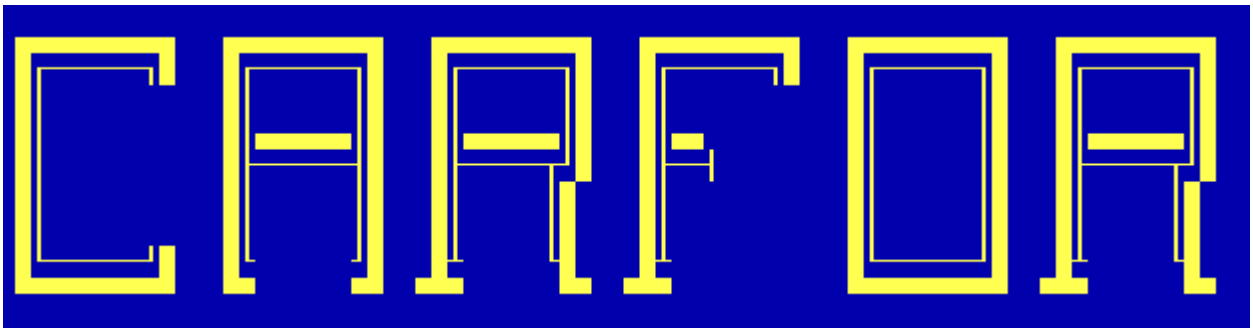

User's Manual

Version 3.30.0

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You can always get the latest User's Manual from my Web Site in PDF format
http://www.magneticlynx.com/carfor/carfor.pdf

General Information

A Computer program designed for the automobile enthusiast that contains formulas that will help you to analyze your race or street vehicle's needs, and improve its performance. CARFOR incorporates a very intuitive user interface. If you wish to change a value simply click on the value or TAB to the value and enter a new one.

The most important thing to remember is that the more accurate your input to the program is, the more accurate the answer will be. So if unexpected results occur please double-check all your input data. If all checks out please email us. Because programs are not always perfect and there is always the possibility of a programming error. See **Reporting Problems** on next page. Although some examples may show only one or two decimal places the program will accept however many you key in, but any more then seven will not hold accuracy. Cells with a **green background** are used for both input and output, a **yellow background** is for user input only, and a **red background** is used by the program for it's calculated output. When you move the mouse over a command button a help window will show on the bottom of the form that gives you more information about which inputs are used by that command and what information will be calculated. See Page 5 for options on how to customize the Help output box. Please remember that these are theoretical answers. How will things like clutch / converter slippage, aerodynamic factors, tire growth, etc., affect your car?

In calculations that use volumetric efficiency, if this is an unknown factor, here are some typical estimates:

Stock smog motor	75%
Stock performance engine	80-85%
Modified performance engine	90-95%
NASCAR short-track engine	95-100%
All out drag engine	110-???%

NOTE: These values are at peak horsepower, and at very low RPM the stocker will have better volumetric efficiency than the modified engines.

NOTE: Remember that most dyno HP figures are converted to some standard conditions (SAE J607), usually sea level (14.69 PSI or 29.92 inches of Mercury, 60 degrees F and zero humidity). Later SAE (J1349) / factory rating use 29.31 inches of Mercury and 77 degrees F.

NOTE: Vehicle weight as used here is the weight of the vehicle with all fluids as raced and with the driver dressed for racing.

Most of the terms used in this User's Manual are standard terms that are used by other publications. To be sure of their meaning please check the **Glossary / Definitions / Abbreviations** Section at the end of this manual.

Computer Requirements:

A minimum screen resolution of 800 by 600 is required. We Recommended a higher resolution to optimize displays for the Graphics Functions. The **"Use Large Screen Resolution"** and **"Use Full Screen Resolution"** functions will adjust the program's display up to a maximum resolution of 4500 by 3000.

Compatible with these versions of Microsoft Windows operating systems: 95, 98, 98SE, ME, NT, 2000, XP, VISTA, Windows 7 and Windows 8 in both 32 and 64 bit versions.

An Intel Pentium or 100% Compatible processor, a faster processor will improve the speed of the following:

- Piston Acceleration and Velocity, or Piston Travel Charts.
- Acceleration and Top Speed Prediction Chart.
- Graphics Functions

You will also need 4 MB of free hard disk space for the program plus supplied files and another 3 MB for the documentation. Addition space will also be needed for parameter and data files that you create.

A printer is optional - It is only needed if you want to make a hard copy of any of the forms, graphs, or other files the program creates.

While I personally have no experience with running CARFOR with other operating systems I do have users that are doing just that.

> Just letting you know that I've received it and that it runs fine under Linux using the Wine windows emulator.
>
> Cheers,

> I'm using a Mac but I run CARFORW through parallels desktop (virtual machine) on windows 7 32-bit.

Getting Started

I n s t a l l a t i o n:

Installation is quick and easy on any computer, as there is no real installation. Just create a Folder/Directory where you want to place the program files. We recommend 'C:\Program Files\carfor\' but 'C:\carfor\' is an alternative example. Then Unzip CARFORW.ZIP or if the DEMO CARFORWD.ZIP into that Folder/Directory. That's it ... No user configuration of CARFORW is required. You are now ready to start using the program, and input your data. Note there is no need to re-boot your machine before starting to use the software.

Uninstalling The Software.

To uninstall the software just delete / remove the folder that you created and copied the files into, any shortcuts you may have created and you are done. The software does not write anything to your systems registry.

Reporting Problems / Getting Help.

Please let me know if you experience any problems at all. I need to know how you try to run the program. Short Cut, Windows Explorer, Start | Run, or a DOS command line. I also need to know what error message you got and if possible a hardcopy of the error screen. What version of the operating system and service packs you are using. If the program is up and running when you have a problem than please write / save the information you have entered and calculated to a parameter file. Be sure to include an in-depth explanation of what the problem is and what you were doing when you got it and saved the file you are sending. Go into the folder where the file is and attached that file to the e-mail reporting your problem. Please include as much information as possible about the problem.

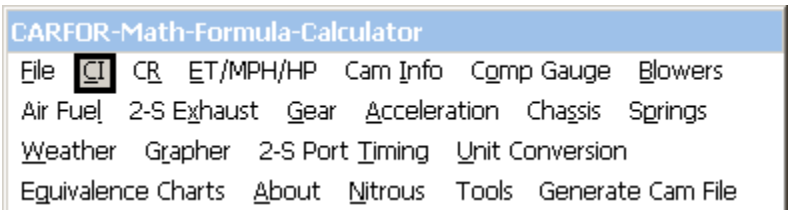
Technical Support Policy: **Free e-mail support to all registered users.**

Software Update Policy: **Updates are free, by e-mail to all registered users. At times I will send out a notice that a new version has been released a long with what changes have been made. You will only be able to receive this if you send me your new email address when your email address changes.**

How does it work?

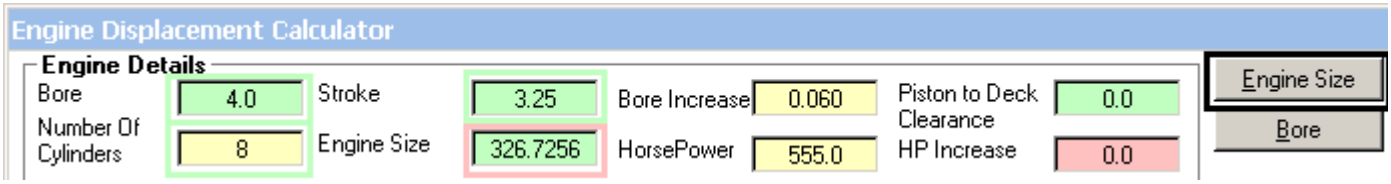
First you must load the program. This can be done many ways. You can use a short cut, windows explorer, the run option of Start, or a DOS command line. The easiest way to use the program is to create a short cut and drag it on to your Desktop; you can then click on the CARFOW icon on your Desktop to start the program.

Now lets calculate your Engine Size. You will select CI from the main menu. Shown inside the black square.



The form will load and displays the current values. If you have just loaded the program these will be the default values. If you have read / open a parameter file these will be the values from that project.

- First you must enter the Bore (4.0), Stroke (3.25), and Number of Cylinders of your engine (8). Shown by the green squares.
- Now lets calculate your Engine Size in cubic inches. You will select Engine Size. Shown by the black square.
- You engine size will be shown in the pink square in cubic inches (326.7256).



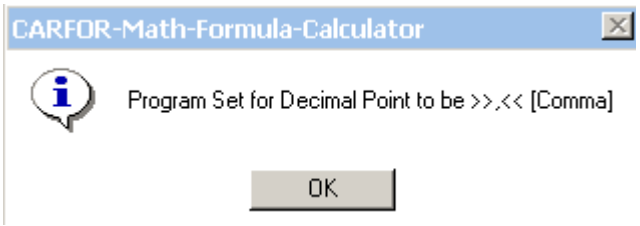
Using Metric Input and Output.

There are two ways to use Metric Input and Output. The first way is when you load a form you check the Metric Box. The second way is on the Main Menu turning ON Metric Mode. Now when you load any form that has a Metric Box the program will automatically check the Metric Box for you when it loads the form.

- First you must enter the Bore (101.6), Stroke (82.55), and Number of Cylinders of your engine (8). Shown by the green squares.
- Now lets you calculate your Engine Size in cubic centimeters - cc's. You will select Engine Size. Shown by the black square.
- You engine size will be shown in the orange square in cubic centimeters (cc's) (5354.073).

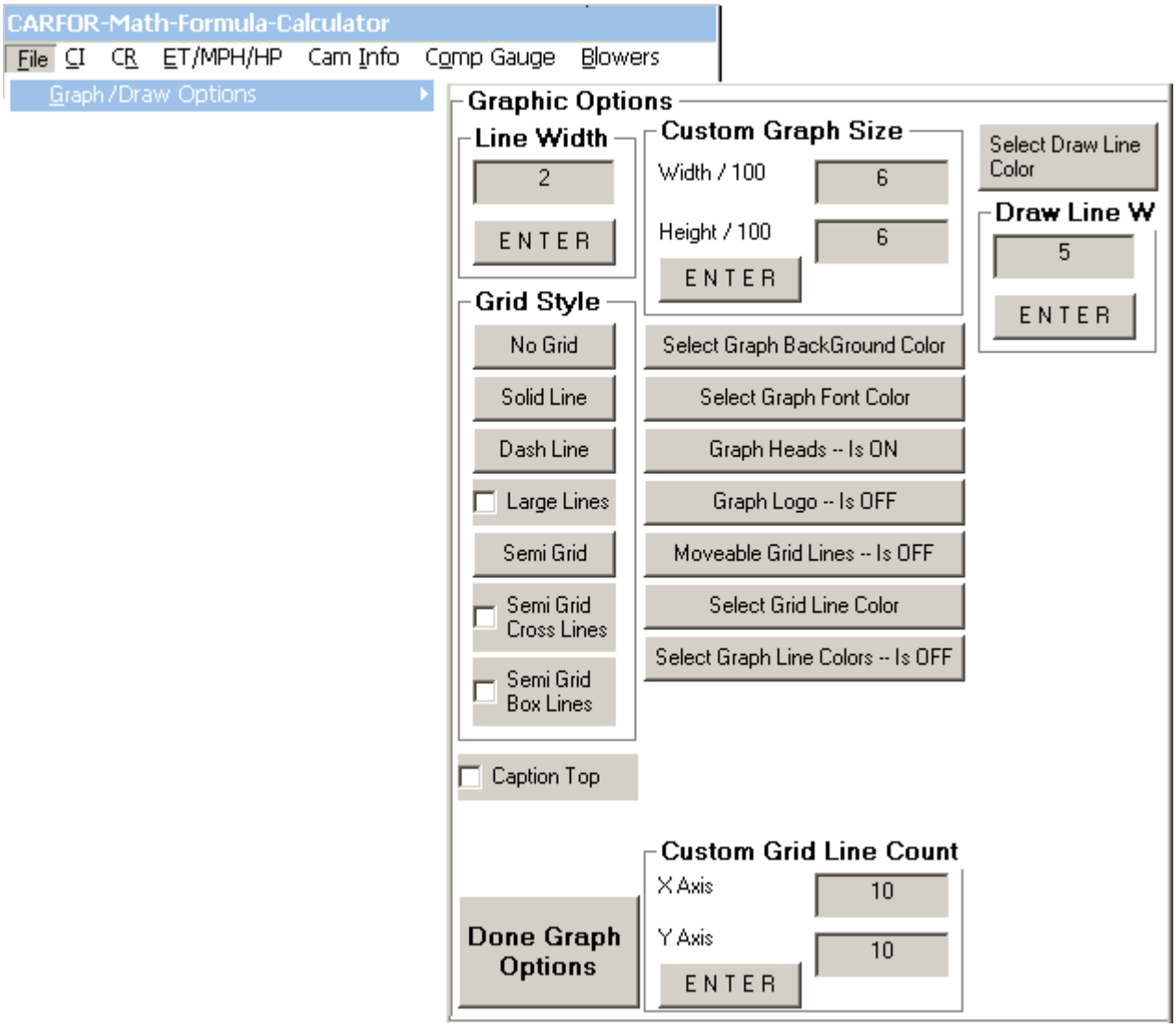
The **Metric Mode** can be toddled ON and OFF while the program is running. If a change is made to the Metric Mode setting, this will also be (written) saved to the parameter file. The Metric Mode will be reloaded when that parameter file is Read (Opened).

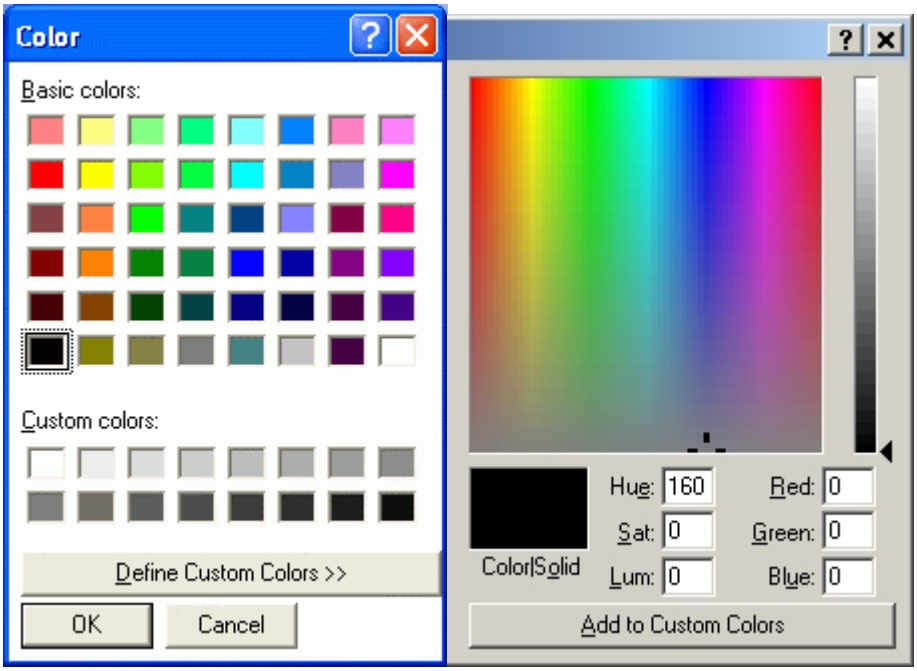
Based on Regional Settings in the Control Panel, the program will display numbers with support for International settings, this will show the "," for a decimal point as required.



In the above example you would enter the Bore (101,6), Stroke (82,55), and Number of Cylinders of your engine (8).

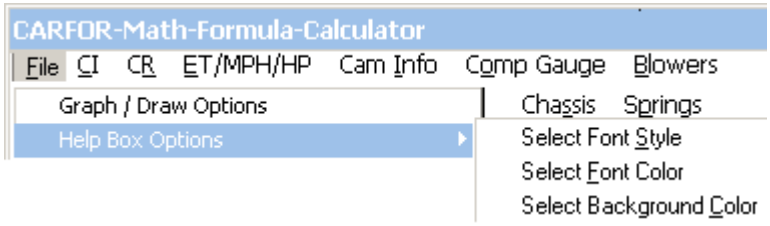
The user can customize the Graph Function.





There are many places where the user can customize colors.

You can customize the help Box. By changing the Font Style and/or size, the Font Color, and the Background Color of the help box.



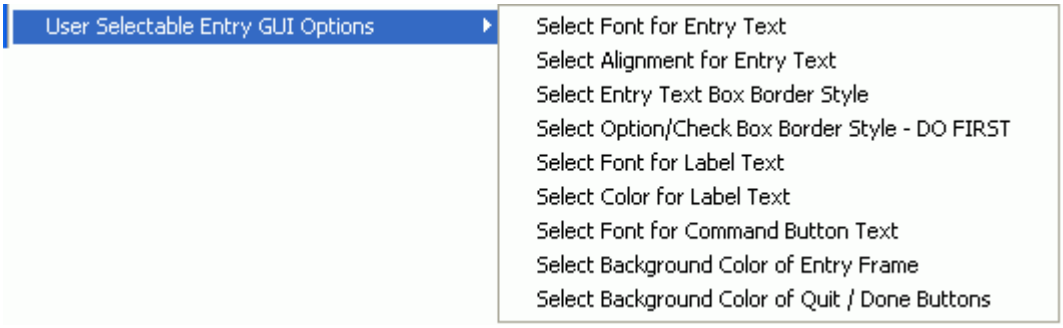
Standard Help Box

Acceleration and Top Speed Prediction Chart with 60 foot, 330 foot, 1/8 Mile, and 1/4 Mile ET using RPM and Torque from Parameter File also Coefficient of Drag, Frontal Area, Tire Rolling Resistance, Tire Diameter, Tire Rolling Radius, Launch RPM, % Rear End Power Loss, % Power Loss, Vehicle Weight with Driver, Dyno Correction Factor, Shift RPMs, Tire Growth Percentages, Trans Gear Ratios, Shift Time.

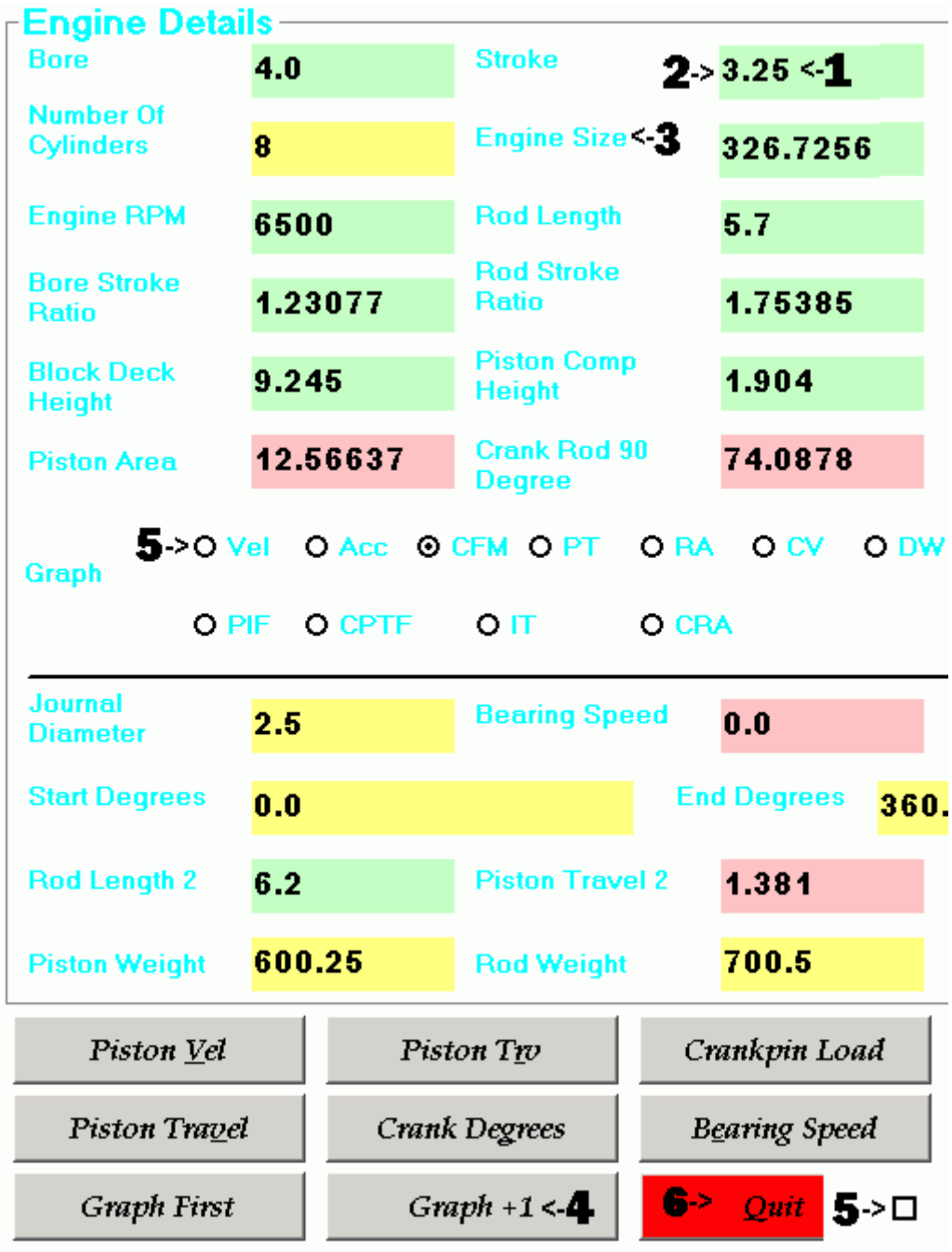
User customized Help Box

Acceleration and Top Speed Prediction Chart with 60 foot, 330 foot, 1/8 Mile, and 1/4 Mile ET using RPM and Torque from Parameter File also Coefficient of Drag, Frontal Area, Tire Rolling Resistance, Tire Diameter, Tire Rolling Radius, Launch RPM, % Rear End Power Loss, % Power Loss, Vehicle Weight with Driver, Dyno Correction Factor, Shift RPMs, Tire Growth Percentages, Trans Gear Ratios, Shift Time.

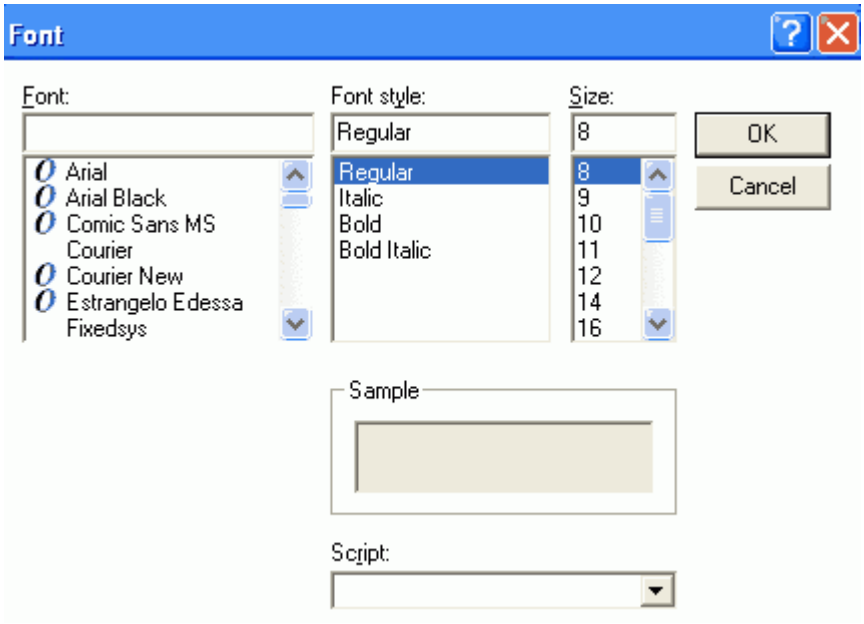
The USER can customize many elements of the GUI (Graphical User Interface).



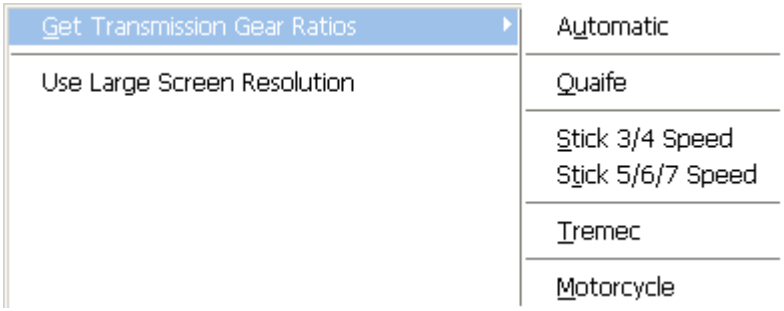
1-> This shows changing the Font Style, size, 2->Alignment, and Border Style for entry text. 3-> This shows changing the Font Style, size, and color for labels. 4-> This shows changing the Font Style, and size Command Buttons. 5-> This shows changing the Option / Check Box Border Style. 6-> This shows a user selected color for the Quit / done / OK buttons, This shows a user selected color for the background of the entry frames, plus **Use Large Screen Resolution.**

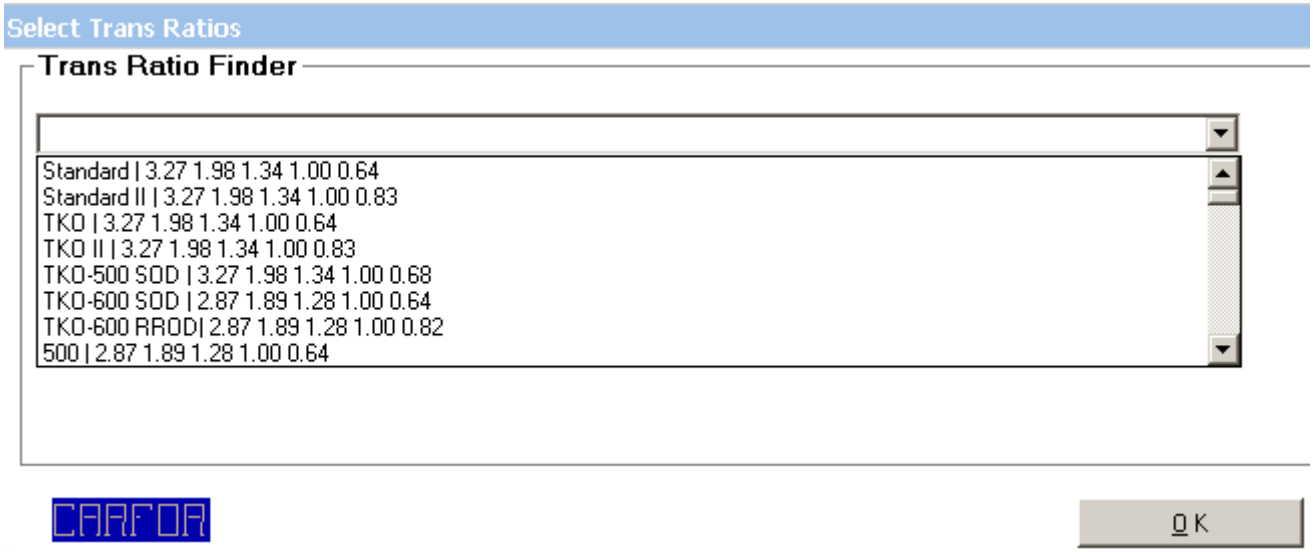


You can select from the available Fonts on your system. You can also select Font Style and Size.

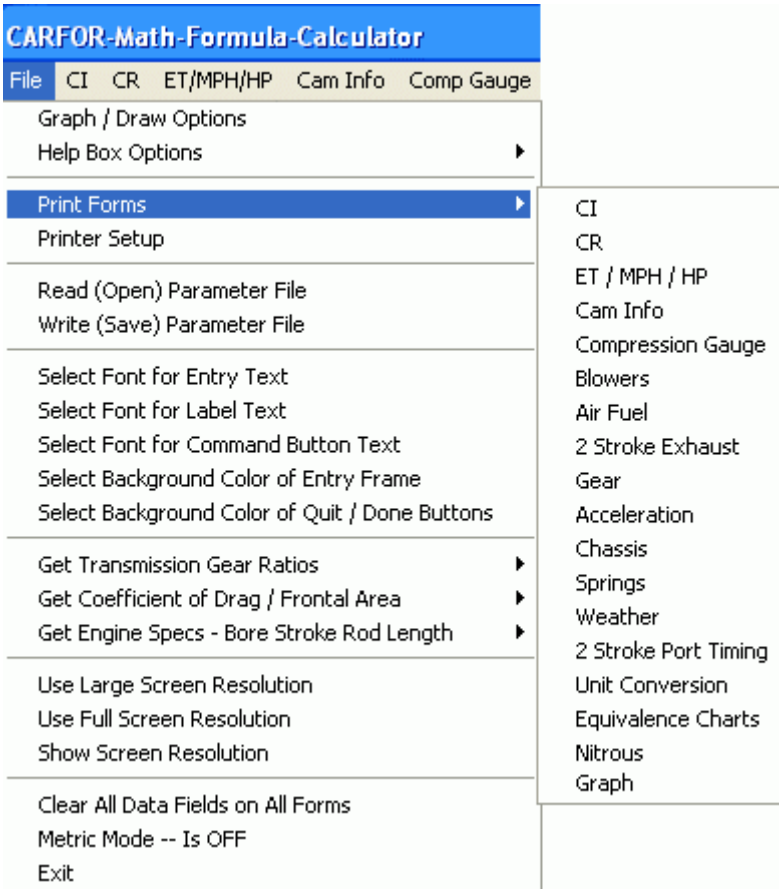


You can select from the built in **Trans Gear Ratios** by selecting the type of trans and then on the popup screen select your trans. Or Enter your own gears ratios on either the gear or acceleration / top speed screen.

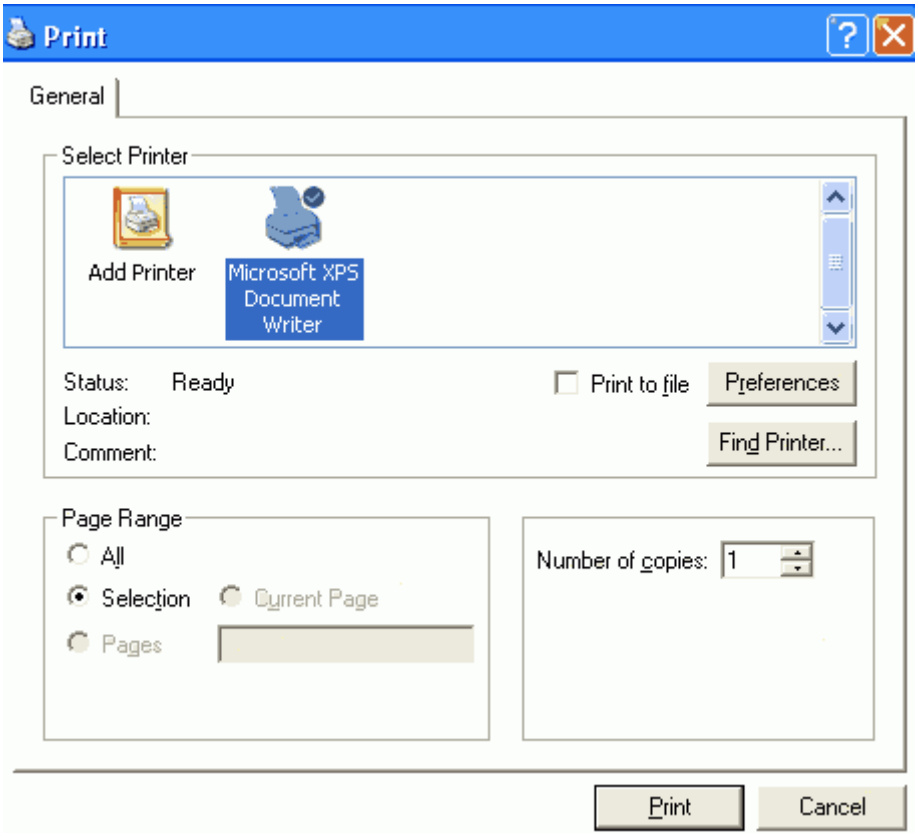




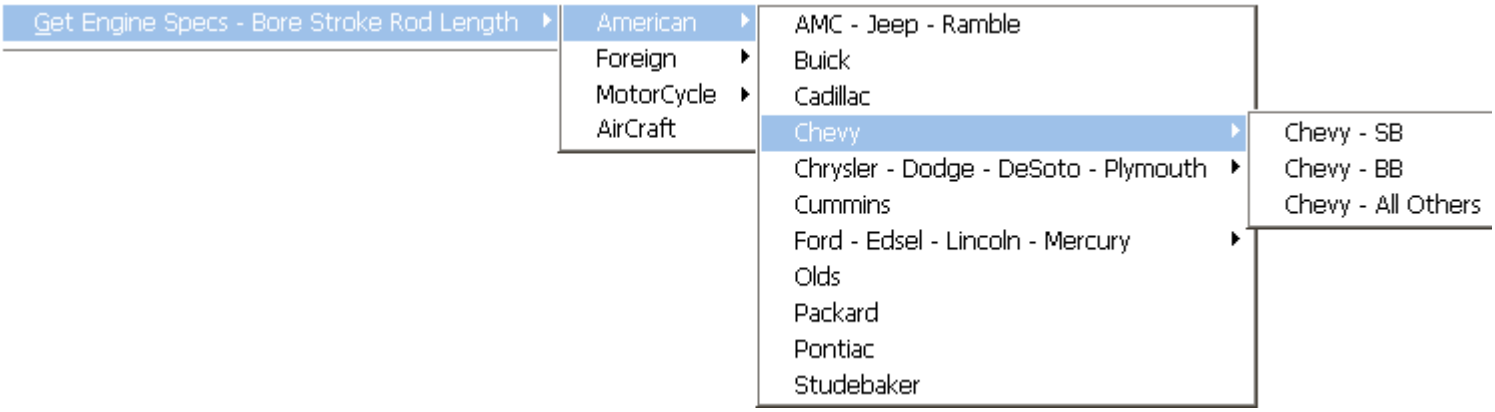
Each form with all the information on it can be printed.

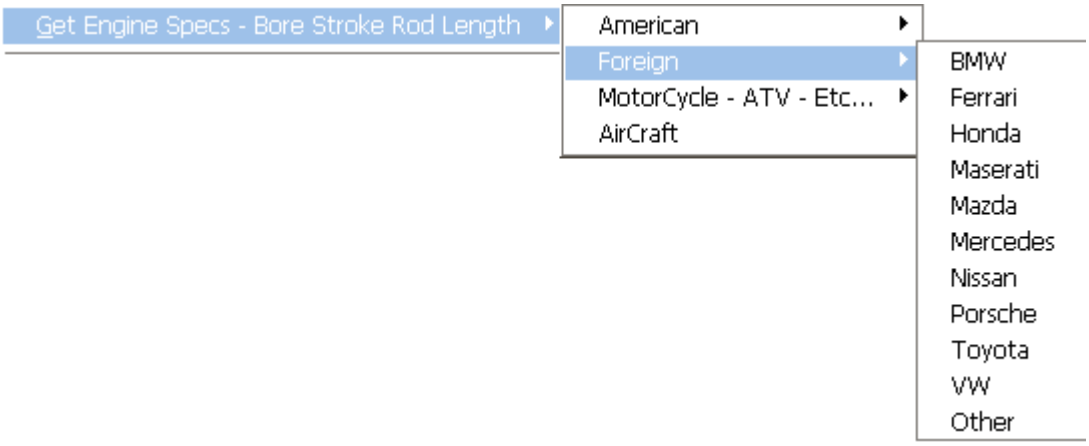


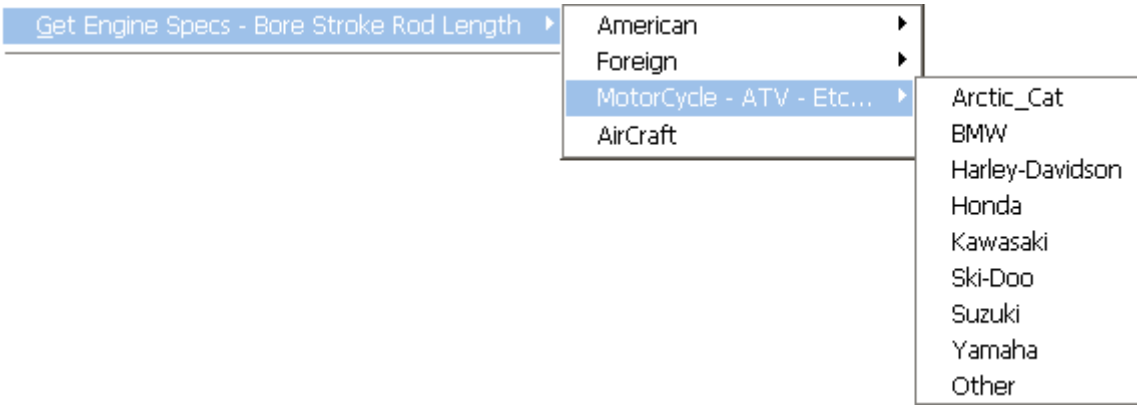
Use **Printer Setup** to select which Printer and to adjust you printouts.

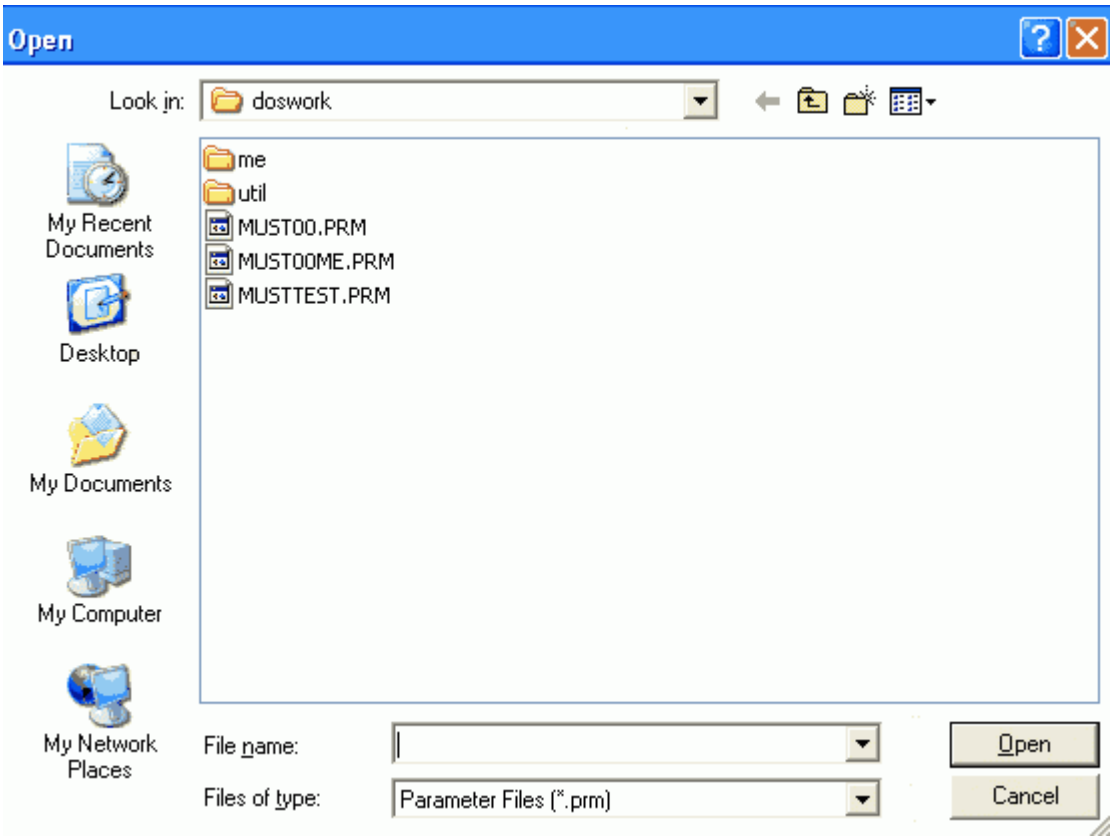


You can select from the built in **Engine Specs** by selecting the type of vehicle and then type of manufacturer and then on the popup screen select your engine size. Or Enter your own specifications on the CI screen.









The default values for each cell are coded into the program. The program will create (Save) a file for you, when you tell it to "**Write (Save) Parameter File**". The file CARFOR.PRM has the default values and is supplied as a sample file. This means the default values that the program uses once changed can be stored and recalled at a later time. This option lets you call the file whatever name you want, so you can create more than one. When you load the program you can than "**Read (Open) Parameter File**" for the car you want to work on. The user can at any point while running the program Read (Open) or Write (Save) whatever parameter file they want.
DO NOT try to edit this file. A ';' as the first character of a line means that, that line is a comment and will be ignored when read by the program. Comment lines may be placed any where in the file. The user may add Acceleration or Road/ROad HP information at the end of the file for use by the program. These files are in ASCII and you can use NotePad to look at them or add Acceleration information.
All parameters will be written using U.S. units except the two-stroke exhaust screen which only works in Metric units.
NOTE in the DEMO version when reading (Opening) parameters for screens where the user cannot change values, these values / parameters will be ignored.

If changes are made to the graph function, help box setting, or Background color of entry forms these will also be saved and then reloaded when that parameter file is Read (Opened).

NOTE Logic has been added to check if a file named zxqvwu00.prm is present in the same folder as the CARFORW executable. If this file is present the program will automatically load in these values at startup.

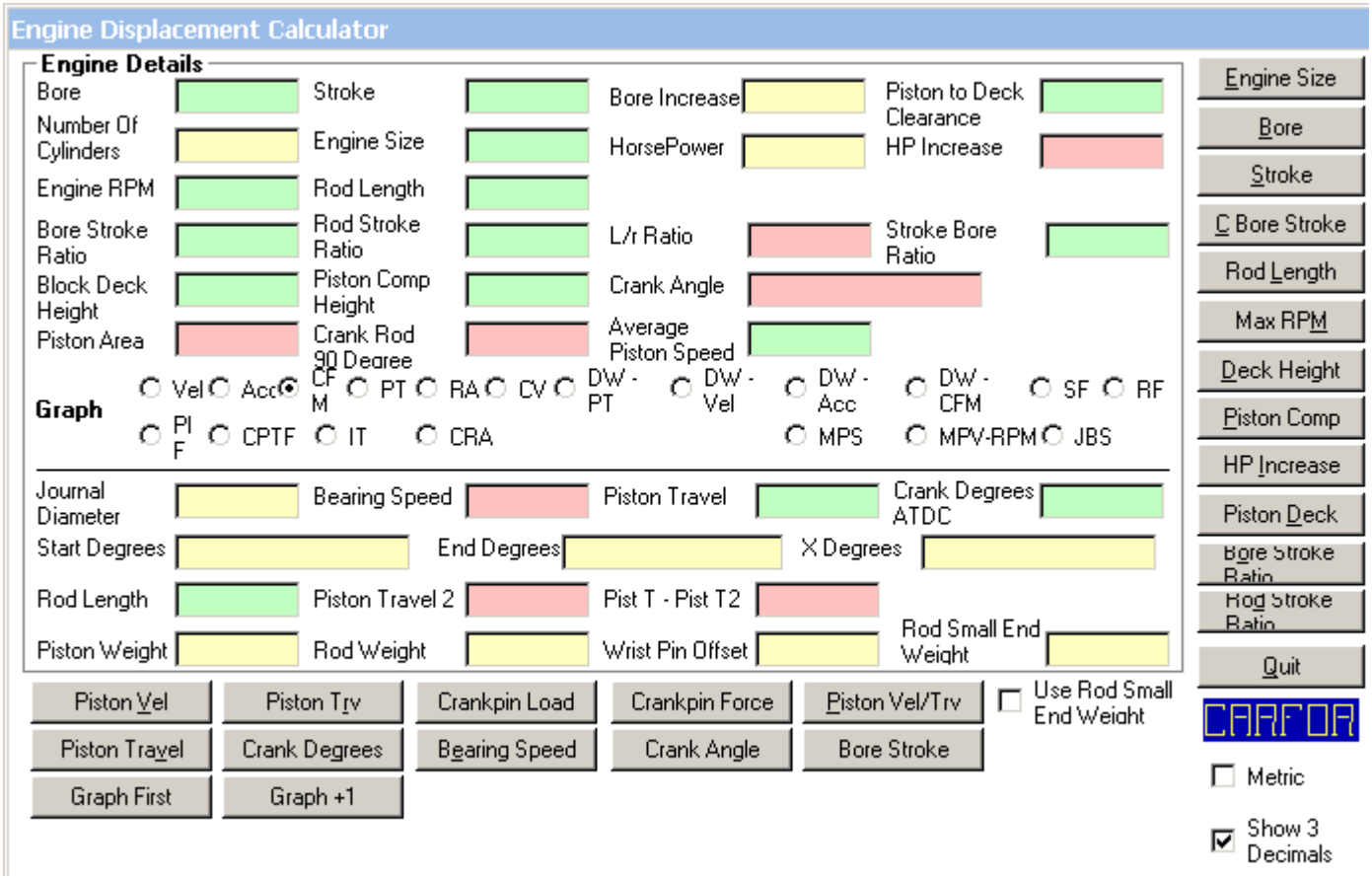
Edit Parameter File Notes Lets the User Add / Update Notes that are save in the CARFOR.PRM file.
The **Use Large Screen Resolution** Mode can only be toddled ON while the program is running. If a change is made to the use Large Screen Resolution, this will also be (written) saved to the parameter file. The Use Large Screen Resolution Mode will be reloaded when that parameter file is Read in (Opened) or if a "CARFOR.LRG" file is present in the same folder as the program, the program will when loading automatically set itself into Large Screen mode. What is Large Screen Resolution Mode? Since the program is developed for 800 by 600 screen resolution when run on monitors that are set to a much higher resolutions the forms will be small and only fill a small area on the screen and maybe hard to read. This function will examine the users system and makes better use the available screen area by enlarging the forms as well as the fonts.

The **Use Full Screen Resolution** Mode can only be toddled ON while the program is running. If a change is made to the use Full Screen Resolution, this will also be (written) saved to the parameter file. The Use Full Screen Resolution Mode will be reloaded when that parameter file is Read in (Opened) or if a "CARFOR.FUL" file is present in the same folder as the program, the program will when loading automatically set itself into Full Screen Mode. How does Full Screen Mode differ from Large Screen Resolution Mode? Since the program is developed for 800 by 600 screen resolution when run on monitors that are set to a much higher resolutions the forms will be small and only fill a small area on the screen and maybe hard to read. This function will examine the users system and makes better use the available screen area by enlarging the forms as well as the fonts to fill the screen where the Large Screen Resolution Mode enlarges all forms by the same percentage increase.

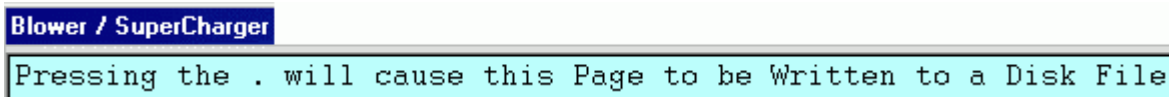
Show Screen Resolution is just a quick way for you to see what resolution the monitor is set to and what dpi the fonts are set to. If you have a problem I may ask for this information.

User Logo On Graphs - Lets the User load his own Logo for display on all of the Graphs that the program produces. The user can than drag the Logo to any position on each Graph where they want it to appear. The Logo must be in "BMP" format and will not be scaled or resized.

Clear All Data Fields on All Forms – Lets the User Clear the data fields on All forms so that a Blank form can be printed.

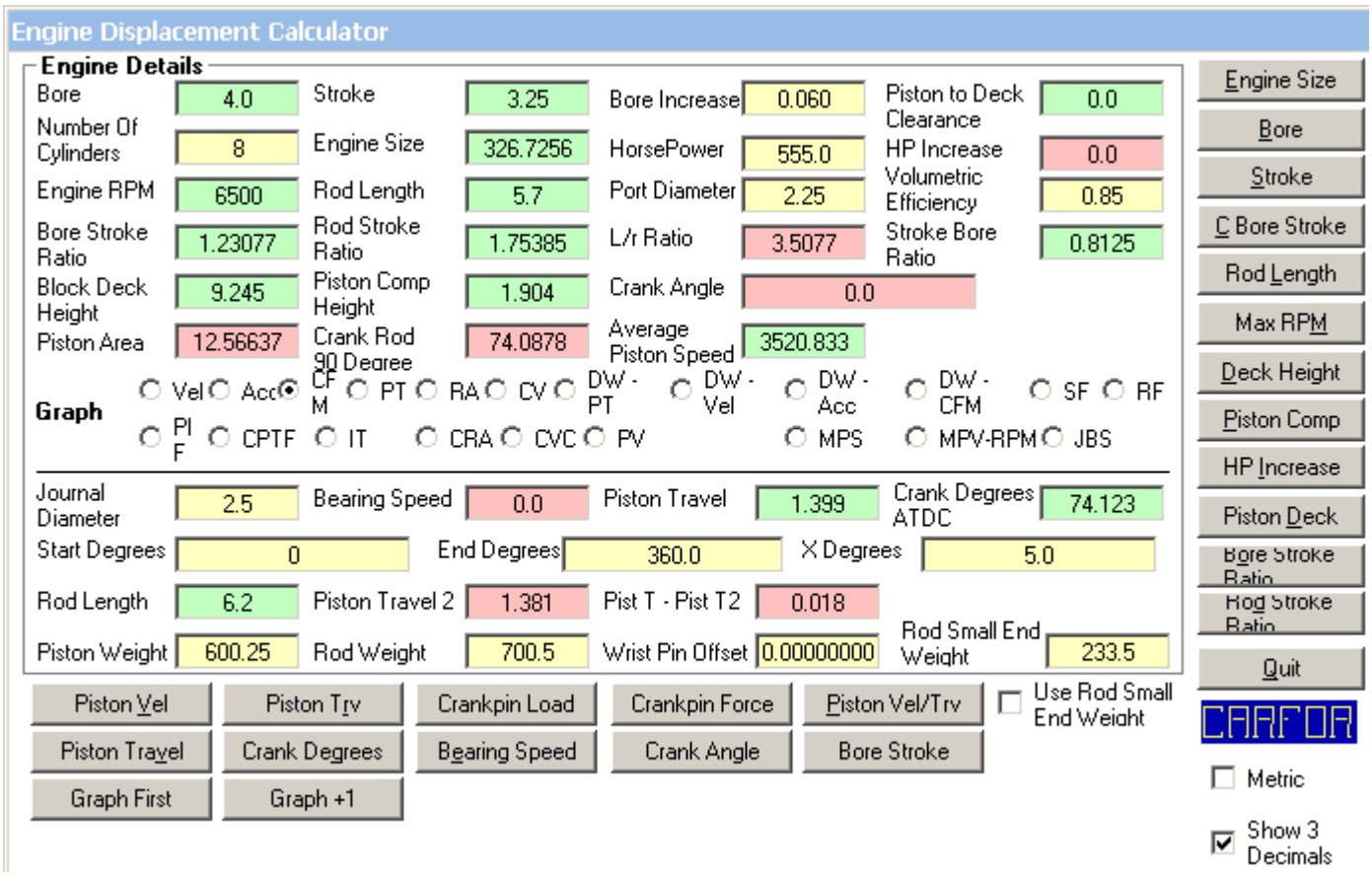


All data files that are written by the program are in ASCII and you can use NotePad, WordPad or any text editor to look at them. These would be both .PRM and .PRT files. Most of the Large BLUE text output fields have an option which lets you press the "." (Period) key and the program will write that information to a Disk file (.PRT). If when you press a key, you hear a bell sound from your computer and nothing happens take your mouse and click anywhere on that page and then hit your key again.



Note: – There maybe times that a report generates more data than can be displayed on the screen. The program does generated all of the data and if you save the data to a "PRT" file and open that "PRT" file with Windows Notepad you will be able to see all of that data.

Quit / Exit the program by clicking on **File** and then **Exit**.



C I – Engine Displacement

Calculate Engine Displacement from Bore and Stroke. Calculate Bore and / or Stroke for required displacement. See how changes to bore and / or stroke changes Displacement, Bore Stroke Ratio, Rod Stroke ratio, Piston Speed, Piston Velocity, Piston Acceleration, Crank Rod Angle and Bore Rod Angle. Calculate any of these Block Deck Height, Piston Compression Height, and Piston to Deck Clearance.

1) Calculate Engine Displacement / Size in Cubic Inches from Bore, Stroke and number of cylinders.
2) Calculate Bore needed from Cubic Inches, Stroke and number of cylinders.
3) Calculate Stroke needed from Cubic Inches, Bore and number of cylinders.
4) Calculate Bore and Stroke needed from cubic inches, Bore Stroke Ratio, and number of cylinders.
5) Calculate Bore and Stroke needed from cubic inches, Stroke Bore Ratio, and number of cylinders.
6) Calculate Rod Length needed from Stroke, and Rod Stroke ratio.
7) Calculate Max RPM from Stroke, and average piston speed.
8) Calculate Block Deck Height from Stroke, Rod Length, Piston Comp Height, and Piston to Deck Clearance.
9) Calculate Piston Comp Height from Stroke, Rod Length, Block Deck Height, and Piston to Deck Clearance.
10) Estimate the Horsepower gain from increasing the Bore and keeping the Cubic Inches and Rod stroke Ratio the same.
11) Calculate Piston to Deck Clearance from Stroke, Rod Length, Block Deck Height, and Piston Comp Height.
12) Calculate Piston Speed, Piston Acceleration and Velocity, showing result ever X Crankshaft degrees. Also will show at what Crankshaft degrees the Rod and Crank are at 90 degrees to each other. Using Bore, Stroke, RPM, Wrist Pin Offset, and Rod Length. This also shows piston flow @ 28 inches of water to give you an idea of what cylinder head flow should be at various RPMs. Head flow because of the inertia of air mass, these numbers will shift towards BDC as RPMs rise.

13) Calculate Piston Travel, Crank Rod Angle, Rod Bore Angle, and Cylinder Volume in both CI and cc, showing results every "X" Crankshaft degrees. Also will show at what Crankshaft degrees the Rod and Crank are at 90 degrees to each other. Using Bore, Stroke, RPM, Wrist Pin Offset, and Rod Length.
14) Calculate Crankpin Load, showing result ever X Crankshaft Degrees. Using Bore, Stroke, RPM, Rod Length, Piston Weight, Wrist Pin Offset, and Rod Weight.
15) Calculate Crankpin Force, showing result ever X Crankshaft Degrees. Using Bore, Stroke, RPM, Rod Length, Piston Weight, Wrist Pin Offset, and Rod Weight.

Note: Piston and Rod weights must be entered in grams. Piston weight includes the weight of rings, wrist pin, and any pin locks or buttons. If the Use Rod Small End Weight box is checked the user will enter that amount, else the program will use 1/3 of the Rod weight for the small end weight.

16) Calculate Piston Travel / Distance Piston has moved down the bore, using Stroke, Rod Length, Wrist Pin Offset and Crank Degrees Rotation from TDC.
17) Calculate Crank Degrees Rotation from TDC, using Stroke, Rod Length, Wrist Pin Offset and Piston Travel / Distance Piston is down the bore.
18) Calculate Piston Travel, Piston Acceleration and Velocity, (Degree Wheel) showing result ever X Degrees. Using Bore, Stroke, Wrist Pin Offset, RPM, and Rod Length. This also shows piston flow @ 28 inches of water to give you an idea of what cylinder head flow should be. This will show the same valves as 12 & 13 as long as wrist pin offset is equal to zero. When there is a wrist pin offset this will use the piston ATDC for zero degrees whereas 12 & 13 use the rod journal position.
19) Calculate Bore Stroke Ratio and Stroke Bore Ratio from Bore, Stroke and Rod Length.
20) Calculate Rod Stroke Ratio from Stroke and Rod Length.
21) Calculate Bearing Speed from Journal Diameter and RPM.
22) Calculate Crank Angle at which Piston and Crank Speed are the same using Rod Length and Stroke.
23) Graph First will set up the X-Axis and Y-Axis ranges and Produce a graph based on the selected option.
24) Graph +1 will add another Graph line to the present Graph; this will produce good results if the same option is selected.

Graph Options:

Vel - Piston Velocity on Y-Axis, 0 to 360 Degrees on X-Axis.
Acc - Piston Acceleration on Y-Axis, 0 to 360 Degrees on X-Axis.
CFM - Piston Flow CFM @ 28 Inches of Water on Y-Axis, 0 to 180 Degrees on X-Axis.
PT - Piston Travel on Y-Axis, 0 to 360 Degrees on X-Axis.
RA - Rod Angle On Y-Axis, 0 to 180 Degrees on X-Axis.
CV - Cylinder Volume on Y-Axis, 0 to 360 Degrees on X-Axis
DW- PT - Using Piston TDC / DW Graph Piston Travel on Y-Axis, 0 to 360 Degrees on X-Axis.
DW – Vel – Using Piston TDC / DW Graph Piston Velocity on Y-Axis, 0 to 360 Degrees on X-Axis.
DW – Acc – using Piston TDC / DW Graph Piston Acceleration on Y-Axis, 0 to 360 Degrees on X-Axis.
DW – CFM - Using Piston TDC / DW Graph Piston Flow CFM @ 28 Inches of Water on Y-Axis, 0 to 180 Degrees on X-Axis.
SF - Side Force, Bore, Stroke, RPM, Rod Length, Piston Weight (this includes the weight of the rings, wrist pin, and any locks or buttons), Wrist Pin Offset, and Rod Weight.
RF – Reciprocating Forces, Bore, Stroke, RPM, Rod Length, Piston Weight (this includes the weight of the rings, wrist pin, and any locks or buttons), Wrist Pin Offset, and Rod Weight.
PIF – Piston Inertia Forces – Positive numbers are Tension and Negative numbers are Compression
CPTF - Crank Pin Tangent Force
IT - Instantaneous Torque
CRA - Crank Rod Angle
CVC - Cylinder Volume Change cc's. Using Bore, Stroke, Wrist Pin Offset, Rod Length.
PV - Piston Demand - Port Velocity. Using Bore, Stroke, Wrist Pin Offset, Rod Length, RPM, Port Diameter and Volumetric Efficiency.
MPS - Mean Piston Speed, Stroke and RPM.
MPV-RPM - Max. Piston Speed, Stroke, RPM, Rod Length and Wrist pin Offset.
JBS - Bearing Speed, Journal Diameter and RPM.

Note: Check each Calculation to see if it uses Wrist Pin Offset. All other calculations are based on **NO** piston pin offset (pin is centered in the piston). **Pin offset toward the Major Thrust is entered as a positive value and pin offset toward the Minor Thrust is entered as a (-) negative value.**

Note: Ever X Crankshaft Degrees can be what ever the user wants examples: 10.0, 1.0, 0.1, 0.00001 in most cases the program will not generate more than 720 lines. What this means is that the user must match his "Ever X" value with his start and end degrees.

Crank Angle - Is the rotational angle of the rod journal centerline from the bore centerline, with 0 and 360 being TDC and 180 being BDC.

Rod Angle - Is the angle formed by the bore centerline and the rod centerline.

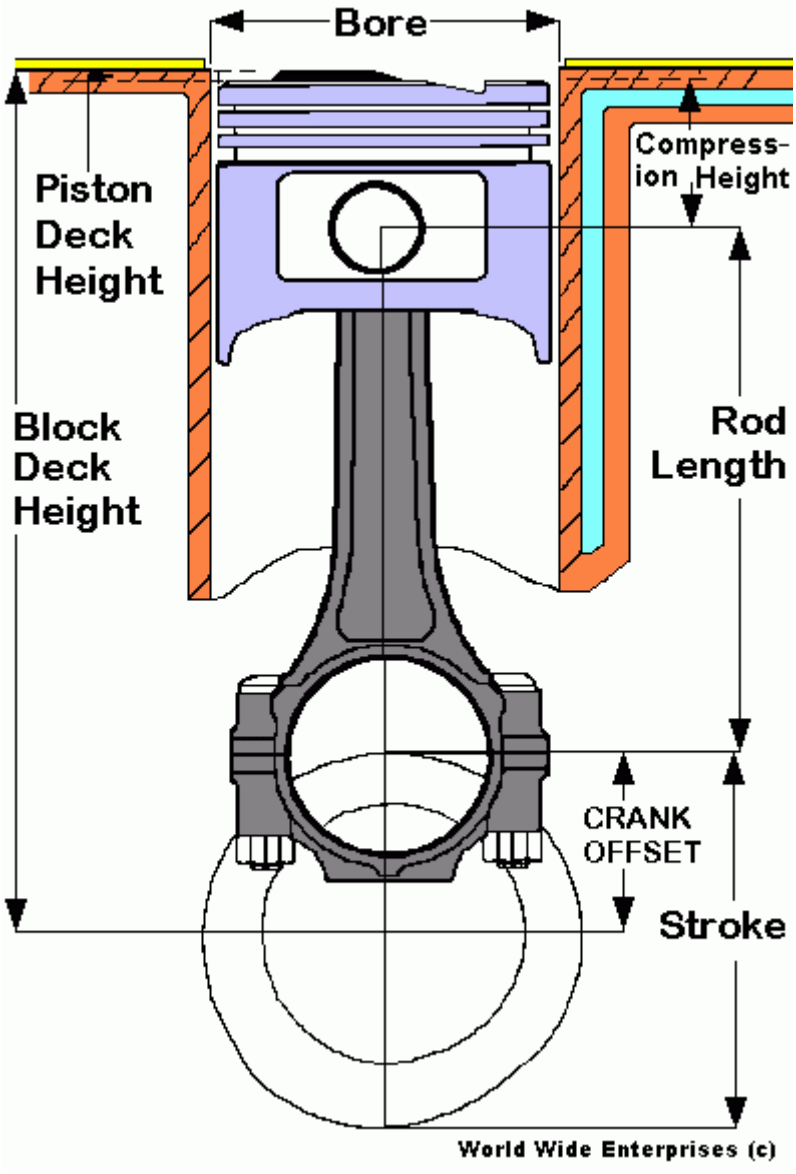
Crank Rod Angle - Is formed by the rod centerline and a line drawn from the rod journal center to the crankshaft centerline.

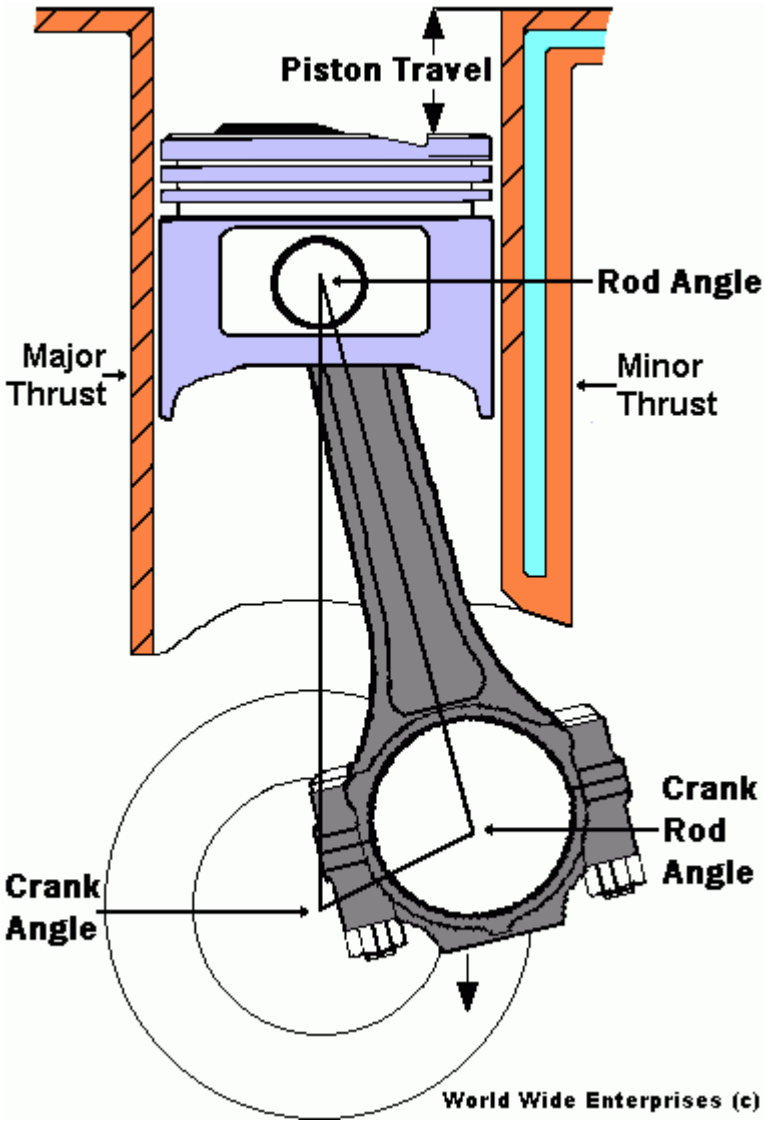
Piston Travel - Is the distance the piston has traveled from where it was at TDC.

Cylinder Volume - Is the volume above the piston, calculated using the bore and the distance the piston traveled as the stroke.

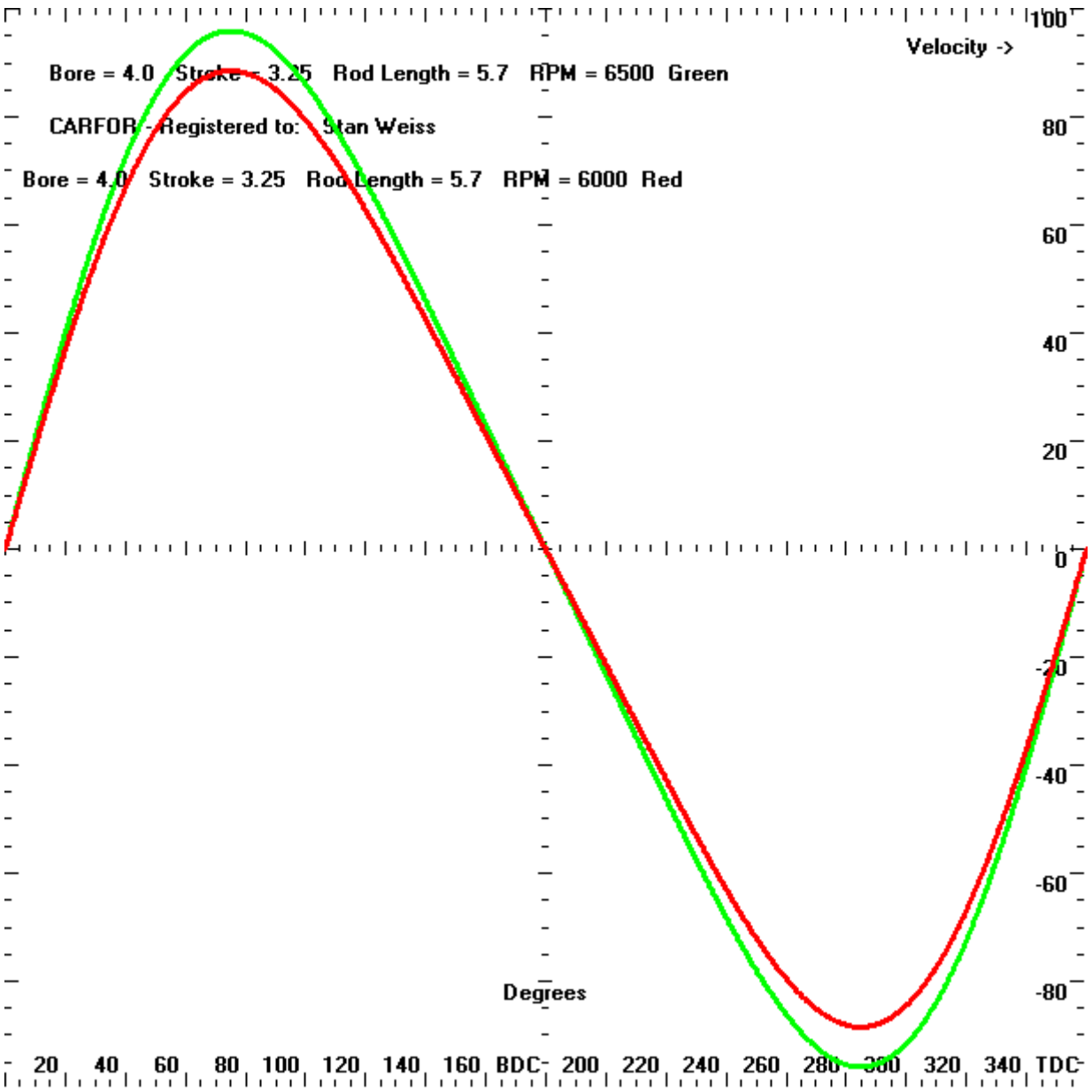
Remember piston speed is and average for your stroke and RPM. Your piston velocity and acceleration will change and at some point in the cycle each will be zero. Also as your rod stroke ratio changes your max. Velocity and acceleration will change, but your piston speed will not for the same stroke and RPM. Your piston velocity starts at 0 at TDC, it will be at its max. Around the point the crank and rod are at 90 degrees, which for a 3.25" stroke and 5.7" rod is around 74 degree ATDC.

Wrist Pin / Crankshaft Centerline Offset – The crank centerline is moved in the opposite direct as you would move the wrist pin to get the same results. In the 2 examples below we are at TDC is the wrist pin offset or is the crank centerline offset? In both of the examples below it can be either which is offset.

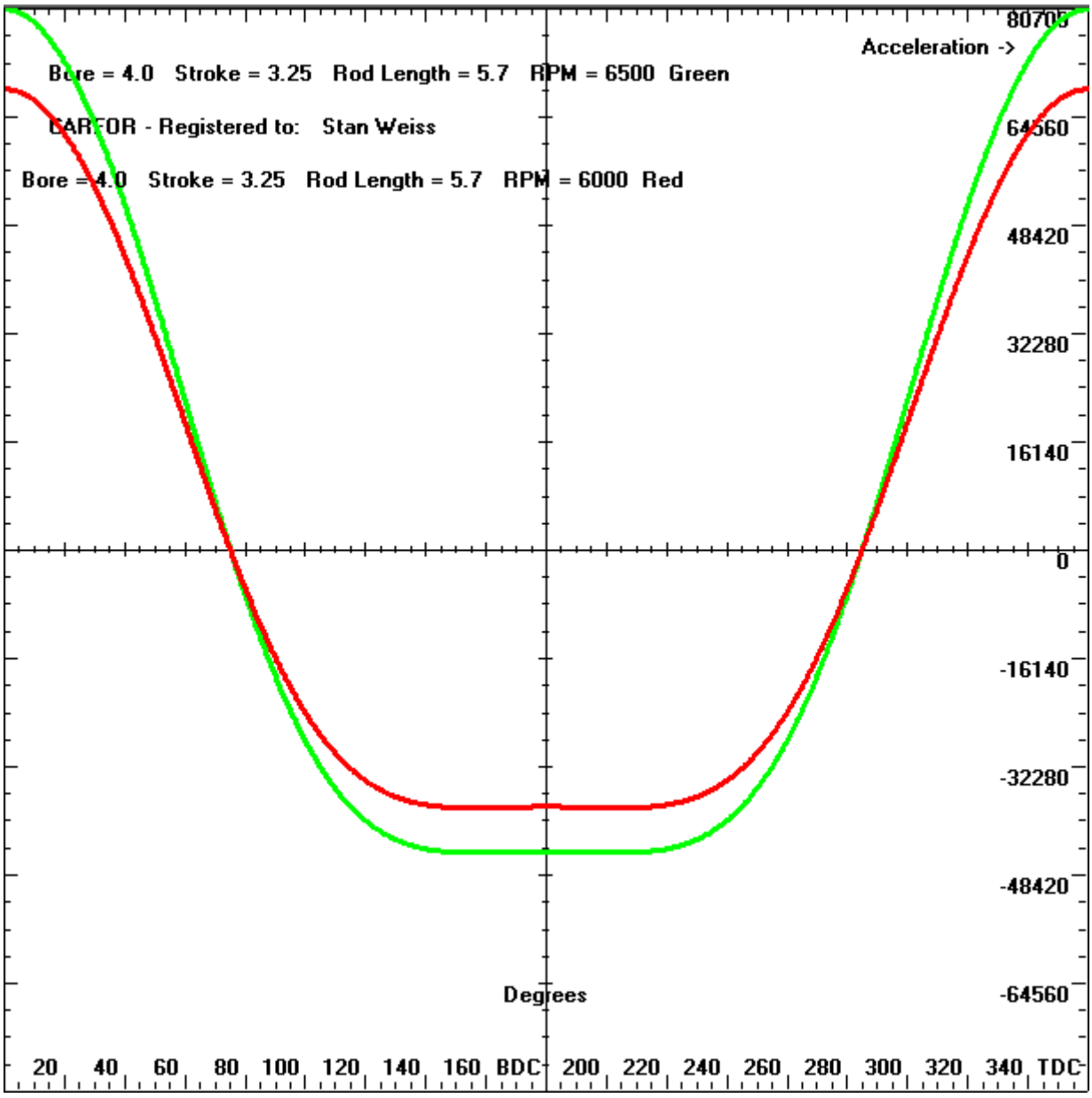

Bore
Piston
Deck
Height
Compress-
ion Height
Block
Deck
Height
Rod
Length
CRANK
OFFSET
Stroke
World Wide Enterprises (c)


Piston Travel
Rod Angle
Major Thrust
Minor Thrust
Crank Rod Angle
Crank Angle
World Wide Enterprises (c)

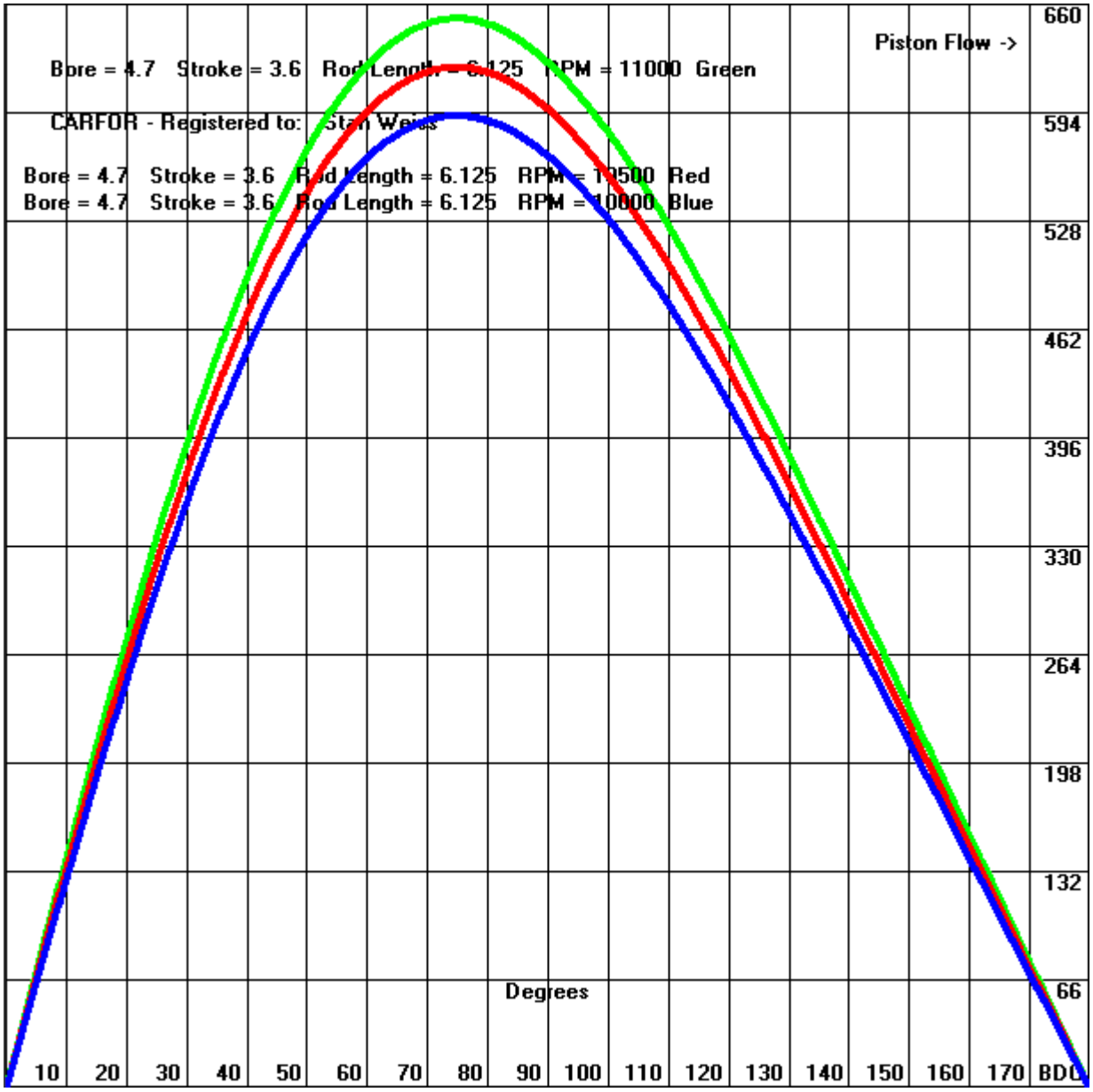
Graph Piston Velocity at various RPMs.



