Include Bench Specs, Include Test Options, Include Head Specs, and (Pro version only) Include Head Details. This paper report contains nearly all the data you need to reproduce this test in the future. Simply store this paper report in a safe place.

### Disadvantage of Paper Back Ups:

For example, say you have accidentally erased a Flow Test File but have a paper report of that data. If you now want to recalculate that data, correct the data to a new Test Pressure, compare new data to this old data, etc, you must re-enter all that RAW data by hand as if you were running a flow test.

## Copying data to disk with Windows commands:

This method is the preferred method. If you are not familiar with Windows commands, have someone help you the first couple of times. However, *this is the most reliable and most efficient way to back up your data.*

Note: Unless stated otherwise, all mouse clicks are with the normal, left button on the mouse.

To copy Entire PFADAT Folder using Windows 95, 98 or NT, which contains all folders and test files in the Test Library:

Click on Start, then Programs, then Windows Explorer (usually at the bottom of the list of programs). You will obtain the Windows Explorer screen shown in Figure A5.

Locate the PERFTRNS.PTI folder (may not be printed in capital letters) on the left side of the Windows Explorer screen, usually on the C drive. Click on the [+] sign to the left of it to display the contents of the PERFTRNS.PTI folder.

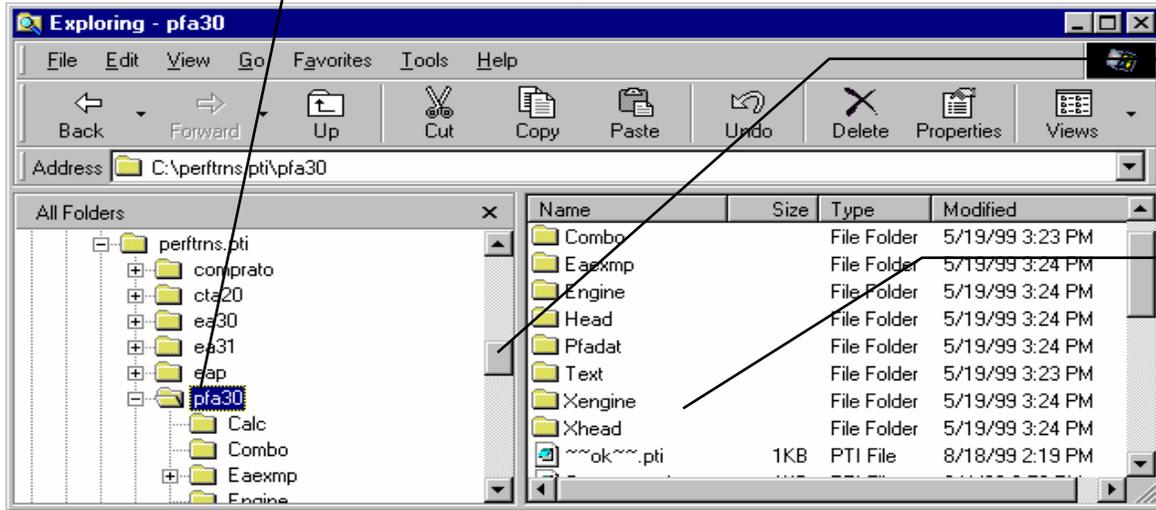
You should now see the PFA30 folder. Click on the [+] sign to the left of it to display the contents of the PFA30 folder.

You should now see the PFADAT folder. Right click on the yellow PFADAT folder icon to display the menu of options. Click on the Copy command to copy this entire folder (all test files in the standard Test File Library).

**NOTE: Version 3.5 has added 1 step Backup and Restore Commands. Check Appendix 7.**

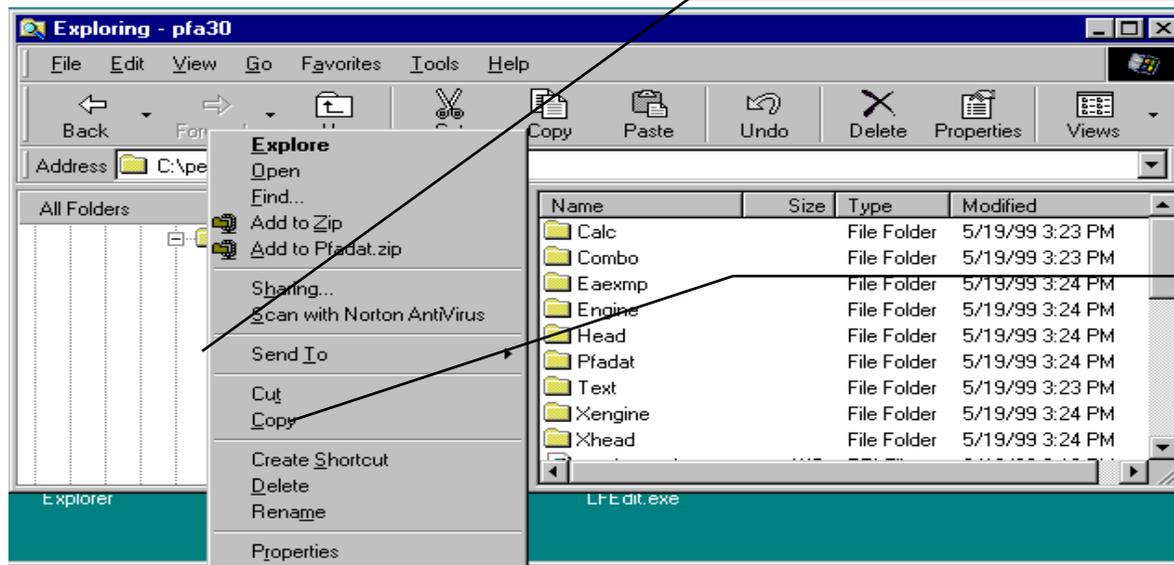
Figure A5 Copying Files with Windows 95, 98 or NT Windows Explorer

Find the PFA30 folder under the PERFTRNS.PTI folder, usually on the C drive. Click on the [ + ] box to the left of a folder to show its contents (folders).



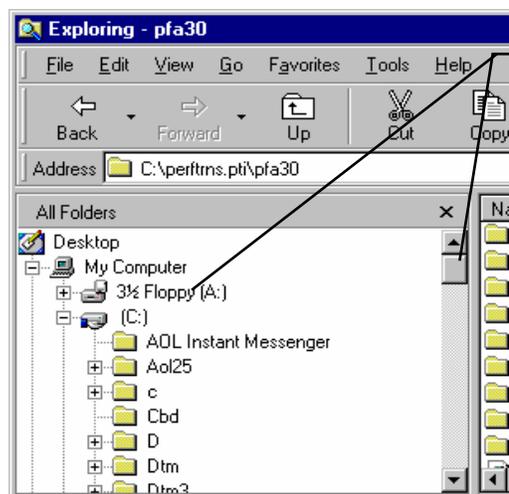
Click and drag the slide bar to move up and down the list of folders.

The contents of the open (clicked on) folder on the left is shown here, including both folders and files.

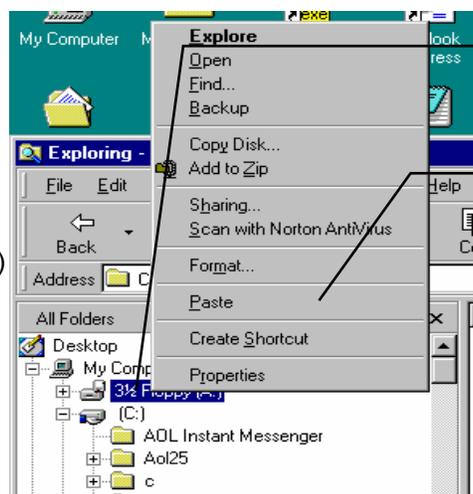


Right click (with the right mouse button) on the PFADAT folder (not seen here) to open a menu of options.

Click on Copy to copy the entire contents of the PFADAT folder (the entire test file library). DO NOT click on Cut.



Drag slide bar to the top of the list to find your External disk drive (usually A)



Right click on the External drive icon.

Then click on Paste to paste whatever you copied (in this example, the entire PFADAT folder) to the disk in the External drive.

Now you must tell the computer where you want to copy the files to. Click and drag the slide bar for the left section of the Windows Explorer screen to the top. (You can also click on the up or down arrow buttons on the slide bar.) Look for the External Drive icon. Put a new, formatted disk in the external drive. Then right click on the External Drive icon, and select Paste from the list of options. You will see the external drive light come on as the entire PFADAT folder and all its contents are copied to the CD or USB drive. Label this disk with something like "PFADAT folder, xx/xx/xx" with a name and date.

Notes:

If you have so many tests in the Test Library, they may not all fit onto 1 external disk. Windows Explorer will tell you this and ask you to insert another new, formatted disk. If this happens, be sure to label all disks with a name, date and sequential #s, and keep the entire disk set together. A suggestion for novice computer users is to make each folder under PFADAT a separate floppy disk. This may require more external disks, but will make it easier to understand restoring just certain folders in the future.

You may just want to back up one particular folder in the test library (in the PFADAT folder) or just 1 particular test. You would do this the same as with copying the entire PFADAT folder, just click on the [+] by the PFADAT folder to display the folders under PFADAT. Then right click on the folder you want to Copy. To find individual test files, click on the yellow folder icon containing the test file and the contents of the folder will be shown on the right side of the Windows Explorer screen. Then right click on the test file name and select Copy.

You can also copy individual test files to the external drive inside the Port Flow Analyzer program. Open the file you want to copy so it is the current test file. Then click on File at the top of the Main Screen, then select Copy to External Disk.

More experienced computer users may want to use the "Backup" features built into Windows 95 and 98 (click on Start, Programs, Accessories, System Tools, Backup). This compresses test files so it takes fewer external disks. However you need to use the Backup program to restore test files, which can be more confusing to novice computer users.

## Restoring Data

**Be very careful when restoring data, as you may overwrite Test Files with old, erroneous information. Read all the information below before restoring data. If you are not familiar with Windows Explorer, have someone more experienced help you.**

**The ONLY reason to restore data is if you have lost test files. This could be because you mistakenly erased it, you had a major computer failure, or you are moving the program to another computer. Do NOT restore data unless you have one of these problems, as you could possible create many more problems than you are trying to fix.**

When restoring test files and folders, you pretty much reverse the procedure for backing up. First you put your backed up external disk in the external drive. Then open Windows Explorer, find the External drive icon and click on it to display its contents. Right click on the folder you want to restore and select Copy.

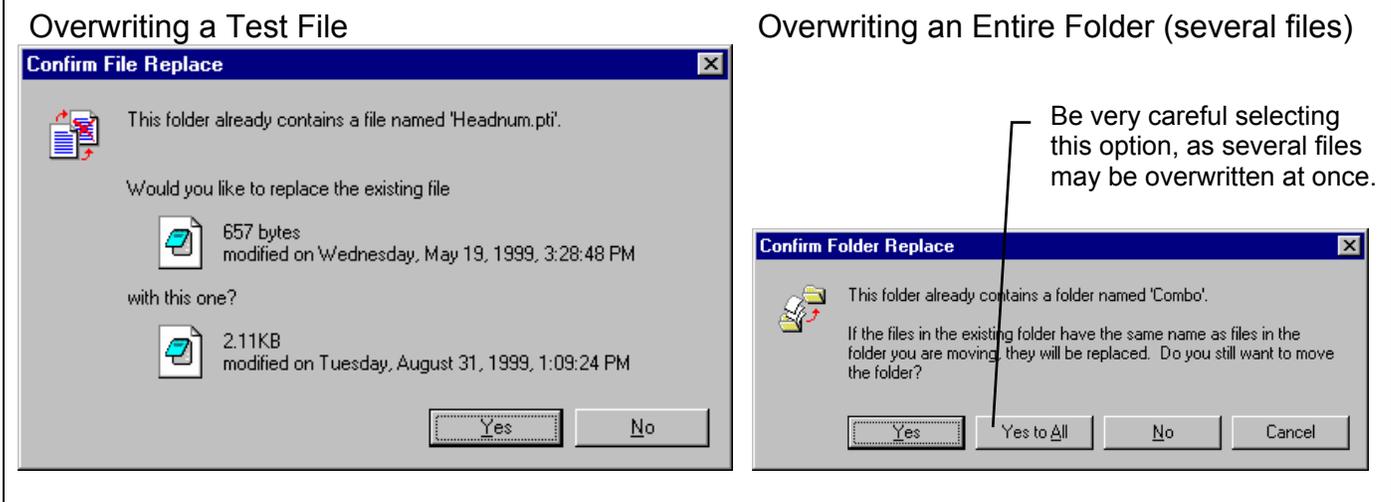
Now find the PFADAT folder under PFA30 under PERFTRNS.PTI, usually on the C: drive. Right click on the folder

**1 level up** from the folder you are restoring. For example, if you are restoring the test file folder CHEV which was in the PFADAT folder, you must click on the PFADAT folder. If you are restoring the entire Test Library folder PFADAT, you must click on the PFA30 folder. If you are restoring the test file 194-150 which was in the CHEV folder under the PFADAT folder, you must click on the CHEV folder.

During the restoring (copying) process, Windows Explorer checks to see if it is overwriting an existing file (Figure A6). If it is, it will ask you if the existing file or folder should be overwritten. Be very careful when overwriting files, as you may overwrite a new test file with data from an old test file of the same name.

**Before restoring test files, it is good practice to back up all test files first. Then if you make a mistake, and overwrite test files you didn't mean to, you have your backup copies to restore the test files from.**

Figure A6 Windows Explorer Warnings when Overwriting Test Files



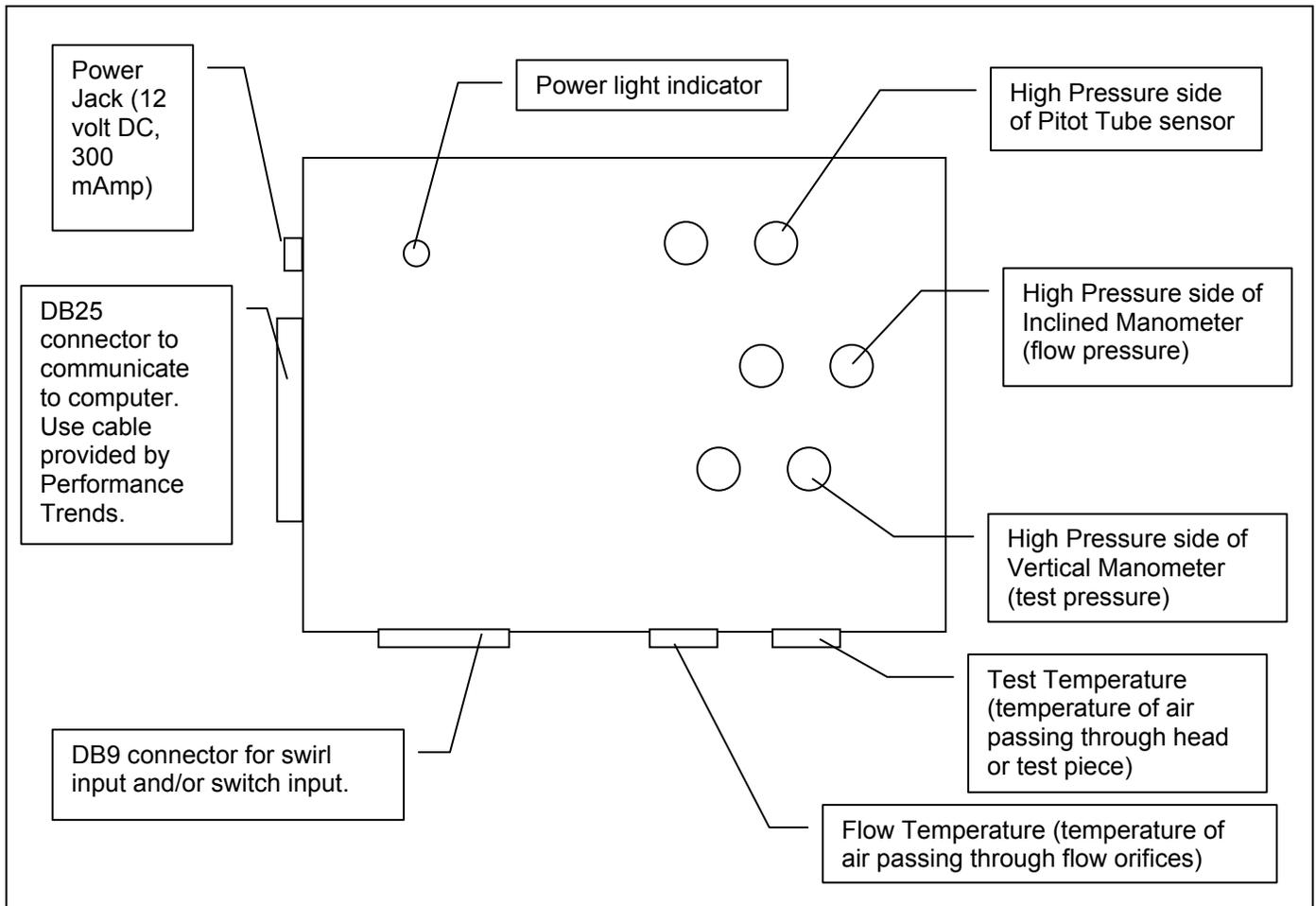
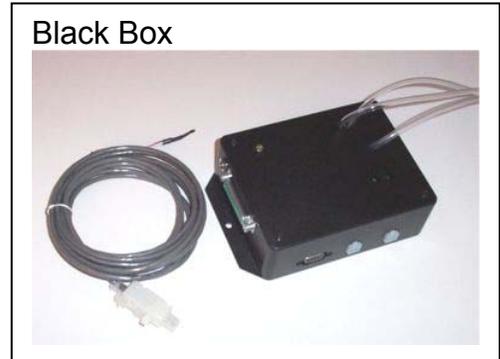
**NOTE: Version 3.5 has added 1 step Backup and Restore Commands. Check Appendix 7.**

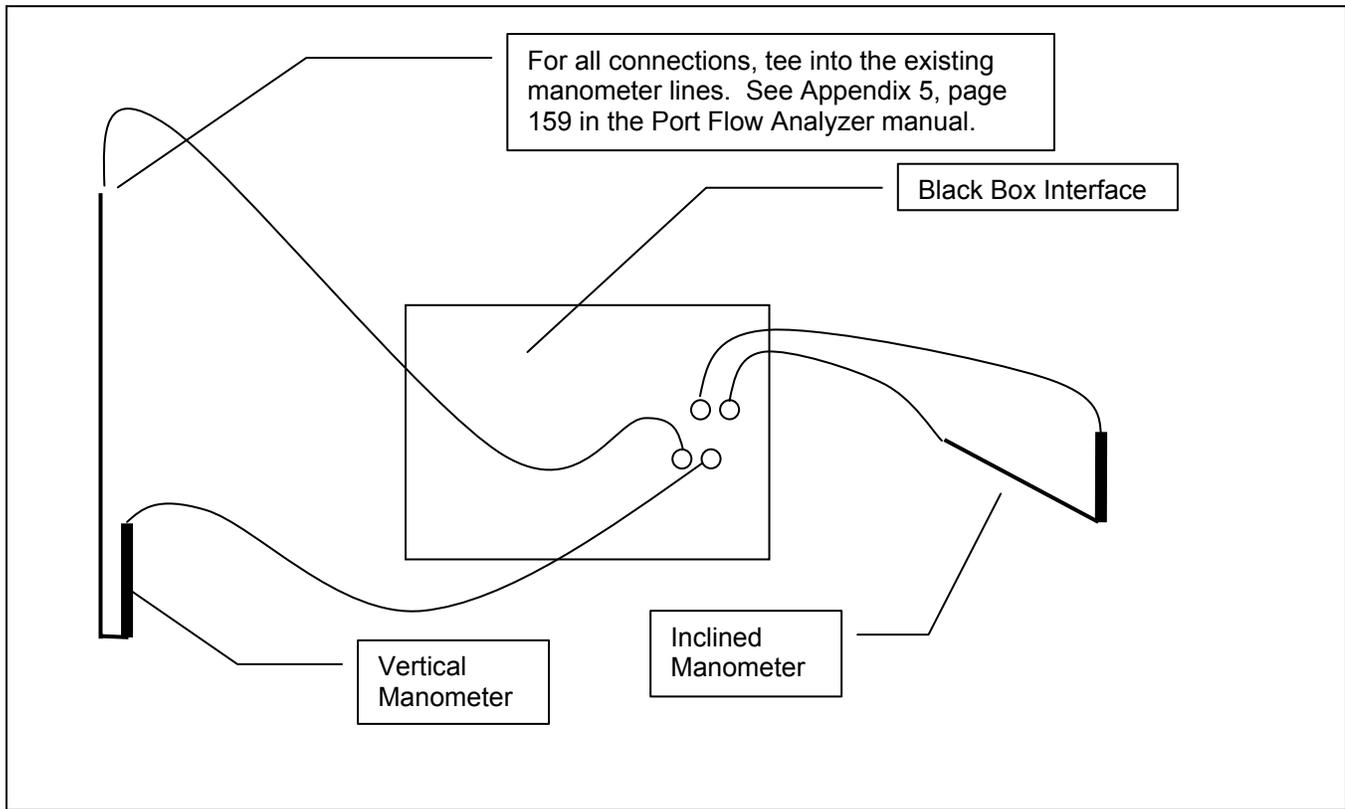
# Appendix 5: Performance Trends “Black Box II” Interface

For information on SuperFlow’s FlowCom refer to SuperFlow’s instructions, Section 2.11 and Example 4.2. This section *does* cover calibrating a Swirl or Tumble Meter which can be read through SuperFlow’s FlowCom. If you are using either Performance Trends’ “Black Box” (released in 2002) or earlier “Electronic Interface”, also take a look at Section 2.11 and Example 4.2.

## Black Box

Performance Trends’ “Black Box” data logger will record data from your flow bench to greatly enhance your flow bench testing. The two figures below give an explanation of the various connections to the Black Box, and how it hooks up to a typical SF 600 or 300 or custom style flow bench.





After you hook up the Black Box, you must calibrate following the procedure later in this section.

You must specify that you are using a Black Box Type of Electronics in the Port Flow Analyzer as shown in the menu to the right. You must also click on the “See Details (calibrations)” button to calibrate the sensors to match the manometers on your bench. See Page 41.

### Flow Bench Specs menu in Port Flow Analyzer (page 41)

The screenshot shows the 'Flow Bench Specs - Metric' window. The 'Type' dropdown is set to 'Performance Trends Black Box'. The 'See Details (calibrations)' button is highlighted with a callout box that says: 'You must set Type to Black Box and then click on See Details to open up the Calibration screen to calibrate the Black Box.'

General Bench Specs	
Type	Std SuperFlow 110
Use Temperature Correction	Yes
Rated Test Pressure, cm	10

Inclined Flow Manometer	
Full Scale Reading	100
Full Scale Pressure, cm	2.2
Linear Scale (like a ruler)	No

Electronics	
Type	Performance Trends 'Black Box'
Com Port	Com 2
# Readings to Average	30
Other Data	None

See Details (calibrations)

## Electronic Interface

The front panel of Performance Trends Electronic Interface has only a power switch and power light indicator in the switch. When the interface is communicating correctly with the computer, you will see the power light flash.

Figure A.7 shows the back panel of the Electronic Interface with its connectors, options and hose routing. Section 2.11 discusses the commands and options for the interface. Section 2.6 discusses the settings for the interface in the Bench Specs menu.

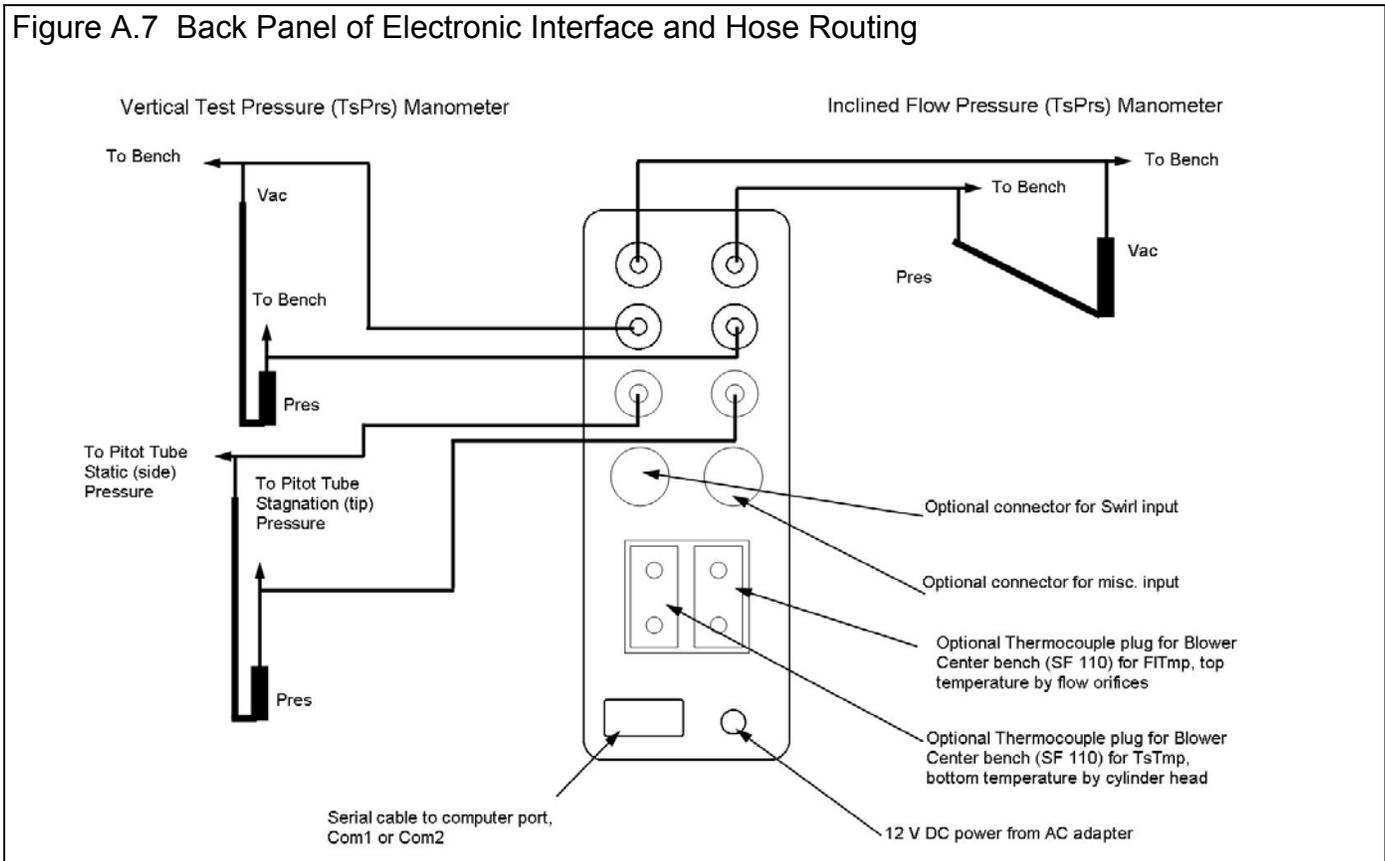
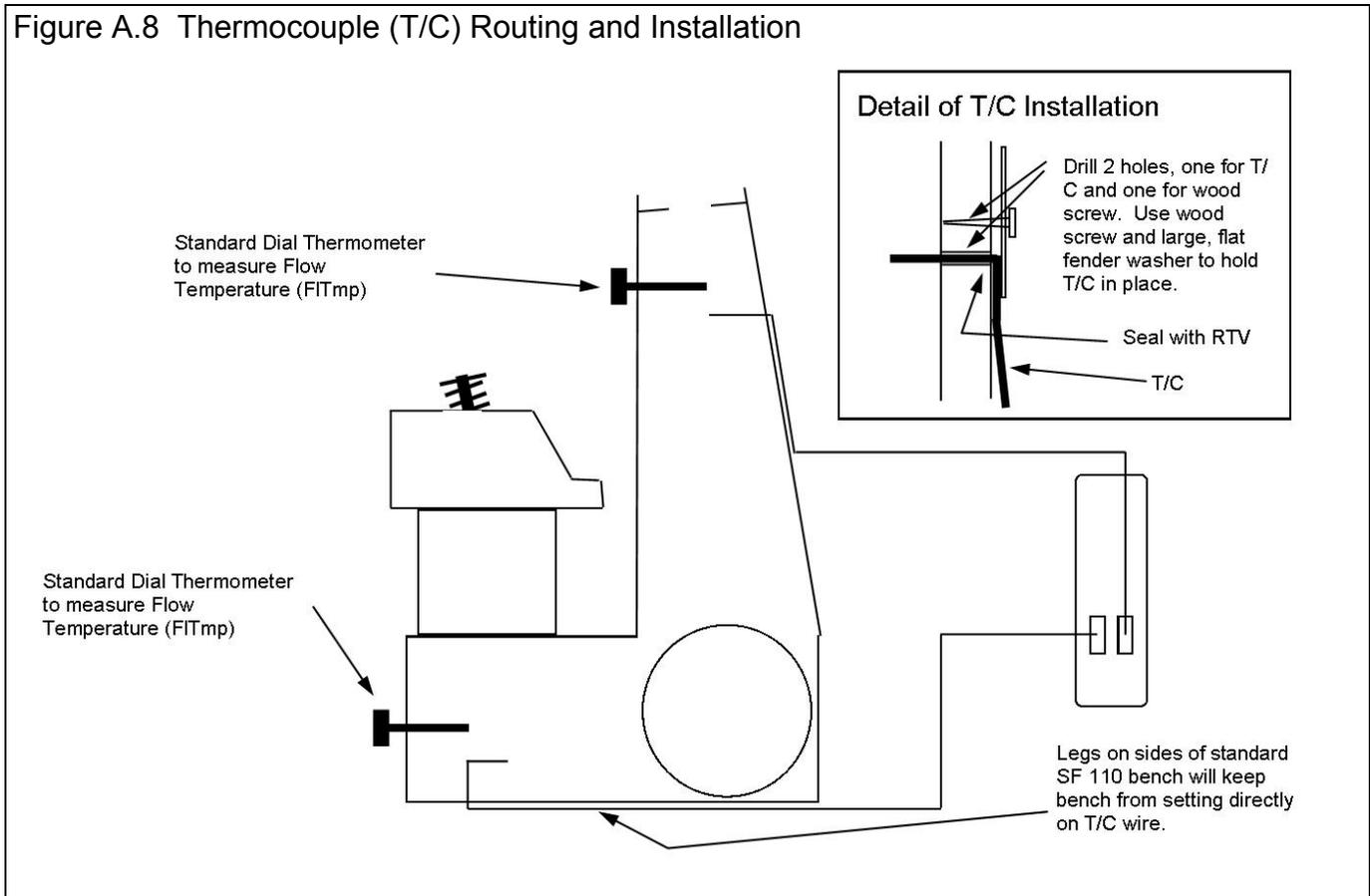


Figure A.8 shows the routing and installation of the optional thermocouples (T/Cs) used for Blower Center (SuperFlow 110) flow benches.

Figure A.8 Thermocouple (T/C) Routing and Installation



### Sensor Calibration:

For accurate readings, the Electronic Interface must first be calibrated to match your bench's sensors. Calibration consists of applying known pressures, temperatures, etc to the sensors and telling the computer what the known pressures, temperatures, etc are.

To run the calibration procedure, you first must have the interface installed and operating, and the Flow Bench Specs set correctly. Then click on the See Details button at the bottom of the Flow Bench Specs menu. See Figure A9. You will bring up the Calibrations screen shown in Figure A10.

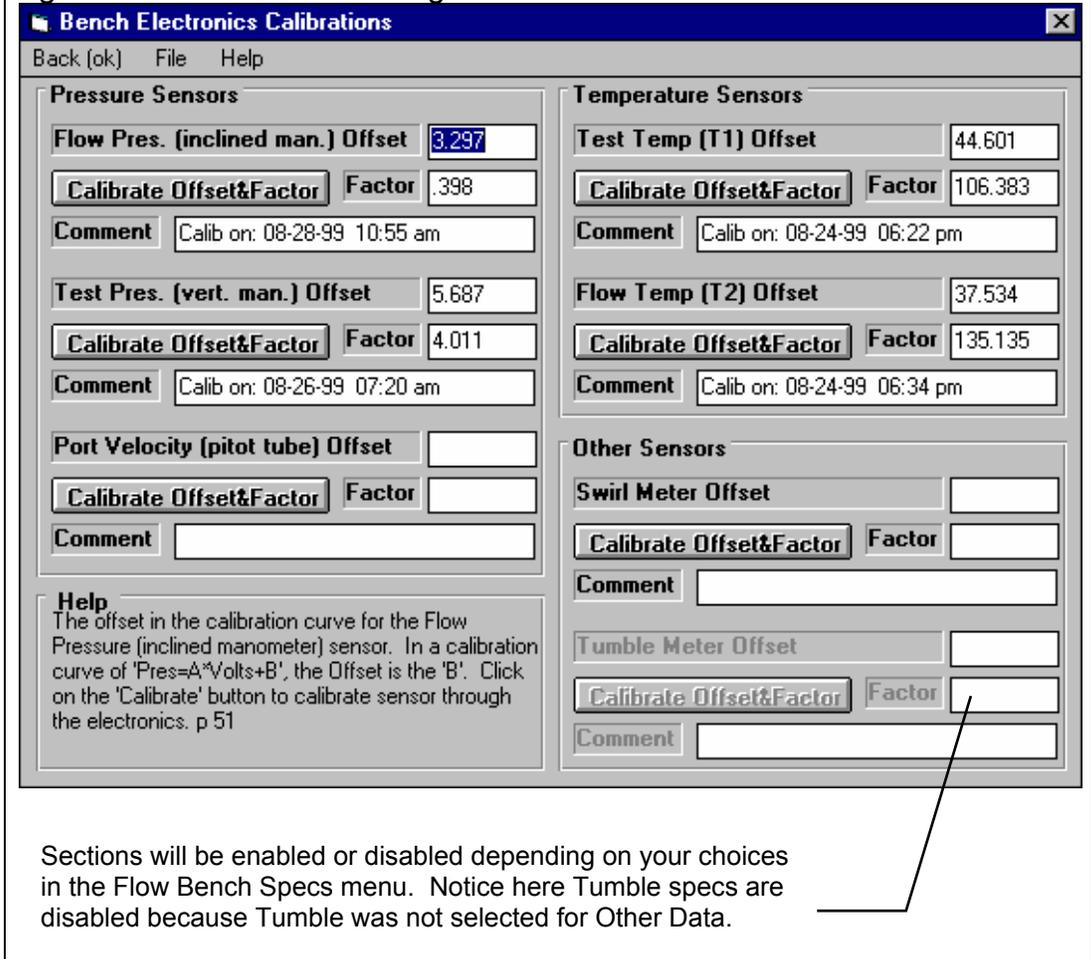
There are 2 basic ways to calibrate a sensor:

1. You can type in calibration settings (Offset and Factor) that you have gotten from Performance Trends or from previous settings you have written down.
2. You can go through the calibration procedure.

Most of the time you will go through an actual calibration procedure. To calibrate, first select which sensor you wish to calibrate, and click on the Calibrate Offset & Factor button. The program will bring up the Electronics Data screen discussed in Section 2.11. After a slight pause, start following the instructions given in the program. The instructions will follow the following basic procedure:

1. The computer will first asks you to apply a known input to the sensor, usually giving you tips on how to do this. For pressure sensors, this is zero pressure to the manometer and interface at the same time. This is most easily done by turning off the flow bench and letting all pressures settle out for 30 seconds or more. You are now getting 0 pressure to the sensors and the manometer. This is also a good time to reset the zero on the fluid manometer. For Swirl or Tumble, turning the bench Off is also a good way to set 0. Verify 0 by watching the swirl meter readout. For temperatures, you will set some known temperature, like room temperature with the bench off, and read the exact temperature off the dial thermometers on the bench.

Figure A10 Calibration Settings Screen



2. Tell the computer you have set this first condition by clicking on OK on the computer screen. The computer will read the sensor signal. For temperatures, the computer will ask you to type in this first temperature reading.
3. The computer asks you to apply a constant known signal to the sensor, different than the first. The program usually gives you tips on how to do this. For pressure sensors, this is most easily done by turning on the flow bench with a head installed with a valve lift which gives smooth, steady flow. Adjust the bench to give a manometer reading in the range requested by the program. For Swirl or Tumble, this method also works if you have the swirl or tumble meter installed with a head giving good, steady tumble or swirl. For temperature, the bench will create heat, especially if you flow in the direction suggested by the program.
4. Tell the computer you have set this second condition by clicking on OK on the computer screen. The computer will read the sensor signal and then ask you to type in this second reading. For pressures, you will read the manometers as well as you can while the computer was making its readings. For swirl or tumble, you will read the digital display. For temperature, you will read the dial thermometers on the bench.
5. The program will show you some information about the new calibration Offset and Factor, and let you decide if you want to use them. If you answer Yes, they will be loaded back into the Calibrations menu.

Verify your calibrations are accurate when running a test by seeing if the program's data display match the bench's sensors.

*Pressure sensors can drift somewhat with time or temperature changes. If the program's pressure readings do not read 0.0 when the bench is off, you may be able to use the "Re-zero" command instead of completely recalibrating. See Section 2.11 for details.*

# Appendix 6: New Features in V 3.0 E

During the 3 years version 3.0 has been available, several minor bugs have been fixed and several new features added. Listed below are some of the main new features in Version 3.0 E. Minor bug fixes are not listed, but are available in the more detailed Readme.doc file available from inside the program.

- You can now jump to the Performance Trends website directly from the program under Help at the main screen.
- You can now view the User's Manual directly from the program under Help at the main screen.
- Program now reads Performance Trends' new, very affordable Black Box electronic data logger (interface). Black box can read flow pressure, test pressure, pitot tube port velocity, test temp, flow temp, swirl, flow direction and an input from a switch to record data. See Appendix 5.
- Several new Edit options are available. Now you can click on the top of the Lift or L/D column on the main screen to generate valve Lifts or L/Ds based on the settings in the Test Options screen. See details below.
- Using a new comp hardware number for unlocking the program, to hopefully be more stable. NOTE that this version will require a different unlock # than previous versions.
- Added feature to increment test pressure instead of valve lift. This is a method used for testing devices without various valve lifts, like mufflers, air cleaners, air meters, turbo components, etc. Pro version only. See details below.
- Added several features to allow program to direct FlowCom to set the Test Pressure for tests which vary test pressure (not valve lift). Three new Preferences allow you to 1) allow varying test pressure, 2) have the program set Test Pressure at each new point, and 3) have the program automatically increment through all test pressures, basically automating the test after you manually record data for the first point. Pro version only. See details below.
- Added several features to allow you to rename, add, delete and copy folders from the Open menu.
- Now allow calibration pressure input for 1020 benches (typically 25 or 50 inches of water). Previously it was assumed 50" for all SF 1020 benches.
- Fixed a bug where the FlowCom's barometer could be read incorrectly by the program as a small, negative number.
- Added features to check and allow for Com Port #s up to 6.
- Added F5, F6, F8, F9 "hot keys" to the main screen and FlowCom screen so you can navigate easier through many screens:
  - F5 Go to FlowCom or Electronics screen when at main screen.
  - F6 Go to Comments section when at main screen.
  - F8 go down one port, for example from Intake on Cyl #3 to Exhaust on Cyl #2. This can be done at the main screen or from the FlowCom or Electronics screen.
  - F9 go up one port, for example from Intake on Cyl #3 to Exhaust on Cyl #3. This can be done at the main screen or from the FlowCom or Electronics screen.
  - Esc key to close the FlowCom or Electronics screen and return to main screen.
- Now allow up to 50 lines of printed comments. This was previously limited to 20 lines of comments.
- Greatly enhanced the ability of the program to read SuperFlow FlowComs with a wide variety of different computers and different generations of FlowComs.
- Added a Browse button to the network folder option in Preferences menu. See Appendix 8 for details.
- Added Tabs to preferences screen to better organize preferences.
- Improved print quality of most all screens and printed reports.
- Add preference for using either Head # (original version) or now File Name for the default Graph Title.
- Added Swirl Analysis report to calculated Estimated swirl torque in Tq, oz in and Newton mm. Pro version only.
- Allow Raw Report to be corrected to different Test Pressures.
- Allow Importing of Flow Pro FP and FP3 files, and some Winflow files, files from other types of flow bench programs. Pro version only.
- Added explanation of what Temperature is recorded in a 1020 bench. (It is not air flow temperature unless you have made provisions to record air temperature in your 1020.)
- Program is now 32 bit, which means:
  - It can use long file names.
  - It should be more compatible with USB printers.

- Program now uses a faster method of reading the FlowCom. This method also proved more reliable on the new, very fast computers.
- Replaced the graph option of Swirl Stab with Swirl (abs) to graph absolute value of swirl. This graphs all swirl numbers as a positive number so you can see RPM, but not direction. Pro version only.
- Corrected a problem where data other than CFM (like swirl) would not always be graphed or reported correctly if the valve lifts were not in order or similar for different ports.
- Correct problem where opening 'Tip' would always show again, even if you selected to not see it again.
- Added Mass Flow calculations to graphs and reports for English units. Pro version only. See details below.
- Added Option in FlowCom screen to ReZero Swirl/Tumble.
- Allowed Foot or Hand Switch to signal to record data. The user must 'double click' the switch in the current version.
- Fixed a bug where the air temperature recorded by a 1020 bench was not being reported correctly in Reports.
- Added a Note Tip that the air temperature recorded by a 1020 bench is "motor box" temperature and not true air temp of the air flow stream.
- Fixed a bug where printouts for head comparison reports were not complete if you requested a comparison of individual cylinders. Pro version only.
- Fixed several things to calculate Velocities, Gs, Piston Pos, FlowCoef, etc for Metric Units.
- Added ability from the File menu (upper left corner of main screen) to Save To or Open From a external disk. This makes it easier to copy files from one computer to another.
- Added ability to read Cam Files in Engine Specs. Now you can combine detailed Cam Dr, Cam Pro Plus, S96, Andrews, etc cam files with flow bench data for more detailed analysis. Pro version only. See details below.
- Added several engine analysis graphs like Psuedo Flow Velocity, Piston Velocity, Piston Acceleration and Piston Position. Pro version only. See details below.
- Main and graph screen now fills screen for larger resolution screens like 600x800 and larger.
- Data tables included with graph were not using 'Alternate Names' which you had entered manually. Pro version only.
- Added feature to allow comparison reports between individual cylinders of different heads in the Pro version. In the Reports Options screen, pick one of the Compare Report Types. Then select one of the individual cylinders for Which Cylinder. Then when you pick the test from the library for comparison, you are also asked which cylinder to compare to the cylinder of the first (current) test.
- Fixed bug where Filter feature did not correctly find Test Dates. Pro version only.
- Fixed bug where Filtering Files = On did not allow head and engine files to be displayed in the Open File screen. Pro version only.
- Added ability to allow L/D increments to be graphed and reported for port velocity measurements. Pro version only.
- Added ability to run JKM style flow bench..
- Fixed bug where arrow keys in Test Options erased Int and Exh port adapters if they were entered by hand.
- Fixed bug where basic version could print Head Details and Engine specs in report printouts.
- Put User Name at top of Report Printouts, moved Perf.Trends (C) to 3rd line.
- Now allow 32 graph lines to be graphed at 1 time, which allows 2 8 cyl heads or 4 4 cyl heads to be graphed at once.
- When Entering CFM Directly, the Test Pres Column has been eliminated. The test pressure for the CFM data is now set as the Test Pressure in the Test Options menu. This change eliminates a possible problem when Test Options Test Pres does not match Test Pres in the Data Grid column.
- Fixed a problem in that not all the CFM data was being requested when you printed a Blank Worksheet.
- Added a Preference to not require a Head # for a New Test. Pro version only.
- Now prints cursor line on graphs when printed.
- Added a Preference to hide barometer in FlowCom screen.
- Added 9 new report options for Pro version, mostly either asking for Int only or Exh only, and new Cyl-Cyl Comparison with cylinder CFM averages included. Pro version only. See details below.
- Added option to 'Hide' individual graph lines by right clicking on their name in the Legend on the right side of the graph. Pro version only. See details below.
- Added new button in Preferences called 'Set Graph Colors' where you can manually set the colors of individual graph lines.
- Program now reads some types of WinFlow files (mostly SF 600). Just 'click on' them (either the .PWD, .DAT or .FTD files) in the 'Open Test File' screen and follow the program directions. Pro version only.
- Added a Preference to disable valve spring specs from being automatically updated (calculated) from other valve spring inputs. Pro version only.
- Fixed bug where Head # was not always updated after being changed in the Head Specs menu. Pro version only.

### Complete List of Types of Reports, Many Are New

Int & Exh Raw Flow Data	Int & Exh Cyl-Cyl Comparisn	Int & Exh Calculated Data
Int & Exh Other Calc Data	Eng. Performance Estimate	Meas Int & Exh VelData
Compare Heads - CrCFM @Lift	Compare Heads - VArea @Lift	Compare Heads - FArea @Lift
Compare Heads - FICf @ Lift	Compare Heads - VVel @ Lift	Compare Heads - PVel @ Lift
Compare Heads - CrCFM @ L/D	Compare Heads - VArea @ L/D	Compare Heads - FArea @ L/D
Compare Heads - FICf @ L/D	Compare Heads - VVel @ L/D	Compare Heads - PVel @ L/D
Int Raw Flow Data	Int Cyl-Cyl Comparisn	Int Calculated Data
Int Other Calc Data	Exh Raw Flow Data	Exh Cyl-Cyl Comparisn
Exh Calculated Data	Exh Other Calc Data	Int & Exh Cyl-Cyl Comp +Avg
Int Mass Flow	Exh Mass Flow	Int & Exh Mass Flow
Calc. Int Swirl Analysis		

### Complete List of Types of Graphs, Many Are New

Corr Int & Exh CFM	Corr Int CFM	Corr Exh CFM
Calc Int Velocities	Calc Exh Velocities	Intake Swirl
Int Swirl (abs)	Intake Tumble	Int Tumble Stab
Int & Exh Flow Coef	Int Flow Coef	Exh Flow Coef
% Exh/Int	Int Stabty	Exh Stabty
Int & Exh Stabty	Int & Exh Flow+Valve Area	Int Flow + Valve Area
Exh Flow + Valve Area	Int & Exh Flow Area+VlvLift	Int Flow Area + Valve Lift
Exh Flow Area + Valve Lift	Overlap Flow + Valve Area	Overlap Flow + Valve Lift
Meas Int Vel (port map)	Meas Exh Vel (port map)	Psuedo Flow Velocity,ft/sec
Psuedo Flow Velocity, Mach#	Piston Velocity, ft/sec	Piston Velocity, ft/min
Piston Acceleration, Gs	Piston Depth from TDC, in	Int Mass Flow Lb/Min
Int STP Mass Flow Lb/Min	Exh Mass Flow Lb/Min	Exh STP Mass Flow Lb/Min
Int & Exh Mass Flow Lb/Min	Int & Exh STP MsFlw Lb/Min	Int Mass Flow Gm/sec
Int STP Mass Flow Gm/sec	Exh Mass Flow Gm/sec	Exh STP Mass Flow Gm/sec
Int & Exh Mass Flow Gm/sec	Int & Exh STP MsFlw Gm/sec	

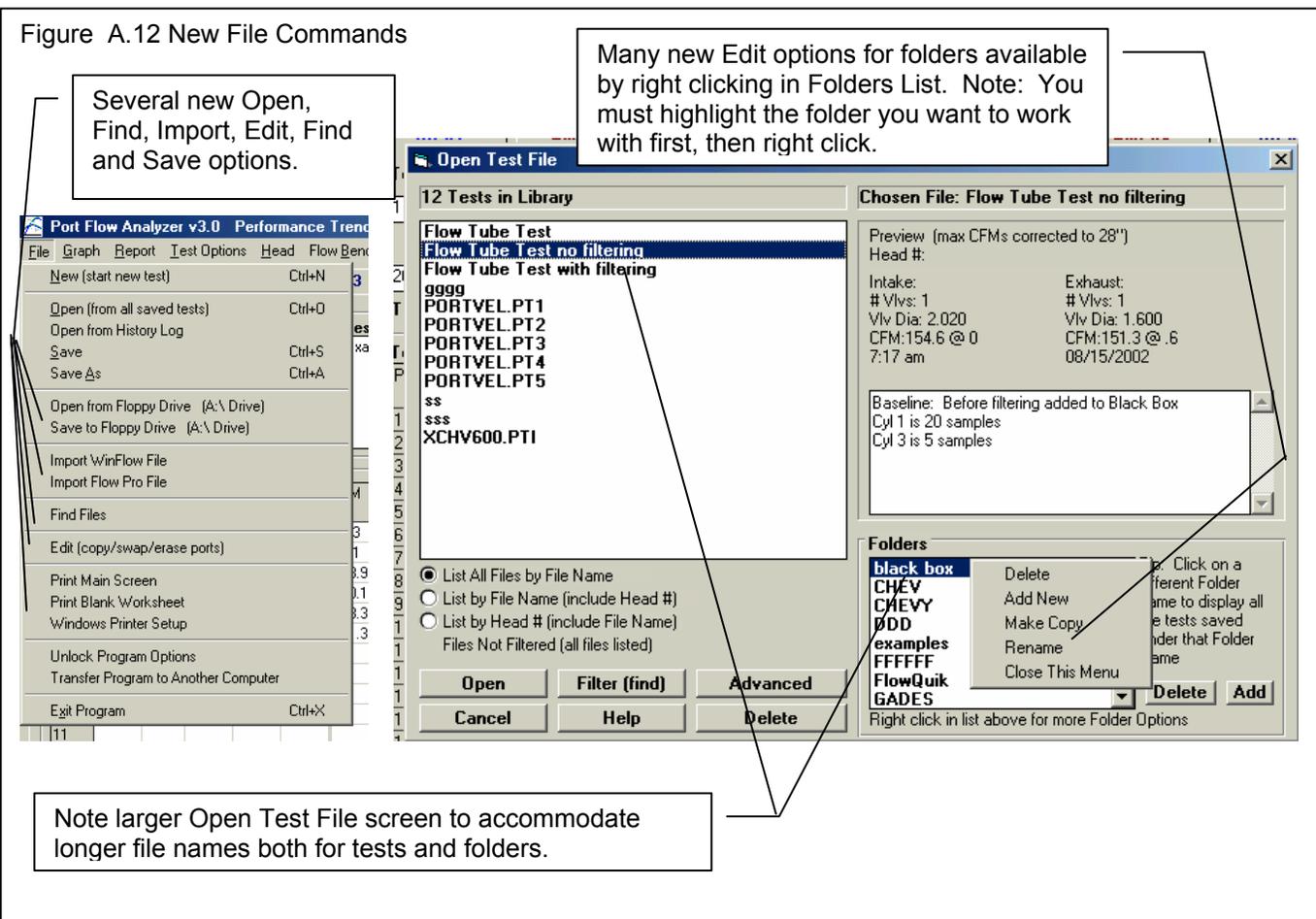
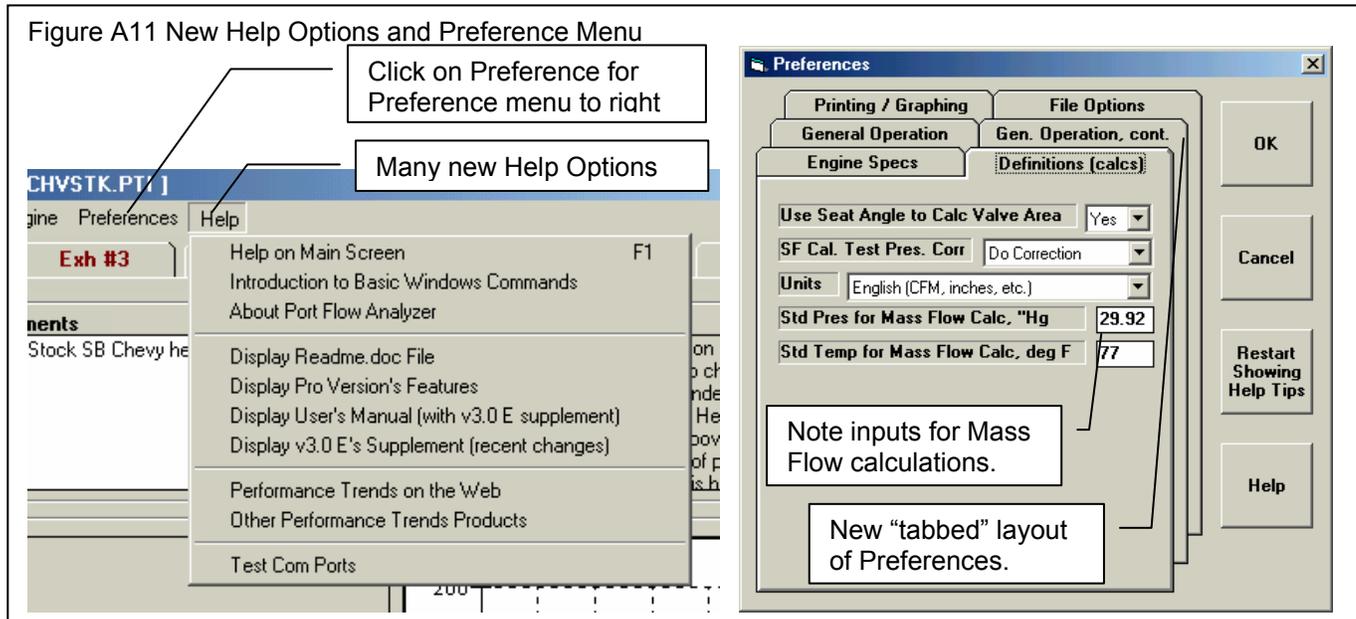


Figure A13 Edit Options

Click on File at top, left of main screen, then Edit for this menu of options to appear.

Click on the top of the Lift or L/D column (or Set Pres if you are varying test pressure) for this new Edit option

Click on 'Generate Lifts' to have Valve L/Ds generated in this pattern: .050, .100, .150, .... .300 based on current settings in Test Options menu. (If you have already recorded data, these new lifts may not correspond to the correct data for that lift.)

Hot Keys for Data Recording (see figure A14 below):

- F5 Go to FlowCom or Electronics screen when at main screen.
- F6 Go to Comments section when at main screen.
- F8 go down one port, for example from Intake on Cyl #3 to Exhaust on Cyl #2. This can be done at the main screen or from the FlowCom or Electronics screen.
- F9 go up one port, for example from Intake on Cyl #3 to Exhaust on Cyl #3. This can be done at the main screen or from the FlowCom or Electronics screen.
- Esc key to close the FlowCom or Electronics screen and return to main screen.

Figure A14 Using "Hot Keys" to Navigate Through Data Recording Screen

F5 from the main screen brings up the FlowCom or Electronics data recording screen.

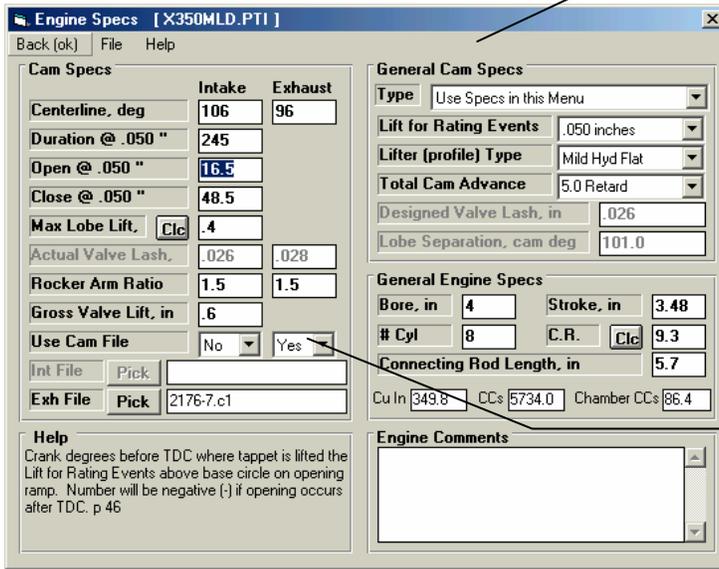
F8 and F9 step forward or back between the different ports without having to leave the FlowCom or Electronics screen.

Esc key closes this data recording screen.

F6 at the main screen puts the cursor in the comments section.

Point	Lift "	L/D	Range	Test Pres "	Flow Pres %	CFM
1	.075	.050	1	20	74	24.6
2	.150	.100	2	19.9	71	50.6
3	.225	.150	3	19.9	50	74.4
4	.300	.200	3	20	62	92.7
5	.375	.250	3	19.9	67	100.7
6	.450	.300	3	20	67	100.4
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						

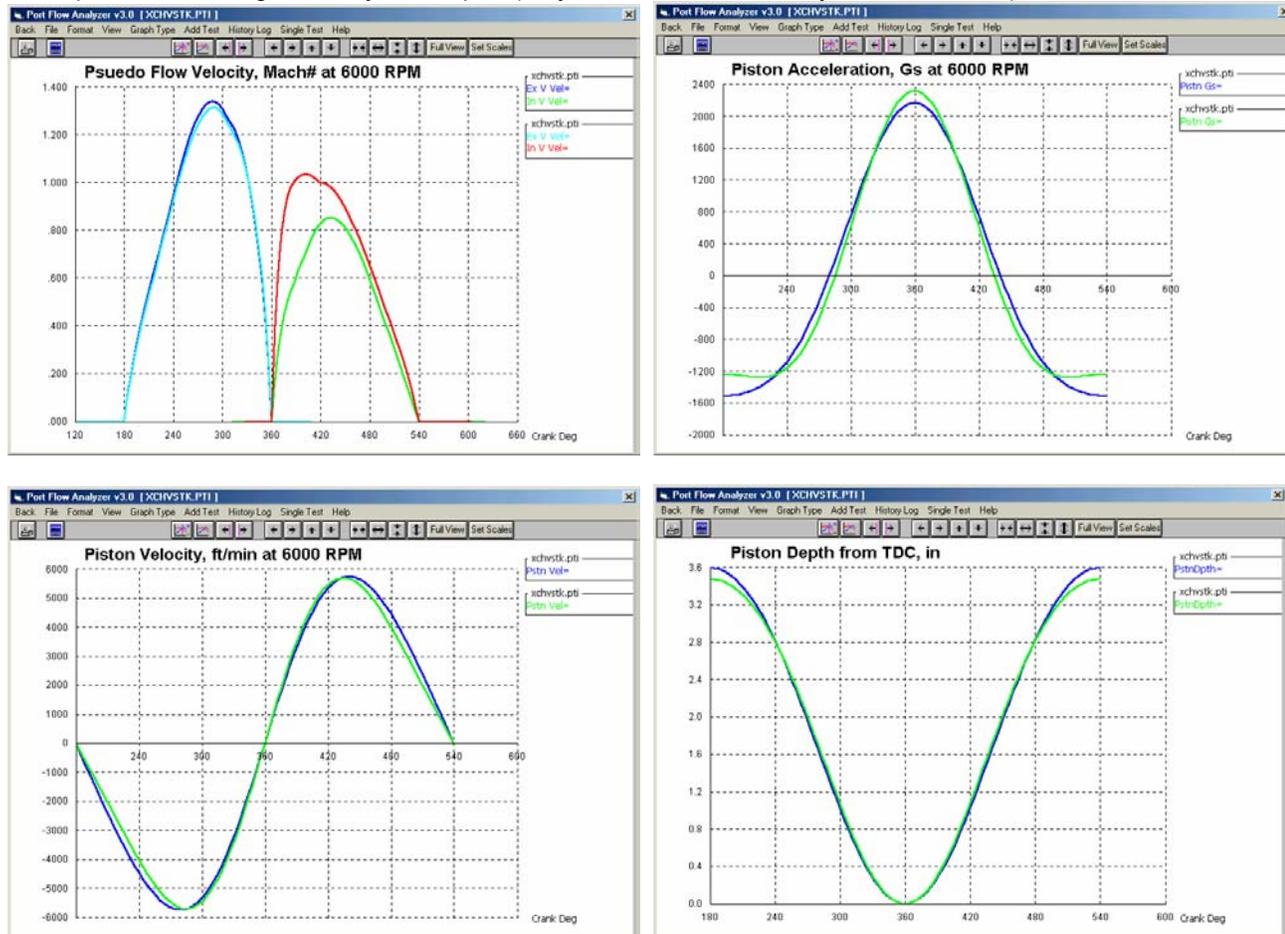
Figure A15 Engine Specs and Using Cam Files



In the Pro version, you can combine flow data with engine specs for doing engine analysis and performance projections. Note that much more detailed analysis is available in our Engine Analyzer Pro, which can read the Port Flow Analyzer's flow files.

Choose Yes for Use Cam File to enable Exh File and the Pick (browse) button to pick a cam file from the folder CamFiles (default) or most any folder on your computer.

Examples of New Engine Analysis Graphs (only Pseudo Flow Velocity uses flow data)



Pseudo (false) Flow Velocity in Figure A15 is the calculated INCOMPRESSIBLE velocity of the air as it passes through the valve. Some engine builders like to look at these numbers as they make changes to the head flow, cam profile, rod length, etc. HOWEVER, this is NOT the TRUE air speed, because air can compress and expand, and its density changes with temperature. True air speed and tuning details ARE calculated in the Engine Analyzer Pro, which gives a much more realistic idea of what is actually happening.