Graph Piston Acceleration at various RPMs.



Graph Piston Flow @ 28 inches of water to give you an idea of what cylinder head flow should be at various RPMs.



Calculate **Piston Speed, Piston Acceleration and Velocity,** showing result ever X Crankshaft degrees. Also will show at what Crankshaft degrees the Rod and Crank are at 90 degrees to each other. Using Bore, Stroke, RPM, Wrist Pin Offset, and Rod Length. This also shows **Piston Flow @ 28 inches of water** to give you an idea of what cylinder head flow should be at various RPMs.

Bore = 4.0 Stroke = 3.25 Rod Length = 5.7 RPM = 6500
Wrist Pin Offset = 0.0
Piston Speed is 58.68056 Feet per Second 17.88583 Meters per Second
Piston Speed is 3520.83333 Feet per Minute 1073.15000 Meters per Minute
Piston Speed is 40.00947 MPH 64.38900 KiloMeters per Hour
Maximum Piston Velocity 5752.115743 FPM @ 75.162557036658 Degrees
Crankshaft Degrees at which Rod and Crank are 90 Degrees 74.0878
Piston Travel from TDC 1.39789 Inches 35.50642 mm
Bore Rod Angle 15.91220
Cylinder Volume 17.56641 CI 287.86192 cc

Crank Angle Degree-ATDC	Piston Velocity FT/Sec	Piston Acceleration FT/Sec/Sec	Piston Flow @ 28" CFM
0.00000000000	0.000000000000	80628.548553667500	.00
5.00000000000	10.315867690807	80134.464948046500	27.01
10.00000000000	20.505378138588	78659.956035034300	53.68
15.00000000000	30.444158841160	76228.238574501200	79.70
20.00000000000	40.011803888645	72877.963436680800	104.75
25.00000000000	49.093846489134	68663.101742119000	128.53
30.00000000000	57.583708739360	63652.690453272700	150.75
35.00000000000	65.384605040876	57930.346895610100	171.18
40.00000000000	72.411362768862	51593.444420471300	189.57
45.00000000000	78.592109373199	44751.833945225200	205.75
50.00000000000	83.869760587523	37526.003222769100	219.57
55.00000000000	88.203232025189	30044.592171952000	230.92
60.00000000000	91.568288870047	22441.231733542600	239.73
65.00000000000	93.957948572782	14850.745473223300	245.98
70.00000000000	95.382362074328	7404.842410519590	249.71
75.00000000000	95.868121688176	227.525119967166	250.98
80.00000000000	95.456978174327	-6569.477594172750	249.91
85.00000000000	94.203993176859	-12890.888497927400	246.63
90.00000000000	92.175201120951	-18661.296480595500	241.31
95.00000000000	89.444900127604	-23827.482055444100	234.17
100.00000000000	86.092727224416	-28359.430628537700	225.39
105.00000000000	82.200692924054	-32249.952691521200	215.20
110.00000000000	77.850350551301	-35512.986961509500	203.81
115.00000000000	73.120256522391	-38180.804863331400	191.43
120.00000000000	68.083842669319	-40300.437448150900	178.24
125.00000000000	62.807776836762	-41929.693867952100	164.43
130.00000000000	57.350840636633	-43133.131899319700	150.14
135.00000000000	51.763310166517	-43978.285537451800	135.52
140.00000000000	46.086791632962	-44532.369636819800	120.65
145.00000000000	40.354441716916	-44859.586248965600	105.65
150.00000000000	34.591492381591	-45019.068321098900	90.56
155.00000000000	28.816000057537	-45063.424959973500	75.44
160.00000000000	23.039747108275	-45037.803654975300	60.32
165.00000000000	17.269236231355	-44979.358719664200	45.21
170.00000000000	11.506733262883	-44917.008459083500	30.12
175.00000000000	5.751328542416	-44871.371428412200	15.06
180.00000000000	0.000000000000	-44854.789809719500	.00

Bore = 101.6 Stroke = 82.55 Rod Length = 144.78 RPM = 6500
Wrist Pin Offset = 0.0
Piston Speed is 58.68056 Feet per Second 17.88583 Meters per Second
Piston Speed is 3520.83333 Feet per Minute 1073.15000 Meters per Minute
Piston Speed is 40.00947 MPH 64.38900 KiloMeters per Hour
Maximum Piston Velocity 1753.244879 MPM @ 75.162557036658 Degrees
Crankshaft Degrees at which Rod and Crank are 90 Degrees 74.0878
Piston Travel from TDC 1.39789 Inches 35.50642 mm
Bore Rod Angle 15.91220
Cylinder Volume 17.56641 CI 287.86192 cc

Crank Angle Degree-ATDC	Piston Velocity M/Sec	Piston Acceleration M/Sec/Sec	Piston Flow @ 28" M^3/S
0.00000000000	0.000000000000	24575.581599157900	0.00000
5.00000000000	3.144276472158	24424.984916164600	0.01275
10.00000000000	6.250039256642	23975.554599478400	0.02534
15.00000000000	9.279379614786	23234.367117508000	0.03762
20.00000000000	12.195597825259	22213.203255500300	0.04944
25.00000000000	14.963804409888	20928.513410997900	0.06066
30.00000000000	17.551514423757	19401.340050157500	0.07115
35.00000000000	19.929227616459	17657.169733782000	0.08079
40.00000000000	22.070983371949	15725.681859359600	0.08947
45.00000000000	23.954874936951	13640.358986504700	0.09710
50.00000000000	25.563503027077	11437.925782300000	0.10363
55.00000000000	26.884345121278	9157.591694010960	0.10898
60.00000000000	27.910014447590	6840.087432383790	0.11314
65.00000000000	28.638382724984	4526.507220238450	0.11609
70.00000000000	29.072543960255	2256.995966726370	0.11785
75.00000000000	29.220603490556	69.349656565992	0.11845
80.00000000000	29.095286947535	-2002.376770703860	0.11794
85.00000000000	28.713377120307	-3929.142814168280	0.11639
90.00000000000	28.095001301666	-5687.963167285500	0.11389
95.00000000000	27.262805558894	-7262.616530499370	0.11051
100.00000000000	26.241063258002	-8643.954455578300	0.10637
105.00000000000	25.054771203252	-9829.785580375660	0.10156
110.00000000000	23.728786848036	-10824.358425868100	0.09619
115.00000000000	22.287054188025	-11637.509322343400	0.09034
120.00000000000	20.751955245608	-12283.573334196400	0.08412
125.00000000000	19.143810379845	-12780.170690951800	0.07760
130.00000000000	17.480536226046	-13146.978602912700	0.07086
135.00000000000	15.777456938754	-13404.581431815300	0.06396
140.00000000000	14.047254089727	-13573.466265302700	0.05694
145.00000000000	12.300033835316	-13673.201888684700	0.04986
150.00000000000	10.543486877909	-13721.812024270900	0.04274
155.00000000000	8.783116817537	-13735.331927799900	0.03560
160.00000000000	7.022514918602	-13727.522554036500	0.02847
165.00000000000	5.263663203317	-13709.708537753600	0.02134
170.00000000000	3.507252298527	-13690.704178328700	0.01422
175.00000000000	1.753004939728	-13676.794011380000	0.00711
180.00000000000	0.000000000000	-13671.739934002500	0.00000

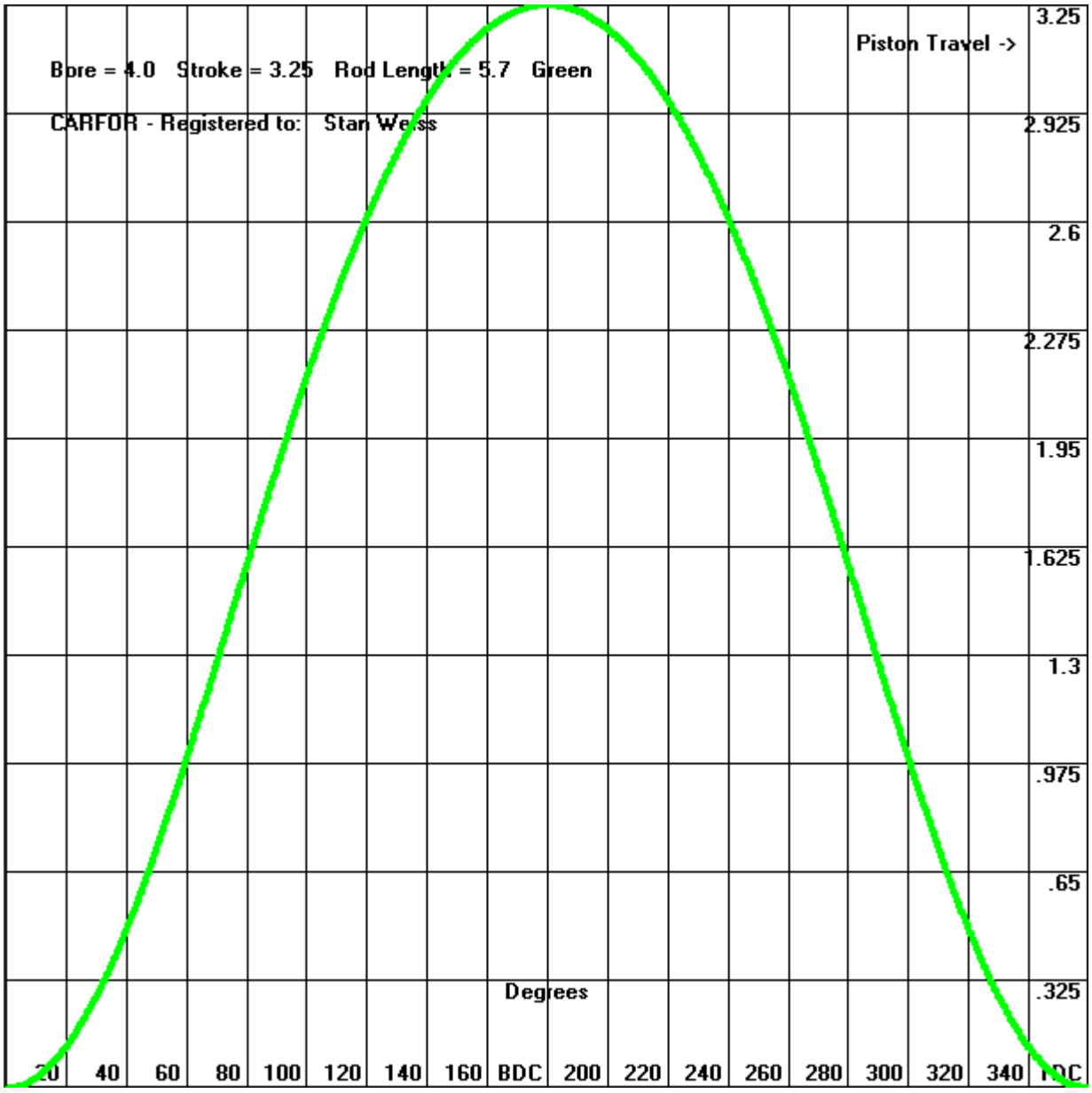
Bore = 4.0 Stroke = 3.25 Rod Length = 5.7 RPM = 6500
Wrist Pin Offset = 0.06
Maximum Piston Velocity 5769.254254 FPM @ 74.65877582351 Degrees

Crank Angle Degree	Piston Velocity FT/Sec	Piston Acceleration FT/Sec/Sec	Flow @ 28" CFM
.000	.970	80631.522	2.54
5.000	11.284	80093.743	29.54
10.000	21.465	78574.984	56.20
15.000	31.390	76098.008	82.18
20.000	40.938	72701.091	107.18
25.000	49.994	68437.948	130.89
30.000	58.452	63377.518	153.03
35.000	66.215	57603.515	173.35
40.000	73.196	51213.644	191.63
45.000	79.325	44318.339	207.67
50.000	84.543	37038.934	221.33
55.000	88.811	29505.170	232.51
60.000	92.104	21851.998	241.13
65.000	94.415	14215.716	247.18
70.000	95.755	6729.576	250.69
75.000	96.152	-480.918	251.73
80.000	95.648	-7302.699	250.41
85.000	94.300	-13639.432	246.88
90.000	92.175	-19415.025	241.31
95.000	89.348	-24576.025	233.91
100.000	85.901	-29092.652	224.89
105.000	81.917	-32958.396	214.46
110.000	77.478	-36188.253	202.84
115.000	72.663	-38815.835	190.23
120.000	67.548	-40889.672	176.84
125.000	62.200	-42469.116	162.84
130.000	56.677	-43620.202	148.38
135.000	51.031	-44411.781	133.60
140.000	45.302	-44912.170	118.60
145.000	39.524	-45186.418	103.47
150.000	33.723	-45294.241	88.29
155.000	27.915	-45288.578	73.08
160.000	22.113	-45214.676	57.89
165.000	16.323	-45109.589	42.73
170.000	10.547	-45001.981	27.61
175.000	4.783	-44912.094	12.52
180.000	-.970	-44851.817	-2.54
185.000	-6.718	-44824.766	-17.59
345.000	-29.500	76363.844	-77.23
350.000	-19.547	78750.622	-51.17
355.000	-9.349	80181.071	-24.47
360.000	.970	80631.522	2.54

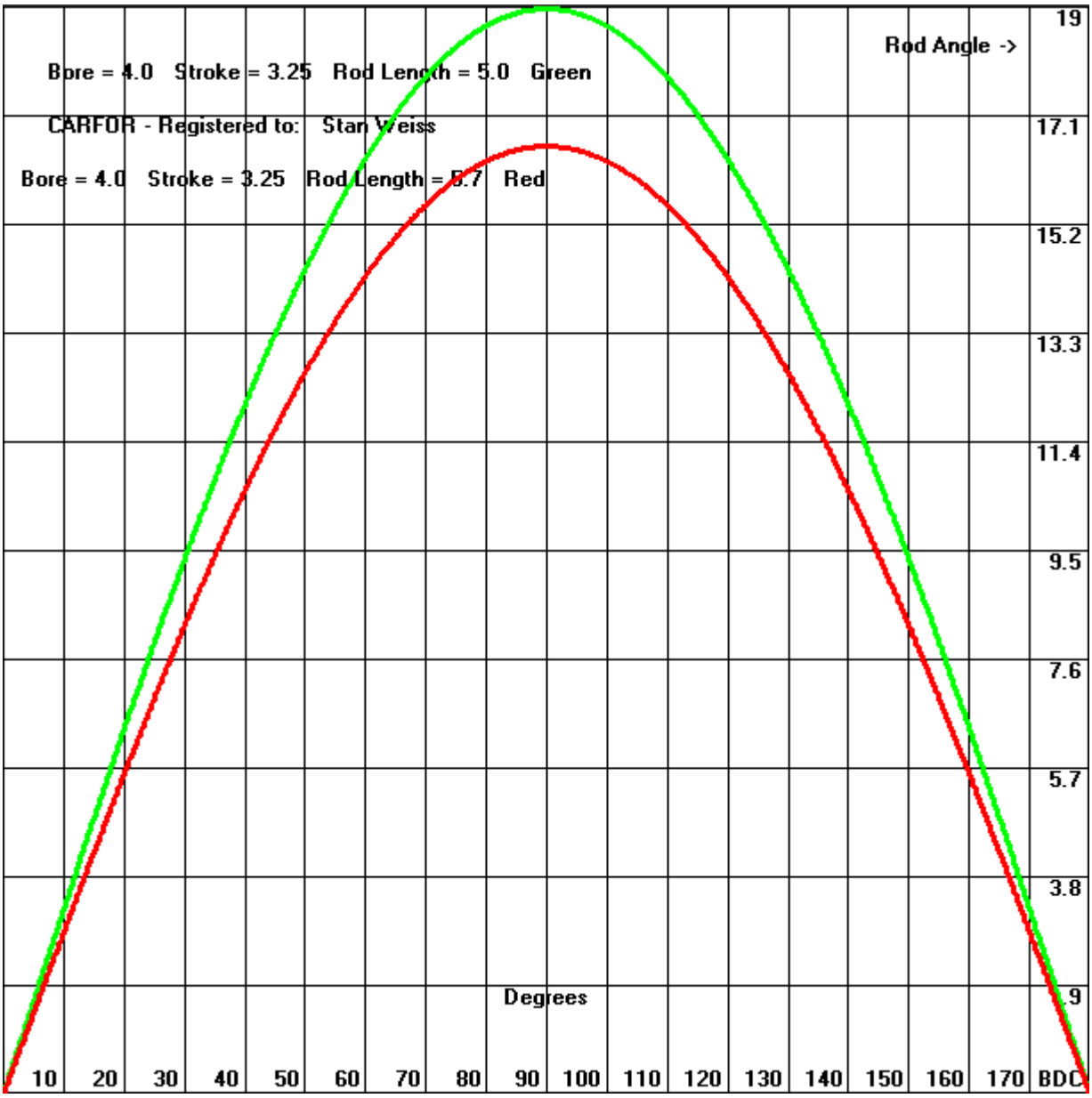
Bore = 4.0 Stroke = 3.25 Rod Length = 5.7 RPM = 6500
Wrist Pin Offset = -0.06
Maximum Piston Velocity on Down Stroke 5735.684153 FPM @ 75.66890445522 Degrees

Crank Angle Degree	Piston Velocity FT/Sec	Piston Acceleration FT/Sec/Sec	Piston Flow @ 28" CFM
.000	-.970	80631.522	-2.54
5.000	9.349	80181.071	24.47
10.000	19.547	78750.622	51.17
15.000	29.500	76363.844	77.23
20.000	39.088	73059.759	102.33
25.000	48.197	68892.593	126.18
30.000	56.719	63931.480	148.49
35.000	64.559	58259.942	169.02
40.000	71.631	51975.030	187.53
45.000	77.864	45186.028	203.85
50.000	83.201	38012.601	217.82
55.000	87.600	30582.324	229.34
60.000	91.037	23027.551	238.34
65.000	93.505	15481.684	244.80
70.000	95.013	8074.945	248.74
75.000	95.587	929.895	250.25
80.000	95.267	-5843.023	249.41
85.000	94.109	-12149.548	246.38
90.000	92.175	-17914.919	241.31
95.000	89.540	-23086.141	234.42
100.000	86.282	-27632.976	225.89
105.000	82.482	-31547.583	215.94
110.000	78.220	-34842.884	204.78
115.000	73.573	-37549.867	192.61
120.000	68.615	-39714.118	179.63
125.000	63.411	-41391.962	166.01
130.000	58.020	-42646.534	151.89
135.000	52.491	-43544.092	137.42
140.000	46.867	-44150.784	122.70
145.000	41.180	-44529.992	107.81
150.000	35.456	-44740.279	92.82
155.000	29.713	-44833.934	77.79
160.000	23.963	-44856.008	62.74
165.000	18.213	-44843.754	47.68
170.000	12.465	-44826.342	32.63
175.000	6.718	-44824.766	17.59
180.000	.970	-44851.817	2.54
185.000	-4.783	-44912.094	-12.52
190.000	-10.547	-45001.981	-27.61

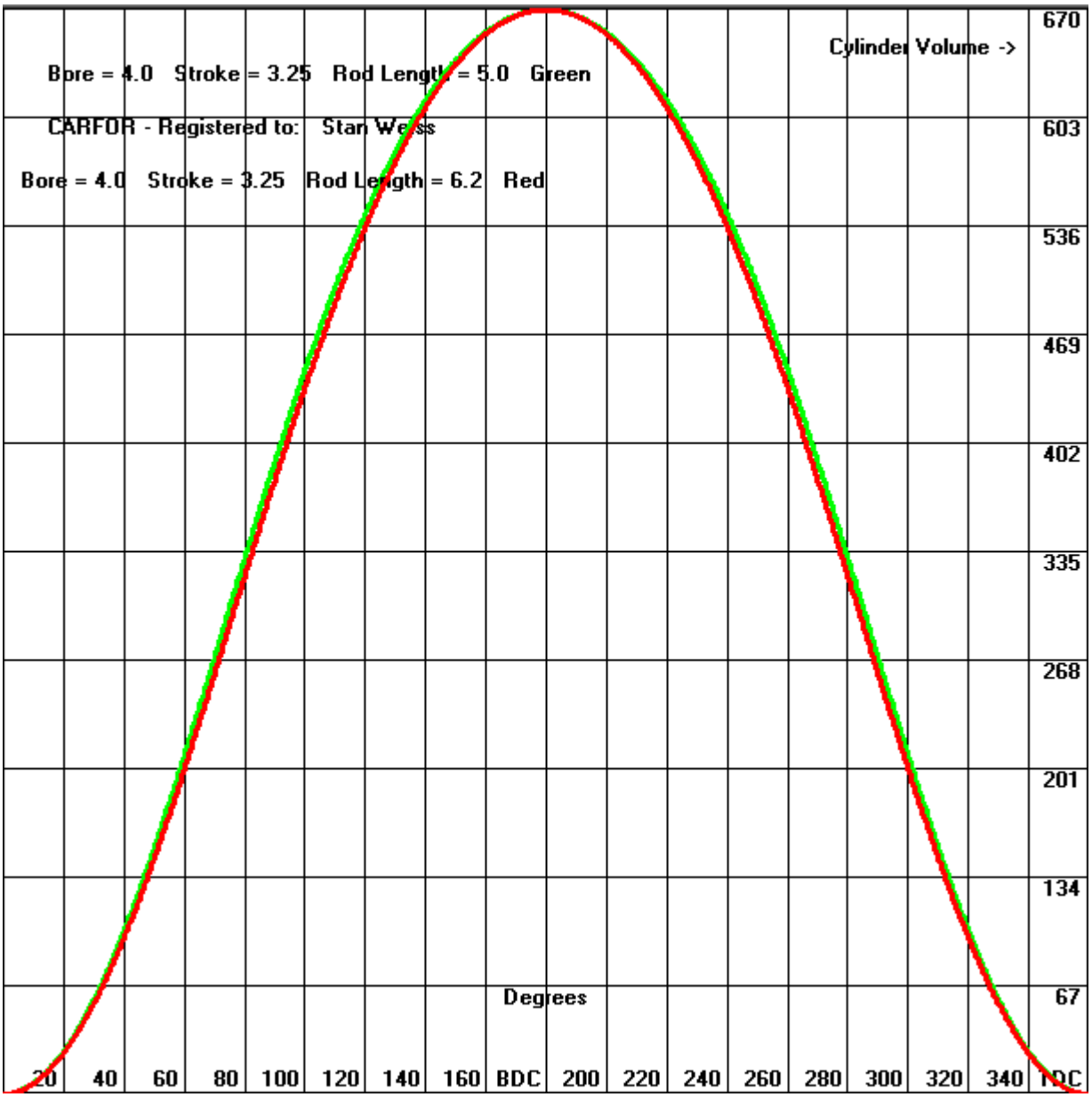
Graph Piston Travel



Graph Rod Bore Angle



Graph Cylinder Volume



Calculate **Piston Travel, Crank Rod Angle, Rod Bore Angle, and Cylinder Volume** in both CI and cc, showing results every "X" Crankshaft degrees. Also will show at what Crankshaft degrees the Rod and Crank are at 90 degrees to each other. Using Bore, Stroke, RPM, Wrist Pin Offset, and Rod Length.

Bore = 4.0 Stroke = 3.25 Rod Length = 5.7 RPM = 6500
Wrist Pin Offset = 0.0
Rotation Time of crank per degree in Milliseconds 0.0256410
Rotation Time of crank per rev in Milliseconds 9.2307692
Crankshaft rev's per Second 108.3333333
Crankshaft Degrees at which Rod and Crank are 90 Degrees 74.0878

Crank Angle Degree -ATDC	Piston Travel Inches	Crank Rod Angle	Rod Bore Angle	Cylinder Volume CI	Cylinder Volume cc
.0000	.000000	180.00000	0.00000	0.00000	0.00000
5.0000	.007943	173.57622	1.42378	0.09982	1.63575
10.0000	.031676	167.16241	2.83759	0.39806	6.52297
15.0000	.070908	160.76852	4.23148	0.89106	14.60184
20.0000	.125160	154.40444	5.59556	1.57281	25.77373
25.0000	.193772	148.08001	6.91999	2.43501	39.90274
30.0000	.275914	141.80492	8.19508	3.46724	56.81792
35.0000	.370599	135.58875	9.41125	4.65709	76.31603
40.0000	.476701	129.44083	10.55917	5.99040	98.16499
45.0000	.592970	123.37020	11.62980	7.45147	122.10780
50.0000	.718059	117.38552	12.61448	9.02340	147.86696
55.0000	.850546	111.49500	13.50500	10.68827	175.14944
60.0000	.988957	105.70626	14.29374	12.42760	203.65181
65.0000	1.131794	100.02621	14.97379	14.22254	233.06571
70.0000	1.277563	94.46096	15.53904	16.05433	263.08328
75.0000	1.424796	89.01572	15.98428	17.90452	293.40253
80.0000	1.572081	83.69463	16.30537	19.75536	323.73231
85.0000	1.718078	78.50075	16.49925	21.59001	353.79687
90.0000	1.861542	73.43591	16.56409	23.39282	383.33972
95.0000	2.001335	68.50075	16.49925	25.14951	412.12666
100.0000	2.136438	63.69463	16.30537	26.84727	439.94796
105.0000	2.265958	59.01572	15.98428	28.47487	466.61957
110.0000	2.389128	54.46096	15.53904	30.02267	491.98342
115.0000	2.505303	50.02621	14.97379	31.48257	515.90688
120.0000	2.613957	45.70626	14.29374	32.84795	538.28143
125.0000	2.714669	41.49500	13.50500	34.11354	559.02076
130.0000	2.807119	37.38552	12.61448	35.27529	578.05851
135.0000	2.891067	33.37020	11.62980	36.33021	595.34554
140.0000	2.966345	29.44083	10.55917	37.27619	610.84732
145.0000	3.032844	25.58875	9.41125	38.11184	624.54110
150.0000	3.090497	21.80492	8.19508	38.83633	636.41342
155.0000	3.139273	18.08001	6.91999	39.44926	646.45760
160.0000	3.179161	14.40444	5.59556	39.95052	654.67170
165.0000	3.210167	10.76852	4.23148	40.34015	661.05663
170.0000	3.232301	7.16241	2.83759	40.61830	665.61466
175.0000	3.245576	3.57622	1.42378	40.78511	668.34826
180.0000	3.250000	0.00000	0.00000	40.84070	669.25924

Bore = 101.6 Stroke = 82.55 Rod Length = 144.78 RPM = 6500
Wrist Pin Offset = 0.0
Rotation Time of crank per degree in Milliseconds 0.0256410
Rotation Time of crank per rev in Milliseconds 9.2307692
Crankshaft rev's per Second 108.3333333
Crankshaft Degrees at which Rod and Crank are 90 Degrees 74.0878

Crank Angle Degree -ATDC	Piston Travel mm	Crank Rod Angle	Rod Bore Angle	Cylinder Volume CI	Cylinder Volume cc
.0000	.000000	180.00000	0.00000	0.00000	0.00000
5.0000	.201763	173.57622	1.42378	0.09982	1.63575
10.0000	.804578	167.16241	2.83759	0.39806	6.52297
15.0000	1.801069	160.76852	4.23148	0.89106	14.60184
20.0000	3.179069	154.40444	5.59556	1.57281	25.77373
25.0000	4.921817	148.08001	6.91999	2.43501	39.90274
30.0000	7.008224	141.80492	8.19508	3.46724	56.81792
35.0000	9.413226	135.58875	9.41125	4.65709	76.31603
40.0000	12.108193	129.44083	10.55917	5.99040	98.16499
45.0000	15.061426	123.37020	11.62980	7.45147	122.10780
50.0000	18.238699	117.38552	12.61448	9.02340	147.86696
55.0000	21.603864	111.49500	13.50500	10.68827	175.14944
60.0000	25.119499	105.70626	14.29374	12.42760	203.65181
65.0000	28.747566	100.02621	14.97379	14.22254	233.06571
70.0000	32.450094	94.46096	15.53904	16.05433	263.08328
75.0000	36.189831	89.01572	15.98428	17.90452	293.40253
80.0000	39.930867	83.69463	16.30537	19.75536	323.73231
85.0000	43.639191	78.50075	16.49925	21.59001	353.79687
90.0000	47.283163	73.43591	16.56409	23.39282	383.33972
95.0000	50.833897	68.50075	16.49925	25.14951	412.12666
100.0000	54.265525	63.69463	16.30537	26.84727	439.94796
105.0000	57.555343	59.01572	15.98428	28.47487	466.61957
110.0000	60.683856	54.46096	15.53904	30.02267	491.98342
115.0000	63.634703	50.02621	14.97379	31.48257	515.90688
120.0000	66.394499	45.70626	14.29374	32.84795	538.28143
125.0000	68.952599	41.49500	13.50500	34.11354	559.02076
130.0000	71.300816	37.38552	12.61448	35.27529	578.05851
135.0000	73.433091	33.37020	11.62980	36.33021	595.34554
140.0000	75.345162	29.44083	10.55917	37.27619	610.84732
145.0000	77.034227	25.58875	9.41125	38.11184	624.54110
150.0000	78.498621	21.80492	8.19508	38.83633	636.41342
155.0000	79.737525	18.08001	6.91999	39.44926	646.45760
160.0000	80.750695	14.40444	5.59556	39.95052	654.67170
165.0000	81.538246	10.76852	4.23148	40.34015	661.05663
170.0000	82.100458	7.16241	2.83759	40.61830	665.61466
175.0000	82.437635	3.57622	1.42378	40.78511	668.34826
180.0000	82.550000	0.00000	0.00000	40.84070	669.25924

Bore = 4.0 Stroke = 3.25 Rod Length = 5.7 RPM = 6500
Wrist Pin Offset = 0.06
Rotation Time of crank per degree in Milliseconds 0.0256410
Rotation Time of crank per rev in Milliseconds 9.2307692
Crankshaft rev's per Second 108.3333333
Actual Piston Stroke 3.25019600382
Cylinder Volume 40.843168 CI 669.299602 cc
Engine Size 326.745340 CI 5354.396814 cc
Crank Angle Piston TDC -0.46932221356 Piston BDC 179.15635067565

Crank Angle Degree	Piston Travel Inches	Rod Angle	Cylinder Volume CI	Cylinder Volume cc
0.000000000	0.00007006031	0.60312	0.00088	0.01443
5.000000000	0.00950512407	2.02717	0.11944	1.95735
10.000000000	0.03472163354	3.44161	0.43632	7.15008
15.000000000	0.07542040487	4.83649	0.94776	15.53102
20.000000000	0.13111351188	6.20188	1.64762	26.99967
25.000000000	0.20113183435	7.52794	2.52750	41.41826
30.000000000	0.28463564913	8.80489	3.57684	58.61386
35.000000000	0.38062822028	10.02314	4.78312	78.38122
40.000000000	0.48797229827	11.17330	6.13204	100.48614
45.000000000	0.60540937015	12.24625	7.60780	124.66948
50.000000000	0.73158141144	13.23327	9.19332	150.65158
55.000000000	0.86505477718	14.12608	10.87060	178.13720
60.000000000	1.00434573922	14.91700	12.62098	206.82082
65.000000000	1.14794704005	15.59903	14.42553	236.39205
70.000000000	1.29435470377	16.16600	16.26534	266.54118
75.000000000	1.44209424096	16.61265	18.12189	296.96458
80.000000000	1.58974532547	16.93478	19.97733	327.36977
85.000000000	1.73596402470	17.12931	21.81477	357.47999
90.000000000	1.87950174269	17.19436	23.61852	387.03813
95.000000000	2.01922018863	17.12931	25.37427	415.80977
100.000000000	2.15410190289	16.93478	27.06924	443.58542
105.000000000	2.28325613754	16.61265	28.69224	470.18162
110.000000000	2.40592016958	16.16600	30.23368	495.44132
115.000000000	2.52145639071	15.59903	31.68556	519.23323
120.000000000	2.62934573922	14.91700	33.04133	541.45044
125.000000000	2.72917819532	14.12608	34.29586	562.00853
130.000000000	2.82064114292	13.23327	35.44522	580.84312
135.000000000	2.90350640900	12.24625	36.48654	597.90723
140.000000000	2.97761673841	11.17330	37.41784	613.16847
145.000000000	3.04287236422	10.02314	38.23786	626.60629
150.000000000	3.09921821143	8.80489	38.94592	638.20936
155.000000000	3.14663214222	7.52794	39.54175	647.97312
160.000000000	3.18511452943	6.20188	40.02533	655.89764
165.000000000	3.21467934031	4.83649	40.39685	661.98580
170.000000000	3.23534683083	3.44161	40.65657	666.24177
175.000000000	3.24713789286	2.02717	40.80474	668.66986
180.000000000	3.25007006031	0.60312	40.84158	669.27367
185.000000000	3.24415516275	-0.82054	40.76726	668.05564
190.0	3.22939861126	-2.23388	40.58182	665.01688

Bore = 4.0 Stroke = 3.25 Rod Length = 5.7 RPM = 6500
Wrist Pin Offset = -0.06
Rotation Time of crank per degree in Milliseconds 0.0256410
Rotation Time of crank per rev in Milliseconds 9.2307692
Crankshaft rev's per Second 108.3333333
Actual Piston Stroke 3.25019600382
Cylinder Volume 40.843168 CI 669.299602 cc
Engine Size 326.745340 CI 5354.396814 cc
Crank Angle Piston TDC 0.46932221356 Piston BDC 180.84364932435

Crank Angle Degree	Piston Travel Inches	Rod Angle	Cylinder Volume CI	Cylinder Volume cc
0.000000000	0.00007006031	-0.60312	0.00088	0.01443
5.000000000	0.00652239396	0.82054	0.08196	1.34313
10.000000000	0.02877341397	2.23388	0.36158	5.92519
15.000000000	0.06654136967	3.62694	0.83618	13.70259
20.000000000	0.11935613763	4.98986	1.49987	24.57852
25.000000000	0.18656691611	6.31283	2.34447	38.41896
30.000000000	0.26735291564	7.58619	3.35966	55.05490
35.000000000	0.36073698645	8.80043	4.53315	74.28510
40.000000000	0.46560207813	9.94627	5.85093	95.87954
45.000000000	0.58071036086	11.01472	7.29742	119.58332
50.000000000	0.70472474996	11.99718	8.85583	145.12109
55.000000000	0.83623246784	12.88553	10.50841	172.20194
60.000000000	0.97377015507	13.67221	12.23676	200.52451
65.000000000	1.11584991453	14.35038	14.02218	229.78242
70.000000000	1.26098555360	14.91398	15.84601	259.66961
75.000000000	1.40771819525	15.35788	17.68991	289.88566
80.000000000	1.55464037805	15.67797	19.53619	320.14075
85.000000000	1.70041777280	15.87125	21.36808	350.16009
90.000000000	1.84380771975	15.93588	23.16997	379.68780
95.000000000	1.98367393673	15.87125	24.92758	408.48988
100.000000000	2.11899695547	15.67797	26.62810	436.35640
105.000000000	2.24888009184	15.35788	28.26026	463.10270
110.000000000	2.37255101941	14.91398	29.81436	488.56975
115.000000000	2.48935926518	14.35038	31.28221	512.62360
120.000000000	2.59877015507	13.67221	32.65711	535.15413
125.000000000	2.70035588598	12.88553	33.93367	556.07327
130.000000000	2.79378448145	11.99718	35.10773	575.31264
135.000000000	2.87880739972	11.01472	36.17616	592.82106
140.000000000	2.95524651827	9.94627	37.13672	608.56186
145.000000000	3.02298113039	8.80043	37.98790	622.51017
150.000000000	3.08193547794	7.58619	38.72874	634.65040
155.000000000	3.13206722398	6.31283	39.35872	644.97382
160.000000000	3.17335715519	4.98986	39.87758	653.47649
165.000000000	3.20580030511	3.62694	40.28527	660.15738
170.000000000	3.22939861126	2.23388	40.58182	665.01688
175.000000000	3.24415516275	0.82054	40.76726	668.05564
180.000000000	3.25007006031	-0.60312	40.84158	669.27367
185.000000000	3.24713789286	-2.02717	40.80474	668.66986
190.000000000	3.23534683083	-3.44161	40.65657	666.24177

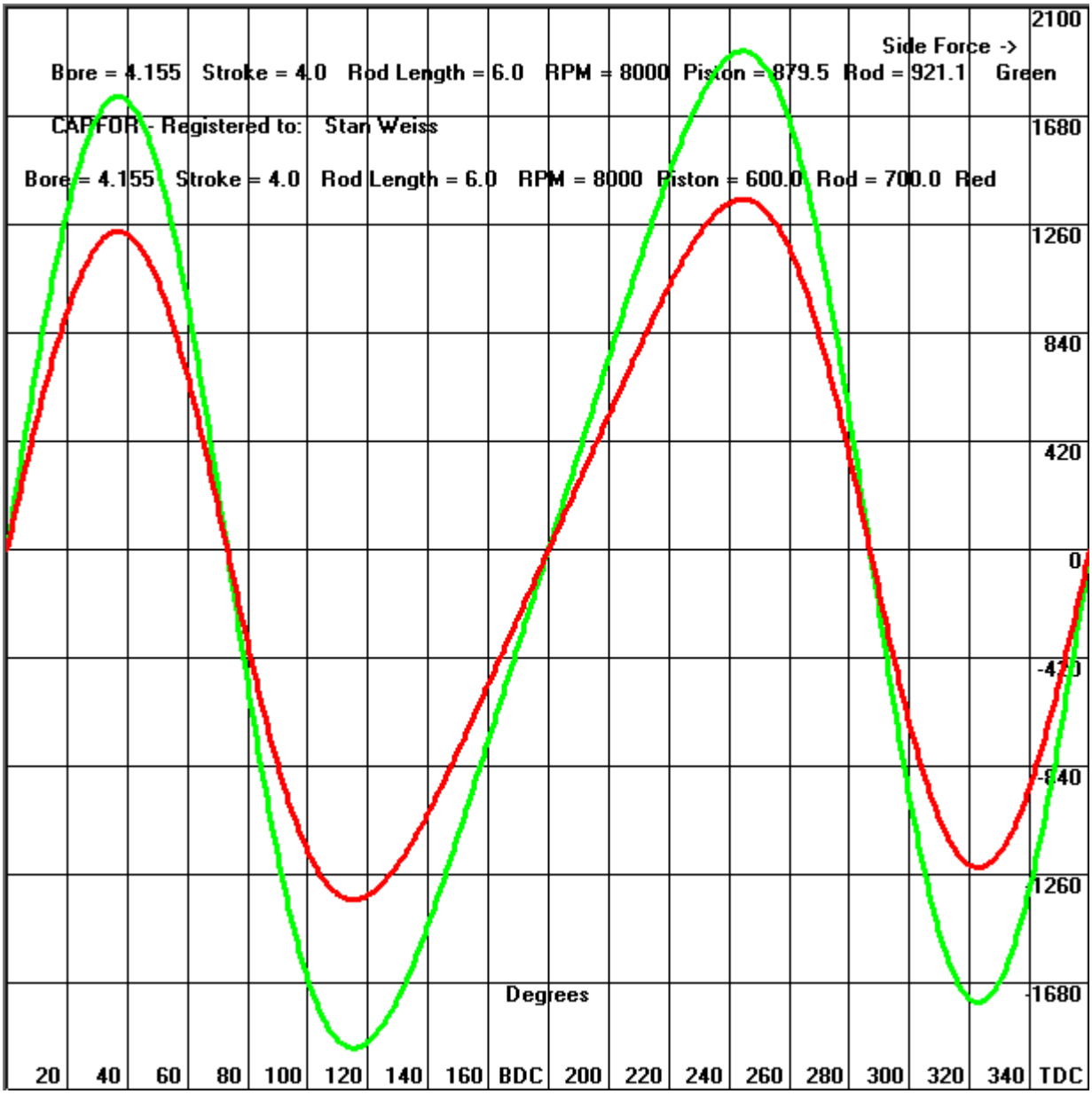
Calculate **Crankpin Load,** showing result ever X Crankshaft Degrees. Using Bore, Stroke, RPM, Rod Length, Piston Weight, Wrist Pin Offset, and Rod Weight.

Bore = 87.0 Stroke = 80.0 Rod Length = 135.0 RPM = 8520
Wrist Pin Offset = 0.0
Piston Weight = 500.0 Rod Weight = 600.0

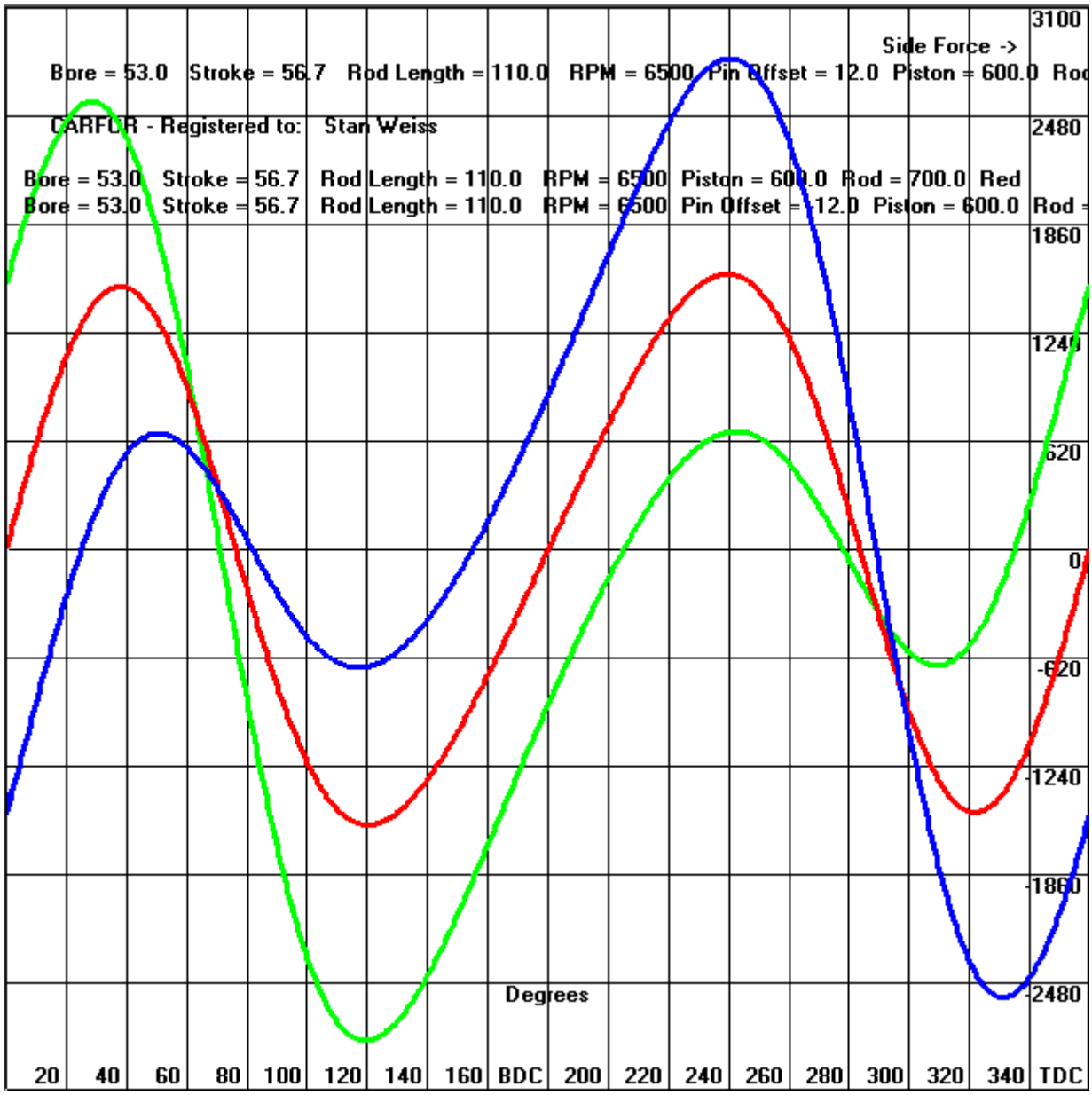
Crank Angle Degree	Crankpin Load Newtons
0.00000000000	45403.923384
5.00000000000	45123.258302
10.00000000000	44285.613844
15.00000000000	42904.046616
20.00000000000	41000.323396
25.00000000000	38604.900655
30.00000000000	35756.838112
35.00000000000	32503.590398
40.00000000000	28900.609049
45.00000000000	25010.680656
50.00000000000	20902.929206
55.00000000000	16651.424934
60.00000000000	12333.370825
65.00000000000	8026.881994
70.00000000000	3808.429766
75.00000000000	-249.915560
80.00000000000	-4083.252209
85.00000000000	-7636.394815
90.00000000000	-10865.964112
95.00000000000	-13741.808643
100.00000000000	-16247.613979
105.00000000000	-18380.647133
110.00000000000	-20150.685797
115.00000000000	-21578.274222
120.00000000000	-22692.512929
125.00000000000	-23528.618232
130.00000000000	-24125.478984
135.00000000000	-24523.399182
140.00000000000	-24762.158180
145.00000000000	-24879.458161
150.00000000000	-24909.772128
155.00000000000	-24883.561732
160.00000000000	-24826.805603
165.00000000000	-24760.764796
170.00000000000	-24701.909908
175.00000000000	-24661.941080
180.00000000000	-24647.844123
185.00000000000	-24661.941080
190.00000000000	-24701.909908
195.00000000000	-24760.764796
200.00000000000	-24826.805603
205.00000000000	-24883.561732
210.0	-24909.772128

Graph Side Force

The green line is piston combo 879.5 grams rod combo 921.1 grams
The red line is piston combo 600 grams rod combo 700 grams
The reciprocating force hits zero when Crank and rod are 90 Degrees 71.565 degree ATDC.
I let the program calculate the rod small end weight.

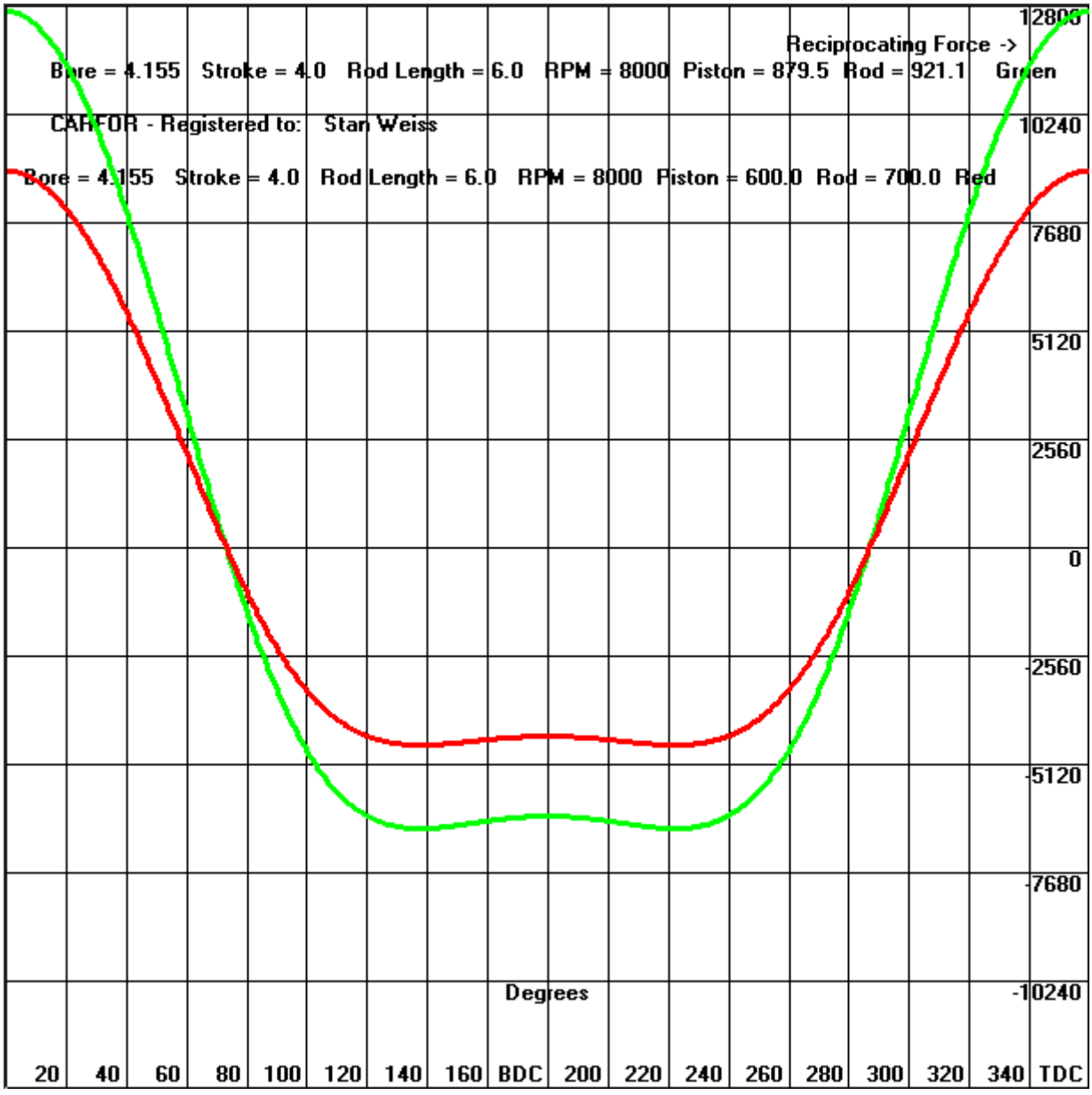


Shows the effects of wrist pin offset

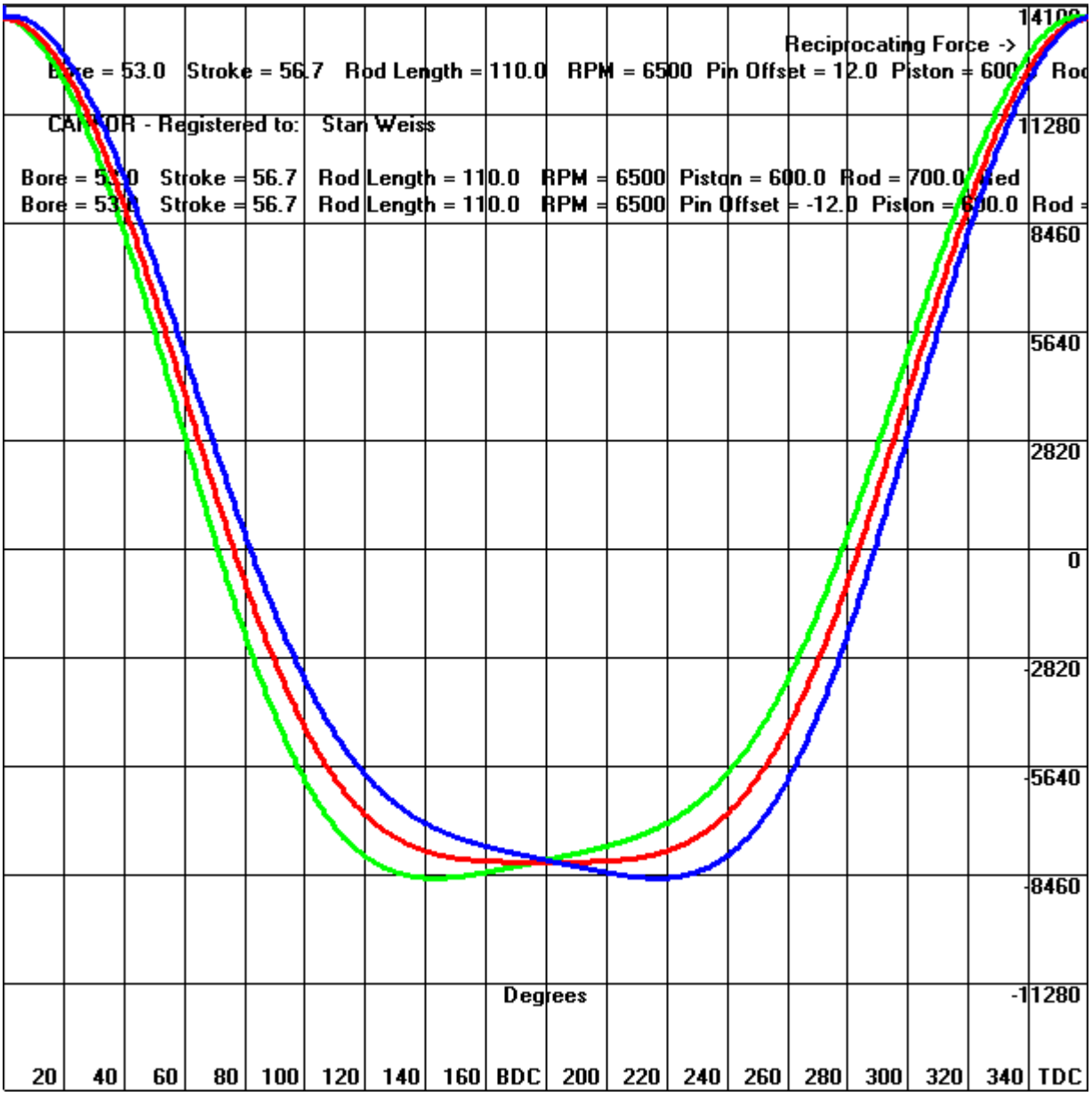


Graph Reciprocating Force

The green line is piston combo 879.5 grams rod combo 921.1 grams
The red line is piston combo 600 grams rod combo 700 grams
The reciprocating force hits zero when Crank and rod are 90 Degrees 71.565 degree ATDC.
I let the program calculate the rod small end weight.



Shows the effects of wrist pin offset



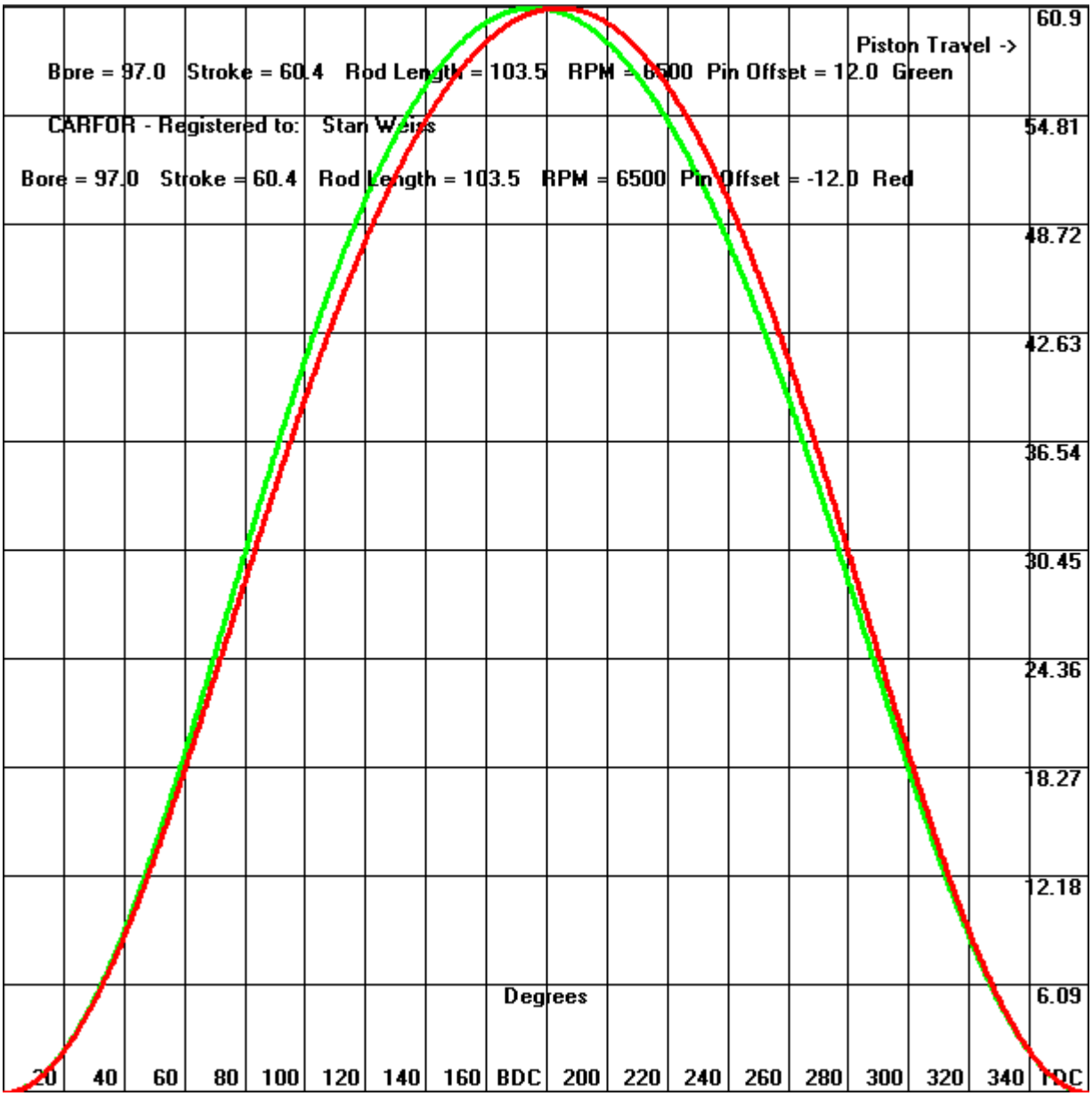
Calculate **Crankpin Force,** showing result ever X Crankshaft Degrees. Using Bore, Stroke, RPM, Rod Length, Piston Weight, Wrist Pin Offset, and Rod Weight.

Note: Piston and Rod weights must be entered in grams. Piston weight includes the weight of rings, wrist pin, and any pin locks or buttons.

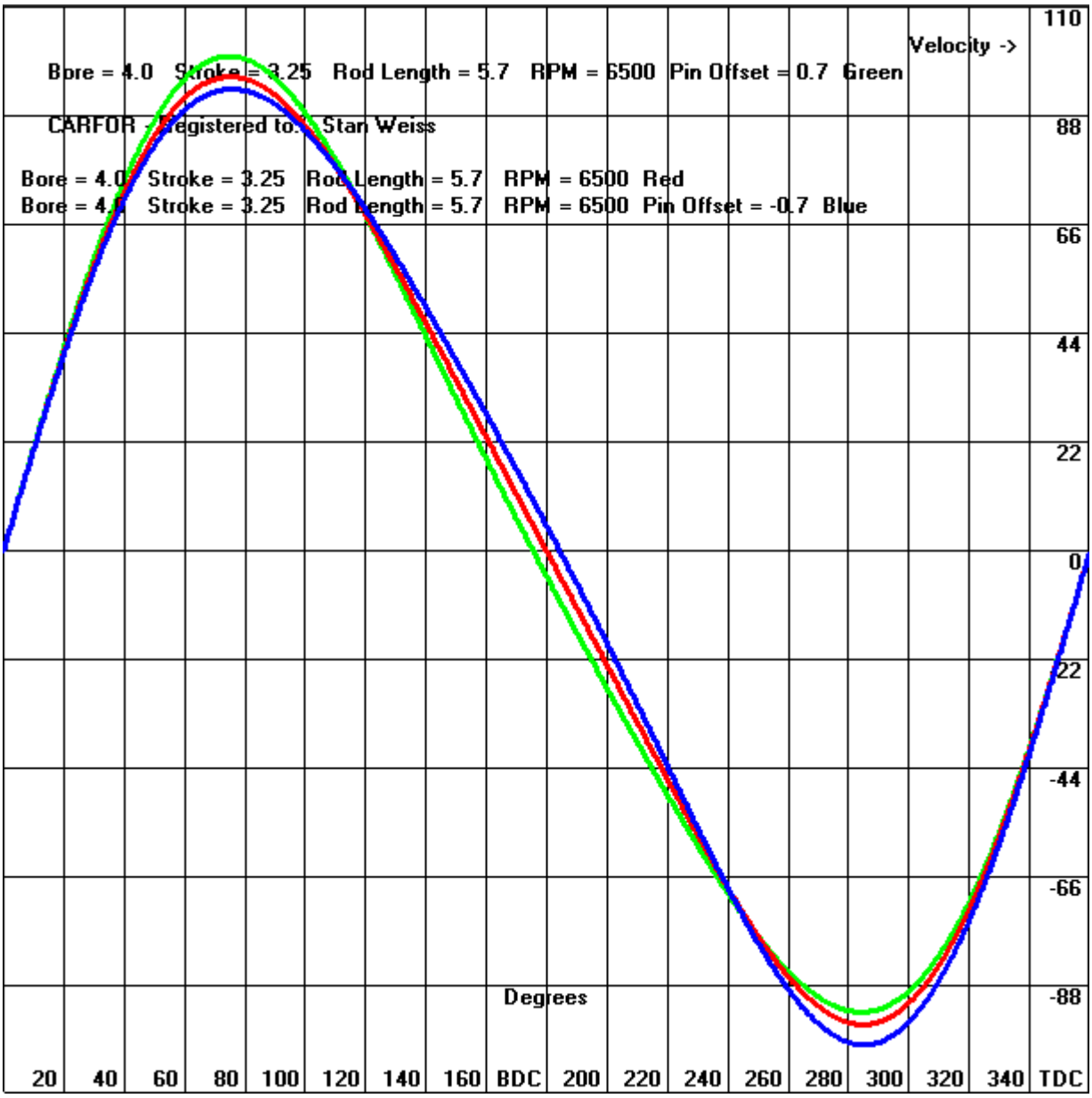
Bore = 4.0 Stroke = 3.25 Rod Length = 5.7 RPM = 6500
Wrist Pin Offset = 0.0
Piston Weight = 600.25 Rod Weight = 700.5
Small End Rod Weight = 233.5 Big End Rod Weight = 467.0
Rod CG / Distance from Small End = 3.8 GAS PRESSURE = 0

Crank Angle Degree	Reciprocating Force Pounds	Total Force Pounds	Piston Side Force Pounds	Piston Inertia Force Pounds
.000	4606.310	6614.023	.000	3316.267
10.000	4493.845	6480.440	222.741	3235.299
20.000	4163.519	6088.995	407.911	2997.484
30.000	3636.479	5468.144	523.706	2618.047
40.000	2947.534	4667.490	549.442	2122.048
50.000	2143.861	3763.043	479.779	1543.452
60.000	1282.068	2872.043	326.646	923.012
70.000	423.039	2188.802	117.629	304.563
80.000	-375.314	1977.391	-109.788	-270.204
90.000	-1066.120	2273.218	-317.097	-767.543
100.000	-1620.175	2790.265	-473.937	-1166.429
110.000	-2028.858	3306.587	-564.141	-1460.656
120.000	-2302.365	3735.542	-586.598	-1657.565
130.000	-2464.197	4057.515	-551.467	-1774.074
140.000	-2544.135	4281.270	-474.246	-1831.625
150.000	-2571.940	4426.014	-370.397	-1851.643
160.000	-2573.011	4512.199	-252.084	-1852.413
170.000	-2566.109	4556.677	-127.191	-1847.445
180.000	-2562.555	4570.267	.000	-1844.886
190.000	-2566.109	4556.677	127.191	-1847.445
200.000	-2573.011	4512.199	252.084	-1852.413
210.000	-2571.940	4426.014	370.397	-1851.643
220.000	-2544.135	4281.270	474.246	-1831.625
230.000	-2464.197	4057.515	551.467	-1774.074
240.000	-2302.365	3735.542	586.598	-1657.565
250.000	-2028.858	3306.587	564.141	-1460.656
260.000	-1620.175	2790.265	473.937	-1166.429
270.000	-1066.120	2273.218	317.097	-767.543
280.000	-375.314	1977.391	109.788	-270.204
290.000	423.039	2188.802	-117.629	304.563
300.000	1282.068	2872.043	-326.646	923.012
310.000	2143.861	3763.043	-479.779	1543.452
320.000	2947.534	4667.490	-549.442	2122.048
330.000	3636.479	5468.144	-523.706	2618.047
340.000	4163.519	6088.995	-407.911	2997.484
350.000	4493.845	6480.440	-222.741	3235.299
360.000	4606.310	6614.023	.000	3316.267

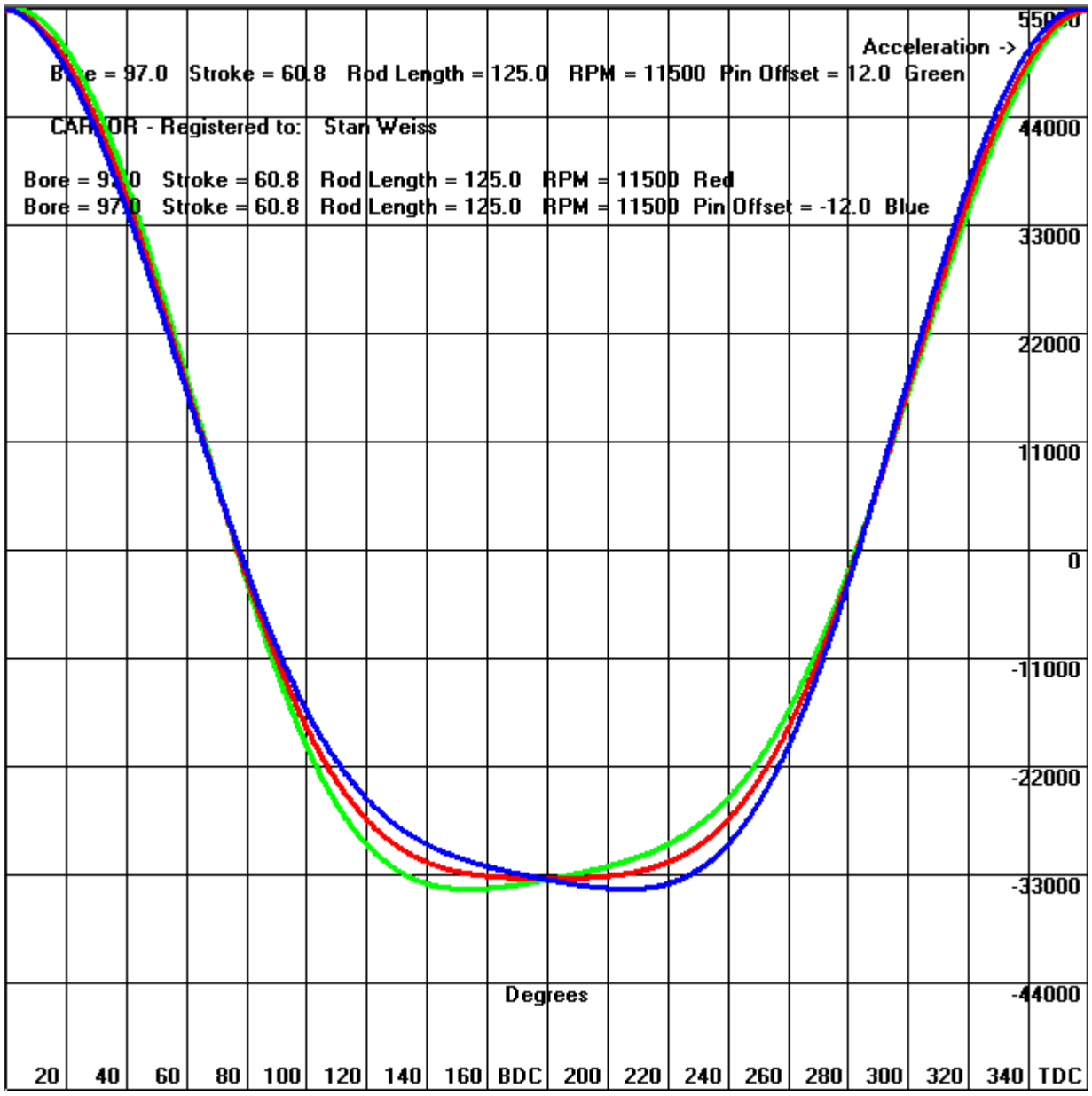
Graph Piston Travel at various Pin Offsets (Degree Wheel).



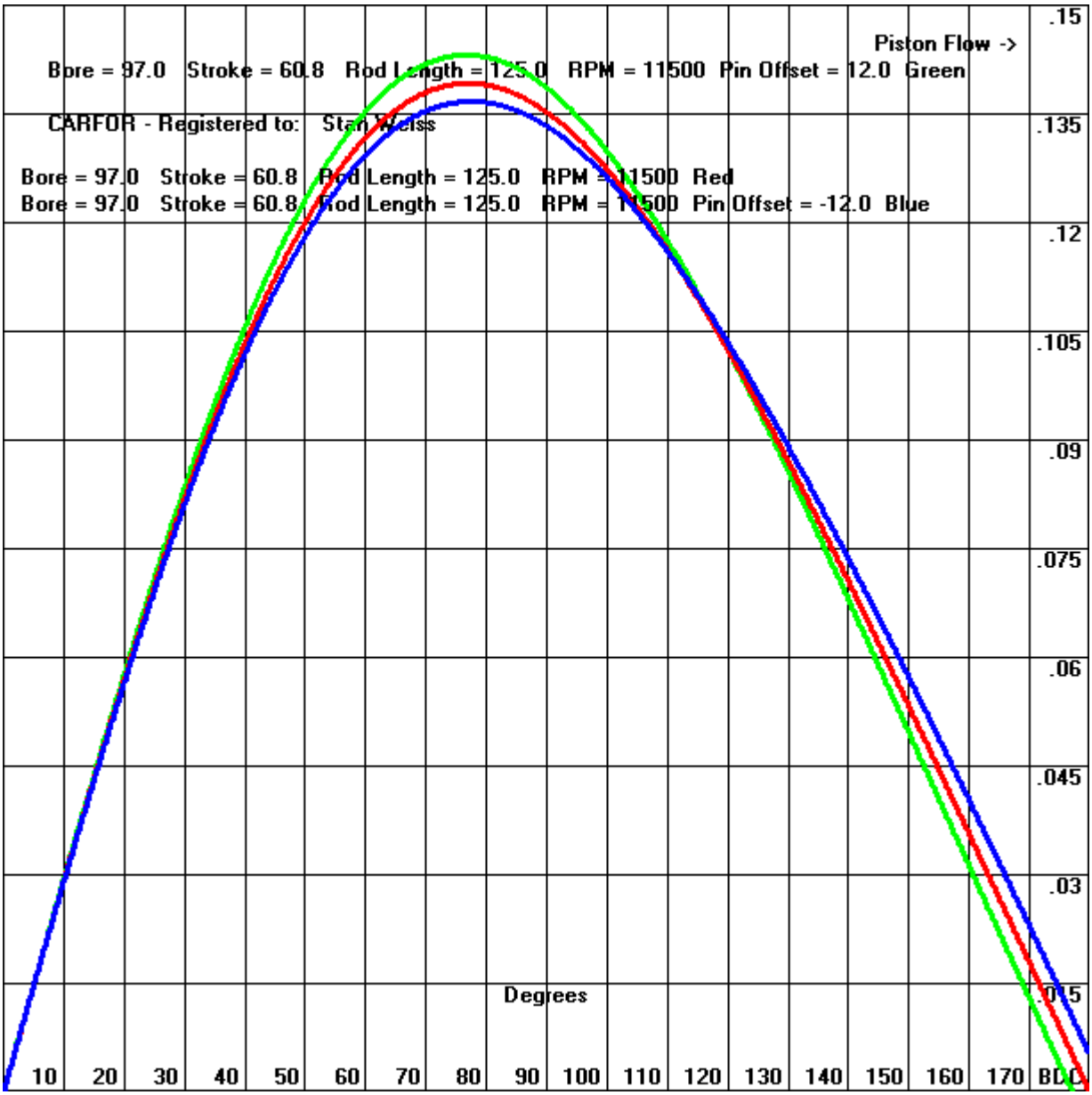
Graph Piston Velocity at various Pin Offsets (Degree Wheel).



Graph Piston Acceleration at various Pin Offsets (Degree Wheel).



Graph Piston Flow at various Pin Offsets (Degree Wheel).