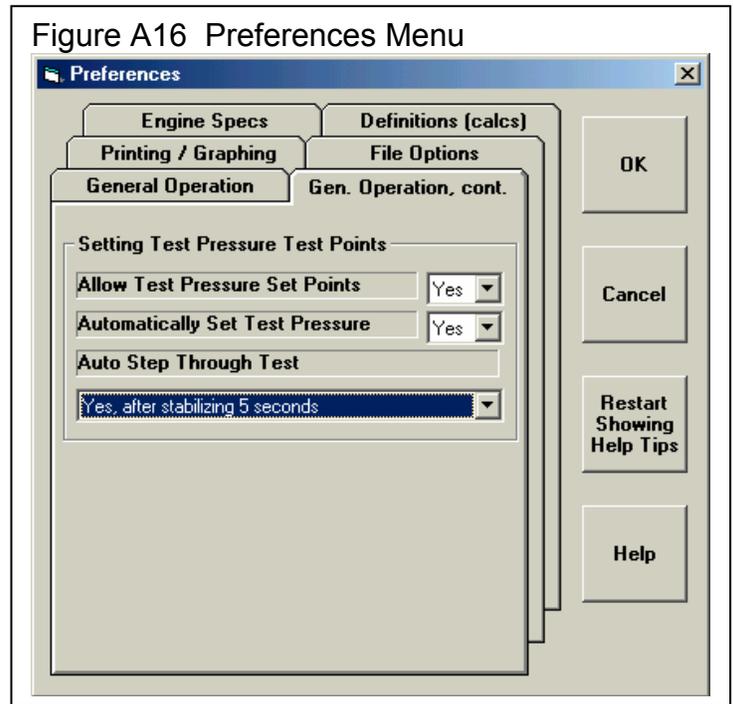
## Running Tests Where Test Pressure is Changing

Rather than recording CFM flow data at different valve lifts, you can now choose to test a component at different Test Pressures. This is a method used for testing devices without various valve lifts, like mufflers, air cleaners, air meters, turbo components, etc.

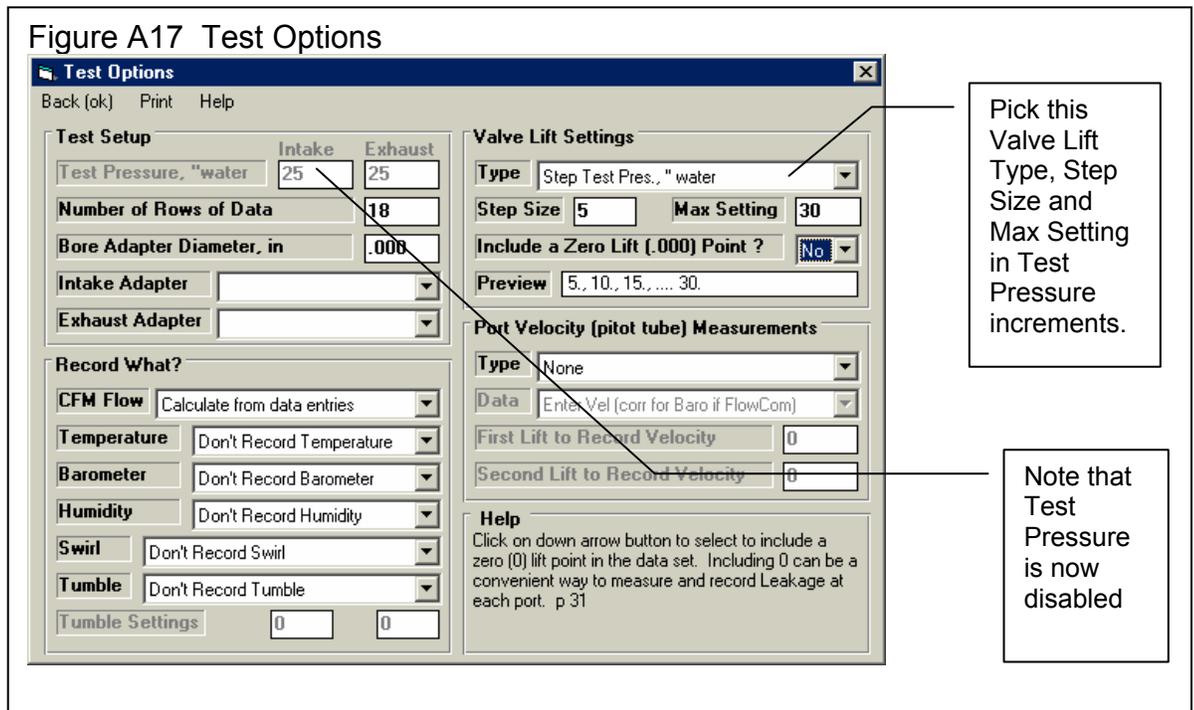
Setup the Preferences menu for the appropriate options by clicking on Preferences at the top of the Main Screen. See Figure A16.

Allow Test Pressure Set Points must be set to Yes. Automatically Set Test Pressure means you want the Port Flow Analyzer to set the test pressure for each new set point. This will only work if you have a motor controller. You may want this turned off if you encounter problems with having the program setting Test Pressure automatically.

If you want the program to automatically step to the next row with a Set Test Pressure, Choose one of the "Yes" options for "Auto Step Through Test". These also let you set the approximate amount of time to stabilize between points.

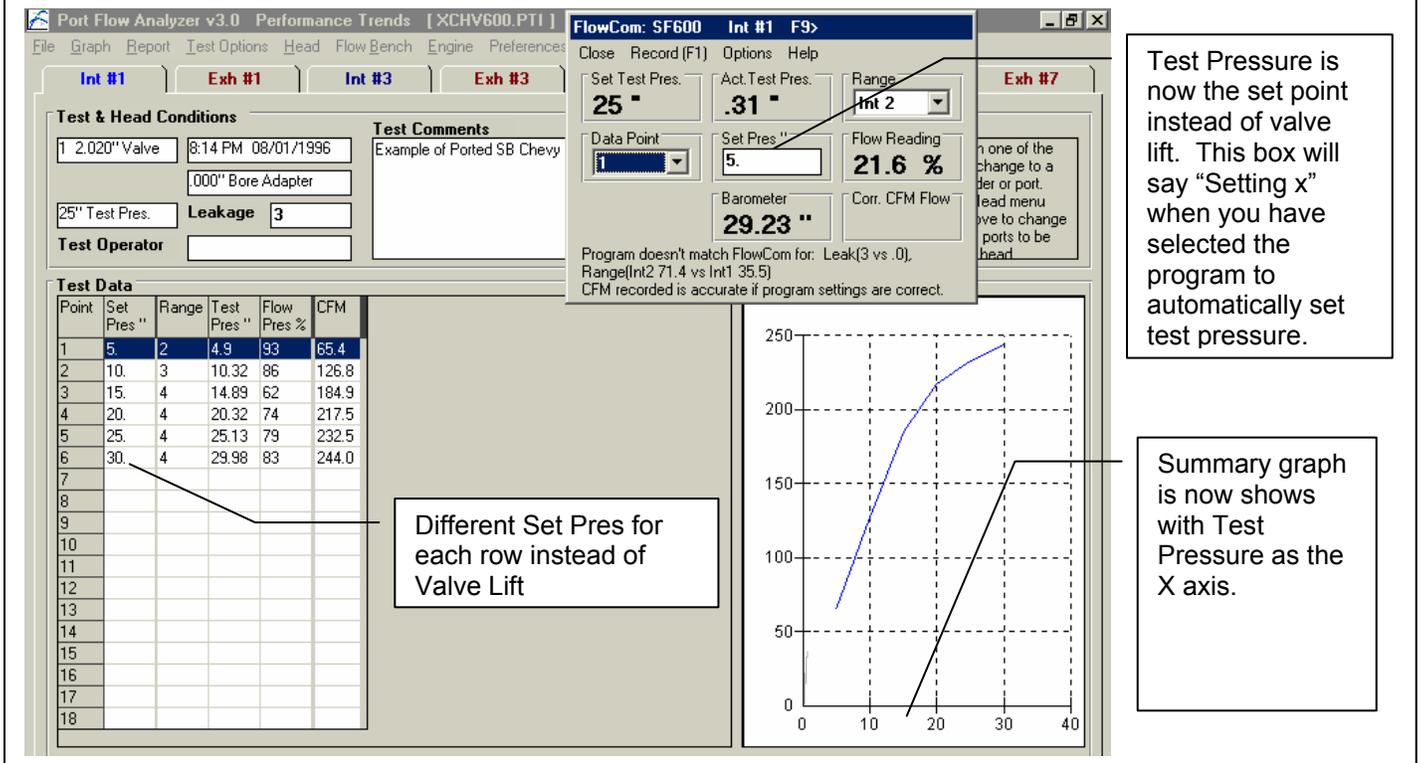


Choose the appropriate option in the Test Options menu. See Figure A17.



Now you will proceed as with any other type of test, except you (or the Port Flow Analyzer software) will set the test pressure at each different row (test point) to a different number in the “Set Pres” column. The program will record the actual test pressure (typically quite close to the Set Pres in the “Test Pres” column, and correct the CFM to what it would have been if you had obtained the exact Set Pres.

Figure A18 Main Screen Setting Test Pressure



If you set the Preference “Auto Step Through Test” to one of the “Yes” options, the program will automatically step to the next row, set the test pressure via the SuperFlow’s Motor Controller through the FlowCom and wait the selected amount of time. Then the program will automatically record the data and step to the next row. For this procedure to work best, you should start at the first row. The sequence is started when you press <F1> or click on the Record menu item. When all rows with a “Set Pres” have been set and recorded, the focus should return to the first row and auto-stepping will stop.

# Appendix 7: New Features in V 3.5

Port Flow Analyzer has had many updates since this user manual was written for the original v3.0 for Windows. These include 3.0 A through v3.0 E and now v3.5. Here is a brief listing of some of the features new since v3.0 E was released, including Version 3.5. Unless stated, most all of these new features apply *Only to the Pro Version of the software*:

## New Features:

- The program now has an “EZ Start Wizard” to walk beginners through the steps of starting a new test. (Fig A20) This feature is in the Basic version also.
- Program will automatically look for old v3.0 files and copy them over to this new v3.5. This feature is in the Basic version also.
- Added several features for emailing graphs, files and PDF reports (if you have the full Adobe Acrobat™). (Fig A21)
- Program now has a 'Website' button in the About screen for jumping to [www.performancetrends.com](http://www.performancetrends.com) website.
- New Preference for Blue and Red text colors in data entry grid on main screen, to better remind user of Intake versus Exhaust data. This feature is in the Basic version also.
- Increased the number of possible data points (rows of data) up to 55. This feature is in the Basic version also..
- Program now has added a new 'Edit' menu with several Edit options for the Main Screen. (Fig A22) This feature is in the Basic version also..
- Program now has added Backup and Restore commands under File at the main screen. (Fig A22) This feature is in the Basic version also..
- Program now has added ability to read WinFlow files from SF 1020 bench, in addition to an SF 600.
- You can now resize the Electronics and FlowCom Recording screen to display these readouts to fill the entire screen, if needed. (Fig A33) This feature is in the Basic version also..
- The program now warns if you pick an Alternate Folder for Saving in Preferences if the path includes "\PFADAT". You should be picking the folder which contains the folder "\PFADAT".
- In Head Details screen, the program would not correctly calculating Area or Width and Height for an Oval port. The program assumes Oval if the Width and Height are not the same and "Round" is the port shape described in the Head specs.
- The main screen now displays better for screen resolutions greater than 600 x 800. This feature is in the Basic version also.
- The screen colors are now more compatible with Windows XP. This feature is in the Basic version also.
- Added a new Port Velocity mode in test options, where you can record 1 pitot tube pressure at every test point. A new Preference called "Prompt for Recording Single Vel. Pt." was also added to let the program Prompt you for recording a single Pitot Tube velocity reading after you record the CFM readings. Set this to No and the program records all data AND Pitot Tube velocity at the same time. Set this to Yes, and the program records all CFM data EXCEPT velocity, then displays a message "Now Record Velocity with <F1>" for about about 1 second, then when you press <F1> again, just the velocity reading is taken. This data is contained in a data column called “Vel #1”. This data is graphed vs Lift or L/D if you select to graph a Port Velocity Map, and is included in Report Types of “Raw Data” and “Calculated Data”. (Fig A23)
- You can save a picture file (like a jpg file) at each lift point, like recording flow patterns with wet flow benches. (Fig A23)
- You can now search (Filter tests) for certain characters or phrases in the test File Name, in addition to comments, spec settings flow results as available in v3.0.
- Now when you click on a graphed point on the main screen, the row for that data point gets highlighted in the table of results. This feature is in the Basic version also.
- Program now better remembers the printer type and printer page orientation when you make changes to the Windows Printer Setup. This feature is in the Basic version also.
- Program now has new preference to let you pick a Company Logo graphics file to appear in your printouts. The logo prints out in Graph printouts also. (Fig A25)

- Updated the routine to locate an appropriate version of Adobe Acrobat™ to view the PDF files for the user manual. This feature is in the Basic version also.

## New Outputs (Features for Graphs and Reports):

- Added several new features for doing Cylinder to Cylinder comparison reports. (Fig A24) When you choose a 'Cyl-Cyl' report type, three new options appear:
  1. Whether to include additional Tests or Heads in the report. This allows you to compare cylinders from different tests or heads on the same report.
  2. Whether to include a difference column to show the difference in the first Column of CFM to all the rest. This first column could be a single cylinder or the average for the first head.
  3. Whether to include averages of the columns at the bottom of each column. This would be like the average CFM flow at all lifts for each cylinder.
- Program now has added ability to specify which Ports to Graph and/or Report with a new 'Pick' option for Which Cylinders in the 'Graph' and 'Report' Options screens. (Fig A24)
- Columns in History Log have been slightly rearranged, and columns now include Which Cylinders, which are the cylinders to Report or Graph if you choose the 'Pick' option. (Fig A24)
- New Format option to Open/Save/Edit a particular graph format. This allows you to save the graph type, test pressure corrections, graph scales, etc to a particular name. Then you can easily Open these saved formats to reproduce a graph format in the future. This is available by clicking on Format, then Open/Save/Edit Graph Format. (Fig A26)
- User Specified Colors now include colors for Port Velocity Maps. Click on Preferences, then Set Graph Colors on the right side, then at the bottom right of the Graph Colors screen are the color choices for the Port Velocity Maps.
- Made several changes so Port Velocity maps would show up better on various computer screen resolutions.
- Added several new features for writing ASCII files from reports. (Fig A29)
  1. Report names can now include the path.
  2. Now you can browse to find or create a file name and path for writing the ASCII file.
  3. ASCII reports can now include comments and all test specifications in the output.
  4. Program now remembers ASCII file settings.
- Program now has added several additional graph styles under format, then Line Style. These include bar graphs, 3D bar graphs, area graphs, etc. (Fig A27)
- Program now has added "3D-Graphs.clc" calc screen to let user change view and other specs about 3D graphs. (Fig A28)
- When opening a WinFlow data file, the program now lets you pick the Comments file for this WinFlow file, so those comments can be imported also.
- The Preference which allows you to choose a default External/CD drive has been expanded to include letter drives from A to Z. This feature is in the Basic version also.
- Changed Preference for Dot Matrix Graph Printer Adjustment to "Graph Printer Adjustment For..." and now have "Acrobat" as a choice. This feature is in the Basic version also.
- Put in checks for blank choices in Graph and Report menus. Blank entries are automatically set to the first choice in the 'Drop Down'. This feature is in the Basic version also.
- Made graph line flash rate independent of computer speed (.2 second flash rate). This feature is in the Basic version also.
- Print B&W now draws graph as B&W on screen for better printing on color printers when B&W has been requested. This feature is in the Basic version also.
- Program now prints headers of graphs and reports the same, and modifies the spacing to better ensure that long test file names are printed completely. As mentioned earlier, you can also include a company logo graphic image.
- A new option has been added so reports can be printed WITHOUT the Flow Data. This allows you to print, for example, just the Head Specs and Head Details with nothing else. This feature is in the Basic version also.

## New Features for Various Flow Benches and Electronics:

- Added some new Flow Bench types and/or features to be more compatible with the following types of Flow Benches. This feature is in the Basic version also.
  - Performance Trends' EZ Flow system. (Fig A32)
  - SuperFlow
  - FMA Flow Benches from Australia
  - Saenz Flow Bench
  - Performance Flow and JKM style benches (using Pitot Tubes to record CFM flow)
  - Several styles of custom or "do it yourself" flow benches.
- Program now will control Performance Trends' automatic Valve Opener. Note: You will be given a new unlock number for your program to open up the Valve Opener menu option in the Flow Bench specs. (Fig A30)
- Program is compatible with SuperFlow's™ new USB FlowCom. This feature is in the Basic version also.
- Added 3 new Preferences for Pro version only, which allows for there to be both an Intake and Exhaust Test Correction. A Test Correction is obtained by flowing a known orifice where the head would go on your flow bench. Knowing the difference between what IS measured and what SHOULD BE measured, a correction is obtained, to put your bench back in Calibration. Now you can do this both in the standard Intake direction AND exhaust direction. The Preferences menu now contains places for you to enter the expected flow for both the intake and exhaust direction. Previously, the program used the Superflow SF110 bench standard of 153.2 CFM.
- Program now has added ability to permanently save some debugging settings in the 'Flow Com' or 'Electronics' screen if these debugging settings are fixing a problem. Click on Options, then the 'Save..' or 'Unsave..' options.
- Program now has added option if FlowCom screen to force FlowCom to change the range of the flow bench.
- If requested Range in Bench Specs is blank, the program now assigns range 1 both in the FlowCom Screen and in the Main Screen grid (spreadsheet).
- Added Calibrate Range screen in Bench Specs for Custom Bench or Performance Trends' EZ Flow Type flow bench. By installing and flowing known sharp edged orifices, you can calibrate your bench to match the CFM results of other production flow benches, like a SuperFlow™ bench. (Fig A31)
- Program now does more extensive of valid com ports for communicating to a FlowCom or Performance Trends Black Box and Black Box II. It checks up to Com Port 20, and gives better suggestions at valid ports. There is also a "Find" button in the Flow Bench specs screen to find your electronics by checking all available Com Ports. This feature is in the Basic version also.
- Expanded some allowable ranges for SF300 and SF600 to cover ranges requested by some customers. Opened up acceptable limits for flow ranges for Custom Bench to 10-5000 CFM. This feature is in the Basic version also.
- New Preference allows you to increase the allowable test and flow pressure inputs up to 1000 each.
- Program now allows printing of Calibrations screen. This feature is in the Basic version also.
- Rearranged Troubleshooting options in FlowCom/Electronics screen to be under Help. This allows more room for features to be listed under Options. This feature is in the Basic version also.

## New Features Specific to the Black Box II:

- Program now has added option for Recording Switch for Black Box II. Click on Options in the Electronics screen, then Foot Switch Enabled to turn on this option. Then click on Options in the Electronics screen again, BB2 Foot Switch, then pick which Temperature channel to have the switch come in on. The Black Box II can read both temperature and the foot switch from the 4 pin analog inputs on its side. This feature is in the Basic version also.
- Added 2 new Troubleshooting Options, of Test Com Ports and Check Boot Message. This feature is in the Basic version also.
- Made major change to EZ Flow flow bench calibration to work with new Black Box II. (Fig A32) This feature is in the Basic version also.

- Program now does better checks for bad data from Black Box II. This feature is in the Basic version also.
- Added new option for Preference of 'Black Box Reads +/- Pressure' but the program does no checks to see if the direction of the flow is correct for the type of port, intake and exhaust. Setting "Black Box Reads +/- Pressure" means a custom bench does not need valves to maintain the high pressure side of the manometer to remain the high pressure side of the manometer when you switch from the Intake to the Exhaust flow direction. This greatly simplifies the design of "do it yourself" and custom benches.
- Fixed bug where if the program is set to 'Black Box Reads +/- Pressure', CFM was being displayed even if the Vertical Manometer reading was less than 2" water. This feature is in the Basic version also.
- Added Preference for Barometer sensor in Black Box II. To get Barometer reading with Black Box II, you must turn on the Preference "Black Box II has Baro Sensor" and also ask to record Barometer in the Test Conditions screen. You can also adjust the Barometer reading slightly with the Weather Calibration section in the Calibrations screen available by clicking on the Calibrations button at the lower left corner of the Flow Bench Specs screen. The Barometer input in this screen will offset the Black Box's barometer reading. For example, enter -.25 and the Black Box's Barometer will be reduced by .25 inches of Mercury.
- Program now has added checks for Black Box or EZ Flow systems to watch for over-ranging the pressure sensors, producing inaccurate data. For example, if a pressure sensor is "maxed out", the program tells you this, rather than letting you think this data point is accurate. This feature is in the Basic version also.
- Fixed a bug where the Black Box could read test pressure incorrectly for certain faster computers. This feature is in the Basic version also.
- Added a Preference to Eliminate program looking for Black Box set up for + or - pressure.

### **New Engine Performance Report Features (Pro Version Only):**

- Program now comes with almost 1000 more example cam profiles built in, including almost the entire Crane catalog.
- Program now offers to fill in blank Engine Specs.
- Program now allows for Rocker Arm Ratios of less than 1, down to .7
- Fixed a bug where if you chose a different Cam Advance in the Engine Specs screen, it would blank out and revert back to straight up.
- Fixed a bug where if you chose something other than .050" events in the Engine Specs screen (.040" or seat timing), the program would always open up the Engine Specs screen with .050" as the labels for cam events.
- Fixed bug where VERY high runner velocities (small ports) could erroneously produce good HP.
- Engine Performance Estimate report now uses Metric Units if Metric units are chosen in Preferences.

Fig A20 Starting a New Test Using the EZ Start Wizard

Click on File, the EZ Start Wizard to start a new flow test using the "Wizard"

You will be presented with a series of screens with questions, explanations and possible settings, to make starting a new test as easy as possible. "Back" button at bottom lets you easily back up to previous steps.

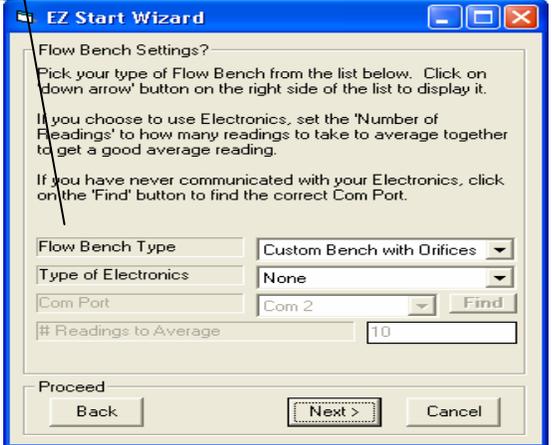
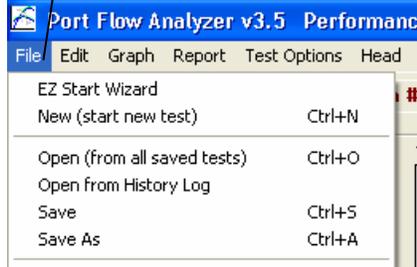
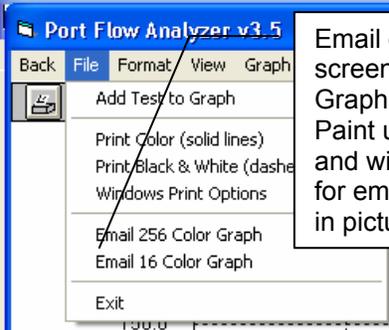
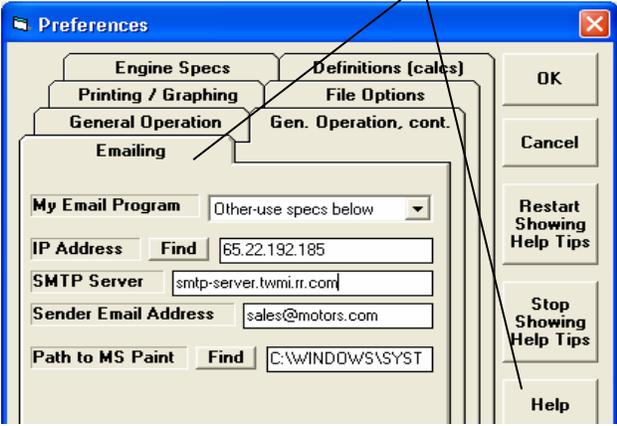


Figure A 21 Emailing Options

Set email options in Preferences. Click on Help button on right for explanation of these features.



Email options in Graph screen. The Email 16 Color Graph requires you to find MS Paint utility on your computer and will create a smaller file for emailing with very little loss in picture quality.

Email as PDF File in the Print Options in the Report Screen.

Email a Test File from the Main Screen, so someone else with Port Flow Analyzer can view it.

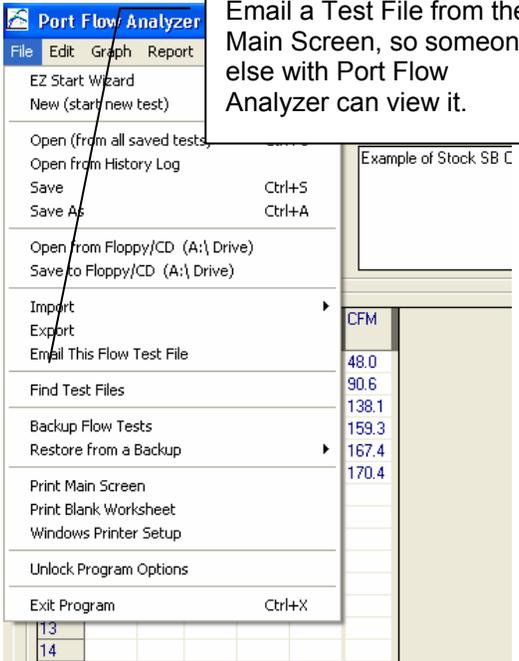
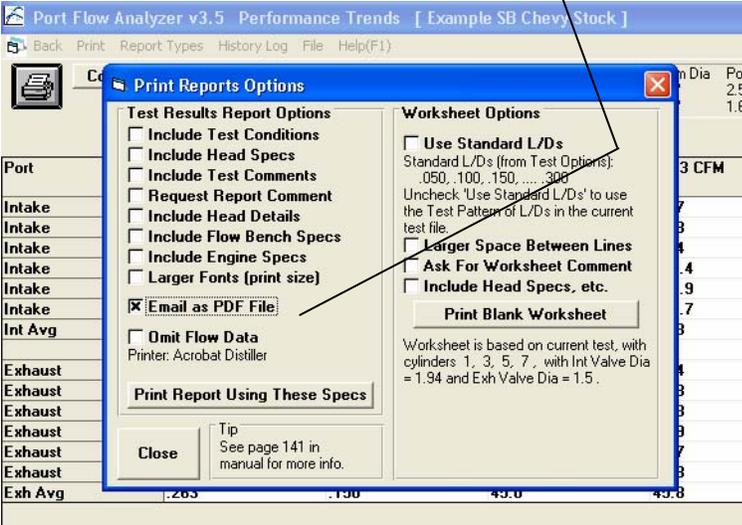


Figure A22 Some New Features on the Main Screen

New Import Commands to import WinFlow™ files (SF 600 and SF 1020) and import files from an earlier version of Port Flow Analyzer, like v3.0. This makes it easy to pull all your v3.0 files over to the new version 3.5.

New Backup and Restore Commands let you backup or restore ALL your test files with a couple of keystrokes.

New Edit Options

- Copy/Swap/Erase Ports
- Erase/Insert/Add Rows
- Erase/Add/Fill In Columns
- Change Number Ports/Cylinder Numbering/Valve-Port Sizes

Figure A23 Options to Record a Single Velocity Data Point

Choose Single Velocity Point in Test Options. Note the additional new option of Recording a Picture File for each lift point, typically used for Wet Flow Benches.

This Preference lets you pick if you want the program to Prompt you for recording the velocity point after you record CFM data.

This is the column where your Single Velocity point will be recorded.

Point	Lift "	L/D	Range	Test Pres "	Flow Pres %	CFM	Vel #1
1	.097	.050	2	20.3	72	48.0	
2	.194	.100	3	20	62	90.6	
3	.291	.150	3	19.8	93	138.1	
4	.388	.200	4	19.8	54	159.3	
5	.485	.250	4	20	57	167.4	
6	.582	.300	4	20	58	170.4	

Figure A24 New Cyl-Cyl Comparison Reports

Pick a "Cyl-Cyl Comparison" Report Type.

New "Pick" option lets you specify which cylinders for this head to include, in this case you have entered "1, 3".

These 3 new settings for "Cyl-Cyl Comparison" reports let you include cylinders from other tests, include a "Dif" column showing CFM improvements, and if you want averages of the columns or flow averages for the head included in the reports.

Click on the "Heads" button for a summary of the heads shown in this Cyl-Cyl Comparison Report, as shown here. These comments will be included in printouts.

Port	Lift	L/D	Cyl 1 CFM	Cyl 5 CFM	Dif	Cyl 3 CFM [A]	Dif	Cyl 4 CFM [A]	Dif
Intake	.097	.050	34.0	27.5	-6.5	35.41 *	1.41	33.75 *	-0.25
Intake	.194	.100	64.1	60.9	-3.2	72.03 *	7.93	67.98 *	3.88
Intake	.291	.150	97.7	85.5				*	-4.49
Intake	.388	.200	112.6	100.4				*	-9.8
Intake	.485	.250	118.4	105.6				*	-14.6
Intake	.582	.300	120.5	109.9				7 *	-17.93
Int Avg	.340	.175	91.2	81.6					
Exhaust	.075	.050	17.4	15.8					
Exhaust	.150	.100	35.9	35.3					
Exhaust	.225	.150	52.8	50.6	-2.2	62.73 *	9.93	61.03 *	8.23
Exhaust	.300	.200	65.8	61.5	-4.3	74.5	8.7	75.5	9.7
Exhaust	.375	.250	71.5	69.3	-2.2	88.35 *	8.85	82.03 *	10.53
Exhaust	.450	.300	71.3	71.3	0.	82.75 *	11.45	84.25 *	12.95
Exh Avg	.263	.150	45.0	43.4	-1.6	52.4	7.4	52.5	7.5

Cyl 3 and 4 picked in History Log from Head "A" for comparison.

1<sup>st</sup> and 3<sup>rd</sup> cylinders from the Baseline head (Cyl #1 and Cyl #5 on this Chevy head) shown here, as picked in the Report Options screen.

Difference between each cylinder and the first cylinder (Cyl 1 CFM in the 4<sup>th</sup> column in this case) is shown in the "Dif" columns.

Column Averages shown at bottom of columns.

Figure A25 Print Options and History Log for Printing Report from Figure A24

In Preferences, set text to be included in Printouts.

In History Log, put a Yes in the "Report" column for tests you want to include in this report.

Use Browse button to find your graphics file on this computer.

Click in the "Cyls to Report" to assign which cylinders to include in the "Cyl-Cyl Comparison" report.

Two lines of text from Preferences is printed here in printouts.