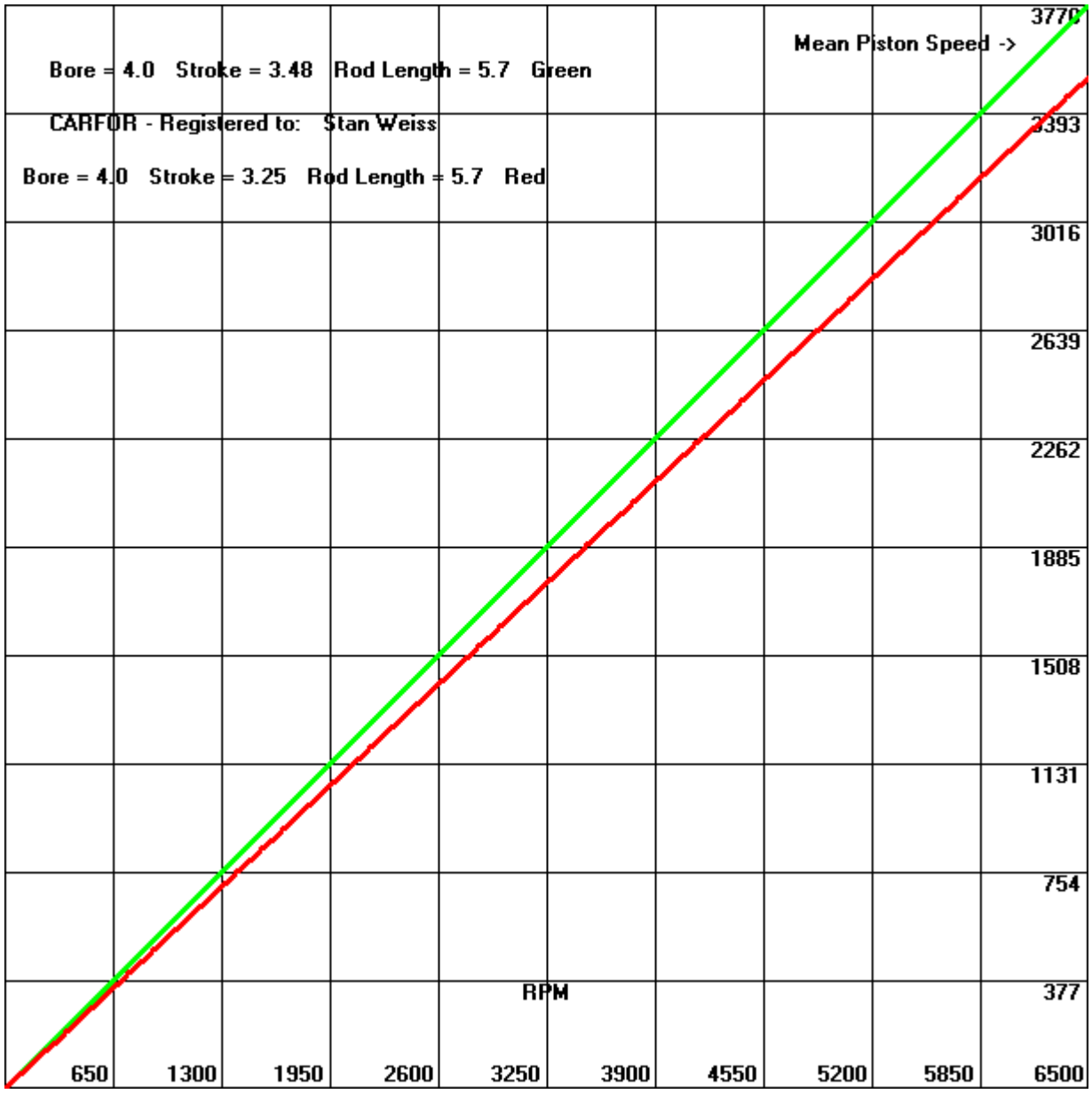


Calculate **Piston Travel, Piston Acceleration and Velocity, (Degree Wheel)** showing result ever X Degrees. Using Bore, Stroke, Wrist Pin Offset, RPM, and Rod Length. This also shows **Piston Flow @ 28 inches of water** to give you an idea of what cylinder head flow should be. This will show the same valves as 12 & 13 as long as wrist pin offset is equal to zero. When there is a wrist pin offset this will use the piston ATDC for zero degrees whereas 12 & 13 use the rod journal position.

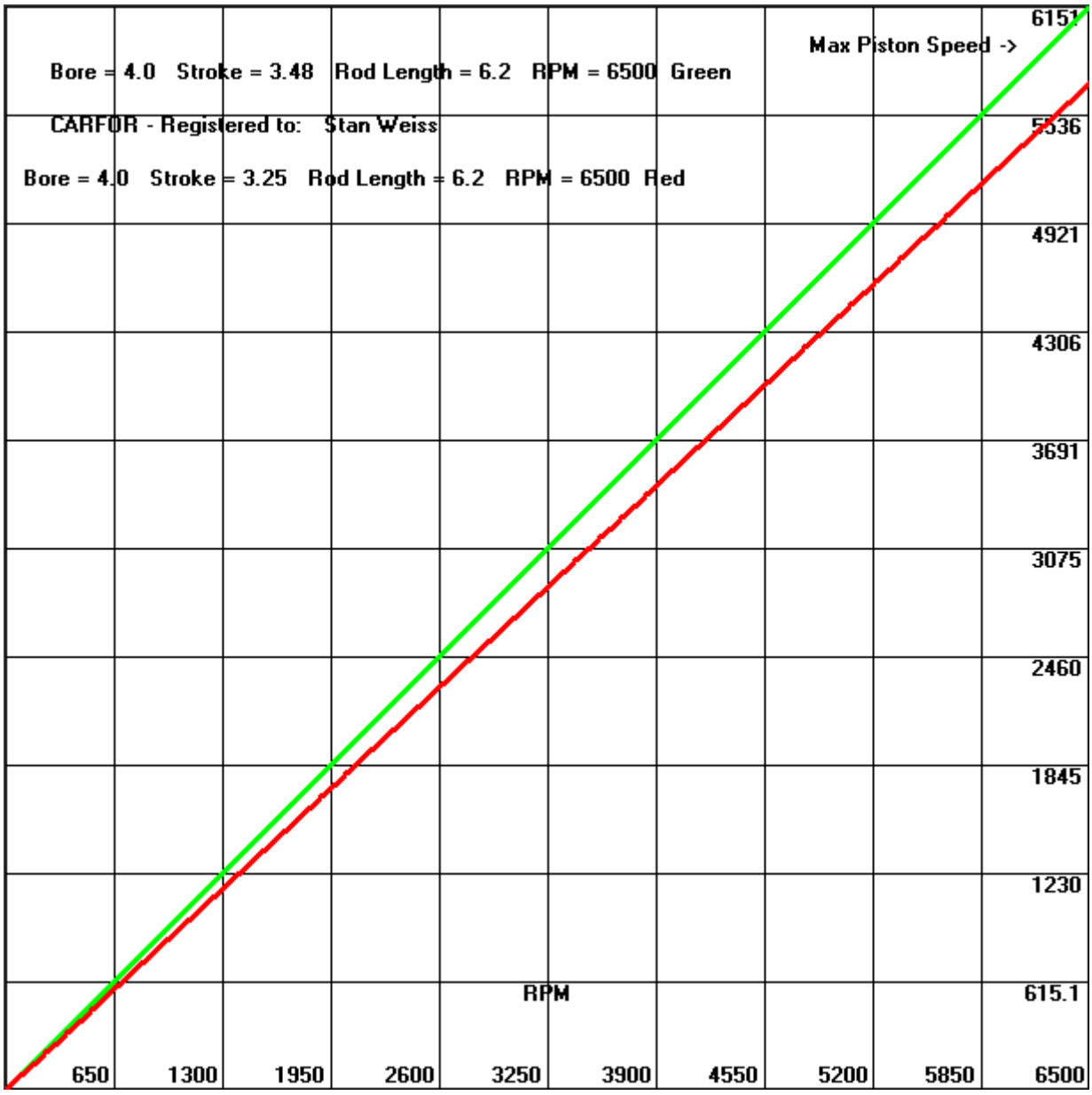
```
Bore = 4.0   Stroke = 3.25   Rod Length = 5.7   RPM = 6500
Wrist Pin Offset = 0.1
Maximum Piston Velocity 5781.079250 FPM @ 75.106549704470 Degrees
```

Degree Wheel Reading	Piston Travel	Piston Velocity FT/Sec	Piston Acceleration FT/Sec/Sec	Piston Flow @ 28" CFM
.000000	.000000	0.000000000	80636.063126519	.00
5.000000	.007947	10.322084060	80223.678572800	27.02
10.000000	.031701	20.528120767	78827.766293294	53.74
15.000000	.070987	30.493134351	76468.352084977	79.83
20.000000	.125340	40.095713985	73181.024924057	104.97
25.000000	.194113	49.220008051	69016.906097804	128.86
30.000000	.276485	57.757707080	64042.490264067	151.21
35.000000	.371477	65.609993414	58339.268491123	171.77
40.000000	.477965	72.689422762	52003.022843175	190.30
45.000000	.594702	78.921687751	45142.670630607	206.62
50.000000	.720336	84.247198021	37878.539226869	220.56
55.000000	.853437	88.622397260	30339.974834923	232.01
60.000000	.992519	92.020727977	22662.235061537	240.91
65.000000	1.136071	94.433152651	14982.686765302	247.23
70.000000	1.282581	95.868148454	7436.423289625	250.98
75.000000	1.430562	96.351113901	151.518154058	252.25
80.000000	1.578579	95.923159992	-6755.771569693	251.13
85.000000	1.725271	94.639303337	-13185.470606977	247.77
90.000000	1.869372	92.566129612	-19057.617358003	242.34
95.000000	2.009724	89.779045364	-24314.900118149	235.04
100.000000	2.145290	86.359276733	-28923.936562947	226.09
105.000000	2.275163	82.390798045	-32875.083565087	215.70
110.000000	2.398562	77.957376891	-36180.833363547	204.09
115.000000	2.514835	73.139904748	-38873.010035304	191.48
120.000000	2.623450	68.014146647	-40999.098287898	178.06
125.000000	2.723987	62.648996287	-42618.096449925	164.01
130.000000	2.816125	57.105272313	-43796.283150073	149.50
135.000000	2.899630	51.435044568	-44603.231991670	134.66
140.000000	2.974344	45.681441771	-45108.318954951	119.59
145.000000	3.040164	39.878867242	-45377.864568259	104.40
150.000000	3.097036	34.053537464	-45472.955804694	89.15
155.000000	3.144942	28.224257774	-45447.914029029	73.89
160.000000	3.183885	22.403357545	-45349.321214427	58.65
165.000000	3.213883	16.597720596	-45215.487357331	43.45
170.000000	3.234964	10.809862307	-45076.234001967	28.30
175.000000	3.247153	5.039020555	-44952.876751878	13.19
180.000000	3.250476	-0.717758472	-44858.308199295	-1.88
185.000000	3.244950	-6.464547431	-44797.107349714	-16.92
190.000000	3.230588	-12.205478089	-44765.629160421	-31.95
195.000000	3.207396	-17.943690675	-44752.056279527	-46.98
200.000000	3.175377	-23.680287849	-44736.423376011	-61.99
205.000000	3.134535	-29.413291919	-44690.651885145	-77.00
210.000000	3.084880	-35.136610435	-44578.658707215	-91.99

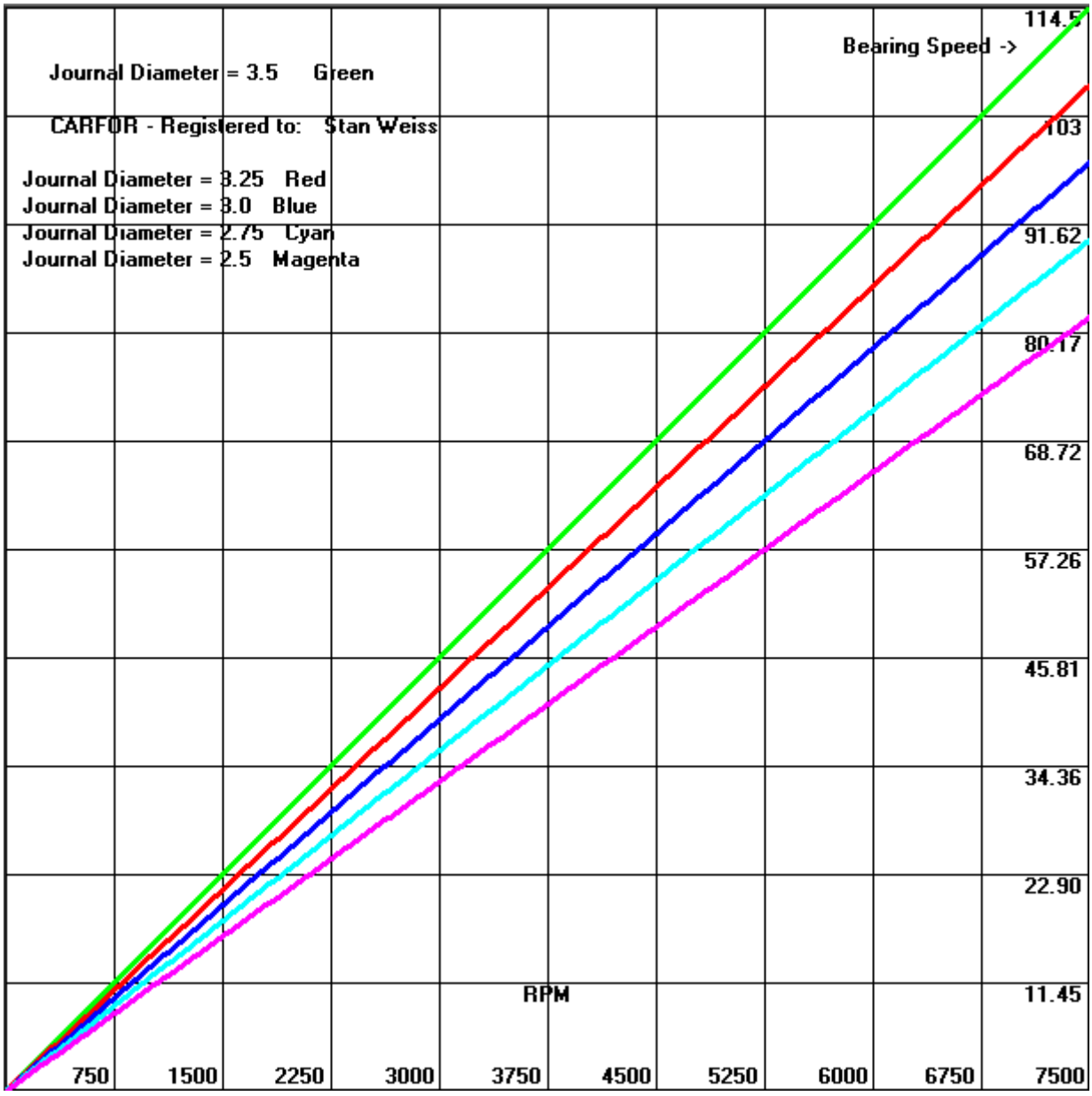
Graph Mean Piston Speed

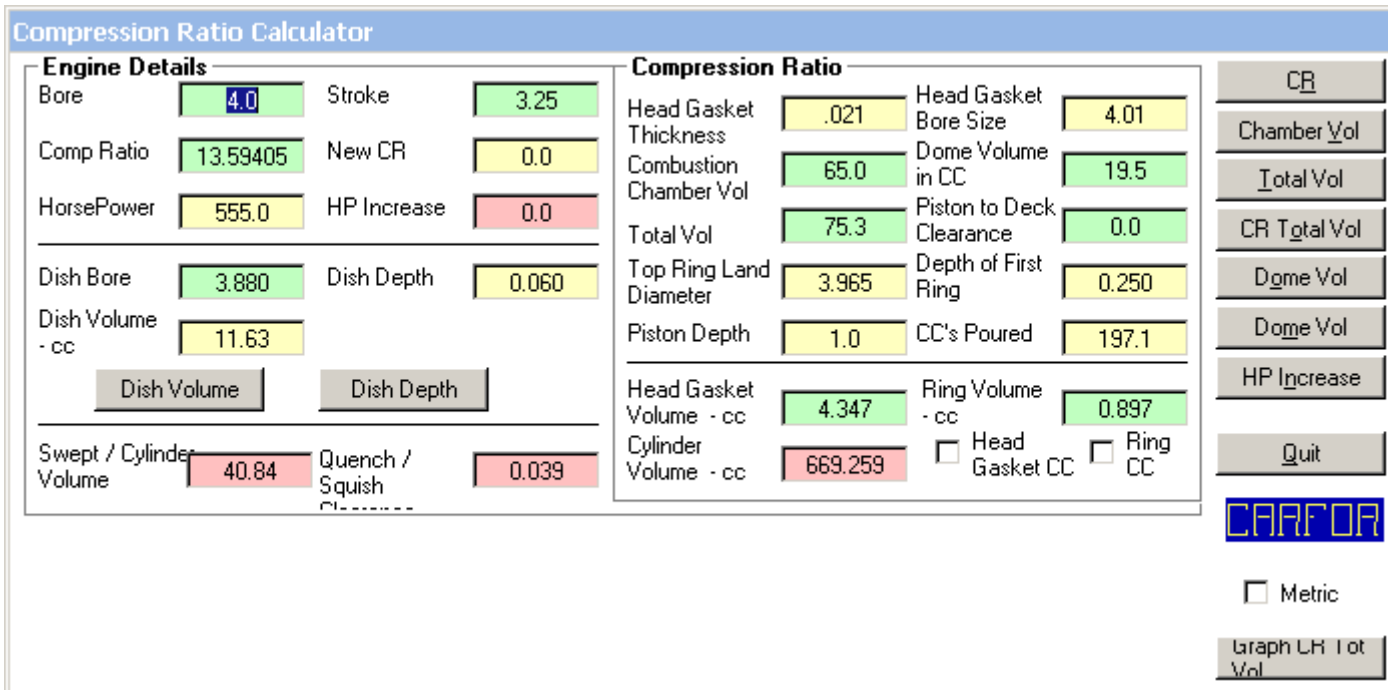


Graph Max Piston Velocity



Graph Bearing Speed





C R – Compression Ratio

Lets the user vary different inputs to see how they will change the CR. As an example you already have a piston and cylinder head, now what head gasket thickness will give the CR you want. If you are looking to bore or stroke your engine you can see what that change will do the CR.

1) Calculate Compression Ratio from Bore, Stroke, Combustion Chamber Volume, Dome Volume, Piston to Deck Clearance, Head Gasket compressed thickness, Head Gasket Bore Size, Depth of First Ring and Piston Top Ring Land Diameter.
   a. **If the piston is above the block deck use (-) for Piston to Deck Clearance value.**
   b. **For dished pistons or flat top pistons with valve relief use (-) for dome volume.**
   c. **The user can enter the head gasket bore size and thickness or the head gasket volume in cc's – to enter the volume in cc's you must check the head gasket cc box.**
   d. **The user can enter the depth of the first ring from the top of the piston and the diameter of the piston above the first ring or the volume above the top ring in cc's – to enter the volume in cc's you must check the ring cc box.**
2) Calculate Combustion Chamber Volume from Bore, Stroke, CR and all other inputs needed to calculate CR except Combustion Chamber Volume.
3) Calculate Total Volume from Bore, Stroke, and CR.
4) Calculate CR from Bore, Stroke, and Total Volume.

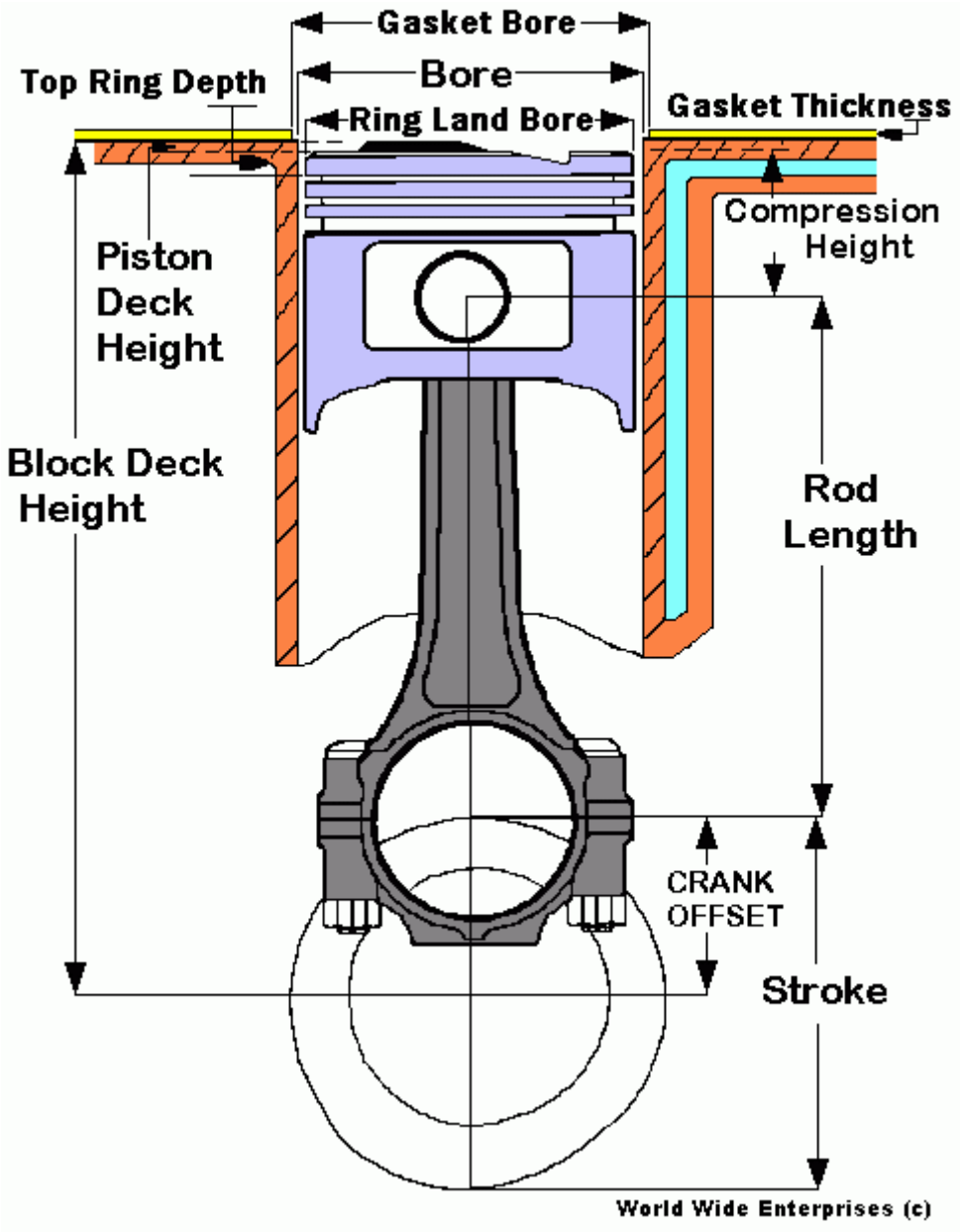
The user should first use #3 above to calculate Total Volume. Then you can vary the Total Volume to see how that will change the Compression Ratio.

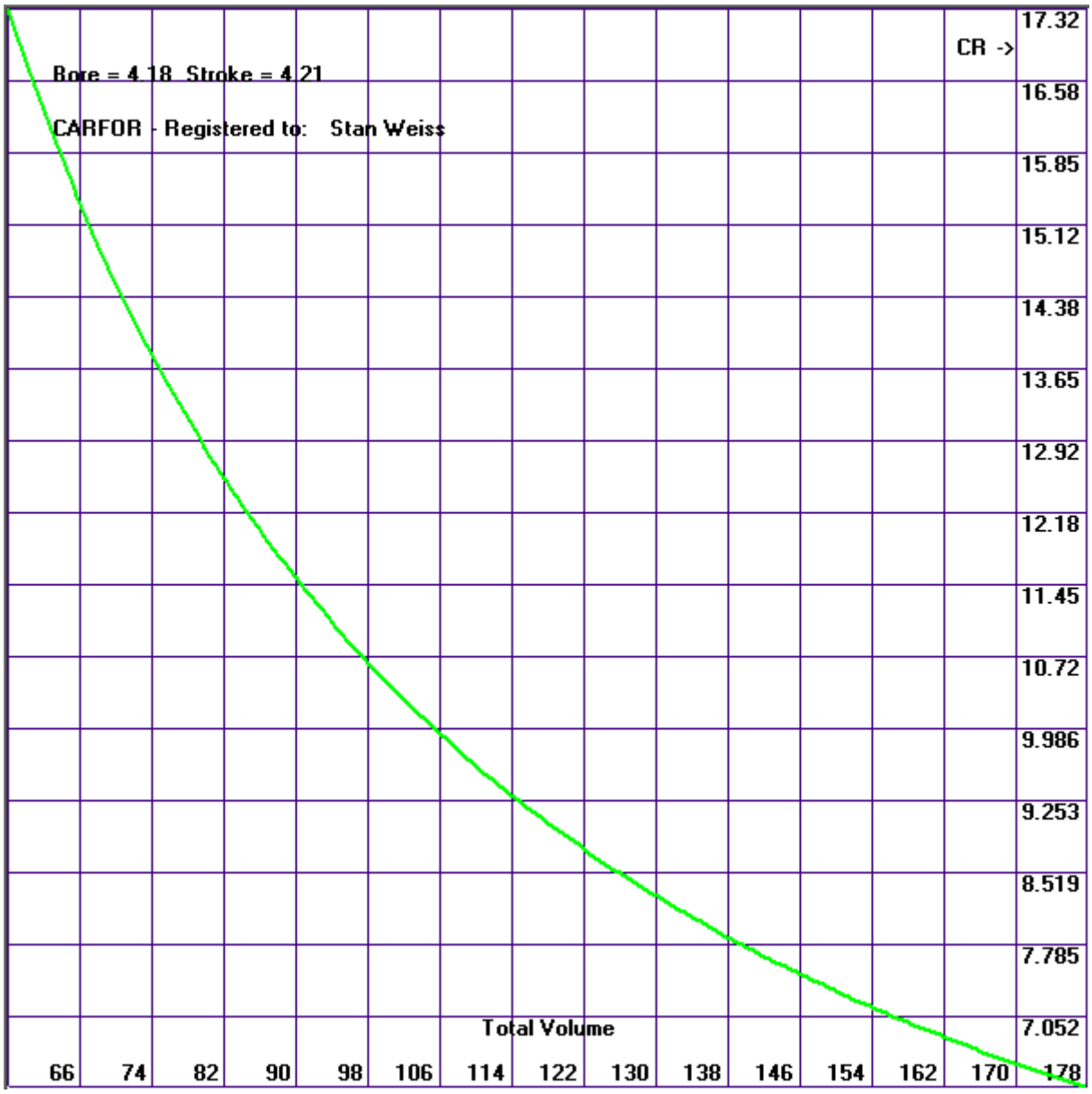
5) Calculate Dome Volume from Bore, Stroke, CR and all other inputs needed to calculate CR Calculate Compression Ratio from Bore, Stroke, Combustion Chamber Volume, Dome Volume, Piston except Dome Volume.
6) Calculate Dome Volume from Bore size and piston depth using CC's poured into cylinder.
7) Estimate the Horsepower gain from increasing the Compress Ratio.
8) Graph CR against Total Volume from Bore, Stroke, and Total Volume.
9) Calculate Dish Volume from Dish Bore and Dish Depth.
10) Calculate Dish Depth from Dish Volume and Dish Bore.

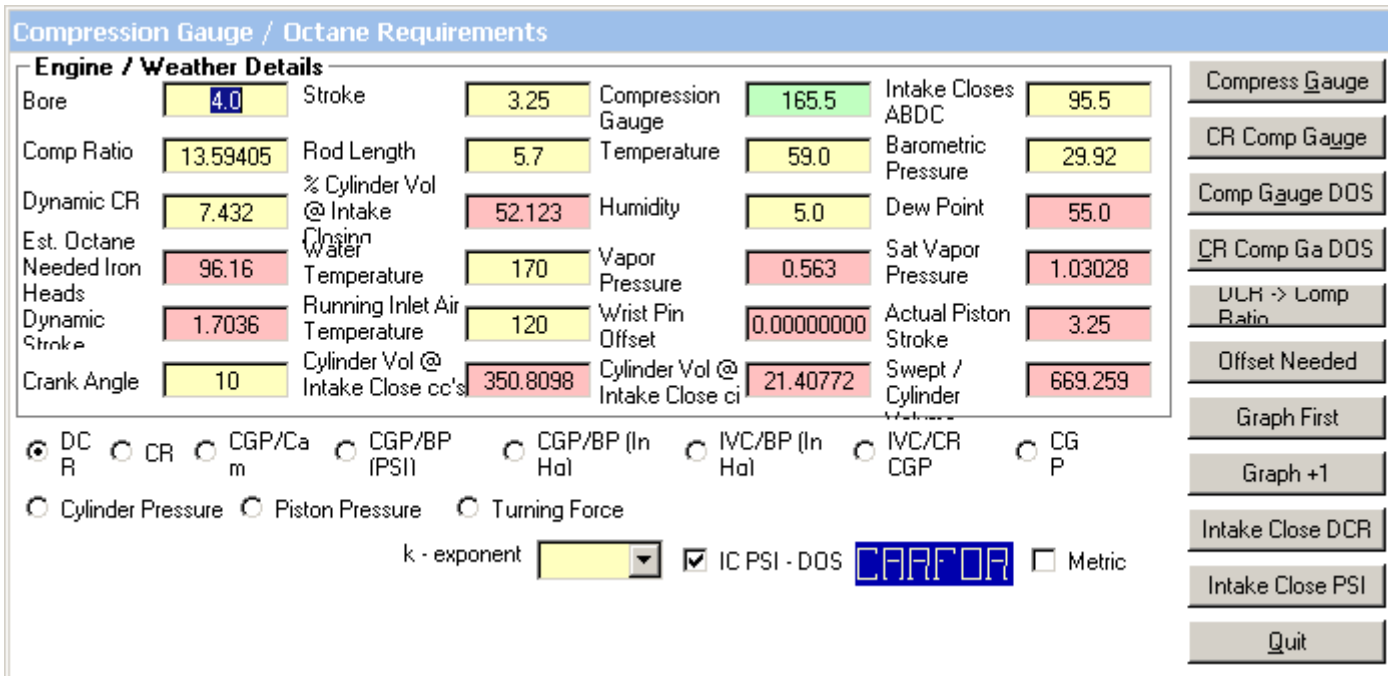
Total Volume – This is the volume measured with the piston ATDC with the head installed with a head gasket and the valves closed thru the spark plug hole.

If the **Head Gasket CC box is checked** the user will enter the **Head Gasket Volume cc** amount, or else the program will calculate it from Head Gasket Thickness and Head Gasket Bore Size.

If the **Ring CC box is checked** the user will enter the **Ring Volume cc** which is the amount of cc's above the top ring, or else the program will calculate this value from Top Ring Land Diameter, Depth of First Ring and Bore.




Bore = 4.18 Stroke = 4.21
CARFOR - Registered to: Stan Weiss
CR ->
17.32
16.58
15.85
15.12
14.38
13.65
12.92
12.18
11.45
10.72
9.986
9.253
8.519
7.785
7.052
Total Volume
66
74
82
90
98
106
114
122
130
138
146
154
162
170
178



Compression Gauge / Octane Requirement

Calculate Cranking Compression Pressure, Dynamic Compression Ratio, Dynamic Stroke, Cylinder Volume @ Intake Closing, Gas Octane requirements.

Note: All of these functions use **Wrist Pin Offset**.

1) Estimate the Compression Gauge reading (PSIA) and Gas Octane needed from the Compression Ratio, Cylinder Size, Rod Length, Intake Valve Closing Cam Timing, Barometric Pressure, Wrist Pin Offset, and Temperature.
2) Estimate the Compression Ratio and gas octane needed from the Compression Gauge Reading (PSIA), Cylinder Size, Rod Length, Intake Valve Closing Cam Timing, Barometric Pressure, Wrist Pin Offset, and Temperature.
3) Calculate Compression Ratio from Dynamic Compression Ratio, Stroke, Rod Length, Intake Valve Closing Degrees, and Wrist Pin Offset.
4) Estimate the Compression Gauge reading (PSIG) and Gas Octane needed (Some what like DOS Version) from the Compression Ratio, Cylinder Size, Rod Length, Intake Valve Closing Cam Timing, Barometric Pressure, Temperature, Humidity, and Wrist Pin Offset.
5) Estimate the Compression Ratio (Just like DOS Version) and gas octane needed from the Compression Gauge Reading (PSIG), Cylinder Size, Rod Length, Intake Valve Closing Cam Timing, Barometric Pressure, Temperature, Humidity, and Wrist Pin Offset.
6) Calculate amount of offset required for crank angle, to have the piston to be at TDC. Using Crank Angle, Rod Length, and Stroke.
7) **DCR** - Graph Dynamic Compression Ratio (Y-axis) against Intake Valve Closing from BDC to TDC (X-Axis). Using Bore, Rod Length, Stroke, Compression Ratio and Wrist Pin Offset.
8) **CR** - Graph Compression Ratio (Y-axis) against Intake Valve Closing from BDC to 40 BTDC (X-Axis). Using Bore, Rod Length, Stroke, Dynamic Compression Ratio and Wrist Pin Offset.
9) **CGP/Cam** - Graph change in Cranking Compression Pressure for change in Intake Valve Closing from BDC to TDC. Using Barometric Pressure, Bore, Rod Length, Stroke, Compression Ratio and Wrist Pin Offset.
10) **CGP/BP (PSI)** - Graph change in Cranking Compression Pressure for change in Barometric Pressure with a fixed Intake Valve Closing. Using Bore, Rod Length, Stroke, Compression Ratio and Wrist Pin Offset.
11) **CGP/BP (In Hg)** - Graph change in Cranking Compression Pressure for change in Barometric Pressure with a fixed Intake Valve Closing. Using Bore, Rod Length, Stroke, Compression Ratio and Wrist Pin Offset.

12) **IVC/BP (In Hg)** - Graph change in Intake Valve Closing for change in Barometric Pressure (In Hg) with a fixed Cranking Compression Pressure. Using Bore, Rod Length, Stroke, Compression Ratio.
13) **IVC/CR CGP** - Graph Intake Valve Closing against Compression Ratio with a fixed Cranking Compression Pressure. Using Bore, Rod Length, Stroke, Barometric Pressure (In Hg), Wrist Pin Offset and Cranking Compression Pressure.
14) **CGP** - Graph change in Cranking Compression Pressure against change Intake Valve Closing against Compression Ratio with a fixed Compression Ratio. Using Bore, Rod Length, Stroke, Barometric Pressure (In Hg), and Wrist Pin Offset.
15) **Cylinder Pressure** - Graph change in Cylinder Pressure (Decay - without anymore burn or any heat loss and no EVO) against Crank Rotational Angle Using Bore, Rod Length, Stroke, Compression Ratio, Crank Angle (Degrees ATDC of Max Cylinder Pressure), Compression Gauge (Max Cylinder Pressure) and Wrist Pin Offset.
16) Graph First will set up the X-Axis and Y-Axis ranges and Produce a graph based on the selected option.
17) Graph +1 will add another Graph line to the present Graph; this will produce good results if the same option is selected.
18) Calculate Intake Valve Close ABDC using Bore, Stroke, Rod Length, Compression Ratio, Dynamic CR and Wrist Pin Offset.
19) Calculate Intake Valve Close ABDC using Bore, Stroke, Rod Length, Compression Ratio, Barometric Pressure, Temperature, Humidity and Compression Gauge Reading.

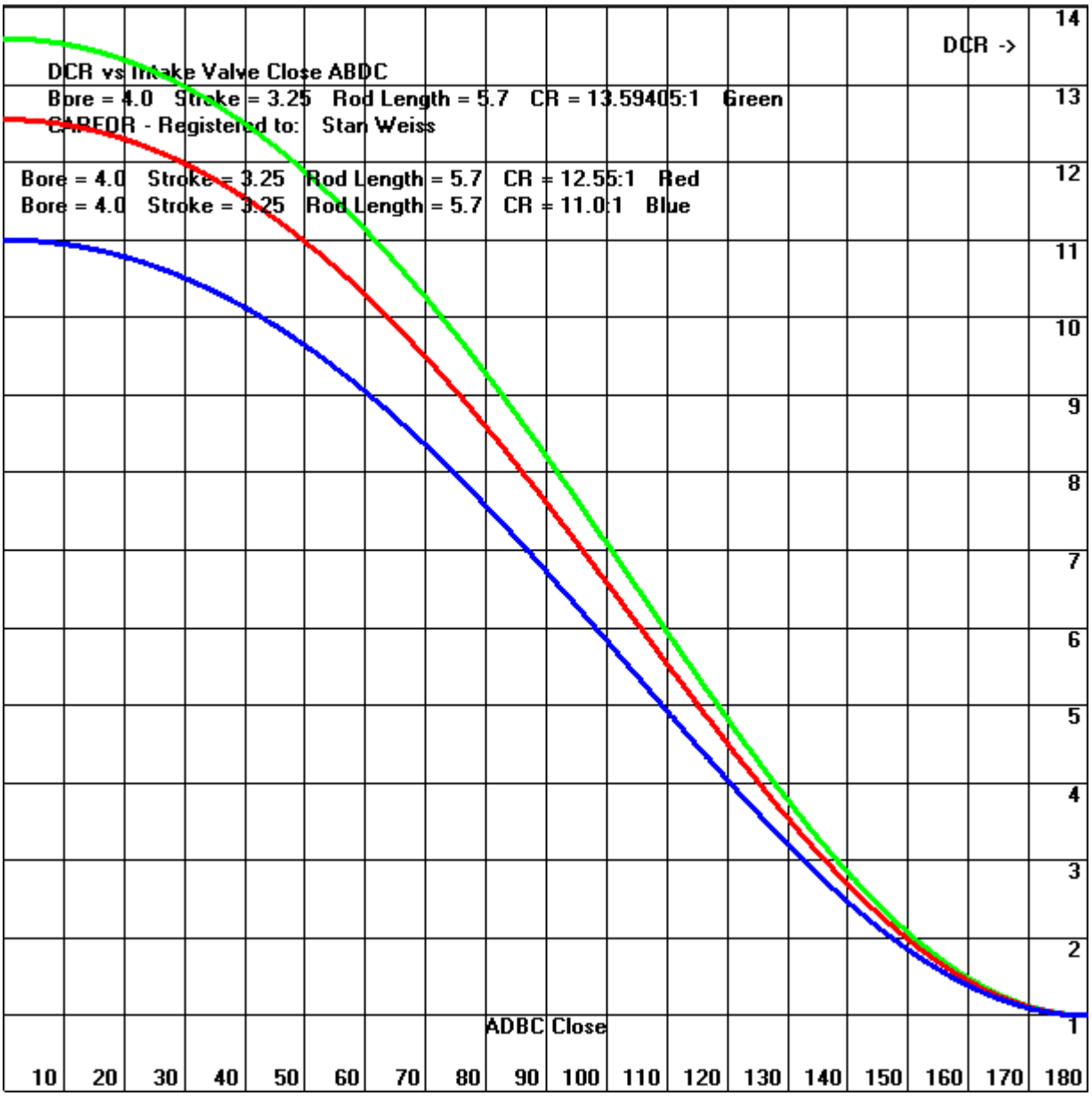
Note: Intake Valve Closing is when the valve actually closes. Compression of the air/fuel mixture cannot start until the intake valve is closed Lets take a (ex 1) SBC using 1.5:1 ratio rocker arms. That has a valve lash of .030" for the intake (solid lifters). That means at .020" of cam lift the valve closes. Lets take a (ex 2) BBC using 1.7:1 ratio rocker arms. That has a valve lash of .017" for the intake (solid lifters). That means at .010" of cam lift the valve closes. Add an extra .004 for valve train flex. Using a degree wheel you need to find where the intake lifter measures .014" lifter on the closing ramp. Hydraulic lifters are another deal and preload, spring seat pressure and oil pressure all can come into play, for general use .004 to .006 cam lift is a good starting point. If you change the Intake centerline or valve lash you have to recalculate your dynamic compression ratio. Your Dynamic Compression Ratio (DCR) can never be higher than your Static Compression Ratio (SRC). But in a racing engine your DCR is generally much lower than SCR. Like the SCR, the DCR, is fixed when the engine is built. But unlike the SCR the DCR can change during the operation of the engine. Thing like pushrod flex, and timing belt stretch can alter the cam timing events and that will change your DRC. For street and street/strip motors a DCR in the range of 8-8.5:1 is normal. This should work well with pump gas and yet not have any detonation problems.

I use dynamic compression ratio to calculate cranking pressure. If I have an engine at sea level and than take it up to Denver the DCR does not change. Let's say I have an engine with 7.6:1 DCR and at 70 degrees no humidity and Barometric Pressure of 29.92 it cranks 186.4 psi. Then I change locations and have 25.95 Barometric Pressure it will only crank 161.5 psi.

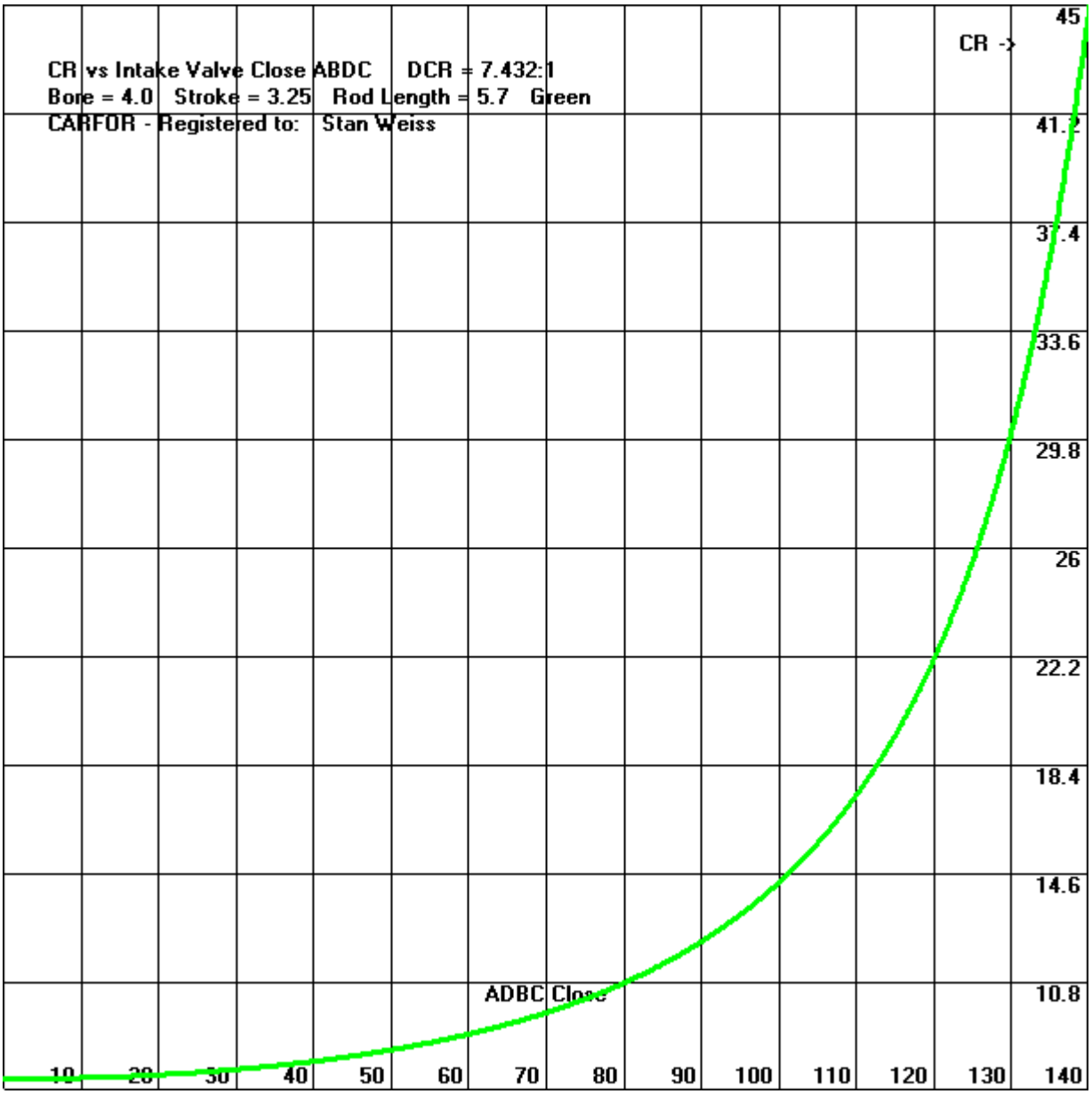
Dynamic compression is the actual physical compression that takes place after the intake valve closes and this generates the cranking pressure. **NOTE** - this is all happening at starter motor RPM's

Roughly this is how I do it.
1) Calculate displacement of one cylinder
2) From CR and displacement of one cylinder #1 above I calculate volume above piston at TDC
3) From IVC I calculate piston position and then dynamic stroke
4) From dynamic stroke #3, bore and volume above piston ATDC calculated in #2 I calculate Dynamic compression ratio
5) From Dynamic compression ratio #4 and atmospheric variables I calculate cranking pressure.

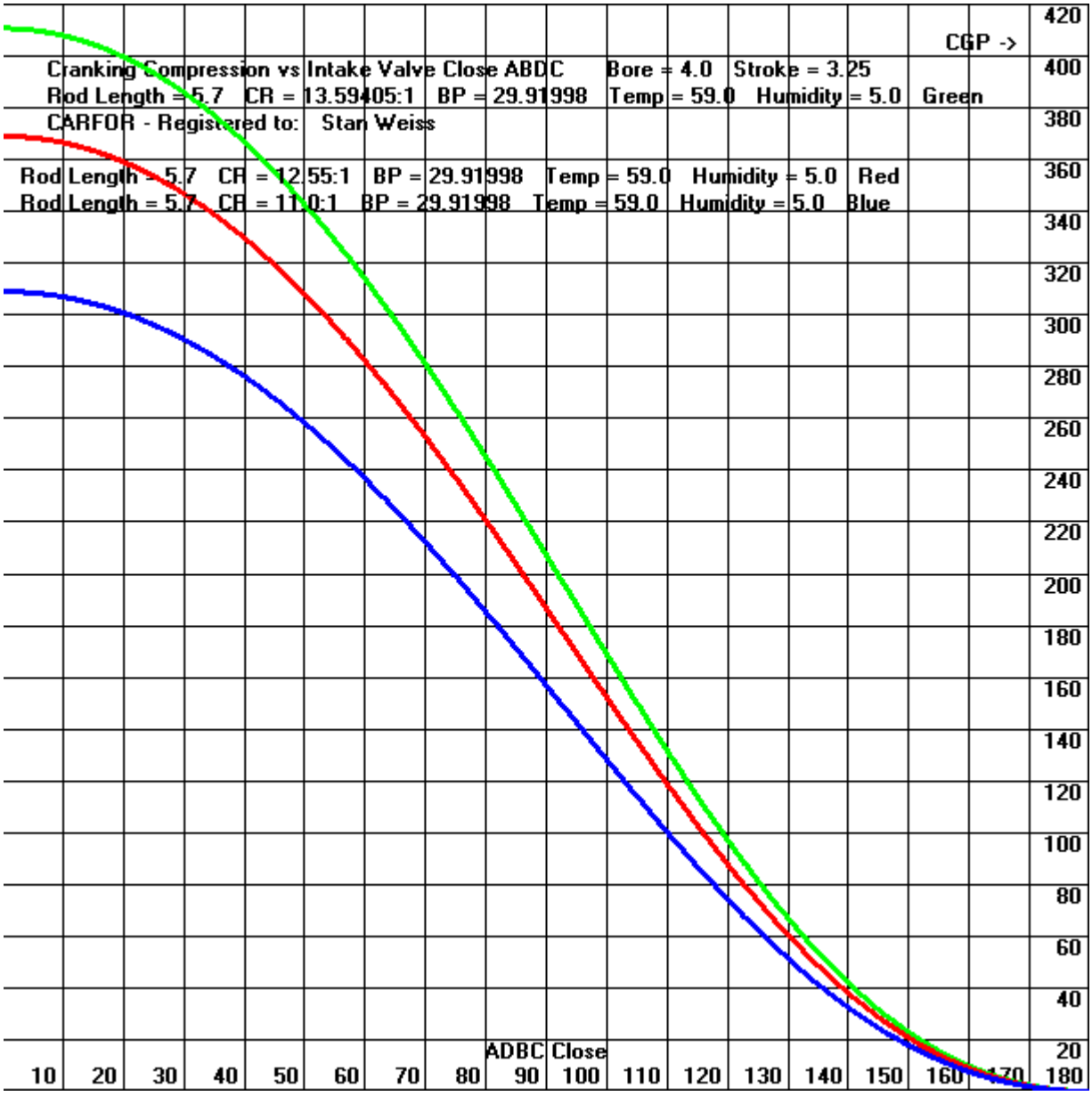
Graph **Dynamic Compression Ratio (Y-axis)** against **Intake Valve Closing** from BDC to TDC **(X-Axis)**.



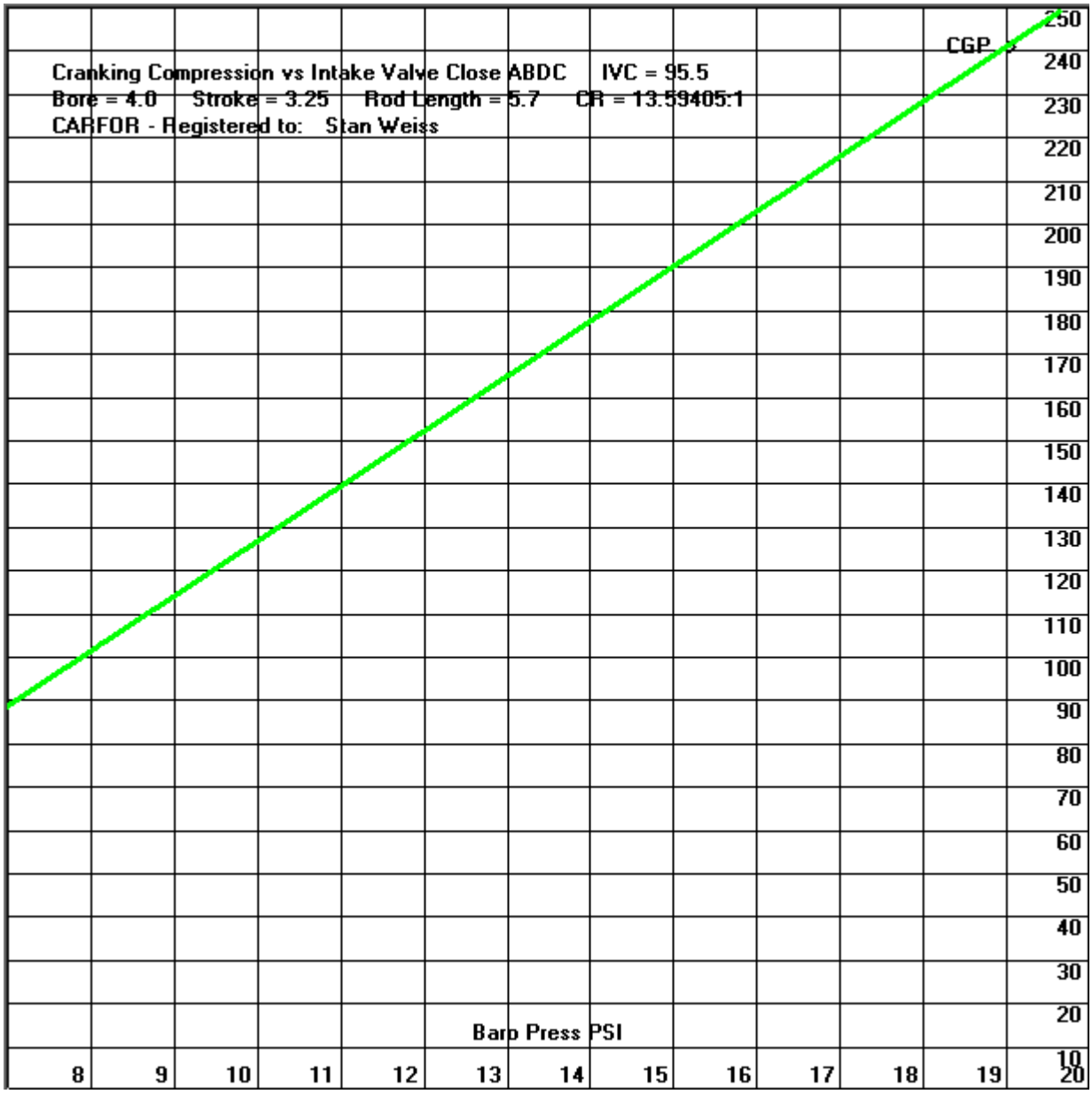
Graph **Compression Ratio (Y-axis)** against **Intake Valve Closing** from BDC to 40 BTDC **(X-Axis)** for a fixed **Dynamic Compression Ratio**.



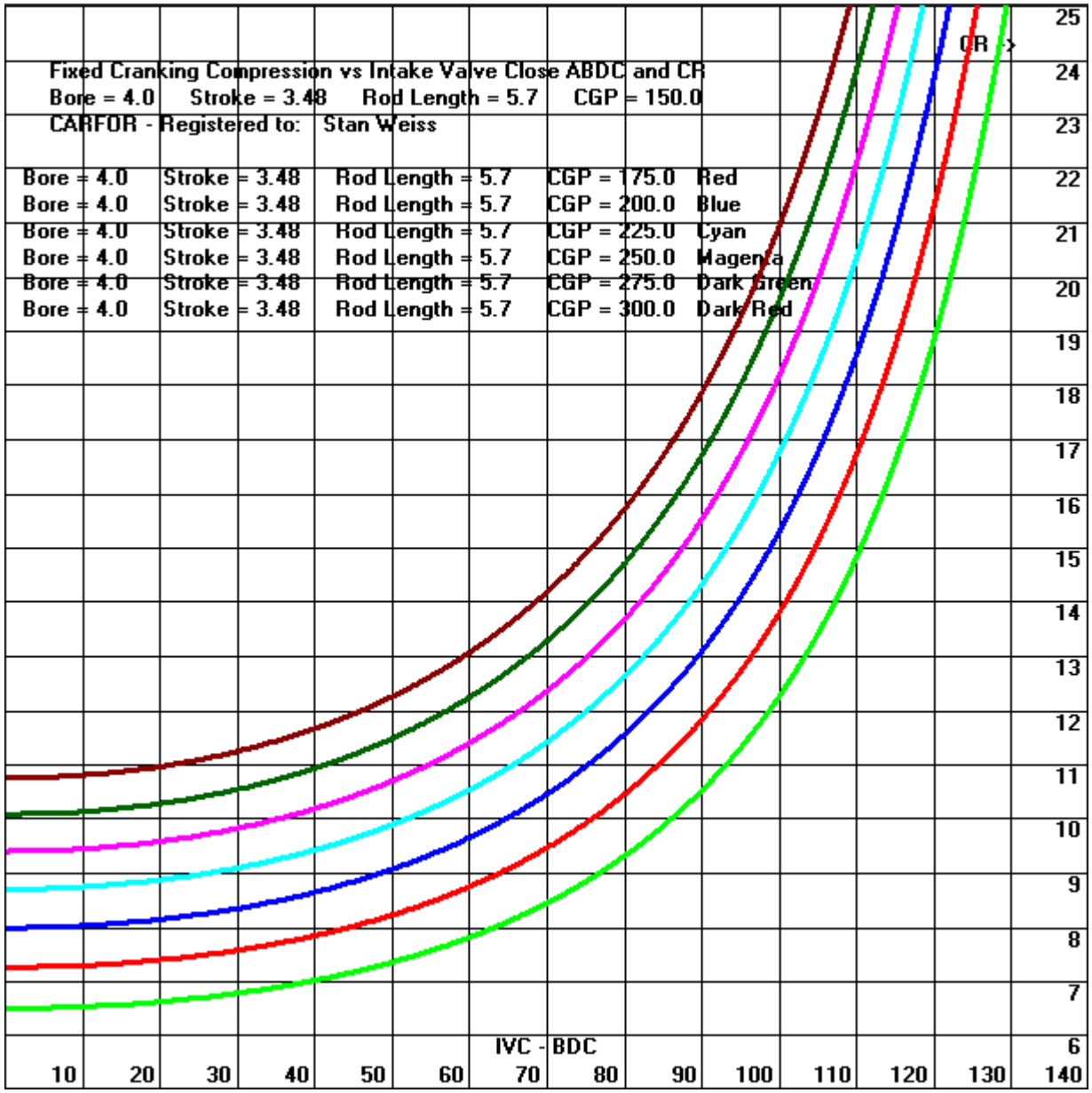
Graph **Compression Gauge Pressure - CGP (Y-axis)** against **Intake Valve Closing** from BDC to TDC **(X-Axis)**.



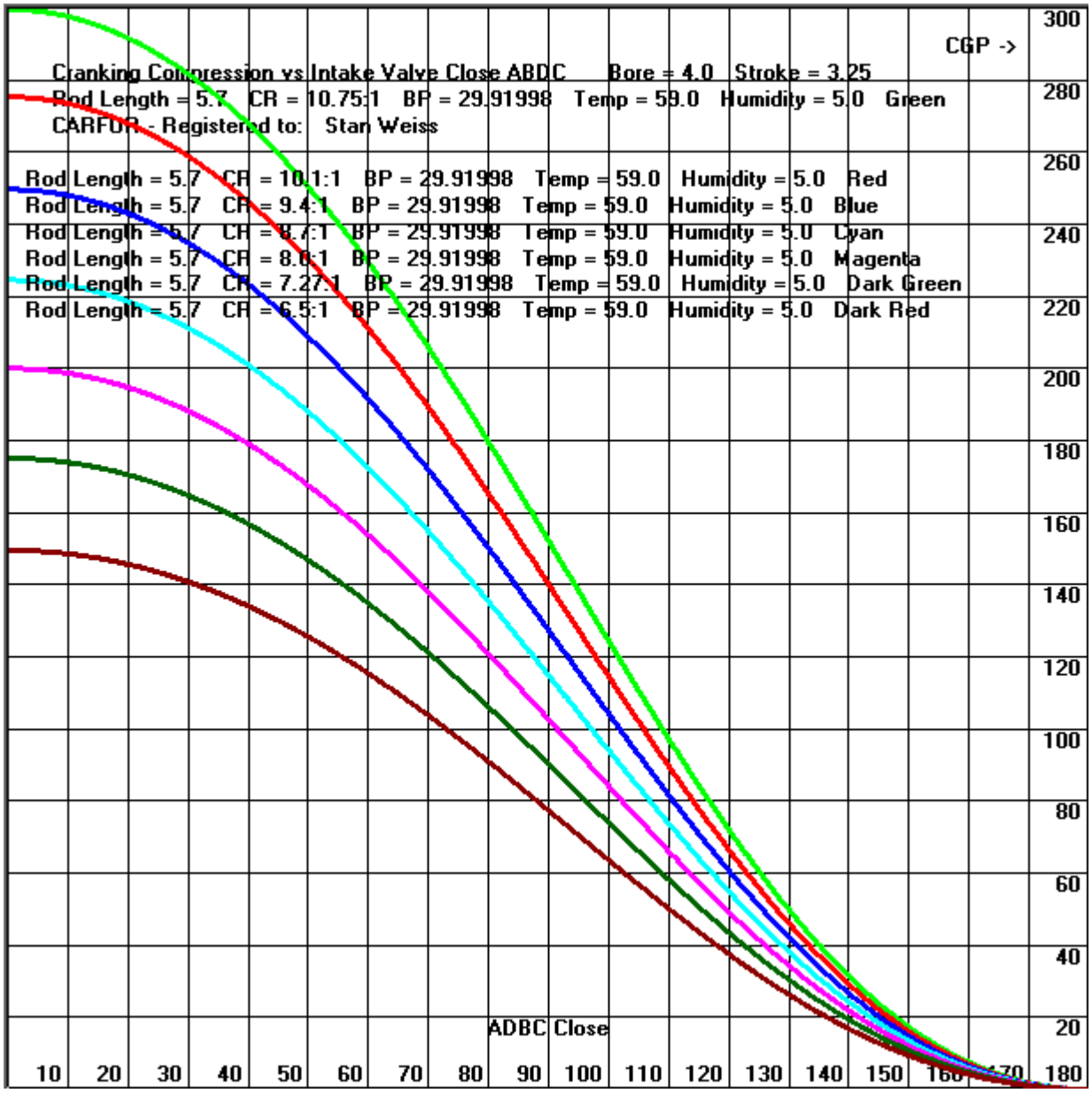
Graph **Compression Gauge Pressure - CGP (Y-axis)** against **BP (X-Axis)**.



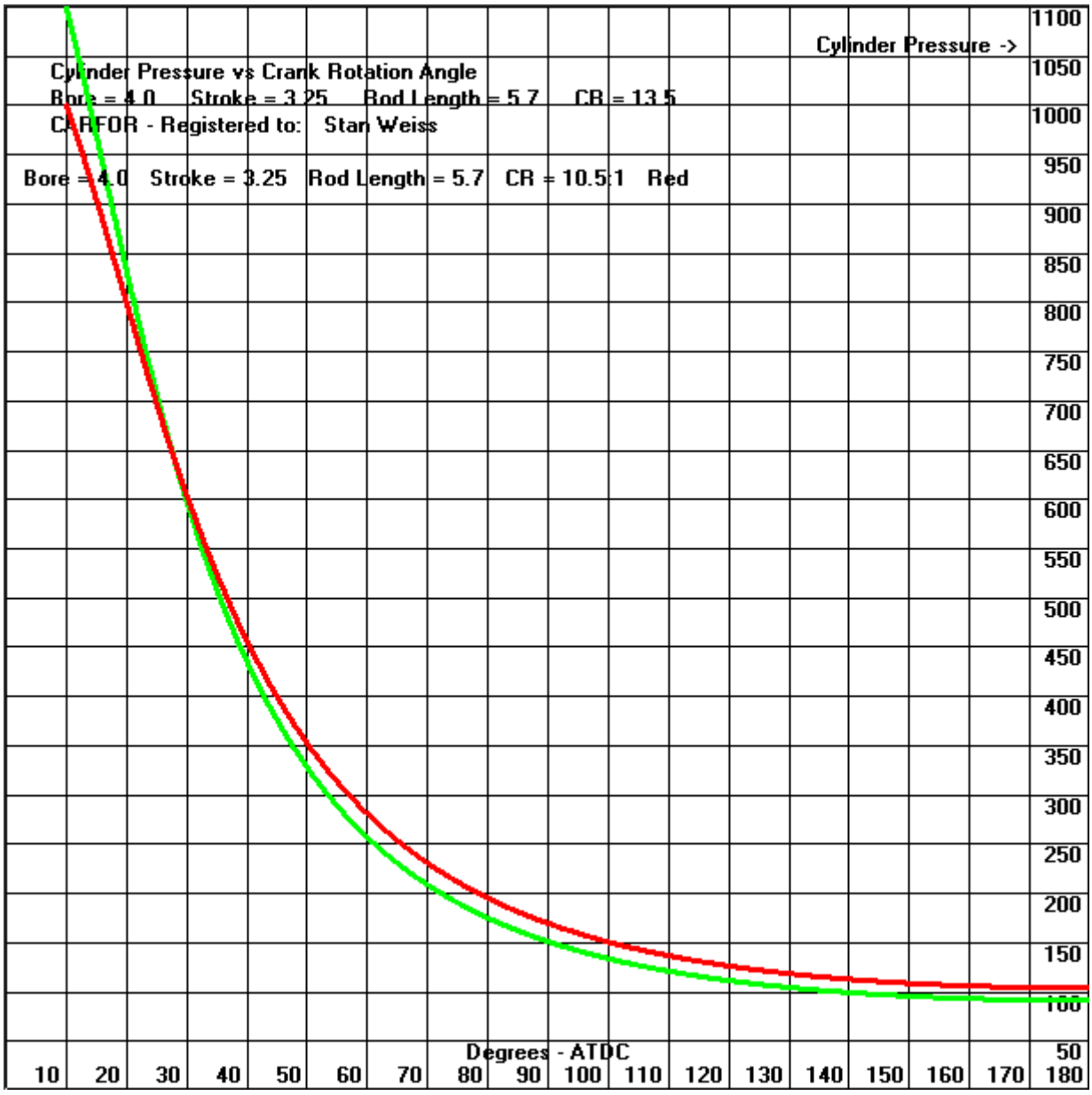
Graph **Compression Ratio (X-axis)** against **Intake Valve Closing (Y-Axis)** for a mixed CGP

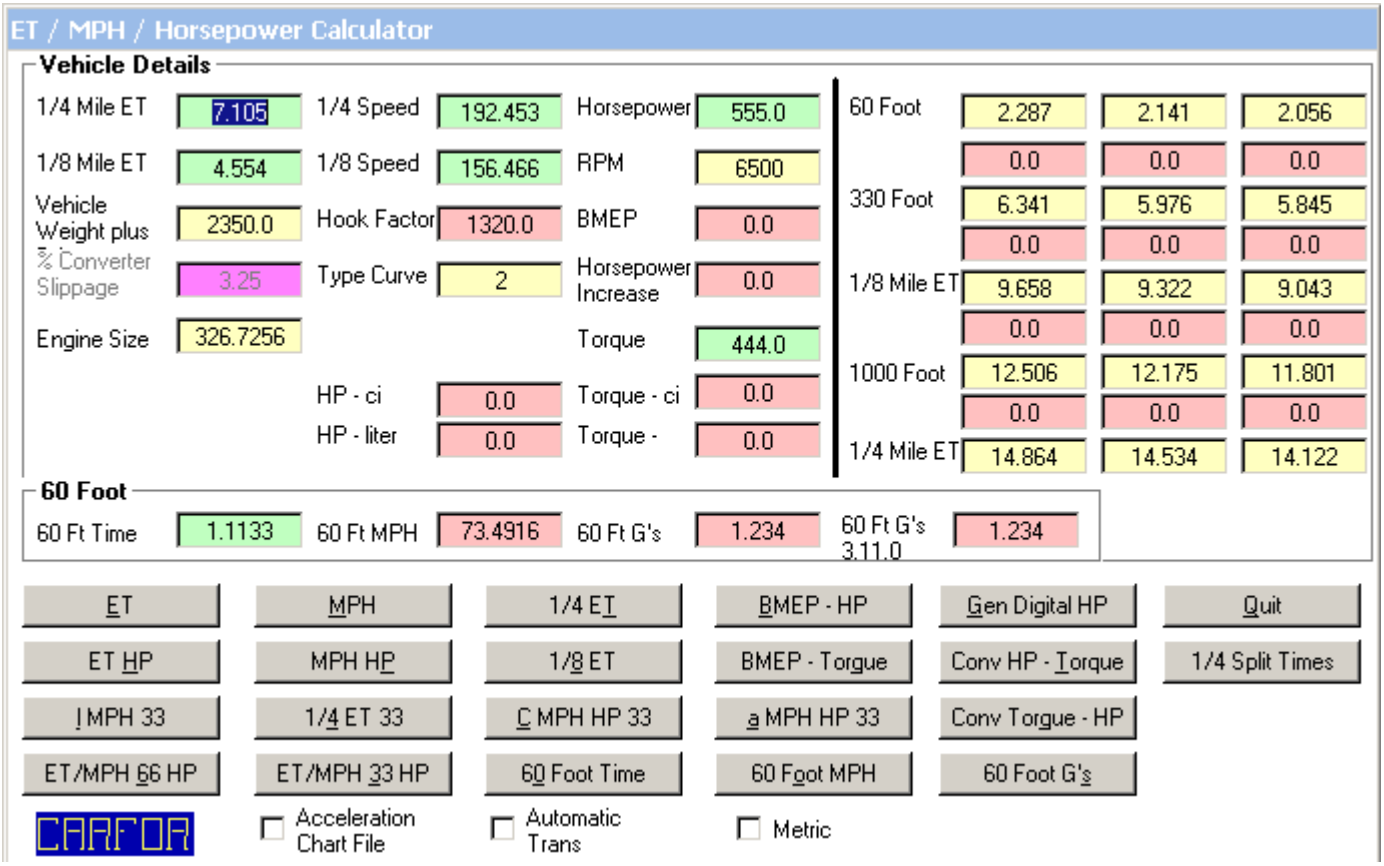


Graph **Cranking Compression Pressure (Y-axis)** against **Intake Valve Closing (X-Axis)** for a mixed CR



This Graph shows cylinder pressure drop from piston travel with no heat loss or EVO. Peak pressure is at 10 ATDC the green line has 1100 PSI and 13.5:1 CR. The red line has 1000 PSI and 10.5:1 CR. CR





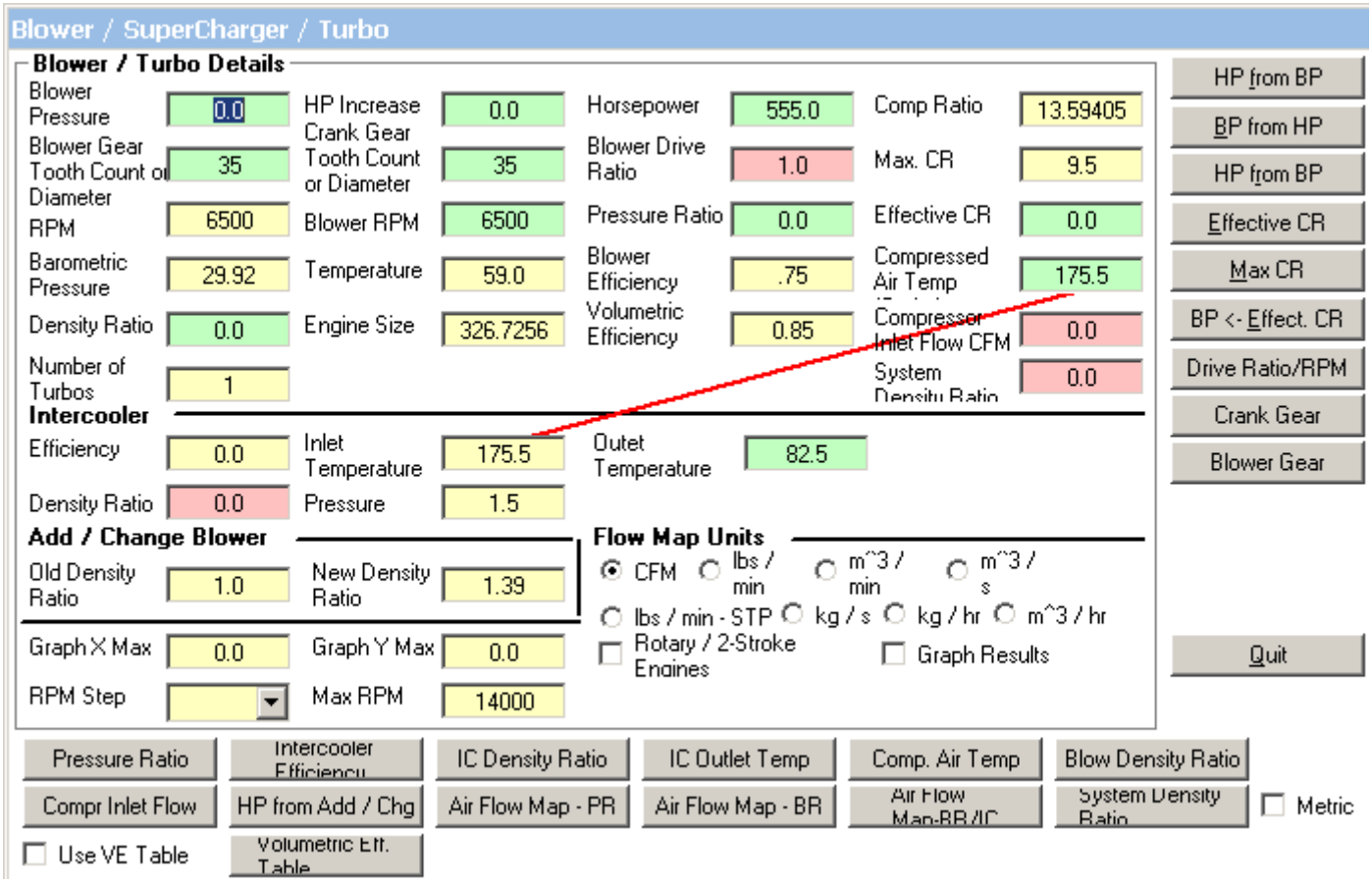
ET / MPH / HP

If the Automatic Trans box is checked the MPH numbers will be adjusted based on the % converter slippage. The % converter slippage is calculated on the GEAR screen.

1) Estimate 1/8 & 1/4 Mile ET from Vehicle Weight and Horsepower.
2) Estimate 1/8 & 1/4 Mile MPH from Vehicle Weight and Horsepower.
3) Estimate 1/4 Mile ET from 1/4 Mile MPH.
4) Estimate 1/4 Mile Horsepower requirement from ET and Vehicle Weight.
5) Estimate 1/4 Mile Horsepower requirement from MPH and Vehicle Weight.
6) Estimate 1/8 Mile ET from 1/8 Mile MPH.
7) Convert Horsepower to Torque with RPM.
8) Convert Torque with RPM to Horsepower.
9) Calculate BMEP, Torque per Cubic Inch, and Torque per Liter from Torque and Cubic Inches.
10) Calculate BMEP from Horsepower, Cubic Inches and RPM.
11) Estimate 1/4 Mile MPH from Vehicle Weight and Horsepower for 33 foot Trap Speed.
12) Estimate 1/4 Mile ET from 1/4 Mile MPH for 33 foot Trap Speed.
13) Estimate 1/4 Mile Horsepower requirement from MPH - 33 foot Trap Speed.
14) Estimate 1/4 Mile Horsepower increase required to increase MPH by one - 33 foot Trap Speed.
15) Generate Generic Digital Horsepower Curve using Horsepower, RPM, Engine Size and Type Curve maybe 1 of 11 different curves. The user selects different curve types to find which one best matches his engine. You can also have the program write this data to a file for use with the Acceleration and Top Speed Calculator (Check the Acceleration Chart File box). Type Curve 10 and 11 uses Peak Torque in place of Horsepower. 10 - This is based on a high flat torque curve type engine. 11 - This is based on a turbo charged or Diesel engine.
16) Estimate 1/4 Mile Horsepower requirement from ET and MPH - 66 foot Trap Speed.
17) Estimate 1/4 Mile Horsepower requirement from ET and MPH - 33 foot Trap Speed.
18) Calculate Split times for up to 3 different runs. This lets you break the run down into 4 different time slices and see how each slice compares to the other runs.
19) Estimate 60 Foot Time form 1/4 ET.

20) Estimate 60 Foot MPH from 60-Foot Time.
21) Estimate Average Rate of Acceleration from Rest to 60 Foot using 60 Foot Time.
    a. This calculation assumes a constant rate of Acceleration.

Note: The 33 Trap speed Calculations are for today's tracks where the speed trap stops at the end of the ¼ mile, whereas the 66-trap speed can be used for much older MPH you may have or have gotten from old magazine articles.



BLOWERS

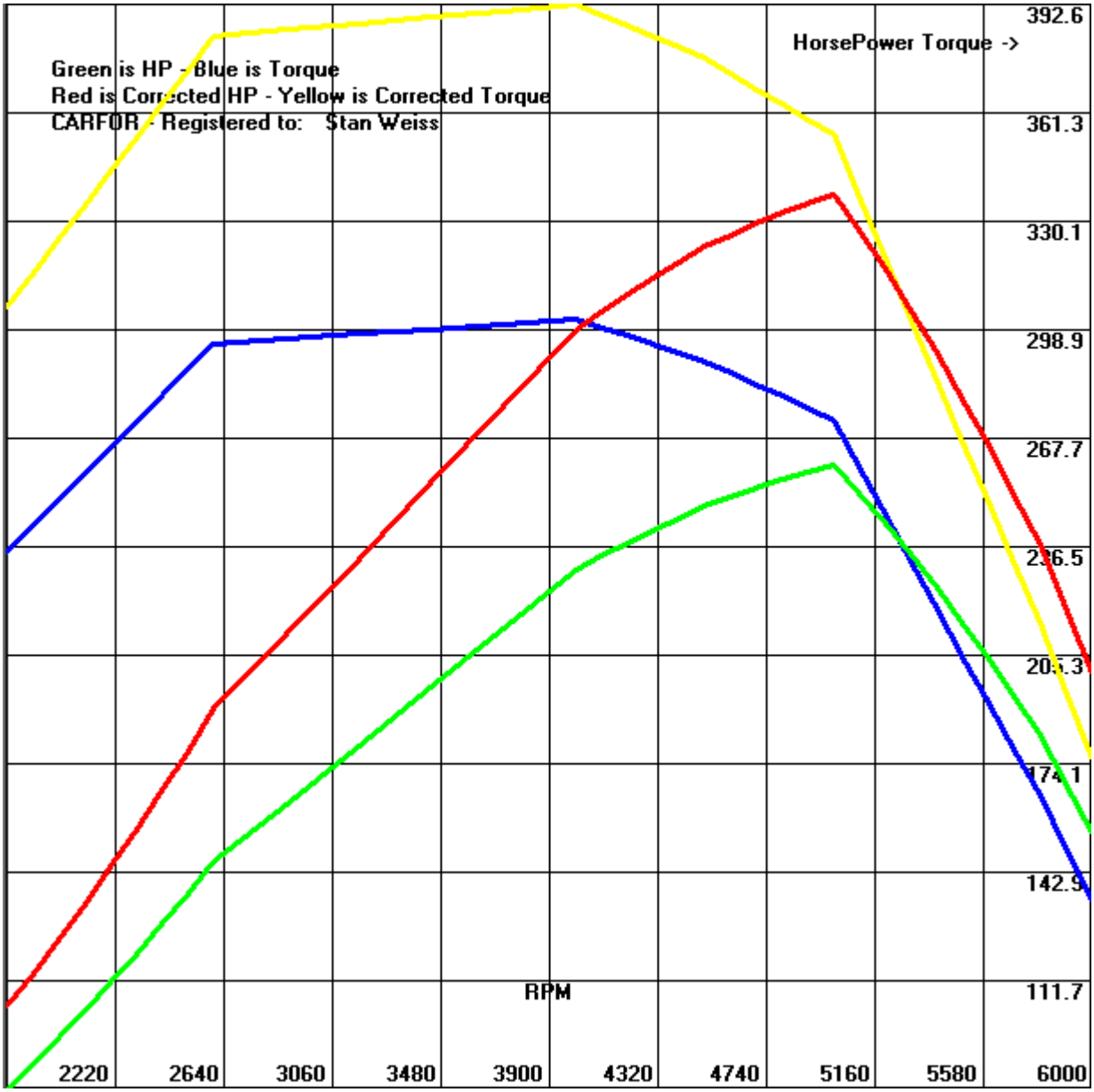
1) Estimate Horsepower (Increase) from adding blower pressure.
2) Estimate Blower Pressure needed from engine Horsepower and Horsepower increase wanted.
3) Estimate Original (Normal) Horsepower from Horsepower and Blower Pressure.
4) Estimate Effective Compression Ratio from Compression Ratio and blower Pressure.
5) Estimate Max Compression Ratio with Blower Pressure from normal (unblown) Max Compression Ratio Running the same fuel.
6) Estimate Blower Pressure needed from Effective Compression Ratio wanted and Compression Ratio.
7) Calculate Blower Drive Ratio and Blower RPM from RPM, Blower Gear and Crank Gear Tooth count.
8) Calculate Crank Gear from Blower RPM, RPM, and Blower Gear Tooth count.
9) Calculate Blower Gear from Blower RPM, RPM, and Crank Gear Tooth count.
10) Calculate Pressure Ratio from Blower Pressure and Barometric Pressure.
11) Calculate Intercooler Efficiency from Blower Outlet / Intercooler Inlet Temperature, Intercooler Outlet Temperature and Air Temperature.
12) Calculate Intercooler Density Ratio from Blower Pressure, Barometric Pressure, Intercooler Inlet Temperature, Intercooler Outlet Temperature, and Intercooler Pressure Loss.
13) Estimate Compressed Air Temperature from Pressure Ratio, Temperature, and Blower Efficiency.
14) Calculate Blower Density Ratio from Blower Pressure, Barometric Pressure, Blower Inlet Temperature, and Blower Outlet Temperature.
15) Calculate Compressor Inlet Flow in CFM. Using Engine Size, Rpm, Volumetric Efficiency, Blower Density Ratio, and Number of Turbos.
16) Graph HP and Torque also New HP and Torque. Using Old and New Density Ratio's.
17) Generate Blower / Turbo Flow Map Driven by Pressure Ratio using Engine Size and Volumetric Efficiency.

18) Generate Blower / Turbo Flow Map Driven by Boost Pressure and Density Ratio using Engine Size, Volumetric Efficiency, Temperature, Blower Efficiency and Barometric Pressure.
19) Generate Blower / Turbo Flow Map Driven by Boost Pressure and Density Ratio using Engine Size, Volumetric Efficiency, Temperature, Blower Efficiency, Barometric Pressure, Intercooler Outlet Temperature, and Intercooler Pressure Loss.
20) Calculate Intercooler Outlet Temperature from Intercooler Efficiency, Blower Outlet / Intercooler Inlet Temperature, and Air Temperature.
21) Calculate System Density Ratio from Intercooler Density Ratio and Blower Density Ratio.

NOTE: Use compressor maps to find the turbo(s) best suited to the airflow (CFM) and pressure ratios.

Notes: When adding a Blower to a Naturally Aspirated engine use an Old Density Ratio of 1. This uses a constant Density Ratio, which will not be true in real testing.

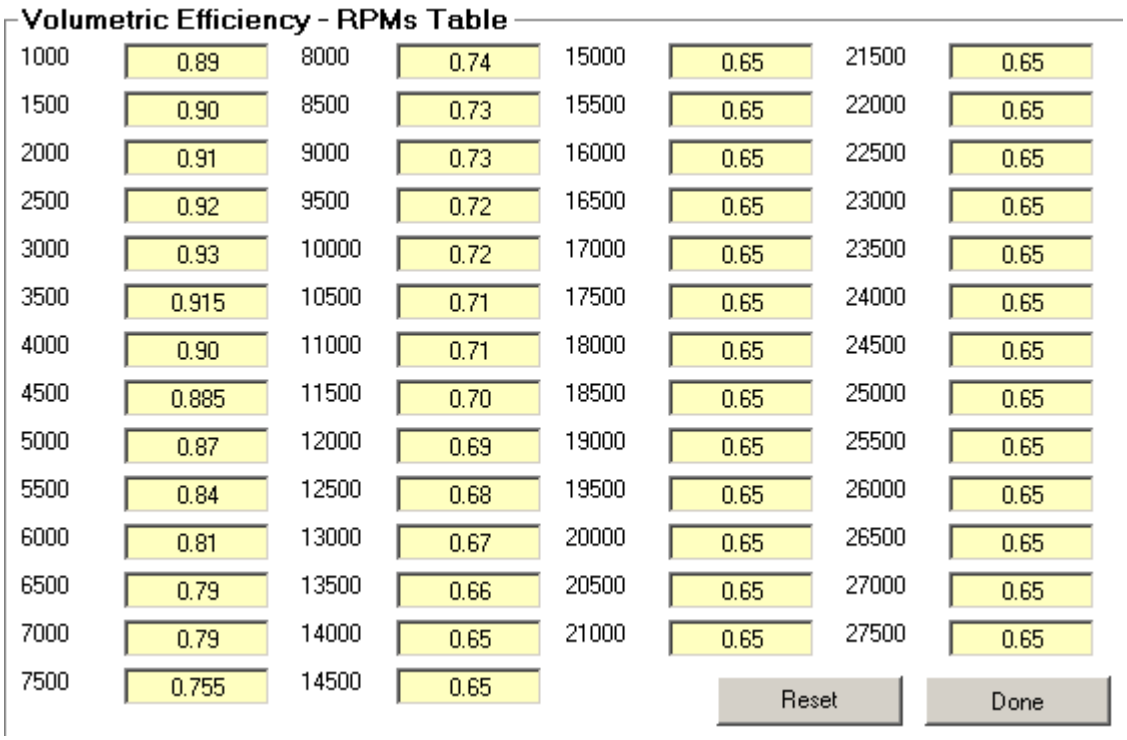
Graph **HP and Torque (Y-Axis)** also New HP and Torque. Using Old and New Density Ratio's. **RPM (X-axis).**



Generate **Blower / Turbo Flow Map** Driven by Boost Pressure and Density Ratio using Engine Size, Volumetric Efficiency, Temperature, Blower Efficiency and Barometric Pressure.

Engine Size = 280.865 Type Engine = 4-Stroke
Volumetric Efficiency = .850
Number of Turbos = 1
Units for Output Flow = CFM

Boost Pressure			RPM						Flow per Turbo				
PSI	BARS	Ratio	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000
.000	.000	1.0	69.1	103.6	138.2	172.7	207.2	241.8	276.3	310.9	345.4	379.9	414.5
1.470	.101	1.1	76.0	114.0	152.0	190.0	228.0	266.0	303.9	341.9	379.9	417.9	455.9
2.939	.203	1.2	82.9	124.3	165.8	207.2	248.7	290.1	331.6	373.0	414.5	455.9	497.4
4.409	.304	1.3	89.8	134.7	179.6	224.5	269.4	314.3	359.2	404.1	449.0	493.9	538.8
5.878	.405	1.4	96.7	145.1	193.4	241.8	290.1	338.5	386.8	435.2	483.5	531.9	580.3
7.348	.507	1.5	103.6	155.4	207.2	259.0	310.9	362.7	414.5	466.3	518.1	569.9	621.7
8.818	.608	1.6	110.5	165.8	221.1	276.3	331.6	386.8	442.1	497.4	552.6	607.9	663.2
10.287	.709	1.7	117.4	176.1	234.9	293.6	352.3	411.0	469.7	528.4	587.2	645.9	704.6
11.757	.811	1.8	124.3	186.5	248.7	310.9	373.0	435.2	497.4	559.5	621.7	683.9	746.0
13.226	.912	1.9	131.2	196.9	262.5	328.1	393.7	459.4	525.0	590.6	656.2	721.9	787.5
14.696	1.013	2.0	138.2	207.2	276.3	345.4	414.5	483.5	552.6	621.7	690.8	759.9	828.9
16.166	1.115	2.1	145.1	217.6	290.1	362.7	435.2	507.7	580.3	652.8	725.3	797.9	870.4
17.635	1.216	2.2	152.0	228.0	303.9	379.9	455.9	531.9	607.9	683.9	759.9	835.8	911.8
19.105	1.317	2.3	158.9	238.3	317.8	397.2	476.6	556.1	635.5	715.0	794.4	873.8	953.3
20.574	1.419	2.4	165.8	248.7	331.6	414.5	497.4	580.3	663.2	746.0	828.9	911.8	994.7
22.044	1.520	2.5	172.7	259.0	345.4	431.7	518.1	604.4	690.8	777.1	863.5	949.8	1036.2
23.514	1.621	2.6	179.6	269.4	359.2	449.0	538.8	628.6	718.4	808.2	898.0	987.8	1077.6
24.983	1.723	2.7	186.5	279.8	373.0	466.3	559.5	652.8	746.0	839.3	932.6	1025.8	1119.1
26.453	1.824	2.8	193.4	290.1	386.8	483.5	580.3	677.0	773.7	870.4	967.1	1063.8	1160.5
27.922	1.925	2.9	200.3	300.5	400.7	500.8	601.0	701.1	801.3	901.5	1001.6	1101.8	1202.0
29.392	2.027	3.0	207.2	310.9	414.5	518.1	621.7	725.3	828.9	932.6	1036.2	1139.8	1243.4
30.862	2.128	3.1	214.1	321.2	428.3	535.4	642.4	749.5	856.6	963.6	1070.7	1177.8	1284.9
32.331	2.229	3.2	221.1	331.6	442.1	552.6	663.2	773.7	884.2	994.7	1105.3	1215.8	1326.3
33.801	2.330	3.3	228.0	341.9	455.9	569.9	683.9	797.9	911.8	1025.8	1139.8	1253.8	1367.8
35.270	2.432	3.4	234.9	352.3	469.7	587.2	704.6	822.0	939.5	1056.9	1174.3	1291.8	1409.2
36.740	2.533	3.5	241.8	362.7	483.5	604.4	725.3	846.2	967.1	1088.0	1208.9	1329.8	1450.6
38.210	2.634	3.6	248.7	373.0	497.4	621.7	746.0	870.4	994.7	1119.1	1243.4	1367.8	1492.1
39.679	2.736	3.7	255.6	383.4	511.2	639.0	766.8	894.6	1022.4	1150.2	1277.9	1405.7	1533.5
41.149	2.837	3.8	262.5	393.7	525.0	656.2	787.5	918.7	1050.0	1181.2	1312.5	1443.7	1575.0
42.618	2.938	3.9	269.4	404.1	538.8	673.5	808.2	942.9	1077.6	1212.3	1347.0	1481.7	1616.4
44.088	3.040	4.0	276.3	414.5	552.6	690.8	828.9	967.1	1105.3	1243.4	1381.6	1519.7	1657.9
45.558	3.141	4.1	283.2	424.8	566.4	708.1	849.7	991.3	1132.9	1274.5	1416.1	1557.7	1699.3
47.027	3.242	4.2	290.1	435.2	580.3	725.3	870.4	1015.5	1160.5	1305.6	1450.6	1595.7	1740.8
48.497	3.344	4.3	297.0	445.6	594.1	742.6	891.1	1039.6	1188.1	1336.7	1485.2	1633.7	1782.2
49.966	3.445	4.4	303.9	455.9	607.9	759.9	911.8	1063.8	1215.8	1367.8	1519.7	1671.7	1823.7
51.436	3.546	4.5	310.9	466.3	621.7	777.1	932.6	1088.0	1243.4	1398.8	1554.3	1709.7	1865.1
52.906	3.648	4.6	317.8	476.6	635.5	794.4	953.3	1112.2	1271.0	1429.9	1588.8	1747.7	1906.6
54.375	3.749	4.7	324.7	487.0	649.3	811.7	974.0	1136.3	1298.7	1461.0	1623.3	1785.7	1948.0
55.845	3.850	4.8	331.6	497.4	663.2	828.9	994.7	1160.5	1326.3	1492.1	1657.9	1823.7	1989.5
57.314	3.952	4.9	338.5	507.7	677.0	846.2	1015.5	1184.7	1353.9	1523.2	1692.4	1861.7	2030.9
58.784	4.053	5.0	345.4	518.1	690.8	863.5	1036.2	1208.9	1381.6	1554.3	1727.0	1899.7	2072.4
PSI	BARS	Ratio	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000



Engine Size = 280.865 Type Engine = 4-Stroke
Volumetric Efficiency = .850
Number of Turbos = 1
Units for Output Flow = CFM

Boost Pressure			RPM				Flow per Turbo						
PSI	BARS	Ratio	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000
.000	.000	1.0	72.3	109.7	147.9	186.9	226.7	260.3	292.6	323.7	353.5	375.5	395.0
1.470	.101	1.1	79.6	120.7	162.7	205.6	249.4	286.3	321.8	356.0	388.9	413.0	434.5
2.939	.203	1.2	86.8	131.7	177.5	224.3	272.1	312.3	351.1	388.4	424.2	450.6	474.0
4.409	.304	1.3	94.0	142.6	192.3	243.0	294.8	338.3	380.3	420.7	459.6	488.1	513.5
5.878	.405	1.4	101.3	153.6	207.1	261.7	317.4	364.4	409.6	453.1	494.9	525.6	553.0
7.348	.507	1.5	108.5	164.6	221.9	280.4	340.1	390.4	438.9	485.5	530.3	563.2	592.4
8.818	.608	1.6	115.7	175.5	236.7	299.1	362.8	416.4	468.1	517.8	565.6	600.7	631.9
10.287	.709	1.7	123.0	186.5	251.4	317.8	385.5	442.4	497.4	550.2	601.0	638.3	671.4
11.757	.811	1.8	130.2	197.5	266.2	336.5	408.1	468.5	526.6	582.6	636.3	675.8	710.9
13.226	.912	1.9	137.4	208.5	281.0	355.1	430.8	494.5	555.9	614.9	671.7	713.4	750.4
14.696	1.013	2.0	144.7	219.4	295.8	373.8	453.5	520.5	585.1	647.3	707.0	750.9	789.9
16.166	1.115	2.1	151.9	230.4	310.6	392.5	476.2	546.6	614.4	679.7	742.4	788.5	829.4
17.635	1.216	2.2	159.1	241.4	325.4	411.2	498.8	572.6	643.6	712.0	777.7	826.0	868.9
19.105	1.317	2.3	166.4	252.3	340.2	429.9	521.5	598.6	672.9	744.4	813.1	863.6	908.4
20.574	1.419	2.4	173.6	263.3	355.0	448.6	544.2	624.6	702.2	776.8	848.4	901.1	947.9
22.044	1.520	2.5	180.8	274.3	369.8	467.3	566.8	650.7	731.4	809.1	883.8	938.7	987.4
23.514	1.621	2.6	188.1	285.3	384.6	486.0	589.5	676.7	760.7	841.5	919.1	976.2	1026.9
24.983	1.723	2.7	195.3	296.2	399.4	504.7	612.2	702.7	789.9	873.9	954.5	1013.7	1066.4
26.453	1.824	2.8	202.5	307.2	414.1	523.4	634.9	728.7	819.2	906.2	989.9	1051.3	1105.9
27.922	1.925	2.9	209.8	318.2	428.9	542.1	657.5	754.8	848.4	938.6	1025.2	1088.8	1145.4
29.392	2.027	3.0	217.0	329.1	443.7	560.8	680.2	780.8	877.7	971.0	1060.6	1126.4	1184.9
30.862	2.128	3.1	224.2	340.1	458.5	579.4	702.9	806.8	907.0	1003.3	1095.9	1163.9	1224.4
32.331	2.229	3.2	231.5	351.1	473.3	598.1	725.6	832.8	936.2	1035.7	1131.3	1201.5	1263.9
33.801	2.330	3.3	238.7	362.1	488.1	616.8	748.2	858.9	965.5	1068.1	1166.6	1239.0	1303.4
35.270	2.432	3.4	245.9	373.0	502.9	635.5	770.9	884.9	994.7	1100.4	1202.0	1276.6	1342.9
36.740	2.533	3.5	253.2	384.0	517.7	654.2	793.6	910.9	1024.0	1132.8	1237.3	1314.1	1382.4
38.210	2.634	3.6	260.4	395.0	532.5	672.9	816.3	936.9	1053.2	1165.1	1272.7	1351.7	1421.9
39.679	2.736	3.7	267.6	405.9	547.3	691.6	838.9	963.0	1082.5	1197.5	1308.0	1389.2	1461.4
41.149	2.837	3.8	274.9	416.9	562.1	710.3	861.6	989.0	1111.8	1229.9	1343.4	1426.8	1500.9
PSI	BARS	Ratio	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000
Boost Pressure			RPM				Flow per Turbo						

Engine Size = 280.865 Type Engine = 4-Stroke
Volumetric Efficiency = .850
Number of Turbos = 1
Units for Output Flow = lbs/min -- Raised Temperature

Boost Pressure			RPM				Flow per Turbo					
PSI	BARS	Ratio	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000
.000	.000	1.0	4.77	7.15	9.53	11.92	14.30	16.68	19.07	21.45	23.83	26.22	28.60
1.470	.101	1.1	5.24	7.86	10.49	13.11	15.73	18.35	20.97	23.59	26.22	28.84	31.46
2.939	.203	1.2	5.72	8.58	11.44	14.30	17.16	20.02	22.88	25.74	28.60	31.46	34.32
4.409	.304	1.3	6.20	9.29	12.39	15.49	18.59	21.69	24.79	27.88	30.98	34.08	37.18
5.878	.405	1.4	6.67	10.01	13.35	16.68	20.02	23.36	26.69	30.03	33.36	36.70	40.04
7.348	.507	1.5	7.15	10.72	14.30	17.87	21.45	25.02	28.60	32.17	35.75	39.32	42.90
8.818	.608	1.6	7.63	11.44	15.25	19.07	22.88	26.69	30.51	34.32	38.13	41.94	45.76
10.287	.709	1.7	8.10	12.15	16.21	20.26	24.31	28.36	32.41	36.46	40.51	44.57	48.62
11.757	.811	1.8	8.58	12.87	17.16	21.45	25.74	30.03	34.32	38.61	42.90	47.19	51.48
13.226	.912	1.9	9.06	13.58	18.11	22.64	27.17	31.70	36.22	40.75	45.28	49.81	54.34
14.696	1.013	2.0	9.53	14.30	19.07	23.83	28.60	33.36	38.13	42.90	47.66	52.43	57.20
16.166	1.115	2.1	10.01	15.01	20.02	25.02	30.03	35.03	40.04	45.04	50.05	55.05	60.06
17.635	1.216	2.2	10.49	15.73	20.97	26.22	31.46	36.70	41.94	47.19	52.43	57.67	62.92
19.105	1.317	2.3	10.96	16.44	21.93	27.41	32.89	38.37	43.85	49.33	54.81	60.30	65.78
20.574	1.419	2.4	11.44	17.16	22.88	28.60	34.32	40.04	45.76	51.48	57.20	62.92	68.64
22.044	1.520	2.5	11.92	17.87	23.83	29.79	35.75	41.71	47.66	53.62	59.58	65.54	71.50
23.514	1.621	2.6	12.39	18.59	24.79	30.98	37.18	43.37	49.57	55.77	61.96	68.16	74.36
24.983	1.723	2.7	12.87	19.30	25.74	32.17	38.61	45.04	51.48	57.91	64.35	70.78	77.22
26.453	1.824	2.8	13.35	20.02	26.69	33.36	40.04	46.71	53.38	60.06	66.73	73.40	80.08
27.922	1.925	2.9	13.82	20.73	27.65	34.56	41.47	48.38	55.29	62.20	69.11	76.02	82.94
29.392	2.027	3.0	14.30	21.45	28.60	35.75	42.90	50.05	57.20	64.35	71.50	78.65	85.80
30.862	2.128	3.1	14.78	22.16	29.55	36.94	44.33	51.72	59.10	66.49	73.88	81.27	88.66
32.331	2.229	3.2	15.25	22.88	30.51	38.13	45.76	53.38	61.01	68.64	76.26	83.89	91.52
33.801	2.330	3.3	15.73	23.59	31.46	39.32	47.19	55.05	62.92	70.78	78.65	86.51	94.37
35.270	2.432	3.4	16.21	24.31	32.41	40.51	48.62	56.72	64.82	72.93	81.03	89.13	97.23

Engine Size = 280.865 Type Engine = 4-Stroke
Volumetric Efficiency = .850
Number of Turbos = 1
Units for Output Flow = m^3/min

Boost Pressure			RPM				Flow per Turbo					
PSI	BARS	Ratio	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000
.000	.000	1.0	1.956	2.934	3.912	4.890	5.868	6.846	7.824	8.802	9.780	10.758	11.736
1.470	.101	1.1	2.152	3.228	4.303	5.379	6.455	7.531	8.607	9.683	10.758	11.834	12.910
2.939	.203	1.2	2.347	3.521	4.695	5.868	7.042	8.216	9.389	10.563	11.736	12.910	14.084
4.409	.304	1.3	2.543	3.814	5.086	6.357	7.629	8.900	10.172	11.443	12.715	13.986	15.257
5.878	.405	1.4	2.739	4.108	5.477	6.846	8.216	9.585	10.954	12.323	13.693	15.062	16.431
7.348	.507	1.5	2.934	4.401	5.868	7.335	8.802	10.269	11.736	13.204	14.671	16.138	17.605
8.818	.608	1.6	3.130	4.695	6.259	7.824	9.389	10.954	12.519	14.084	15.649	17.214	18.778
10.287	.709	1.7	3.325	4.988	6.651	8.313	9.976	11.639	13.301	14.964	16.627	18.289	19.952
11.757	.811	1.8	3.521	5.281	7.042	8.802	10.563	12.323	14.084	15.844	17.605	19.365	21.126
13.226	.912	1.9	3.717	5.575	7.433	9.291	11.150	13.008	14.866	16.724	18.583	20.441	22.299
14.696	1.013	2.0	3.912	5.868	7.824	9.780	11.736	13.693	15.649	17.605	19.561	21.517	23.473
16.166	1.115	2.1	4.108	6.162	8.216	10.269	12.323	14.377	16.431	18.485	20.539	22.593	24.647
17.635	1.216	2.2	4.303	6.455	8.607	10.758	12.910	15.062	17.214	19.365	21.517	23.669	25.820
19.105	1.317	2.3	4.499	6.748	8.998	11.247	13.497	15.746	17.996	20.245	22.495	24.744	26.994
20.574	1.419	2.4	4.695	7.042	9.389	11.736	14.084	16.431	18.778	21.126	23.473	25.820	28.168
22.044	1.520	2.5	4.890	7.335	9.780	12.225	14.671	17.116	19.561	22.006	24.451	26.896	29.341
23.514	1.621	2.6	5.086	7.629	10.172	12.715	15.257	17.800	20.343	22.886	25.429	27.972	30.515
24.983	1.723	2.7	5.281	7.922	10.563	13.204	15.844	18.485	21.126	23.766	26.407	29.048	31.688
26.453	1.824	2.8	5.477	8.216	10.954	13.693	16.431	19.170	21.908	24.647	27.385	30.124	32.862
27.922	1.925	2.9	5.673	8.509	11.345	14.182	17.018	19.854	22.691	25.527	28.363	31.199	34.036
29.392	2.027	3.0	5.868	8.802	11.736	14.671	17.605	20.539	23.473	26.407	29.341	32.275	35.209
30.862	2.128	3.1	6.064	9.096	12.128	15.160	18.192	21.223	24.255	27.287	30.319	33.351	36.383
32.331	2.229	3.2	6.259	9.389	12.519	15.649	18.778	21.908	25.038	28.168	31.297	34.427	37.557
33.801	2.330	3.3	6.455	9.683	12.910	16.138	19.365	22.593	25.820	29.048	32.275	35.503	38.730
35.270	2.432	3.4	6.651	9.976	13.301	16.627	19.952	23.277	26.603	29.928	33.253	36.579	39.904

Generate **Blower / Turbo Flow Map** Driven by Boost Pressure and Density Ratio using Engine Size, Volumetric Efficiency, Temperature, Blower Efficiency and Barometric Pressure.

Engine Size = 280.865 Type Engine = 4-Stroke
Volumetric Efficiency = .850 Blower Efficiency = .750
Number of Turbos = 1
Units for Output Flow = CFM

Boost PSI	Pressure BARS	Ratio	Output Temp	Blower Ratio	Air Density	RPM 1000	1500	2000	2500	Flow per Turbo 3000	3500	4000	4500	5000
2.00	.138	1.1361	84.44	1.0830	0.07293	74.8	112.2	149.6	187.0	224.4	261.8	299.2	336.7	374.1
3.00	.207	1.2041	96.35	1.1233	0.07137	77.6	116.4	155.2	194.0	232.8	271.6	310.4	349.2	388.0
4.00	.276	1.2722	107.79	1.1629	0.06994	80.3	120.5	160.7	200.8	241.0	281.2	321.3	361.5	401.6
5.00	.345	1.3402	118.79	1.2018	0.06861	83.0	124.5	166.0	207.5	249.1	290.6	332.1	373.6	415.1
6.00	.414	1.4083	129.40	1.2401	0.06737	85.7	128.5	171.3	214.2	257.0	299.8	342.6	385.5	428.3
7.00	.483	1.4763	139.65	1.2778	0.06622	88.3	132.4	176.5	220.7	264.8	308.9	353.1	397.2	441.3
8.00	.552	1.5444	149.57	1.3149	0.06514	90.8	136.2	181.7	227.1	272.5	317.9	363.3	408.7	454.2
9.00	.621	1.6124	159.18	1.3516	0.06413	93.4	140.0	186.7	233.4	280.1	326.8	373.5	420.1	466.8
10.00	.689	1.6805	168.50	1.3877	0.06318	95.9	143.8	191.7	239.7	287.6	335.5	383.4	431.4	479.3
11.00	.758	1.7485	177.55	1.4234	0.06228	98.3	147.5	196.7	245.8	295.0	344.1	393.3	442.5	491.6
12.00	.827	1.8165	186.36	1.4586	0.06143	100.8	151.1	201.5	251.9	302.3	352.7	403.0	453.4	503.8
13.00	.896	1.8846	194.93	1.4935	0.06063	103.2	154.8	206.3	257.9	309.5	361.1	412.7	464.3	515.8
14.00	.965	1.9526	203.28	1.5279	0.05987	105.5	158.3	211.1	263.9	316.6	369.4	422.2	475.0	527.7
15.00	1.034	2.0207	211.43	1.5620	0.05914	107.9	161.8	215.8	269.7	323.7	377.6	431.6	485.5	539.5
16.00	1.103	2.0887	219.38	1.5957	0.05845	110.2	165.3	220.5	275.6	330.7	385.8	440.9	496.0	551.1
17.00	1.172	2.1568	227.15	1.6290	0.05779	112.5	168.8	225.1	281.3	337.6	393.9	450.1	506.4	562.7
18.00	1.241	2.2248	234.74	1.6621	0.05716	114.8	172.2	229.6	287.0	344.4	401.8	459.3	516.7	574.1
19.00	1.310	2.2929	242.17	1.6948	0.05655	117.1	175.6	234.1	292.7	351.2	409.8	468.3	526.8	585.4
20.00	1.379	2.3609	249.45	1.7272	0.05597	119.3	179.0	238.6	298.3	357.9	417.6	477.2	536.9	596.6
21.00	1.448	2.4290	256.57	1.7593	0.05541	121.5	182.3	243.1	303.8	364.6	425.4	486.1	546.9	607.6
22.00	1.517	2.4970	263.55	1.7911	0.05488	123.7	185.6	247.5	309.3	371.2	433.1	494.9	556.8	618.6
23.00	1.586	2.5651	270.40	1.8227	0.05437	125.9	188.9	251.8	314.8	377.7	440.7	503.6	566.6	629.5
24.00	1.655	2.6331	277.12	1.8540	0.05387	128.1	192.1	256.1	320.2	384.2	448.2	512.3	576.3	640.4
25.00	1.724	2.7011	283.71	1.8850	0.05339	130.2	195.3	260.4	325.5	390.6	455.8	520.9	586.0	651.1
26.00	1.793	2.7692	290.19	1.9158	0.05293	132.3	198.5	264.7	330.9	397.0	463.2	529.4	595.5	661.7
27.00	1.862	2.8372	296.56	1.9464	0.05249	134.5	201.7	268.9	336.1	403.4	470.6	537.8	605.0	672.3
28.00	1.931	2.9053	302.81	1.9767	0.05206	136.6	204.8	273.1	341.4	409.7	477.9	546.2	614.5	682.8
29.00	1.999	2.9733	308.96	2.0069	0.05164	138.6	207.9	277.3	346.6	415.9	485.2	554.5	623.8	693.2
30.00	2.068	3.0414	315.01	2.0368	0.05124	140.7	211.0	281.4	351.7	422.1	492.4	562.8	633.1	703.5
31.00	2.137	3.1094	320.97	2.0665	0.05085	142.7	214.1	285.5	356.9	428.2	499.6	571.0	642.4	713.7
32.00	2.206	3.1775	326.83	2.0959	0.05047	144.8	217.2	289.6	362.0	434.4	506.7	579.1	651.5	723.9
33.00	2.275	3.2455	332.60	2.1252	0.05010	146.8	220.2	293.6	367.0	440.4	513.8	587.2	660.6	734.0
34.00	2.344	3.3136	338.29	2.1543	0.04974	148.8	223.2	297.6	372.0	446.5	520.9	595.3	669.7	744.1
35.00	2.413	3.3816	343.89	2.1833	0.04940	150.8	226.2	301.6	377.0	452.4	527.9	603.3	678.7	754.1
36.00	2.482	3.4496	349.42	2.2120	0.04906	152.8	229.2	305.6	382.0	458.4	534.8	611.2	687.6	764.0
37.00	2.551	3.5177	354.86	2.2405	0.04873	154.8	232.2	309.5	386.9	464.3	541.7	619.1	696.5	773.9
38.00	2.620	3.5857	360.23	2.2689	0.04841	156.7	235.1	313.5	391.8	470.2	548.6	626.9	705.3	783.7
39.00	2.689	3.6538	365.53	2.2972	0.04810	158.7	238.0	317.4	396.7	476.1	555.4	634.7	714.1	793.4
40.00	2.758	3.7218	370.76	2.3252	0.04780	160.6	240.9	321.2	401.6	481.9	562.2	642.5	722.8	803.1
41.00	2.827	3.7899	375.92	2.3531	0.04750	162.5	243.8	325.1	406.4	487.6	568.9	650.2	731.5	812.7
42.00	2.896	3.8579	381.01	2.3808	0.04722	164.5	246.7	328.9	411.2	493.4	575.6	657.9	740.1	822.3
43.00	2.965	3.9260	386.04	2.4084	0.04693	166.4	249.6	332.7	415.9	499.1	582.3	665.5	748.7	831.9
44.00	3.034	3.9940	391.01	2.4359	0.04666	168.3	252.4	336.5	420.7	504.8	588.9	673.1	757.2	841.3
45.00	3.103	4.0621	395.92	2.4632	0.04639	170.2	255.2	340.3	425.4	510.5	595.5	680.6	765.7	850.8
46.00	3.172	4.1301	400.77	2.4903	0.04613	172.0	258.0	344.1	430.1	516.1	602.1	688.1	774.1	860.1
47.00	3.241	4.1981	405.56	2.5173	0.04588	173.9	260.8	347.8	434.7	521.7	608.6	695.6	782.5	869.5
48.00	3.309	4.2662	410.30	2.5442	0.04563	175.8	263.6	351.5	439.4	527.3	615.1	703.0	790.9	878.8
49.00	3.378	4.3342	414.98	2.5710	0.04538	177.6	266.4	355.2	444.0	532.8	621.6	710.4	799.2	888.0
50.00	3.447	4.4023	419.61	2.5976	0.04514	179.4	269.2	358.9	448.6	538.3	628.0	717.8	807.5	897.2
PSI	BARS	Ratio	Temp	Ratio	Density	1000	1500	2000	2500	3000	3500	4000	4500	5000
Boost	Pressure	Output	Blower	Air		RPM				Flow per Turbo				

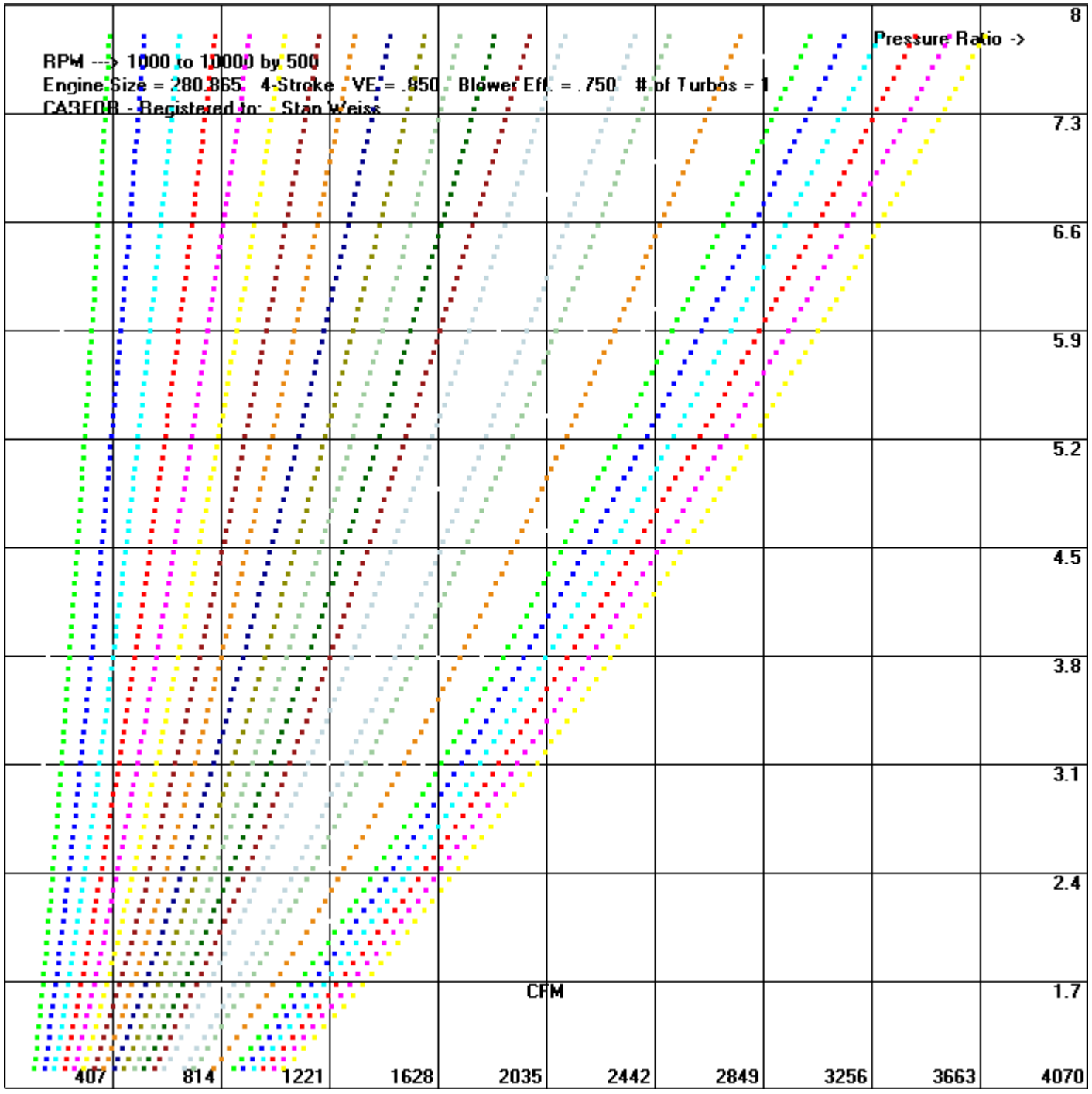
Generate **Blower / Turbo Flow Map** Driven by Boost Pressure and Density Ratio using Engine Size, Volumetric Efficiency, Temperature, Blower Efficiency, Barometric Pressure, Intercooler Outlet Temperature, and Intercooler Pressure Loss.

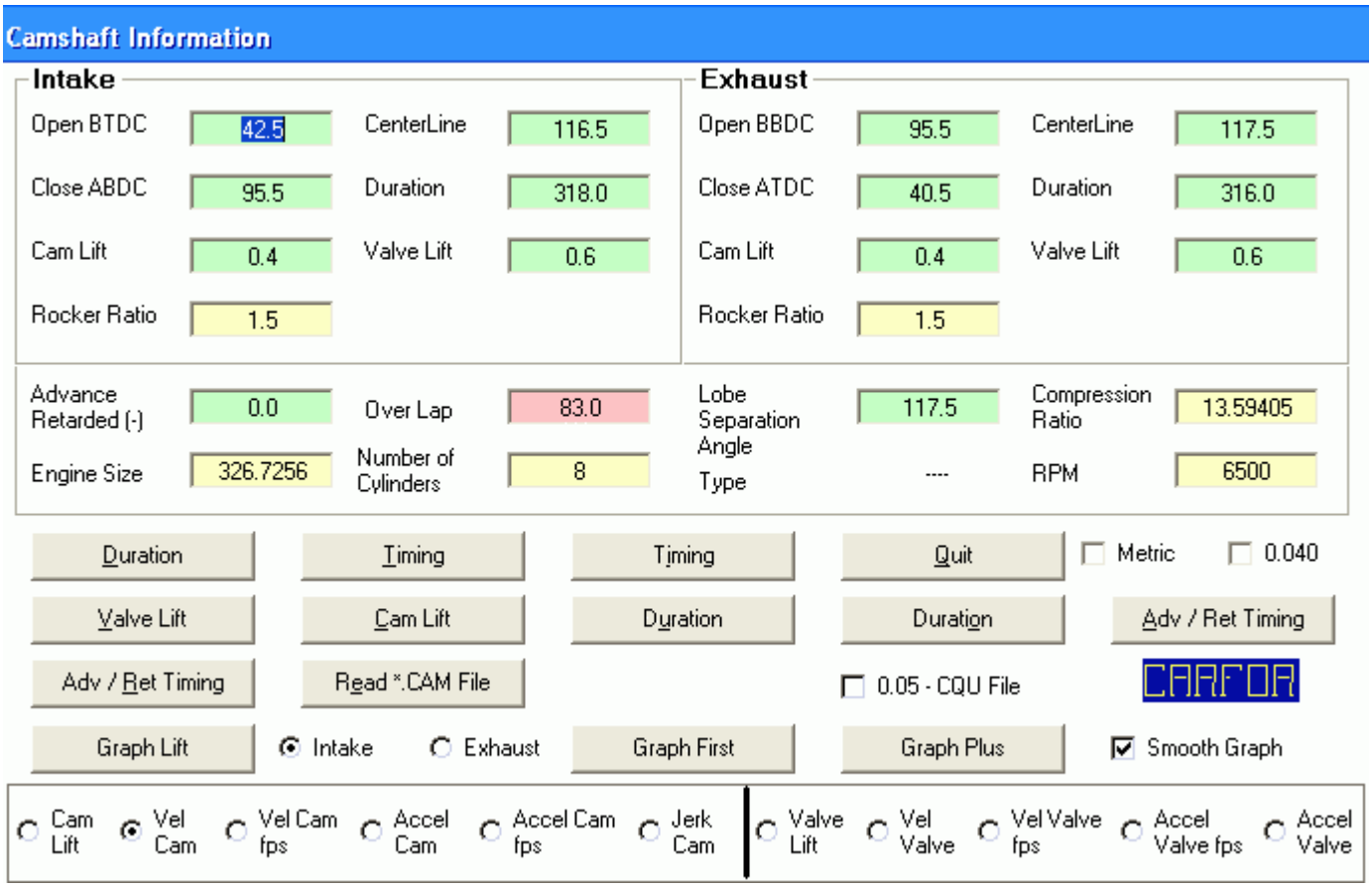
```
Engine Size = 280.865        Type Engine = 4-Stroke
Volumetric Efficiency = .850      Blower Efficiency = .750
InterCooler Outlet Temp = 82.500      InterCooler Pressure Loss = 1.500
Number of Turbos = 1
Units for Output Flow = CFM
```

Boost Pressure PSI	BARS	Ratio	Output Temp	Blower Air Ratio	Density Ratio	IC Ratio	RPM 1000	1500	2000	2500	Flow per Turbo 3000	3500	4000	4500
2.0	.138	1.136	84.44	1.083	0.07293	.913	.989	68.3	102.5	136.7	170.8	205.0	239.2	273.3	307.5
3.0	.207	1.204	96.35	1.123	0.07137	.939	1.054	72.8	109.2	145.7	182.1	218.5	254.9	291.3	327.7
4.0	.276	1.272	107.79	1.163	0.06994	.963	1.119	77.3	116.0	154.7	193.3	232.0	270.7	309.3	348.0
5.0	.345	1.340	118.79	1.202	0.06861	.986	1.185	81.8	122.7	163.7	204.6	245.5	286.4	327.3	368.2
6.0	.414	1.408	129.40	1.240	0.06737	1.008	1.250	86.3	129.5	172.6	215.8	259.0	302.1	345.3	388.5
7.0	.483	1.476	139.65	1.278	0.06622	1.029	1.315	90.8	136.2	181.6	227.1	272.5	317.9	363.3	408.7
8.0	.552	1.544	149.57	1.315	0.06514	1.049	1.380	95.3	143.0	190.6	238.3	286.0	333.6	381.3	428.9
9.0	.621	1.612	159.18	1.352	0.06413	1.069	1.445	99.8	149.7	199.6	249.5	299.4	349.3	399.3	449.2
10.0	.689	1.680	168.50	1.388	0.06318	1.088	1.510	104.3	156.5	208.6	260.8	312.9	365.1	417.2	469.4
11.0	.758	1.749	177.55	1.423	0.06228	1.107	1.575	108.8	163.2	217.6	272.0	326.4	380.8	435.2	489.6
12.0	.827	1.817	186.36	1.459	0.06143	1.124	1.640	113.3	170.0	226.6	283.3	339.9	396.6	453.2	509.9
13.0	.896	1.885	194.93	1.493	0.06063	1.142	1.705	117.8	176.7	235.6	294.5	353.4	412.3	471.2	530.1
14.0	.965	1.953	203.28	1.528	0.05987	1.159	1.770	122.3	183.4	244.6	305.7	366.9	428.0	489.2	550.3
15.0	1.034	2.021	211.43	1.562	0.05914	1.175	1.836	126.8	190.2	253.6	317.0	380.4	443.8	507.2	570.6
16.0	1.103	2.089	219.38	1.596	0.05845	1.191	1.901	131.3	196.9	262.6	328.2	393.9	459.5	525.2	590.8
17.0	1.172	2.157	227.15	1.629	0.05779	1.207	1.966	135.8	203.7	271.6	339.5	407.4	475.3	543.2	611.1
18.0	1.241	2.225	234.74	1.662	0.05716	1.222	2.031	140.3	210.4	280.6	350.7	420.9	491.0	561.2	631.3
19.0	1.310	2.293	242.17	1.695	0.05655	1.237	2.096	144.8	217.2	289.6	362.0	434.4	506.7	579.1	651.5
20.0	1.379	2.361	249.45	1.727	0.05597	1.251	2.161	149.3	223.9	298.6	373.2	447.8	522.5	597.1	671.8
21.0	1.448	2.429	256.57	1.759	0.05541	1.265	2.226	153.8	230.7	307.6	384.4	461.3	538.2	615.1	692.0
22.0	1.517	2.497	263.55	1.791	0.05488	1.279	2.291	158.3	237.4	316.6	395.7	474.8	554.0	633.1	712.2
23.0	1.586	2.565	270.40	1.823	0.05437	1.293	2.356	162.8	244.2	325.5	406.9	488.3	569.7	651.1	732.5
24.0	1.655	2.633	277.12	1.854	0.05387	1.306	2.421	167.3	250.9	334.5	418.2	501.8	585.4	669.1	752.7
25.0	1.724	2.701	283.71	1.885	0.05339	1.319	2.487	171.8	257.7	343.5	429.4	515.3	601.2	687.1	773.0
26.0	1.793	2.769	290.19	1.916	0.05293	1.332	2.552	176.3	264.4	352.5	440.7	528.8	616.9	705.1	793.2
27.0	1.862	2.837	296.56	1.946	0.05249	1.344	2.617	180.8	271.1	361.5	451.9	542.3	632.7	723.0	813.4
28.0	1.931	2.905	302.81	1.977	0.05206	1.357	2.682	185.3	277.9	370.5	463.1	555.8	648.4	741.0	833.7
29.0	1.999	2.973	308.96	2.007	0.05164	1.369	2.747	189.8	284.6	379.5	474.4	569.3	664.1	759.0	853.9
30.0	2.068	3.041	315.01	2.037	0.05124	1.381	2.812	194.3	291.4	388.5	485.6	582.8	679.9	777.0	874.1
31.0	2.137	3.109	320.97	2.066	0.05085	1.392	2.877	198.8	298.1	397.5	496.9	596.3	695.6	795.0	894.4
32.0	2.206	3.177	326.83	2.096	0.05047	1.404	2.942	203.2	304.9	406.5	508.1	609.7	711.4	813.0	914.6
33.0	2.275	3.246	332.60	2.125	0.05010	1.415	3.007	207.7	311.6	415.5	519.4	623.2	727.1	831.0	934.8
34.0	2.344	3.314	338.29	2.154	0.04974	1.426	3.072	212.2	318.4	424.5	530.6	636.7	742.8	849.0	955.1
35.0	2.413	3.382	343.89	2.183	0.04940	1.437	3.138	216.7	325.1	433.5	541.8	650.2	758.6	867.0	975.3
36.0	2.482	3.450	349.42	2.212	0.04906	1.448	3.203	221.2	331.9	442.5	553.1	663.7	774.3	884.9	995.6
37.0	2.551	3.518	354.86	2.241	0.04873	1.458	3.268	225.7	338.6	451.5	564.3	677.2	790.1	902.9	1015.8
38.0	2.620	3.586	360.23	2.269	0.04841	1.469	3.333	230.2	345.3	460.5	575.6	690.7	805.8	920.9	1036.0
39.0	2.689	3.654	365.53	2.297	0.04810	1.479	3.398	234.7	352.1	469.5	586.8	704.2	821.5	938.9	1056.3
40.0	2.758	3.722	370.76	2.325	0.04780	1.489	3.463	239.2	358.8	478.4	598.1	717.7	837.3	956.9	1076.5
41.0	2.827	3.790	375.92	2.353	0.04750	1.499	3.528	243.7	365.6	487.4	609.3	731.2	853.0	974.9	1096.7
42.0	2.896	3.858	381.01	2.381	0.04722	1.509	3.593	248.2	372.3	496.4	620.5	744.7	868.8	992.9	1117.0
43.0	2.965	3.926	386.04	2.408	0.04693	1.519	3.658	252.7	379.1	505.4	631.8	758.1	884.5	1010.9	1137.2
44.0	3.034	3.994	391.01	2.436	0.04666	1.529	3.723	257.2	385.8	514.4	643.0	771.6	900.2	1028.8	1157.5
45.0	3.103	4.062	395.92	2.463	0.04639	1.538	3.789	261.7	392.6	523.4	654.3	785.1	916.0	1046.8	1177.7
46.0	3.172	4.130	400.77	2.490	0.04613	1.547	3.854	266.2	399.3	532.4	665.5	798.6	931.7	1064.8	1197.9
47.0	3.241	4.198	405.56	2.517	0.04588	1.557	3.919	270.7	406.1	541.4	676.8	812.1	947.5	1082.8	1218.2
48.0	3.309	4.266	410.30	2.544	0.04563	1.566	3.984	275.2	412.8	550.4	688.0	825.6	963.2	1100.8	1238.4
49.0	3.378	4.334	414.98	2.571	0.04538	1.575	4.049	279.7	419.5	559.4	699.2	839.1	978.9	1118.8	1258.6
50.0	3.447	4.402	419.61	2.598	0.04514	1.584	4.114	284.2	426.3	568.4	710.5	852.6	994.7	1136.8	1278.9
Boost Pressure PSI	BARS	Ratio	Output Temp	Blower Air Ratio	Density Ratio	IC Ratio	RPM 1000	1500	2000	2500	Flow per Turbo 3000	3500	4000	4500

Generate **Blower / Turbo Flow Map** Driven by Boost Pressure and Density Ratio using Engine Size, Volumetric Efficiency, Temperature, Blower Efficiency, Barometric Pressure, Intercooler Outlet Temperature, and Intercooler Pressure Loss.

This is the same as the above text screens, but with the **"Graph Results" Box checked.**





CAM_INFO

Lobe Separation Angle / Lobe Centerline - Is the amount of degrees between the exhaust centerline and the intake centerline and is the only measurement here in camshaft degrees. In a single camshaft engine this angle is set at the time the camshaft is ground and cannot be changed. This angle will normally vary between 100 to 120 degrees.

Overlap - Is the number of degrees that both the exhaust and intake valves are open at the same time.

Intake Centerline - Is the number of degrees ATDC at which maximum lift occurs.

Advance / Retard - Is the number of degrees the Intake centerline has been moved. Advancing the camshaft will reduce the centerline and improve mid range torque. Retarding will increase the centerline and improve high-end horsepower.

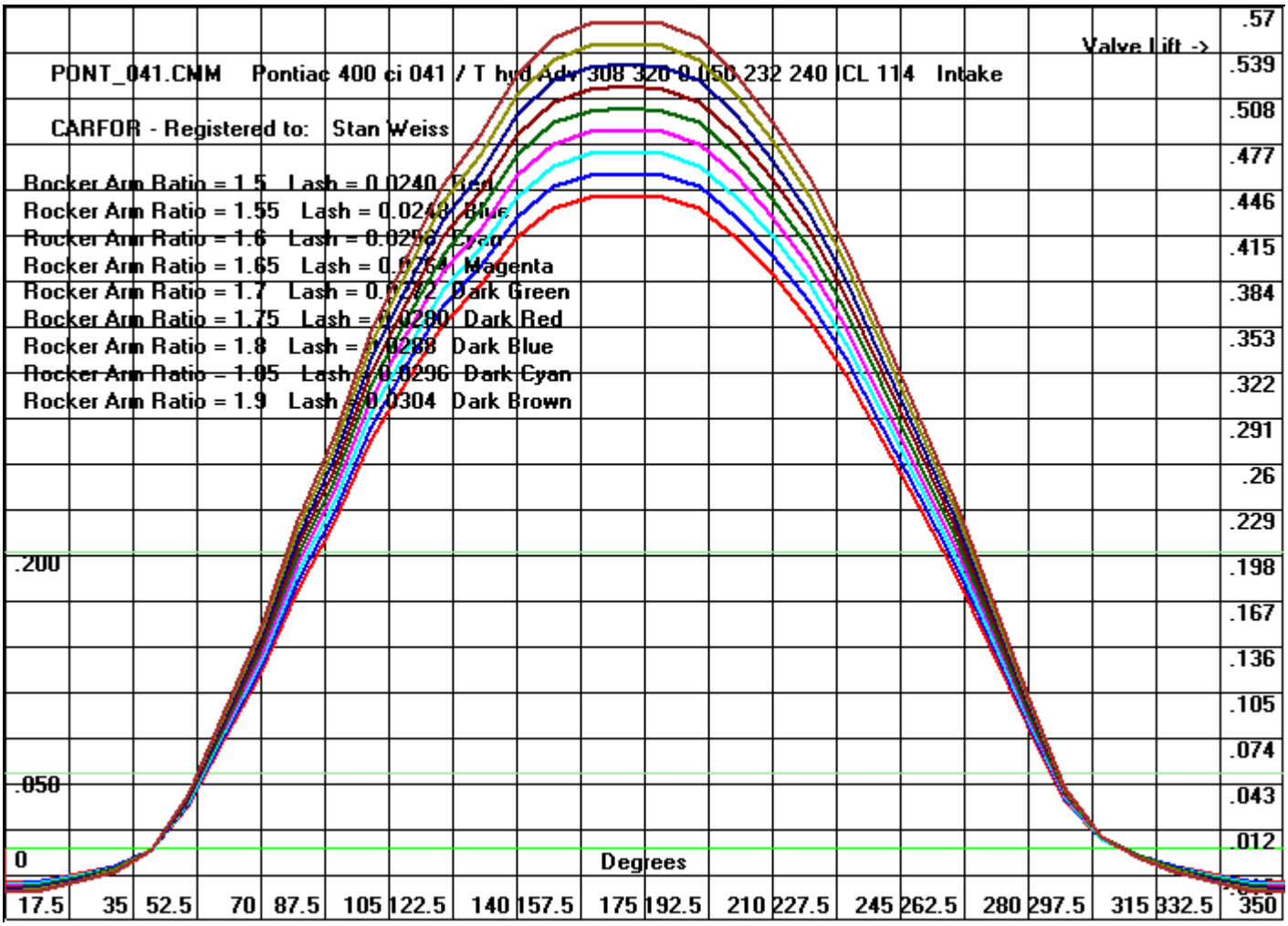
NOTE: - Calculation like CL or based on CL are only correct if the cam has a symmetrical lobe.

1) Calculate Cam Duration, Centerline, and Lobe Separation Angle from Cam Events.
2) Calculate Cam Events from Duration, Centerlines.
3) Calculate Cam Events from Duration, Intake Centerline, and Lobe Separation Angle.
4) Calculate Valve Lift from Cam Lift and Rocker Arm Ratio.
5) Calculate Cam Lift from Valve Lift and Rocker Arm Ratio.
6) Calculate Intake Duration from Compression Ratio.
7) Adjust All Cam Events using Advance / Retard, Duration and Centerlines.
8) Adjust All Cam Events using Advance / Retard and Cam Events".
9) Calculate Intake Duration from Compression Ratio, Engine Size, Number of Cylinders and RPM.
10) Read in (Open) Cam Information from a file. There are many *.cam and *.dyn files on the Internet for use with Dyno Programs. This will Read in (Open) these file and search for cam information.
11) Graph Lift - Will read in a cam information file *.CMM and Graph lift at valve using Rocker Arm Ratio and Valve Lash.
12) Graph First - Will read in a cam information file *.CMM and Graph selected function on a clean Graph.
13) Graph Plus - will add a second, third, etc. Graph to the present Graph.

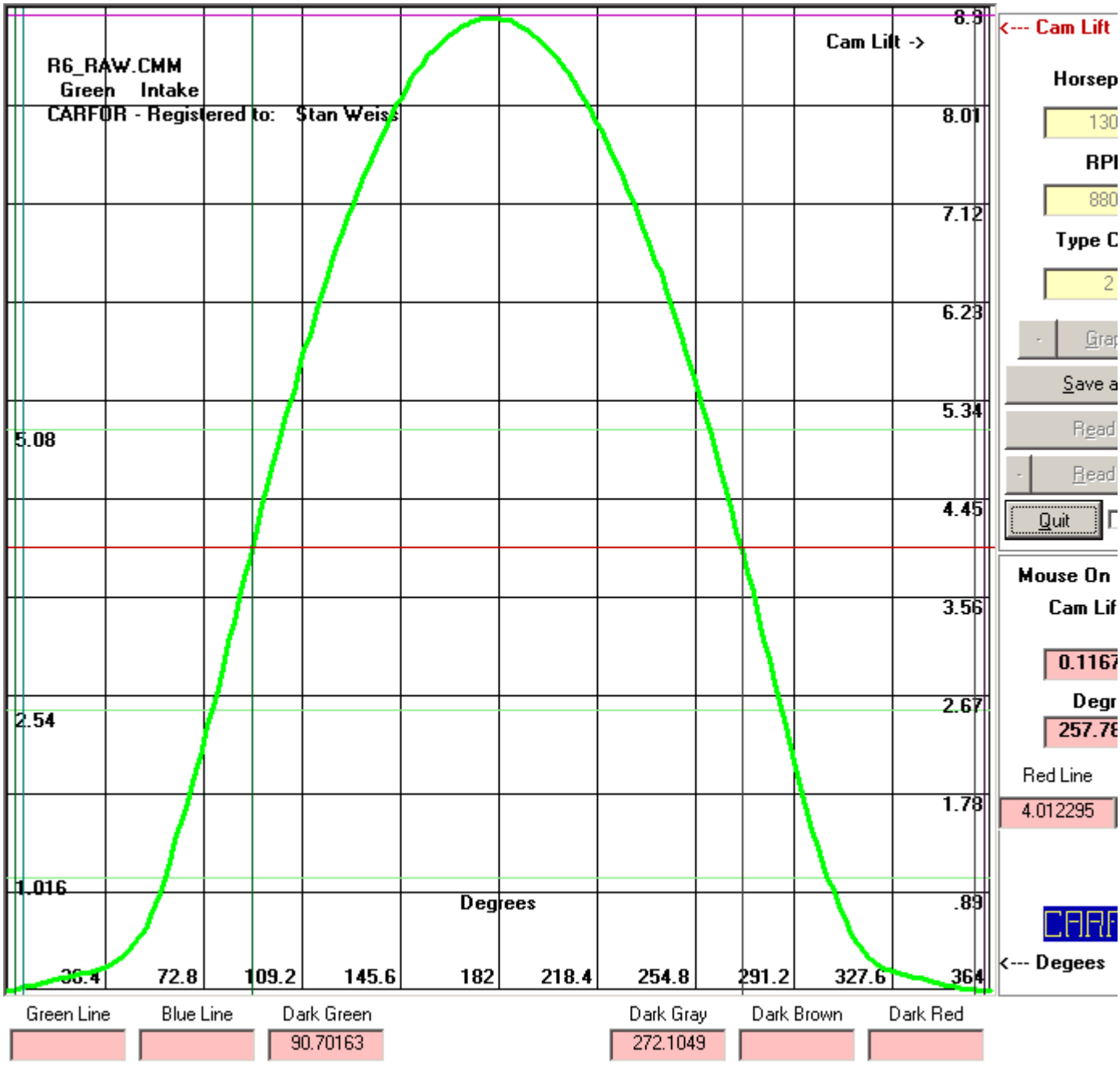
Use the Intake or exhaust radio buttons to select which lobe you want to Graph.

When Checked Smooth Graph will use an algorithm to smooth the Graphed data - see below.
When 0.040 box is Checked this will draw the line at 0.040" lift instead of 0.050" lift.

Graph Lift at Valve using Rocker Arm Ratio (Range) and Valve Lash Adjusted for ratio change which keeps the seat-to-seat duration the same.

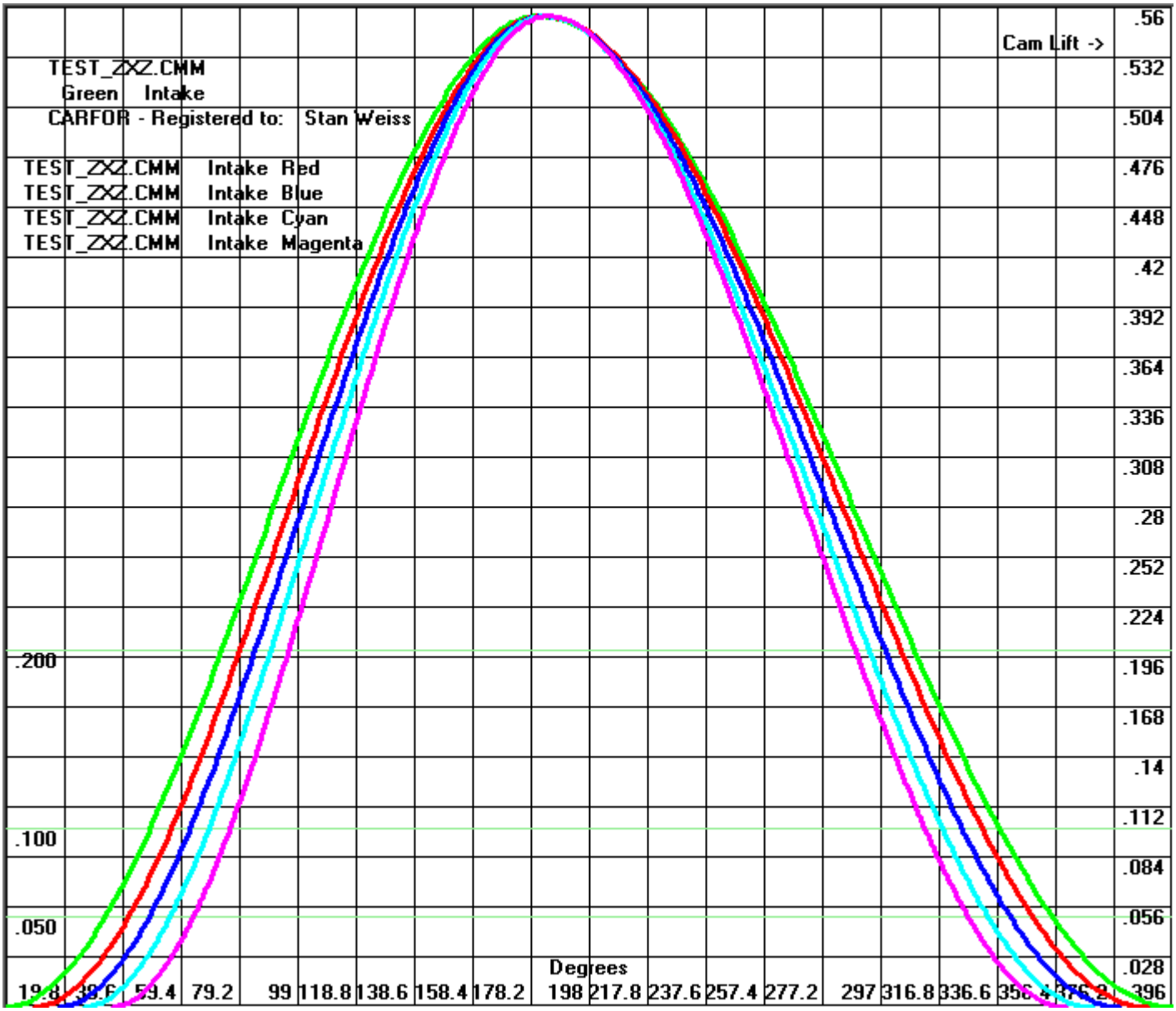


Graph Lift at the Cam with Metric and 0.040 Checked

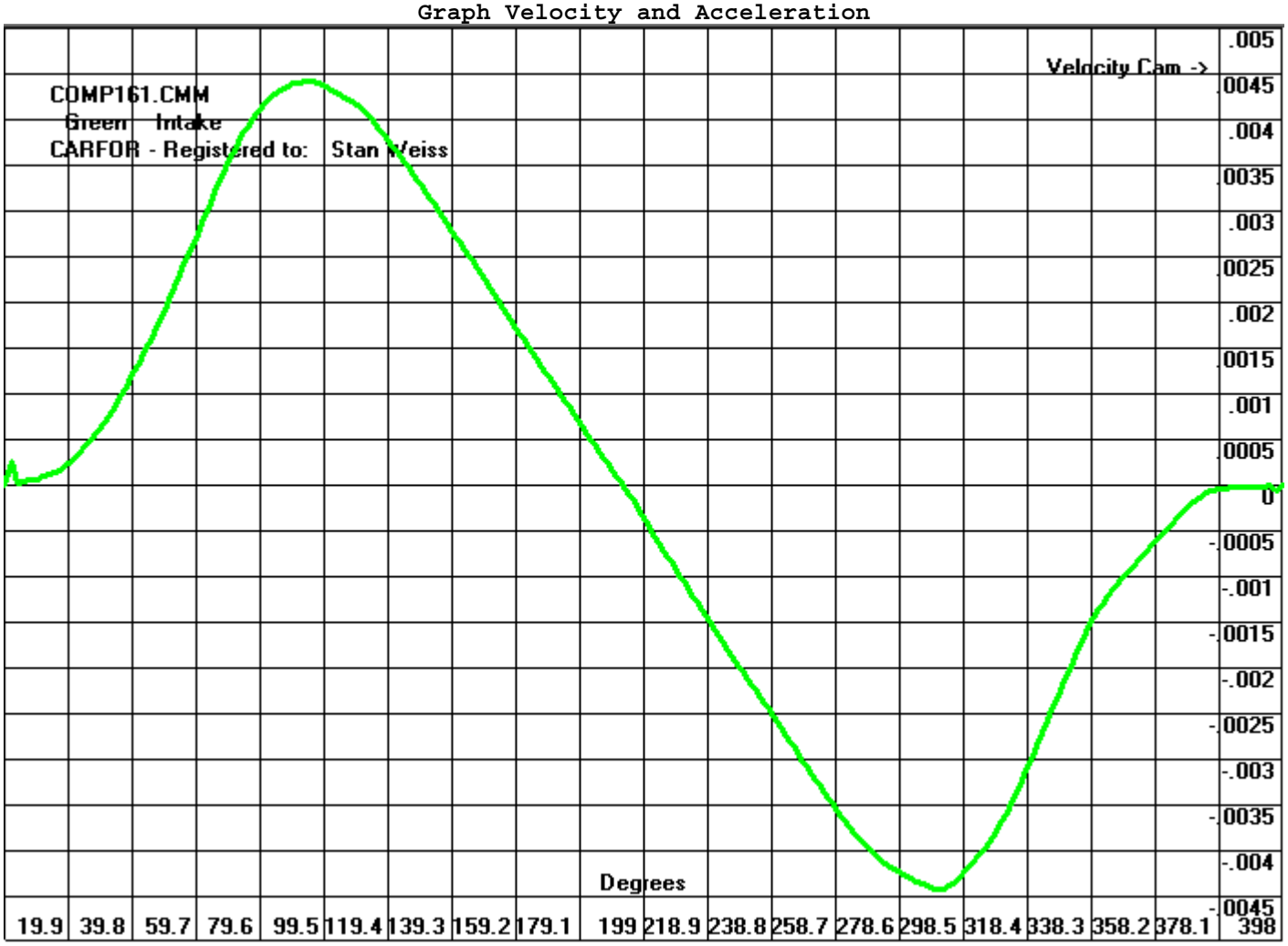


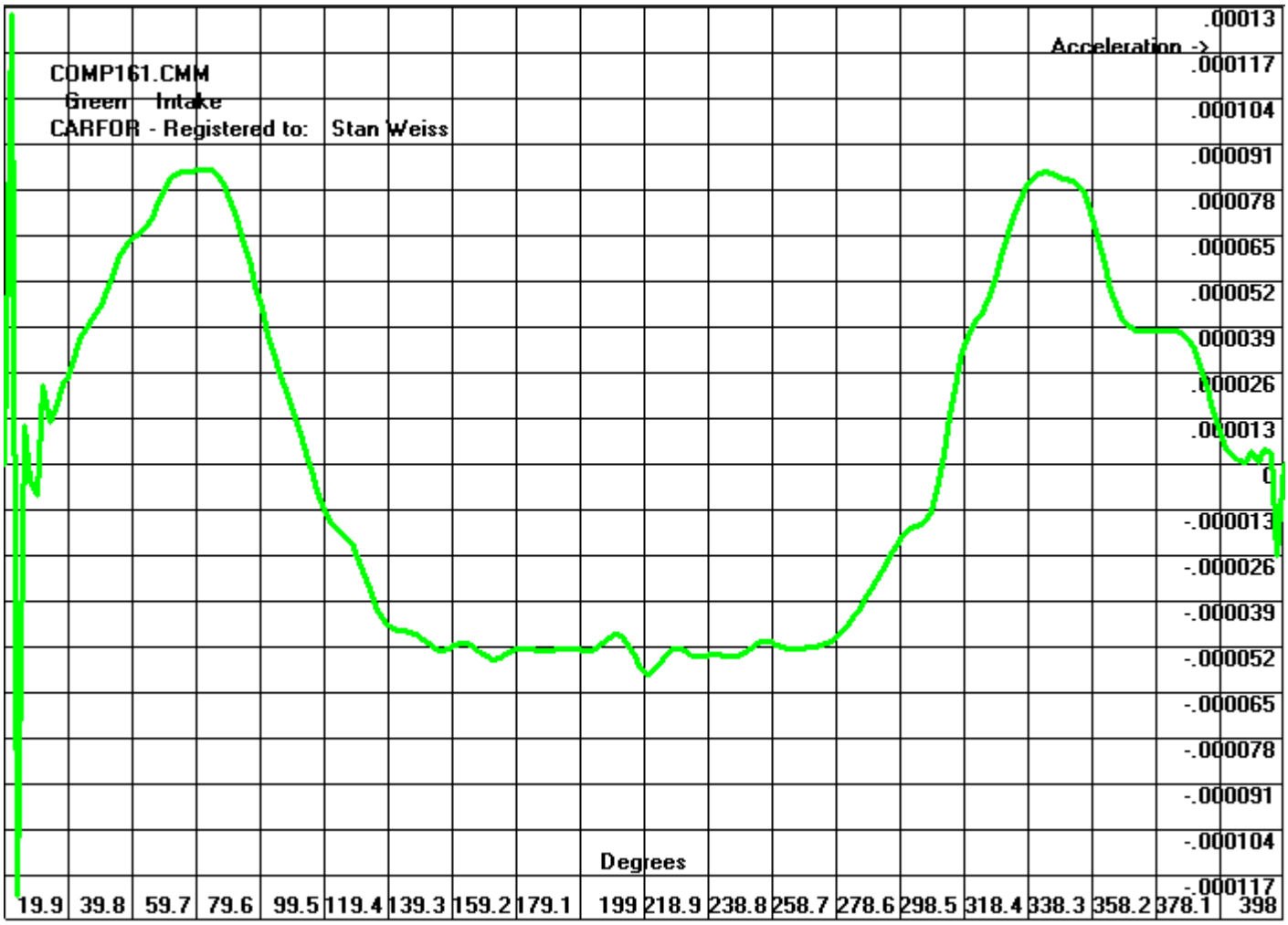
Graph Lift at the Cam with Different values for "every x degrees = " which show how this profile will look if the duration is increased or decreased.