	Port Test Folder: EXAMPLES	Your name / company name can go here. See Preferences.	This Report Printed: 12:17 pm 06-25-07 Page: 1						
<p>Test Comments: Example of Stock SB Chevy head on SF 600 Bench</p>									
Report of: Comparing 4 Cylinders	Test Time: 8:14 PM 08/01/1996	Tested at: 20" Int: 20" Exh: 20"	Corr to: 10.0" 1 1.5" .34" 1.69 sq in						
<p>Baseline Title: example sb chevy stock Head Number: Test Date: 08/01/1996                  File\Path: c:\vb98\projects6\pfa\pfadat\examples\example sb chevy stock                  Intake: 1 1.94 diameter valve(s) Exhaust: 1 1.5 diameter valve(s)</p>									
<p>Head (A) Title: example sb ford sf 110 w port velocity Head Number: Test Date: 08/01/1996                  File\Path: c:\vb98\projects6\pfa\pfadat\examples\example sb ford sf 110 w port velocity                  Intake: 1 1.78 diameter valve(s) Exhaust: 1 1.45 diameter valve(s)</p>									
Port	Lift	L/D	Cyl 1 CFM	Cyl 5 CFM	Dif	Cyl 3 CFM (A)	Dif	Cyl 4 CFM (A)	Dif
Intake	.097	.050	34.0	27.5	-6.5	35.41 *	1.41	33.75 *	-0.25
Intake	.194	.100	64.1	60.9	-3.2	72.03 *	7.93	67.98 *	3.88
Intake	.291	.150	97.7	85.5	-12.2	99.78 *	2.08	93.21 *	-4.49
Intake	.388	.200	112.6	100.4	-12.2	108.64 *	-3.96	102.8 *	-9.8
Intake	.485	.250	118.4	105.6	-12.8	110.61 *	-7.79	103.8 *	-14.6
Intake	.582	.300	120.5	109.9	-10.6	111.87 *	-8.63	102.57 *	-17.93
Int Avg	.340	.175	91.2	81.6	-9.6	89.7	-1.5	84.0	-7.2
Exhaust	.075	.050	17.4	15.8	-1.6	22.25 *	4.85	21.7 *	4.3
Exhaust	.150	.100	35.9	35.3	-0.6	44.15 *	8.25	42.7 *	6.8
Exhaust	.225	.150	52.8	50.6	-2.2	62.73 *	9.93	61.03 *	8.23
Exhaust	.300	.200	65.8	61.5	-4.3	74.5	8.7	75.5	9.7
Exhaust	.375	.250	71.5	69.3	-2.2	80.35 *	8.85	82.03 *	10.53
Exhaust	.450	.300	71.3	71.3	0.	82.75 *	11.45	84.25 *	12.95
Exh Avg	.263	.150	45.0	43.4	-1.6	52.4	7.4	52.5	7.5

Figure A26 Saving a Graph Format, and more

Click here to allowing Saving of the current graph settings as a Format.

Type in a name for the current graph settings, then click on Save to save them under that name and add it to the list.

To open a saved format, click on the format name from the list, then click on OK. Do the same but click on Delete to delete that saved Format.

CFM

Graph Format Name  
All cyls 0-250 CFM corr to 28  
All cyls 0-300 CFM corr to 28

OK Delete Close Help

Keep Vertical (Y) Scales  
Keep Horizontal (X) Scales  
Turn Auto-Scaling Off  
Current Graph Format is Auto-Scaled, saved scales will have no effect

Figure A27 New Graph Format Styles

Click on Format, then Line Style, then choose one of these 5 new "Line" Styles.

3D Options are shown in Figure A28

CFM Corr to:

Thin Lines  
Thick Lines  
Area Graph  
Bar Graph  
3D Bar Graph  
3D Tape Graph  
3D Area Graph  
3D Options

Avg Int & Exh CFM Corr to: 20.0° Int, 20.0° Exh

Avg Int & Exh CFM Corr to: 20.0° Int, 20.0° Exh

Avg Int & Exh CFM Corr to: 20.0° Int, 20.0° Exh

Avg Int & Exh CFM Corr to: 20.0° Int, 20.0° Exh

Figure A28 Using 3D Graph Options Mentioned in Figure A27

The figure illustrates the relationship between 3D graph settings and the resulting surface plot. It is divided into two rows, each showing a '3D Graph Specs' dialog box on the left and a corresponding 3D surface plot on the right.

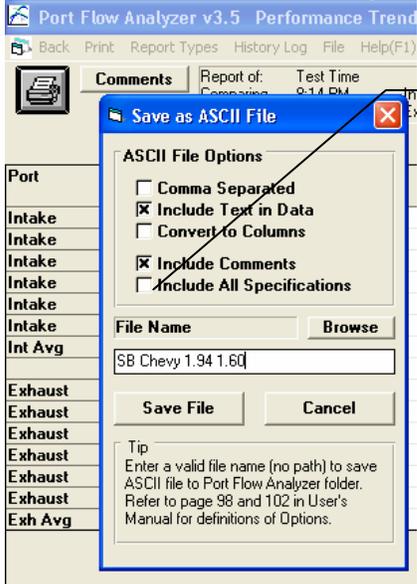
**Top Row:**

- 3D Graph Specs Dialog:** Type: Solid, Use Defaults: No, Rotation: -40, Eye Level: 10, Depth of Graph: 100, Perspective: 50.
- 3D Plot:** A surface plot titled 'Avg Int & Exh CFM Corr to: 20.0" Int, 20.0" Exh'. The plot shows a blue surface above a green surface. The vertical axis ranges from 0 to 175.0. The horizontal axes are labeled with values like 0, 1, 2, 100, 125, 150, 175, 200, 225, 250, 275, 300.
- Annotation:** A text box above the plot says 'These settings make this graph.' with an arrow pointing to the plot.

**Bottom Row:**

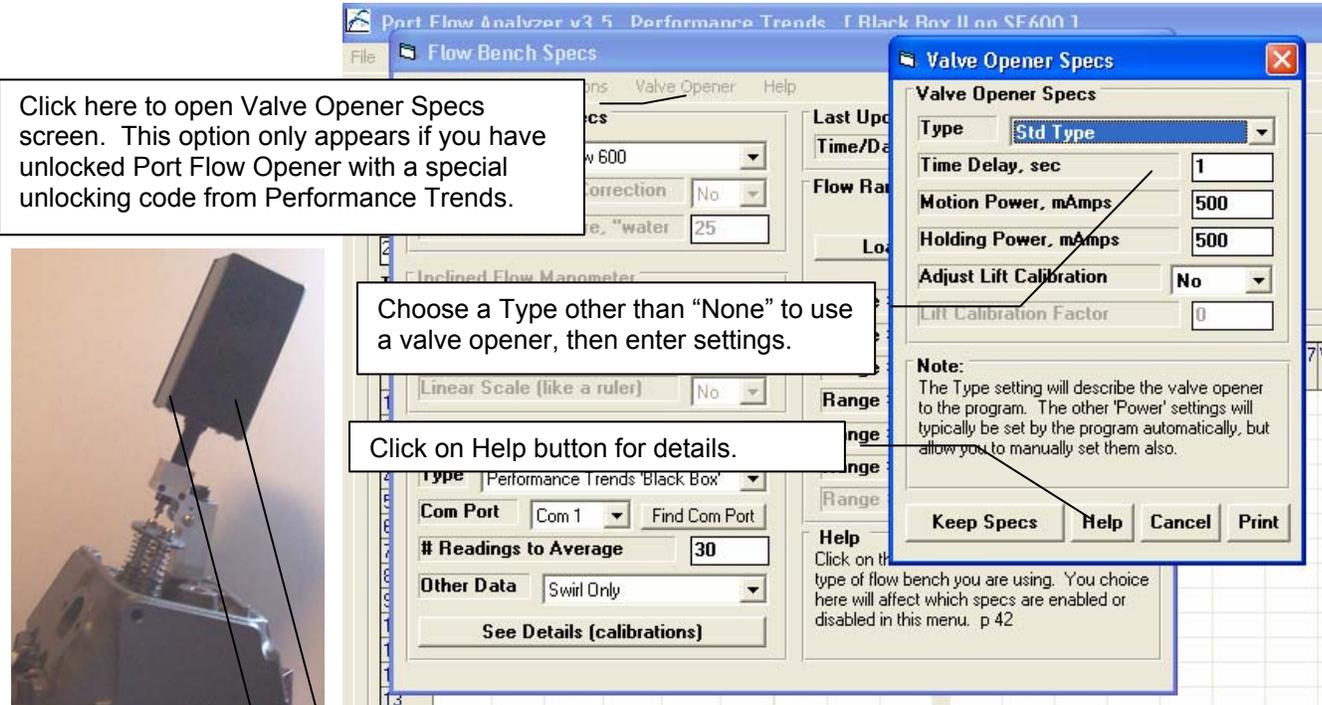
- 3D Graph Specs Dialog:** Type: Solid, Use Defaults: No, Rotation: -30, Eye Level: -20, Depth of Graph: 30, Perspective: 0.
- 3D Plot:** A surface plot titled 'Avg Int & Exh CFM Corr to: 20.0" Int, 20.0" Exh'. The plot shows a blue surface above a green surface. The vertical axis ranges from 0 to 175.0. The horizontal axes are labeled with values like 0, 25, 50, 75, 100, 125, 150, 175, 200, 225, 250, 275, 300.
- Annotation:** A text box above the plot says 'These settings make this graph.' with an arrow pointing to the plot.

Figure A29 New ASCII File Options



Several new options have been added to writing ASCII data files for importing into other data base programs, like Microsoft Excel.

Figure A30 Prototype Automatic Valve Opener

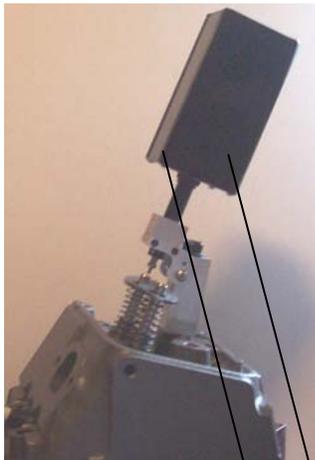


Click here to open Valve Opener Specs screen. This option only appears if you have unlocked Port Flow Opener with a special unlocking code from Performance Trends.

Choose a Type other than "None" to use a valve opener, then enter settings.

Click on Help button for details.

Note:  
The Type setting will describe the valve opener to the program. The other 'Power' settings will typically be set by the program automatically, but allow you to manually set them also.



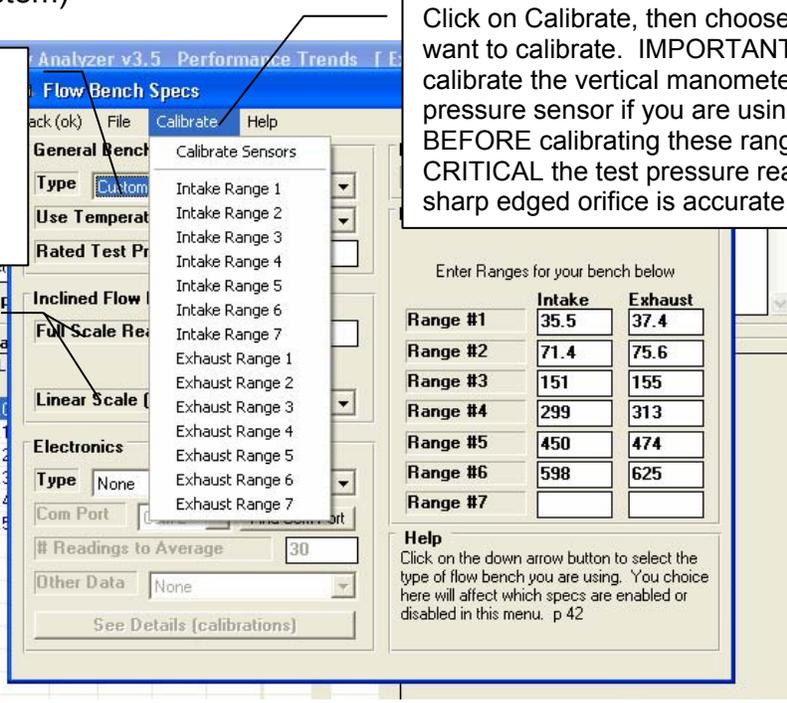
Production unit will be about half this size, but was not available at time of printing this update.

Unit automatically finds valve stem and zero's itself out. Then it steps through all valve lists you have chosen, returns the valve to closed position, checks for any slippage, and turns off bench.

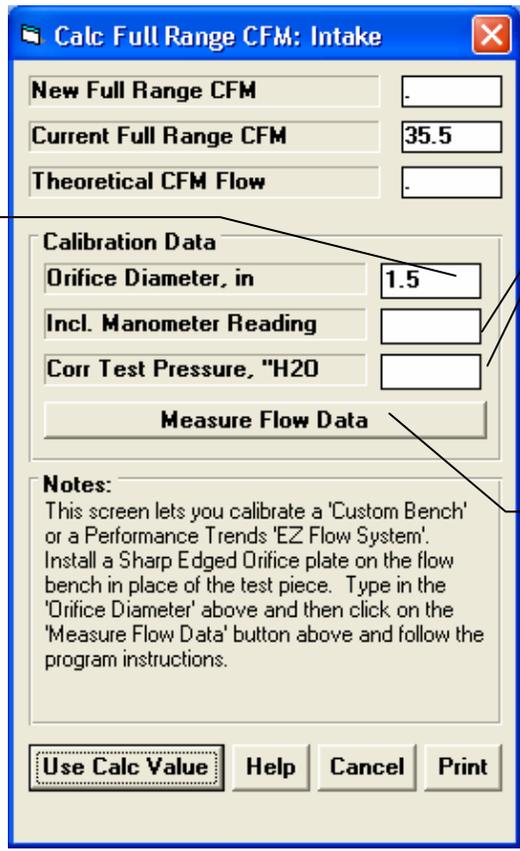
Figure A31 Features to Calibrate a Custom Flow Bench (similar to calibrating a Performance Trends' EZ Flow System)

If you have selected a "Custom with Orifices" or "EZ Flow" style of bench, then the Calibrate menu option is made available.

Before Calibrating: For a Custom Bench, you must enter the "Full Scale Reading", or the highest reading you can see on your inclined manometer. Without electronics, you must also set the "Linear Scale" parameter also.



Click on Calibrate, then choose which range you want to calibrate. IMPORTANT: You must calibrate the vertical manometer (test pressure) pressure sensor if you are using electronics BEFORE calibrating these ranges. It is CRITICAL the test pressure reading across the sharp edged orifice is accurate.



To calibrate, you will install a sharp edged orifice of a known diameter where the cylinder head typically goes. You will turn on your bench and flow this orifice as you would a cylinder head.

Without Electronics you will type in the inclined manometer reading and the test pressure across the orifice. Test pressure is the pressure typically 10, 25 or 28 inches of water).

With electronics or for our EZ Flow System, you will click on this Measure Flow Data button to record the Inclined Manometer and Corr Test Pressure data electronically.

Figure A32 Performance Trends' EZ Flow System

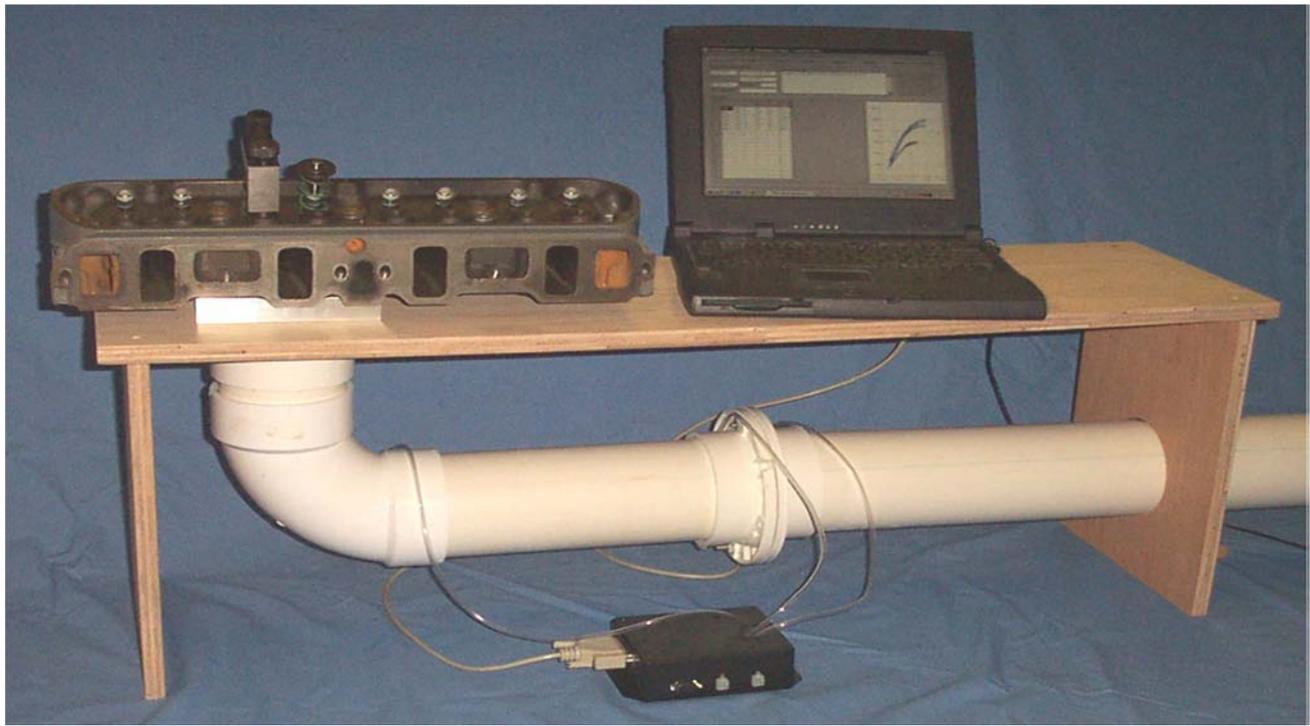
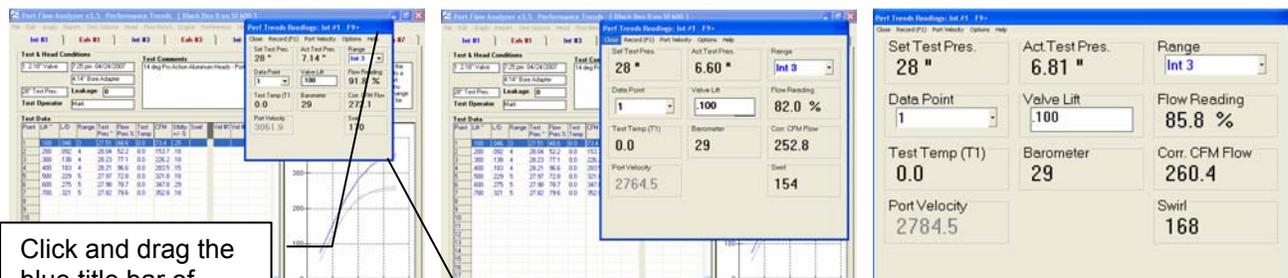


Figure A33 Resizing FlowCom / Electronics Recording Screen



Click and drag the blue title bar of screen to most any location on screen you want it.

Place the mouse pointer on the border to get a double arrow mouse pointer, then drag the border in the direction you want to expand the screen or shrink it.



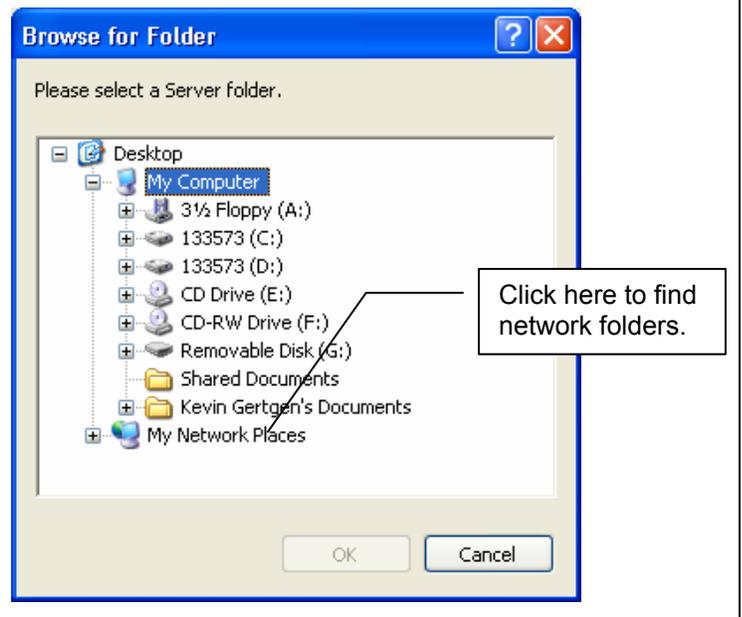
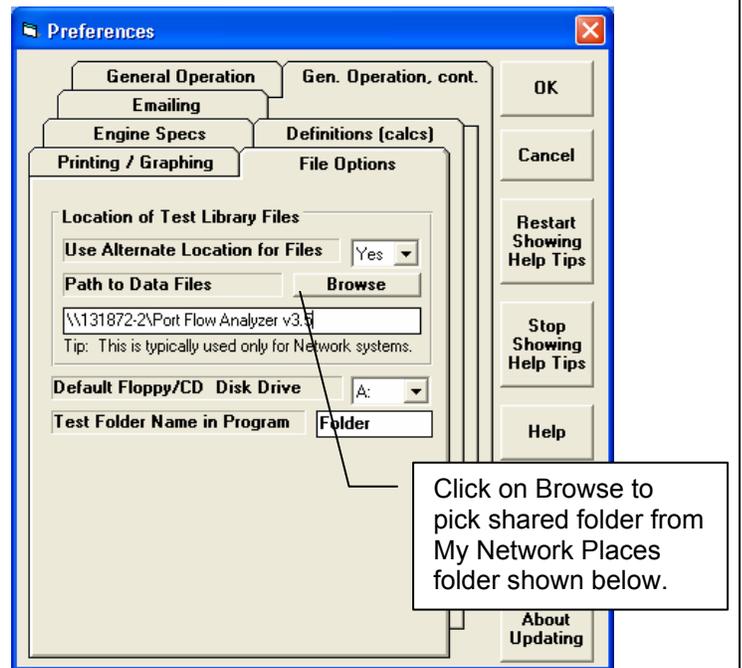
# Appendix 8: Sharing Data Files on a Hub (network)

Assume you want to share your Port Flow Analyzer files on 2 different computers, one called the Shop Computer and one called the Office Computer. We will assume that the Office computer is where you want all the new files you create to be stored.

This is the procedure to follow:

1. Install and activate the Port Flow Analyzer on both computers.
2. Using Windows Explorer, set up the Port Flow Analyzer folder (PFA) on the Office computer to be shared. Usually this is done by right clicking on the "Port Flow Analyzer v3.5" folder (usually under the "Performance Trends" folder under the "Program Files" folder on the C drive) and selecting the Sharing option. If you don't see Sharing, click on Start, then Help and look for help on Sharing Resources.
3. In the PFA program in the Shop Computer, set the Preference to Yes for Use Alternate File Location. Then click on the Browse button and find the path to the Mapped drive from the Office Computer.
4. Now, when both computers are running, all your flow files, engine and head spec files, etc are being opened from and saved to the Office Computer, both for the Port Flow Analyzer program on either the Office Computer or the Shop Computer.

Figure A40 Preference Menu for Networking Settings





# Appendix 9: New Features in v3.5 B

Port Flow Analyzer has had many updates since this user manual was written for the original v3.0 for Windows. These include 3.0 A through v3.0 E, v3.5 and now v3.5 B. For the features added to the v3.5, refer to the Readme.doc file (click on Help, then Display Readme.doc File) in the program. Listed here are features introduced in v3.5 B. Also, v3.5 B has a more advanced version we call “Head Porter”. So now there are 3 versions of Port Flow Analyzer:

- Basic Version
- Professional (Pro) Version (includes all Basic features and more advanced Pro features)
- Head Porter Version (includes all Professional features and more advanced Head Porter features)

Here is a listing of the major enhancements and new features for v3.5 B.

## Data Recording:

In Test Options, you can now select to record port velocity data at 3 depths in the port. See Figure A41, 47. Head Porter only.

Several enhancements to Port Velocity Report for Head Porter version have been added, to allow more averaging for all possible combinations of recording port velocity. See Figure A42. Head Porter only.

A new Preference to allow for English units of CFM, Deg F, inches of water pressure, etc. but mm valve, lift and engine dimensions has been added. See Figure A43. Head Porter only.

The Electronics or FlowCom screen has been enlarged in its default setting. You can still enlarge to most any size you want by turning on the appropriate Preference setting. See Figure A43-B. All versions.

You can now include a “gauge” (bar graph) for some readings on the Electronics or FlowCom screen. This gives you a graphical representation of the stability of the readings and if the readings are going higher or lower than expected values. See Figure A43-B. Head Porter only.

## Data Analysis (including Graphs and Reports):

You can create custom, user defined graphs, where you choose what data gets included. For example, you can graph CFM and Swirl and % Exh/Int on the same graph. See Figure A44, A45. Head Porter only.

Program now allows for graphing Flow results corrected to 2 different test pressures. See Figure A46. Head Porter only.

You have several options to allow for more options for doing Port Velocity Graphs. This is an extension to the feature to be able to record Port Velocity for many more data points. See Figure A47. Head Porter only.

You can now specify if you want the Test Piece picture to be drawn smaller in printouts in portrait mode. (See “Other” category for Test Piece picture.) This can allow for more printed text to be included with the graph on 1 page. NOTE: In landscape mode, the Test Piece picture is always drawn small on the same line as the test title. The Test Piece picture can also be printed in reports. See Figure A48. Head Porter only.

You can now select a single cylinder to make graphs which require a valve lift profile, like Flow Area and Pseudo Flow Velocity. In previous versions, only the Average Flow for the entire head was used. Head Porter only.

You can now request the graph to be printed in a smaller height. This can allow for more printed text to be included with the graph on 1 page. See Figure A49. Pro and Head Porter only.

You can now select a Preference to have the graph NOT autoscale when you first open it. This can be handy if you are using some pre-defined scales and want to keep them for all graphs. Pro and Head Porter only.

Added a graph line thickness between Thin and Thick, called Thin 'Plus'. See Figure A50. All versions.

The graph line styles in the drop down menu of line thicknesses are listed together, with the appropriate check mark by the type currently used. See Figure A50. All versions.

You can now select larger legends (labels) in the graph screen. See Figure A50. Pro and Head Porter only.

Added label to better explain what cylinder or that Average of All Cylinders will be used for Flow Area and Pseudo Flow Velocity graphs. Pro and Head Porter only.

The graph screen now should more completely fill the available screen in most all situations. All versions.

Improved appearance of some printed graphs, especially in Landscape orientation. Previously the graphs had a border drawn around them. On the left side, the border could be broken. On the right side the legend (labels) could also be distorted. Now the border is not drawn in those locations. See Figure A49. All versions.

The graph choices have been simplified by eliminating many of the Int, Exh, and Int & Exh choices into just 1 choice. Now the program looks to a separate input of "Port to Graph" for this setting Int, Exh, and Int & Exh choices. See Figure A45. All versions.

Fixed bug where the Port Velocity Map was not being graphed correctly. Pro and Head Porter only.

Made Overlap Graphs go to zero at start and beginning of graph to look more correct. Pro and Head Porter only.

Fixed bug where graphs for % Exh/Int only showed the first cylinder on the head even though you requested all cylinders to be graphed. Pro and Head Porter only.

Added menu command 'Edit Printed Comments & Data Output' under the File option on the Graph screen in the printing options section. Pro and Head Porter only.

Program now includes more example cam files, the same files included in the new Engine Analyzer v3.4. See Figure A51. Pro and Head Porter only.

## Hardware:

Pro version now allows for Performance Trends' motor controller to be used. See Figure A52. Pro and Head Porter only.

Program now allows for a USB switch to be used for starting to record data. This option does not present conflicts with some features of the SuperFlow Flowcom. This is done by purchasing the proper switch from Performance Trends, then going into FlowCom or Electronics screen, clicking on Options at the top, then select the USB Switch Option. You must also set the proper Com Port for the USB Switch under this option also. See Figure A53. All versions.

In the Bench Specs screen, the program now allows for Valve Opener for any Pro version. Pro and Head Porter only.

Added Hot Wire (hot wire anemometer mass air flow sensor) as a Custom Bench Type. See Figure A54. All versions.

## Other:

The program now lets you "Filter" tests in the library for finding tests of a certain date, certain file name, etc. Pro and Head Porter only.

When quitting program and you select 'Cancel' for Saving Changes to current test file, now the program keeps program open. Before v3.5B, it continued shutting down. All versions.

The option for using a 2 pulse swirl meter, to be read directly with a FlowCom (no Performance Trends electronics) has been added. In addition, a special calibration factor for this 2 Blade Swirl meter is also possible. Pro and Head Porter only.

Fixed bug where reports may be requested for intake and exhaust ports, but only intake ports were reported. All versions.

Fixed bug where the cylinders you may "Pick" for a report were not being shown clearly (another input was in front of it). All versions.

Fixed bug where FlowCom/Electronics screen could be off screen too high or too far to left. All versions.

Fixed bug where Test Comments were not being shown in the Preview when opening some older Port Flow files. All versions.

Updated a text file to more accurately show Mass Flow correctly for gm/sec and lb/min, and correct for proper air density specs. Pro and Head Porter only.

Program now hides the 'Range' column for bench types which have only 1 range, like EZ Flow, JKM, new Hot Wire, and LFE. See Figure A55. All versions.

Program now shows the Company Logo graphic on the main screen. See Figure A55. Pro and Head Porter only.

Added option to include a Test Piece Pic with your data file. This could be of the head, carb, etc. It is displayed on the main screen and in printouts if you choose to included it from the "Print Options" list (graphs and reports). See Figure A55. Head Porter only.

Program no longer 'nags' as much about using the CFM at 0 lift as Leakage. All versions.

New Example Flow Files have been added to show new features.

Figure A41 More Port Velocity Options

Click on Test Options at Main Screen

New choice for Type of Port Velocity data: Record 9 points across the port (3 rows of 3 positions) at all lift data points.

New option of "Depths in Port" to allow you to record data at different depths in the port, 1 depth (the only choice in previous versions and in the current Pro version), 2 and 3.

Click on Graph button (shown here as "Layout" because Graph is being shown) and with more than 1 depth you have 2 options. Front View (as done before) or new Side View (as shown here. The depth in Front View (A, B, or C) or the depth in Side View is determined by which cell is currently highlighted in the grid. In this case, it is side depth 3 (farthest from viewer).

Different depths marked as "A", "B" and "C".

Labels let you know which data points are being graphed.

Arrow shows you flow direction.

Slide side bar left to see all the entry points for port velocity.

Point	Lit	Full CFM	Test Pres"	Flow Pres %	CFM	Stability +/- %	Swirl	Vel #1 [A]	Vel #2 [A]	Vel #3 [A]	Vel #4 [A]	Vel #5 [A]	Vel #6 [A]	Vel #7 [A]	Vel #8 [A]	Vel #9 [A]	Vel #1 [B]	Vel #2 [B]
1	100	321.0	27.92	20.1	64.7	24	-1504	75.5	75.5	70.4	72	53.6	64.6	48.4	64.9	57.2	61.5	40.
2	200	321.0	27.95	40.4	129.8	28	-1781	113.4	105.1	92.6	80.1	106.4	131.	93	136.7	110.2	82.9	125.8
3	300	321.0	27.94	57.4	184.5	80	-1972	169.3	163.4	163.2	168.5	159.6	109.6	164.1	212.7	213.7	121.8	125.5
4	400	321.0	27.94	70.1	225.3	50	-2496	160.5	183.5	165.8	270.7	183.8	180.4	153.1	257.7	209.	260.6	136.1
5	500	321.0	27.92	77.2	248.2	1.10	-2617	256.6	199.4	281.2	208.2	175.8	229.5	228.	295.2	171.3	287.5	274.5
6	600	321.0	28.05	79.1	253.7	86	-3105	238.1	323.1	284.5	160.8	189.6	279.6	184.2	157.4	302.	296.6	214.2

Figure A42 Port Velocity Reports

**Report Options**

Report Specs

Type: Meas Int & Exh VelData

Correct to New Test Pressure: Yes

New Int Test Pres, "water": 28

New Exh Test Pres, "water": 28

Which Cylinders: All Cylinders

Cyl to Report: 1

Notes:  
Select the options you want for this report. Some options may be disabled (grayed out so you can't change them) depending on the type of report you select or other settings. Then click on the 'Make Report' button.