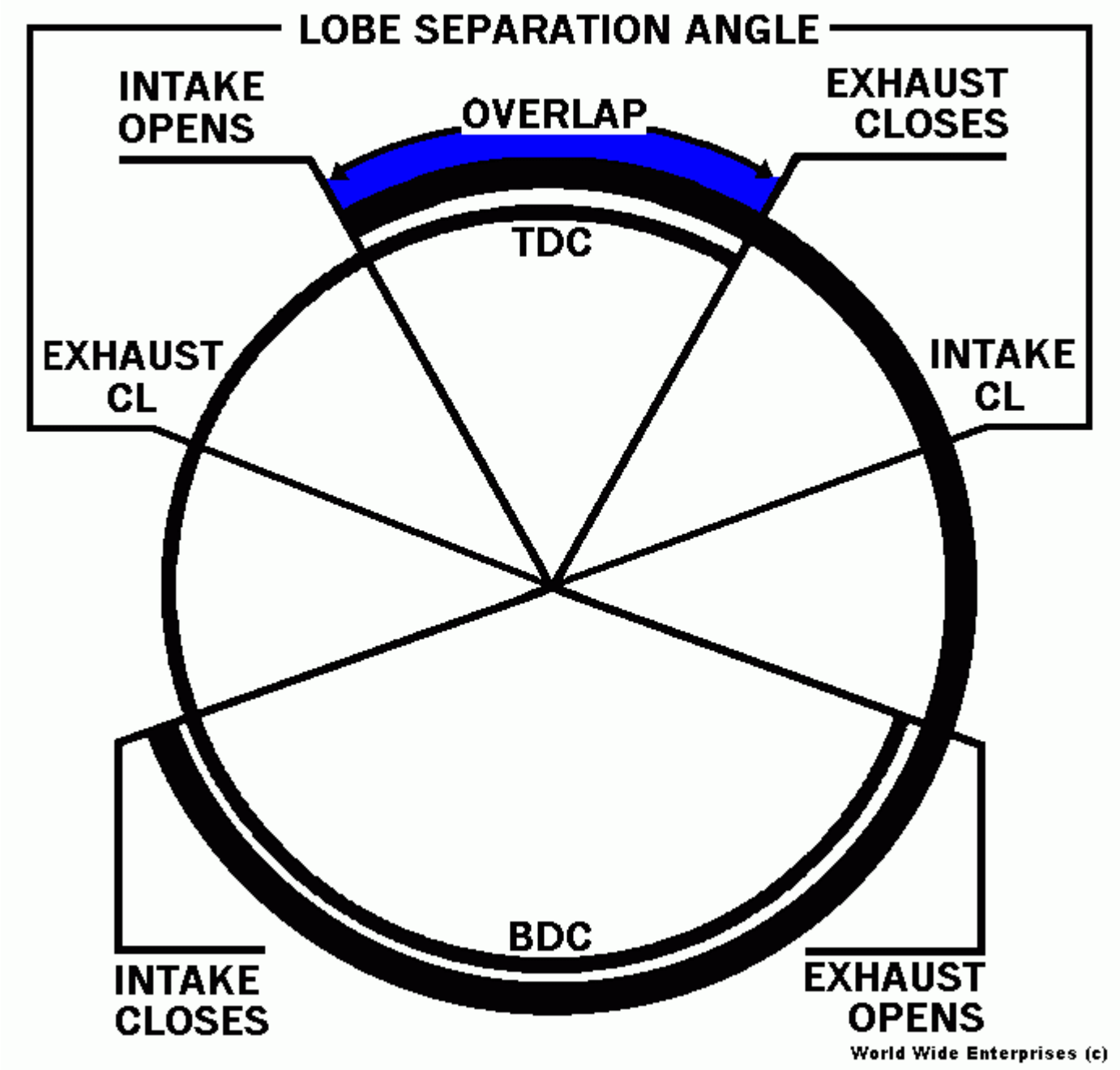
For this Graph I used 1.1 Green Line, 1.05 Red Line, 1.0 Blue Line (Actual Cam Lobe), 0.95 Cyan Line and 0.90 Magenta Line

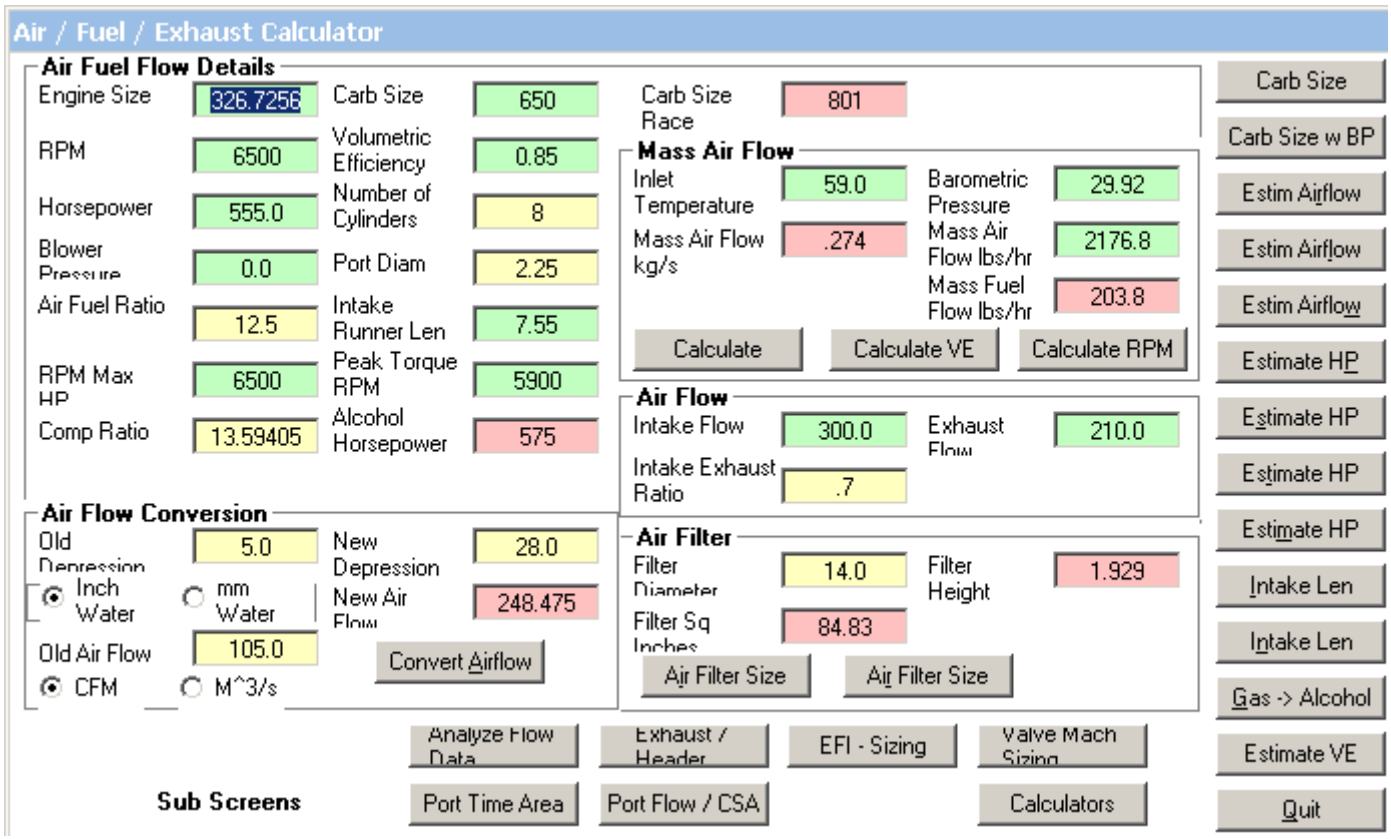


Graph Velocity and Acceleration




COMP161.CMM
Green Intake
CARFOR - Registered to: Stan Weiss
Acceleration ->
.00013
.000117
.000104
.000091
.000078
.000065
.000052
.000039
.000026
.000013
0
-.000013
-.000026
-.000039
-.000052
-.000065
-.000078
-.000091
-.000104
-.000117
Degrees
19.9 39.8 59.7 79.6 99.5 119.4 139.3 159.2 179.1 199 218.9 238.8 258.7 278.6 298.5 318.4 338.3 358.2 378.1 398


LOBE SEPARATION ANGLE
INTAKE OPENS
OVERLAP
EXHAUST CLOSES
TDC
EXHAUST CL
INTAKE CL
BDC
INTAKE CLOSES
EXHAUST OPENS
World Wide Enterprises (c)



AIR FUEL

The **Flow Rate** of an Injector is usually in Pounds of fuel it can flow per hour at a fuel pressure of 43.5 PSI (this pressure may vary with the manufacturer).

The general rule of thumb is that it takes about (.5) 1/2 pounds of fuel to make 1 HP for a naturally aspirated motor and .6 pounds for a Turbo motor. This is your Brake Specific Fuel Consumption – **BSFC**. More efficient (racing) engines will have a lower BSFC (more HP from a pound of fuel) less efficient engines will have a higher BSFC.

The **Duty Cycle** represents what percent of the time the injector is open. Max normally is in the 80-90% range.

General Note on fuel pressure.

a) All fuel pumps' capacity (volume) decreases with an increase in fuel pressure.

b) If your engine is running boost, the fuel pressure needs to be the amount of boost (PSI) higher – fuel pressure wanted plus boost pressure equals fuel pressure needed. In other words the rated flow at "X" PSI is the differential pressure across the injector. A good way to control this is use a Boost adjustable regulator.

1) Convert Airflow from one Depression to a different Depression Using Old Depression, New Depression, and Old Airflow.
2) Estimate Intake and Exhaust Airflow and RPM of Max HP from Horsepower, Intake Exhaust Ratio and Number of Cylinders - Pro Stock Style.
3) Estimate Intake and Exhaust Airflow and RPM of Max HP from Horsepower, Intake Exhaust Ratio and Number of Cylinders - Racing Only Engine.
4) Estimate Intake and Exhaust Airflow and RPM of Max HP from Horsepower, Intake Exhaust Ratio and Number of Cylinders - Street Engine.
5) Estimate Horsepower from Intake Airflow and Number of Cylinders - Pro Stock Style.
6) Estimate Horsepower from Intake Airflow and Number of Cylinders - Racing Only Engine.
7) Estimate Horsepower from Intake Airflow and Number of Cylinders - Street Engine.
8) Estimate Horsepower from Intake Airflow and Number of Cylinders - Using AFR Formula as seen in many magazines.
9) Calculate Carburetor Size in CFM. Using Engine Size, RPM, and Volumetric Efficiency.
10) Calculate Carburetor Size in CFM. Using Engine Size, RPM, Blower Pressure, and Volumetric Efficiency. Also calculates a Race Carburetor Size in CFM.
11) Estimate Intake Runner Length using Engine Size, Peak Torque RPM and Port Diameter.
12) Estimate Intake Runner Length using Peak HP RPM.
13) Estimate Horsepower from running Alcohol over gas using Horsepower.
14) Estimate VE / Volumetric Efficiency from Horsepower, Engine Size, RPM and Compression Ratio.

15) Estimate Header Tube Length using Cubic Inches, RPM, Number of Cylinders and Tube Diameter.
16) Estimate Header Tube Length using Peak HP RPM.
17) Estimate Header Tube Optimum Diameter using Engine Size, RPM, Number of Cylinders, and Tube Length.
18) Estimate Header Tube Optimum Diameter using Engine Size, Peak Torque RPM, and Number of Cylinders.
19) Estimate Header Tube Optimum Inside Diameter using Exhaust Flow at Max lift.
20) Estimate Affect RPM from Header Tube Diameter and Length, Engine Size and Number of Cylinders.
21) Estimate Peak Torque RPM from Header Tube Diameter, Engine Size and Number of Cylinders.
22) Estimate Minimum Collector Length using Engine Size, Number of Cylinders, and Collector Diameter.
23) Calculate Air Filter Size Paper Element using Engine Size, RPM, and Filter Diameter.
24) Calculate Air Filter Size Foam Element using Engine Size, RPM, and Filter Diameter.
25) Estimate Exhaust/Muffler(s) airflow needed for no Horsepower lose using Horsepower.
26) Calculate Engine Mass Air Flow. Using Engine Size, RPM, Volumetric Efficiency, Inlet Temperature, Barometric Pressure and Blower Pressure. Also Mass Fuel Flow using Air Fuel Ratio.
27) Calculate VE / Volumetric Efficiency Using Engine Mass Air Flow, Engine Size, RPM, Inlet Temperature, Barometric Pressure.
28) Calculate RPM Using VE / Volumetric Efficiency, Engine Mass Air Flow, Engine Size, Inlet Temperature, Barometric Pressure.

Sub Screens - They will pop-up when their button is clicked.

Analyze Air Flow Data Form.

This will calculate the average Velocity at the valve throat if CSA % of valve size box is checked, and discharge coefficients for each valve lift and port flow cfm using the valve size, the valve stem size, and the throat CSA. How is CSA calculated? Valve Diameter * Percent CSA is used to calculate throat CSA. Than the Valve Stem CSA is calculated from Valve Stem Diameter and this is subtracted from the throat CSA.

If CSA in Sq Inches box is checked it will use the value enter for CSA subtracting the Value calculated for the Valve Stem CSA to calculate the average Velocity at that CSA location of the port. **NOTE:** To just use the CSA value entered Set Valve Stem Diameter to zero. This can be used to see how the average velocity will vary through the port as the CSA changes.

Discharge Coefficient - Is the ratio of the actual flow to the theoretical flow through an area defined by the valve diameter * PI * valve lift (Curtain / Window Area).

Read in (Open) Flow Information from a file. There are many *.flw files on the Internet for use with Dyno Programs. **Note** these file do not have valve stem diameter or CSA information. If the flow numbers are at a depression other than 28 inches of water they will be converted to 28 inches of water.

Options:

Original, which does Velocity at the Throat area and Discharge Coefficient at the Curtain Area.
Velocity and Discharge Coefficient at Curtain Area.
Velocity and Discharge Coefficient at Throat Area.
Velocity and Discharge Coefficient at Valve Area.
CFM Flow per Sq. Inch at Throat Area and at Valve Area.

EFI – Sizing.

Calculate EFI Injector Size and Fuel Pump Flow needed from Horsepower, BSFC, Number of Injectors and Duty Cycle.

Calculate Max Horsepower from EFI Injector Size, Fuel Pressure (Rated), New Fuel Pressure (Running) BSFC, Duty Cycle, and Number of Injectors.

NOTE: If you have not changed fuel pressure set New Fuel Pressure the same as Fuel Pressure.

Calculate change in Injector Flow Rating from Fuel Pressure Change, using Fuel Pressure, New Fuel Pressure, and Injector Size.

Calculate needed Fuel Pressure Change for Desired Injector Flow Rate from Injector Size, New Injector Size and Fuel Pressure.

Estimate Fuel Flow needed for a given Engine Size, RPM, Air Fuel Ratio and Volumetric Efficiency.

Estimate Throttle Body Flow in CFM, at 28 inches of water. Using Engine Size, Rpm, and Volumetric Efficiency – **If you do not know the Volumetric Efficiency then use a VE of 1.**

Calculate Pulse Width in Milliseconds From Duty Cycle and RPM.

Calculate Duty Cycle From Pulse Width in Milliseconds and RPM.

Valve Mach Sizing.

Calculate Mach Number and Velocity From Bore, Stroke, Valve Diameter, Valve Lift and RPM.

Calculate RPM From Bore, Stroke, Valve Diameter, Valve Lift and Mach Number.

Calculate Valve Lift From Bore, Stroke, Valve Diameter, Mach Number and RPM.

Calculate Valve Diameter From Bore, Stroke, Mach Number, Valve Lift and RPM.

Calculate Mach Number (CSA) and Velocity From Bore, Stroke, CSA, and RPM.

Calculate CSA From Velocity, Bore, Stroke, and RPM.

Calculate Mach Number (CD) and Velocity From Bore, Stroke, Valve Size, Coefficient of Discharge, and RPM.

Graph Mach Number (CD) From Bore, Stroke, Valve Size, Coefficient of Discharge, and RPM.

Graph Velocity (CD) From Bore, Stroke, Valve Size, Coefficient of Discharge, and RPM.

Helmholtz Tuning

Calculates RPM (Peak Torque) From Bore, Stroke, Length - Port + Runner, CSA, Compression Ratio, and Speed of Sound.

Calculate Length - Port + Runner From Bore, Stroke, RPM (Peak Torque), CSA, Compression Ratio, and Speed of Sound.

Graph Length - Port + Runner Varying CSA From Bore, Stroke, RPM (Peak Torque), CSA, Compression Ratio, and Speed of Sound.

H Factor - I use 77 in my calculations. There are a number of online calculators and spreadsheets that use 80. I have added this option so the user can use 80 or any other number they want.

Port Time Area.

Calculate Port Time Area in milliseconds in cm^2 and cm^2/cc for each user supplied lift and duration numbers, bore, stroke, intake valve size, exhaust valve size and RPM.

Port Time Area 2.

Calculate Port Time Area in milliseconds in cm^2 and cm^2/cc and cylinder head flow at each valve lift point, piston travel/position and cylinder volume, vertical and horizontal valve lift. Open and close points, duration numbers, area, at different standard lift points. Using user supplied lift and, bore, stroke, intake valve size, exhaust valve size, Intake rocker arm ratio, exhaust rocker arm ratio, intake valve lash, exhaust valve lash, cylinder head flow, valve incline angle and RPM.

Note: – There maybe times due to the amount of valve lift points that this report generates more data than can be displayed on the screen. The program does generated all of the data and if you save the data to a "PRT" file and open that "PRT" file with Windows Notepad you will be able to see all of that data.

Graphing Options

Flow – Graph Cylinder head flow against cam / crank degrees

Cur DC – Graph Curtain area DC against cam / crank degrees

Cur Area – Graph Curtain / Flow Area against cam / crank degrees

Time Area – Graph Time Area against cam / crank degrees

Time Area/cc – Graph Time Area/cc per cylinder against cam / crank degrees

Lift – Graph Cam or Valve Lift by adjusting Rocker Arm Ratio and Lash against crank degrees

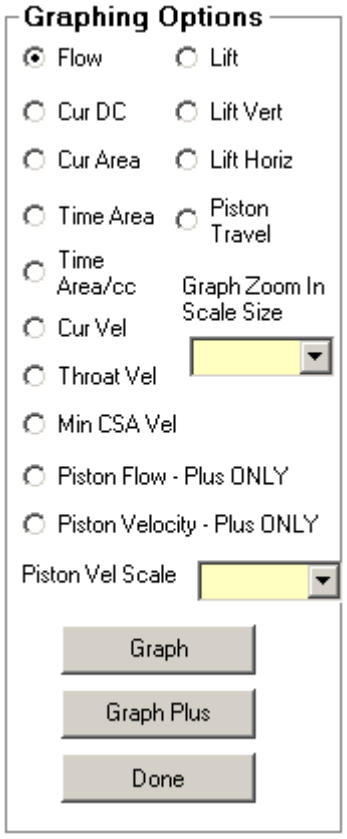
Lift Vert – Graph Valve Vertical Lift (Using valve angle) against crank degrees

Lift Horiz – Graph Valve Horizontal Lift (Using valve angle) against crank degrees

Piston Travel – Graph Piston Travel against crank degrees this can be modified by Valve to Piston Clearance @ TDC. NOTE: - Valve to Piston Clearance @ TDC is measured @ TDC with both valves closed – **Not overlap TDC**.

Graph Zoom In Scale Size – Lets the User Zoom In the Graph area around TDC in greater detail.
Cur Vel – Graph Curtain Velocity (Cylinder head flow) against cam / crank degrees.
Throat Vel – Graph Throat Velocity (Cylinder head flow) against cam / crank degrees.
Min CSA Vel – Graph Minimum CSA Velocity (Cylinder head flow) against cam / crank degrees.
Piston Flow – Graph Piston Flow Demand CFM – Note this only works when using the Graph Plus button.
Note: These only works when using the Graph Plus button.
Piston Vel – Graph Piston Velocity.
Piston Vel Scale – Lets the User Scale the Piston Velocity.

By using the Graph button you can create a new Graph. Using the Graph Plus button lets the user plot multiple images on the same Graph. As an example you could Graph Lift, Lift Vert, and Piston Travel on the same Graph.



Port Flow / CSA.

Calculate Port characteristics using each user supplied information and valve sizing information based on selected option.

1) Calculate Intake and Exhaust Choke RPM, CFM @ 28 Inches, CSA @ 300 fps velocity, and Velocity @ User CSA this uses RPM Max HP, Volumetric Efficiency from left screen.
2) Get Valve Size, Valve Stem Size, Throat Information and Number of Valves.
3) Graph Intake or Exhaust Choke RPM, CFM @ 28 Inches, CSA @ 300 fps velocity, and Velocity @ User CSA Based on selected Graph Options.

Graph Options:

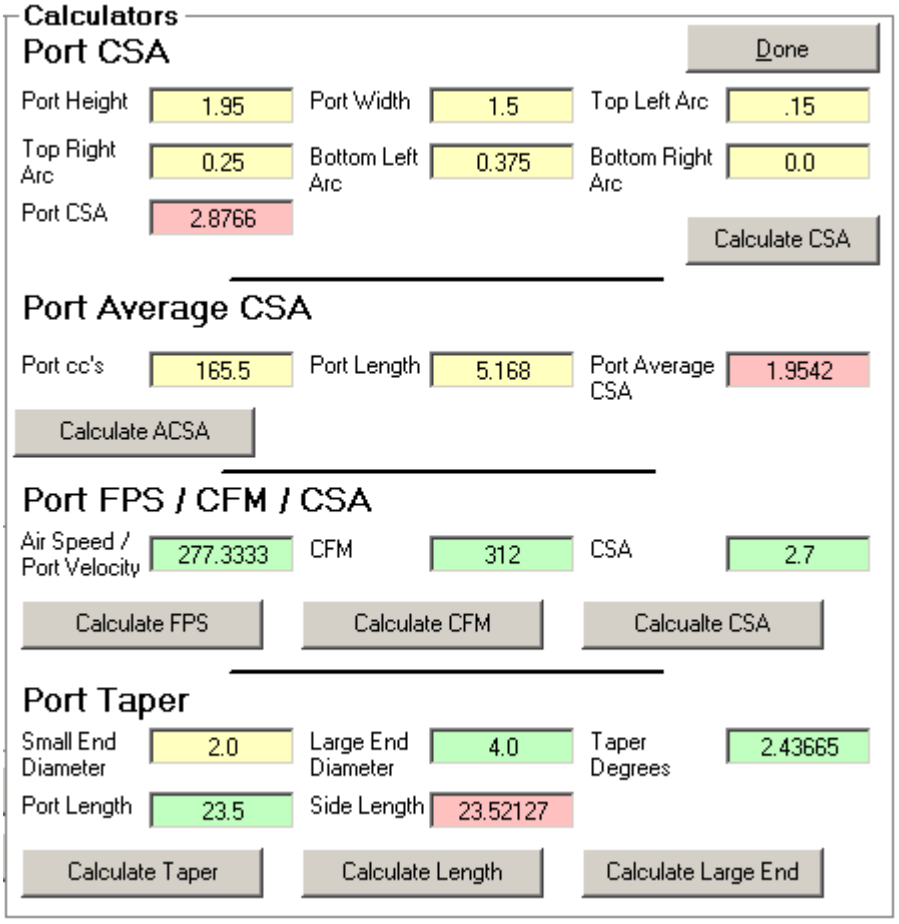
Intake CFM on Y-Axis, Lift on X-Axis against VE.
Exhaust CFM on Y-Axis, Lift on X-Axis against VE.
Intake CSA @ 300 fps on Y-Axis, Lift on X-Axis against VE.
Exhaust CSA @ 300 fps on Y-Axis, Lift on X-Axis against VE.
Intake Velocity on Y-Axis, Lift on X-Axis against VE.
Exhaust Velocity on Y-Axis, Lift on X-Axis against VE.
Intake Choke RPM on Y-Axis, Lift on X-Axis against VE.
Exhaust Choke RPM on Y-Axis, Lift on X-Axis against VE.
Intake Choke CSA on Y-Axis, FPS on X-Axis against VE.
Exhaust Choke CSA on Y-Axis, FPS on X-Axis against VE.
Intake CSA @ USER entered fps on Y-Axis, Lift on X-Axis against VE.

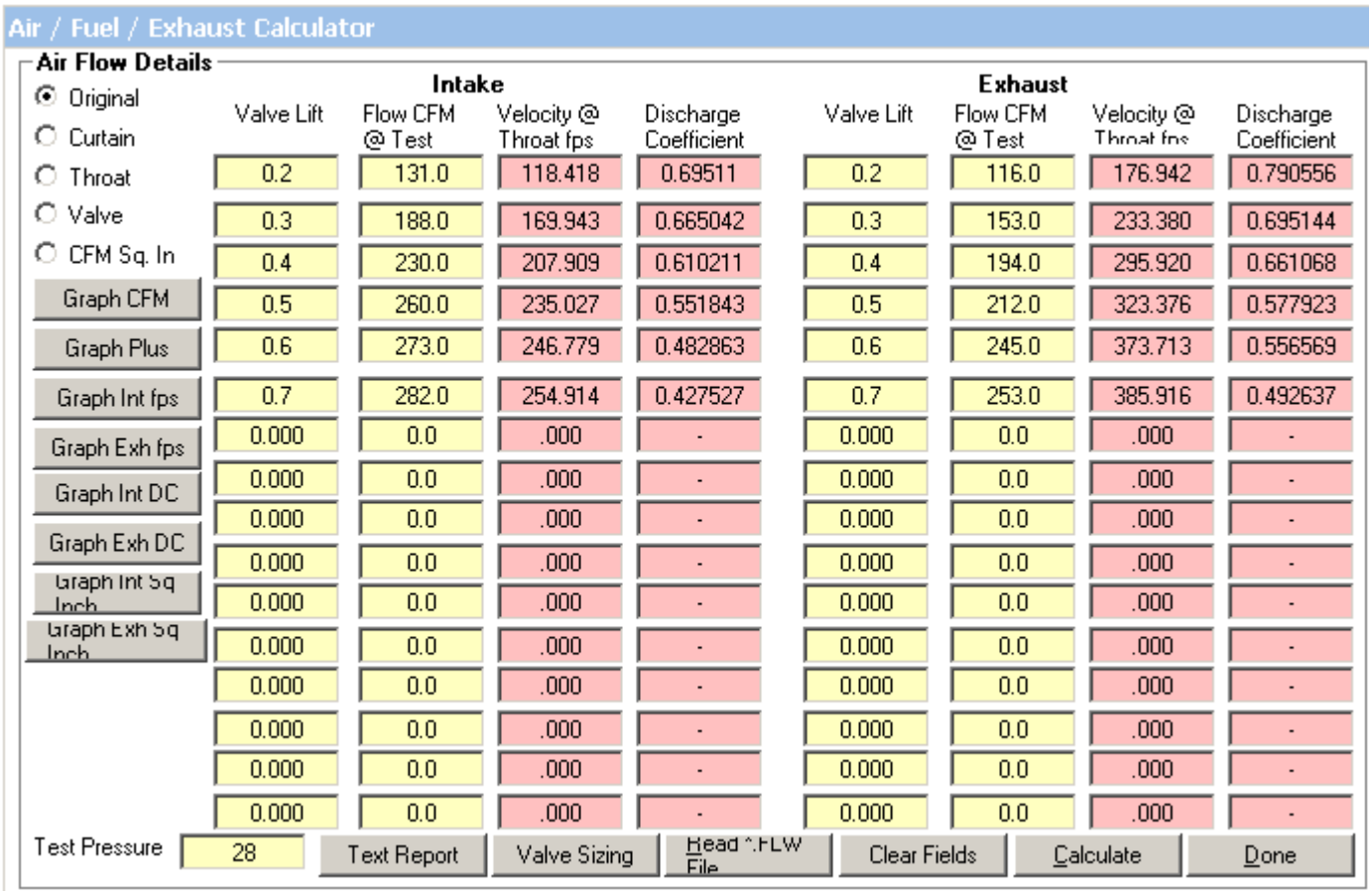
Exhaust CSA @ USER entered fps on Y-Axis, Lift on X-Axis against VE.

Calculators.

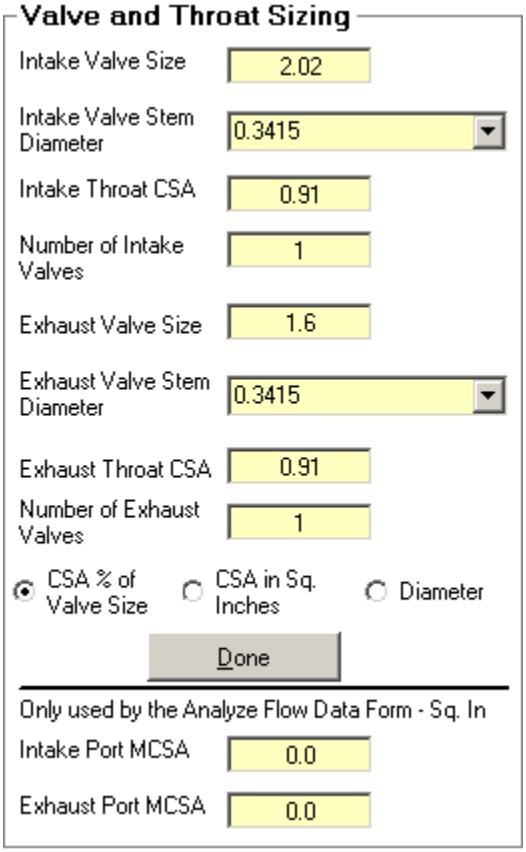
Calculate port CSA from its width, height, and corner radius
Calculate port ACSA from its Volume in cc's and the port centerline length
Calculate port FPS from its CFM and CSA
Calculate port CFM from its FPS and CSA
Calculate port CSA from its CFM and FPS
Calculate Port Taper from Small End Diameter, Large End Diameter and Port Length
Calculate Port Length from Small End Diameter, Large End Diameter and Port Taper
Calculate Large End Diameter from Small End Diameter, Port Length and Port TapeR

Taper here means the angle between the port centerline and one side at the small end.
Side length - is the length from the end of the small diameter to the end of the large diameter (diagonal).





Read in Flow Information from a file. There are many *.flw or *.dfw or *.dyn files on the Internet for use with Engine Simulation Programs. This will import the flow and lift information.



Calculate Velocity and Discharge Coefficient at Curtain Area.

- ○ Original
- ◉ Curtain
- ○ Throat
- ○ Valve
- ○ CFM Sq. In

Intake				Exhaust			
Valve Lift	Flow CFM @ Test	Velocity @ Curtain fps	Discharge Coefficient	Valve Lift	Flow CFM @ Test	Velocity @ Curtain fps	Discharge Coefficient
0.2	131.0	243.495	0.69511	0.2	116.0	276.930	0.790556
0.3	188.0	232.963	0.665042	0.3	153.0	243.507	0.695144
0.4	230.0	213.756	0.610211	0.4	194.0	231.570	0.661068
0.5	260.0	193.309	0.551843	0.5	212.0	202.445	0.577923
0.6	273.0	169.146	0.482863	0.6	245.0	194.965	0.556569
0.7	282.0	149.762	0.427527	0.7	253.0	172.569	0.492637

Calculate Velocity and Discharge Coefficient at Throat Area.

- ○ Original
- ○ Curtain
- ◉ Throat
- ○ Valve
- ○ CFM Sq. In

Intake				Exhaust			
Valve Lift	Flow CFM @ Test	Velocity @ Throat fps	Discharge Coefficient	Valve Lift	Flow CFM @ Test	Velocity @ Throat fps	Discharge Coefficient
0.2	131.0	118.418	0.338049	0.2	116.0	176.942	0.505119
0.3	188.0	169.943	0.485139	0.3	153.0	233.380	0.666234
0.4	230.0	207.909	0.593521	0.4	194.0	295.920	0.844767
0.5	260.0	235.027	0.670936	0.5	212.0	323.376	0.923148
0.6	273.0	246.779	0.704483	0.6	245.0	373.713	1.066845
0.7	282.0	254.914	0.727708	0.7	253.0	385.916	1.101681

Calculate Velocity and Discharge Coefficient at Valve Area.

- ○ Original
- ○ Curtain
- ○ Throat
- ◉ Valve
- ○ CFM Sq. In

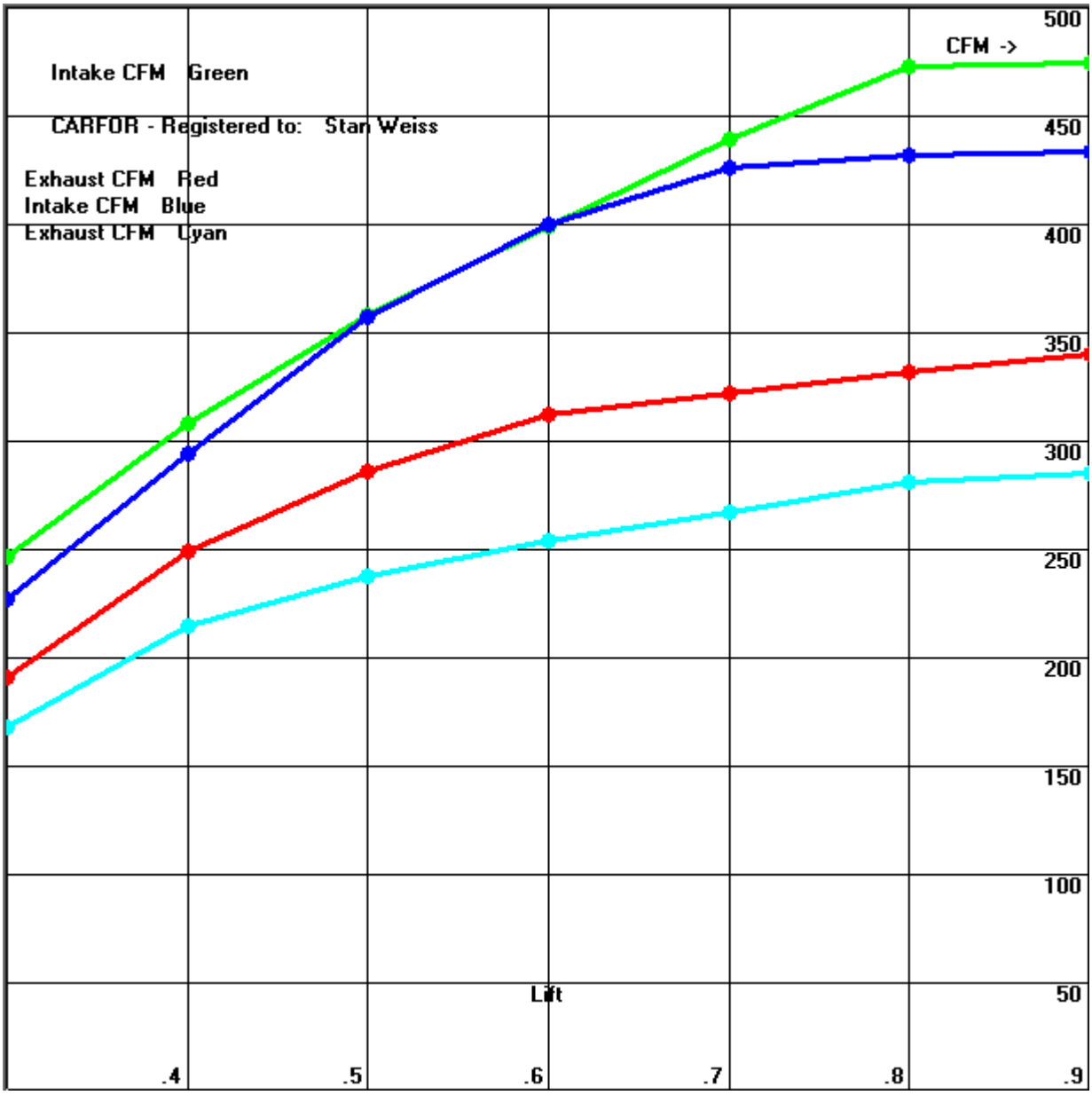
Intake				Exhaust			
Valve Lift	Flow CFM @ Test	Velocity @ Valve fps	Discharge Coefficient	Valve Lift	Flow CFM @ Test	Velocity @ Valve fps	Discharge Coefficient
0.2	131.0	94.791	0.270603	0.2	116.0	138.465	0.395278
0.3	188.0	136.037	0.388346	0.3	153.0	182.630	0.521358
0.4	230.0	166.428	0.475104	0.4	194.0	231.570	0.661068
0.5	260.0	188.136	0.537074	0.5	212.0	253.056	0.722404
0.6	273.0	197.542	0.563928	0.6	245.0	292.447	0.834854
0.7	282.0	204.055	0.582519	0.7	253.0	301.997	0.862114

CFM Flow per Sq. Inch at Throat Area and at Valve Area.

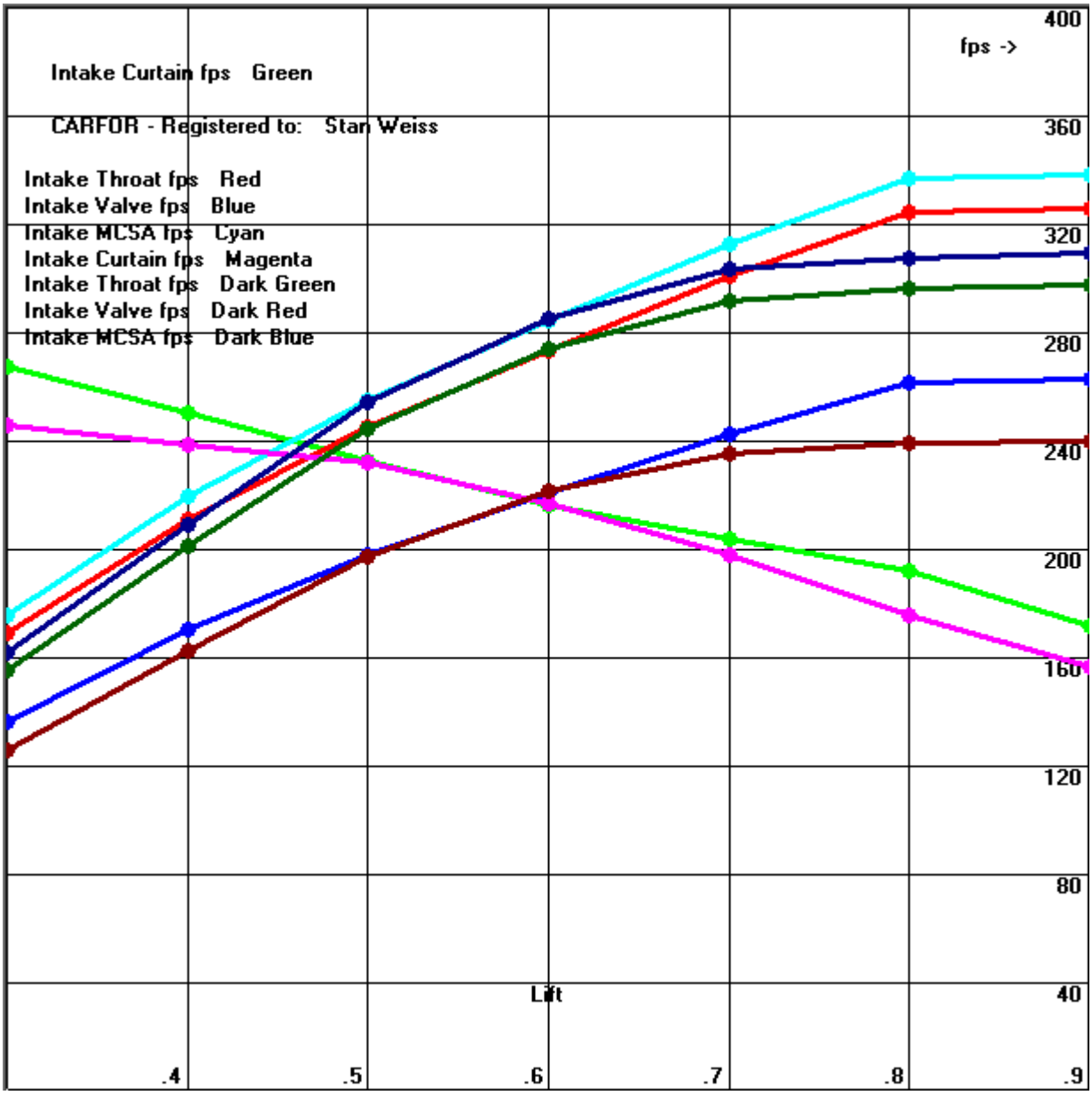
- ○ Original
- ○ Curtain
- ○ Throat
- ○ Valve
- ◉ CFM Sq. In

Intake				Exhaust			
Valve Lift	Flow CFM @ Test	CFM per Sq In @ Throat	CFM per Sq In @ Valve	Valve Lift	Flow CFM @ Test	CFM per Sq In @ Throat	CFM per Sq In @ Valve
0.2	131.0	49.341	39.496	0.2	116.0	73.726	57.694
0.3	188.0	70.810	56.682	0.3	153.0	97.242	76.096
0.4	230.0	86.629	69.345	0.4	194.0	123.300	96.488
0.5	260.0	97.928	78.390	0.5	212.0	134.740	105.440
0.6	273.0	102.824	82.309	0.6	245.0	155.714	121.853
0.7	282.0	106.214	85.023	0.7	253.0	160.798	125.832

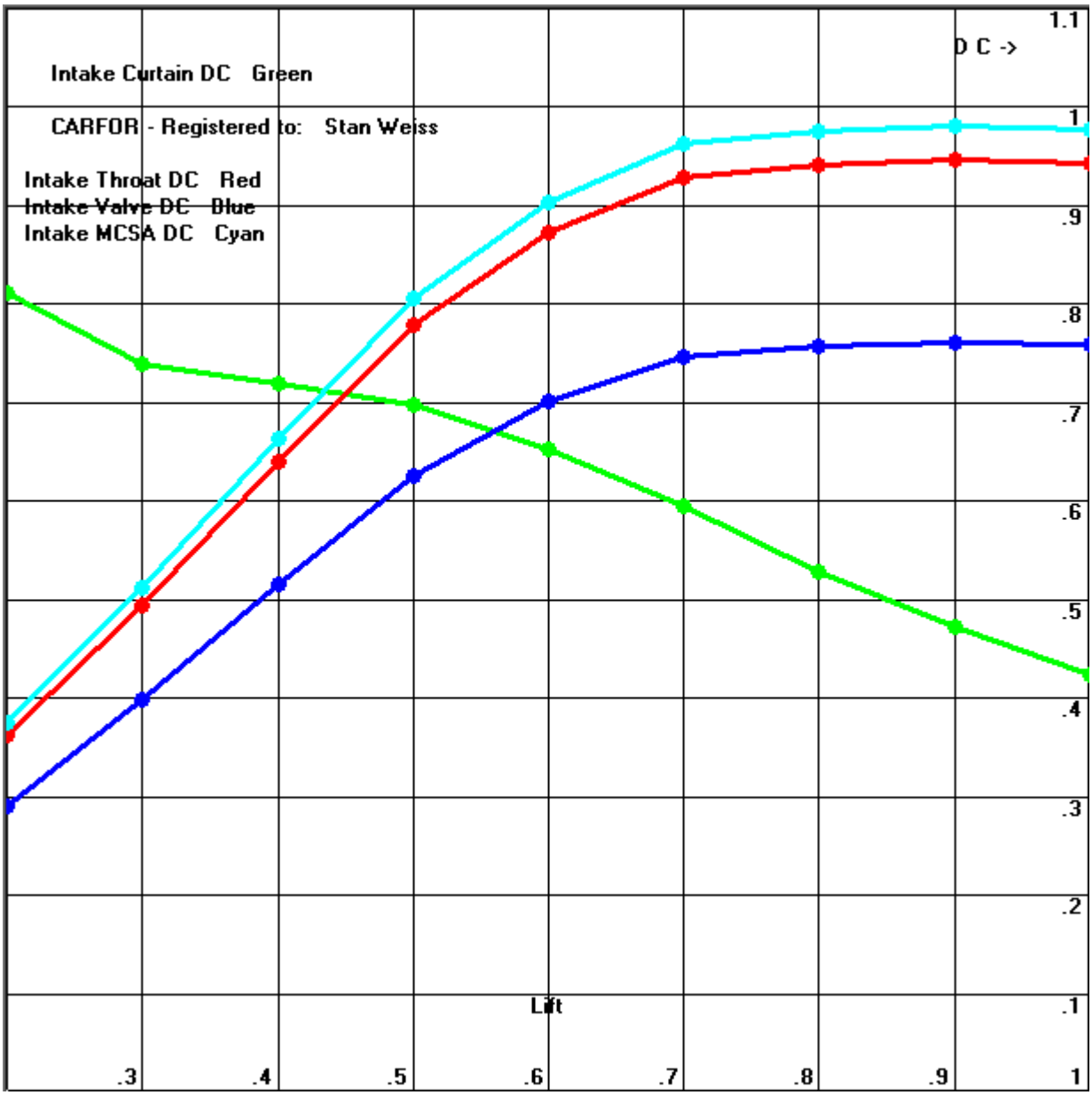
Graph CFM


Intake CFM Green
CARFOR - Registered to: Stan Weiss
Exhaust CFM Red
Intake CFM Blue
Exhaust CFM Cyan
CFM ->
500
450
400
350
300
250
200
150
100
50
Lift
.4
.5
.6
.7
.8
.9

Graph FPS


Intake Curtain fps Green
CARFOR - Registered to: Stan Weiss
Intake Throat fps Red
Intake Valve fps Blue
Intake MCSA fps Cyan
Intake Curtain fps Magenta
Intake Throat fps Dark Green
Intake Valve fps Dark Red
Intake MCSA fps Dark Blue
fps ->
400
360
320
280
240
200
160
120
80
40
Lift
.4
.5
.6
.7
.8
.9

Graph DC


Intake Curtain DC Green
CARFOR - Registered to: Stan Weiss
Intake Throat DC Red
Intake Valve DC Blue
Intake MCSA DC Cyan
D C ->
1.1
1
.9
.8
.7
.6
.5
.4
.3
.2
.1
Lift
.3
.4
.5
.6
.7
.8
.9
1

Text Report Output

```
Bore = 4.225     Stroke = 3.5625          Rod Length = 5.7     RPM = 9800
Wrist Pin Offset = 0.0                    Number of - Intake Valves = 1 - Exhaust Valves = 1
Intake Valve Size = 2.27                  Exhaust Valve Size = 1.6
Intake Valve / Bore Ratio = 0.537278      Exhaust Valve / Bore Ratio = 0.378698
Intake Valve Area = 4.047078 sq. in.      Exhaust Valve Area = 2.010619 sq. in.
Intake Valve Stem Size = 0.3415           Exhaust Valve Stem Size = 0.3415
Intake Valve Stem Area = 0.091595 sq. in. Exhaust Valve Stem Area = 0.091595 sq. in.
Valve Lift at which the Valve Area and Window / Curtain Area are the SAME SIZE
At that point the velocity will be the same in both areas
Intake Valve Lift = 0.5675 Inches         Exhaust Valve Lift = 0.4 Inches
Intake Centerline = 111.0                 User Selected DC - Discharge Coefficient = 0.5
Throat CSA (0.91) Intake = 3.2598 sq. in. Throat CSA (0.91) Exhaust = 1.5734 sq. in.
Effective Throat CSA = 0.89748            Effective Throat CSA = 0.88462
Valve Lift at which the Throat Area and Window / Curtain Area are the SAME SIZE
At that point the velocity will be the same in both areas
Intake Valve Lift = 0.45710 Inches        Exhaust Valve Lift = 0.31302 Inches
User - Intake MCSA / Choke = 3.142731     User - Exhaust MCSA / Choke = 1.583673
```

Intake		------ Curtain -----		Effective	--- Throat --		---- Valve ---		---- MCSA ----	
Lift	CFM	fps	DC	Area	Area	fps	DC	fps	DC	fps	DC
.2000	146.000	245.674	0.7013	1.426	1.000	107.492	0.3069	86.581	0.2472	111.495	0.3183
.3000	231.000	259.135	0.7398	2.139	1.583	170.072	0.4855	136.988	0.3911	176.407	0.5036
.4000	314.000	264.183	0.7542	2.853	2.151	231.180	0.6600	186.208	0.5316	239.791	0.6845
.5000	384.000	258.462	0.7378	3.566	2.631	282.718	0.8071	227.720	0.6501	293.248	0.8371
.6000	426.000	238.943	0.6821	4.279	2.919	313.640	0.8954	252.627	0.7212	325.322	0.9287
.7000	450.000	216.347	0.6176	4.992	3.083	331.310	0.9458	266.859	0.7618	343.650	0.9810
.8000	465.000	195.613	0.5584	5.705	3.186	342.353	0.9773	275.754	0.7872	355.105	1.0137
.9000	473.000	176.870	0.5049	6.418	3.241	348.243	0.9941	280.499	0.8007	361.214	1.0312
1.0000	482.000	162.212	0.4631	7.131	3.302	354.869	1.0131	285.836	0.8160	368.087	1.0508
Avg	374.556	224.160	0.6399	4.279	2.566	275.764	0.7872	222.119	0.6341	286.036	0.8166

Intake		% Step	-------- CFM per Sq. In. -------				L/D	Lift	
Lift	CFM	Increase	Throat	Valve	Curtain	MCSA	Ratio	mm	M^3/s
.2000	146.000		44.788	36.075	102.364	46.456	.088	5.08	0.0689
.3000	231.000	58.22	70.863	57.078	107.973	73.503	.132	7.62	0.1090
.4000	314.000	35.93	96.325	77.587	110.076	99.913	.176	10.16	0.1482
.5000	384.000	22.29	117.799	94.883	107.693	122.187	.220	12.70	0.1812
.6000	426.000	10.94	130.683	105.261	99.559	135.551	.264	15.24	0.2010
.7000	450.000	5.63	138.046	111.191	90.144	143.188	.308	17.78	0.2124
.8000	465.000	3.33	142.647	114.898	81.506	147.960	.352	20.32	0.2195
.9000	473.000	1.72	145.101	116.874	73.696	150.506	.396	22.86	0.2232
1.0000	482.000	1.90	147.862	119.098	67.588	153.370	.441	25.40	0.2275
Avg	374.556		114.902	92.550	93.400	119.182			

Exhaust		------ Curtain -----		Effective	--- Throat --		---- Valve ---		---- MCSA ----	
Lift	CFM	fps	DC	Area	Area	fps	DC	fps	DC	fps	DC
.2000	92.000	219.634	0.6270	1.005	.630	140.333	0.4006	109.817	0.3135	139.423	0.3980
.3000	151.000	240.324	0.6861	1.508	1.035	230.329	0.6575	180.243	0.5145	228.835	0.6533
.4000	188.000	224.408	0.6406	2.011	1.288	286.768	0.8186	224.408	0.6406	284.907	0.8133
.5000	238.000	227.273	0.6488	2.513	1.631	363.036	1.0364	284.092	0.8110	360.681	1.0296
.6000	271.000	215.655	0.6156	3.016	1.857	413.373	1.1801	323.482	0.9235	410.691	1.1724
.7000	286.000	195.078	0.5569	3.519	1.959	436.253	1.2454	341.387	0.9746	433.423	1.2373
.8000	296.000	176.662	0.5043	4.021	2.028	451.507	1.2889	353.324	1.0086	448.577	1.2806
.9000	297.000	157.563	0.4498	4.524	2.035	453.032	1.2933	354.518	1.0120	450.093	1.2849
1.0000	299.000	142.762	0.4075	5.027	2.049	456.083	1.3020	356.905	1.0189	453.124	1.2935
Avg	235.333	199.929	0.5707	3.016	1.612	358.968	1.0248	280.908	0.8019	356.639	1.0181

Exhaust		% Step	-------- CFM per Sq. In. -------				L/D	Lift	
Lift	CFM	Increase	Throat	Valve	Curtain	MCSA	Ratio	mm	M^3/s
.2000	92.000		58.472	45.757	91.514	58.093	.125	5.08	0.0434
.3000	151.000	64.13	95.971	75.101	100.135	95.348	.188	7.62	0.0713
.4000	188.000	24.50	119.487	93.504	93.504	118.711	.250	10.16	0.0887
.5000	238.000	26.60	151.265	118.371	94.697	150.284	.313	12.70	0.1123
.6000	271.000	13.87	172.239	134.784	89.856	171.121	.375	15.24	0.1279
.7000	286.000	5.54	181.772	142.245	81.283	180.593	.438	17.78	0.1350
.8000	296.000	3.50	188.128	147.218	73.609	186.907	.500	20.32	0.1397
.9000	297.000	.34	188.763	147.716	65.651	187.539	.563	22.86	0.1402
1.0000	299.000	.67	190.034	148.710	59.484	188.802	.625	25.40	0.1411
Avg	235.333		149.570	117.045	83.304	148.600			

To get the same Throat numbers as posted on my web site for the Throat calculations use a valve stem size = 0

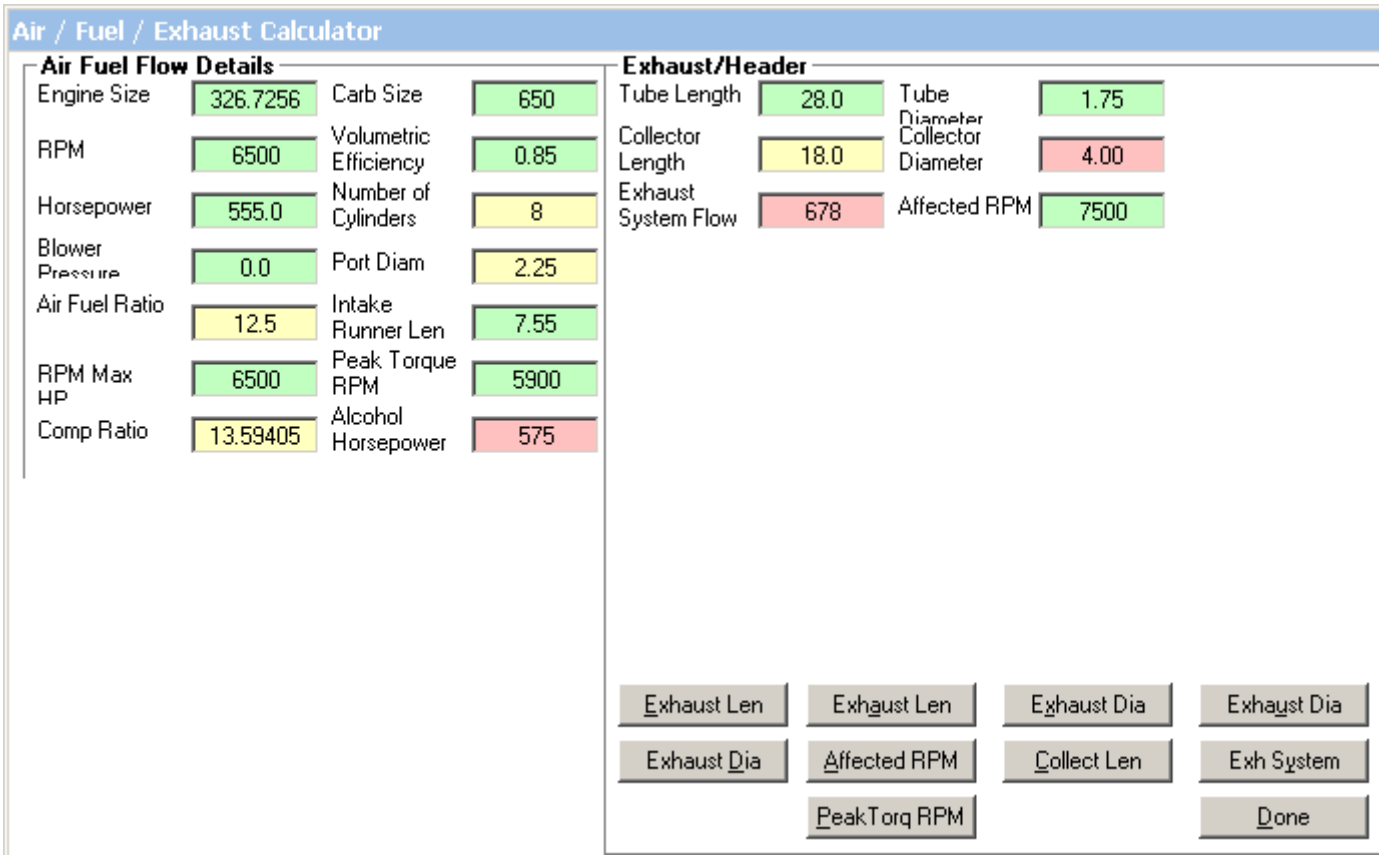
Bore = 4.225 Stroke = 3.5625 Rod Length = 5.7 RPM = 9800
Wrist Pin Offset = 0.0 Number of - Intake Valves = 1 - Exhaust Valves = 1
Intake Valve Size = 2.27 Exhaust Valve Size = 1.6
Intake Valve / Bore Ratio = 0.537278 Exhaust Valve / Bore Ratio = 0.378698
Intake Valve Area = 4.047078 sq. in. Exhaust Valve Area = 2.010619 sq. in.
Intake Valve Stem Size = 0.0 Exhaust Valve Stem Size = 0.0
Intake Valve Stem Area = 0.0 sq. in. Exhaust Valve Stem Area = 0.0 sq. in.
Valve Lift at which the Valve Area and Window / Curtain Area are the SAME SIZE
At that point the velocity will be the same in both areas
Intake Valve Lift = 0.5675 Inches Exhaust Valve Lift = 0.4 Inches
Intake Centerline = 111.0 User Selected DC - Discharge Coefficient = 0.5
Throat CSA (0.91) Intake = 3.3514 sq. in. Throat CSA (0.91) Exhaust = 1.6650 sq. in.
Effective Throat CSA = 0.91 Effective Throat CSA = 0.91
Valve Lift at which the Throat Area and Window / Curtain Area are the SAME SIZE
At that point the velocity will be the same in both areas
Intake Valve Lift = 0.46995 Inches Exhaust Valve Lift = 0.33124 Inches
User - Intake MCSA / Choke = 3.142731 User - Exhaust MCSA / Choke = 1.583673

Intake		------ Curtain -----		Effective	--- Throat --		---- Valve ---		---- MCSA ----	
Lift	CFM	fps	DC	Area	fps	DC	fps	DC	fps	DC
.2000	146.000	245.674	0.7013	1.426	1.000	104.554	0.2985	86.581	0.2472	111.495	0.3183
.3000	231.000	259.135	0.7398	2.139	1.583	165.424	0.4722	136.988	0.3911	176.407	0.5036
.4000	314.000	264.183	0.7542	2.853	2.151	224.862	0.6419	186.208	0.5316	239.791	0.6845
.5000	384.000	258.462	0.7378	3.566	2.631	274.991	0.7850	227.720	0.6501	293.248	0.8371
.6000	426.000	238.943	0.6821	4.279	2.919	305.068	0.8709	252.627	0.7212	325.322	0.9287
.7000	450.000	216.347	0.6176	4.992	3.083	322.255	0.9199	266.859	0.7618	343.650	0.9810
.8000	465.000	195.613	0.5584	5.705	3.186	332.997	0.9506	275.754	0.7872	355.105	1.0137
.9000	473.000	176.870	0.5049	6.418	3.241	338.726	0.9670	280.499	0.8007	361.214	1.0312
1.0000	482.000	162.212	0.4631	7.131	3.302	345.171	0.9854	285.836	0.8160	368.087	1.0508
Avg	374.556	224.160	0.6399	4.279	2.566	268.227	0.7657	222.119	0.6341	286.036	0.8166

Intake		% Step	-------- CFM per Sq. In. -------				L/D	Lift	
Lift	CFM	Increase	Throat	Valve	Curtain	MCSA	Ratio	mm	M^3/s
.2000	146.000		43.564	36.075	102.364	46.456	.088	5.08	0.0689
.3000	231.000	58.22	68.927	57.078	107.973	73.503	.132	7.62	0.1090
.4000	314.000	35.93	93.693	77.587	110.076	99.913	.176	10.16	0.1482
.5000	384.000	22.29	114.579	94.883	107.693	122.187	.220	12.70	0.1812
.6000	426.000	10.94	127.112	105.261	99.559	135.551	.264	15.24	0.2010
.7000	450.000	5.63	134.273	111.191	90.144	143.188	.308	17.78	0.2124
.8000	465.000	3.33	138.749	114.898	81.506	147.960	.352	20.32	0.2195
.9000	473.000	1.72	141.136	116.874	73.696	150.506	.396	22.86	0.2232
1.0000	482.000	1.90	143.821	119.098	67.588	153.370	.441	25.40	0.2275
Avg	374.556		111.761	92.550	93.400	119.182			

Exhaust		------ Curtain -----		Effective	--- Throat --		---- Valve ---		---- MCSA ----	
Lift	CFM	fps	DC	Area	fps	DC	fps	DC	fps	DC
.2000	92.000	219.634	0.6270	1.005	.630	132.613	0.3786	109.817	0.3135	139.423	0.3980
.3000	151.000	240.324	0.6861	1.508	1.035	217.658	0.6214	180.243	0.5145	228.835	0.6533
.4000	188.000	224.408	0.6406	2.011	1.288	270.992	0.7736	224.408	0.6406	284.907	0.8133
.5000	238.000	227.273	0.6488	2.513	1.631	343.064	0.9794	284.092	0.8110	360.681	1.0296
.6000	271.000	215.655	0.6156	3.016	1.857	390.632	1.1151	323.482	0.9235	410.691	1.1724
.7000	286.000	195.078	0.5569	3.519	1.959	412.254	1.1769	341.387	0.9746	433.423	1.2373
.8000	296.000	176.662	0.5043	4.021	2.028	426.668	1.2180	353.324	1.0086	448.577	1.2806
.9000	297.000	157.563	0.4498	4.524	2.035	428.110	1.2221	354.518	1.0120	450.093	1.2849
1.0000	299.000	142.762	0.4075	5.027	2.049	430.993	1.2304	356.905	1.0189	453.124	1.2935
Avg	235.333	199.929	0.5707	3.016	1.612	339.220	0.9684	280.908	0.8019	356.639	1.0181

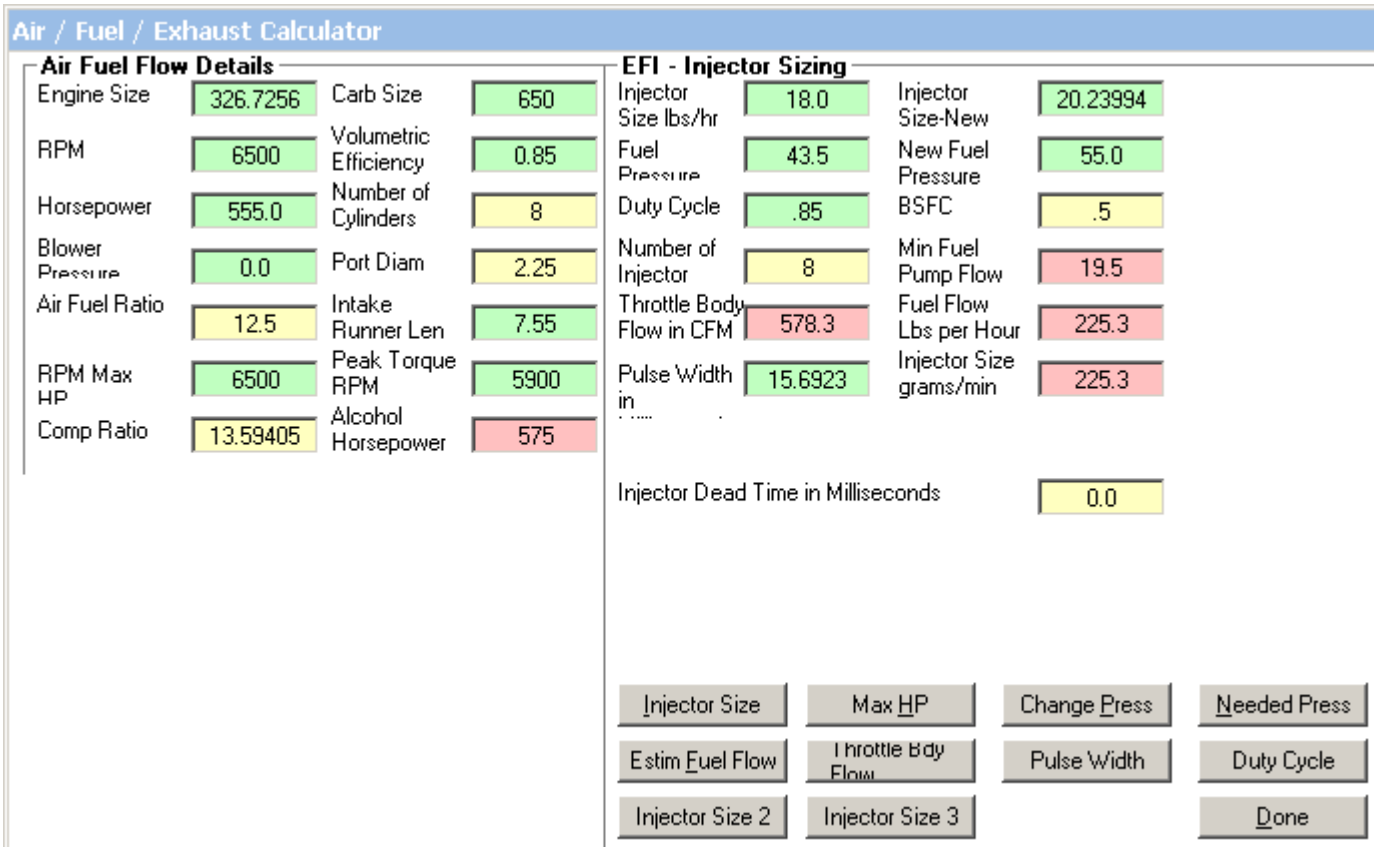
Exhaust		% Step	-------- CFM per Sq. In. -------				L/D	Lift	
Lift	CFM	Increase	Throat	Valve	Curtain	MCSA	Ratio	mm	M^3/s
.2000	92.000		55.255	45.757	91.514	58.093	.125	5.08	0.0434
.3000	151.000	64.13	90.691	75.101	100.135	95.348	.188	7.62	0.0713
.4000	188.000	24.50	112.913	93.504	93.504	118.711	.250	10.16	0.0887
.5000	238.000	26.60	142.943	118.371	94.697	150.284	.313	12.70	0.1123
.6000	271.000	13.87	162.763	134.784	89.856	171.121	.375	15.24	0.1279
.7000	286.000	5.54	171.772	142.245	81.283	180.593	.438	17.78	0.1350
.8000	296.000	3.50	177.778	147.218	73.609	186.907	.500	20.32	0.1397
.9000	297.000	.34	178.379	147.716	65.651	187.539	.563	22.86	0.1402
1.0000	299.000	.67	179.580	148.710	59.484	188.802	.625	25.40	0.1411
Avg	235.333		141.342	117.045	83.304	148.600			


Air / Fuel / Exhaust Calculator
Air Fuel Flow Details
Engine Size
326.7256
Carb Size
650
RPM
6500
Volumetric Efficiency
0.85
Horsepower
555.0
Number of Cylinders
8
Blower Pressure
0.0
Port Diam
2.25
Air Fuel Ratio
12.5
Intake Runner Len
7.55
RPM Max HP
6500
Peak Torque RPM
5900
Comp Ratio
13.59405
Alcohol Horsepower
575
Exhaust/Header
Tube Length
28.0
Tube Diameter
1.75
Collector Length
18.0
Collector Diameter
4.00
Exhaust System Flow
678
Affected RPM
7500
Exhaust Len
Exhaust Len
Exhaust Dia
Exhaust Dia
Exhaust Dia
Affected RPM
Collect Len
Exh System
PeakTorq RPM
Done

Injector Size 1 - Calculate EFI Injector Size and Fuel Pump Flow needed from Horsepower, BSFC, Number of Injectors and Duty Cycle.
Calculate Max Horsepower from EFI Injector Size, Fuel Pressure (Rated), New Fuel Pressure (Running) BSFC, Duty Cycle, and Number of Injectors.

NOTE: If you have not changed fuel pressure set New Fuel Pressure the same as Fuel Pressure.

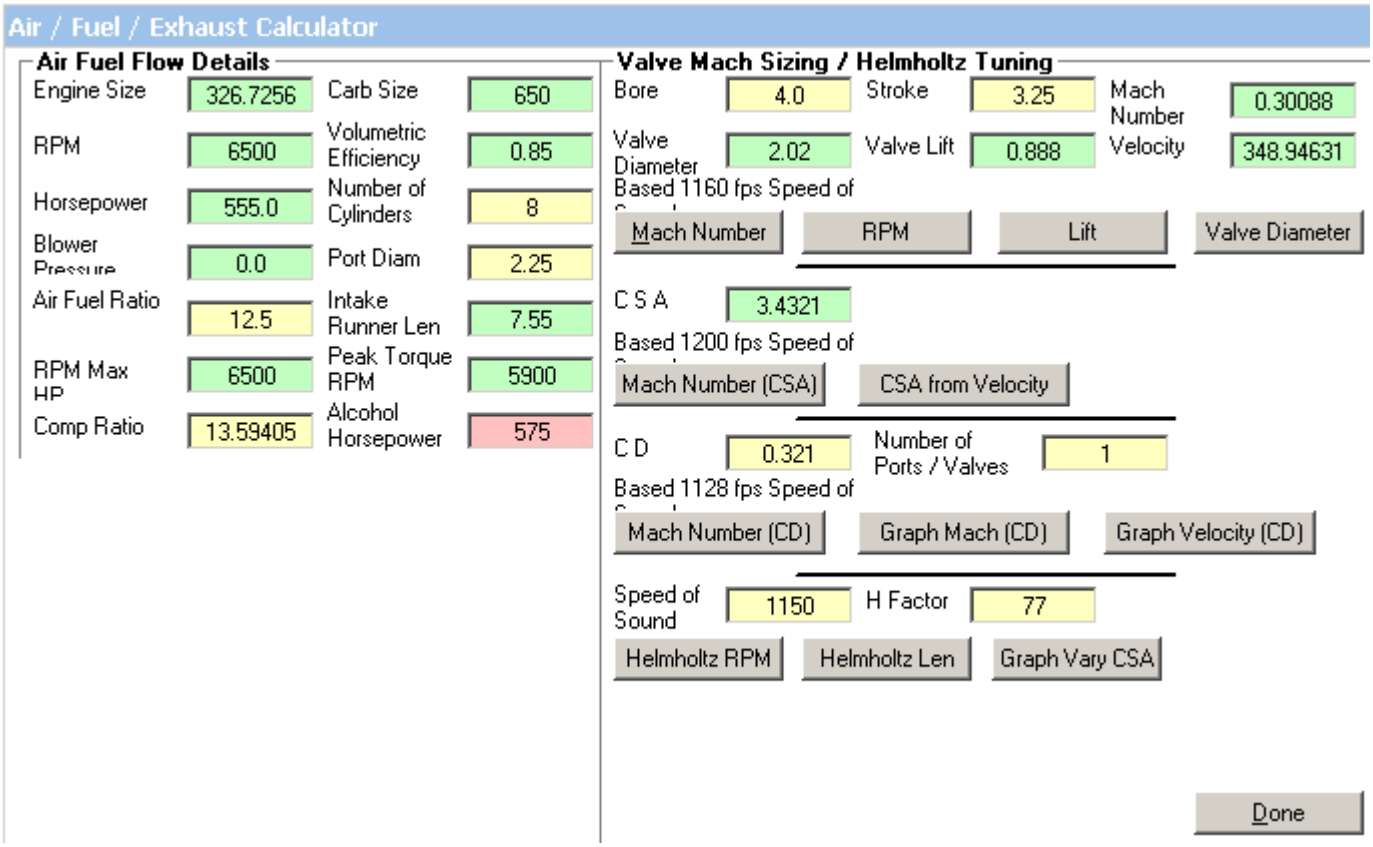
Calculate change in Injector Flow Rating from Fuel Pressure Change, using Fuel Pressure, New Fuel Pressure, and Injector Size.
Calculate needed Fuel Pressure Change for Desired Injector Flow Rate from Injector Size, New Injector Size and Fuel Pressure.
Estimate Fuel Flow needed for a given Engine Size, RPM, Air Fuel Ratio and Volumetric Efficiency.
Estimate Throttle Body Flow in CFM, at 28 inches of water. Using Engine Size, Rpm, and Volumetric Efficiency – If you do not know the Volumetric Efficiency then use a VE of 1.
Calculate Pulse Width in Milliseconds From Duty Cycle and RPM.
Calculate Duty Cycle From Pulse Width in Milliseconds and RPM.
Injector Size 2 - Estimate Fuel Injector Size needed for a given Engine Size, RPM, Air Fuel Ratio, Duty Cycle, Number of Injectors, Volumetric Efficiency and Blower Pressure. For N/A engine make sure Blower Pressure is set to zero (0.0).
Injector Size 3 - Estimate Fuel Injector Size needed for a given Engine Size, RPM, Air Fuel Ratio, Pulse Width, Number of Injectors, Volumetric Efficiency, Injector Dead Time and Blower Pressure. For N/A engine make sure Blower Pressure is set to zero (0.0).



Calculate Mach Number and Velocity From Bore, Stroke, Valve Diameter, Valve Lift and RPM.
Calculate RPM From Bore, Stroke, Valve Diameter, Valve Lift and Mach Number.
Calculate Valve Lift From Bore, Stroke, Valve Diameter, Mach Number and RPM.
Calculate Valve Diameter From Bore, Stroke, Mach Number, Valve Lift and RPM.

Calculate Mach Number (CSA) and Velocity From Bore, Stroke, CSA, and RPM.
Calculate CSA From Velocity, Bore, Stroke, and RPM.
Calculate Mach Number (CD) and Velocity From Bore, Stroke, Valve Size, Coefficient of Discharge, and RPM.
Graph Mach Number (CD) From Bore, Stroke, Valve Size, Coefficient of Discharge, and RPM.
Graph Velocity (CD) From Bore, Stroke, Valve Size, Coefficient of Discharge, and RPM.

Helmholtz Tuning
Calculates RPM (Peak Torque) From Bore, Stroke, Length - Port + Runner, CSA, Compression Ratio, and Speed of Sound.
Calculate Length - Port + Runner From Bore, Stroke, RPM (Peak Torque), CSA, Compression Ratio, and Speed of Sound.
Graph Length - Port + Runner Varying CSA From Bore, Stroke, RPM (Peak Torque), CSA, Compression Ratio, and Speed of Sound.
H Factor - I use 77 in my calculations. There are a number of online calculators and spreadsheets that use 80. I have added this option so the user can use 80 or any other number they want.