Make Report Help Cancel Print

	Vel #1	Vel #2	Vel #3	Vel #4	Vel #5	Vel #6	Vel #7 (C)	Vel #8 (C)	Vel #9 (C)	Avg	Avg (B)	Avg (C)
Int #1 .100" Lift	79	75	70	72	53		74	72	66	65	60	55
Int #1 .200" Lift	113	105	82	80	106		159	79	104	106	118	122
Int #1 .300" Lift	169	163	183	168	158		215	214	204	171	153	194
Int #1 .400" Lift	160	181					190	239	166	197	215	205
Int #1 .500" Lift	255	191					0	161	293	227	231	218
Int #1 .600" Lift	238	32					0	293	241	238	239	223
Exh #1 .100" Lift	62	55	71	66	95		61	87	88	68	78	74
Exh #1 .200" Lift	107	191	168	109	113		104	145	191	140	138	149
Exh #1 .300" Lift	143	207	192	171	254		187	178	155	181	202	190
Exh #1 .400" Lift	274	267	156	174	229		275	192	166	213	206	234
Exh #1 .500" Lift	319	209	323	192	242		252	208	317	252	249	234
Exh #1 .600" Lift	244	208	329	183	272		194	281	220	248	254	240
Int #3 .100" Lift	60	76	75	74	74		58	75	68	66	58	58
Int #3 .200" Lift	134	153	95	139	127		125	150	145	131	112	120
Int #3 .300" Lift	187	188	188	188	149		201	185	158	156	178	151
Int #3 .400" Lift	258						227	201	221	195	204	211
Int #3 .500" Lift	181						148	293	267	204	204	216
Int #3 .600" Lift	269						309	291	234	243	265	227
Exh #3 .100" Lift	86						81	55	76	77	68	70
Exh #3 .200" Lift	126						185	123	111	139	135	151
Exh #3 .300" Lift	163						167	223	204	194	187	190
Exh #3 .400" Lift	156						153	188	213	224	210	207
Exh #3 .500" Lift	236	304	327	172	329		232	161	258	237	271	248
Exh #3 .600" Lift	237	203	242	209	178		167	208	186	220	272	236
Int #5 .100" Lift	42	71	57	64	48		62	58	53	56	60	57
Int #5 .200" Lift	82	92	108	117	142		97	122	156	119	119	115
Int #5 .300" Lift	225	137	186	147	140		144	167	194	163	163	163
Int #5 .400" Lift	257	137	141	256	198		179	222	242	196	217	214
Int #5 .500" Lift	290	285	239	161	207		165	223	214	228	230	203
Int #5 .600" Lift	256	219	238	197	213		284	304	209	235	247	248
Exh #5 .100" Lift	80	65	61	89	91		76	91	61	75	70	69
Exh #5 .200" Lift	98	186	168	152	171		105	170	135	153	163	143
Exh #5 .300" Lift	257	166	229	183	259		148	127	127	222	223	183
Exh #5 .400" Lift	290	174	256	250	284		277	228	262	244	245	235
Exh #5 .500" Lift	269	224	169	294	159		236	217	234	224	224	238
Exh #5 .600" Lift	182	340	267	260	186		265	299	200	265	289	279
Int #7 .100" Lift	58	49	47	73	48		77	49	52	55	55	64
Int #7 .200" Lift	100	148	100	77	132		137	137	117	114	126	141
Int #7 .300" Lift	137	180	139	166	219		132	131	166	161	183	161
Int #7 .400" Lift	177	213	262	137	255		266	266	195	211	201	194
Int #7 .500" Lift	260	156	181	245	213		263	228	253	244	218	227
Int #7 .600" Lift	314	272	234	242	315		271	282	292	265	254	263
Exh #7 .100" Lift	83	62	54	56	96		52	81	82	75	77	69
Exh #7 .200" Lift	195	191	199	132	119		149	156	136	158	139	144
Exh #7 .300" Lift	256	253	131	130	236		233	130	164	184	183	181
Exh #7 .400" Lift	167	285	226	214	297		295	275	294	235	239	244
Exh #7 .500" Lift	203	270	320	174	204		219	161	202	227	238	237
Exh #7 .600" Lift	215	216	178	293	250		263	329	217	238	240	282
Avg Int .100 Lift	60	68	62	70	55		68	63	60			59
Avg Int .200 Lift	107	125	96	103	126		129	122	130			120
Avg Int .300 Lift	179	150	165	155	167		173	174	180			166
Avg Int .400 Lift	196	186	178	202	223		208	232	206			204
Avg Int .500 Lift	244	218	227	200	194		207	226	257			220
Avg Int .600 Lift	256	273	249	189	247		271	290	244			245
Avg Exh .100 Lift	78	68	70	75	92		72	78	76			72
Avg Exh .200 Lift	132	169	171	132	132		136	148	143			146
Avg Exh .300 Lift	205	214	175	179	228		184	165	162			193
Avg Exh .400 Lift	222	233	201	202	278		250	221	238			228
Avg Exh .500 Lift	257	252	285	208	234		235	187	253			239
Avg Exh .600 Lift	219	242	254	236	222		222	279	206			255

Figure A43 English Units but Using Millimeters for Lift and Dimensions

The Preferences window shows the 'Units' dropdown set to 'English with Millimeters'. The 'Std Pres' dropdown is set to 'Metric (Liter/Sec, mm, etc.)' and 'Std Tem' is 'English with Millimeters'. The 'Expected Intake Flow for Test Cor.' is 153.2.

The Test Data window shows the following table:

Point	Lift mm	Full CFM	Test Pres"	Flow Pres %	CFM	Stbly +/- %	Swirl	Vel # (A)
1	2.00	321.	27.82	20.1	62.7	.24	-1504	80
2	4.00	321.	27.95	48.4	127.8	.28	-1781	113
3	6.00	321.	27.94	57.4	182.5	.80	-1972	169
4	8.00	321.	27.94	70.1	223.3	.50	-2496	161
5	10.00	321.	27.92	77.2	246.2	1.10	-2617	256
6	12.00	321.	28.05	79.1	251.7	.86	-3105	238

The Head Specs window shows the following specifications:

**Head #, Customer and Comments**  
 Head #: TRI261, Customer: Progressive Racing, Comments: Head specs from V2.1 File: VORTEC (some head specs new to v3.0 have been estimated)

**Intake**  
 Layout: 1 valve & 1 port  
 Valve Diameter, mm: 51.31  
 Stem Diameter, mm: 8.74  
 Throat Diameter, mm: 45.47  
 Avg Seat Angle, deg: 45  
 Port Shape: Rectangular  
 Port Volume, ccs: 217  
 Avg Port Width, mm: 33.81  
 Avg Port Height, mm: 50.44  
 Port Length, mm: 127.0

**Exhaust**  
 Layout: 1 valve & 1 port  
 Valve Diameter, mm: 40.64  
 Stem Diameter, mm: 8.74  
 Throat Diameter, mm: 35.56  
 Avg Seat Angle, deg: 45  
 Port Shape: Rectangular  
 Port Volume, ccs: 83  
 Avg Port Width, mm: 26.92  
 Avg Port Height, mm: 40.64  
 Port Length, mm: 76.2

**Cylinder Numbering**  
 Number of Cylinders to Test: 4  
 Starting #: 1, Step Size: 2  
 Cyl # Preview: 1, 3, 5, 7

Figure A43-B Bar Gauges for Selected Readings.

**Gauge Options**

This option lets program pick the scales for the gauges.

Choose options to change the settings for each particular gauge, the high and low value of the bar graph, and any limits to be flagged out in either red or yellow color (warnings or cautions).

Click this and program will generate "reasonable" scales for the gauges. This is useful when first turning on "Use User Defined Settings" because these will all be blank.

Bar gauge with real time updates. This one shown in red because reading went above user defined limit of 29.5. See screen to right for setting scales and limits.

**Perf Trends Readings: Int #1 F9>**

Set Test Pres. 28"	Act. Test Pres. 29.79"	Range Int 4
Data Point 1	Valve Lift .300	Flow Reading 87.2 %
Swirl 3129	Barometer 29	Corr. CFM Flow .8
Port Velocity 241.7		

**Gauge Settings**

Gauge Starts At	0
Gauge Stops At	32
Change Color at Limits?	Yes
Warn if Above this Level	29.5
Warn if Below this Level	26.5

**Notes:**  
Choose the starting and ending values for the gauge. If you enter 50 for 'Starts At' and 90 for 'Stops At' the gauge will show values from 50 to 90. If you set 'Warn if Above this Level' to 85, then the gauge will turn RED if the number goes above 85.

Buttons: Keep Specs, Cancel, Print

Figure A44 Custom, User Defined Graphs

Check here to get these Custom Options

Choose what data you want graphed.

If you choose data types which are graphed vs different parameters (like in this case lift and crank degrees) a warning is given here and only one data type will be graphed.

2 different types of 'vs' X data chosen

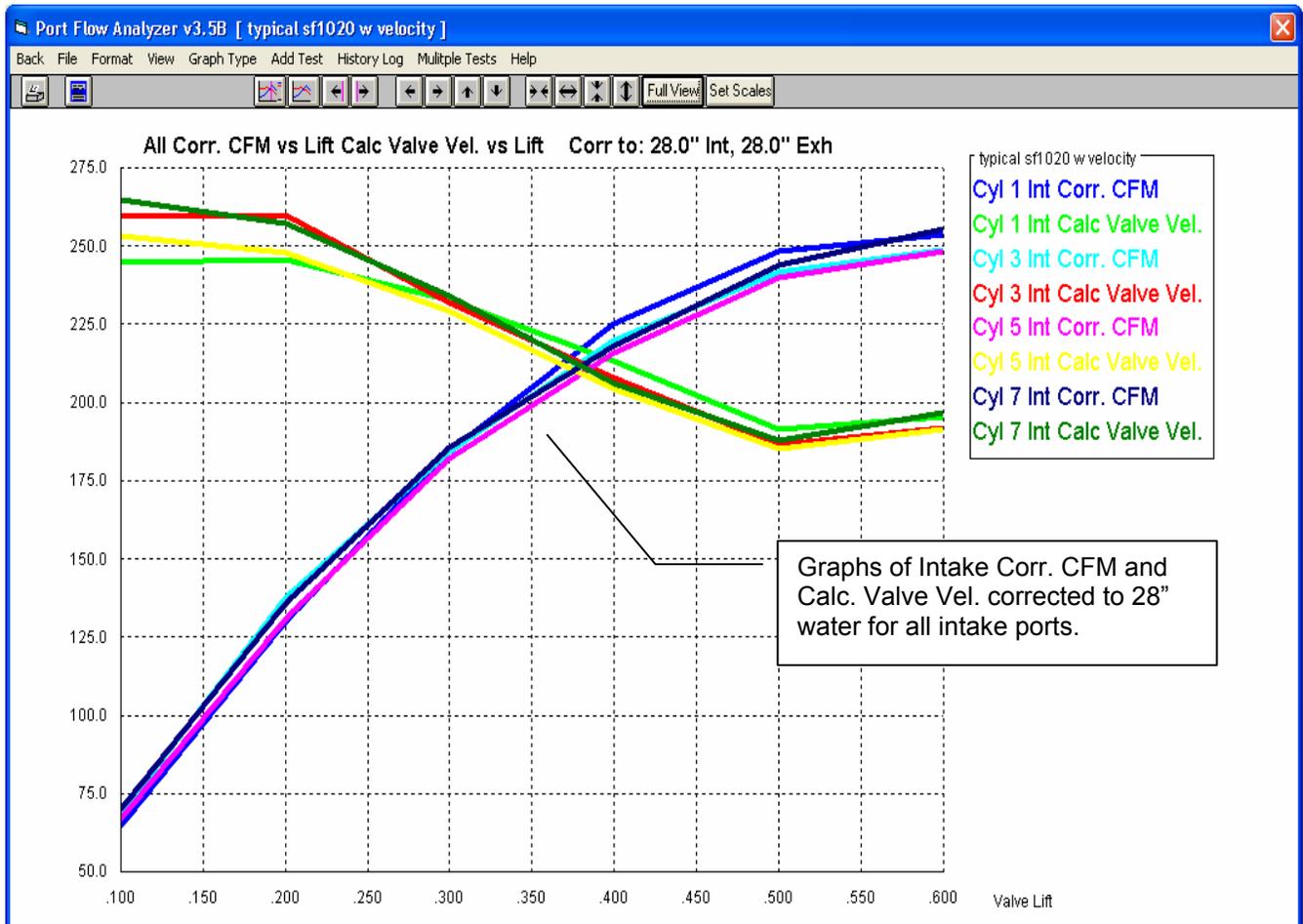


Figure A45 Custom, User Defined Graphs

Graph Options

**Graph Specs**

Type: Corr CFM

Correct to New Test Pressure: No

New Int Test Pres, "water": 28

New Exh Test Pres, "water": 28

Which Cylinder(s): 1st Cylinder Only

Port to Graph: Intake and Exhaust

Horizontal X Axis: Lift, inches

1000

Notes:  
Select the options you want for this graph. Some options may be disabled (grayed out so you can't change them) depending on the type of graph you select or other settings. Then click on the 'Make Graph' button.

**Pick from List Below**

- Corr. CFM vs Lift
- Calc Valve Vel. vs Lift
- Calc Port Vel. vs Lift
- Swirl vs Lift
- Swirl Stab. vs Lift
- Tumble vs Lift
- Tumble Stab. vs Lift
- Flow Coef. vs Lift
- % Exh/Int vs Lift
- Flow Stab. vs Lift
- Flow Area vs Crank Deg
- Valve Area vs Crank Deg
- Valve Lift vs Crank Deg

'Pick from List' Details

Correct to a 2nd Test Pres.: No

2nd New Int Test Pres, "water": 20

2nd New Exh Test Pres, "water": 10

Port Velocity Map Options

Type: Front View, all data

Lift for Graphing: 1st

Cylinder for Graphing: 1st

Buttons: Make Graph, Help, Cancel, Print

Check here to get these Custom Options

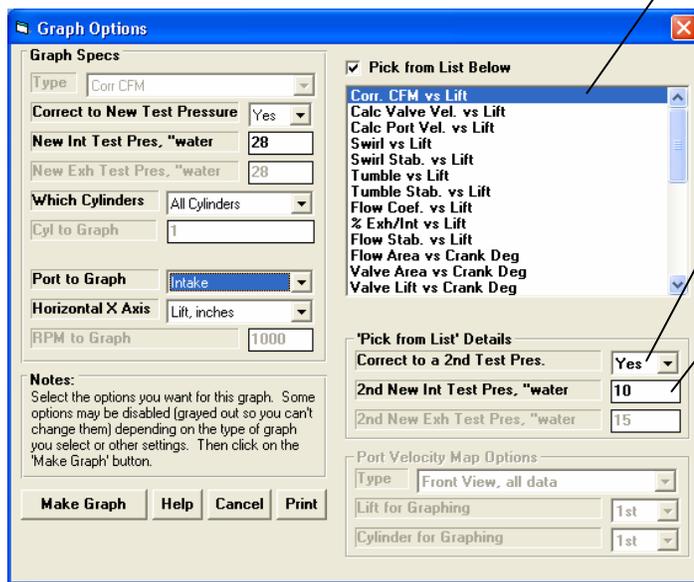
Pick your graph data types

Which Cylinder(s)

Which Ports



Figure A46 Custom Graph at 2 Test Pressures



Choose Corr. CFM vs Lift ONLY. Note, correcting to 2 test pressures only works for this data type.

Set this to Yes.

Select the Second Test Pressure you want the data corrected to. Note: The First Test Pressure is set as "New Int Test Pres, "water" on the left side.

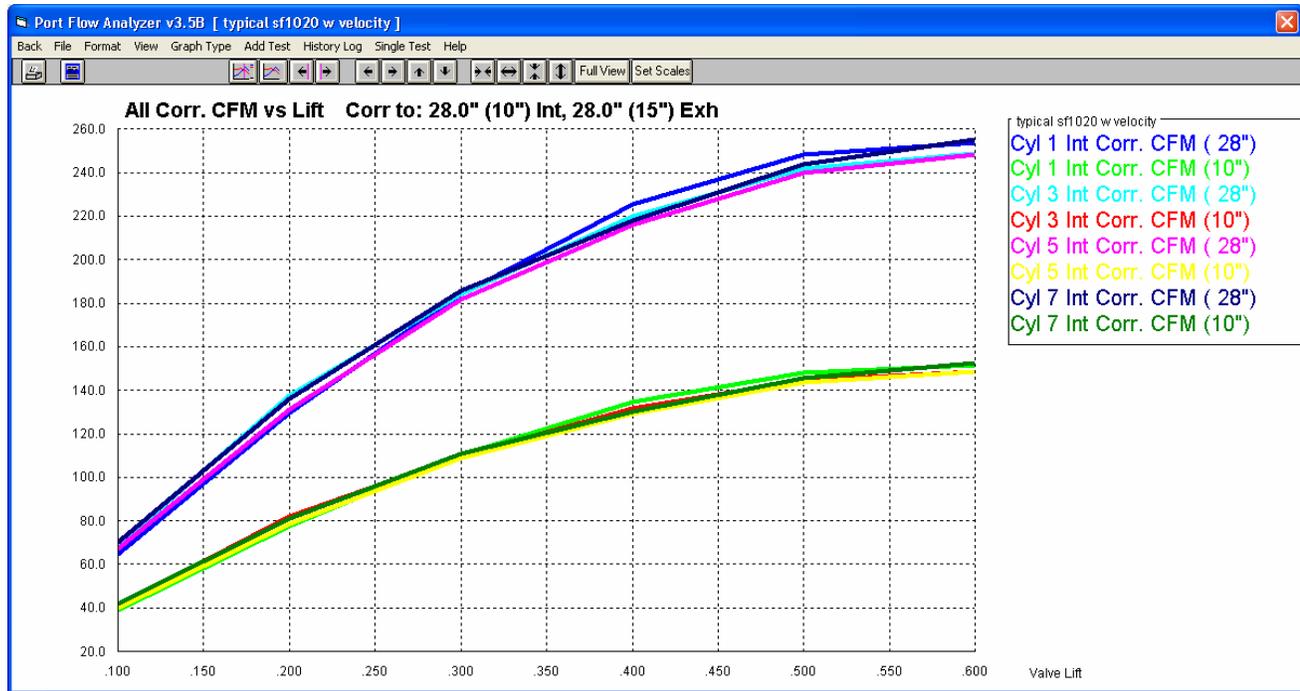


Figure A47 Custom Port Velocity Graphs

**Graph Options**

**Graph Specs**

Type: Corr CFM

Correct to New Test Pressure: No

New Int Test Pres. "water": 28

New Exh Test Pres. "water": 28

Which Cylinders: 1st Cylinder Only

Cyl to Graph: 1

Port to Graph: Intake

Horizontal X Axis: Lift, inches

RPM to Graph: 1000

Pick from List Below

Flow Stab. vs Lift  
Flow Area vs Crank Deg  
Valve Area vs Crank Deg  
Valve Lift vs Crank Deg  
Overlap Flow Area vs Crank Deg  
Overlap Valve Area vs Crank Deg  
Overlap Valve Lift vs Crank Deg  
**Port Velocity Map**  
Pseudo Flow Vel. vs Crank Deg @ RPM  
Pseudo Flow mach # vs Crank Deg @ RPM  
Piston Vel., ft/min vs Crank Deg @ RPM  
Piston Vel., ft/sec vs Crank Deg @ RPM  
Piston Accel, Gs vs Crank Deg @ RPM

**'Pick from List' Details**

Correct to a 2nd Test Pres.: No

2nd New Int Test Pres. "water": 20

2nd New Exh Test Pres. "water": 10

**Port Velocity Map Options**

Type: Side View, one lift

Lift for Graphing: 1st

Cylinder: 1st

**Graph Options**

**Graph Specs**

Type: Corr CFM

Correct to New Test Pressure: No

New Int Test Pres. "water": 28

New Exh Test Pres. "water": 28

Which Cylinders: 1st Cylinder Only

Cyl to Graph: 1

Port to Graph: Intake

Horizontal X Axis: Lift, inches

RPM to Graph: 1000

Pick from List Below

Flow Stab. vs Lift  
Flow Area vs Crank Deg  
Valve Area vs Crank Deg  
Valve Lift vs Crank Deg  
Overlap Flow Area vs Crank Deg  
Overlap Valve Area vs Crank Deg  
Overlap Valve Lift vs Crank Deg  
**Port Velocity Map**  
Pseudo Flow Vel. vs Crank Deg @ RPM  
Pseudo Flow mach # vs Crank Deg @ RPM  
Piston Vel., ft/min vs Crank Deg @ RPM  
Piston Vel., ft/sec vs Crank Deg @ RPM  
Piston Accel, Gs vs Crank Deg @ RPM

**'Pick from List' Details**

Correct to a 2nd Test Pres.: No

2nd New Int Test Pres. "water": 20

2nd New Exh Test Pres. "water": 10

**Notes:**  
Select the options you want for this graph. Some

**Port Velocity Map Options**

Type: Side View, one lift

Lift for Graphing: 1st

Cylinder for Graphing: 1st

**Pick Port Velocity**  
change them) depending on the type of graph you select or other settings. Then click on the 'Make Graph' button.

**Pick View and what lifts and cylinders to graph**

**Pick Lift or Cylinder for graphing, which ever needed**

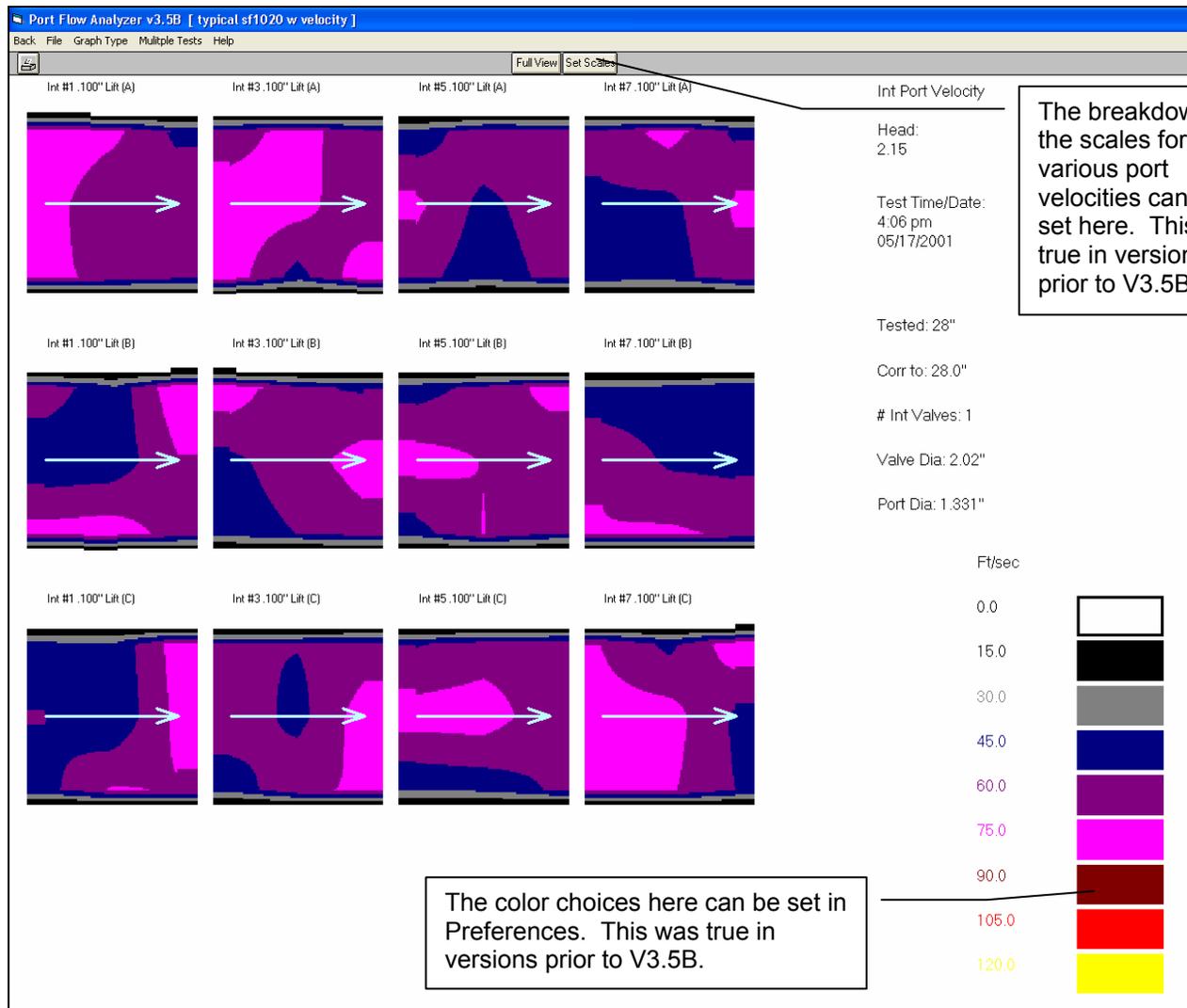


Figure A48 Smaller Test Piece Picture in Portrait Mode Printer Orientation

**Port Flow Analyzer v3.5 B**  
 Back File Format View Gra  
 Add Text to Graph  
 Print Color (solid lines)  
 Print Black & White (dashed lines)  
 Edit Printed Comments and Data Output  
 Windows Print Options  
 Email 256 Color Graph  
 Email 16 Color Graph  
 Exit

**Printed Graph Comments**  
 1 Graph Data Sets (comments available for each Data Set)  
 Graph Title: typical sf1020 w velocity  
 Test Comment: [empty]  
 Test Summary: Test Summaries are created by the program and include valve and port sizes, test times and dates, etc. They can not be changed by the user.  
 Include on Graph:  
 Test Summaries  
 Test Comments  
 Graph Comment  
 Data Table  
 Test Piece Picture  
 Make Picture Smaller  
 Titles to Use:  
 Std Titles  
 Alt. Titles  
 See Titles  
 Graph Height, %: 100  
 OK Help

Click here for screen to right. This feature is also listed under Format.

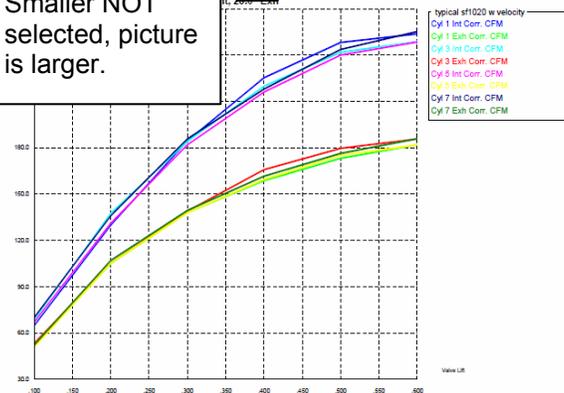
Choose to include Test Piece Picture in printout

You can choose to make the picture smaller, which can give you more room on a printed page.

Picture Smaller. This only applies to Portrait page orientation. Landscape always does this.

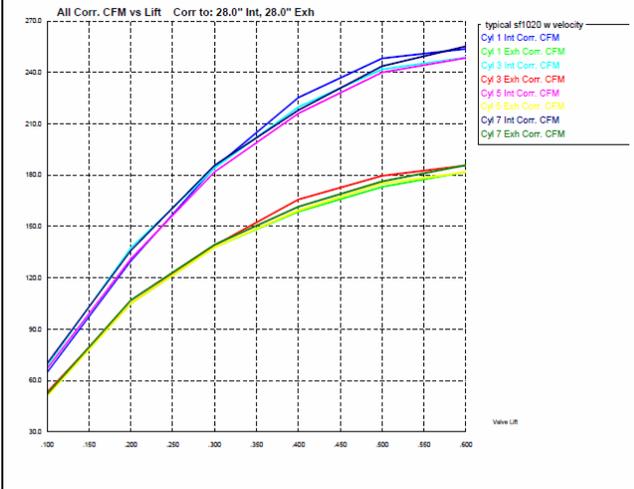
Port Flow Analyzer v3.5 B  
 Eng: typical sf1020 w velocity  
 Calculated Test Results  
 Your name / company name can go here. See Preferences.  
 Performance Trends (C) 2009  
 This Graph Printed: 8:28 pm 06-26-13  
 Page: 1

Smaller NOT selected, picture is larger.



No room on this page for Data Table.

Port Flow Analyzer v3.5 B  
 Eng: typical sf1020 w velocity  
 Calculated Test Results  
 Your name / company name can go here. See Preferences.  
 Performance Trends (C) 2009  
 This Graph Printed: 8:35 pm 06-26-13  
 Page: 1



Test Summary and Comments for: typical sf1020 w velocity

Lift	.100	.200	.300	.400	.500	.600
Cyl 1 Int Corr. CFM	64.7	129.8	184.5	225.3	249.2	253.7
Cyl 3 Int Corr. CFM	68.5	137.5	184.1	219.8	241.8	248.8
Cyl 5 Int Corr. CFM	66.9	131.1	181.8	216.0	240.0	248.4
Cyl 7 Int Corr. CFM	70.0	135.9	185.7	217.9	243.6	255.3
Cyl 1 Exh Corr. CFM	51.8	104.9	137.9	158.6	173.1	181.8
Cyl 3 Exh Corr. CFM	53.3	105.3	138.9	165.7	179.6	185.6
Cyl 5 Exh Corr. CFM	50.8	105.1	137.9	159.5	175.0	181.8
Cyl 7 Exh Corr. CFM	52.1	106.9	139.3	161.5	176.3	185.8

Room for Data Table on a single sheet.

Figure A49 Smaller Graph Fits All Results on 1 Printed Sheet

The screenshot shows the 'Printed Graph Comments' dialog box with the following settings:

- Graph Title:** typical sf1020 w velocity
- Test Comment:** Progressive racing World Products heads  
Includes examples of Port Velocity data and Test Piece picture file for Head Porter Version
- Include on Graph:**
  - Test Summaries
  - Test Comments
  - Graph Comment
  - Data Table
  - Test Piece Picture
  - Make Picture Smaller
- Titles to Use:**
  - Std Titles
  - Alt. Titles
- Graph Height, %:** 85

The 'File' menu is open, showing options like 'Print Color (solid lines)', 'Print Black & White (dashed lines)', and 'Edit Printed Comments and Data Output'.

Choose a % to reduce the height of the printed graph. This option works in both Portrait and Landscape printer orientations.

The printed page includes a header with the logo 'Your Logo Your Name', software version 'Port Flow Analyzer v3.5 B', and test details: 'Eng: typical sf1020 w velocity', 'Calculated Test Results', 'Your name / company name can go here. See Preferences. Performance Trends (C) 2009', and 'This Graph Printed: 8:53 pm 06-26-13 Page: 1'.

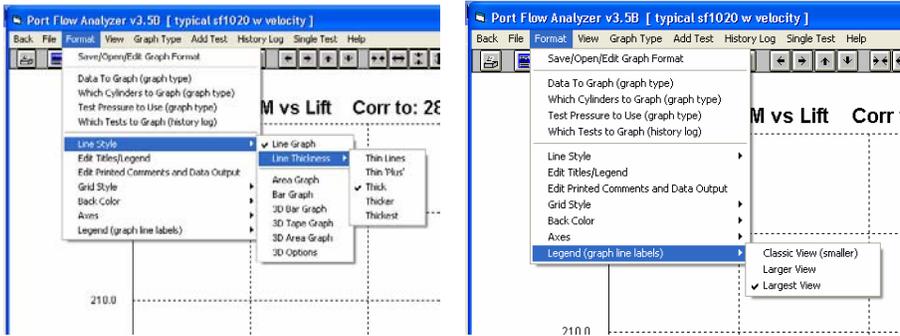
The graph is titled 'All Corr. CFM vs Lift Corr to: 28.0° Int, 28.0° Exh' and shows CFM values for various cylinders and ports across a lift range of 100 to 600. A data table is included below the graph.

Test Summary and Comments for: typical sf1020 w velocity						
Lift	.100	.200	.300	.400	.500	.600
Cyl 1 Int Corr. CFM	64.7	129.8	184.5	225.3	248.2	253.7
Cyl 3 Int Corr. CFM	68.5	137.5	184.1	219.8	241.8	248.8
Cyl 5 Int Corr. CFM	66.9	131.1	181.8	216.0	240.0	248.4
Cyl 7 Int Corr. CFM	70.0	135.9	185.7	217.9	243.6	255.3
Cyl 1 Exh Corr. CFM	51.8	104.9	137.9	158.6	173.1	181.8
Cyl 3 Exh Corr. CFM	53.3	105.3	138.9	165.7	179.6	185.6
Cyl 5 Exh Corr. CFM	50.8	105.1	137.9	159.5	175.0	181.8
Cyl 7 Exh Corr. CFM	52.1	106.9	139.3	161.5	176.3	185.8

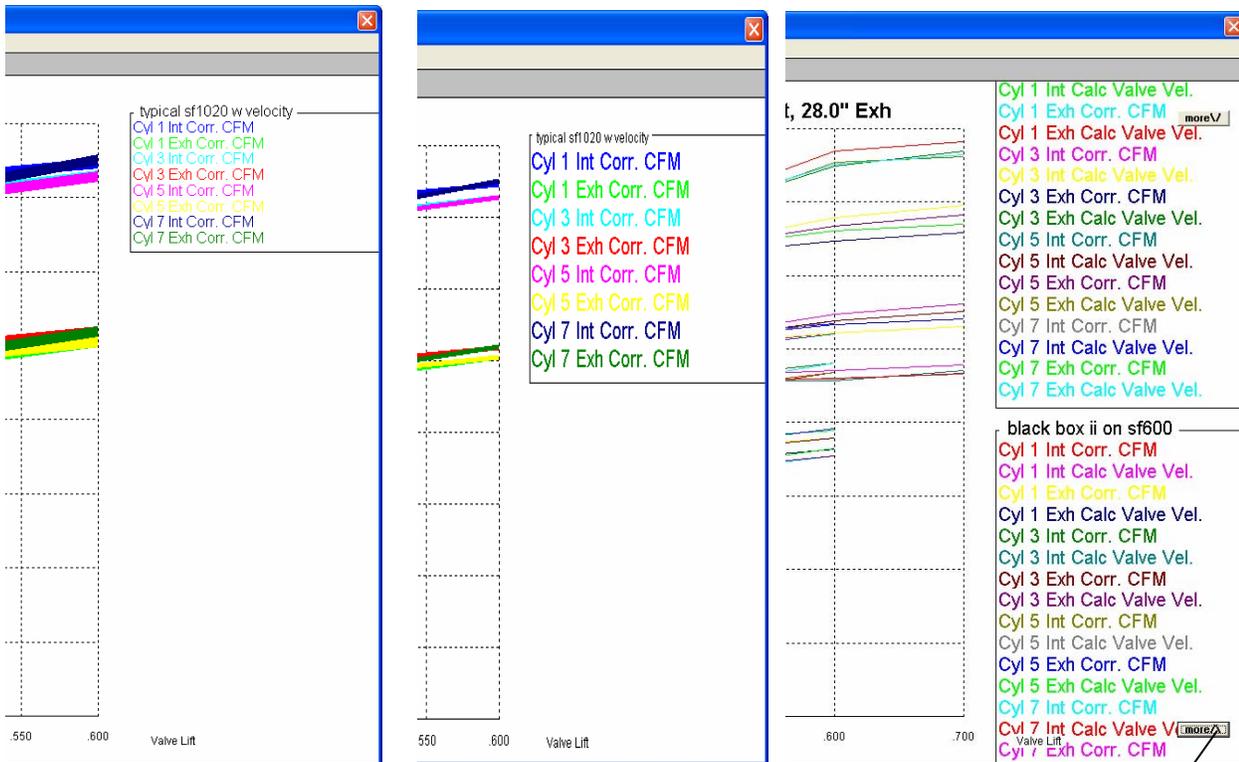
Printed graphs no longer have a border on the left and right sides around the graph. This border often had a slight "jog" in it depending on printer, screen resolution, etc. Now without a border, there is no "jog".

The graph can be printed to include the Data Table even though the Test Piece picture is printed large.

Figure A50 New Graph Features: Line Thickness and Larger Legends



Various combinations of line thickness and Legend Size



If the legend is too large to fit on the screen, "more" buttons appear at top and or bottom. You can click on these buttons to scroll through the labels.

Figure A51 More Example Cams for Engine Specs Screen

**Engine Specs [ CHEVY-97.LS1 ]**

Back (ok) File Help

**Cam Specs**

	Intake	Exhaust
Centerline, deg	113	121
Duration @ .050 "	202	210
Open @ .050 "	-12	46
Close @ .050 "	34	-16
Max Lobe Lift, Clc	.278	.281
Actual Valve Lash,		
Rocker Arm Ratio	1.7	1.7
Gross Valve Lift, in	.473	.478
Use Cam File	No	No

**General Cam Specs**

Type: Ex: Stock 97 LS1 SB Chevy

Lift for: Use Specs in this Menu  
Pick an Example

Lifter (Ex: Stock 97 LS1 SB Chevy)

Total Cam Advance: 4.0 Advance

Designed Valve Lash, in

Lobe Separation, cam deg: 117.0

**General Engine Specs**

Bore, in: 3.9 Stroke, in: 3.62

# Cyl: 8 C.R. Clc: 10

Connecting Rod Length, in: 6.098

Cu In: 346.0 CCs: 5670.2 Chamber CCs: 78.8

**Engine Comments**

Stock 97 LS1 small block Chevy

**Categories of Cam Exempl...**

Categories (groups) of Performance Trends' Examples

- Buick - Other Engines
- Cadillac
- Small Block Chevy
- Big Block Chevy
- Chevy 4 Cyl
- Chevy Inline 6 Cyl
- Chevy V-6**
- Other Chevy V-8s
- Chevy Corvair
- Chevy Gen III LS V-8
- Comp Cams All Mopar
- Crane All Mopar

Use Category Cancel

Tip: Click on a category in either section to highlight it, then click on the 'Use Category' button, or just Double Click on the category in one step. (Categories are groups of examples, like a group of Chevy heads, not individual examples.)

Choose Pick an Example

Choose a Category of Cam from a much larger list than in earlier versions.

**Examples**

Cam Name	Rated Lift	Lifter Profile	Valve Train	Center Line	Dur	Lobe Lift	Valv
Chevy V-6 Cams							
Stock CHEVROLET 79-84 V6 231 cid All w/2BC even fire eng.	.050	MHydFlt	P+RA prd	104	181	239	na
(exh)				110	194	256	na
Stock CHEVROLET 78-83 V6 231 cid All w/4BC turbo even fire eng	.050	MHydFlt	P+RA prd	104	181	239	na
(exh)				110	194	256	na
Stock CHEVROLET 85-87 V6 231 cid All w/2BC Export & Canada	.050	MHydFlt	P+RA prd	104	181	239	na
(exh)				110	194	256	na
Crower 03340 Chevy 262 90° V6 (4.3L)	.050	MHydFlt	P+RA imp	110	182	257	na
(exh)				118	190	258	na
Crower 03140 Chev 200 229 90° V6 (3.8L)	.050	MHydFlt	P+RA imp	110	182	257	na
(exh)				118	190	258	na
Crower 03040 Chev 173 60° (2.8L) 189 (3.1L) V6	.050	MHydFlt	P+RA imp	110	182	257	na
(exh)				118	192	258	na
Stock CHEVROLET L6 63-89 292/4.8-T 292 cid A11	.050	MHydFlt	P+RA prd	113	188	271	na
(exh)				110	188	271	na
CompCam 246-HR10 GM 3800/3.8 V6 1996-PRESENT	.050	MHydFlt	P+RA imp	110	191	.3	na
(exh)				110	201	.31	na
CompCam 240H Chevy 2.8/3.1/3.4L V-6 1980-95	.050	AHydFlt	P+RA imp	104	192	.26	na
(exh)				112	200	.26	na
CompCam 240H CHEVROLET 2.8L 3.1L 3.4L V-6 1980-1995	.050	AHydFlt	P+RA imp	104	192	.26	na
(exh)				112	200	.26	na
CompCam 240H CHEVY 200,229 V-6 1978,1984 w/ 90° ODD FIRE RACE	.050	AHydFlt	P+RA imp	104	192	.26	na

Abbreviations: BIR=Blue Racer CC=Comp Cams Lun=Lunati Ms=Motorsports Comp Cams Grinds: DEH=Duel-Energy XR/XE=Extreme-Energy NX=Nitrous-HP

Tip: Click on Example to highlight it, then click on 'Pick' or 'Delete' button. Double click to pick Example in 1 step.

Pick Delete Print Cancel

Pick the particular cam from a large list of cams, almost double from what was in earlier versions.

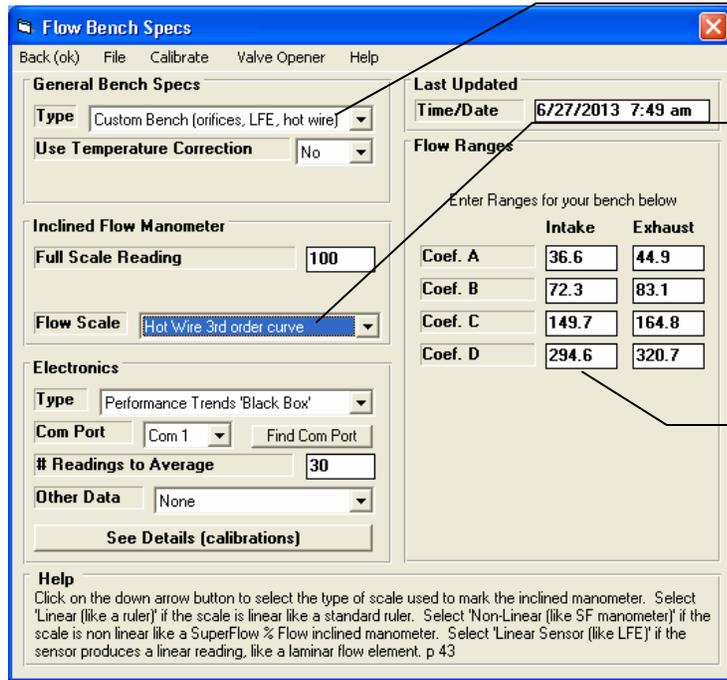
Figure A52 Motor Controller to Control Test Pressure

The figure shows a software interface on the left and a photograph of hardware on the right. The software interface displays various readings: 'Set Te: 28', 'Data P: 1', 'Act. Test Pres.: 7.99"', 'Range: Int 3', 'Valve Lift: 100', 'Flow Reading: 95.6', and 'Corr. CFM Flow: 267.9'. A menu is open over the 'Motor Controller' option, listing actions like 'Turn Motor Controller On', 'Turn Motor Controller Off', and 'Temporarily Power Down'. The photograph shows a metal motor controller box with two AC power outlets, connected to a black power cord and a coiled control cable. Callout boxes identify 'Controlled AC power to bench', 'AC power in', 'Motor controller options. Current design only works with special Black Box IIs.', and 'Control lines from special Black Box II'.

Figure A53 USB Recording Switch

The figure shows a software interface on the left and two photographs of hardware on the right. The software interface shows the 'Options' menu with 'USB Switch' selected. The hardware photographs show a 'Foot Switch w USB connector' and a 'Hand Switch w USB connector'. A text box at the bottom provides instructions: 'Under Options, click on USB Switch to see options. First, click on Set USB Switch Com Port and set that to one of the available Com Ports shown by the program when you click on this. Then click on Use USB Switch to tell program to look for this switch input for recording data. F1 keystroke will still work also.'

Figure A54 New Bench Type: Hot Wire Anemometer

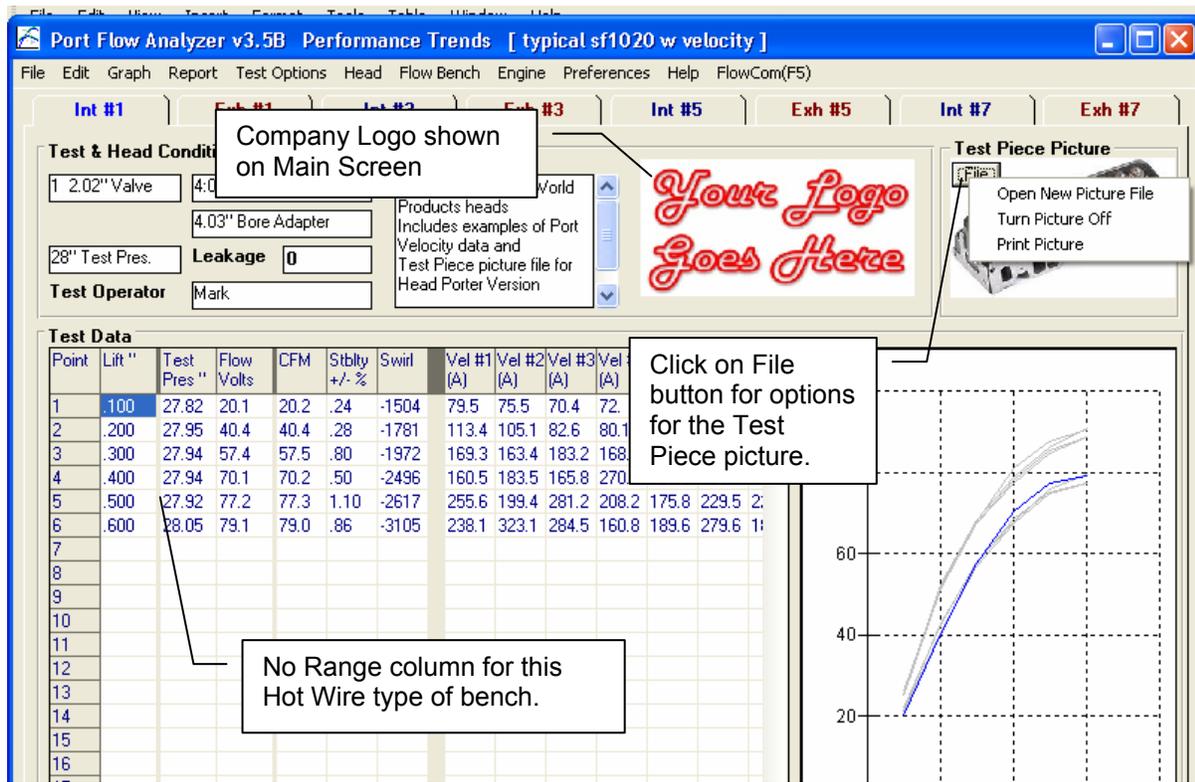


Choose Custom Bench Type

Choose Hot Wire

Enter the 3<sup>rd</sup> order coefficients for a curve of flow vs voltage. Most likely you will have to obtain this from Performance Trends after you run a calibration on your bench.

Figure A55 Main Screen: No Range Column for Certain Benches and Logo Picture



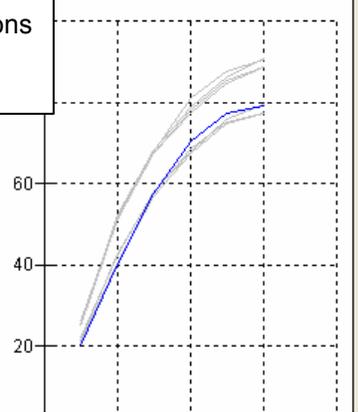
Company Logo shown on Main Screen

Your Logo Goes Here

Test Piece Picture  
Open New Picture File  
Turn Picture Off  
Print Picture

Click on File button for options for the Test Piece picture.

No Range column for this Hot Wire type of bench.





# Appendix 10: New Features in v3.5 C

Port Flow Analyzer has had many updates since this user manual was written for the original v3.0 for Windows. These include 3.0 A through v3.0 E, v3.5 A, v3.5 B and now v3.5 C. For the features added to the v3.5 B since Appendix 9 was written, refer to the Readme.doc file (click on Help, then Display Readme.doc File) in the program. Listed here are features introduced in v3.5 C:

- Basic Version
- Professional (Pro) Version (includes all Basic features and more advanced Pro features)
- Head Porter Version (includes all Basic and Professional features and more advanced Head Porter features)

Here is a listing of the major enhancements and new features for v3.5 C.

## Data Recording:

There is now an option under Velocity in the Recording screen for producing different pitch sounds for the port velocity. This way you can listen to the port velocity change as you move your pitot tube or Electronic Velocity Probe in the port. Now you can concentrate on exactly where the probe is and hear if that area has high or low velocity. Head Porter Version only. Fig A56.

The program now has several new features for reading swirl and tumble. Fig A56.

- The program now saves individual USB Swirl Readings and checks them to see if there are any outliers (outside 25% of the average). If there are any of these readings, they are omitted and a new average and spread (+/- %) is calculated.
- You can now pick from 3 different analog swirl meter inputs for the new USB Black Box.
- The program now disables menu item Micro USB Swirl Version if you have not checked Micro USB Swirl as the type of Swirl Meter.
- The program is now more reliable at realizing Swirl readings were not being recorded, and eliminated checking swirl settings "behind the scenes".
- Now there is an option under Swirl/Tumble in Calibrations screen of None to turn off Swirl and Tumble features.
- Program now checks to see if USB Swirl Meter and Logger (SF Flowcom, Black Box, etc) are using same Com Port and warns you of conflict.
- If you are not recording either Swirl or Tumble, the "Rezero Swirl/Tumble" option in the Recording screen is not shown. Fig A59.

The program now displays message only once for each program startup that the units are not matching between the Flowcom and the program's settings.

Program now records only 1 reading for Port Velocity reading if you are using a FlowCom and was having the FlowCom doing "slower, more reliable" communications via a Preference Setting. This speeds up testing when recording slowly.

The program now better averages data readings you are using a FlowCom and was having the FlowCom doing "slower, more reliable" communications via a Preference Setting to speed up testing.

Program now fixes corrupt FlowCom strings when checking for flow bench type.

Added option in FlowCom or Electronics screen to allow displaying of the Actual CFM (not corrected for test pressure). If you request 'Show Actual CFM', the Corrected CFM is displayed in a slightly smaller font, and the Actual CFM (not corrected for test pressure) is displayed in an even smaller font below it. Pro and Head Porter version only. Fig A63.

The program now has a lower limit for displaying live CFM reading for some types of loggers. Note that the correct data was recorded and displayed if you recorded the data point, it was just not displayed in the FlowCom or Electronics screen.

The program now more reliably lets you know the pressure sensors are maxed out (producing incorrect data) for the new Black Box Mini USB. Fig A58.

## Data Analysis (including Graphs and Reports):

Program now has a Printed Data option for printing the actual Port Velocity numbers on the Port Velocity Maps. Click on File, then "Edit Printed Comments and Data Output" and check "Include Port Vel. Map Numbers". Head Porter Version only. Fig A62.

Fixed bug where the averages for the Exhaust data in reports could be done incorrectly. Intake data was always OK.

The limits for the bar gauges in the Recording Screen for the Head Porter version are now set in Preferences, under the "Printing/Graphing" tab. Before this they were set in the Recording Screen, but this was unreliable because of communications taking place with a data logger. Fig A59.

You can now include a graph or "live data" on the Recording Screen to track trends in several variables during testing. Head Porter Version only. Fig A63.

There is now a Preference setting to let you keep the Graph on the main screen always at the same graph scales. This can cause problems if you open files with different lifts and flows than you normally run, or the heads you flow produce quite different flows. However, if your tests are always at about the same lift and flow, this new Preference makes it easier to spot changes with the graph on the main screen. Pro and Head Porter Version only. Fig A64.

## Hardware:

For our EZ Flow systems, there is a new feature letting you add a special "Low Flow" sensor. This lets you measure very low flows to check for leakage or for measuring flows on very small components or at very low valve lifts. Head Porter Version only. Fig A65, A66.

Added option in FlowCom screen to set the Delay Time for turning the SF1020 motor on/off if doing flow range change or flow direction change. Fig A59.

FlowCom screen lets you change the flow direction for the SF1020 bench. Fig A59.

If you use a recording switch in a temperature channel AND use the same channel for recording temperature, the "temperature" which is considered pressing the Record Switch has been lowered from about 158 deg F down to about 150 deg F. This better ensure the system will see the recording switch, but can create problems if you are trying to record temperatures which are close to 150 deg F (extremely unusual condition).

## Emailing and File Handling:

Under 'File', then 'Save As' there are new options to see other files in each folder, then choose a name from the folder to make it easy to modify a new name based on a previously used name. There is also a new "Add New" button to easily add a new folder name. Fig A67.

Under 'File', then 'Save As' there is a new "Edit Many Tests" button. This allows you to identify many tests, by using the Ctrl key when clicking on a test, or clicking on a test, then hold the shift key to click on another test and identify all the tests in between. Then you can choose to Delete these tests (actually send to recycle bin), or copy or move these tests to a different folder. If you choose 'Move' they are removed from the current folder. Pro and Header Porter versions only. Fig A69.

There is a new Open option of "List by Access Date". With this activated, the most recent test files you have worked with show up at the top of the list. Pro and Header Porter versions only. Fig A73.

Many screens now allow for much longer folder and file names. These include the "Open a File", "Save As", "Starting a New Test", Filtered Files displayed in Notepad, etc.

Now using the Filter Files option, you can select which folders to check when you click "Print list of all files fitting these conditions". Pro and Header Porter versions only.

Replaced "Copy" with "Copy (or Merge)" to list of Folder Options possible in 'Save As' screen.

Program can now better display PDFs like the users manual in some versions of Windows 10. Related to this, there is a new button in Preferences for "Look for New Adobe Acrobat Reader". This way you can manually browse your computer to find the program you want to use for displaying PDFs. Fig A64.

Made several refinements to printouts and displaying screens, especially if you were including a company logo or a Test Piece picture.

There is a new Edit option of Combine Tests. It lets you combine 2 or more tests into 1. Header Porter versions only. Fig A60, A61.

Files and folders you delete now are actually sent to the Recycle Bin so they can be recovered later if you want. Fig A68.

The program is better at adding numbers to the end of file names by default. Now it will add 3 digits, like "testname001" so that you can record up to 1000 files with the base name "testname". Prior to this it would just default to "testname1".

Now when you open a file which has a Graph Name specified in the History Log, that Graph Name stays with the file. Previously it was restored to the default as being the File Name.

The program now has several enhancements for automatically emailing files, reports and graphs. Many of these are required to work with newer OSs, like Win 7 and Win 10. Pro and Header Porter versions only. Fig A71, A72. These include

- Program now has an 'Email Report' option in the Report screen under 'File' to explain how to email a report. There is also a new 'Emailing' option at the top of the Reports screen explaining different emailing options for reports.
- Under 'File' on the Reports screen, there is now a check box for emailing the ASCII file to an email address after it has been written.
- There is a new option in Preferences to manually locate "Location of PDF Printer Output File". This is needed in newer OSs where the PDF printer can be unpredictable.
- Now if you cancel the process of printing a PDF file for a report and emailing it, the process stops and does not proceed through to the Emailing screen.

After making a report, the File option for creating an ASCII text file has a new option. It is for making a .csv file which is compatible with Microsoft Excel. Pro and Header Porter versions only. Fig A72.

## Other:

The Main Screen graph now has a title and a description of test pressure. Fig A61.

The program now better handles the Preference Setting "Early (pre 1998) FlowCom?" when it is set to "No".

There is now a button in Preferences to explain how the weather corrections are used and when they are needed.

Program now explains why changes in 'Starting a New Test' screen are not saved if you don't start a new test.

If you change the printer within the program to something other than the computer's default printer, the program now restores the default printer (and printer orientation) when it shuts down.

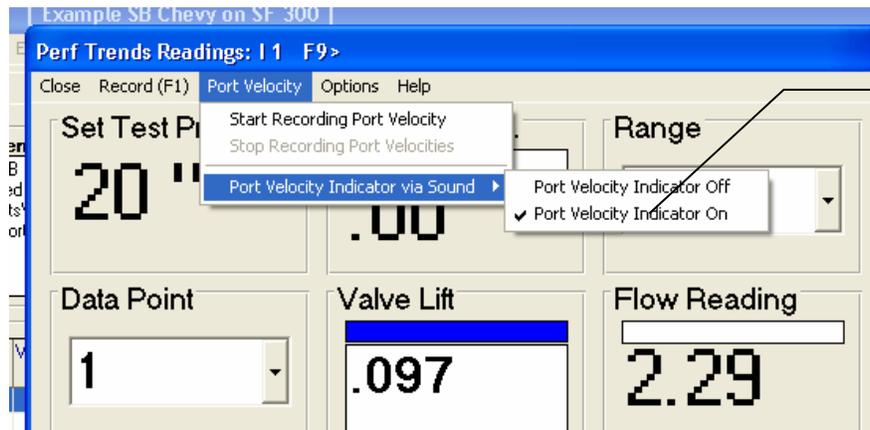
The program is now be more reliable at opening pages on the internet for a wider range in internet browsers.

The main screen is refreshed any time you resize it. This way all parts of the main screen displayed when you make a change. Prior to this, you may not see all parts of the main screen until you went into a different screen and then returned to the main screen.

Program now displays a Progress Bar when looking for Com Ports so you know something is happening when it is checking. The program is now also less likely to say Com 3 is a correct Com Port, when it actually is not the correct port.

Program as an improved method for "Force These Lifts" button in Test Options screen, where extra rows are not blanked out and program checks if you want increments of Lift or L/D (previously was just Lift).

Figure A56 Sound to Indicate Port Velocity



Choose this option to turn on Sound and install a head set or ear buds on your computer to listen to a tone. The higher the pitch of the tone, the higher the velocity.



Visit our website page [www.performancetrends.com](http://www.performancetrends.com). Then click on Support at the top, then Movie Demo Files for our movies page **to watch and hear how this feature works**. There is also a link on that page to visit our youtube page, where the movies may play better for a wider range of computers.