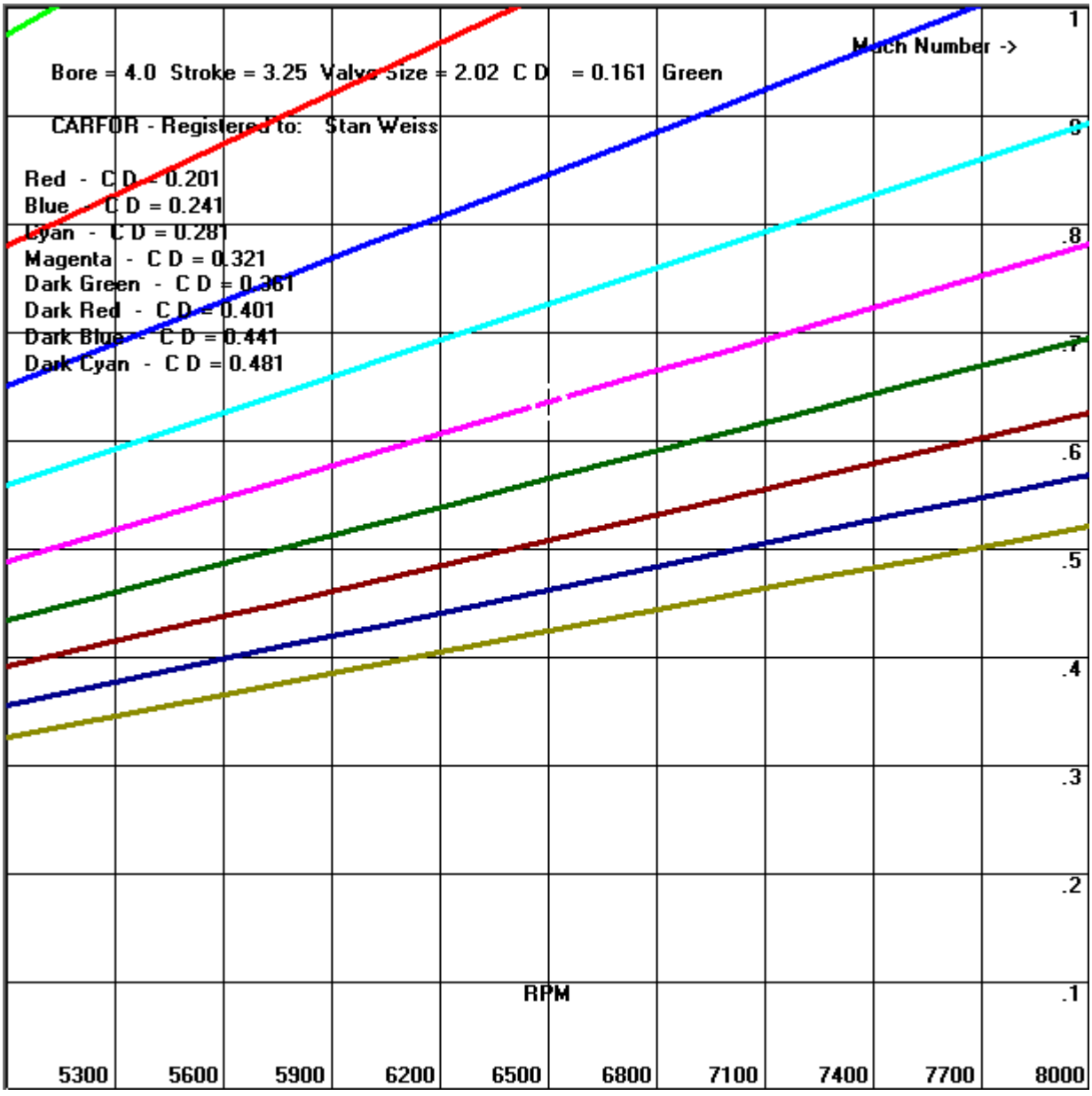


Mach Number 0.6355 Velocity 716.8139

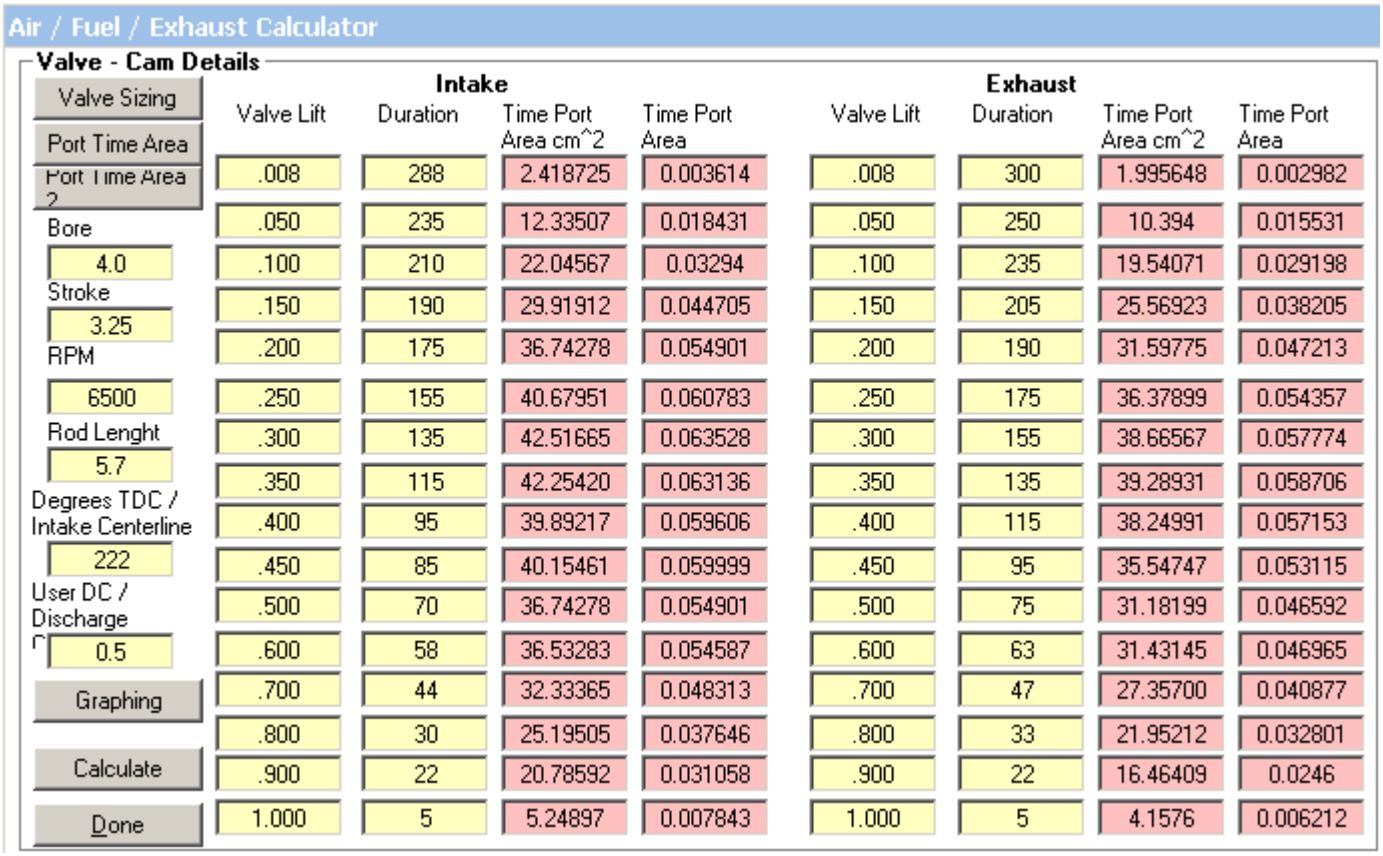
C D 0.321 Number of Ports / Valves 1

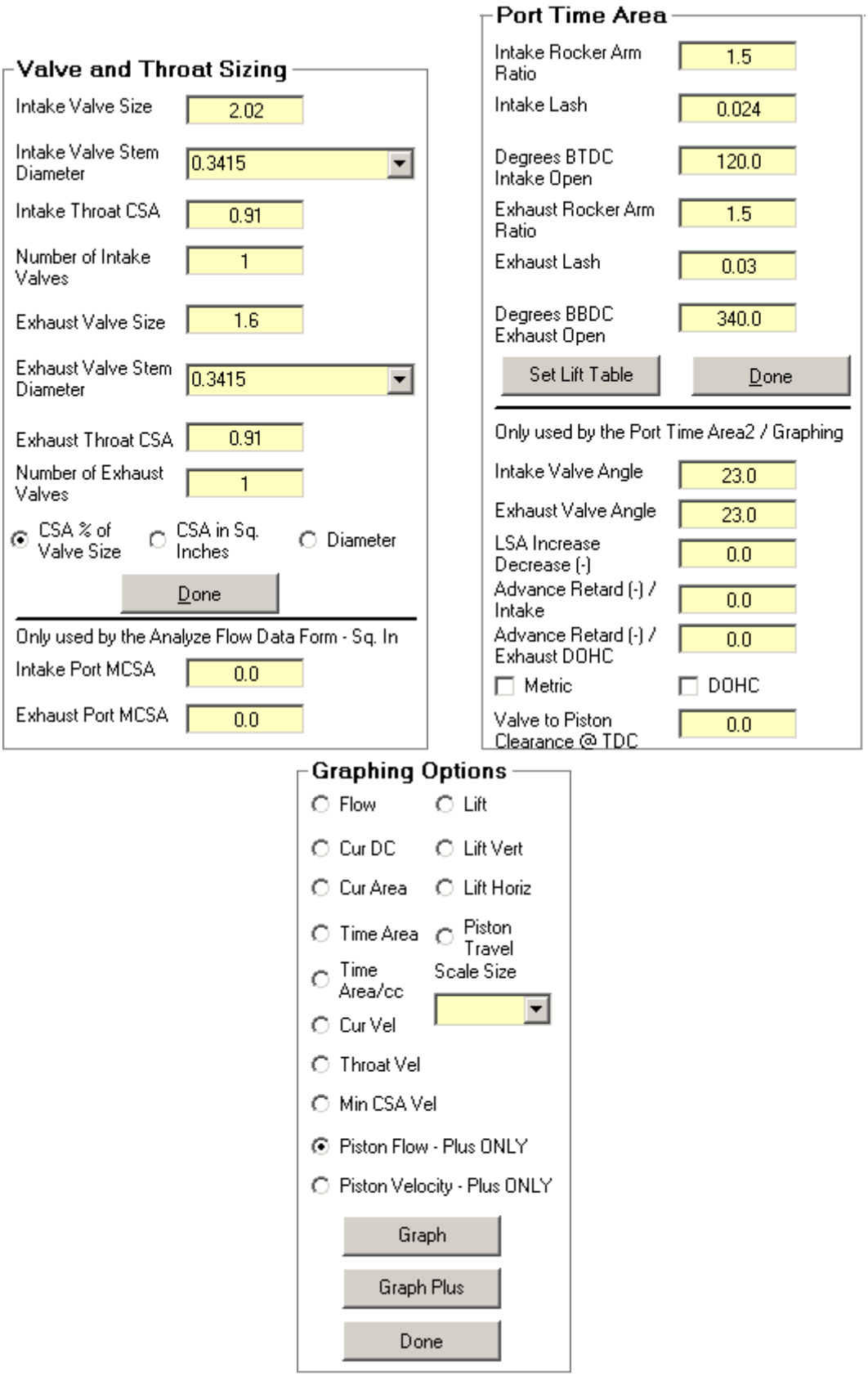
Based 1128 fps Speed of Sound

Mach Number (CD) | Graph Mach (CD) | Graph Velocity (CD)



Calculate Port Time Area in milliseconds in cm^2 and cm^2/cc for each user supplied lift and duration numbers, bore stroke, intake valve size, exhaust valve size and RPM.





Advance / Retard Camshaft - Is the number of degrees the Intake centerline has been moved. The intake centerline in the above and first example below is 111 degrees. If we change **Degrees TDC / Intake Centerline** to 232, we have moved the intake centerline to 116 degrees and **Retarded** the camshaft 5 degrees. See second example below.

Bore = 4.0000 Stroke = 3.2500 Rod Length = 5.7000 RPM = 6500
Wrist Pin Offset = 0.0 Number of - Intake Valves = 1 - Exhaust Valves = 1
Intake Valve Size = 2.02 Exhaust Valve Size = 1.6
Intake Valve / Bore Ratio = 0.505 Exhaust Valve / Bore Ratio = 0.4
Intake Valve Area = 3.204739 sq. in. Exhaust Valve Area = 2.010619 sq. in.
Intake Valve Stem Size = 0.375 Exhaust Valve Stem Size = 0.375
Intake Valve Stem Area = 0.110447 sq. in. Exhaust Valve Stem Area = 0.110447 sq. in.
Valve Lift at which the Valve Area and Window / Curtain Area are the SAME SIZE
At that point the velocity will be the same in both areas
Intake Valve Lift = 0.505 Inches Exhaust Valve Lift = 0.4 Inches

Intake Centerline = 111.00000 User Selected DC - Discharge Coefficient = 0.5

Throat CSA (0.91) Intake = 2.5434 sq. in. Throat CSA (0.91) Exhaust = 1.5545 sq. in.
Effective Throat CSA = 0.89086 Effective Throat CSA = 0.8793
Valve Lift at which the Throat Area and Window / Curtain Area are the SAME SIZE
At that point the velocity will be the same in both areas
Intake Valve Lift = 0.40079 Inches Exhaust Valve Lift = 0.30927 Inches

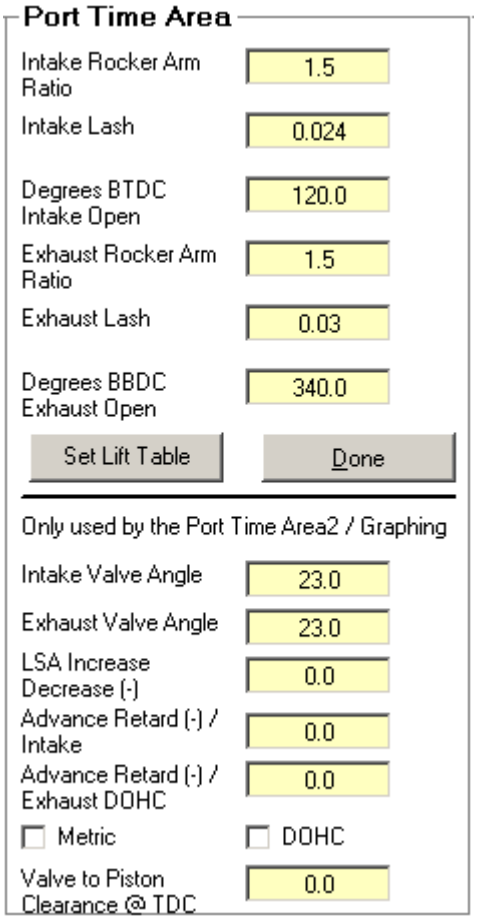
Valve Lift	Duration	Time Port Area cm^2	Time Port Area cm^2/cc	Piston Travel	Cylinder Volume cc	Valve Velocity Inch/Deg	Degrees ATDC	Piston Flow @ 28" CFM	Curtain Area Velocity	Depress- ion for DC of 1	Depress- ion for User DC	Throat Area Velocity
0.07600	222.00	17.71212	0.02647	0.00000	0.00000	0.00200	.00	.00	.00	.000	.000	.00
0.07800	221.00	18.09635	0.02704	0.00008	0.01637	0.00200	.50	2.71	13.12	.039	.157	2.55
0.08000	220.00	18.47637	0.02761	0.00032	0.06549	0.00200	1.00	5.41	25.58	.149	.597	5.11
0.08200	219.00	18.85220	0.02817	0.00072	0.14735	0.00200	1.50	8.12	37.44	.320	1.279	7.66
0.08400	218.00	19.22383	0.02872	0.00127	0.26195	0.00200	2.00	10.82	48.72	.542	2.167	10.21
0.08600	217.00	19.59125	0.02927	0.00199	0.40925	0.00200	2.50	13.52	59.47	.807	3.228	12.76
0.08800	216.00	19.95448	0.02982	0.00286	0.58926	0.00200	3.00	16.23	69.73	1.109	4.438	15.31
0.09000	215.00	20.31351	0.03035	0.00389	0.80194	0.00200	3.50	18.92	79.52	1.443	5.772	17.86
0.09200	214.00	20.66834	0.03088	0.00509	1.04727	0.00200	4.00	21.62	88.88	1.803	7.210	20.40
0.09400	213.00	21.01897	0.03141	0.00644	1.32522	0.00200	4.50	24.32	97.83	2.184	8.735	22.94
0.09600	212.00	21.36541	0.03192	0.00794	1.63575	0.00200	5.00	27.01	106.39	2.583	10.332	25.48
0.09800	211.00	21.70764	0.03244	0.00961	1.97884	0.00200	5.50	29.69	114.59	2.996	11.986	28.02
0.10000	210.00	22.04567	0.03294	0.01143	2.35442	0.00200	6.00	32.38	122.45	3.422	13.687	30.55
0.10250	209.00	22.48921	0.03360	0.01341	2.76247	0.00250	6.50	35.06	129.36	3.818	15.273	33.08
0.10500	208.00	22.92750	0.03426	0.01555	3.20293	0.00250	7.00	37.74	135.92	4.215	16.861	35.61
0.10750	207.00	23.36054	0.03491	0.01785	3.67574	0.00250	7.50	40.41	142.15	4.611	18.444	38.13
0.11000	206.00	23.78833	0.03554	0.02030	4.18085	0.00250	8.00	43.07	148.09	5.004	20.017	40.64
0.11250	205.00	24.21087	0.03618	0.02291	4.71820	0.00250	8.50	45.73	153.74	5.394	21.575	43.16
0.11500	204.00	24.62817	0.03680	0.02568	5.28771	0.00250	9.00	48.39	159.14	5.779	23.114	45.66
0.11750	203.00	25.04021	0.03741	0.02860	5.88933	0.00250	9.50	51.04	164.28	6.158	24.632	48.16
0.12000	202.00	25.44701	0.03802	0.03168	6.52297	0.00250	10.00	53.68	169.19	6.532	26.126	50.66
0.12250	201.00	25.84855	0.03862	0.03491	7.18856	0.00250	10.50	56.32	173.87	6.898	27.594	53.14
0.12500	200.00	26.24485	0.03921	0.03830	7.88602	0.00250	11.00	58.95	178.35	7.258	29.034	55.63
0.12750	199.00	26.63590	0.03980	0.04184	8.61526	0.00250	11.50	61.57	182.64	7.611	30.445	58.10
0.13000	198.00	27.02170	0.04038	0.04553	9.37619	0.00250	12.00	64.19	186.73	7.956	31.826	60.57
0.13250	197.00	27.40225	0.04094	0.04938	10.16872	0.00250	12.50	66.79	190.65	8.294	33.176	63.03
0.13500	196.00	27.77755	0.04150	0.05338	10.99275	0.00250	13.00	69.39	194.40	8.623	34.494	65.48
0.13750	195.00	28.14760	0.04206	0.05754	11.84819	0.00250	13.50	71.98	197.99	8.945	35.780	67.93
0.14000	194.00	28.51240	0.04260	0.06184	12.73492	0.00250	14.00	74.57	201.43	9.258	37.034	70.36
0.14250	193.00	28.87196	0.04314	0.06630	13.65284	0.00250	14.50	77.14	204.72	9.564	38.255	72.79
0.14500	192.00	29.22626	0.04367	0.07091	14.60184	0.00250	15.00	79.70	207.88	9.861	39.443	75.21
0.14750	191.00	29.57532	0.04419	0.07567	15.58180	0.00250	15.50	82.26	210.90	10.150	40.599	77.62
0.15000	190.00	29.91913	0.04470	0.08058	16.59260	0.00250	16.00	84.80	213.80	10.431	41.723	80.02
0.15333	189.00	30.42303	0.04546	0.08563	17.63412	0.00333	16.50	87.33	215.40	10.587	42.349	82.41
0.15667	188.00	30.91993	0.04620	0.09084	18.70623	0.00333	17.00	89.86	216.91	10.736	42.944	84.79
0.16000	187.00	31.40984	0.04693	0.09619	19.80880	0.00333	17.50	92.37	218.33	10.877	43.507	87.16
0.16333	186.00	31.89274	0.04765	0.10170	20.94170	0.00333	18.00	94.87	219.66	11.010	44.040	89.52
0.16667	185.00	32.36865	0.04836	0.10734	22.10478	0.00333	18.50	97.36	220.92	11.136	44.545	91.87
0.17000	184.00	32.83755	0.04907	0.11314	23.29791	0.00333	19.00	99.83	222.09	11.255	45.021	94.20
0.17333	183.00	33.29946	0.04976	0.11908	24.52095	0.00333	19.50	102.30	223.20	11.368	45.471	96.53
0.17667	182.00	33.75438	0.05044	0.12516	25.77373	0.00333	20.00	104.75	224.24	11.474	45.895	98.84
0.18000	181.00	34.20229	0.05110	0.13139	27.05612	0.00333	20.50	107.19	225.21	11.574	46.295	101.15
0.18333	180.00	34.64320	0.05176	0.13776	28.36794	0.00333	21.00	109.62	226.12	11.667	46.670	103.44
0.18667	179.00	35.07712	0.05241	0.14427	29.70906	0.00333	21.50	112.03	226.98	11.756	47.022	105.71
0.19000	178.00	35.50403	0.05305	0.15092	31.07930	0.00333	22.00	114.43	227.77	11.838	47.352	107.98
0.19333	177.00	35.92395	0.05368	0.15772	32.47849	0.00333	22.50	116.82	228.51	11.915	47.660	110.23
0.19667	176.00	36.33687	0.05429	0.16465	33.90647	0.00333	23.00	119.19	229.20	11.987	47.947	112.47
0.20000	175.00	36.74279	0.05490	0.17173	35.36306	0.00333	23.50	121.54	229.84	12.054	48.214	114.69
0.20250	174.00	36.98949	0.05527	0.17894	36.84809	0.00250	24.00	123.89	231.37	12.215	48.862	116.90
0.20500	173.00	37.23094	0.05563	0.18629	38.36138	0.00250	24.50	126.22	232.85	12.371	49.486	119.10
0.20750	172.00	37.46715	0.05598	0.19377	39.90274	0.00250	25.00	128.53	234.25	12.522	50.086	121.28
0.21000	171.00	37.69810	0.05633	0.20139	41.47199	0.00250	25.50	130.82	235.60	12.666	50.664	123.45
0.21250	170.00	37.92381	0.05667	0.20915	43.06894	0.00250	26.00	133.11	236.89	12.805	51.220	125.60
0.21500	169.00	38.14426	0.05699	0.21704	44.69340	0.00250	26.50	135.37	238.12	12.938	51.753	127.74
0.21750	168.00	38.35947	0.05732	0.22506	46.34516	0.00250	27.00	137.62	239.29	13.066	52.264	129.86
0.22000	167.00	38.56943	0.05763	0.23321	48.02404	0.00250	27.50	139.85	240.41	13.188	52.753	131.97
0.22250	166.00	38.77414	0.05794	0.24149	49.72983	0.00250	28.00	142.07	241.47	13.305	53.221	134.06
0.22500	165.00	38.97360	0.05823	0.24991	51.46232	0.00250	28.50	144.26	242.49	13.417	53.668	136.13
0.22750	164.00	39.16781	0.05852	0.25845	53.22130	0.00250	29.00	146.45	243.45	13.524	54.094	138.19
0.23000	163.00	39.35678	0.05881	0.26712	55.00657	0.00250	29.50	148.61	244.36	13.625	54.500	140.23

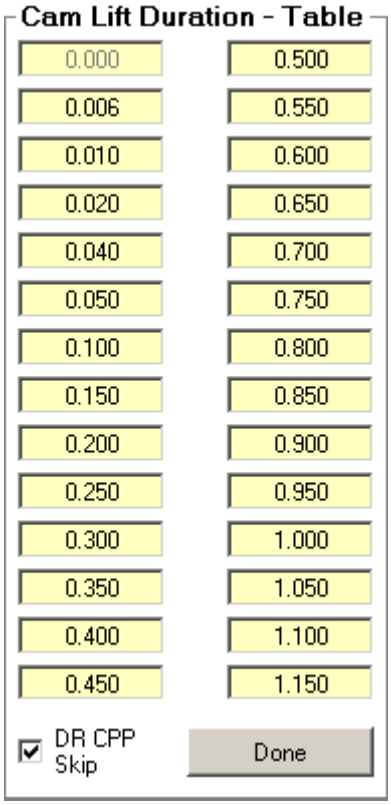
Bore = 4.0000 Stroke = 3.2500 Rod Length = 5.7000 RPM = 6500
Wrist Pin Offset = 0.0 Number of - Intake Valves = 1 - Exhaust Valves = 1
Intake Valve Size = 2.02 Exhaust Valve Size = 1.6
Intake Valve / Bore Ratio = 0.505 Exhaust Valve / Bore Ratio = 0.4
Intake Valve Area = 3.204739 sq. in. Exhaust Valve Area = 2.010619 sq. in.
Intake Valve Stem Size = 0.375 Exhaust Valve Stem Size = 0.375
Intake Valve Stem Area = 0.110447 sq. in. Exhaust Valve Stem Area = 0.110447 sq. in.
Valve Lift at which the Valve Area and Window / Curtain Area are the SAME SIZE
At that point the velocity will be the same in both areas
Intake Valve Lift = 0.505 Inches Exhaust Valve Lift = 0.4 Inches

Intake Centerline = 116.00000 User Selected DC - Discharge Coefficient = 0.5

Throat CSA (0.91) Intake = 2.5434 sq. in. Throat CSA (0.91) Exhaust = 1.5545 sq. in.
Effective Throat CSA = 0.89086 Effective Throat CSA = 0.8793
Valve Lift at which the Throat Area and Window / Curtain Area are the SAME SIZE
At that point the velocity will be the same in both areas
Intake Valve Lift = 0.40079 Inches Exhaust Valve Lift = 0.30927 Inches

Valve Lift	Duration	Time Port Area cm^2	Time Port Area cm^2/cc	Piston Travel	Cylinder Volume cc	Valve Velocity Inch/Deg	Degrees ATDC	Piston Flow @ 28" CFM	Curtain Area Velocity	Depress- ion for DC of 1	Depress- ion for User DC	Throat Area Velocity
0.05600	232.00	13.63892	0.02038	0.00000	0.00000	0.00200	.00	.00	.00	.000	.000	.00
0.05800	231.00	14.06514	0.02102	0.00008	0.01637	0.00200	.50	2.71	17.65	.071	.284	2.55
0.06000	230.00	14.48716	0.02165	0.00032	0.06549	0.00200	1.00	5.41	34.11	.266	1.062	5.11
0.06200	229.00	14.90497	0.02227	0.00072	0.14735	0.00200	1.50	8.12	49.51	.559	2.238	7.66
0.06400	228.00	15.31859	0.02289	0.00127	0.26195	0.00200	2.00	10.82	63.95	.933	3.732	10.21
0.06600	227.00	15.72801	0.02350	0.00199	0.40925	0.00200	2.50	13.52	77.50	1.370	5.481	12.76
0.06800	226.00	16.13323	0.02411	0.00286	0.58926	0.00200	3.00	16.23	90.24	1.858	7.432	15.31
0.07000	225.00	16.53425	0.02471	0.00389	0.80194	0.00200	3.50	18.92	102.24	2.385	9.542	17.86
0.07200	224.00	16.93108	0.02530	0.00509	1.04727	0.00200	4.00	21.62	113.57	2.943	11.772	20.40
0.07400	223.00	17.32370	0.02588	0.00644	1.32522	0.00200	4.50	24.32	124.27	3.524	14.095	22.94
0.07600	222.00	17.71212	0.02647	0.00794	1.63575	0.00200	5.00	27.01	134.39	4.121	16.485	25.48
0.07800	221.00	18.09635	0.02704	0.00961	1.97884	0.00200	5.50	29.69	143.98	4.730	18.921	28.02
0.08000	220.00	18.47637	0.02761	0.01143	2.35442	0.00200	6.00	32.38	153.07	5.346	21.385	30.55
0.08200	219.00	18.85220	0.02817	0.01341	2.76247	0.00200	6.50	35.06	161.70	5.966	23.864	33.08
0.08400	218.00	19.22383	0.02872	0.01555	3.20293	0.00200	7.00	37.74	169.89	6.586	26.345	35.61
0.08600	217.00	19.59125	0.02927	0.01785	3.67574	0.00200	7.50	40.41	177.69	7.205	28.819	38.13
0.08800	216.00	19.95448	0.02982	0.02030	4.18085	0.00200	8.00	43.07	185.11	7.819	31.276	40.64
0.09000	215.00	20.31351	0.03035	0.02291	4.71820	0.00200	8.50	45.73	192.18	8.428	33.710	43.16
0.09200	214.00	20.66834	0.03088	0.02568	5.28771	0.00200	9.00	48.39	198.92	9.029	36.116	45.66
0.09400	213.00	21.01897	0.03141	0.02860	5.88933	0.00200	9.50	51.04	205.35	9.622	38.488	48.16
0.09600	212.00	21.36541	0.03192	0.03168	6.52297	0.00200	10.00	53.68	211.48	10.206	40.822	50.66
0.09800	211.00	21.70764	0.03244	0.03491	7.18856	0.00200	10.50	56.32	217.34	10.779	43.116	53.14
0.10000	210.00	22.04567	0.03294	0.03830	7.88602	0.00200	11.00	58.95	222.94	11.341	45.366	55.63
0.10250	209.00	22.48921	0.03360	0.04184	8.61526	0.00250	11.50	61.57	227.18	11.777	47.107	58.10
0.10500	208.00	22.92750	0.03426	0.04553	9.37619	0.00250	12.00	64.19	231.19	12.196	48.785	60.57
0.10750	207.00	23.36054	0.03491	0.04938	10.16872	0.00250	12.50	66.79	234.99	12.600	50.400	63.03
0.11000	206.00	23.78833	0.03554	0.05338	10.99275	0.00250	13.00	69.39	238.58	12.989	51.954	65.48
0.11250	205.00	24.21087	0.03618	0.05754	11.84819	0.00250	13.50	71.98	241.99	13.362	53.449	67.93
0.11500	204.00	24.62817	0.03680	0.06184	12.73492	0.00250	14.00	74.57	245.22	13.721	54.885	70.36
0.11750	203.00	25.04021	0.03741	0.06630	13.65284	0.00250	14.50	77.14	248.28	14.066	56.265	72.79
0.12000	202.00	25.44701	0.03802	0.07091	14.60184	0.00250	15.00	79.70	251.19	14.397	57.590	75.21
0.12250	201.00	25.84855	0.03862	0.07567	15.58180	0.00250	15.50	82.26	253.95	14.715	58.861	77.62
0.12500	200.00	26.24485	0.03921	0.08058	16.59260	0.00250	16.00	84.80	256.56	15.020	60.081	80.02
0.12750	199.00	26.63590	0.03980	0.08563	17.63412	0.00250	16.50	87.33	259.05	15.312	61.249	82.41
0.13000	198.00	27.02170	0.04038	0.09084	18.70623	0.00250	17.00	89.86	261.40	15.592	62.369	84.79
0.13250	197.00	27.40225	0.04094	0.09619	19.80880	0.00250	17.50	92.37	263.64	15.860	63.441	87.16
0.13500	196.00	27.77755	0.04150	0.10170	20.94170	0.00250	18.00	94.87	265.76	16.117	64.466	89.52
0.13750	195.00	28.14760	0.04206	0.10734	22.10478	0.00250	18.50	97.36	267.78	16.362	65.447	91.87
0.14000	194.00	28.51240	0.04260	0.11314	23.29791	0.00250	19.00	99.83	269.69	16.596	66.383	94.20
0.14250	193.00	28.87196	0.04314	0.11908	24.52095	0.00250	19.50	102.30	271.50	16.819	67.278	96.53
0.14500	192.00	29.22626	0.04367	0.12516	25.77373	0.00250	20.00	104.75	273.21	17.033	68.130	98.84
0.14750	191.00	29.57532	0.04419	0.13139	27.05612	0.00250	20.50	107.19	274.84	17.236	68.943	101.15
0.15000	190.00	29.91913	0.04470	0.13776	28.36794	0.00250	21.00	109.62	276.37	17.429	69.717	103.44
0.15333	189.00	30.42303	0.04546	0.14427	29.70906	0.00333	21.50	112.03	276.32	17.422	69.689	105.71
0.15667	188.00	30.91993	0.04620	0.15092	31.07930	0.00333	22.00	114.43	276.23	17.411	69.645	107.98
0.16000	187.00	31.40984	0.04693	0.15772	32.47849	0.00333	22.50	116.82	276.12	17.397	69.587	110.23
0.16333	186.00	31.89274	0.04765	0.16465	33.90647	0.00333	23.00	119.19	275.97	17.379	69.515	112.47
0.16667	185.00	32.36865	0.04836	0.17173	35.36306	0.00333	23.50	121.54	275.80	17.357	69.429	114.69
0.17000	184.00	32.83755	0.04907	0.17894	36.84809	0.00333	24.00	123.89	275.61	17.332	69.330	116.90
0.17333	183.00	33.29946	0.04976	0.18629	38.36138	0.00333	24.50	126.22	275.38	17.305	69.219	119.10
0.17667	182.00	33.75438	0.05044	0.19377	39.90274	0.00333	25.00	128.53	275.14	17.274	69.095	121.28
0.18000	181.00	34.20229	0.05110	0.20139	41.47199	0.00333	25.50	130.82	274.87	17.240	68.960	123.45
0.18333	180.00	34.64320	0.05176	0.20915	43.06894	0.00333	26.00	133.11	274.58	17.203	68.813	125.60
0.18667	179.00	35.07712	0.05241	0.21704	44.69340	0.00333	26.50	135.37	274.26	17.164	68.656	127.74
0.19000	178.00	35.50403	0.05305	0.22506	46.34516	0.00333	27.00	137.62	273.93	17.122	68.488	129.86
0.19333	177.00	35.92395	0.05368	0.23321	48.02404	0.00333	27.50	139.85	273.57	17.077	68.309	131.97
0.19667	176.00	36.33687	0.05429	0.24149	49.72983	0.00333	28.00	142.07	273.19	17.030	68.121	134.06
0.20000	175.00	36.74279	0.05490	0.24991	51.46232	0.00333	28.50	144.26	272.80	16.981	67.924	136.13
0.20250	174.00	36.98949	0.05527	0.25845	53.22130	0.00250	29.00	146.45	273.50	17.069	68.275	138.19
0.20500	173.00	37.23094	0.05563	0.26712	55.00657	0.00250	29.50	148.61	274.16	17.151	68.603	140.23





Increasing Degrees BTDC will Advance the ICL Decreasing Degrees BTDC will Retard the ICL.
Increasing Degrees BBDC will Retard the ECL Decreasing Degrees BBDC will Advance the ECL.
Once you have the Intake and exhaust lobes positioned correctly you can advance or retard and or increase or decrease the LSA.
Valve Angle is needed to correctly calculate the vertical and horizontal part of the valve lift.

NOTE: Since you can now change the Cam Lift Duration Table, if you either change the position of 0.010, 0.020, and 0.050 or remove any of them the Major and Minor Intensity will not be correct.

With the change to the Cam Lift Duration Table the Metric check box will not these value now. The User must enter their own Metric lift numbers. You can also copy and paste the below numbers using a text editor and create a parameter file, which can then read into CARFOR.

```
;---------------------------------
Lift Table = 0.0
Lift Table = 0.25
Lift Table = 0.5
Lift Table = 1.0
Lift Table = 1.0
Lift Table = 1.5
Lift Table = 2.5
Lift Table = 3.0
Lift Table = 3.5
Lift Table = 4.0
Lift Table = 4.5
Lift Table = 5.0
Lift Table = 5.5
Lift Table = 6.0
Lift Table = 6.5
Lift Table = 7.0
Lift Table = 7.5
```

```
Lift Table = 8.0
Lift Table = 8.5
Lift Table = 9.0
Lift Table = 9.5
Lift Table = 10.5
Lift Table = 10.5
Lift Table = 11.0
Lift Table = 11.5
Lift Table = 12.0
Lift Table = 12.5
Lift Table = 13.0
;---------------------------------
```

---EXAMPLE--

C1 File - Header Information

PVN,ICL,ECL = 1.006,113.2,113.2

0.050 Overlap = 28

Intake 0.050 Open = 12 Close = 60.6 Duration = 252.6

Intake Cam Lift = .35807 Valve Lift = .6302 Area = 30.86

Exhaust 0.050 Open = 60.5 Close = 16 Duration = 256.5

Exhaust Cam Lift = .36339 Valve Lift = .63956 Area = 31.72

```
Bore = 4.0000     Stroke = 3.2500          Rod Length = 5.7000     RPM = 6500
Wrist Pin Offset = 0.0                     Number of - Intake Valves = 1 - Exhaust Valves = 1
Intake Valve Size = 2.055                  Exhaust Valve Size = 1.6
Intake Valve / Bore Ratio = 0.51375        Exhaust Valve / Bore Ratio = 0.4
Intake Valve Area = 3.316756 sq. in.       Exhaust Valve Area = 2.010619 sq. in.
Intake Valve Stem Size = 0.3415            Exhaust Valve Stem Size = 0.3415
Intake Valve Stem Area = 0.091595 sq. in.  Exhaust Valve Stem Area = 0.091595 sq. in.
Valve Lift at which the Valve Area and Window / Curtain Area are the SAME SIZE
At that point the velocity will be the same in both areas
Intake Valve Lift = 0.51375 Inches         Exhaust Valve Lift = 0.4 Inches
Intake Centerline = 111.0                  User Selected DC - Discharge Coefficient = 0.5
Throat CSA (0.91) Intake = 2.6550 sq. in.  Throat CSA (0.91) Exhaust = 1.5734 sq. in.
Effective Throat CSA = 0.8947              Effective Throat CSA = 0.88462
Valve Lift at which the Throat Area and Window / Curtain Area are the SAME SIZE
At that point the velocity will be the same in both areas
Intake Valve Lift = 0.41125 Inches         Exhaust Valve Lift = 0.31302 Inches

       I  N  T  A  K  E
Rocker Arm Ratio = 1.500         Valve Lash = 0.0240         Valve Angle = 23.0
```

Cam Lift	Valve Lift	Crank Angle	Time Port Area cm^2	Time Port Area cm^2/cc	Valve Velocity FPS	Valve Acceleration FPS^2	Valve Lift Horiz	Valve Lift Vert	Piston Travel	Cylinder Volume cc	User Supplied Air Flow	Valve Discharge Coefficient	L/D Ratio
0.0000	-0.0240	-120.0			0.0000	0.0000							
0.0020	-0.0210	-110.0			0.9750	3.8025							
0.0050	-0.0165	-100.0			1.4625	1.9013							
0.0070	-0.0135	-90.0			0.9750	-1.9013							
0.0100	-0.0090	-80.0			1.4625	1.9013							
0.0130	-0.0045	-70.0			1.4625	0.0000							
0.0160	0.0000	-60.0	0.0000	0.0000	1.4625	0.0000	0.0000	0.0000	0.9890	203.652	.00	-1.#IND	0.0000
0.0220	0.0090	-50.0	0.0961	0.0001	2.9250	5.7038	0.0083	0.0035	0.7181	147.867	5.90	0.6951	0.0044
0.0330	0.0255	-40.0	0.2723	0.0004	5.3625	9.5063	0.0235	0.0100	0.4767	98.165	16.70	0.6951	0.0124
0.0500	0.0510	-30.0	0.5447	0.0008	8.2875	11.4075	0.0469	0.0199	0.2759	56.818	33.41	0.6951	0.0248
0.0780	0.0930	-20.0	0.9932	0.0015	13.6500	20.9138	0.0856	0.0363	0.1252	25.774	60.92	0.6951	0.0453
0.1150	0.1485	-10.0	1.5860	0.0024	18.0375	17.1113	0.1367	0.0580	0.0317	6.523	97.27	0.6951	0.0723
0.1450	0.1935	.0	2.0665	0.0031	14.6250	-13.3088	0.1781	0.0756	0.0000	.000	126.74	0.6951	0.0942
0.1800	0.2460	10.0	2.6272	0.0039	17.0625	9.5063	0.2264	0.0961	0.0317	6.523	157.22	0.6782	0.1197
0.2150	0.2985	20.0	3.1879	0.0048	17.0625	0.0000	0.2748	0.1166	0.1252	25.774	187.15	0.6653	0.1453
0.2500	0.3510	30.0	3.7486	0.0056	17.0625	0.0000	0.3231	0.1371	0.2759	56.818	209.42	0.6332	0.1708
0.2810	0.3975	40.0	4.2452	0.0063	15.1125	-7.6050	0.3659	0.1553	0.4767	98.165	228.95	0.6112	0.1934
0.3100	0.4410	50.0	4.7098	0.0070	14.1375	-3.8025	0.4059	0.1723	0.7181	147.867	242.30	0.5831	0.2146
0.3340	0.4770	60.0	5.0943	0.0076	11.7000	-9.5062	0.4391	0.1864	0.9890	203.652	253.10	0.5631	0.2321
0.3500	0.5010	70.0	5.3506	0.0080	7.8000	-15.2100	0.4612	0.1958	1.2776	263.083	260.13	0.5510	0.2438
0.3670	0.5265	80.0	5.6229	0.0084	8.2875	1.9013	0.4846	0.2057	1.5721	323.732	263.45	0.5310	0.2562
0.3790	0.5445	90.0	5.8152	0.0087	5.8500	-9.5062	0.5012	0.2128	1.8615	383.340	265.79	0.5180	0.2650
0.3850	0.5535	100.0	5.9113	0.0088	2.9250	-11.4075	0.5095	0.2163	2.1364	439.948	266.96	0.5118	0.2693
0.3880	0.5580	110.0	5.9593	0.0089	1.4625	-5.7037	0.5136	0.2180	2.3891	491.983	267.54	0.5088	0.2715
0.3860	0.5550	120.0	5.9273	0.0089	-0.9750	-9.5063	0.5109	0.2169	2.6140	538.281	267.15	0.5108	0.2701
0.3800	0.5460	130.0	5.8312	0.0087	-2.9250	-7.6050	0.5026	0.2133	2.8071	578.059	265.98	0.5170	0.2657
0.3690	0.5295	140.0	5.6550	0.0084	-5.3625	-9.5063	0.4874	0.2069	2.9663	610.847	263.84	0.5288	0.2577
0.3520	0.5040	150.0	5.3826	0.0080	-8.2875	-11.4075	0.4639	0.1969	3.0905	636.413	260.52	0.5486	0.2453
0.3320	0.4740	160.0	5.0622	0.0076	-9.7500	-5.7038	0.4363	0.1852	3.1792	654.672	252.20	0.5646	0.2307

0.3090	0.4395	170.0	4.6938	0.0070	-11.2125	-5.7038	0.4046	0.1717	3.2323	665.615	241.85	0.5840	0.2139
0.2820	0.3990	180.0	4.2613	0.0064	-13.1625	-7.6050	0.3673	0.1559	3.2500	669.259	229.58	0.6106	0.1942
0.2500	0.3510	190.0	3.7486	0.0056	-15.6000	-9.5062	0.3231	0.1371	3.2323	665.615	209.42	0.6332	0.1708
0.2140	0.2970	200.0	3.1719	0.0047	-17.5500	-7.6050	0.2734	0.1160	3.1792	654.672	186.29	0.6656	0.1445
0.1800	0.2460	210.0	2.6272	0.0039	-16.5750	3.8025	0.2264	0.0961	3.0905	636.413	157.22	0.6782	0.1197
0.1450	0.1935	220.0	2.0665	0.0031	-17.0625	-1.9013	0.1781	0.0756	2.9663	610.847	126.74	0.6951	0.0942
0.1110	0.1425	230.0	1.5219	0.0023	-16.5750	1.9013	0.1312	0.0557	2.8071	578.059	93.34	0.6951	0.0693
0.0820	0.0990	240.0	1.0573	0.0016	-14.1375	9.5062	0.0911	0.0387	2.6140	538.281	64.85	0.6951	0.0482
0.0500	0.0510	250.0	0.5447	0.0008	-15.6000	-5.7037	0.0469	0.0199	2.3891	491.983	33.41	0.6951	0.0248
0.0350	0.0285	260.0	0.3044	0.0005	-7.3125	32.3213	0.0262	0.0111	2.1364	439.948	18.67	0.6951	0.0139
0.0240	0.0120	270.0	0.1282	0.0002	-5.3625	7.6050	0.0110	0.0047	1.8615	383.340	7.86	0.6951	0.0058
0.0170	0.0015	280.0	0.0160	0.0000	-3.4125	7.6050	0.0014	0.0006	1.5721	323.732	.98	0.6951	0.0007
0.0140	-0.0030	290.0			-1.4625	7.6050							
0.0110	-0.0075	300.0			-1.4625	0.0000							
0.0090	-0.0105	310.0			-0.9750	1.9013							
0.0070	-0.0135	320.0			-0.9750	0.0000							
0.0040	-0.0180	330.0			-1.4625	-1.9013							
0.0010	-0.0225	340.0			-1.4625	0.0000							
0.0000	-0.0240	350.0			-0.4875	3.8025							
0.0000	-0.0240	360.0			0.0000	1.9013							
Totals			109.8314	0.1613							80027		

VALVE	Lift	Opens Deg BTDC	Closes Deg ABDC	Duration	Area
	0.00000	60.00	103.33	343.33	54.19
	0.00600	53.33	95.71	329.05	54.11
	0.01000	49.39	91.90	321.30	54.09
	0.02000	43.33	85.15	308.48	53.91
	0.04000	34.31	74.89	289.20	53.51
	0.05000	30.39	70.44	280.84	53.51
	0.10000	18.74	59.77	258.51	51.52
	0.15000	9.67	48.53	238.20	49.82
	0.20000	-1.24	38.76	217.52	47.61
	0.25000	-10.76	29.22	198.45	44.90
	0.30000	-20.29	19.44	179.16	41.64
	0.35000	-29.81	10.19	160.38	41.64
	0.40000	-40.57	-0.25	139.18	33.74
	0.45000	-52.50	-13.04	114.46	29.18
	0.50000	-69.58	-28.67	81.75	24.29
	0.55000	-96.11	-54.44	29.44	8.32
CAM					
	0.00600	95.00	143.33	418.33	39.34
	0.01000	80.00	125.00	385.00	39.20
	0.02000	53.33	95.71	329.05	38.72
	0.04000	35.88	76.67	292.55	37.99
	0.05000	30.00	70.00	280.00	37.99
	0.10000	14.05	53.79	247.85	36.35
	0.15000	-1.43	38.57	217.14	33.42
	0.20000	-15.71	24.12	188.40	31.45
	0.25000	-30.00	10.00	160.00	29.12
	0.30000	-46.55	-6.67	126.78	23.53
	0.35000	-70.00	-29.00	81.00	16.92

Major Intensity 49.05
Minor Intensity 105.00

I N T A K E

Rocker Arm Ratio = 1.600 Valve Lash = 0.0256 Valve Angle = 23.0

Cam Lift	Valve Lift	Crank Angle	Time Port Area cm^2	Time Port Area cm^2/cc	Valve Velocity FPS	Valve Acceleration FPS^2	Valve Lift Horiz	Valve Lift Vert	Piston Travel	Cylinder Volume cc	User Supplied Valve Air Flow	L/D Ratio Discharge Coefficient
0.0000	-0.0256	-120.0			0.0000	0.0000						
0.0020	-0.0224	-110.0			1.0400	4.0560						
0.0050	-0.0176	-100.0			1.5600	2.0280						
0.0070	-0.0144	-90.0			1.0400	-2.0280						
0.0100	-0.0096	-80.0			1.5600	2.0280						
0.0130	-0.0048	-70.0			1.5600	0.0000						
0.0160	0.0000	-60.0	0.0000	0.0000	1.5600	0.0000	0.0000	0.0000	0.9890	203.652	.00	-1.#IND 0.0000
0.0220	0.0096	-50.0	0.1008	0.0002	3.1200	6.0840	0.0088	0.0038	0.7181	147.867	8.16	0.9177 0.0048
0.0330	0.0272	-40.0	0.2855	0.0004	5.7200	10.1400	0.0250	0.0106	0.4767	98.165	23.12	0.9177 0.0135
0.0500	0.0544	-30.0	0.5711	0.0009	8.8400	12.1680	0.0501	0.0213	0.2759	56.818	46.24	0.9177 0.0269
0.0780	0.0992	-20.0	1.0414	0.0016	14.5600	22.3080	0.0913	0.0388	0.1252	25.774	84.32	0.9177 0.0491
0.1150	0.1584	-10.0	1.6629	0.0025	19.2400	18.2520	0.1458	0.0619	0.0317	6.523	132.30	0.9018 0.0784
0.1450	0.2064	TDC	2.1668	0.0032	15.6000	-14.1960	0.1900	0.0806	0.0000	.000	170.03	0.8894 0.1022
0.1800	0.2624	10.0	2.7547	0.0041	18.2000	10.1400	0.2415	0.1025	0.0317	6.523	205.31	0.8447 0.1299
0.2150	0.3184	20.0	3.3425	0.0050	18.2000	0.0000	0.2931	0.1244	0.1252	25.774	240.96	0.8170 0.1576
0.2500	0.3744	30.0	3.9304	0.0059	18.2000	0.0000	0.3446	0.1463	0.2759	56.818	277.36	0.7998 0.1853
0.2810	0.4240	40.0	4.4511	0.0067	16.1200	-8.1120	0.3903	0.1657	0.4767	98.165	307.44	0.7828 0.2099
0.3100	0.4704	50.0	4.9382	0.0074	15.0800	-4.0560	0.4330	0.1838	0.7181	147.867	333.42	0.7652 0.2329

0.3340	0.5088	60.0	5.3414	0.0080	12.4800	-10.1400	0.4684	0.1988	0.9890	203.652	358.80	0.7613	0.2519
0.3500	0.5344	70.0	5.6101	0.0084	8.3200	-16.2240	0.4919	0.2088	1.2776	263.083	384.40	0.7766	0.2646
0.3670	0.5616	80.0	5.8956	0.0088	8.8400	2.0280	0.5170	0.2194	1.5721	323.732	405.80	0.7801	0.2780
0.3790	0.5808	90.0	6.0972	0.0091	6.2400	-10.1400	0.5346	0.2269	1.8615	383.340	415.40	0.7722	0.2875
0.3850	0.5904	100.0	6.1980	0.0093	3.1200	-12.1680	0.5435	0.2307	2.1364	439.948	420.20	0.7684	0.2923
0.3880	0.5952	110.0	6.2484	0.0093	1.5600	-6.0840	0.5479	0.2326	2.3891	491.983	422.60	0.7665	0.2947
0.3860	0.5920	120.0	6.2148	0.0093	-1.0400	-10.1400	0.5449	0.2313	2.6140	538.281	421.00	0.7678	0.2931
0.3800	0.5824	130.0	6.1140	0.0091	-3.1200	-8.1120	0.5361	0.2276	2.8071	578.059	416.20	0.7715	0.2883
0.3690	0.5648	140.0	5.9292	0.0089	-5.7200	-10.1400	0.5199	0.2207	2.9663	610.847	407.40	0.7788	0.2796
0.3520	0.5376	150.0	5.6437	0.0084	-8.8400	-12.1680	0.4949	0.2101	3.0905	636.413	387.60	0.7784	0.2661
0.3320	0.5056	160.0	5.3078	0.0079	-10.4000	-6.0840	0.4654	0.1976	3.1792	654.672	355.60	0.7593	0.2503
0.3090	0.4688	170.0	4.9214	0.0074	-11.9600	-6.0840	0.4315	0.1832	3.2323	665.615	332.53	0.7658	0.2321
0.2820	0.4256	BDC	4.4679	0.0067	-14.0400	-8.1120	0.3918	0.1663	3.2500	669.259	308.34	0.7822	0.2107
0.2500	0.3744	190.0	3.9304	0.0059	-16.6400	-10.1400	0.3446	0.1463	3.2323	665.615	277.36	0.7998	0.1853
0.2140	0.3168	200.0	3.3257	0.0050	-18.7200	-8.1120	0.2916	0.1238	3.1792	654.672	239.92	0.8176	0.1568
0.1800	0.2624	210.0	2.7547	0.0041	-17.6800	4.0560	0.2415	0.1025	3.0905	636.413	205.31	0.8447	0.1299
0.1450	0.2064	220.0	2.1668	0.0032	-18.2000	-2.0280	0.1900	0.0806	2.9663	610.847	170.03	0.8894	0.1022
0.1110	0.1520	230.0	1.5957	0.0024	-17.6800	2.0280	0.1399	0.0594	2.8071	578.059	127.12	0.9029	0.0752
0.0820	0.1056	240.0	1.1086	0.0017	-15.0800	10.1400	0.0972	0.0413	2.6140	538.281	89.54	0.9154	0.0523
0.0500	0.0544	250.0	0.5711	0.0009	-16.6400	-6.0840	0.0501	0.0213	2.3891	491.983	46.24	0.9177	0.0269
0.0350	0.0304	260.0	0.3191	0.0005	-7.8000	34.4760	0.0280	0.0119	2.1364	439.948	25.84	0.9177	0.0150
0.0240	0.0128	270.0	0.1344	0.0002	-5.7200	8.1120	0.0118	0.0050	1.8615	383.340	10.88	0.9177	0.0063
0.0170	0.0016	280.0	0.0168	0.0000	-3.6400	8.1120	0.0015	0.0006	1.5721	323.732	1.36	0.9177	0.0008
0.0140	-0.0032	290.0			-1.5600	8.1120							
0.0110	-0.0080	300.0			-1.5600	0.0000							
0.0090	-0.0112	310.0			-1.0400	2.0280							
0.0070	-0.0144	320.0			-1.0400	0.0000							
0.0040	-0.0192	330.0			-1.5600	-2.0280							
0.0010	-0.0240	340.0			-1.5600	0.0000							
0.0000	-0.0256	350.0			-0.5200	4.0560							
0.0000	-0.0256	TDC			0.0000	2.0280							
Totals			115.1582	0.1721							84787		

VALVE	Lift	Opens Deg BTDC	Closes Deg ABDC	Duration	Area
	0.00000	60.00	103.33	343.33	57.80
	0.00600	53.75	96.07	329.82	57.72
	0.01000	49.77	92.50	322.27	57.70
	0.02000	44.09	85.91	310.00	57.50
	0.04000	35.29	76.00	291.29	57.08
	0.05000	31.62	71.83	283.45	57.08
	0.10000	19.86	61.09	260.96	55.83
	0.15000	11.42	50.43	241.85	54.96
	0.20000	1.33	41.18	222.51	53.14
	0.25000	-7.79	32.21	204.43	50.78
	0.30000	-16.71	23.09	186.37	47.89
	0.35000	-25.64	14.24	168.59	44.42
	0.40000	-35.16	5.00	149.84	40.43
	0.45000	-45.60	-5.65	128.75	35.98
	0.50000	-57.71	-18.48	103.81	31.13
	0.55000	-75.74	-34.56	69.71	20.41
CAM					
	0.00600	95.00	143.33	418.33	39.34
	0.01000	80.00	125.00	385.00	39.20
	0.02000	53.33	95.71	329.05	38.72
	0.04000	35.88	76.67	292.55	37.99
	0.05000	30.00	70.00	280.00	37.99
	0.10000	14.05	53.79	247.85	36.35
	0.15000	-1.43	38.57	217.14	33.42
	0.20000	-15.71	24.12	188.40	31.45
	0.25000	-30.00	10.00	160.00	29.12
	0.30000	-46.55	-6.67	126.78	23.53
	0.35000	-70.00	-29.00	81.00	16.92

Major Intensity 49.05
Minor Intensity 105.00

E X H A U S T

Rocker Arm Ratio = 1.500 Valve Lash = 0.0300 Valve Angle = 23.0

Cam Lift	Valve Lift	Crank Angle	Time Port Area cm^2	Time Port Area cm^2/cc	Valve Velocity FPS	Valve Acceleration FPS^2	Valve Lift Horiz	Valve Lift Vert	Piston Travel	Cylinder Volume cc	User Supplied Valve Air Flow	L/D Ratio Discharge Coefficient
0.0000	-0.0300	-340.0			0.0000	0.0000						
0.0010	-0.0285	-330.0			0.4875	1.9013						
0.0040	-0.0240	-320.0			1.4625	3.8025						
0.0070	-0.0195	-310.0			1.4625	0.0000						
0.0100	-0.0150	-300.0			1.4625	0.0000						
0.0130	-0.0105	-290.0			1.4625	0.0000						
0.0160	-0.0060	-280.0			1.4625	0.0000						

0.0290	0.0135	-270.0	0.1123	0.0002	6.3375	19.0125	0.0124	0.0053	1.8615	383.340	7.83	0.7906	0.0084
0.0450	0.0375	-260.0	0.3118	0.0005	7.8000	5.7037	0.0345	0.0147	2.1364	439.948	21.75	0.7906	0.0234
0.0600	0.0600	-250.0	0.4989	0.0007	7.3125	-1.9012	0.0552	0.0234	2.3891	491.983	34.80	0.7906	0.0375
0.0780	0.0870	-240.0	0.7234	0.0011	8.7750	5.7037	0.0801	0.0340	2.6140	538.281	50.46	0.7906	0.0544
0.1040	0.1260	-230.0	1.0477	0.0016	12.6750	15.2100	0.1160	0.0492	2.8071	578.059	73.08	0.7906	0.0788
0.1380	0.1770	-220.0	1.4718	0.0022	16.5750	15.2100	0.1629	0.0692	2.9663	610.847	102.66	0.7906	0.1106
0.1740	0.2310	-210.0	1.9208	0.0029	17.5500	3.8025	0.2126	0.0903	3.0905	636.413	127.47	0.7521	0.1444
0.2100	0.2850	-200.0	2.3698	0.0035	17.5500	0.0000	0.2623	0.1114	3.1792	654.672	147.45	0.7052	0.1781
0.2420	0.3330	-190.0	2.7690	0.0041	15.6000	-7.6050	0.3065	0.1301	3.2323	665.615	166.53	0.6816	0.2081
0.2700	0.3750	-180.0	3.1182	0.0047	13.6500	-7.6050	0.3452	0.1465	3.2500	669.259	183.75	0.6679	0.2344
0.2960	0.4140	-170.0	3.4425	0.0051	12.6750	-3.8025	0.3811	0.1618	3.2323	665.615	196.52	0.6470	0.2588
0.3220	0.4530	-160.0	3.7668	0.0056	12.6750	0.0000	0.4170	0.1770	3.1792	654.672	203.54	0.6124	0.2831
0.3440	0.4860	-150.0	4.0412	0.0060	10.7250	-7.6050	0.4474	0.1899	3.0905	636.413	209.48	0.5875	0.3038
0.3590	0.5085	-140.0	4.2283	0.0063	7.3125	-13.3088	0.4681	0.1987	2.9663	610.847	214.81	0.5758	0.3178
0.3710	0.5265	-130.0	4.3780	0.0065	5.8500	-5.7037	0.4846	0.2057	2.8071	578.059	220.75	0.5715	0.3291
0.3780	0.5370	-120.0	4.4653	0.0067	3.4125	-9.5062	0.4943	0.2098	2.6140	538.281	224.21	0.5691	0.3356
0.3810	0.5415	-110.0	4.5027	0.0067	1.4625	-7.6050	0.4985	0.2116	2.3891	491.983	225.70	0.5681	0.3384
0.3790	0.5385	-100.0	4.4777	0.0067	-0.9750	-9.5062	0.4957	0.2104	2.1364	439.948	224.71	0.5688	0.3366
0.3740	0.5310	-90.0	4.4154	0.0066	-2.4375	-5.7037	0.4888	0.2075	1.8615	383.340	222.23	0.5704	0.3319
0.3670	0.5205	-80.0	4.3281	0.0065	-3.4125	-3.8025	0.4791	0.2034	1.5721	323.732	218.77	0.5729	0.3253
0.3490	0.4935	-70.0	4.1036	0.0061	-8.7750	-20.9137	0.4543	0.1928	1.2776	263.083	210.83	0.5823	0.3084
0.3310	0.4665	-60.0	3.8790	0.0058	-8.7750	0.0000	0.4294	0.1823	0.9890	203.652	205.97	0.6018	0.2916
0.3070	0.4305	-50.0	3.5797	0.0053	-11.7000	-11.4075	0.3963	0.1682	0.7181	147.867	199.49	0.6316	0.2691
0.2790	0.3885	-40.0	3.2305	0.0048	-13.6500	-7.6050	0.3576	0.1518	0.4767	98.165	189.29	0.6641	0.2428
0.2520	0.3480	-30.0	2.8937	0.0043	-13.1625	1.9012	0.3203	0.1360	0.2759	56.818	172.68	0.6763	0.2175
0.2200	0.3000	-20.0	2.4946	0.0037	-15.6000	-9.5062	0.2762	0.1172	0.1252	25.774	153.00	0.6951	0.1875
0.1860	0.2490	-10.0	2.0705	0.0031	-16.5750	-3.8025	0.2292	0.0973	0.0317	6.523	134.13	0.7342	0.1556
0.1530	0.1995	.0	1.6589	0.0025	-16.0875	1.9013	0.1836	0.0780	0.0000	.000	115.71	0.7906	0.1247
0.1200	0.1500	10.0	1.2473	0.0019	-16.0875	0.0000	0.1381	0.0586	0.0317	6.523	87.00	0.7906	0.0938
0.0890	0.1035	20.0	0.8606	0.0013	-15.1125	3.8025	0.0953	0.0404	0.1252	25.774	60.03	0.7906	0.0647
0.0630	0.0645	30.0	0.5363	0.0008	-12.6750	9.5063	0.0594	0.0252	0.2759	56.818	37.41	0.7906	0.0403
0.0420	0.0330	40.0	0.2744	0.0004	-10.2375	9.5062	0.0304	0.0129	0.4767	98.165	19.14	0.7906	0.0206
0.0270	0.0105	50.0	0.0873	0.0001	-7.3125	11.4075	0.0097	0.0041	0.7181	147.867	6.09	0.7906	0.0066
0.0170	-0.0045	60.0			-4.8750	9.5063							
0.0120	-0.0120	70.0			-2.4375	9.5062							
0.0090	-0.0165	80.0			-1.4625	3.8025							
0.0060	-0.0210	90.0			-1.4625	0.0000							
0.0030	-0.0255	100.0			-1.4625	0.0000							
0.0000	-0.0300	110.0			-1.4625	0.0000							
0.0000	-0.0300	120.0			0.0000	5.7038							
Totals			83.3058	0.1245									

VALVE	Lift	Opens Deg BBDC	Closes Deg ATDC	Duration	Area
	0.00000	96.92	57.00	333.92	52.71
	0.00600	93.85	53.00	326.85	52.71
	0.01000	91.79	50.33	322.13	52.71
	0.02000	87.29	45.78	313.07	52.47
	0.04000	78.89	37.78	296.67	51.94
	0.05000	74.44	34.60	289.05	51.94
	0.10000	56.67	20.90	257.56	50.71
	0.15000	45.29	10.00	235.29	49.31
	0.20000	35.74	-0.10	215.64	46.07
	0.25000	26.48	-10.20	196.29	43.42
	0.30000	16.88	-20.00	176.88	42.13
	0.35000	5.95	-30.49	155.46	36.68
	0.40000	-6.41	-42.74	130.85	32.65
	0.45000	-19.23	-55.42	105.35	28.26
	0.50000	-36.22	-72.41	71.37	18.54
CAM					
	0.00600	133.33	90.00	403.33	39.02
	0.01000	120.00	76.67	376.67	38.87
	0.02000	96.92	57.00	333.92	38.44
	0.04000	83.13	41.33	304.46	38.08
	0.05000	76.67	36.19	292.86	37.53
	0.10000	51.54	16.45	247.99	35.73
	0.15000	36.67	0.91	217.58	33.82
	0.20000	22.78	-14.12	188.66	30.85
	0.25000	7.14	-29.38	157.77	27.42
	0.30000	-11.54	-47.50	120.96	21.65
	0.35000	-34.00	-70.56	75.44	13.06

Example of METRIC

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Bore =  2.6378     Stroke = 1.67323         Rod Length = 3.56299     RPM = 16200
Wrist Pin Offset = 0.0                    Number of - Intake Valves = 2 - Exhaust Valves = 2
Intake Valve Size = 1.06299               Exhaust Valve Size = 0.90551
Intake Valve / Bore Ratio = 0.402984      Exhaust Valve / Bore Ratio = 0.343282
Intake Valve Area = 1.774918 sq. in.      Exhaust Valve Area = 1.287972 sq. in.
Intake Valve Stem Size = 0.17717          Exhaust Valve Stem Size = 0.17717
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Intake Valve Stem Area = 0.049306 sq. in. Exhaust Valve Stem Area = 0.049306 sq. in.
Valve Lift at which the Valve Area and Window / Curtain Area are the SAME SIZE
At that point the velocity will be the same in both areas
Intake Valve Lift = 0.265748 Inches Exhaust Valve Lift = 0.226378 Inches
Intake Centerline = 111.0 User Selected DC - Discharge Coefficient = 0.5
Throat CSA (0.91) Intake = 1.4205 sq. in. Throat CSA (0.91) Exhaust = 1.0173 sq. in.
Effective Throat CSA = 1.26516 Effective Throat CSA = 1.25684
Valve Lift at which the Throat Area and Window / Curtain Area are the SAME SIZE
At that point the velocity will be the same in both areas
Intake Valve Lift = 0.42537 Inches Exhaust Valve Lift = 0.35759 Inches

I N T A K E

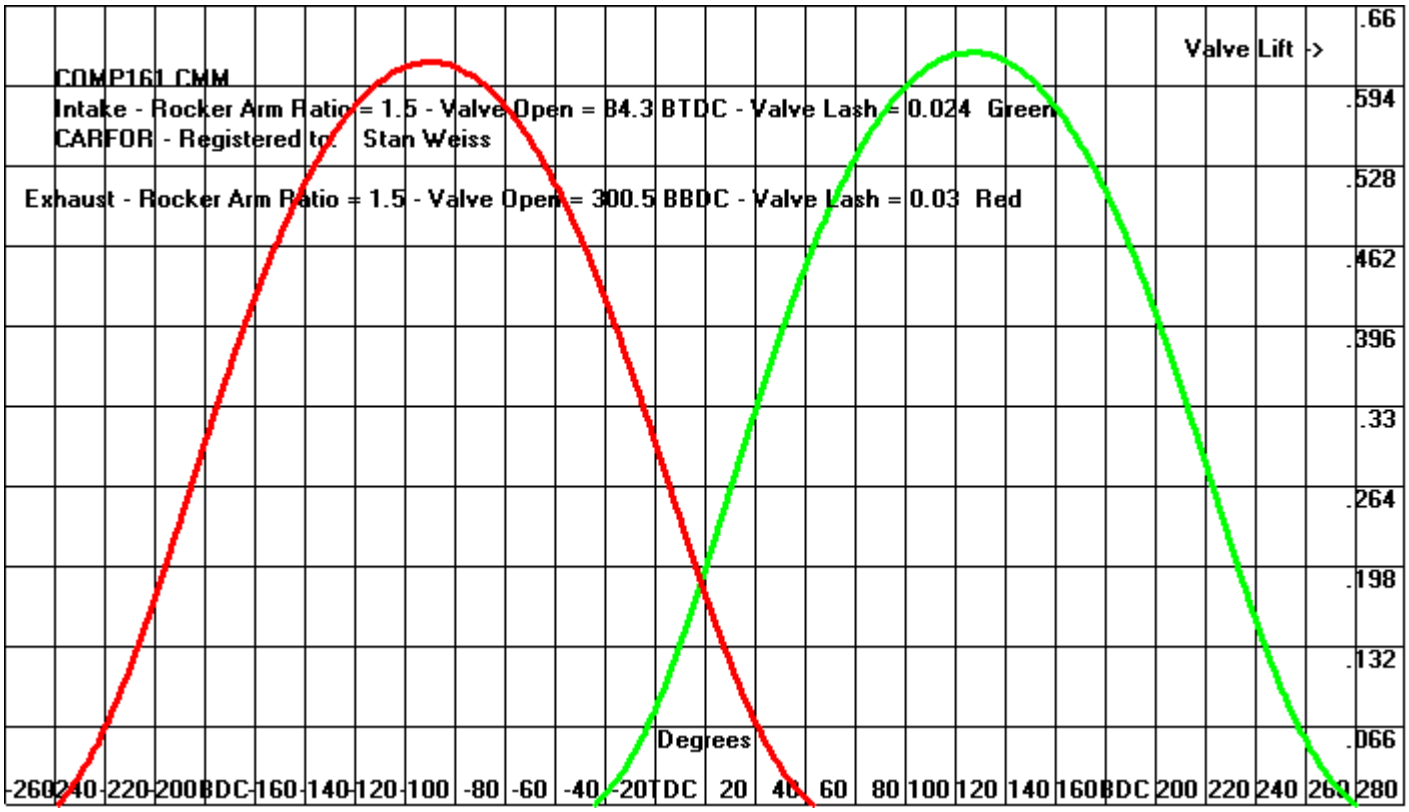
Rocker Arm Ratio = 1.000 Valve Lash = 0.0000 Valve Angle = 11.5

Cam Lift	Valve Lift	Crank Angle	Time Port Area cm^2	Time Port Area cm^2/cc	Valve Velocity FPS	Valve Acceleration FPS^2	Valve Lift Horiz	Valve Lift Vert	Piston Travel	Cylinder Volume cc	User Supplied Valve Air Discharge Flow Coefficient	L/D Ratio
.000	0.0000	-72.0			0.0000	0.0000						
.000	0.0000	-70.0			0.0000	0.0000						
.020	0.0200	-68.0	0.0177	0.0001	3.1890	30.9969	.020	0.0040	15.460	54.508	.39 0.5129	0.0007
.030	0.0300	-66.0	0.0266	0.0002	1.5945	-15.4984	.029	0.0060	14.713	51.875	.59 0.5129	0.0011
.040	0.0400	-64.0	0.0355	0.0002	1.5945	0.0000	.039	0.0080	13.973	49.264	.79 0.5129	0.0015
.050	0.0500	-62.0	0.0443	0.0003	1.5945	0.0000	.049	0.0100	13.240	46.680	.98 0.5129	0.0019
.065	0.0650	-60.0	0.0576	0.0004	2.3917	7.7492	.064	0.0130	12.516	44.127	1.28 0.5129	0.0024
.075	0.0750	-58.0	0.0665	0.0004	1.5945	-7.7492	.073	0.0150	11.802	41.609	1.48 0.5129	0.0028
.085	0.0850	-56.0	0.0754	0.0005	1.5945	0.0000	.083	0.0169	11.098	39.129	1.67 0.5129	0.0031
.095	0.0950	-54.0	0.0842	0.0006	1.5945	0.0000	.093	0.0189	10.407	36.693	1.87 0.5129	0.0035
.110	0.1100	-52.0	0.0975	0.0007	2.3917	7.7492	.108	0.0219	9.730	34.304	2.17 0.5129	0.0041
.120	0.1200	-50.0	0.1064	0.0007	1.5945	-7.7492	.118	0.0239	9.067	31.967	2.36 0.5129	0.0044
.130	0.1300	-48.0	0.1153	0.0008	1.5945	0.0000	.127	0.0259	8.419	29.684	2.56 0.5129	0.0048
.150	0.1500	-46.0	0.1330	0.0009	3.1890	15.4984	.147	0.0299	7.789	27.461	2.95 0.5129	0.0056
.155	0.1550	-44.0	0.1374	0.0009	0.7972	-23.2476	.152	0.0309	7.176	25.300	3.05 0.5129	0.0057
.165	0.1650	-42.0	0.1463	0.0010	1.5945	7.7492	.162	0.0329	6.582	23.207	3.25 0.5129	0.0061
.175	0.1750	-40.0	0.1552	0.0010	1.5945	0.0000	.171	0.0349	6.008	21.183	3.44 0.5129	0.0065
.190	0.1900	-38.0	0.1685	0.0011	2.3917	7.7492	.186	0.0379	5.455	19.234	3.74 0.5129	0.0070
.205	0.2050	-36.0	0.1818	0.0012	2.3917	0.0000	.201	0.0409	4.924	17.362	4.04 0.5129	0.0076
.235	0.2350	-34.0	0.2084	0.0014	4.7835	23.2476	.230	0.0469	4.416	15.571	4.63 0.5129	0.0087
.265	0.2650	-32.0	0.2350	0.0016	4.7835	0.0000	.260	0.0528	3.932	13.864	5.22 0.5129	0.0098
.295	0.2950	-30.0	0.2616	0.0017	4.7835	0.0000	.289	0.0588	3.473	12.244	5.81 0.5129	0.0109
.340	0.3400	-28.0	0.3015	0.0020	7.1752	23.2476	.333	0.0678	3.039	10.714	6.69 0.5129	0.0126
.395	0.3950	-26.0	0.3502	0.0023	8.7697	15.4984	.387	0.0788	2.631	9.277	7.78 0.5129	0.0146
.445	0.4450	-24.0	0.3945	0.0026	7.9724	-7.7492	.436	0.0887	2.251	7.936	8.76 0.5129	0.0165
.510	0.5100	-22.0	0.4522	0.0030	10.3642	23.2476	.500	0.1017	1.898	6.692	10.04 0.5129	0.0189
.590	0.5900	-20.0	0.5231	0.0035	12.7559	23.2476	.578	0.1176	1.574	5.549	11.61 0.5129	0.0219
.720	0.7200	-18.0	0.6384	0.0043	20.7283	77.4921	.706	0.1435	1.279	4.508	14.17 0.5129	0.0267
.850	0.8500	-16.0	0.7536	0.0050	20.7283	0.0000	.833	0.1695	1.013	3.571	16.73 0.5129	0.0315
.970	0.9700	-14.0	0.8600	0.0057	19.1339	-15.4984	.951	0.1934	.777	2.741	19.09 0.5129	0.0359
1.160	1.1600	-12.0	1.0285	0.0069	30.2953	108.4890	1.137	0.2313	.572	2.018	22.83 0.5129	0.0430
1.355	1.3550	-10.0	1.2014	0.0080	31.0925	7.7492	1.328	0.2701	.398	1.404	26.67 0.5129	0.0502
1.490	1.4900	-8.0	1.3211	0.0088	21.5256	-92.9906	1.460	0.2971	.255	.900	29.33 0.5129	0.0552
1.645	1.6450	-6.0	1.4585	0.0097	24.7146	30.9969	1.612	0.3280	.144	.507	32.38 0.5129	0.0609
1.820	1.8200	-4.0	1.6137	0.0108	27.9035	30.9969	1.783	0.3628	.064	.225	35.83 0.5129	0.0674
1.985	1.9850	-2.0	1.7600	0.0117	26.3091	-15.4984	1.945	0.3957	.016	.056	39.07 0.5129	0.0735
2.175	2.1750	TDC	1.9284	0.0129	30.2953	38.7461	2.131	0.4336	.000	.000	42.81 0.5129	0.0806
2.390	2.3900	2.0	2.1190	0.0141	34.2815	38.7461	2.342	0.4765	.016	.056	47.05 0.5129	0.0885
2.525	2.5250	4.0	2.2387	0.0149	21.5256	-123.9874	2.474	0.5034	.064	.225	49.70 0.5129	0.0935
2.730	2.7300	6.0	2.4205	0.0162	32.6870	108.4890	2.675	0.5443	.144	.507	56.06 0.5350	0.1011
2.925	2.9250	8.0	2.5934	0.0173	31.0925	-15.4984	2.866	0.5832	.255	.900	62.28 0.5548	0.1083
3.150	3.1500	10.0	2.7929	0.0186	35.8760	46.4953	3.087	0.6280	.398	1.404	69.45 0.5745	0.1167
3.325	3.3250	12.0	2.9480	0.0197	27.9035	-77.4921	3.258	0.6629	.572	2.018	75.03 0.5880	0.1231
3.555	3.5550	14.0	3.1520	0.0210	36.6732	85.2413	3.484	0.7088	.777	2.741	82.37 0.6037	0.1317
3.740	3.7400	16.0	3.3160	0.0221	29.4980	-69.7429	3.665	0.7456	1.013	3.571	88.27 0.6149	0.1385
3.920	3.9200	18.0	3.4756	0.0232	28.7008	-7.7492	3.841	0.7815	1.279	4.508	94.01 0.6249	0.1452
4.115	4.1150	20.0	3.6485	0.0243	31.0925	23.2476	4.032	0.8204	1.574	5.549	100.23 0.6346	0.1524
4.395	4.3950	22.0	3.8967	0.0260	44.6457	131.7366	4.307	0.8762	1.898	6.692	109.16 0.6471	0.1628
4.545	4.5450	24.0	4.0297	0.0269	23.9173	-201.4795	4.454	0.9061	2.251	7.936	113.94 0.6532	0.1683
4.730	4.7300	26.0	4.1937	0.0280	29.4980	54.2445	4.635	0.9430	2.631	9.277	119.84 0.6601	0.1752
4.925	4.9250	28.0	4.3666	0.0291	31.0925	15.4984	4.826	0.9819	3.039	10.714	126.06 0.6669	0.1824
5.100	5.1000	30.0	4.5218	0.0302	27.9035	-30.9969	4.998	1.0168	3.473	12.244	131.45 0.6716	0.1889
5.270	5.2700	32.0	4.6725	0.0312	27.1063	-7.7492	5.164	1.0507	3.932	13.864	135.26 0.6688	0.1952
5.410	5.4100	34.0	4.7966	0.0320	22.3228	-46.4953	5.301	1.0786	4.416	15.571	138.41 0.6666	0.2004
5.615	5.6150	36.0	4.9784	0.0332	32.6870	100.7398	5.502	1.1195	4.924	17.362	143.01 0.6636	0.2080
5.805	5.8050	38.0	5.1469	0.0343	30.2953	-23.2476	5.688	1.1573	5.455	19.234	147.27 0.6610	0.2150
5.925	5.9250	40.0	5.2533	0.0351	19.1339	-108.4890	5.806	1.1813	6.008	21.183	149.96 0.6595	0.2194
6.100	6.1000	42.0	5.4084	0.0361	27.9035	85.2413	5.978	1.2161	6.582	23.207	153.89 0.6573	0.2259
6.260	6.2600	44.0	5.5503	0.0370	25.5118	-23.2476	6.134	1.2480	7.176	25.300	157.48 0.6555	0.2319
6.415	6.4150	46.0	5.6877	0.0380	24.7146	-7.7492	6.286	1.2789	7.789	27.461	160.96 0.6538	0.2376
6.575	6.5750	48.0	5.8296	0.0389	25.5118	7.7492	6.443	1.3108	8.419	29.684	164.55 0.6521	0.2435
6.725	6.7250	50.0	5.9626	0.0398	23.9173	-15.4984	6.590	1.3407	9.067	31.967	167.92 0.6506	0.2491
6.860	6.8600	52.0	6.0823	0.0406	21.5256	-23.2476	6.722	1.3677	9.730	34.304	170.94 0.6493	0.2541