Figure A59 New FlowCom Options for SF1020 and No “Rezero Tumble/Swirl”

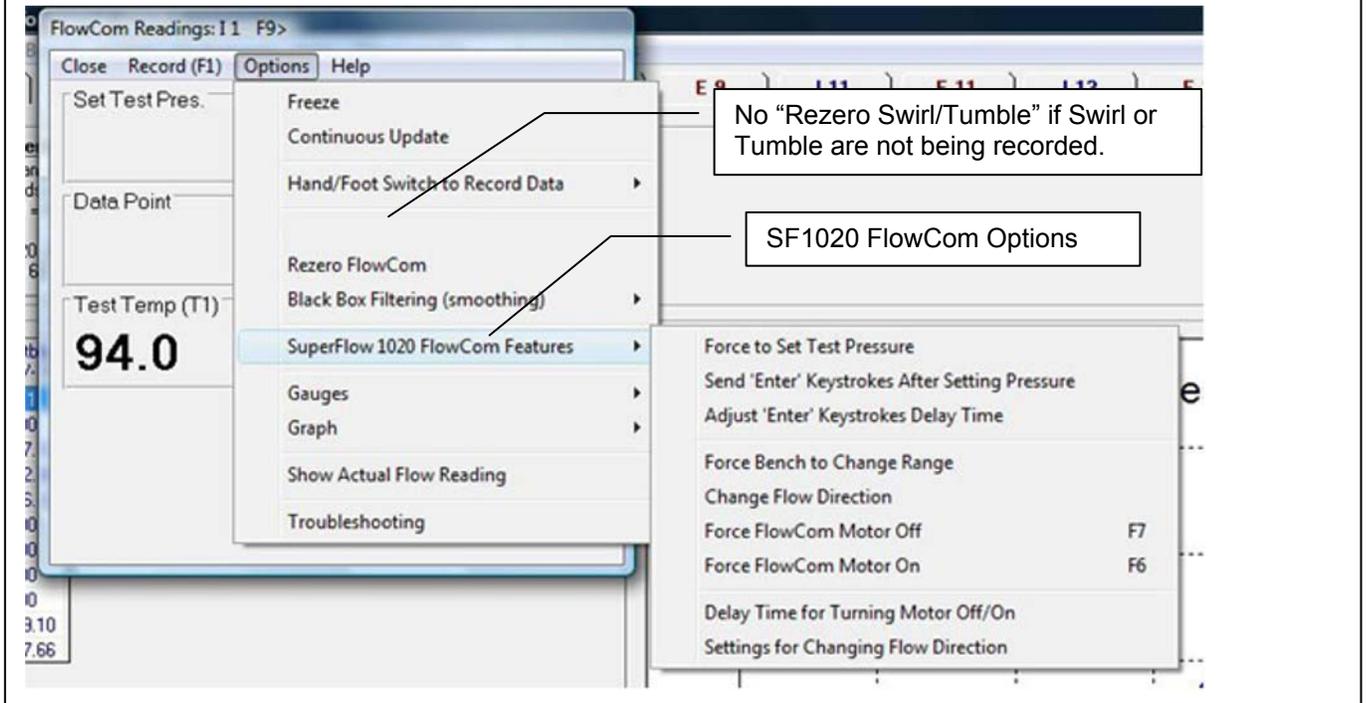


Figure A59 A New Preference Setting for Graph Scales on Recording Screen

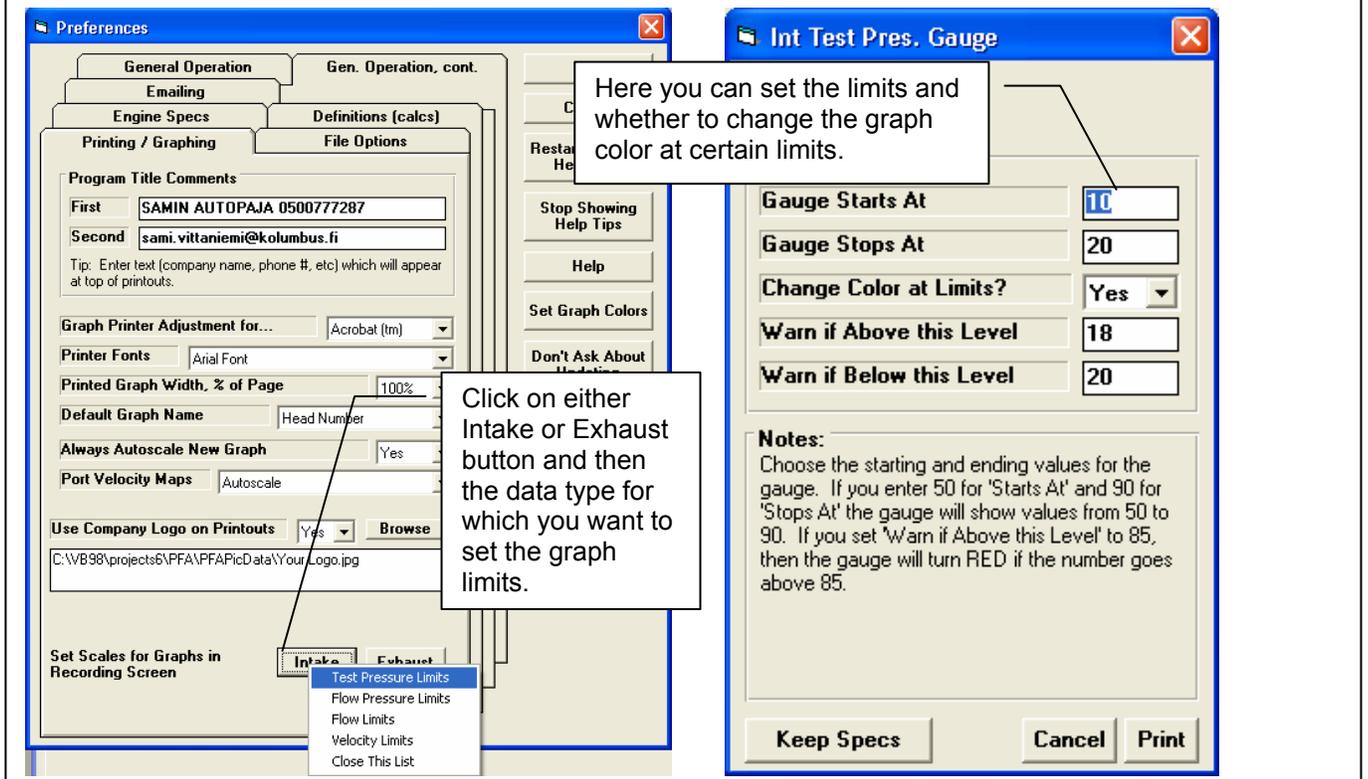
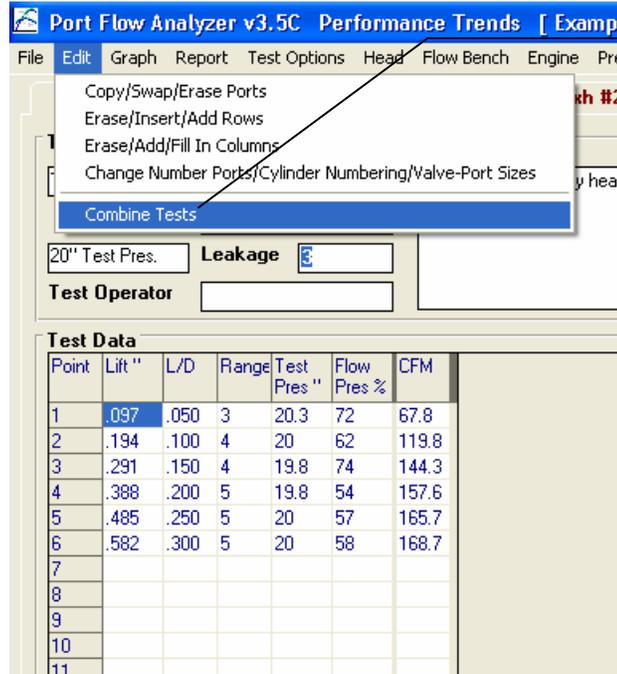


Figure A60 New Edit Feature to Combine 2 Tests into 1 Test File



If you have Head Porter version, this Edit option will appear here. It will walk you through a process as outlined by the messages below.

NOTE: You want to start this process with the file which starts with Cylinder #1. For example, a file which contains cylinders 1,3,5,7 or 1,2,3,4 are typical for V8 heads.

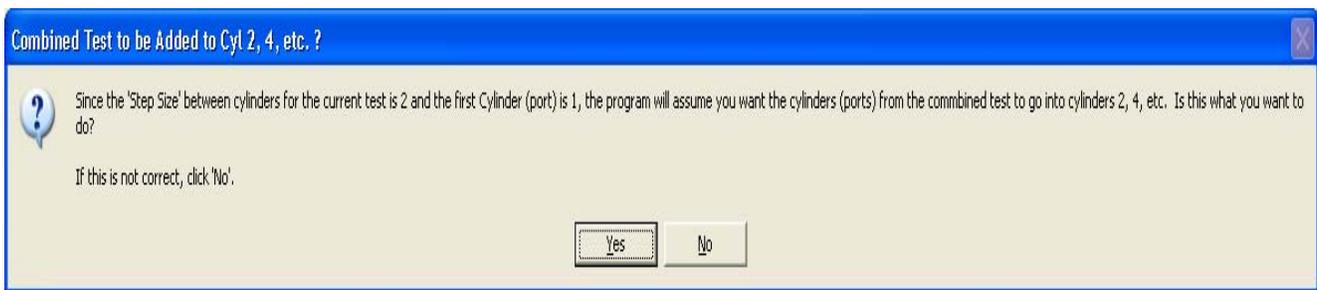
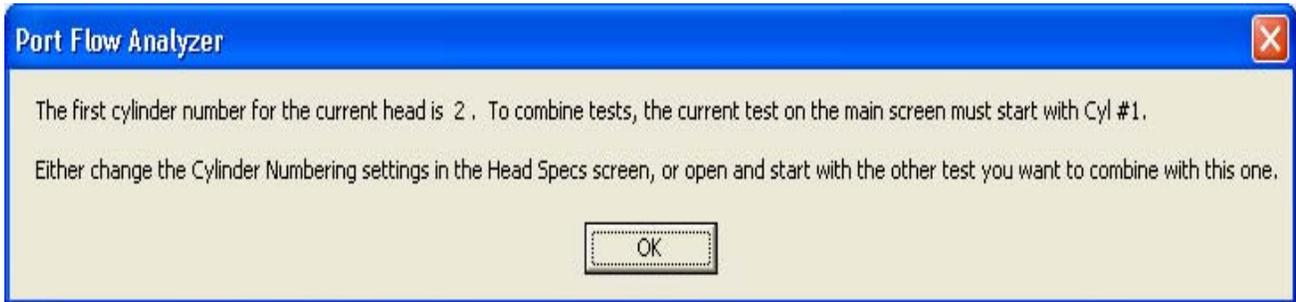


Figure A61 New Edit Feature to Combine 2 Tests into 1 Test File, cont

Find the test file you want to combine with the current test you started the "Combine" process with.

Then click the "Combine" button to complete the process.

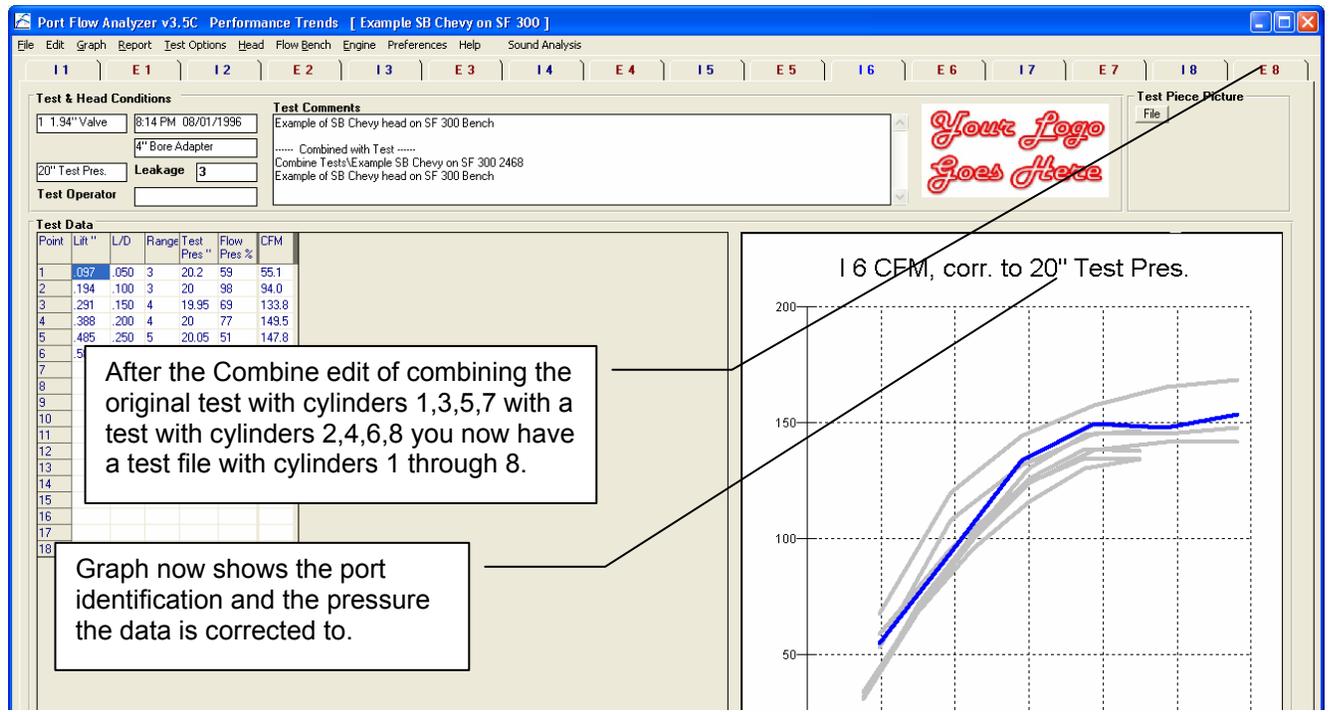
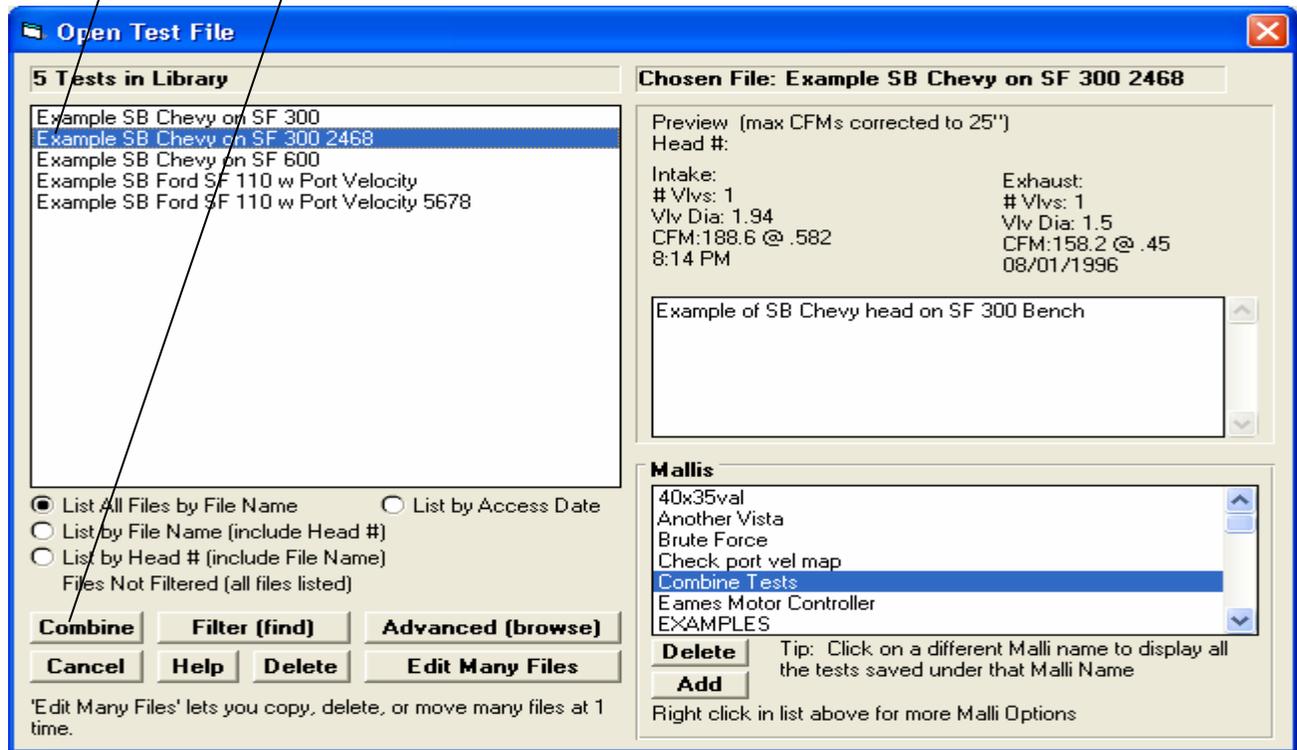


Figure A62 Including Port Velocity Numbers on Printed Port Velocity Maps

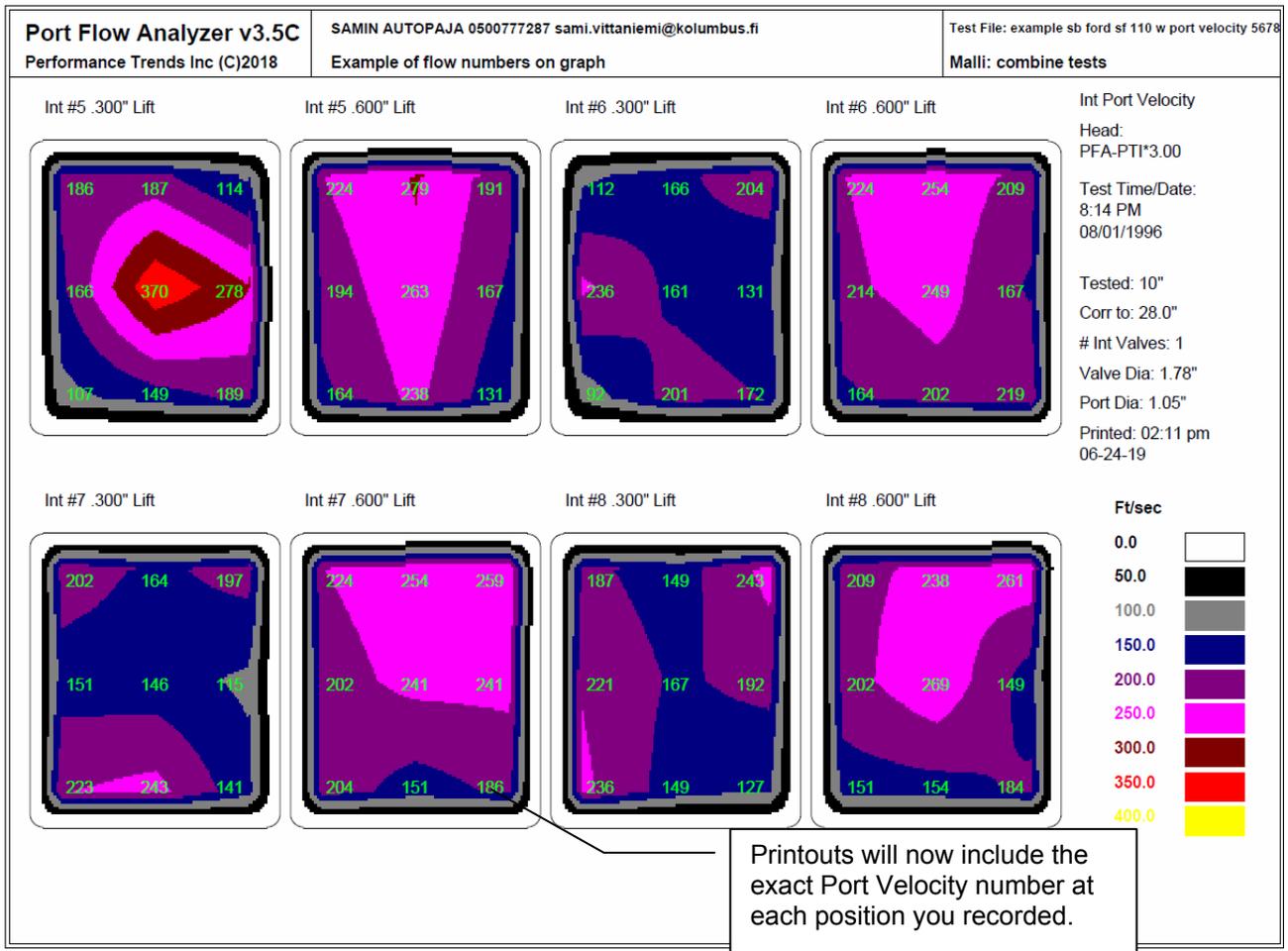
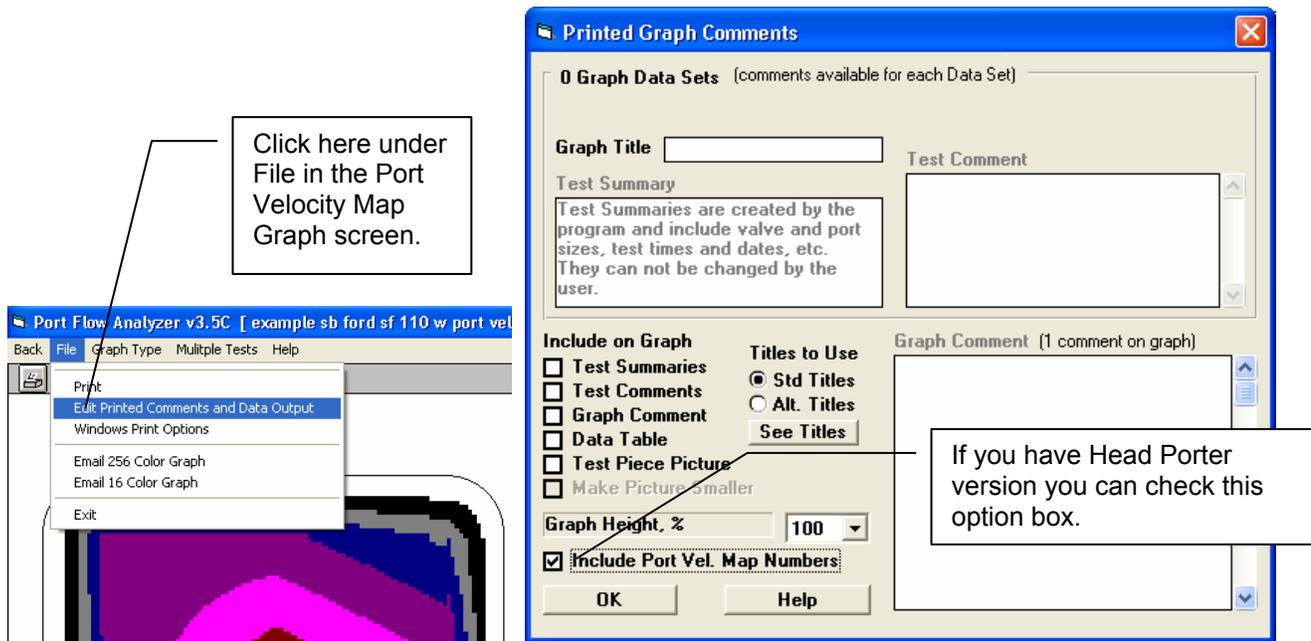


Figure A63 Include Graph on Recording Screen and Display Actual CFM

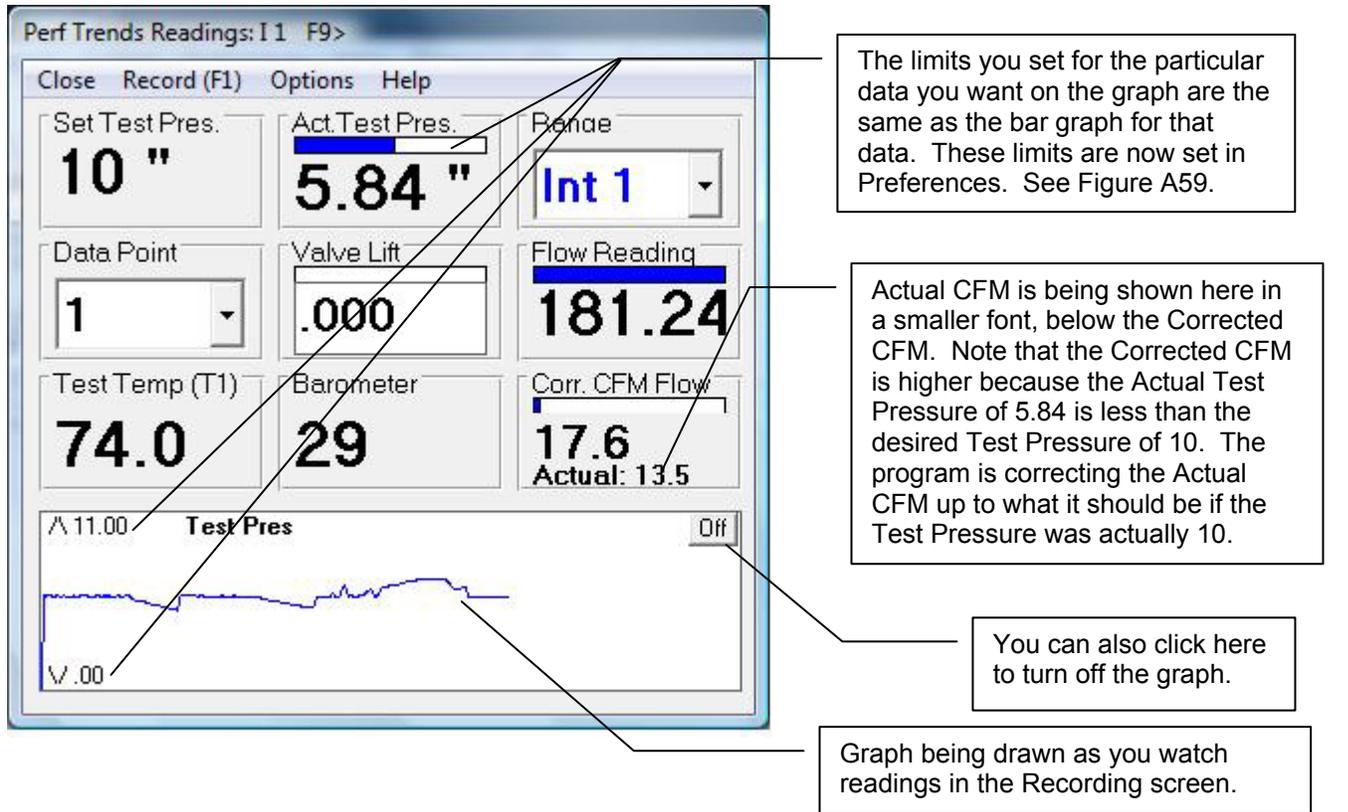
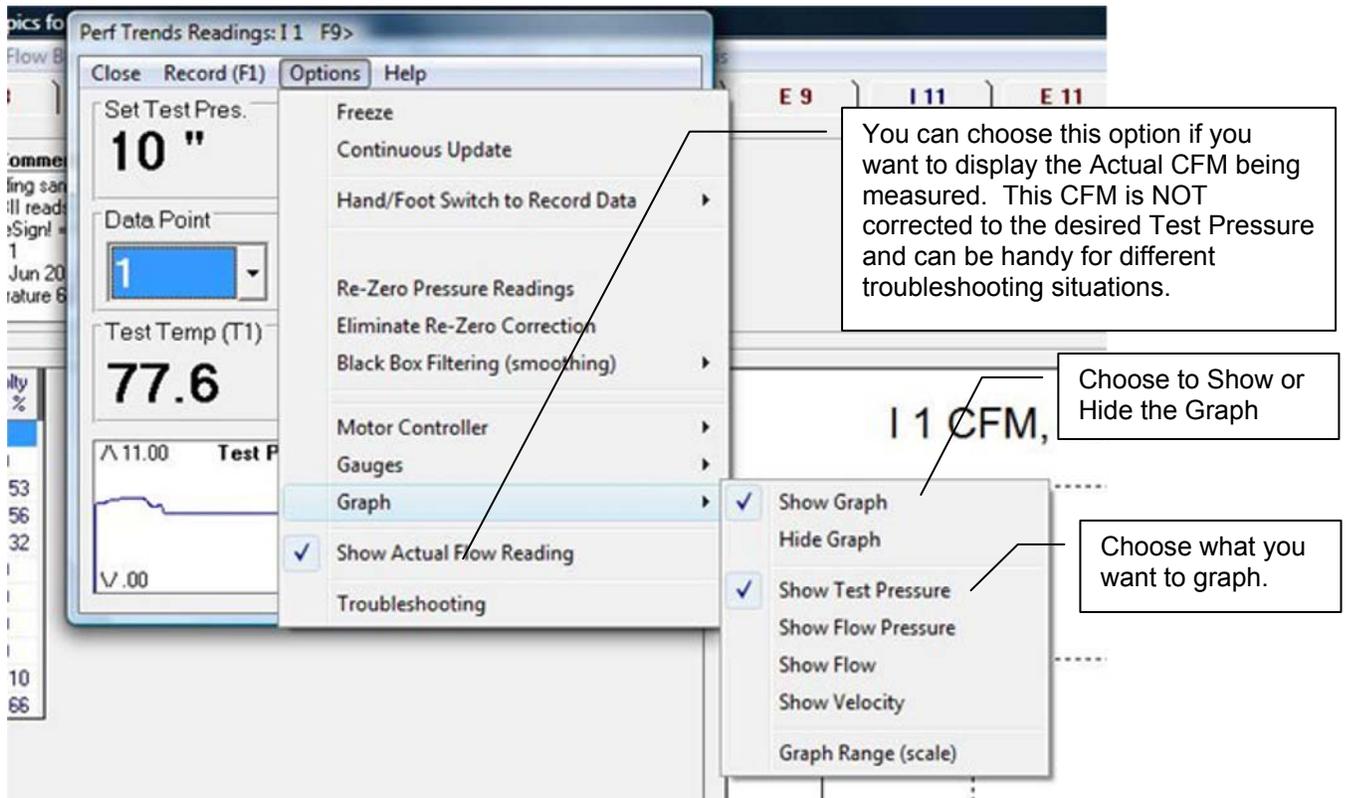


Figure A64 New Preference Settings

When Changing Head Specs Port Length  
Calculate new CCs from existing Port Diameter

Test Pres. for History Mx Flow: 25  
# Tests Kept in History Log: 25  
Require Head # for New Test: No  
Display SF FlowCom's Barometer: No  
Recalculate Valve Spring Specs: Yes  
Allow Resizing of Recording Screen: Yes  
Auto. Update Engine Bore, Stroke Calcs: No  
Show FlowCom Flow to .01%: Yes  
Slower FlowCom Readings (more reliable): No

Main Screen Graph Lines: Thick  
Main Screen, Other Cyl. Graphs: Yes  
Main Screen, Grid Text Color: Blue/Red  
Main Screen, Include Flow Coef. Graph: No

Main Screen Graph Scales: Use settings below  
Graph Maximum Flow: 300 CFM or LPS  
Graph Maximum Lift: 0.70 inch or 17.5 mm

Buttons: OK, Cancel, Restart Showing Help Tips, Stop Showing Help Tips, Help, Set Graph Colors, Don't Ask About Updating, Reset to Defaults, Look for New Adobe Acrobat Reader

Several other settings for the graph on the main screen were moved down on this tab (page) to be grouped together.

This button lets you browse your computer to find Acrobat Reader for displaying PDF files, like the User Manual.

Three new Preference settings for the graph scales on the main screen. Choose Auto-Scaling to have the graphs automatically scaled to match the data for a particular test. This was the method done before this Preference was added.

Test & Head Conditions  
1 2.0" Valve 014 PM 08/01/1996  
4" Bore Adapter  
25" Test Pres. Leakage 3  
Test Operator

Port	Lin	L/D	Range	Test Pres.	Flow Pres. %	CFM
1	101	050	2	25	53	63.4
2	202	100	3	25	86	126.9
3	303	150	4	25	62	182.4
4	404	200	4	25	74	218.3
5	505	250	4	25	79	233.2
6	606	300	4	25	63	245.2
7						
8						
9						
10						
11						
12						
13						
14						
15						

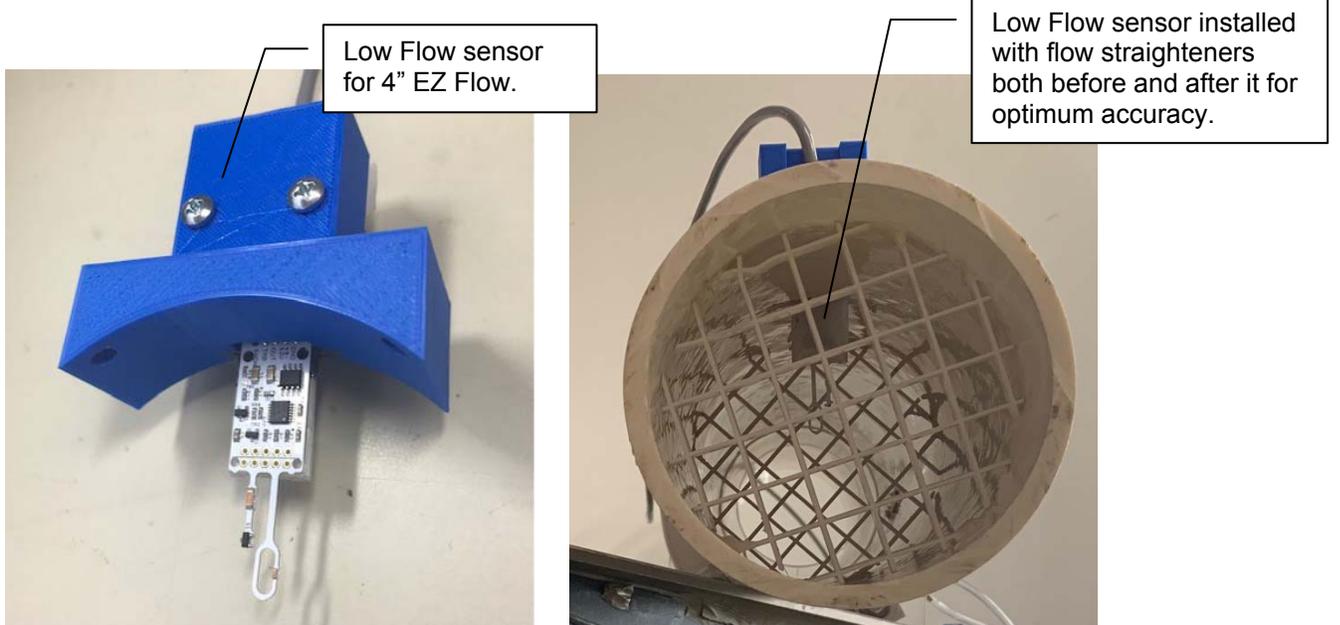
Int #1 CFM, corr. to 25" Test Pres.