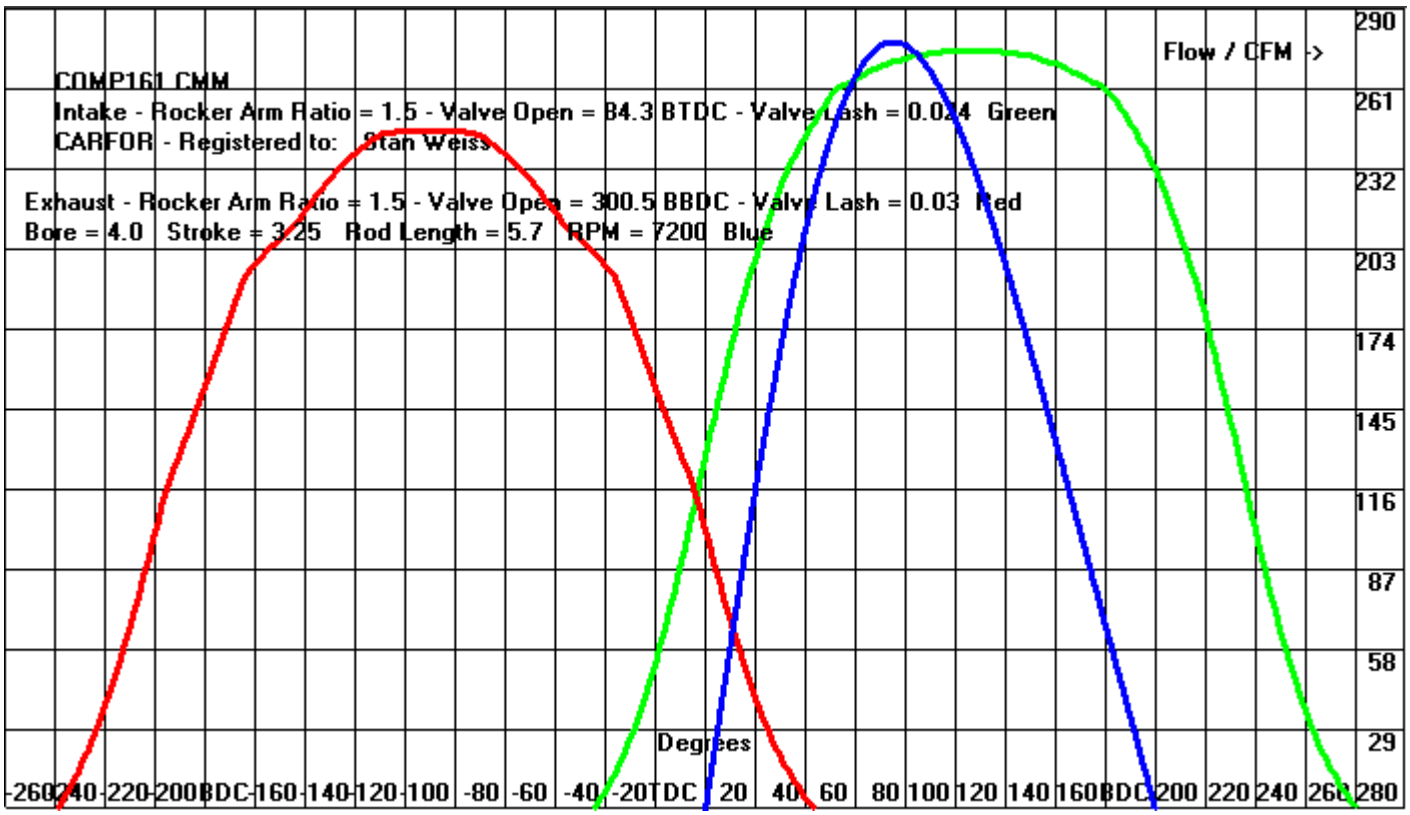
7.000	7.0000	54.0	6.2064	0.0414	22.3228	7.7492	6.859	1.3956	10.407	36.693	174.09	0.6480	0.2593
7.125	7.1250	56.0	6.3172	0.0422	19.9311	-23.2476	6.982	1.4205	11.098	39.129	176.89	0.6469	0.2639
7.255	7.2550	58.0	6.4325	0.0429	20.7283	7.7492	7.109	1.4464	11.802	41.609	179.81	0.6458	0.2687
7.375	7.3750	60.0	6.5389	0.0436	19.1339	-15.4984	7.227	1.4703	12.516	44.127	182.50	0.6448	0.2731
7.480	7.4800	62.0	6.6320	0.0443	16.7421	-23.2476	7.330	1.4913	13.240	46.680	184.86	0.6439	0.2770
7.590	7.5900	64.0	6.7295	0.0449	17.5394	7.7492	7.438	1.5132	13.973	49.264	187.33	0.6431	0.2811
7.695	7.6950	66.0	6.8226	0.0455	16.7421	-7.7492	7.541	1.5341	14.713	51.875	189.24	0.6408	0.2850
7.805	7.8050	68.0	6.9201	0.0462	17.5394	7.7492	7.648	1.5561	15.460	54.508	191.06	0.6378	0.2891
7.910	7.9100	70.0	7.0132	0.0468	16.7421	-7.7492	7.751	1.5770	16.213	57.160	192.80	0.6351	0.2930
8.010	8.0100	72.0	7.1019	0.0474	15.9449	-7.7492	7.849	1.5969	16.969	59.826	194.45	0.6325	0.2967
8.080	8.0800	74.0	7.1639	0.0478	11.1614	-46.4953	7.918	1.6109	17.728	62.503	195.61	0.6308	0.2993
8.165	8.1650	76.0	7.2393	0.0483	13.5531	23.2476	8.001	1.6278	18.489	65.187	197.01	0.6287	0.3024
8.270	8.2700	78.0	7.3324	0.0489	16.7421	30.9969	8.104	1.6488	19.251	67.873	198.75	0.6262	0.3063
8.335	8.3350	80.0	7.3900	0.0493	10.3642	-61.9937	8.168	1.6617	20.013	70.559	199.82	0.6247	0.3087
8.385	8.3850	82.0	7.4344	0.0496	7.9724	-23.2476	8.217	1.6717	20.773	73.239	200.65	0.6235	0.3106
8.475	8.4750	84.0	7.5142	0.0501	14.3504	61.9937	8.305	1.6896	21.531	75.911	202.14	0.6215	0.3139
8.500	8.5000	86.0	7.5363	0.0503	3.9862	-100.7398	8.329	1.6946	22.285	78.571	202.55	0.6209	0.3148
8.555	8.5550	88.0	7.5851	0.0506	8.7697	46.4953	8.383	1.7056	23.035	81.215	203.46	0.6197	0.3169
8.600	8.6000	90.0	7.6250	0.0509	7.1752	-15.4984	8.427	1.7146	23.780	83.841	204.20	0.6187	0.3185
8.645	8.6450	92.0	7.6649	0.0512	7.1752	0.0000	8.471	1.7235	24.519	86.445	204.95	0.6177	0.3202
8.685	8.6850	94.0	7.7003	0.0514	6.3780	-7.7492	8.511	1.7315	25.250	89.023	205.61	0.6168	0.3217
8.720	8.7200	96.0	7.7314	0.0516	5.5807	-7.7492	8.545	1.7385	25.973	91.574	206.19	0.6161	0.3230
8.745	8.7450	98.0	7.7535	0.0517	3.9862	-15.4984	8.569	1.7435	26.688	94.093	206.60	0.6156	0.3239
8.765	8.7650	100.0	7.7713	0.0519	3.1890	-7.7492	8.589	1.7475	27.393	96.578	206.93	0.6151	0.3246
8.785	8.7850	102.0	7.7890	0.0520	3.1890	0.0000	8.609	1.7514	28.087	99.027	207.26	0.6147	0.3254
8.795	8.7950	104.0	7.7979	0.0520	1.5945	-15.4984	8.618	1.7534	28.771	101.437	207.43	0.6145	0.3257
8.805	8.8050	106.0	7.8067	0.0521	1.5945	0.0000	8.628	1.7554	29.443	103.805	207.59	0.6143	0.3261
8.805	8.8050	108.0	7.8067	0.0521	0.0000	-15.4984	8.628	1.7554	30.102	106.130	207.59	0.6143	0.3261
8.800	8.8000	110.0	7.8023	0.0521	-0.7972	-7.7492	8.623	1.7544	30.748	108.409	207.51	0.6144	0.3259
8.790	8.7900	112.0	7.7934	0.0520	-1.5945	-7.7492	8.614	1.7524	31.381	110.640	207.35	0.6146	0.3256
8.780	8.7800	114.0	7.7846	0.0520	-1.5945	0.0000	8.604	1.7505	32.000	112.821	207.18	0.6148	0.3252
8.755	8.7550	116.0	7.7624	0.0518	-3.9862	-23.2476	8.579	1.7455	32.604	114.950	206.77	0.6154	0.3243
8.730	8.7300	118.0	7.7402	0.0517	-3.9862	0.0000	8.555	1.7405	33.193	117.026	206.35	0.6159	0.3233
8.695	8.6950	120.0	7.7092	0.0514	-5.5807	-15.4984	8.520	1.7335	33.766	119.047	205.78	0.6166	0.3220
8.660	8.6600	122.0	7.6782	0.0512	-5.5807	0.0000	8.486	1.7265	34.323	121.012	205.20	0.6174	0.3207
8.620	8.6200	124.0	7.6427	0.0510	-6.3780	-7.7492	8.447	1.7186	34.864	122.919	204.54	0.6182	0.3193
8.575	8.5750	126.0	7.6028	0.0507	-7.1752	-7.7492	8.403	1.7096	35.388	124.767	203.79	0.6192	0.3176
8.530	8.5300	128.0	7.5629	0.0505	-7.1752	0.0000	8.359	1.7006	35.896	126.556	203.05	0.6202	0.3159
8.480	8.4800	130.0	7.5186	0.0502	-7.9724	-7.7492	8.310	1.6906	36.385	128.282	202.22	0.6213	0.3141
8.425	8.4250	132.0	7.4698	0.0499	-8.7697	-7.7492	8.256	1.6797	36.858	129.947	201.31	0.6226	0.3120
8.360	8.3600	134.0	7.4122	0.0495	-10.3642	-15.4984	8.192	1.6667	37.312	131.549	200.24	0.6241	0.3096
8.285	8.2850	136.0	7.3457	0.0490	-11.9587	-15.4984	8.119	1.6518	37.748	133.087	199.00	0.6258	0.3069
8.215	8.2150	138.0	7.2836	0.0486	-11.1614	7.7492	8.050	1.6378	38.166	134.560	197.84	0.6275	0.3043
8.130	8.1300	140.0	7.2083	0.0481	-13.5531	-23.2476	7.967	1.6209	38.565	135.968	196.43	0.6295	0.3011
8.035	8.0350	142.0	7.1240	0.0475	-15.1476	-15.4984	7.874	1.6019	38.946	137.310	194.86	0.6319	0.2976
7.960	7.9600	144.0	7.0575	0.0471	-11.9587	30.9969	7.800	1.5870	39.308	138.586	193.62	0.6338	0.2948
7.865	7.8650	146.0	6.9733	0.0465	-15.1476	-30.9969	7.707	1.5680	39.651	139.795	192.05	0.6362	0.2913
7.775	7.7750	148.0	6.8935	0.0460	-14.3504	7.7492	7.619	1.5501	39.974	140.936	190.56	0.6386	0.2880
7.680	7.6800	150.0	6.8093	0.0454	-15.1476	-7.7492	7.526	1.5311	40.279	142.010	188.99	0.6412	0.2844
7.570	7.5700	152.0	6.7118	0.0448	-17.5394	-23.2476	7.418	1.5092	40.564	143.016	186.88	0.6432	0.2804
7.460	7.4600	154.0	6.6142	0.0441	-17.5394	0.0000	7.310	1.4873	40.830	143.953	184.41	0.6441	0.2763
7.370	7.3700	156.0	6.5344	0.0436	-14.3504	30.9969	7.222	1.4693	41.077	144.822	182.39	0.6448	0.2730
7.235	7.2350	158.0	6.4147	0.0428	-21.5256	-69.7429	7.090	1.4424	41.303	145.622	179.36	0.6459	0.2680
7.120	7.1200	160.0	6.3128	0.0421	-18.3366	30.9969	6.977	1.4195	41.511	146.353	176.78	0.6469	0.2637
7.000	7.0000	162.0	6.2064	0.0414	-19.1339	-7.7492	6.859	1.3956	41.699	147.015	174.09	0.6480	0.2593
6.875	6.8750	164.0	6.0956	0.0407	-19.9311	-7.7492	6.737	1.3707	41.867	147.608	171.28	0.6491	0.2546
6.730	6.7300	166.0	5.9670	0.0398	-23.1201	-30.9969	6.595	1.3417	42.015	148.131	168.03	0.6505	0.2493
6.600	6.6000	168.0	5.8517	0.0391	-20.7283	23.2476	6.468	1.3158	42.144	148.584	165.11	0.6518	0.2444
6.490	6.4900	170.0	5.7542	0.0384	-17.5394	30.9969	6.360	1.2939	42.252	148.968	162.64	0.6530	0.2404
6.320	6.3200	172.0	5.6035	0.0374	-27.1063	-92.9906	6.193	1.2600	42.342	149.282	158.83	0.6548	0.2341
6.200	6.2000	174.0	5.4971	0.0367	-19.1339	77.4921	6.076	1.2361	42.411	149.527	156.13	0.6562	0.2296
6.025	6.0250	176.0	5.3419	0.0357	-27.9035	-85.2413	5.904	1.2012	42.460	149.701	152.21	0.6582	0.2231
5.875	5.8750	178.0	5.2089	0.0348	-23.9173	38.7461	5.757	1.1713	42.490	149.806	148.84	0.6601	0.2176
5.715	5.7150	BDC	5.0671	0.0338	-25.5118	-15.4984	5.600	1.1394	42.500	149.841	145.25	0.6622	0.2117
5.565	5.5650	182.0	4.9341	0.0329	-23.9173	15.4984	5.453	1.1095	42.490	149.806	141.88	0.6643	0.2061
5.405	5.4050	184.0	4.7922	0.0320	-25.5118	-15.4984	5.296	1.0776	42.460	149.701	138.29	0.6667	0.2002
5.240	5.2400	186.0	4.6459	0.0310	-26.3091	-7.7492	5.135	1.0447	42.411	149.527	134.59	0.6692	0.1941
5.080	5.0800	188.0	4.5041	0.0301	-25.5118	7.7492	4.978	1.0128	42.342	149.282	131.00	0.6719	0.1881
4.900	4.9000	190.0	4.3445	0.0290	-28.7008	-30.9969	4.802	0.9769	42.252	148.968	125.26	0.6661	0.1815
4.725	4.7250	192.0	4.1893	0.0280	-27.9035	7.7492	4.630	0.9420	42.144	148.584	119.68	0.6600	0.1750
4.525	4.5250	194.0	4.0120	0.0268	-31.8898	-38.7461	4.434	0.9021	42.015	148.131	113.30	0.6524	0.1676
4.360	4.3600	196.0	3.8657	0.0258	-26.3091	54.2445	4.272	0.8692	41.867	147.608	108.04	0.6456	0.1615
4.155	4.1550	198.0	3.6839	0.0246	-32.6870	-61.9937	4.072	0.8284	41.699	147.015	101.50	0.6365	0.1539
3.980	3.9800	200.0	3.5288	0.0236	-27.9035	46.4953	3.900	0.7935	41.511	146.353	95.92	0.6280	0.1474
3.790	3.7900	202.0	3.3603	0.0224	-30.2953	-23.2476	3.714	0.7556	41.303	145.622	89.86	0.6178	0.1404
3.605	3.6050	204.0	3.1963	0.0213	-29.4980	7.7492	3.533	0.7187	41.077	144.822	83.96	0.6068	0.1335
3.375	3.3750	206.0	2.9924	0.0200	-36.6732	-69.7429	3.307	0.6729	40.830	143.953	76.63	0.5916	0.1250
3.175	3.1750	208.0	2.8150	0.0188	-31.8898	46.4953	3.111	0.6330	40.564	143.016	70.25	0.5765	0.1176
3.000	3.0000	210.0	2.6599	0.0178	-27.9035	38.7461	2.940	0.5981	40.279	142.010	64.67	0.5617	0.1111
2.790	2.7900	212.0	2.4737	0.0165	-33.4843	-54.2445	2.734	0.5562	39.974	140.936	57.97	0.5414	0.1033
2.615	2.6150	214.0	2.3185	0.0155	-27.9035	54.2445	2.563	0.5213	39.651	139.795	52.39	0.5220	0.0969

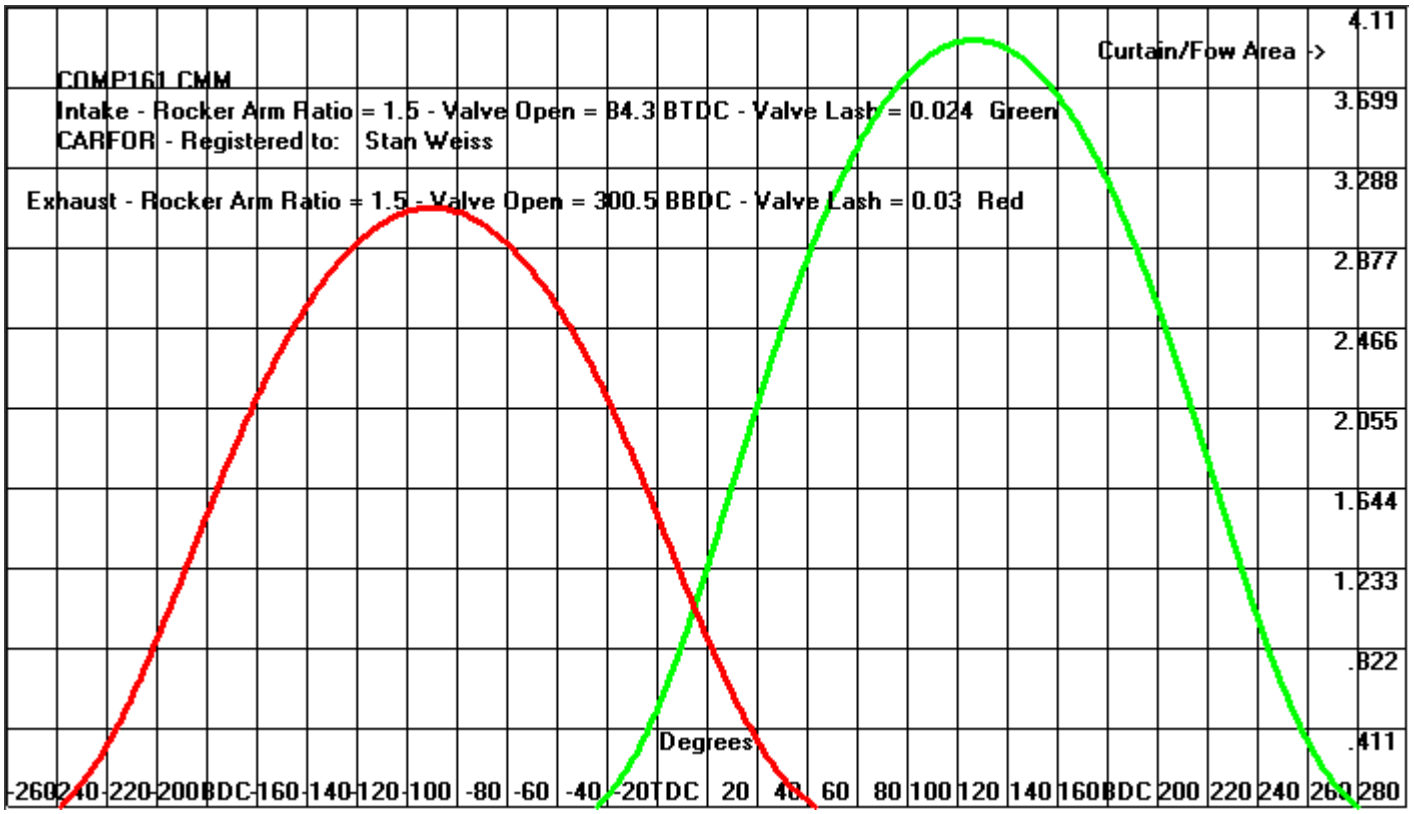
2.400	2.4000	216.0	2.1279	0.0142	-34.2815	-61.9937	2.352	0.4785	39.308	138.586	47.24	0.5129	0.0889
2.200	2.2000	218.0	1.9506	0.0130	-31.8898	23.2476	2.156	0.4386	38.946	137.310	43.31	0.5129	0.0815
2.020	2.0200	220.0	1.7910	0.0120	-28.7008	30.9969	1.979	0.4027	38.565	135.968	39.76	0.5129	0.0748
1.785	1.7850	222.0	1.5826	0.0106	-37.4705	-85.2413	1.749	0.3559	38.166	134.560	35.14	0.5129	0.0661
1.615	1.6150	224.0	1.4319	0.0096	-27.1063	100.7398	1.583	0.3220	37.748	133.087	31.79	0.5129	0.0598
1.450	1.4500	226.0	1.2856	0.0086	-26.3091	7.7492	1.421	0.2891	37.312	131.549	28.54	0.5129	0.0537
1.305	1.3050	228.0	1.1570	0.0077	-23.1201	30.9969	1.279	0.2602	36.858	129.947	25.69	0.5129	0.0483
1.135	1.1350	230.0	1.0063	0.0067	-27.1063	-38.7461	1.112	0.2263	36.385	128.282	22.34	0.5129	0.0420
1.005	1.0050	232.0	0.8911	0.0059	-20.7283	61.9937	.985	0.2004	35.896	126.556	19.78	0.5129	0.0372
.900	0.9000	234.0	0.7980	0.0053	-16.7421	38.7461	.882	0.1794	35.388	124.767	17.72	0.5129	0.0333
.755	0.7550	236.0	0.6694	0.0045	-23.1201	-61.9937	.740	0.1505	34.864	122.919	14.86	0.5129	0.0280
.645	0.6450	238.0	0.5719	0.0038	-17.5394	54.2445	.632	0.1286	34.323	121.012	12.70	0.5129	0.0239
.525	0.5250	240.0	0.4655	0.0031	-19.1339	-15.4984	.514	0.1047	33.766	119.047	10.33	0.5129	0.0194
.450	0.4500	242.0	0.3990	0.0027	-11.9587	69.7429	.441	0.0897	33.193	117.026	8.86	0.5129	0.0167
.375	0.3750	244.0	0.3325	0.0022	-11.9587	0.0000	.367	0.0748	32.604	114.950	7.38	0.5129	0.0139
.325	0.3250	246.0	0.2882	0.0019	-7.9724	38.7461	.318	0.0648	32.000	112.821	6.40	0.5129	0.0120
.270	0.2700	248.0	0.2394	0.0016	-8.7697	-7.7492	.265	0.0538	31.381	110.640	5.31	0.5129	0.0100
.235	0.2350	250.0	0.2084	0.0014	-5.5807	30.9969	.230	0.0469	30.748	108.409	4.63	0.5129	0.0087
.205	0.2050	252.0	0.1818	0.0012	-4.7835	7.7492	.201	0.0409	30.102	106.130	4.04	0.5129	0.0076
.185	0.1850	254.0	0.1640	0.0011	-3.1890	15.4984	.181	0.0369	29.443	103.805	3.64	0.5129	0.0069
.170	0.1700	256.0	0.1507	0.0010	-2.3917	7.7492	.167	0.0339	28.771	101.437	3.35	0.5129	0.0063
.155	0.1550	258.0	0.1374	0.0009	-2.3917	0.0000	.152	0.0309	28.087	99.027	3.05	0.5129	0.0057
.140	0.1400	260.0	0.1241	0.0008	-2.3917	0.0000	.137	0.0279	27.393	96.578	2.76	0.5129	0.0052
.130	0.1300	262.0	0.1153	0.0008	-1.5945	7.7492	.127	0.0259	26.688	94.093	2.56	0.5129	0.0048
.120	0.1200	264.0	0.1064	0.0007	-1.5945	0.0000	.118	0.0239	25.973	91.574	2.36	0.5129	0.0044
.110	0.1100	266.0	0.0975	0.0007	-1.5945	0.0000	.108	0.0219	25.250	89.023	2.17	0.5129	0.0041
.100	0.1000	268.0	0.0887	0.0006	-1.5945	0.0000	.098	0.0199	24.519	86.445	1.97	0.5129	0.0037
.085	0.0850	270.0	0.0754	0.0005	-2.3917	-7.7492	.083	0.0169	23.780	83.841	1.67	0.5129	0.0031
.075	0.0750	272.0	0.0665	0.0004	-1.5945	7.7492	.073	0.0150	23.035	81.215	1.48	0.5129	0.0028
.065	0.0650	274.0	0.0576	0.0004	-1.5945	0.0000	.064	0.0130	22.285	78.571	1.28	0.5129	0.0024
.050	0.0500	276.0	0.0443	0.0003	-2.3917	-7.7492	.049	0.0100	21.531	75.911	.98	0.5129	0.0019
.040	0.0400	278.0	0.0355	0.0002	-1.5945	7.7492	.039	0.0080	20.773	73.239	.79	0.5129	0.0015
.030	0.0300	280.0	0.0266	0.0002	-1.5945	0.0000	.029	0.0060	20.013	70.559	.59	0.5129	0.0011
.020	0.0200	282.0	0.0177	0.0001	-1.5945	0.0000	.020	0.0040	19.251	67.873	.39	0.5129	0.0007
.010	0.0100	284.0	0.0089	0.0001	-1.5945	0.0000	.010	0.0020	18.489	65.187	.20	0.5129	0.0004
.008	0.0080	286.0	0.0071	0.0000	-0.3189	12.3987	.008	0.0016	17.728	62.503	.16	0.5129	0.0003
.005	0.0050	288.0	0.0044	0.0000	-0.4783	-1.5498	.005	0.0010	16.969	59.826	.10	0.5129	0.0002
.000	0.0000	290.0			-0.7972	-3.0997							
.000	0.0000	292.0			0.0000	7.7492							
Totals			655.7553	4.3763							35926		

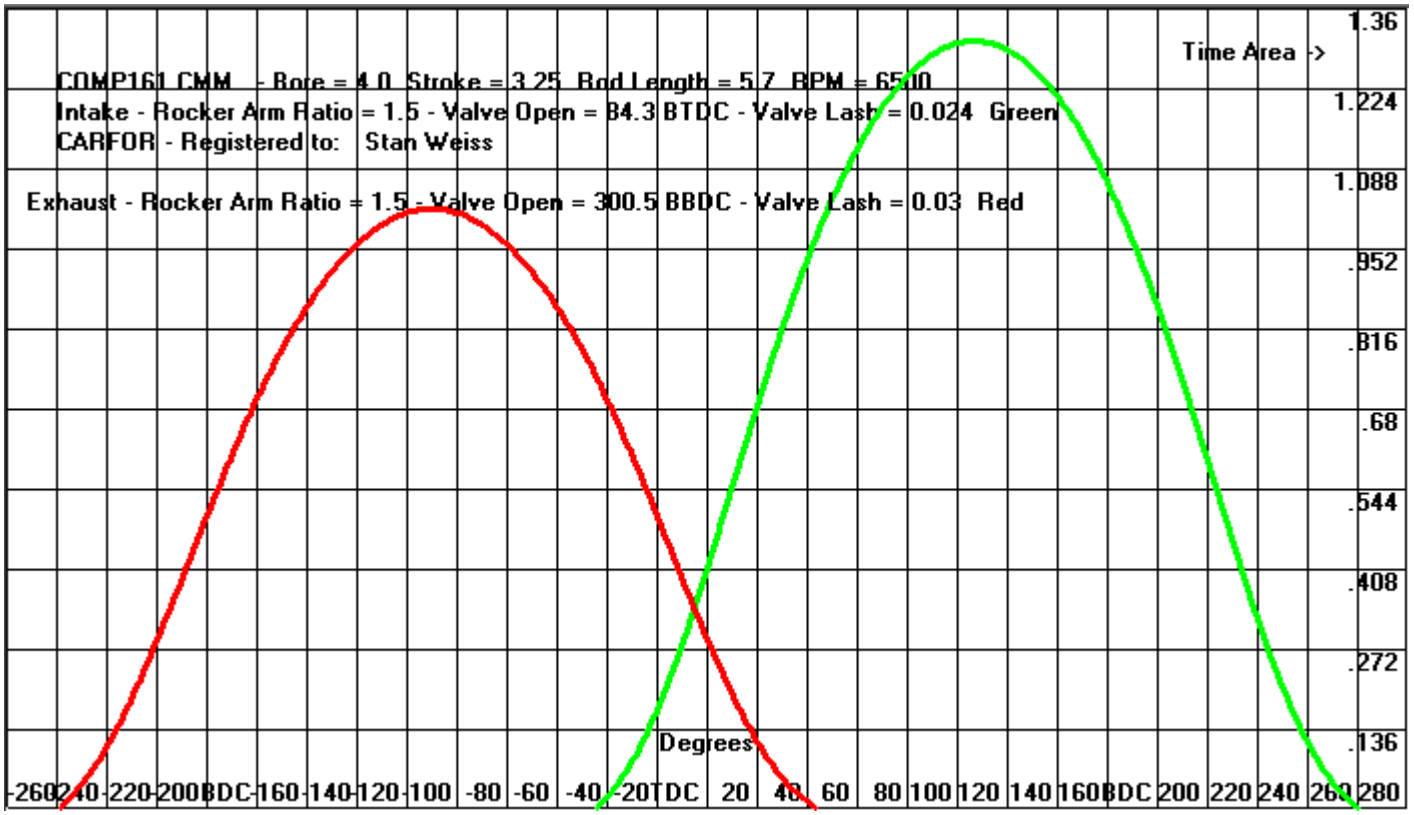
VALVE	Lift	Opens	Closes	Duration	
		Deg BTDC	Deg ABDC		Area
	0.00000	70.00	110.00	360.00	748.41
	0.25000	33.00	69.14	282.14	744.09
	0.50000	22.31	60.67	262.97	740.66
	1.00000	13.68	52.10	245.78	733.73
	1.00000	13.68	52.10	245.78	733.73
	1.50000	7.87	45.39	233.26	724.18
	2.50000	-3.63	35.07	211.44	703.09
	3.00000	-8.67	30.00	201.33	689.20
	3.50000	-13.52	24.91	191.39	672.47
	4.00000	-18.82	19.77	180.95	649.35
	4.50000	-23.40	14.30	170.90	632.01
	5.00000	-28.86	8.89	160.03	603.09
	5.50000	-34.88	2.81	147.93	571.10
	6.00000	-40.86	-3.67	135.48	536.17
	6.50000	-47.06	-10.18	122.76	491.74
	7.00000	-54.00	-18.00	108.00	451.00
	7.50000	-62.36	-26.73	90.91	378.03
	8.00000	-71.80	-37.07	71.13	307.70
	8.50000	-86.00	-50.80	43.20	191.59
CAM					
	0.25000	33.00	69.14	282.14	744.09
	0.50000	22.31	60.67	262.97	740.66
	1.00000	13.68	52.10	245.78	733.73
	1.00000	13.68	52.10	245.78	733.73
	1.50000	7.87	45.39	233.26	724.18
	2.50000	-3.63	35.07	211.44	703.09
	3.00000	-8.67	30.00	201.33	689.20
	3.50000	-13.52	24.91	191.39	672.47
	4.00000	-18.82	19.77	180.95	649.35
	4.50000	-23.40	14.30	170.90	632.01
	5.00000	-28.86	8.89	160.03	603.09
	5.50000	-34.88	2.81	147.93	571.10
	6.00000	-40.86	-3.67	135.48	536.17
	6.50000	-47.06	-10.18	122.76	491.74
	7.00000	-54.00	-18.00	108.00	451.00
	7.50000	-62.36	-26.73	90.91	378.03
	8.00000	-71.80	-37.07	71.13	307.70
	8.50000	-86.00	-50.80	43.20	191.59



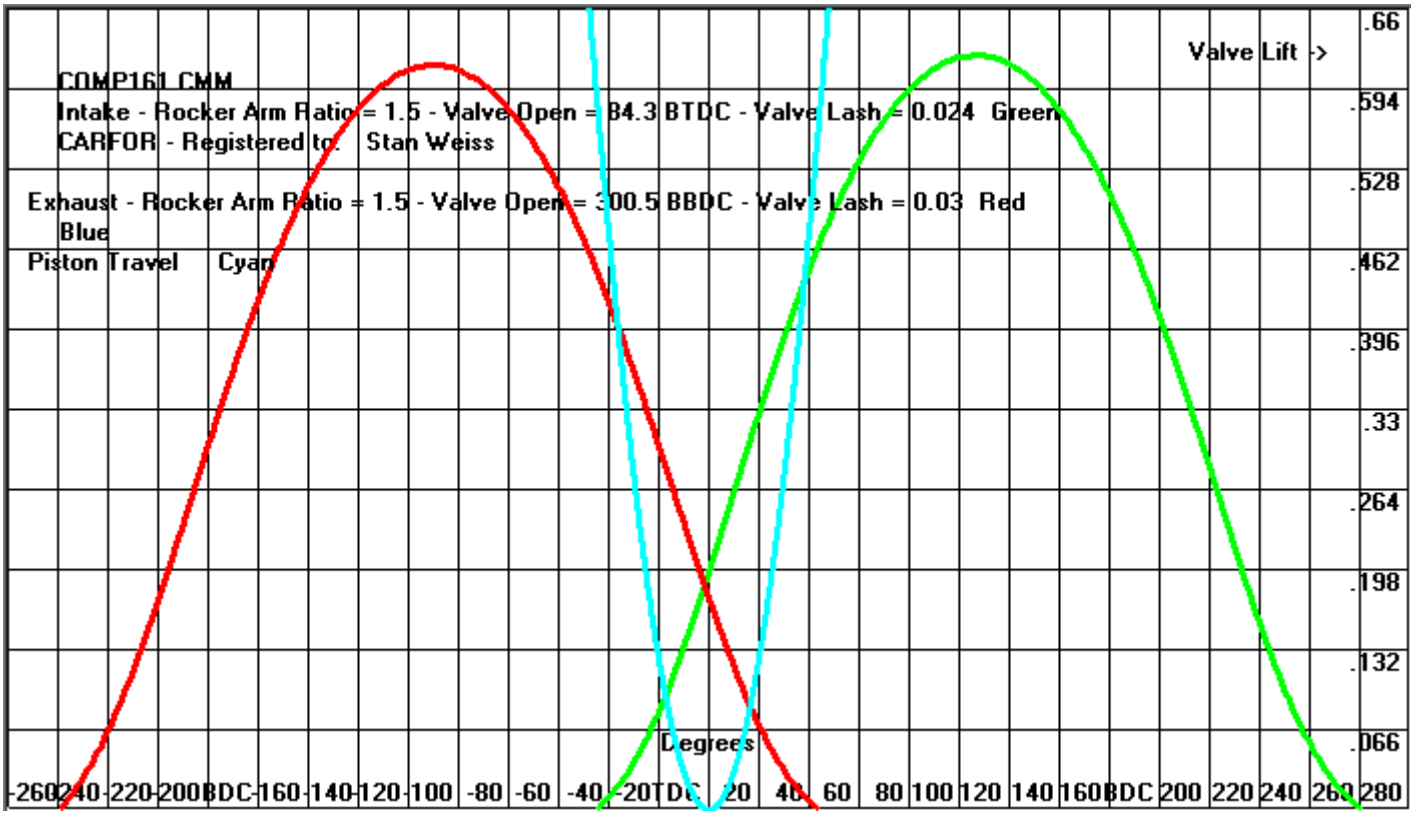
Cylinder head flow against Cam Valve Lift and Piston Flow CFM (Magenta)



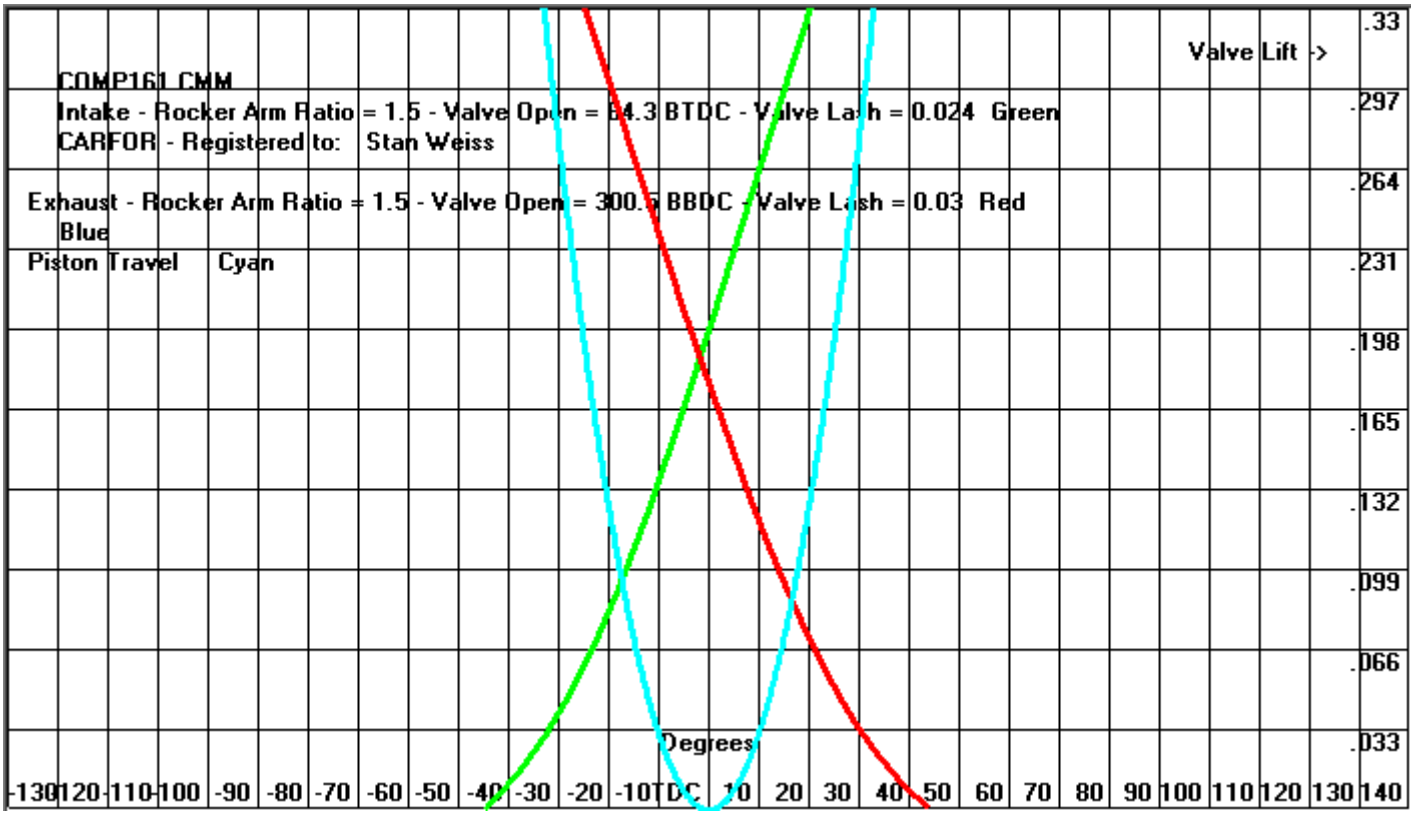

Curtain/Fow Area ->
4.11
3.699
3.288
2.877
2.466
2.055
1.644
1.233
.822
.411
COMP161 CMM
Intake - Rocker Arm Ratio = 1.5 - Valve Open = 84.3 BTDC - Valve Lash = 0.024 Green
CARFOR - Registered to: Stan Weiss
Exhaust - Rocker Arm Ratio = 1.5 - Valve Open = 300.5 BBDC - Valve Lash = 0.03 Red
Degrees
-260 240 220 200 BDC 160 140 120 100 80 60 40 20 TDC 20 40 60 80 100 120 140 160 BDC 200 220 240 260 280


Time Area ->
1.36
1.224
1.088
.952
.816
.68
.544
.408
.272
.136
COMP161 CMM - Bore = 4.0 Stroke = 3.25 Rod Length = 5.7 RPM = 6500
Intake - Rocker Arm Ratio = 1.5 - Valve Open = 84.3 BTDC - Valve Lash = 0.024 Green
CARFOR - Registered to: Stan Weiss
Exhaust - Rocker Arm Ratio = 1.5 - Valve Open = 300.5 BBDC - Valve Lash = 0.03 Red
Degrees
-260 240 220 200 BDC 160 140 120 100 80 60 40 20 TDC 20 40 60 80 100 120 140 160 BDC 200 220 240 260 280

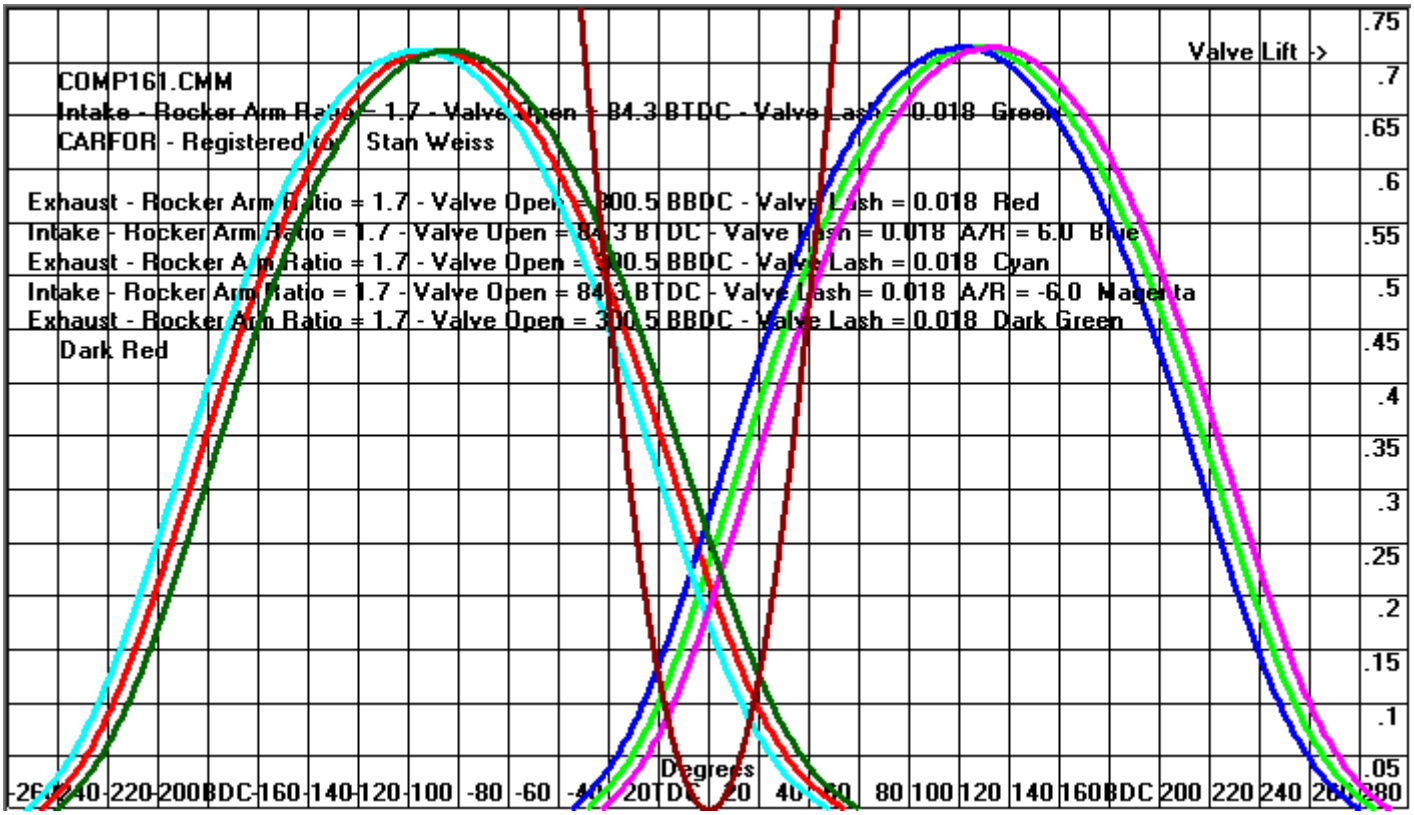
Valve Lift and Piston Travel



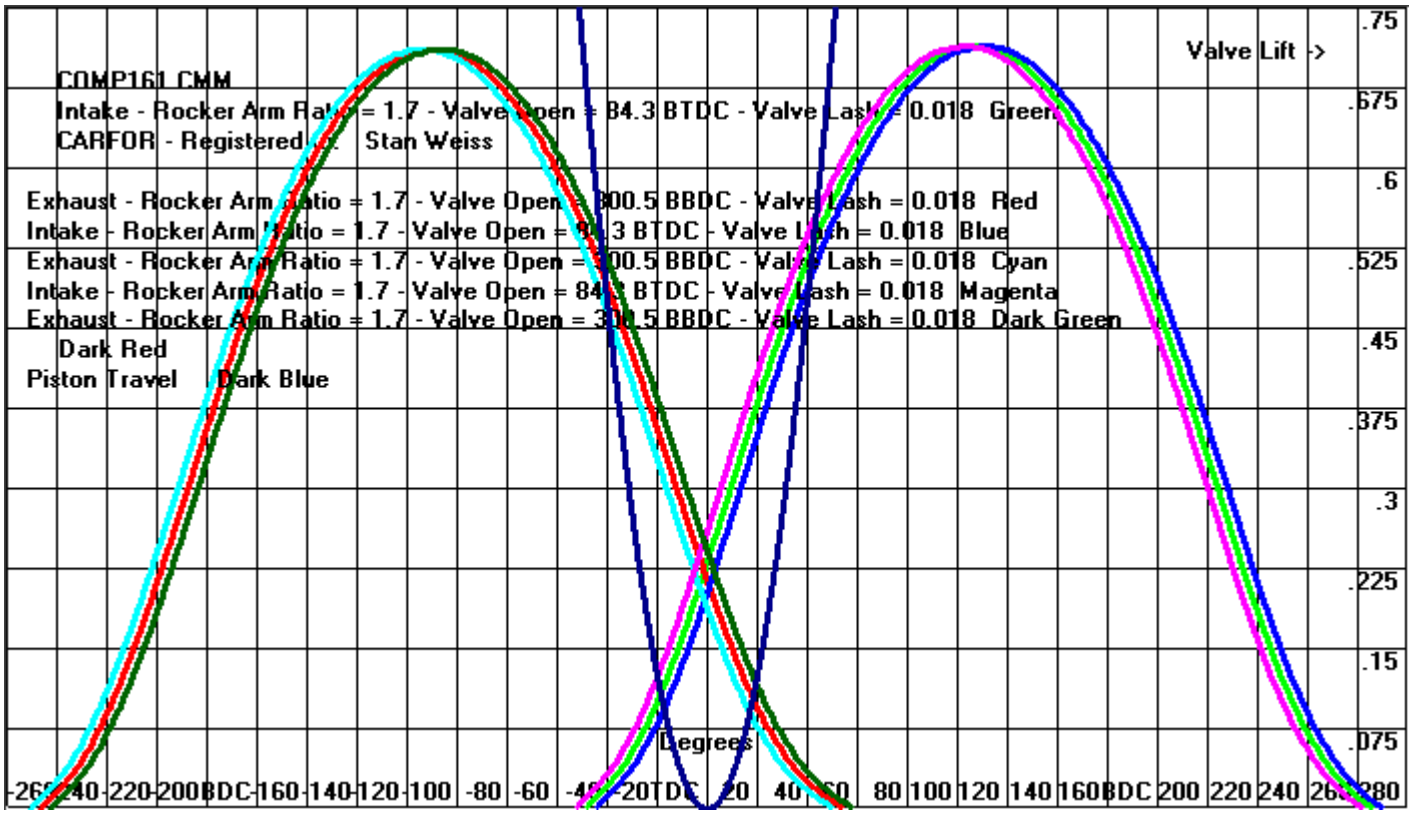
Vertical Valve Lift and Piston Travel Scaled 0.5



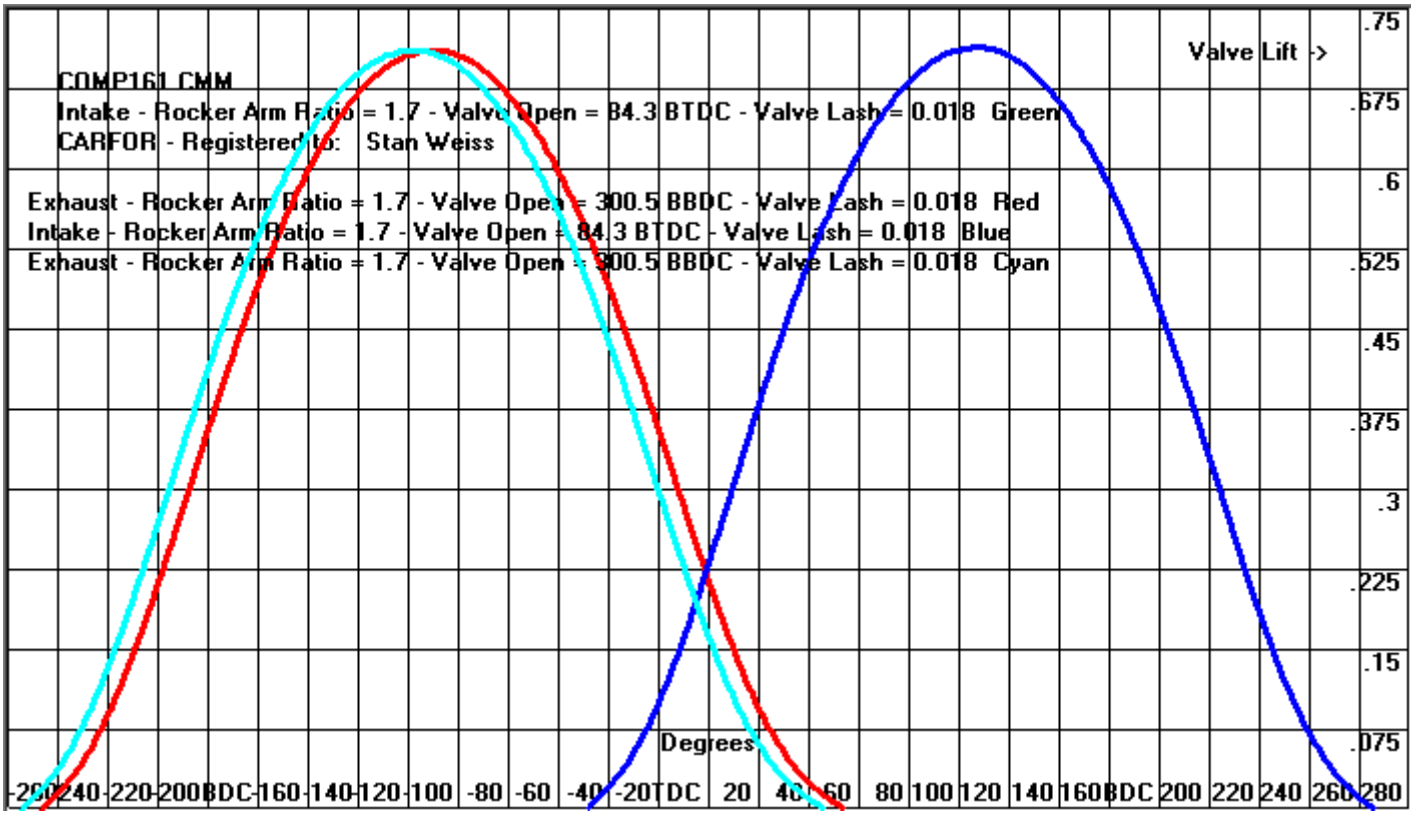
Valve Lift and Piston Travel Plus Cam Advanced 6 degrees and Retarded 6 degrees



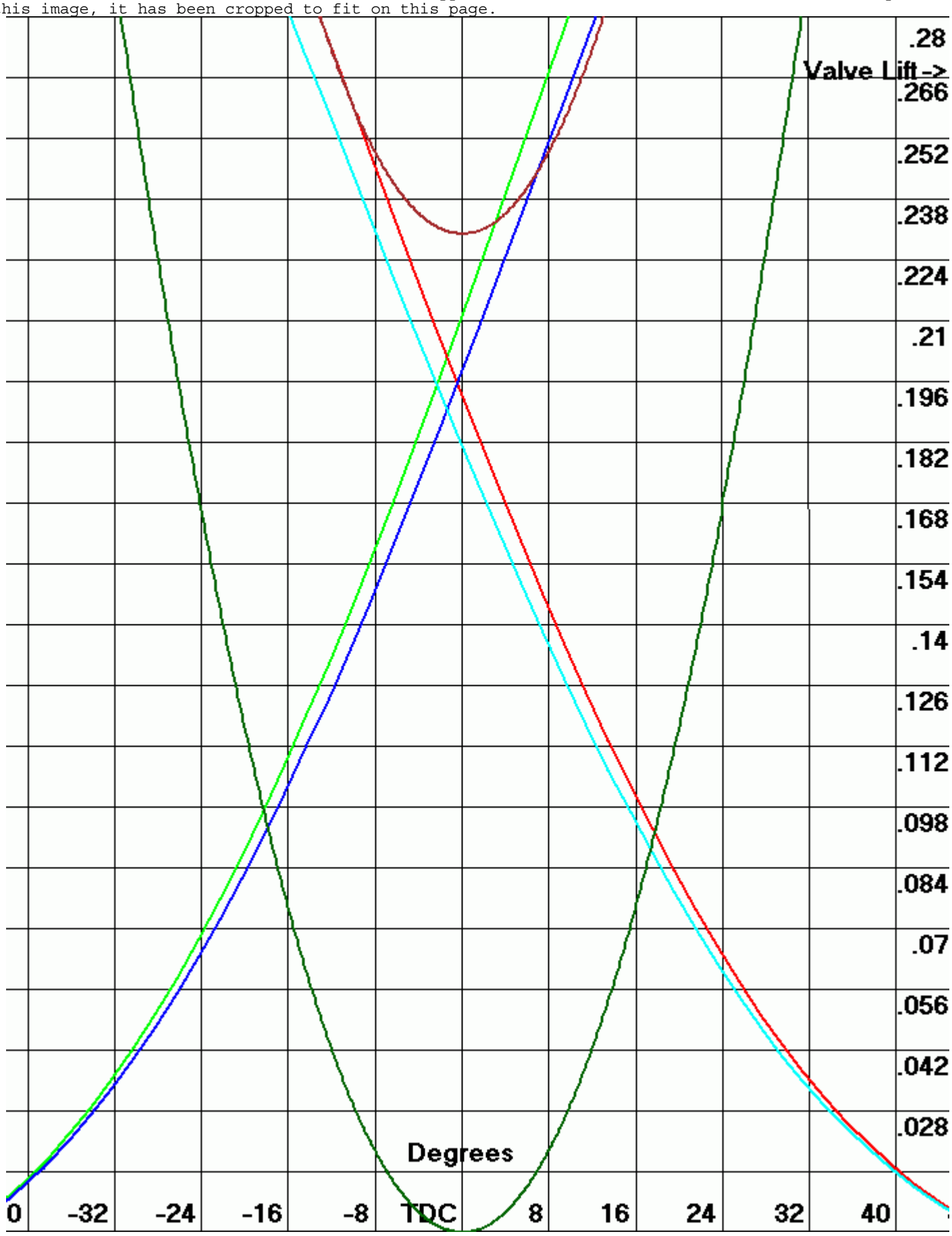
Valve Lift and Piston Travel Plus LSA Increased 4 degrees and LSA Decreased 4 degrees



Intake and Exhaust Valve Lift Plus LSA Increased by 4 degrees and Cam Advance 4 degrees
NOTE that both Intake Lift curves are in the same place



(Intake Green - Exhaust Red) Plus Valve Vertical (Intake Blue - Exhaust Cyan) Plus Piston Travel (Dark Green) and Piston Travel with Valve Clearance @ TDC (Dark Brown). Note how the you can see no intake valve to piston clearance but when using the Exhaust vertical valve lift you have some clearance. This really needs to be done twice, once using the Intake valve clearance @ TDC to check the Intake and the other time using the Exhaust valve clearance @ TDC to check the Exhaust. You can also advance or retard the cam to see what happens to the clearances. While this software produced this image, it has been cropped to fit on this page.



This shows Curtain area velocity (Green Intake, Red Exhaust), Throat area velocity (Blue Intake, Cyan Exhaust), Min CSA velocity (Magenta Intake, Dark Green Exhaust) and Piston Velocity (Dark Red Intake, Dark Blue Exhaust).

Intake

Valve Lift	Flow CFM @ Test Pressure
0.2	131.0
0.3	188.0
0.4	230.0
0.5	260.0
0.6	273.0
0.7	282.0

Exhaust

Valve Lift	Flow CFM @ Test Pressure
0.2	116.0
0.3	153.0
0.4	194.0
0.5	212.0
0.6	245.0
0.7	253.0

Valve and Throat Sizing

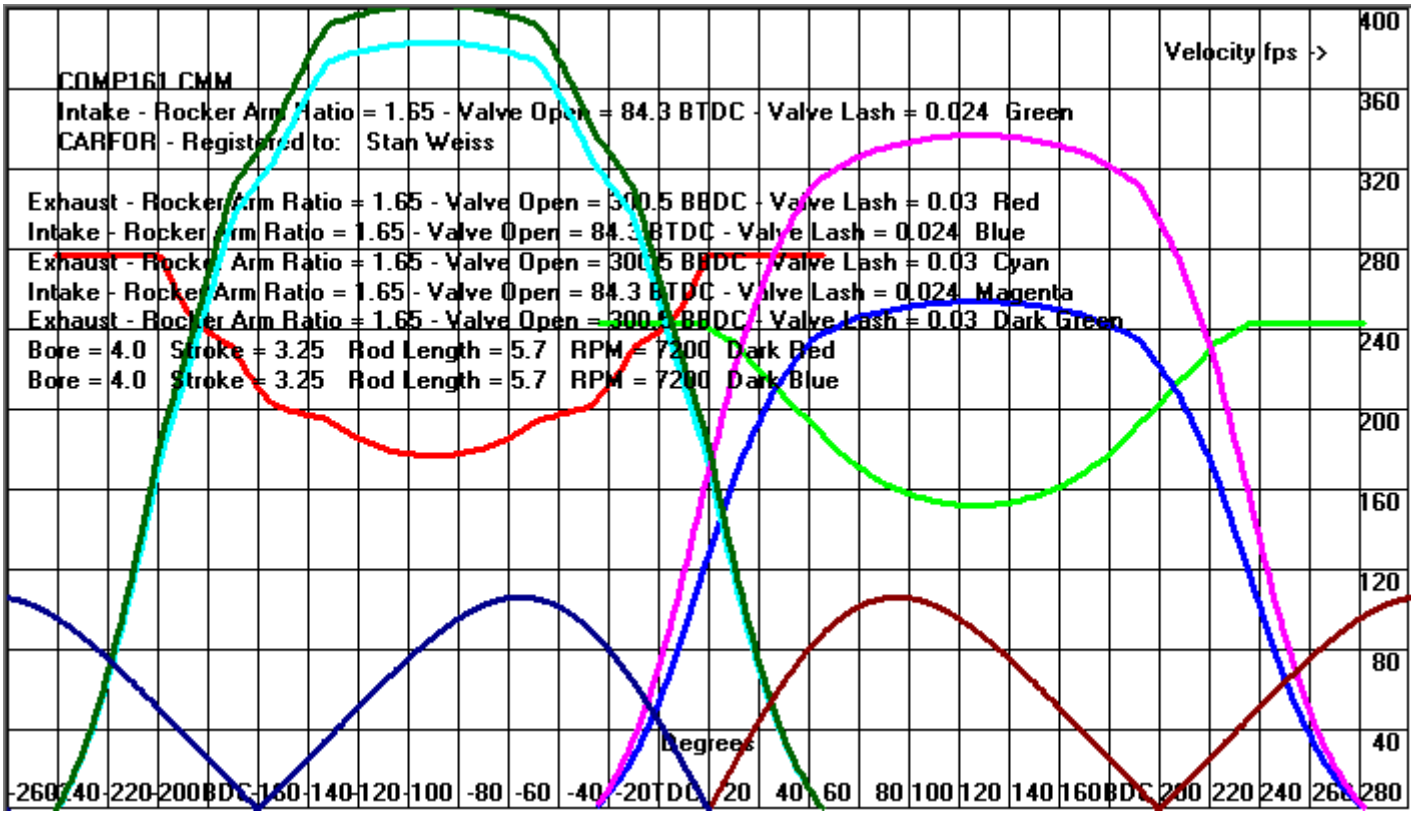
Intake Valve Size	2.055
Intake Valve Stem Diameter	0.3415
Intake Throat CSA	0.91
Number of Intake Valves	1
Exhaust Valve Size	1.600
Exhaust Valve Stem Diameter	0.3415
Exhaust Throat CSA	0.91
Number of Exhaust Valves	1

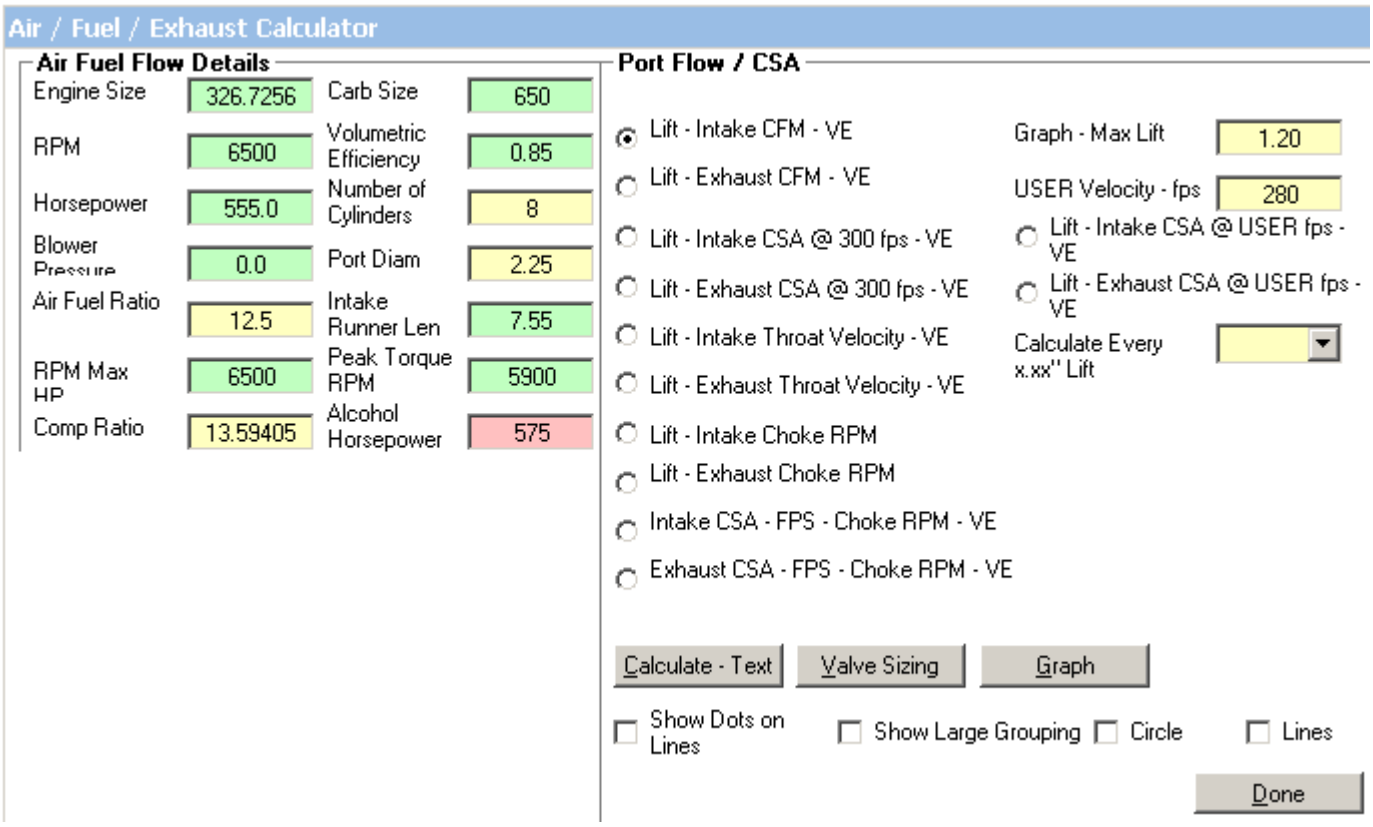
(•) CSA % of Valve Size ( ) CSA in Sq. Inches ( ) Diameter

Done

Only used by the Analyze Flow Data Form - Sq. In

Intake Port MCSA	2
Exhaust Port MCSA	1.5





4) Calculate Intake and Exhaust Choke RPM, CFM @ 28 Inches, CSA @ 300 fps velocity, and Velocity @ User CSA this uses RPM Max HP, Volumetric Efficiency from left screen.
5) Get Valve Size, Valve Stem Size, Throat Information and Number of Valves.
6) Graph Intake or Exhaust Choke RPM, CFM @ 28 Inches, CSA @ 300 fps velocity, and Velocity @ User CSA Based on selected Graph Options.

Graph Options:

Intake CFM on Y-Axis, Lift on X-Axis against VE.
Exhaust CFM on Y-Axis, Lift on X-Axis against VE.
Intake CSA @ 300 fps on Y-Axis, Lift on X-Axis against VE.
Exhaust CSA @ 300 fps on Y-Axis, Lift on X-Axis against VE.
Intake Velocity on Y-Axis, Lift on X-Axis against VE.
Exhaust Velocity on Y-Axis, Lift on X-Axis against VE.
Intake Choke RPM on Y-Axis, Lift on X-Axis against VE.
Exhaust Choke RPM on Y-Axis, Lift on X-Axis against VE.
Intake Choke CSA on Y-Axis, FPS on X-Axis against VE.
Exhaust Choke CSA on Y-Axis, FPS on X-Axis against VE.
Intake CSA @ USER entered fps on Y-Axis, Lift on X-Axis against VE.
Exhaust CSA @ USER entered fps on Y-Axis, Lift on X-Axis against VE.

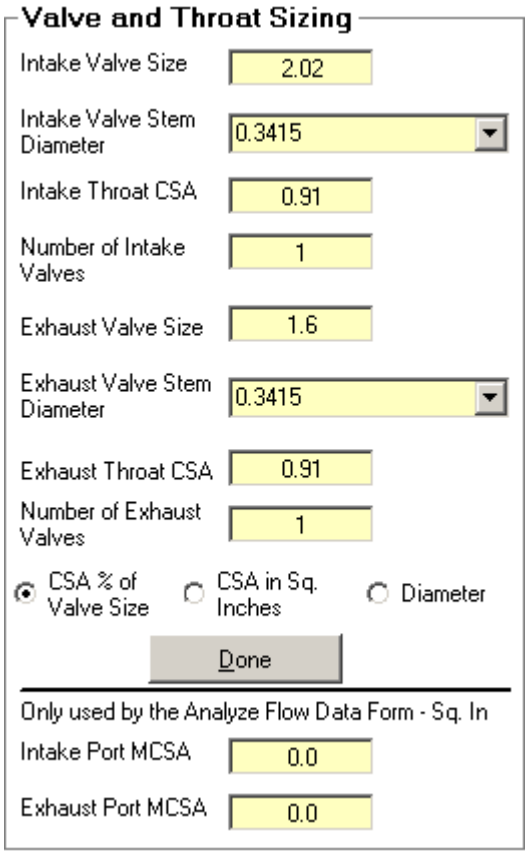
Graph Max Lift:

Lets the user limit the maximum lift shown on the X-Axis. The lower limit is .3” and the upper limit is 1.5”.

Check Boxes:

Show Dots on Lines will place a dot at each 0.025” lift or every 10 fps
The Default is to group 3 line over each 0.05 VE higher and 3 lines below each 0.05 VE lower. Show Large Grouping shows 7 lines above and 7 lines below each 0.05 VE from the last.
Circle will place a small circle whose center is at the point where the x and y coordinates meet.
Line will place a line at the x coordinate which runs threw all the other lines.

Calculate Every x.xx" Lift lets the USER select from 0.100, 0.050, 0.025 0.010, or 0.005 inches of lift, with the default being every .025".



For the user to enter CSA in sq. inches check the "CSA in Sq. Inches" button and then enter the sq. inch valve into the "Intake Throat CSA" and "Exhaust Throat CSA" fields.
NOTE: Since the throat area has the valve stem area remove from it, if you want to use this as a **TRUE CSA** set the Intake and Exhaust Valve Stem Diameter to zero.