Int #1 CFM, corr. to 25" Test Pres.

With the settings shown in Preferences screen above, the graph for this particular head is shown with good detail. If the next head you flow has significantly higher flow, it will be easier to spot because the graph scales stay the same.

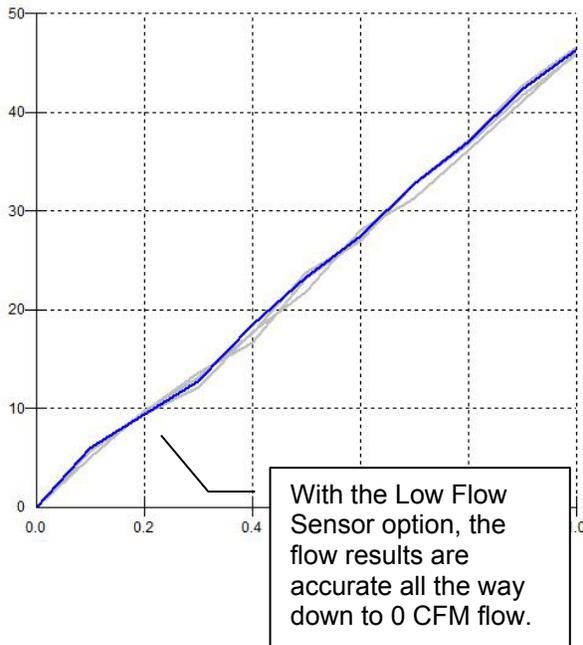
Scales were set for 200 CFM and .500" lift, which are too small for this data. If your results change a lot, select "Auto-Scaling" to avoid this problem

Figure A65 EZ Flow with Low Flow Sensor



Each graph below is for 4 repeat tests where the CFM was changed from 0 CFM at the 0 lift point linearly up to 45 CFM at the 1.0 lift point on an SF300 flow bench on range 2. This 4" EZ Flow system has a max flow capability of 400 CFM. With perfect results, we would see a perfectly straight line from 0 to 45 CFM.

15 CFM, corr. to 10" Test Pres.



1 CFM, corr. to 10" Test Pres.

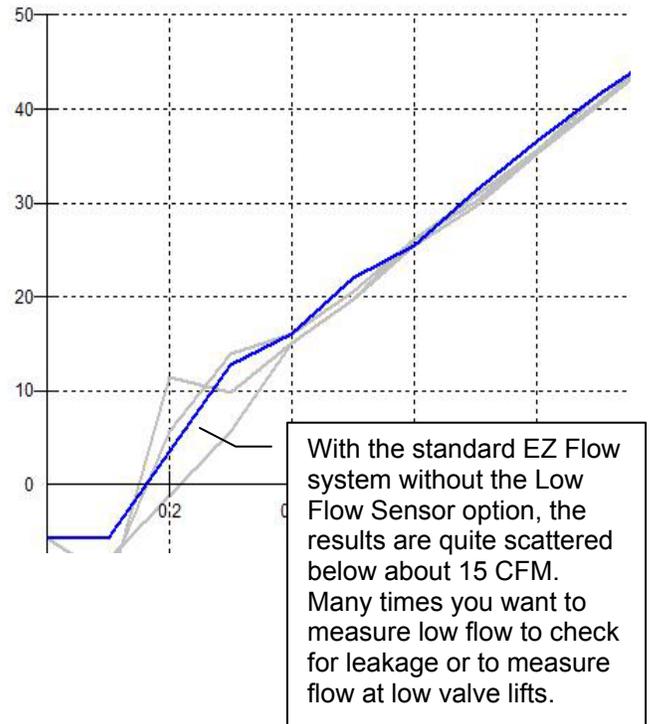
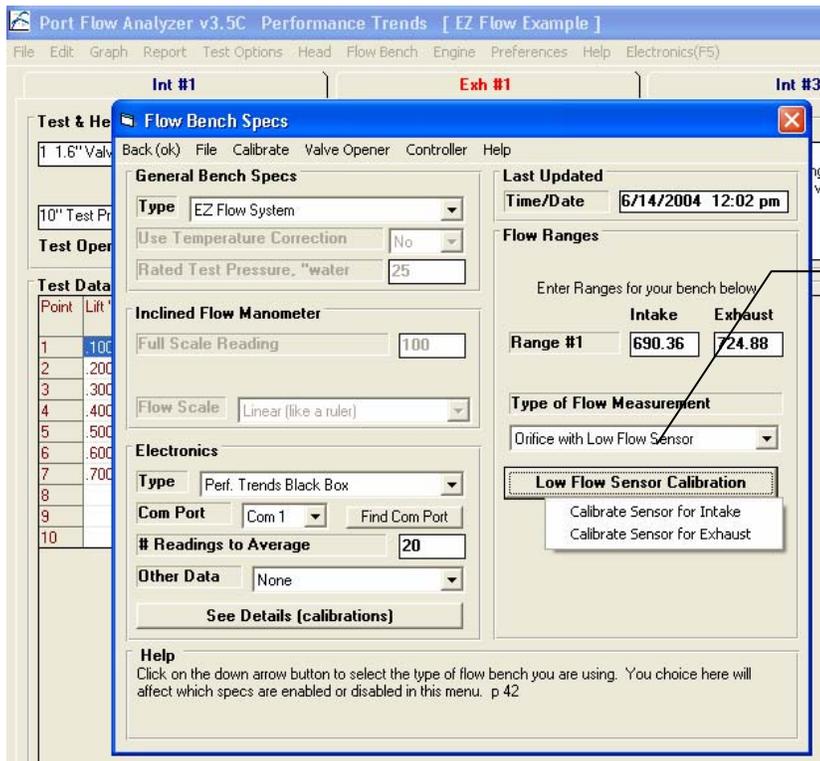


Figure A66 EZ Flow with Low Flow Sensor, cont



New option with Head Porter version is for the EZ Flow to be with just "Orifice" or "Orifice with Low Flow Sensor". Choose the latter and the "Low Flow Sensor Calibration" button becomes enabled. If you click this button, you are presented with 2 options for entering calibration data for either the Intake or Exhaust flow direction. Then you can enter calibration data for your sensor.

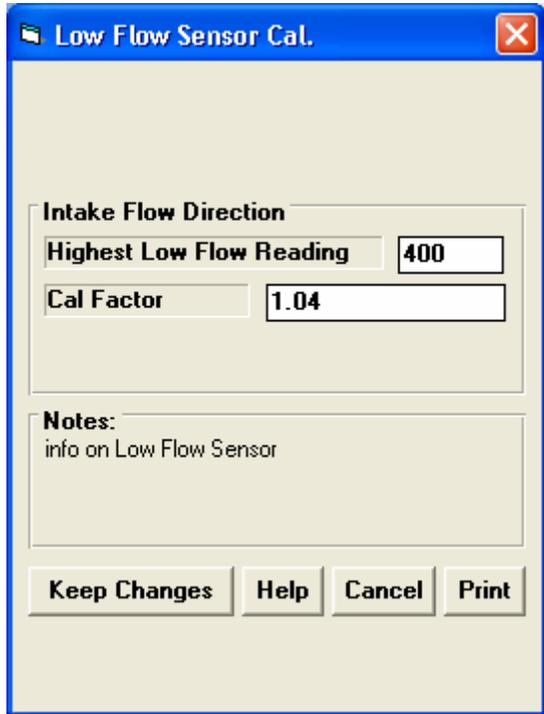
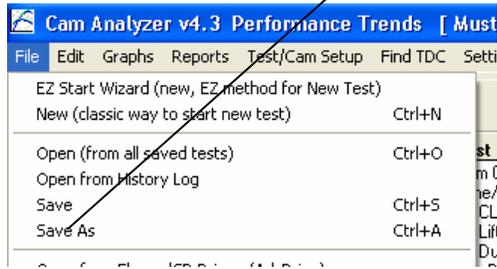
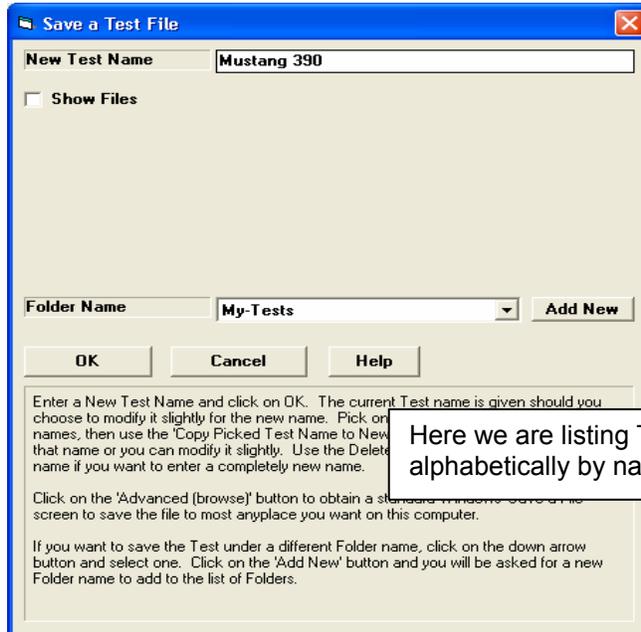


Figure A67 New "Save As" Features

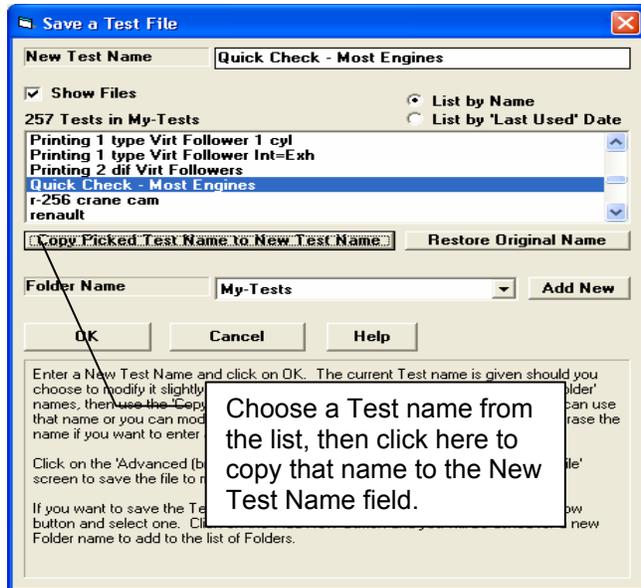
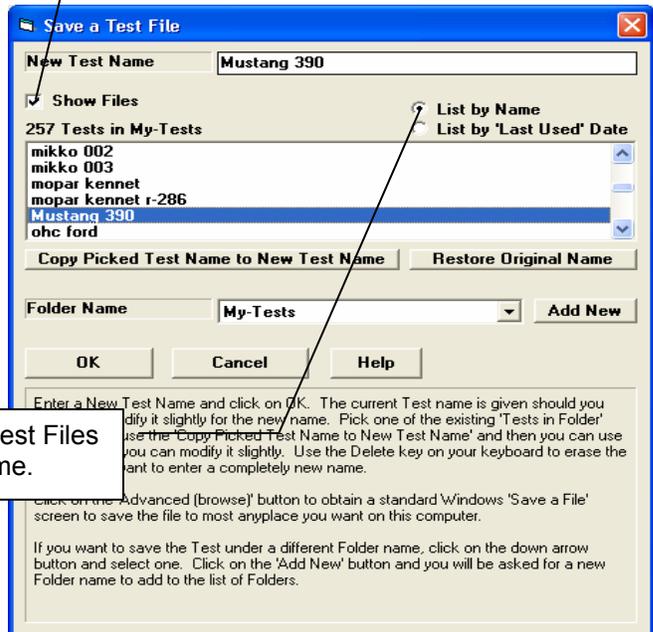


Click on File, then Save As

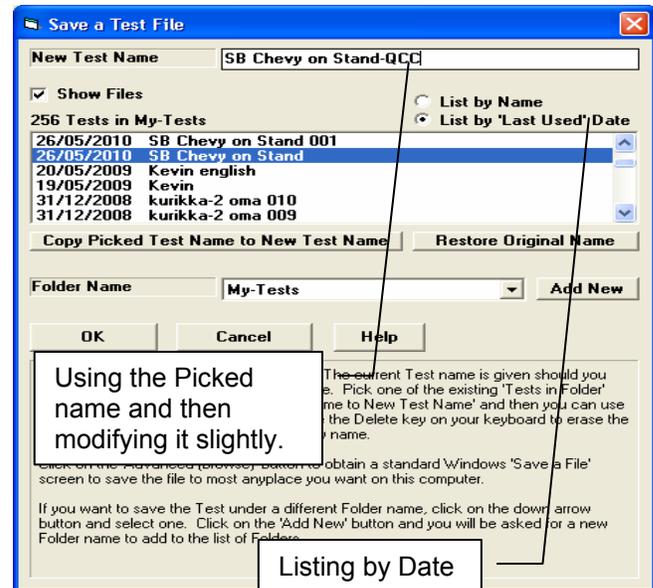
Click this Check Box for new info and options. Many times you may want to see what other files are in this same folder, or use one of these file names as the New Test Name, or possibly modify that name slightly.



Here we are listing Test Files alphabetically by name.



Choose a Test name from the list, then click here to copy that name to the New Test Name field.



Using the Picked name and then modifying it slightly.

Listing by Date

Figure A68 Saving Deleted Files and Folders to Recycle Bin

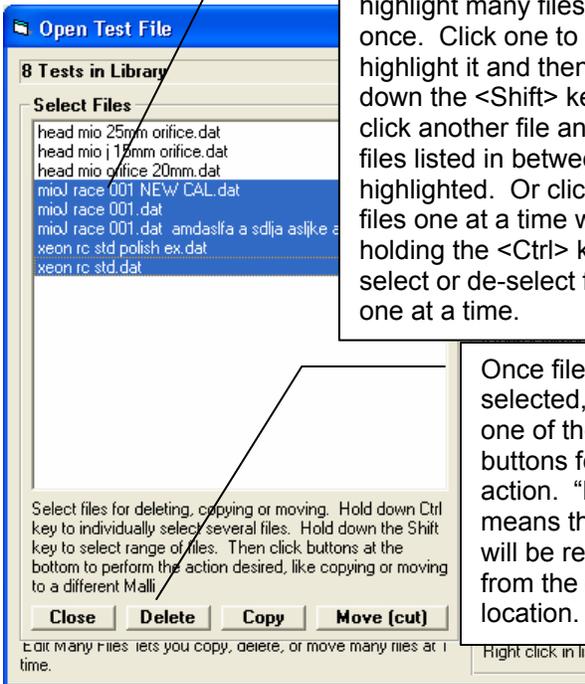
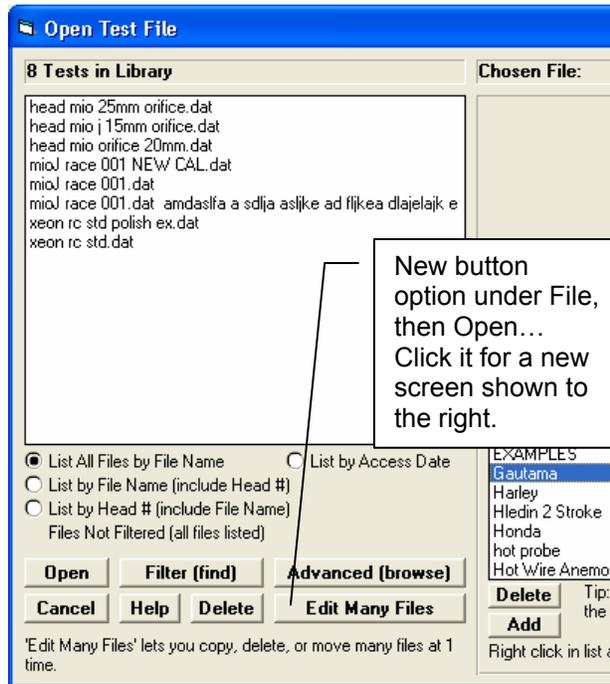
The figure illustrates the process of deleting a test file in Cam Analyzer v4.3 and its subsequent location in the Recycle Bin. It consists of four main screenshots:

- Open Test File Dialog:** Shows a list of 257 tests in the library. The file 'BF-64' is selected. A preview pane on the right shows details for 'BF-64', including intake and exhaust metrics. A 'Delete' button is visible at the bottom.
- Delete a Test File Dialog:** A warning dialog with a red 'X' icon. It states: 'Permanently delete Test BF-64 From Folder My-Tests ! If you are not sure, choose No. Note: File BF-64 will actually sent to the Recycle Bin, so can be restored later if needed.' Buttons for 'Yes' and 'No' are at the bottom.
- Confirm File Delete Dialog:** A dialog with a recycle bin icon asking: 'Are you sure you want to send 'BF-64' to the Recycle Bin?' with 'Yes' and 'No' buttons.
- Recycle Bin Window:** Shows the Recycle Bin containing several files. The file 'BF-64' is highlighted, indicating it has been successfully moved to the Recycle Bin.

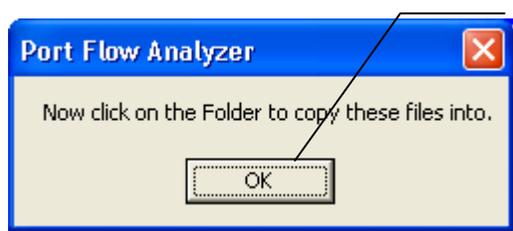
Annotations and callouts provide additional context:

- A callout points to the 'Open' menu item in the Cam Analyzer interface, stating: 'Click here for the Open screen shown to the right.'
- A callout points to the 'Delete' button in the 'Open Test File' dialog, stating: 'Pick a Test File, then click Delete button.'
- A callout points to the 'Delete' button in the 'Open Test File' dialog, stating: 'Deleted Folders are also sent to the Recycle Bin.'
- A callout points to the 'BF-64' file in the Recycle Bin, stating: 'Deleted test file now shows up in the Recycle Bin, so you can restore it later if you have made a mistake deleting it.'

Figure A69 New "Edit Many" Feature



Once files are selected, click one of these 4 buttons for the action. "Move" means the files will be removed from the existing location.



If you selected Copy or Move, the program will ask you to choose a Folder to Copy or Move the files to. In this example, we chose to "Move" the files highlighted, and chose the folder "Harley" as shown below.

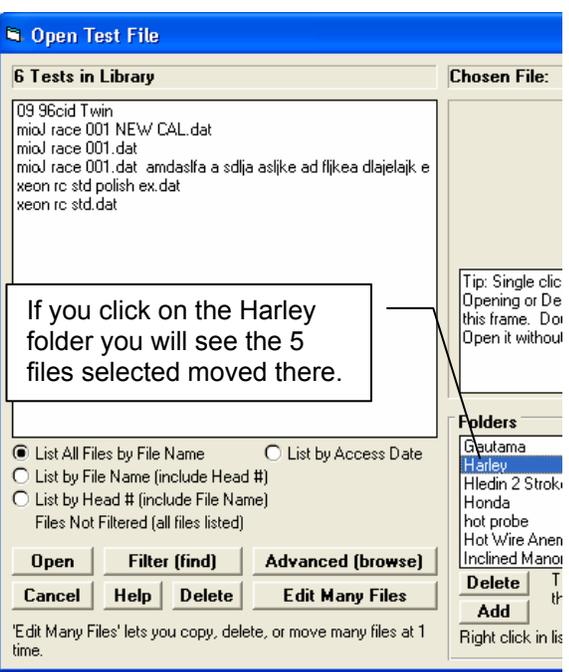
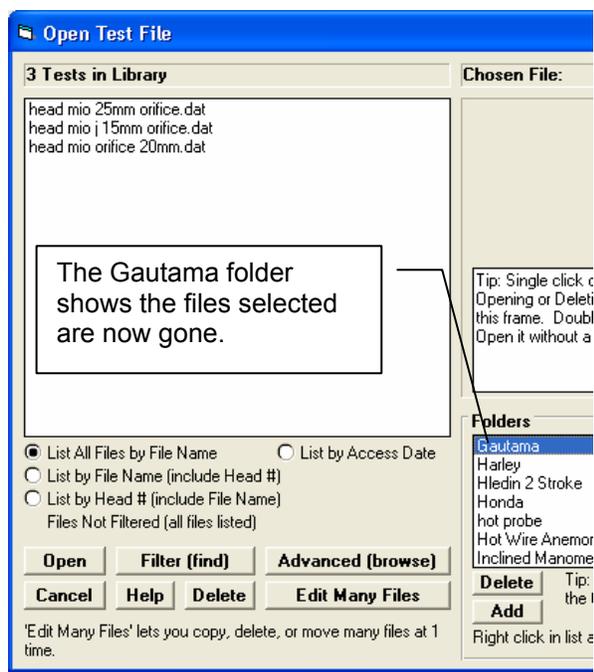
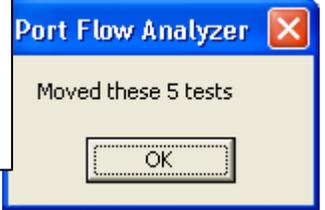


Figure A70 New Emailing Preferences

**Preferences**

Engine Specs Definitions (calcs) OK  
Printing / Graphing File Options Cancel  
General Operation Gen. Operation, cont. Restart Showing

**Emailing**

Email Method Method 2: Default Gmail  
SMTP Server smtp.gmail.com  
Port Number 465 Use Secure Socket Layer Yes  
Password \*\*\*\*\* Enter/Edit PW  
Sender "From" Email Address gagesjunk1@gmail.com  
Path to MS Paint C:\Windows\System32\ Find  
PDF Printer Acrobat Distiller Find  
Location of PDF Printer Output File C:\Microsoft Visual Basic.pdf Find  
Browse to PDF File When Emailing It Yes  
Send Test Email Emailing Help

You can enter a file name and path where the program will write the PDF file for emailing.

Or click the Find button to browse to a PDF file the program has already written.

Check this box to email as a PDF file.

Then click Print Report to create PDF file and get process started for emailing.

**Print Reports Options**

Test Results Report Options  
 Include Test Conditions  
 Include Head Specs  
 Include Test Comments  
 Request Report Comment  
 Include Head Details  
 Include Flow Bench Specs  
 Include Engine Specs  
 Larger Fonts (print size)  
 Email as PDF File  
 Include Test Piece Picture  
 Small Picture (if portrait)  
 Omit Flow Data  
Printer: Acrobat Distiller  
Print Report Using These Specs  
Close Tip See page

Worksheet Options  
 Use Standard Lifts  
Standard Lifts (from Test Options):  
.000 (leak), .100, .200, ..... 600  
Uncheck 'Use Standard Lifts' to use the Test Pattern of Lifts in the current test file.  
 Larger Space Between Lines  
 Ask For Worksheet Comment  
 Include Head Specs, etc.  
Print Blank Worksheet  
Worksheet is based on current test, with cylinders: 5, 6, 7, 8, with Int Valve Dia = 1.78 and Exh Valve Dia = 1.45. Port Valve

**Port Flow Analyzer**

At the next screen, enter a name for saving the PDF file.

Then when the screen for actually sending the email comes up you will have to browse and find this PDF file. If you consistently save to the same name and location, that will be the default name and location when you browse before emailing.

This message given only once until program is restarted.

OK

**Save PDF File As**

Save in: Desktop

File name: Microsoft Visual Basic.pdf Save  
Save as type: PDF files (\*.PDF) Cancel

Choose the location and file name for writing the PDF file. If you set the Preference of "Browse to PDF File When Emailing It" to Yes, this should be that location and file name.

Figure A71 New Emailing Features, cont

The screenshot displays the Port Flow Analyzer v3.5 B interface. At the top, a header shows 'SAMIN AUTOPAJA 0500777287 This Report Printed 8:36 am 06-25-19' and 'sami.vittaniemi@kolumbus.fi Page: 2'. Below this, a table of data is partially visible with columns for 'Time', 'Int:', 'Exh:', 'Range', 'Te', 'Pres', 'Temp', and 'CFM'. The main area is dominated by several dialog boxes and windows:

- Email To:** A dialog box with 'Email to:' set to 'tech@performancetrends.com' and 'Message to Send' containing 'Port Flow Report'. A 'Send' button is visible.
- Port Flow Analyzer:** A message box with the text: 'Note: If you see the ACRODIST.EXE program on your screen or on your task bar at the bottom of your screen, you must shut this program down to release the PDF file being emailed BEFORE you by emailing it. If it shows up on your task bar, or on the screen behind this message, shut it down. If you do NOT see this program running, simply click OK to continue. AFTER shutting it down, click on OK to continue emailing your PDF file.' An 'OK' button is at the bottom.
- Port Flow Analyzer: Find the PDF File:** A file explorer window showing a list of PDF files on the Desktop. 'Microsoft Visual Basic.pdf' is selected. The 'File name' field contains 'Microsoft Visual Basic.pdf' and 'Files of type' is set to 'PDF Files (\*.PDF)'. 'Open' and 'Cancel' buttons are at the bottom right.
- Port Flow Analyzer:** A message box stating: 'At the next screen, 'Browse' to find your PDF file you printed. This message given only once until program is restarted.' An 'OK' button is at the bottom.
- Email To:** A larger version of the email dialog box, showing the path 'Emailing: C:\Documents and Settings\Kevin Gertgen\Desktop\Microsoft Visual Basic.pdf' at the bottom.
- Port Flow Analyzer:** A final message box stating 'Message sent' with an 'OK' button.

Text boxes with arrows provide instructions: 'Once Acrobat is shut down, enter "Email to:", and message, and other info here, then click the Send button.'; 'If you set the Preference of "Browse to PDF File When Emailing It" to Yes, this message will appear. Click OK to proceed to locating the PDF file for emailing.'; 'Browse to the PDF file, then click Open.'; 'Emailing screen after finding and "opening" the PDF file.'; and 'Message that email and PDF file have been sent.'

Figure A72 New Export a Report as an Excel File

Click on File at the top of the Report screen to export an ASCII text file of the report.

New option to export as a .csv file which can be open with Microsoft Excel.

New option to automatically email the ASCII file you create.

If the File Name you specify does not end with a .csv extension, one will be added automatically.

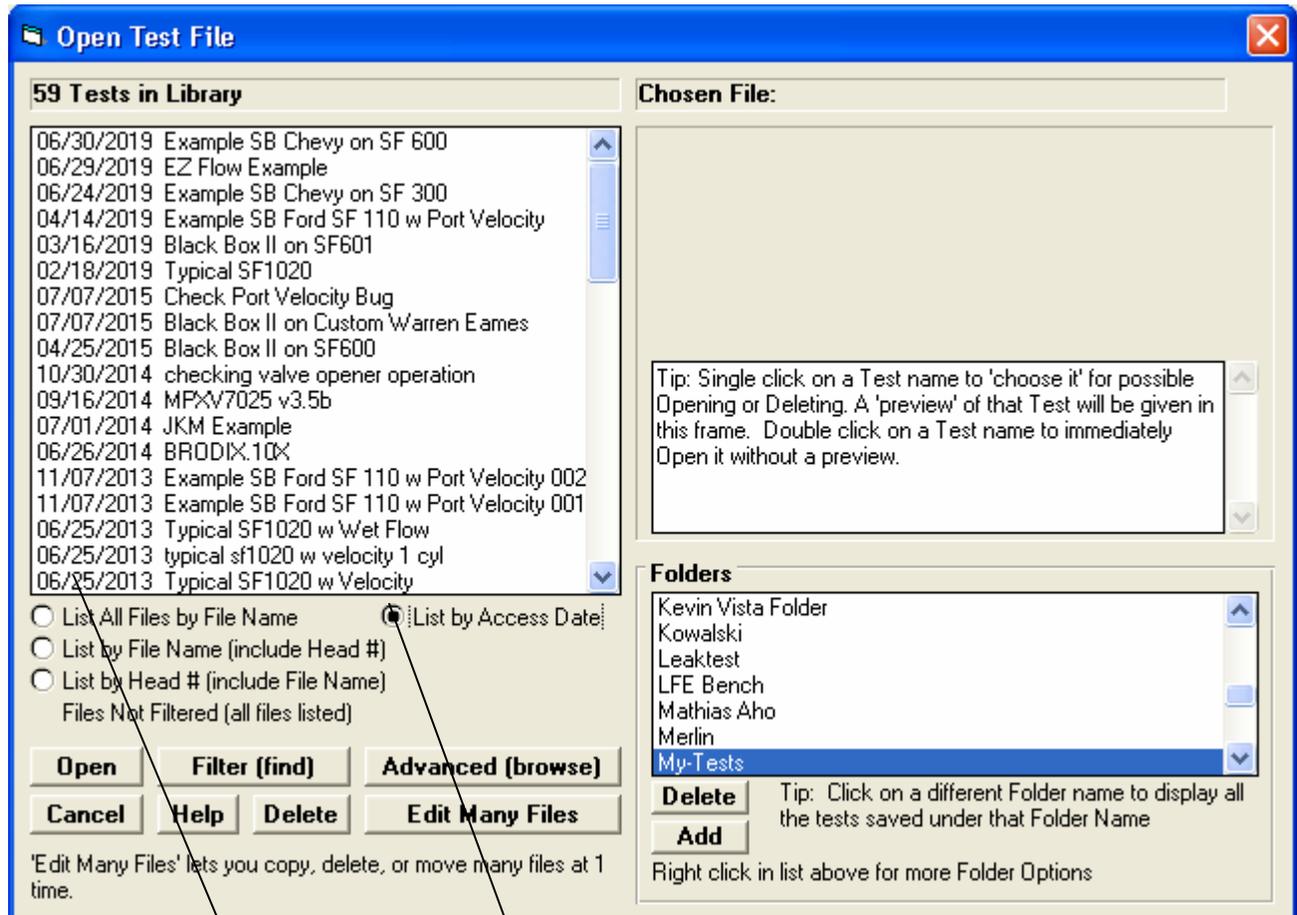
File name changed to 'C:\WB98\projects6\PFA\SB Chevy.csv' to include a '.csv' extension that is used to identify Microsoft Excel files.

File is created and Excel is the default program to open it.

Port Flow Report data opened up in Excel.

Port	Lift	L/D	Range	Test Pres	Flow Pres	Test Temp	Flow Tem	Leak CFM	Corr CFM
Int #5	0	0	1	10	25	90	125	2.4	0.1
Int #5	0.05	0.028	3	10	75	85	135	2.4	31
Int #5	0.1	0.056	5	10	68	80	130	2.4	60.6
Int #5	0.2	0.112	7	10	73.3	78	122	2.4	120.5

Figure A73 List Files by Access Date



Choose this option and the files will be listed by the date they were last modified or opened.

With this option checked, you will see the date listed here, with the tests with the most recent date listed at the top.



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