The last two columns are calculated using the user entered "Velocity – fps". If the user enters 350 these columns will show the Minimum CSA.

```
Bore = 4.0000     Stroke = 3.2500          Rod Length = 5.7000     RPM = 6500
Wrist Pin Offset = 0.0                     Number of - Intake Valves = 1 - Exhaust Valves = 1
Intake Valve Size = 2.02                   Exhaust Valve Size = 1.6
Intake Valve / Bore Ratio = 0.505          Exhaust Valve / Bore Ratio = 0.4
Intake Valve Area = 3.204739 sq. in.       Exhaust Valve Area = 2.010619 sq. in.
Intake Valve Stem Size = 0.3415            Exhaust Valve Stem Size = 0.3415
Intake Valve Stem Area = 0.091595 sq. in.  Exhaust Valve Stem Area = 0.091595 sq. in.
Valve Lift at which the Valve Area and Window / Curtain Area are the SAME SIZE
At that point the velocity will be the same in both areas
Intake Valve Lift = 0.505 Inches           Exhaust Valve Lift = 0.4 Inches
Intake Centerline = 111.0                  User Selected DC - Discharge Coefficient = 0.5
Throat CSA (0.91) Intake = 2.5622 sq. in.  Throat CSA (0.91) Exhaust = 1.5734 sq. in.
Effective Throat CSA = 0.89416             Effective Throat CSA = 0.88462
Valve Lift at which the Throat Area and Window / Curtain Area are the SAME SIZE
At that point the velocity will be the same in both areas
Intake Valve Lift = 0.40376 Inches         Exhaust Valve Lift = 0.31302 Inches

Crank Angle of Max. Piston Velocity = 75.163      Volumetric Efficiency = 0.85
Choke RPM       Minimum Intake Lift = 0.5674      Minimum Exhaust Lift = 0.5344
                Maximum Intake Lift = 0.6501      Maximum Exhaust Lift = 0.6123
```

Valve Lift	Choke RPM		Minimum CFM @ 28 Inches Water		CSA @ 300 fps Velocity		Throat Velocity fps - User CSA		CSA @ 280 fps Velocity		L/D Ratio	
	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust
.025	286	304	7.50	5.61	0.0600	0.0449	7.028	8.552	0.0643	0.0481	0.0124	0.0156
.050	573	608	15.01	11.21	0.1200	0.0897	14.056	17.104	0.1286	0.0961	0.0248	0.0313
.075	859	912	22.51	16.82	0.1801	0.1346	21.083	25.656	0.1929	0.1442	0.0371	0.0469

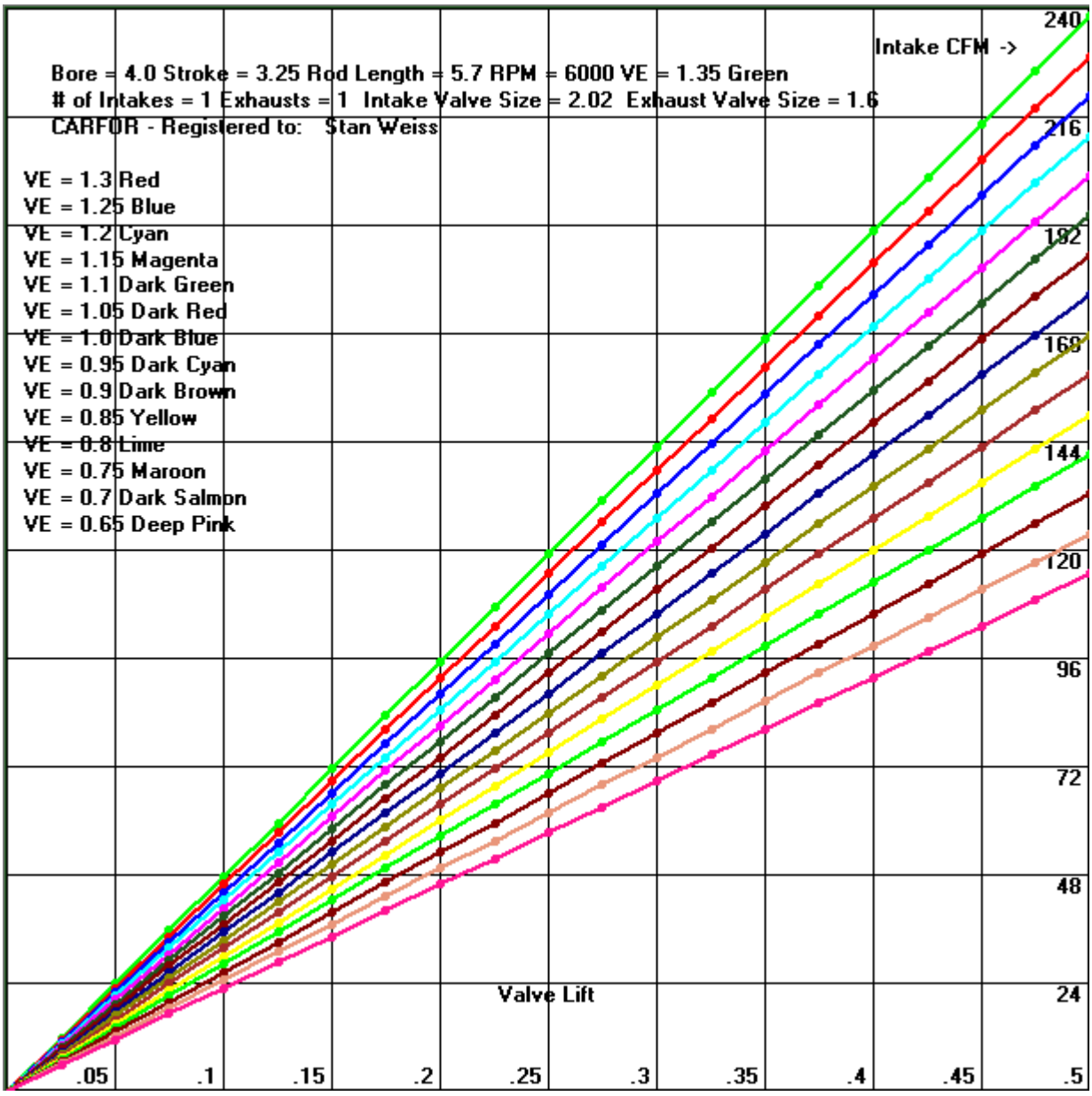
.100	1146	1216	30.01	22.43	0.2401	0.1794	28.111	34.208	0.2572	0.1922	0.0495	0.0625
.125	1432	1520	37.51	28.03	0.3001	0.2243	35.139	42.759	0.3216	0.2403	0.0619	0.0781
.150	1718	1824	45.02	33.64	0.3601	0.2691	42.167	51.311	0.3859	0.2883	0.0743	0.0938
.175	2005	2128	52.52	39.25	0.4202	0.3140	49.194	59.863	0.4502	0.3364	0.0866	0.1094
.200	2291	2432	60.02	44.85	0.4802	0.3588	56.222	68.415	0.5145	0.3844	0.0990	0.1250
.225	2578	2737	67.53	50.46	0.5402	0.4037	63.250	76.967	0.5788	0.4325	0.1114	0.1406
.250	2864	3041	75.03	56.06	0.6002	0.4485	70.278	85.519	0.6431	0.4806	0.1238	0.1563
.275	3150	3345	82.53	61.67	0.6603	0.4934	77.305	94.071	0.7074	0.5286	0.1361	0.1719
.300	3437	3649	90.03	67.28	0.7203	0.5382	84.333	102.623	0.7717	0.5767	0.1485	0.1875
.325	3723	3953	97.54	72.88	0.7803	0.5831	91.361	111.175	0.8360	0.6247	0.1609	0.2031
.350	4010	4257	105.04	78.49	0.8403	0.6279	98.389	119.726	0.9003	0.6728	0.1733	0.2188
.375	4296	4561	112.54	84.10	0.9003	0.6728	105.416	128.278	0.9647	0.7208	0.1856	0.2344
.400	4582	4865	120.05	89.70	0.9604	0.7176	112.444	136.830	1.0290	0.7689	0.1980	0.2500
.425	4869	5169	127.55	95.31	1.0204	0.7625	119.472	145.382	1.0933	0.8169	0.2104	0.2656
.450	5155	5473	135.05	100.92	1.0804	0.8073	126.500	153.934	1.1576	0.8650	0.2228	0.2813
.475	5442	5777	142.55	106.52	1.1404	0.8522	133.527	162.486	1.2219	0.9131	0.2351	0.2969
.500	5728	6081	150.06	112.13	1.2005	0.8970	140.555	171.038	1.2862	0.9611	0.2475	0.3125
.525	6014	6385	157.56	117.74	1.2605	0.9419	147.583	179.590	1.3505	1.0092	0.2599	0.3281
.550	6301	6689	165.06	123.34	1.3205	0.9867	154.611	188.141	1.4148	1.0572	0.2723	0.3438
.575	6587	6993	172.57	128.95	1.3805	1.0316	161.638	196.693	1.4791	1.1053	0.2847	0.3594
.600	6874	7297	180.07	134.56	1.4405	1.0764	168.666	205.245	1.5434	1.1533	0.2970	0.3750
.625	7160	7601	187.57	140.16	1.5006	1.1213	175.694	213.797	1.6078	1.2014	0.3094	0.3906
.650	7446	7906	195.07	145.77	1.5606	1.1661	182.722	222.349	1.6721	1.2494	0.3218	0.4063
.675	7733	8210	202.58	151.37	1.6206	1.2110	189.749	230.901	1.7364	1.2975	0.3342	0.4219
.700	8019	8514	210.08	156.98	1.6806	1.2558	196.777	239.453	1.8007	1.3456	0.3465	0.4375
.725	8306	8818	217.58	162.59	1.7407	1.3007	203.805	248.005	1.8650	1.3936	0.3589	0.4531
.750	8592	9122	225.09	168.19	1.8007	1.3456	210.833	256.557	1.9293	1.4417	0.3713	0.4688
.775	8878	9426	232.59	173.80	1.8607	1.3904	217.860	265.108	1.9936	1.4897	0.3837	0.4844
.800	9165	9730	240.09	179.41	1.9207	1.4353	224.888	273.660	2.0579	1.5378	0.3960	0.5000
.825	9451	10034	247.59	185.01	1.9808	1.4801	231.916	282.212	2.1222	1.5858	0.4084	0.5156
.850	9737	10338	255.10	190.62	2.0408	1.5250	238.944	290.764	2.1865	1.6339	0.4208	0.5313
.875	10024	10642	262.60	196.23	2.1008	1.5698	245.971	299.316	2.2509	1.6819	0.4332	0.5469
.900	10310	10946	270.10	201.83	2.1608	1.6147	252.999	307.868	2.3152	1.7300	0.4455	0.5625
.925	10597	11250	277.61	207.44	2.2208	1.6595	260.027	316.420	2.3795	1.7781	0.4579	0.5781
.950	10883	11554	285.11	213.05	2.2809	1.7044	267.055	324.972	2.4438	1.8261	0.4703	0.5938
.975	11169	11858	292.61	218.65	2.3409	1.7492	274.082	333.524	2.5081	1.8742	0.4827	0.6094
1.000	11456	12162	300.11	224.26	2.4009	1.7941	281.110	342.075	2.5724	1.9222	0.4950	0.6250
1.025	11742	12466	307.62	229.87	2.4609	1.8389	288.138	350.627	2.6367	1.9703	0.5074	0.6406
1.050	12029	12771	315.12	235.47	2.5210	1.8838	295.166	359.179	2.7010	2.0183	0.5198	0.6563
1.075	12315	13075	322.62	241.08	2.5810	1.9286	302.193	367.731	2.7653	2.0664	0.5322	0.6719
1.100	12601	13379	330.13	246.68	2.6410	1.9735	309.221	376.283	2.8296	2.1144	0.5446	0.6875
1.125	12888	13683	337.63	252.29	2.7010	2.0183	316.249	384.835	2.8940	2.1625	0.5569	0.7031
1.150	13174	13987	345.13	257.90	2.7611	2.0632	323.277	393.387	2.9583	2.2106	0.5693	0.7188
1.175	13461	14291	352.63	263.50	2.8211	2.1080	330.304	401.939	3.0226	2.2586	0.5817	0.7344
1.200	13747	14595	360.14	269.11	2.8811	2.1529	337.332	410.490	3.0869	2.3067	0.5941	0.7500
1.225	14033	14899	367.64	274.72	2.9411	2.1977	344.360	419.042	3.1512	2.3547	0.6064	0.7656
1.250	14320	15203	375.14	280.32	3.0011	2.2426	351.388	427.594	3.2155	2.4028	0.6188	0.7813
1.275	14606	15507	382.65	285.93	3.0612	2.2874	358.415	436.146	3.2798	2.4508	0.6312	0.7969
1.300	14893	15811	390.15	291.54	3.1212	2.3323	365.443	444.698	3.3441	2.4989	0.6436	0.8125
1.325	15179	16115	397.65	297.14	3.1812	2.3771	372.471	453.250	3.4084	2.5469	0.6559	0.8281
1.350	15465	16419	405.15	302.75	3.2412	2.4220	379.499	461.802	3.4728	2.5950	0.6683	0.8437
1.375	15752	16723	412.66	308.36	3.3013	2.4668	386.527	470.354	3.5371	2.6430	0.6807	0.8594
1.400	16038	17027	420.16	313.96	3.3613	2.5117	393.554	478.906	3.6014	2.6911	0.6931	0.8750
1.425	16325	17331	427.66	319.57	3.4213	2.5566	400.582	487.457	3.6657	2.7392	0.7054	0.8906
1.450	16611	17635	435.17	325.18	3.4813	2.6014	407.610	496.009	3.7300	2.7872	0.7178	0.9062
1.475	16897	17940	442.67	330.78	3.5413	2.6463	414.638	504.561	3.7943	2.8353	0.7302	0.9219
1.500	17184	18244	450.17	336.39	3.6014	2.6911	421.665	513.113	3.8586	2.8833	0.7426	0.9375

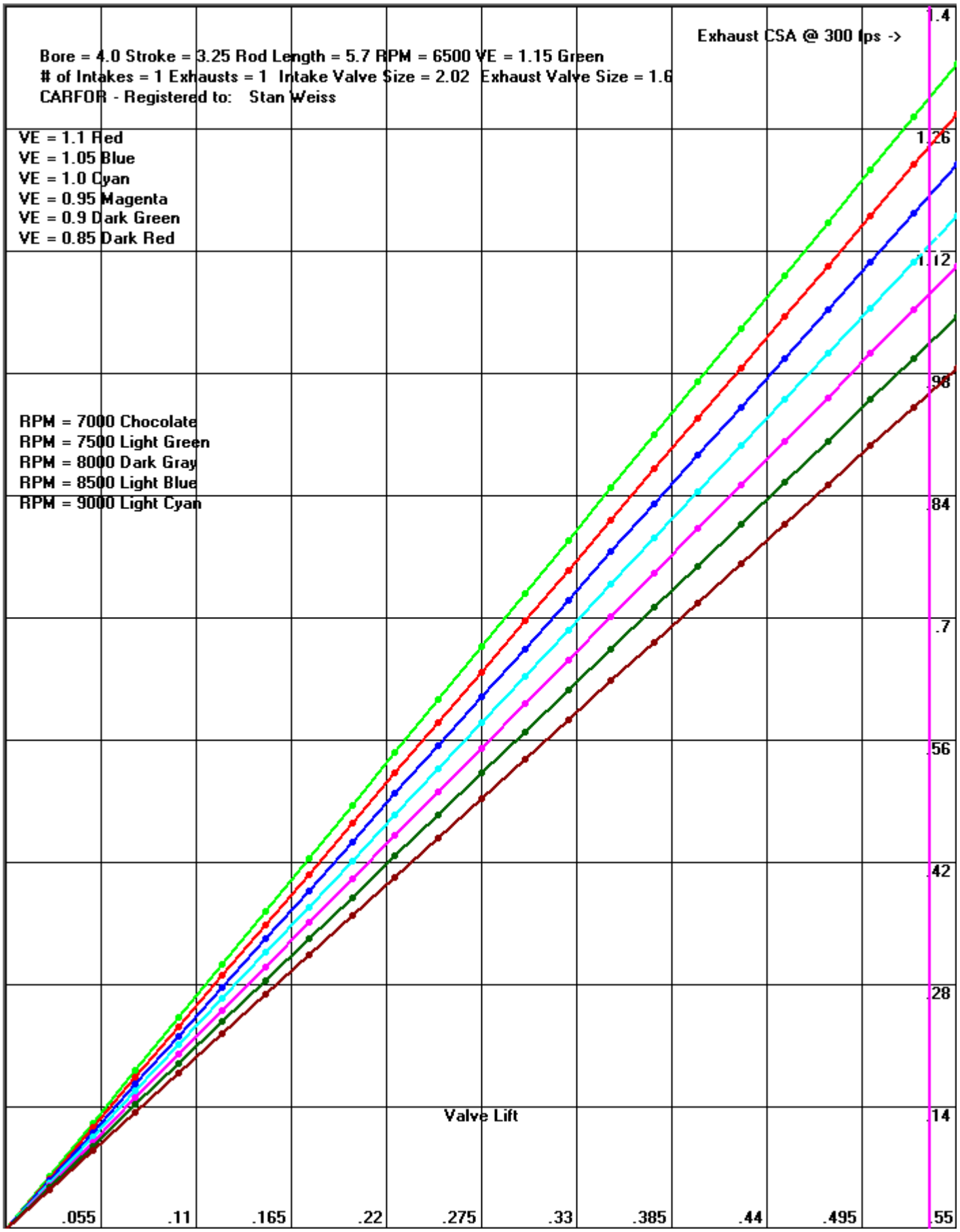
Vel FPS	CSA Sq. In. Intake	CSA Sq. In. Exhaust
200	2.0434	1.4382
205	1.9936	1.4031
210	1.9461	1.3697
215	1.9008	1.3379
220	1.8576	1.3075
225	1.8164	1.2784
230	1.7769	1.2506
235	1.7391	1.2240
240	1.7028	1.1985
245	1.6681	1.1741
250	1.6347	1.1506
255	1.6027	1.1280
260	1.5718	1.1063
265	1.5422	1.0854
270	1.5136	1.0653
275	1.4861	1.0460
280	1.4596	1.0273
285	1.4340	1.0093
290	1.4092	0.9919

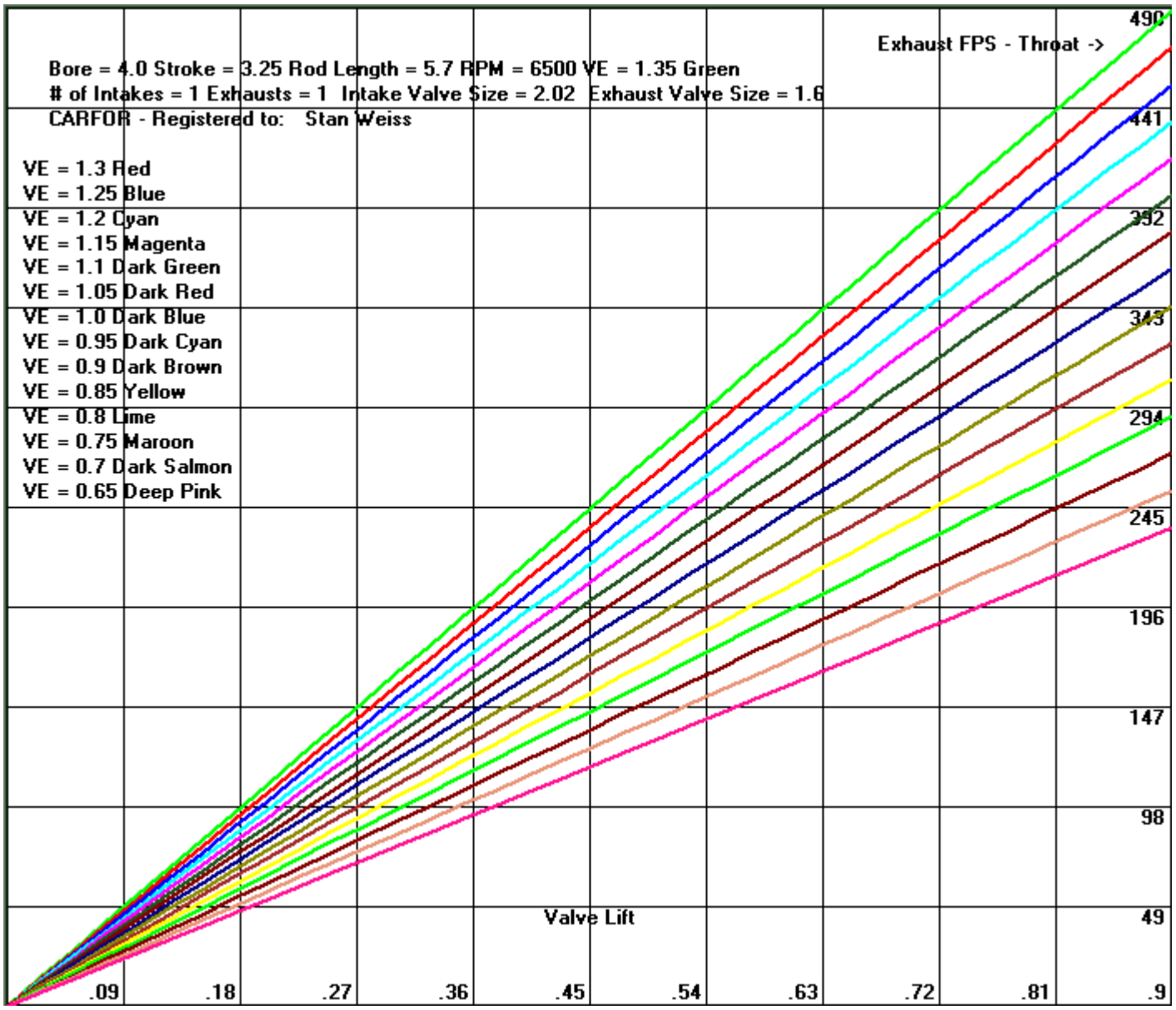
295	1.3854	0.9751
300	1.3623	0.9588
305	1.3399	0.9431
310	1.3183	0.9279
315	1.2974	0.9132
320	1.2771	0.8989
325	1.2575	0.8851
330	1.2384	0.8716
335	1.2199	0.8586
340	1.2020	0.8460
345	1.1846	0.8338
350	1.1677	0.8218

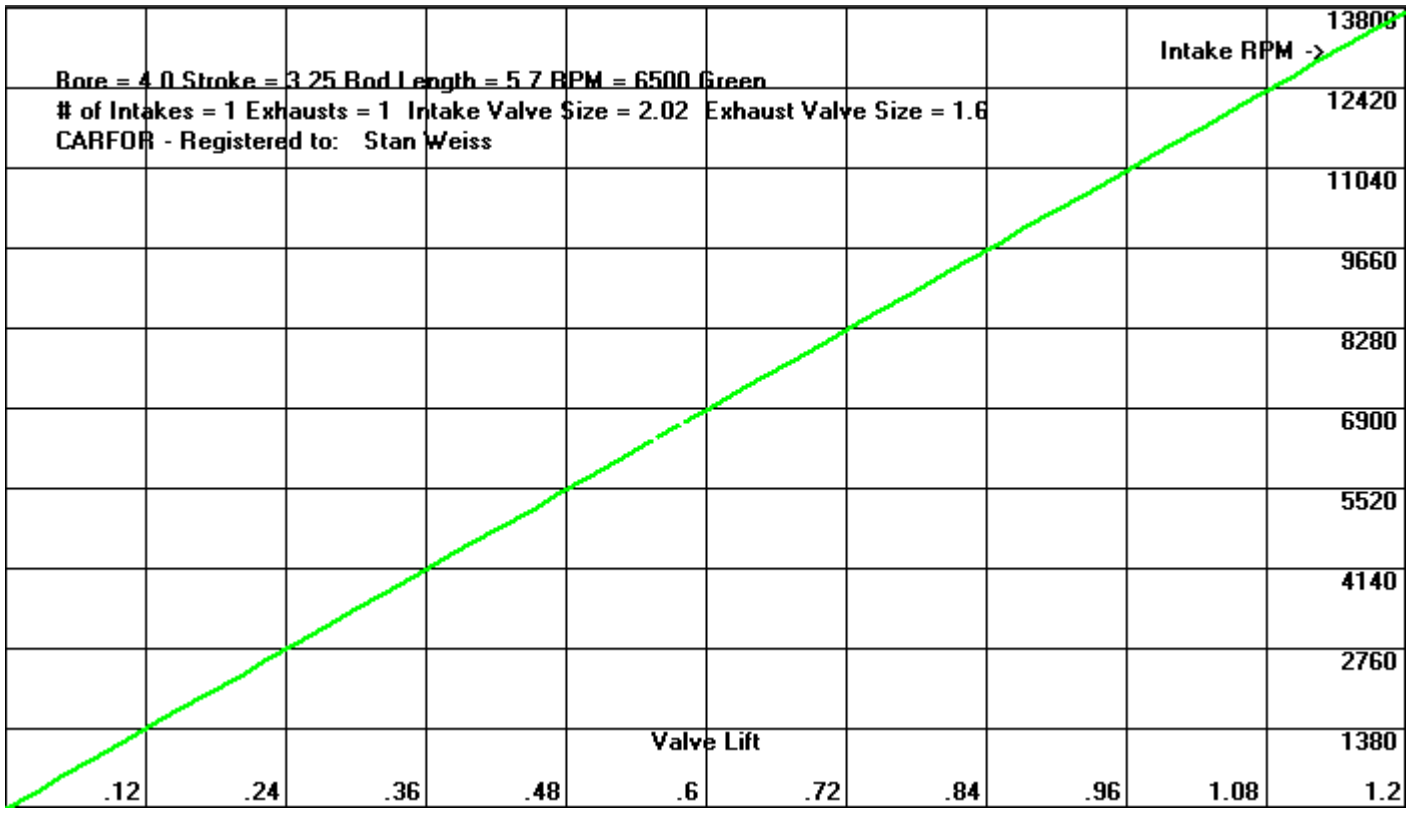
Choke RPM	Intake Valve Lift	Exhaust Valve Lift
500	0.0436	0.0411
750	0.0655	0.0617
1000	0.0873	0.0822
1250	0.1091	0.1028
1500	0.1309	0.1233
1750	0.1528	0.1439
2000	0.1746	0.1644
2250	0.1964	0.1850
2500	0.2182	0.2056
2750	0.2401	0.2261
3000	0.2619	0.2467
3250	0.2837	0.2672
3500	0.3055	0.2878
3750	0.3273	0.3083
4000	0.3492	0.3289
4250	0.3710	0.3494
4500	0.3928	0.3700
4750	0.4146	0.3905
5000	0.4365	0.4111
5250	0.4583	0.4317
5500	0.4801	0.4522
5750	0.5019	0.4728
6000	0.5237	0.4933
6250	0.5456	0.5139
6500	0.5674	0.5344
6750	0.5892	0.5550
7000	0.6110	0.5755
7250	0.6329	0.5961
7500	0.6547	0.6167
7750	0.6765	0.6372
8000	0.6983	0.6578
8250	0.7202	0.6783
8500	0.7420	0.6989
8750	0.7638	0.7194
9000	0.7856	0.7400
9250	0.8074	0.7605
9500	0.8293	0.7811
9750	0.8511	0.8017
10000	0.8729	0.8222
10250	0.8947	0.8428
10500	0.9166	0.8633
10750	0.9384	0.8839
11000	0.9602	0.9044
11250	0.9820	0.9250
11500	1.0039	0.9455
11750	1.0257	0.9661
12000	1.0475	0.9866
12250	1.0693	1.0072
12500	1.0911	1.0278
12750	1.1130	1.0483
13000	1.1348	1.0689
13250	1.1566	1.0894
13500	1.1784	1.1100
13750	1.2003	1.1305
14000	1.2221	1.1511
14250	1.2439	1.1716
14500	1.2657	1.1922
14750	1.2875	1.2128
15000	1.3094	1.2333
15250	1.3312	1.2539
15500	1.3530	1.2744
15750	1.3748	1.2950
16000	1.3967	1.3155

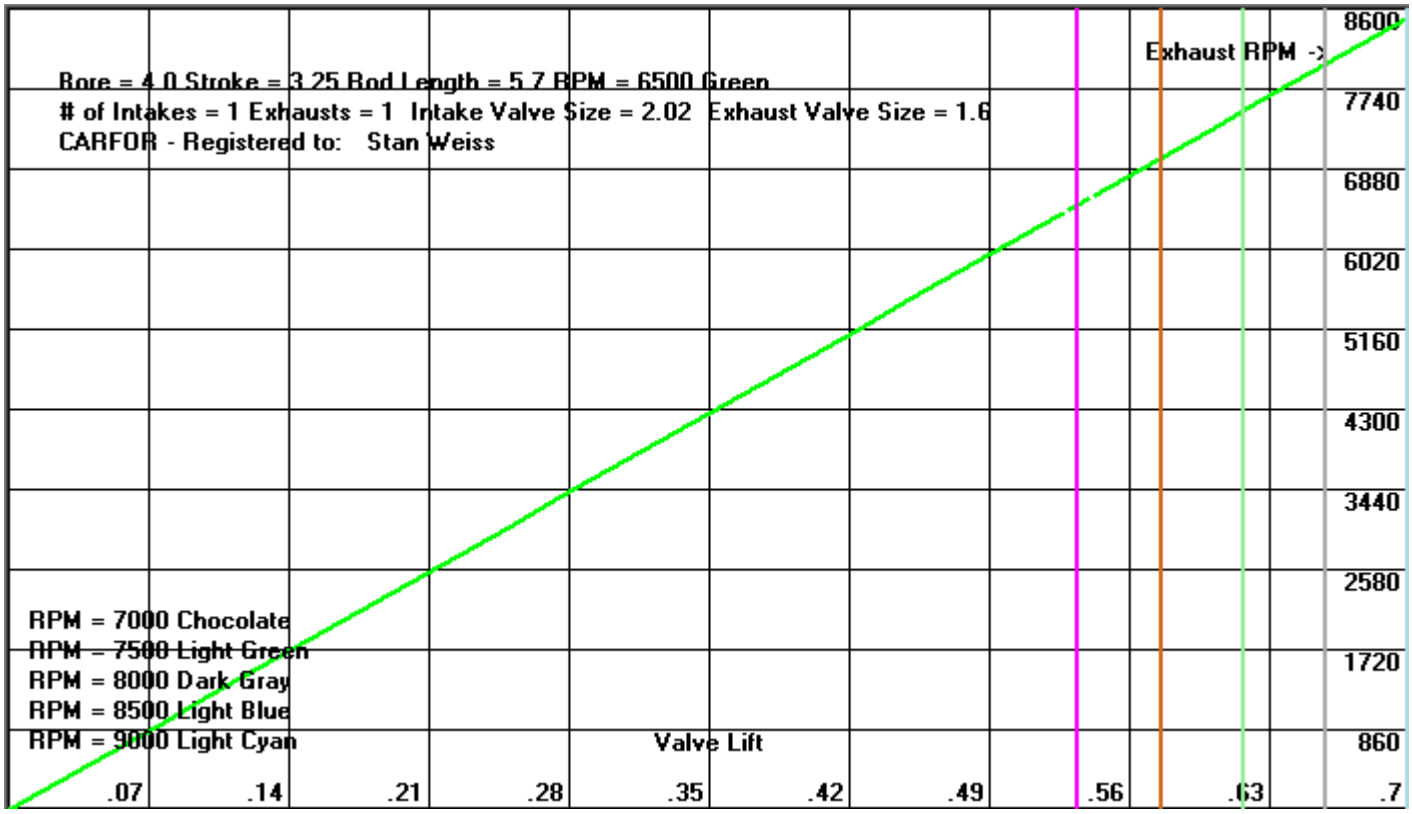
```
16250   1.4185   1.3361
16500   1.4403   1.3566
16750   1.4621   1.3772
17000   1.4840   1.3978
17250   1.5058   1.4183
17500   1.5276   1.4389
17750   1.5494   1.4594
18000   1.5712   1.4800
```

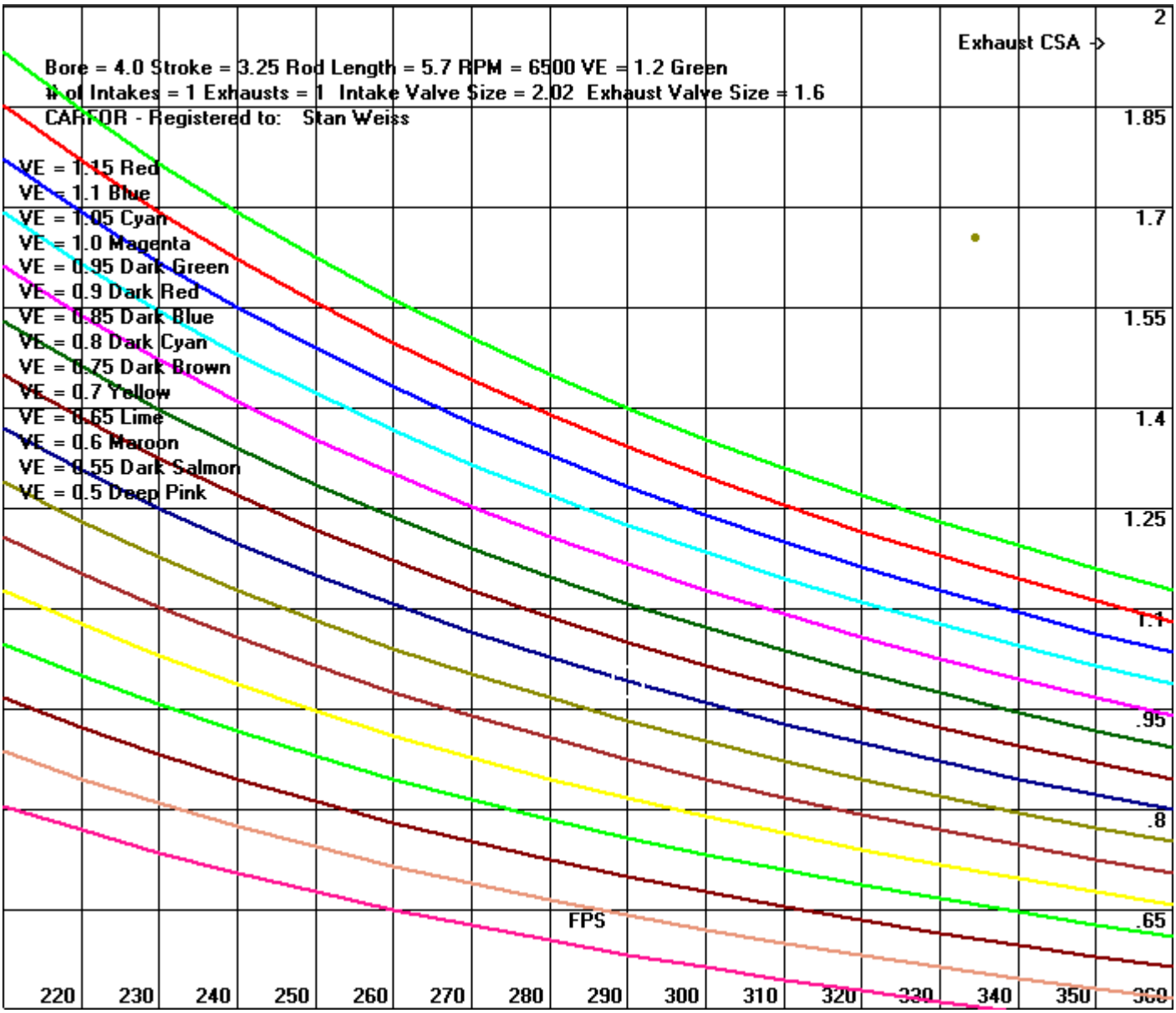



Bore = 4.0 Stroke = 3.25 Rod Length = 5.7 RPM = 6500 VE = 1.15 Green
# of Intakes = 1 Exhausts = 1 Intake Valve Size = 2.02 Exhaust Valve Size = 1.6
CARFOR - Registered to: Stan Weiss
Exhaust CSA @ 300 fps ->
VE = 1.1 Red
VE = 1.05 Blue
VE = 1.0 Cyan
VE = 0.95 Magenta
VE = 0.9 Dark Green
VE = 0.85 Dark Red
RPM = 7000 Chocolate
RPM = 7500 Light Green
RPM = 8000 Dark Gray
RPM = 8500 Light Blue
RPM = 9000 Light Cyan
1.4
1.26
1.12
.98
.84
.7
.56
.42
.28
.14
Valve Lift
.055
.11
.165
.22
.275
.33
.385
.44
.495
.55


Bore = 4.0 Stroke = 3.25 Rod Length = 5.7 RPM = 6500 VE = 1.35 Green
# of Intakes = 1 Exhausts = 1 Intake Valve Size = 2.02 Exhaust Valve Size = 1.6
CARFOR - Registered to: Stan Weiss
Exhaust FPS - Throat ->
VE = 1.3 Red
VE = 1.25 Blue
VE = 1.2 Cyan
VE = 1.15 Magenta
VE = 1.1 Dark Green
VE = 1.05 Dark Red
VE = 1.0 Dark Blue
VE = 0.95 Dark Cyan
VE = 0.9 Dark Brown
VE = 0.85 Yellow
VE = 0.8 Lime
VE = 0.75 Maroon
VE = 0.7 Dark Salmon
VE = 0.65 Deep Pink
490
441
392
343
294
245
196
147
98
49
Valve Lift
.09
.18
.27
.36
.45
.54
.63
.72
.81
.9


Bore = 4.0 Stroke = 3.25 Rod Length = 5.7 RPM = 6500 Green
# of Intakes = 1 Exhausts = 1 Intake Valve Size = 2.02 Exhaust Valve Size = 1.6
CARFOR - Registered to: Stan Weiss
Intake RPM ->
13800
12420
11040
9660
8280
6900
5520
4140
2760
1380
Valve Lift
.12
.24
.36
.48
.6
.72
.84
.96
1.08
1.2


Bore = 4.0 Stroke = 3.25 Rod Length = 5.7 RPM = 6500 Green
# of Intakes = 1 Exhausts = 1 Intake Valve Size = 2.02 Exhaust Valve Size = 1.6
CARFOR - Registered to: Stan Weiss
Exhaust RPM ->
8600
7740
6880
6020
5160
4300
3440
2580
1720
860
RPM = 7000 Chocolate
RPM = 7500 Light Green
RPM = 8000 Dark Gray
RPM = 8500 Light Blue
RPM = 9000 Light Cyan
Valve Lift
.07
.14
.21
.28
.35
.42
.49
.56
.63
.7


Bore = 4.0 Stroke = 3.25 Rod Length = 5.7 RPM = 6500 VE = 1.2 Green
# of Intakes = 1 Exhausts = 1 Intake Valve Size = 2.02 Exhaust Valve Size = 1.6
CARFOR - Registered to: Stan Weiss
VE = 1.15 Red
VE = 1.1 Blue
VE = 1.05 Cyan
VE = 1.0 Magenta
VE = 0.95 Dark Green
VE = 0.9 Dark Red
VE = 0.85 Dark Blue
VE = 0.8 Dark Cyan
VE = 0.75 Dark Brown
VE = 0.7 Yellow
VE = 0.65 Lime
VE = 0.6 Maroon
VE = 0.55 Dark Salmon
VE = 0.5 Deep Pink
Exhaust CSA ->
2
1.85
1.7
1.55
1.4
1.25
1.1
.95
.8
.65
FPS
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360

Two Stroke Exhaust, Expansion Chamber/Diffuser Design

Note: All input and output on this screen is in **Metric units only**.

This will let you calculate the dimensions of a single, one, two, or three stage expansion chamber / diffuser exhaust systems for your two stroke engine. Based on which command is selected unused output cells will be grayed out when the results are displayed.

Some of the main parameters in exhaust design are exhaust duration, the effective exhaust port diameter (calculated from exhaust width and height as a basic rectangle), engine RPM, and the speed of sound, and the variable that causes changes in the speed of sound which is Exhaust Gas Temperature. The user can enter each of these or check either or both check boxes and have the program calculate these values for you.

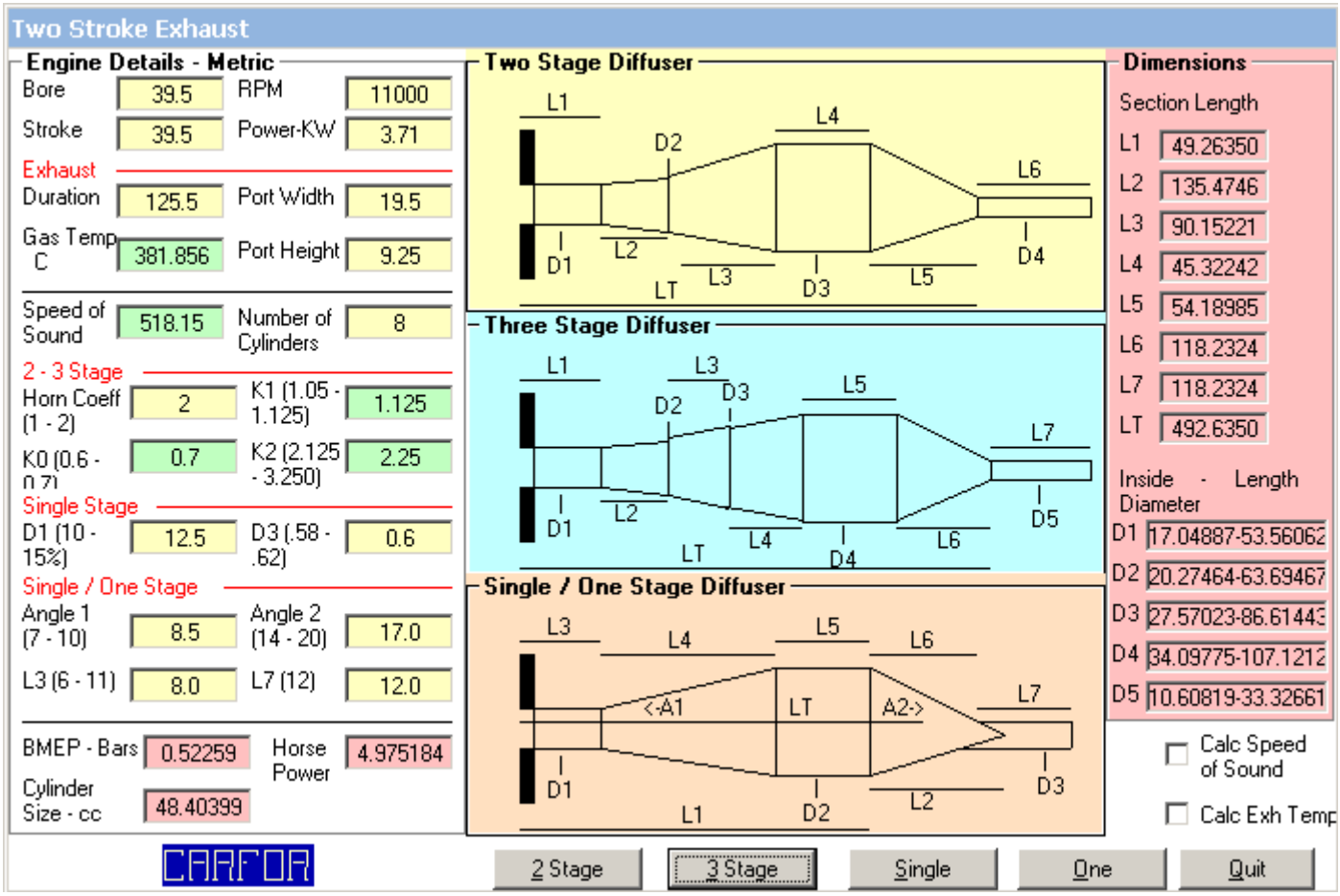
The LT value is calculated from the piston face.

These constants will let you customize the calculations. For these you have 3 choices.

1) Use the default values in the program.
2) Enter the values you want to use.
3) Have the program calculate the values for you. This only works for exhaust gas temperature, Horn Coefficient, K0, K1 and K2. To do this the program needs to calculate BMEP using cylinder capacity, power in KW, and RPM's.

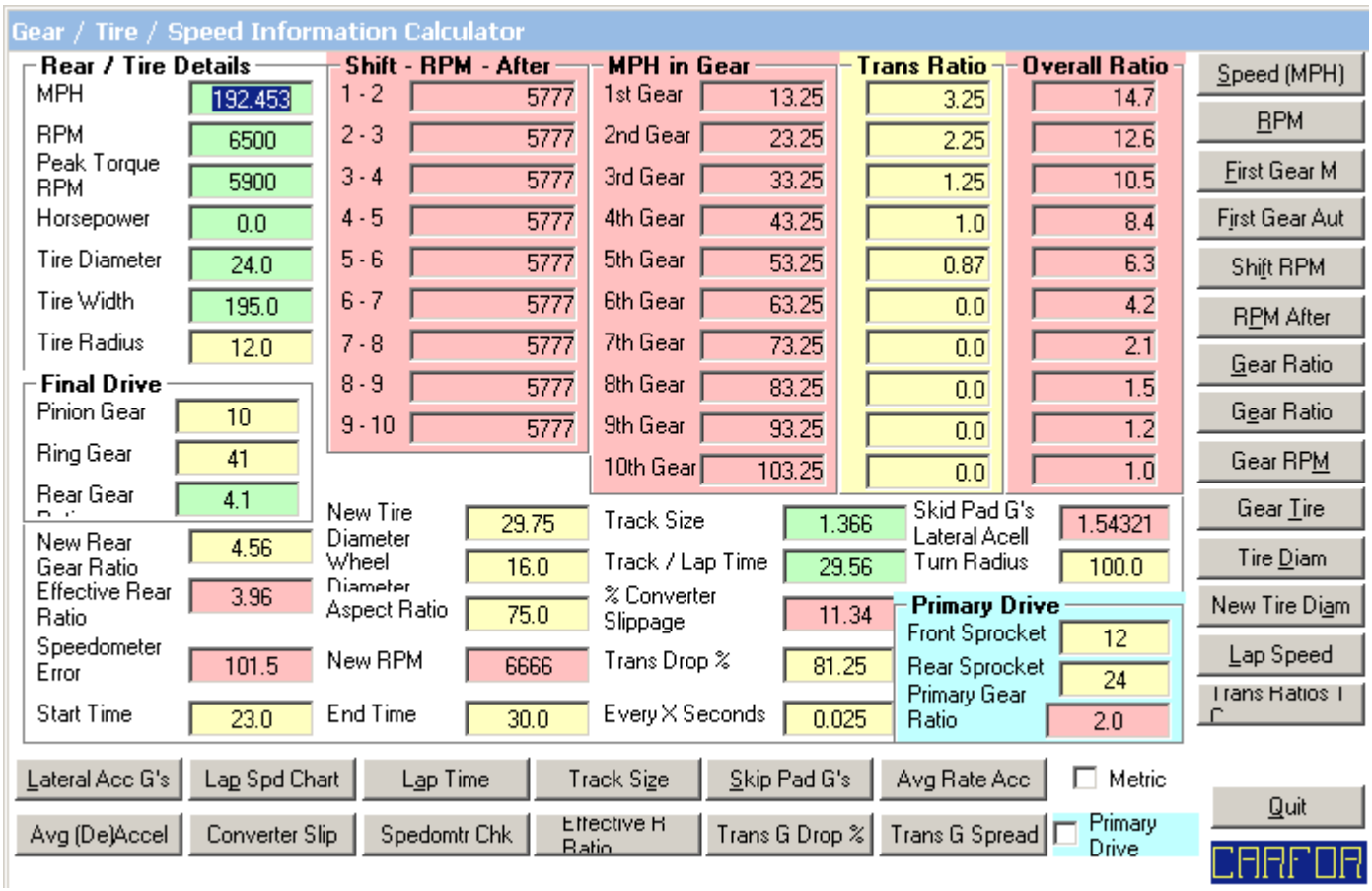
Constant Value based on Engine Type:	Exhaust Temp	K0	K1	K2
Road Bike	375	0.70	1.125	2.0
Enduro	500	0.7	1.125	2.25
Motocross	600	0.65	1.0875	2.75
Grand Prix Racer	650	0.6	1.05	3.25

Lower **K1 and K2** numbers will give you a boarder power band and higher numbers for a higher / very narrow RPM range.
The **Horn Coefficient** works with smaller values for narrow power band and larger values are for a boarder power band.



Angle A1 normally is between 7 to 10 degrees, while angle A2 is normally set to twice A1 or between 14 to 20 degrees.

Single Stage Diffuser is based on the book "2-Stroke Tuner's Handbook" by Gordon Jennings.
Two and Three Stage Diffusers are based on the book "Design and Simulation of Two Stroke Engines" by Dr. Gordon P. Blair.



G E A R

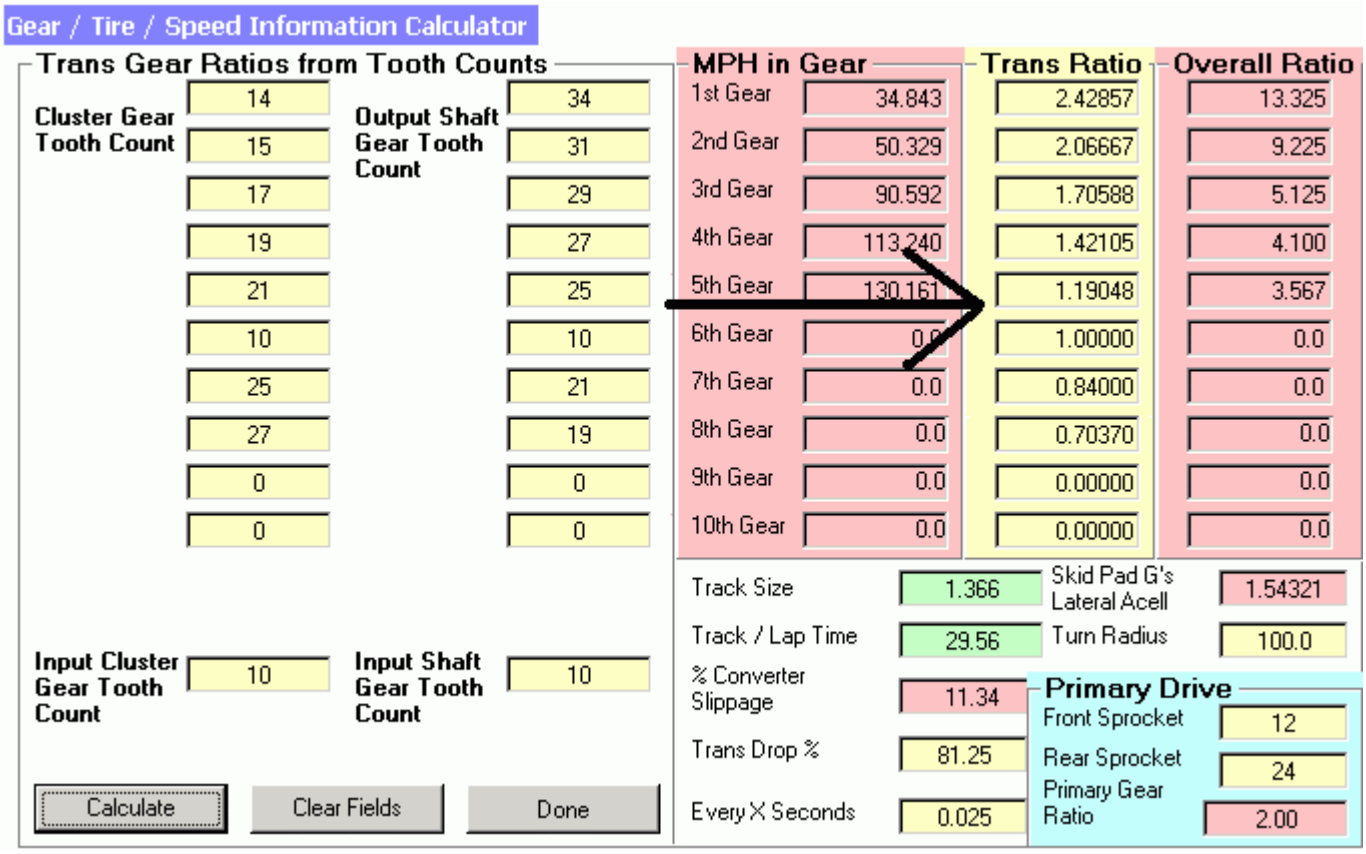
1) Calculate Speed (MPH) from RPM, Rear Gear Ratio, Trans Gear Ratio(s), and Tire Diameter.
2) Calculate RPM from MPH, Rear Gear Ratio, and Tire Diameter.
3) Estimate Trans First Gear Ratio Needed – Manual.
4) Estimate Trans First Gear Ratio Needed – Automatic.
5) Calculate RPM after Trans Gear Change (Shift) and percent of original RPM using RPM, and Trans Gear Ratios.
6) Calculate Rear Gear Ratio needed using MPH, RPM, Tire Diameter, and Trans Gear Ratio 1.
7) Calculate Rear Gear Ratio from tooth count of Ring (Motorcycle Front Sprocket) and Pinion Gears (Motorcycle Rear Sprocket).
8) Calculate Rear Gear Ratio change on RPM using Rear Gear Ratio, New Rear Gear Ratio, MPH, and Tire Diameter. Output is RPM will be for Rear Gear Ratio and New RPM will be for New Rear Gear Ratio.
9) Calculate Rear Gear Ratio needed after Tire Size Change using Tire Diameter, New Tire Diameter, and Gear Ratio. Also speedometer error if not Rear Ratio change.
10) Calculate Lap Speed (MPH) over Measured Distance (Track Size) in Miles and Track / Lap Time in seconds.
11) Calculate Lap Speed (MPH) Chart over Measured Distance (Track Size) in Miles and Start/End/Every Time in seconds.
12) Calculate Lap Time in second from Measured Distance (Track Size) in miles and Lap Speed (MPH).
13) Calculate Measured Distance (Track Size) in miles from Lap time in seconds and Lap Speed (MPH).
14) Calculate Skip Pad G's (Lateral Acceleration) from Turn Radius in feet and Lap Time in seconds.
15) Speedometer Check maintain constant 60 MPH and enter time to travel one mile in Track /Lap Time in seconds. MPH will show True MPH.
16) Calculate Trans Gear Change (Shift) using Peak Torque RPM, and Trans Gear Ratios.

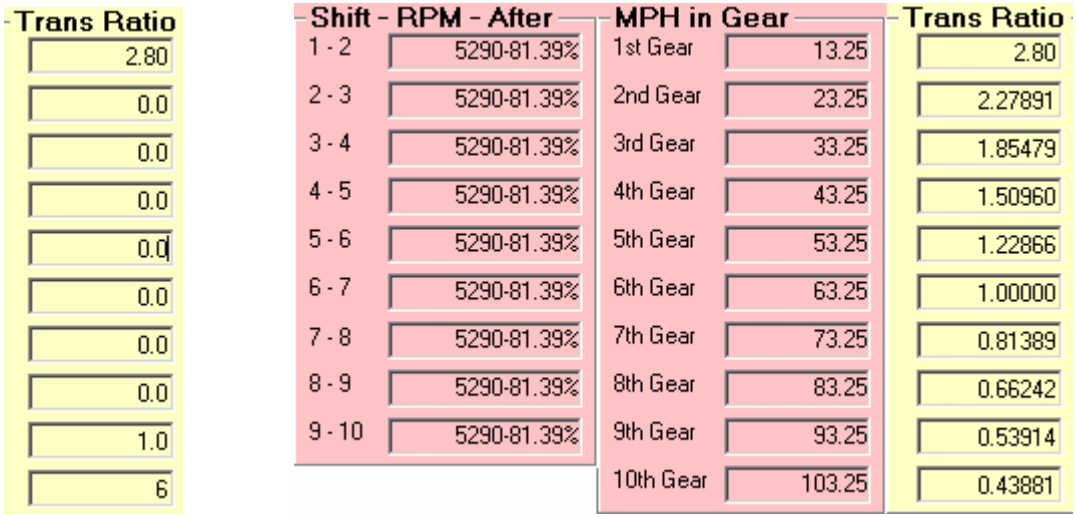
a. **Note:** If the engine has a flat torque curve, use the RPM at which the curve starts to dip.

17) Calculate Tire's nominal Diameter using Wheel Size, Tire width, and Aspect Ratio.
18) Calculate New Tire's nominal Diameter using Wheel Size, Tire width, and Aspect Ratio.
19) Calculate Cornering G's (Lateral Acceleration) from Turn Radius in feet and MPH.
20) Calculate Average Rate of Acceleration from Rest to x Feet using Track Size, Track / Lap Time showing results in Skip Pad G's.
    a. This calculation assumes a constant rate of Acceleration.
21) Calculate Average Rate of (DE) Acceleration from Rest to x MPH using Track / Lap Time and MPH, showing results in Skip Pad G's. Can also Calculate Rate for change in MPH enter (High MPH - Low MPH) Value in MPH.
    a. This calculation assumes a constant rate of (DE) Acceleration.
22) Calculate Percent Converter Slippage from Speed (MPH), RPM, Rear Gear Ratio, Trans Gear Ratio 7, and Tire Diameter.
23) Calculate Effective Rear Ratio Using Tire Radius, Rear Gear Ratio, and Trans 1st Gear Ratio.
24) Calculate Trans Gears From 1st Gear and percentage drop.
25) Added Calculate Trans Drop % Needed Using Trans 1st Gear Ratio (low gear), Trans 9th Gear Ratio (high gear), and Trans 10th Gear Ratio (number of gears).
26) Calculate Trans Gear Ratios using the user supplied Input Shaft, Cluster Gears, and Output Shaft Gears Tooth Counts.

NOTE: All calculations are based on **NO** Tire Growth.

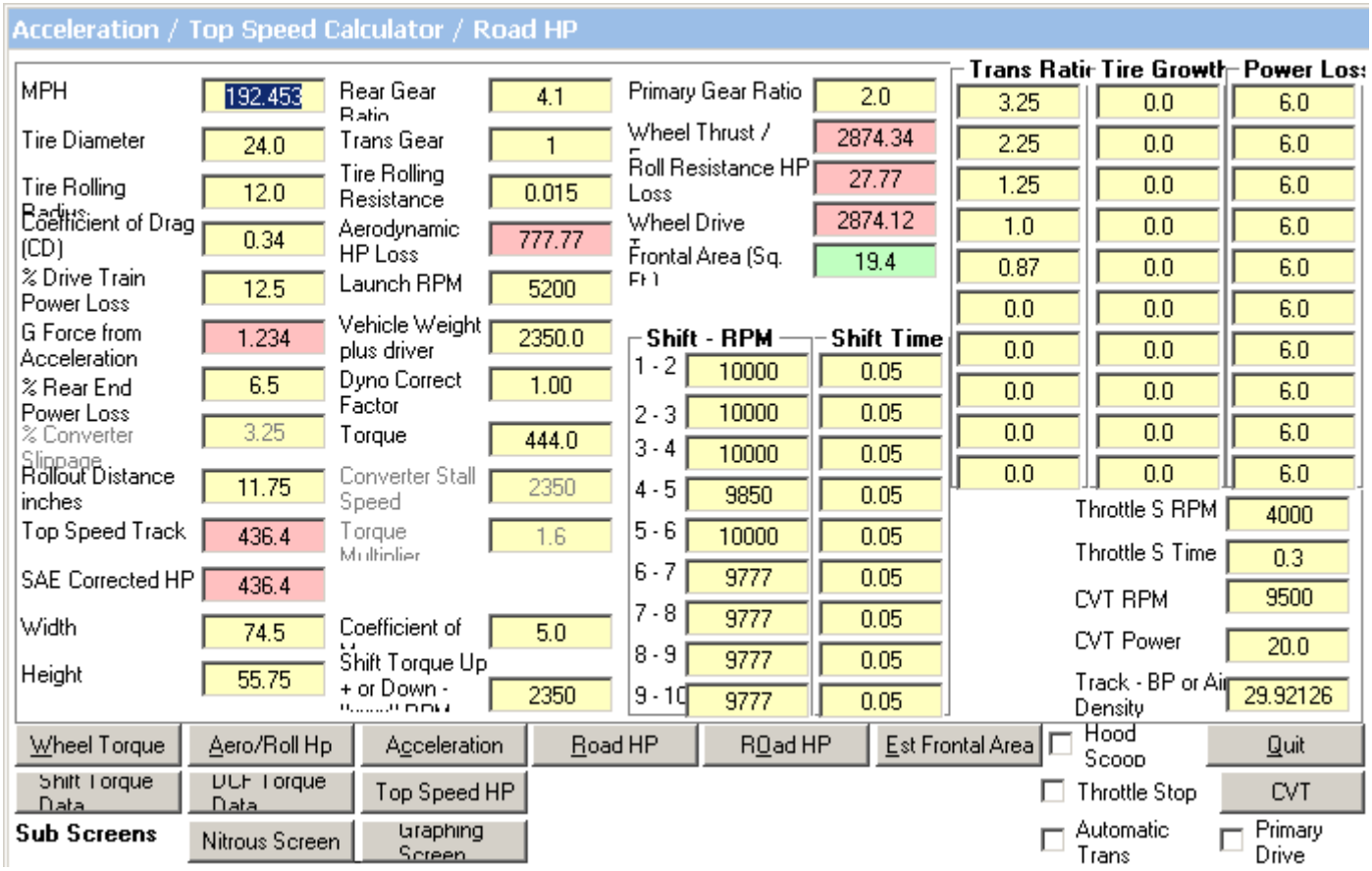
NOTE: The Primary Drive can also be used for Gear Vendors overdrive unit. If you have a 0.765:1 overdrive enter 1000 for the front sprocket and 765 for the rear sprocket check Primary drive and it will show 0.076500:1 rato. It can also be used if you are working with a quick change rear end.





Track Size is 1.366 Miles

Lap Time	MPH	Lap Time	MPH	Lap Time	MPH
23.000	213.80870	23.675	207.71278	24.350	201.95483
23.025	213.57655	23.700	207.49367	24.375	201.74769
23.050	213.34490	23.725	207.27503	24.400	201.54098
23.075	213.11376	23.750	207.05684	24.425	201.33470
23.100	212.88312	23.775	206.83912	24.450	201.12883
23.125	212.65297	23.800	206.62185	24.475	200.92339
23.150	212.42333	23.825	206.40504	24.500	200.71837
23.175	212.19417	23.850	206.18868	24.525	200.51376
23.200	211.96552	23.875	205.97277	24.550	200.30957
23.225	211.73735	23.900	205.75732	24.575	200.10580
23.250	211.50968	23.925	205.54232	24.600	199.90244
23.275	211.28249	23.950	205.32777	24.625	199.69949
23.300	211.05579	23.975	205.11366	24.650	199.49696
23.325	210.82958	24.000	204.90000	24.675	199.29483
23.350	210.60385	24.025	204.68678	24.700	199.09312
23.375	210.37861	24.050	204.47401	24.725	198.89181
23.400	210.15385	24.075	204.26168	24.750	198.69091
23.425	209.92956	24.100	204.04979	24.775	198.49041
23.450	209.70576	24.125	203.83834	24.800	198.29032
23.475	209.48243	24.150	203.62733	24.825	198.09063
23.500	209.25957	24.175	203.41675	24.850	197.89135
23.525	209.03719	24.200	203.20661	24.875	197.69246
23.550	208.81529	24.225	202.99690	24.900	197.49398
23.575	208.59385	24.250	202.78763	24.925	197.29589
23.600	208.37288	24.275	202.57878	24.950	197.09820
23.625	208.15238	24.300	202.37037	24.975	196.90090
23.650	207.93235	24.325	202.16238	25.000	196.70400



Acceleration and Top Speed

This form lets enthusiasts predict many aspects of vehicle acceleration run. You can then vary 1 or more parameters like “Rear End Gear Ratio” or “Tire Diameter” and “Tire Radius” and rerun to see what effect the changes have on performance. These estimates can be used for street performance, drag strip, or all out speed runs.

To see how changes in weather will affect a run, use the **Weather Form** to calculate the Dyno Correction Factor. Because weather conditions influence engine torque and HP you need to adjust the Dyno Correction Factor to match the weather conditions at the track if you are trying to match a run.

These calculations may take a number of seconds on slower computers.

1) Calculate Drive Wheel Torque using Torque, Trans First Gear, Rear Gear Ratio, and % Drive Train Power Loss (est. RWD Manual Trans 15%, RWD Automatic Trans 20%) also Wheel Thrust from Drive Wheel Torque and Tire Rolling Radius.
2) Calculate Aerodynamic Drag / HP Loss from Coefficient of Drag, Frontal Area, and MPH, and Track - BP or Air Density. --- Calculate Rolling Resistance / HP Loss from Tire Rolling Resistance, Car Weight, and MPH.

NOTE: If the Torque numbers (Entered in the parameter file with Acceleration = RPM Torque. See example parameter file CARFOR.PRM or the listing at the end of this manual) are from a chassis dyno use 0 (zero) for % Rear End Power Loss and Trans % Power Loss.

NOTE: All calculations are based on **NO** tire slippage and **NO** clutch slippage. Adjusting the Coefficient of Mu can modify this.

NOTE: If **Automatic Trans Box is checked** then user may enter % Converter Slippage, Converter Stall Speed (For best results this should be about peak torque RPM) and Converter Torque Multiplier (for stock this is 2.0 to 2.3, for street / strip this is 1.7 to 2.1, for racing this is 1.4 to 1.8, best to check with converter manufacturer).

NOTE: If **Automatic Trans Box is checked** and the converter and is not a lockup than the vehicle will normally run a lower MPH than a stick shift because of converter slippage.

NOTE: The Coefficient of Drag also known as CD many times can be gotten from the manufacturer, Automotive magazines or the Internet.
NOTE: The Frontal Area many times can be gotten from the manufacturer, if not it can be estimated on this screen from the vehicle width and height. On calculations below around 135 MPH this will not have a large effect.
NOTE: For most street tires use a Tire Growth percentage of 0 (zero).
NOTE: If **Hood Scoop Box is checked** (Ram Air) this will calculate a positive pressure in the intake track.

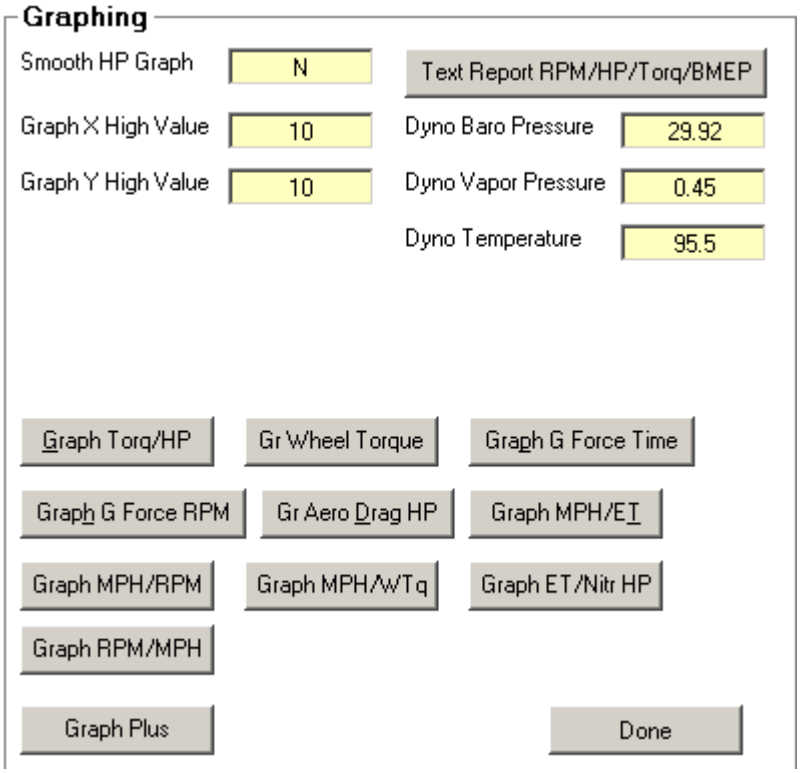
3) Acceleration and Top Speed Prediction Chart with 60 foot, 330 foot, 1/8 Mile, and 1/4 Mile ET using RPM and Torque from Acceleration = in Parameter File also Coefficient of Drag, Frontal Area, Tire Rolling Resistance (use 0.015 Concrete/0.017 Asphalt), Tire Diameter, Tire Rolling Radius, Launch RPM, % Rear End Power Loss, % Power Loss, Vehicle Weight with Driver, Dyno Correction Factor, Shift RPM's, Tire Growth Percentages, Trans Gear Ratios, Shift Time.

NOTE: Data is logged from a full throttle acceleration run in a single Trans. Gear. Log each MPH or RPM with a time stamp. You will get the best result will be using a 1:1 trans gear. These numbers are added to a parameter file with Road HP = MPH Time and ROad HP = RPM Time. See example parameter file CARFOR.PRM or the listing at the end of this manual
NOTE: The Horse Power and Torque numbers generated will be similar to those from a chassis dyno for this vehicle.
Smooth HP Graph: Can content an "N" for NO or NONE or a1 to a5 (moving average) or w1 to w4 (weighted moving average) or s1 to s4 (squared weighted moving average).

4) Horse Power (Rear Wheel) Prediction Chart using MPH and Times from Parameter File also Coefficient of Drag, Frontal Area, Tire Rolling Resistance, Tire Growth, Tire Diameter, Vehicle Weight with Driver, Trans Gear.
5) Horse Power (Rear Wheel) Prediction Chart using RPM and Times from Parameter File also Coefficient of Drag, Frontal Area, Tire Rolling Resistance, Tire Growth, Tire Diameter, Vehicle Weight with Driver, Trans Gear.
6) Estimate Frontal Area (Sq. Ft.) from Width and Height (inches).
7) Graph Engine RPM (X-axis) / Torque (BLUE) / Corrected Torque (YELLOW) / Horse Power (GREEN) / Corrected Horse Power (RED) Y-axis using Torque and RPM inputs for Acceleration / Top Speed Graph. Corrected numbers will only show if Dyno Correction Factor is anything other than one.
8) Graph Wheel Torque, RPM on X-axis and Wheel Torque on Y-axis using same inputs as Acceleration / Top Speed.
9) Graph Wheel Torque, MPH on X-axis and Wheel Torque on Y-axis using same inputs as Acceleration / Top Speed and Graph X high value / Graph Y high value.
10) Graph G Forces, Time on X-axis and G force on Y-axis using same inputs as Acceleration / Top Speed.
11) Graph G Forces, RPM on X-axis and G force on Y-axis using same inputs as Acceleration / Top Speed.
12) Graph MPH on X axis, Aero Drag HP, Tire Rolling Resistance HP, Total HP Drag (DARK BLUE) and Corrected HP at Drive Wheel(s) on Y axis using same inputs as Acceleration / Top Speed and Graph X high value / Graph Y high value.
13) Graph MPH on X-axis, ET on Y-axis using same inputs as Acceleration / Top Speed and Graph X high value / Graph Y high value.
14) Graph MPH on X-axis, RPM on Y-axis using same inputs as Acceleration / Top Speed and Graph X high value / Graph Y high value.
15) This will Shift the Torque Curve Up or Down 'XXXX' RPM.
16) Graph ET on X-axis, Nitrous HP on Y-axis using same inputs as Acceleration / Top Speed and Graph X high value / Graph Y high value.
17) Acceleration and Top Speed Prediction Chart with 60 foot, 330 foot, 1/8 Mile, and 1/4 Mile ET using RPM and Torque from Acceleration = in Parameter File also Coefficient of Drag, Frontal Area, Tire Rolling Resistance (use 0.015 Concrete/0.017 Asphalt), Tire Diameter, Tire Rolling Radius, CVT RPM, CVT Power Loss, Vehicle Weight with Driver, Dyno Correction Factor, Tire Growth Percentages, CVT.
18) Nitrous Screen. This will bring up the Nitrous Entry Screen.
19) Modify Torque Curve Up or Down using DCF (Dyno Correct Factor)
20) Estimate HP for Top Speed Prediction / MPH using MPH, Coefficient of Drag, Frontal Area, Tire Rolling Resistance, Tire Diameter, % Rear End Power Loss, % Power Loss, Dyno Correction Factor, Track - BP or Air Density. -- **For Bonneville** try using these as a baseline -- TRR = 0.09, DCF = 1.2134, Track BP = 25.65
NOTE: This is NOT for 1/4 Mile or Drag Racing.

NOTE: How different changes will effect the 1 / 4 Mile Acceleration Simulation (60 foot, ET, and MPH).

1) Aero Drag – Reduce it increases MPH and increase it decrease MPH with almost no effect on ET.
2) Engine Power Curve – Increase it decreases ET and increases MPH and reduce it increases ET and lowers MPH
3) Traction – Reduce it decreases 60 foot times and increase it increases 60 foot times with almost no effect on MPH.
4) Tire Growth – Increase it increases MPH and reduce it decrease MPH with almost no effect on ET.
5) Shift Times – Increase it increases ET and reduce it decrease ET with almost no effect on MPH.
6) Power Loss % – Increase it increases ET and lowers MPH and reduce it decrease ET increases MPH.
7) **Coefficient of Mu (Traction) A larger number will increase traction (lower 60 foot times and ET) and a smaller number will decrease traction (raise 60 foot times and ET).**
8) Converter Stall RPM



Example of the Text Report RPM / HP / Torque / BMEP

Engine Size = 598.0 ci

RPM	Horse	Torque	BMEP	Fuel lb/hr	BSFC	UnCorr HP	UnCorr Torque	UnCorr BMEP	Correct Factor
5000	666.4	700.0	176.5						
5500	754.0	720.0	181.6						
6000	856.8	750.0	189.1						
6500	965.3	780.0	196.7						
7000	1079.6	810.0	204.3						
7500	1199.5	840.0	211.8						
8000	1249.0	820.0	206.8						
8500	1319.0	815.0	205.5						
9000	1336.6	780.0	196.7						
9500	1333.1	737.0	185.9						

```
10000  1304.3   685.0  172.7
AVG:
 7500  1096.7   767.0  193.4
MIN:
 5000   666.4   685.0  172.7
MAX:
10000  1336.6   840.0  211.8

Average based on = 11 points

Engine Size =  564.9466 ci
Bore = 4.335
Stroke = 4.25
Rod Length = 6.4
Cubic Inches = 501.8188
Dyno BP = 30.07
Dyno VP = 0.46
Dyno Temp = 73.0
;   Data for Acceleration / Top speed calculator
;   The following parameters must be in Ascending Order by RPM
;              RPM  Torque Fuel BSFC  A/F
;                           lb/hr      Ratio
Acceleration = 4500 567.5 217.6 0.46 13.2
Acceleration = 4600 577.2 234.5 0.48 12.6
Acceleration = 4700 584.5 233.2 0.46 13.0
Acceleration = 4800 584.2 244.5 0.47 12.8
Acceleration = 4900 583.8 238.6 0.45 13.4
Acceleration = 5000 591.1 246.8 0.45 13.4
Acceleration = 5100 593.7 251.9 0.45 13.4
Acceleration = 5200 595.1 270.4 0.47 12.9
Acceleration = 5300 587.2 271.1 0.47 13.0
Acceleration = 5400 582.6 279.1 0.48 13.0
Acceleration = 5500 579.6 281.8 0.48 13.1
Acceleration = 5600 578.9 294.6 0.49 12.9
Acceleration = 5700 566.4 298.9 0.50 12.9
Acceleration = 5800 564.3 302.5 0.50 13.1
Acceleration = 5900 562.0 304.7 0.49 13.2
Acceleration = 6000 563.6 307.3 0.49 13.4
Acceleration = 6100 559.9 322.4 0.51 12.9
Acceleration = 6200 546.5 310.8 0.49 13.4
Acceleration = 6300 534.5 333.6 0.53 12.5
Acceleration = 6400 522.7 337.5 0.54 12.6
Acceleration = 6500 499.1 334.2 0.56 12.6
Acceleration = 6600 489.2 334.3 0.56 12.8

Engine Size =  501.8188 ci

Dyno Barometric Pressure = 30.07 - Dyno Vapor Pressuree = 0.46 - Dyno Air Temperature = 73.0
                                Fuel            UnCorr  UnCorr UnCorr Correct   A/F
  RPM   Horse  Torque   BMEP    lb/hr      BSFC      HP  Torque   BMEP  Factor  Ratio    SCFM    VE%
 4500   486.2   567.5  170.5   217.60     .4600   473.0   552.1  165.9  1.0279  13.20   627.1   99.4
 4600   505.5   577.2  173.5   234.50     .4800   488.5   557.8  167.6  1.0348  12.60   645.1  100.0
 4700   523.1   584.5  175.6   233.20     .4600   507.0   566.5  170.2  1.0318  13.00   661.9  100.5
 4800   533.9   584.2  175.6   244.50     .4700   520.2   569.2  171.0  1.0264  12.80   683.3  101.5
 4900   544.7   583.8  175.4   238.60     .4500   530.2   568.3  170.8  1.0273  13.40   698.1  101.6
 5000   562.7   591.1  177.6   246.80     .4500   548.4   576.1  173.1  1.0261  13.40   722.1  103.0
 5100   576.5   593.7  178.4   251.90     .4500   559.8   576.5  173.2  1.0299  13.40   737.0  103.1
 5200   589.2   595.1  178.8   270.40     .4700   575.3   581.1  174.6  1.0241  12.90   761.6  104.5
 5300   592.6   587.2  176.5   271.10     .4700   576.8   571.6  171.8  1.0273  13.00   769.5  103.6
 5400   599.0   582.6  175.1   279.10     .4800   581.5   565.5  169.9  1.0302  13.00   792.2  104.6
 5500   607.0   579.6  174.2   281.80     .4800   587.1   560.6  168.5  1.0339  13.10   806.0  104.5
 5600   617.3   578.9  174.0   294.60     .4900   601.2   563.9  169.4  1.0267  12.90   829.8  105.7
 5700   614.7   566.4  170.2   298.90     .5000   597.8   550.8  165.5  1.0283  12.90   841.9  105.3
 5800   623.2   564.3  169.6   302.50     .5000   605.0   547.8  164.6  1.0300  13.10   865.2  106.4
 5900   631.3   562.0  168.9   304.70     .4900   621.8   553.5  166.3  1.0153  13.20   878.2  106.2
 6000   643.9   563.6  169.4   307.30     .4900   627.1   549.0  165.0  1.0267  13.40   899.1  106.9
```

6100	650.3	559.9	168.3	322.40	.5100	632.2	544.3	163.6	1.0287	12.90	908.1	106.2
6200	645.1	546.5	164.2	310.80	.4900	634.3	537.3	161.5	1.0171	13.40	909.3	104.6
6300	641.2	534.5	160.6	333.60	.5300	629.4	524.7	157.7	1.0186	12.50	910.5	103.1
6400	637.0	522.7	157.1	337.50	.5400	625.0	512.9	154.1	1.0191	12.60	928.5	103.5
6500	617.7	499.1	150.0	334.20	.5600	596.8	482.2	144.9	1.0350	12.60	919.4	100.9
6600	614.8	489.2	147.0	334.30	.5600	597.0	475.0	142.8	1.0298	12.80	934.3	101.0
AVG:												
5550	593.5	564.3	169.6	284.10	.4900	578.0	549.4	165.1		13.00	805.8	103.5
MIN:												
4500	486.2	489.2	147.0	217.60	.4500	473.0	475.0	142.8		12.50	627.1	99.4
MAX:												
6600	650.3	595.1	178.8	337.50	.5600	634.3	581.1	174.6		13.40	934.3	106.9

Average based on = 22 points

Dyno BP = 29.92
Dyno VP = 0.46
Dyno Temp = 71.0

;	RPM	Torque	Fuel lb/hr	BSFC	A/F Ratio	SCFM
Acceleration =	3600	517.2	176.7	0.498	0.0	447.0
Acceleration =	3700	537.7	175.9	0.464	0.0	469.0
Acceleration =	3800	552.4	174.4	0.436	0.0	487.0
Acceleration =	3900	556.8	172.3	0.417	0.0	510.0
Acceleration =	4000	564.1	180.4	0.42	0.0	522.0
Acceleration =	4100	570.0	189.9	0.427	0.0	533.0
Acceleration =	4200	571.9	196.9	0.431	0.0	562.0
Acceleration =	4300	572.4	198.0	0.423	0.0	592.0
Acceleration =	4400	571.4	213.0	0.445	0.0	595.0
Acceleration =	4500	566.1	213.0	0.439	0.0	620.0
Acceleration =	4600	565.1	221.9	0.448	0.0	638.0
Acceleration =	4700	570.5	223.2	0.437	0.0	665.0
Acceleration =	4800	557.3	227.4	0.446	0.0	693.0
Acceleration =	4900	550.4	236.0	0.46	0.0	699.0
Acceleration =	5000	548.5	230.6	0.442	0.0	690.0
Acceleration =	5100	542.1	243.0	0.462	0.0	721.0
Acceleration =	5200	525.5	251.4	0.483	0.0	715.0
Acceleration =	5300	517.2	251.5	0.482	0.0	710.0
Acceleration =	5400	518.2	252.3	0.474	0.0	717.0
Acceleration =	5500	511.8	259.1	0.483	0.0	739.0
Acceleration =	5600	496.7	251.9	0.476	0.0	750.0
Acceleration =	5700	481.6	255.0	0.488	0.0	789.0
Acceleration =	5800	480.1	258.6	0.488	0.0	771.0
Acceleration =	5900	468.9	254.5	0.483	0.0	766.0
Acceleration =	6000	455.7	253.1	0.486	0.0	774.0

Engine Size = 458.8724 ci

Dyno Barometric Pressure = 29.92 - Dyno Vapor Pressuree = 0.45 - Dyno Air Temperature = 71.0

RPM	Horse	Torque	BMEP	Fuel lb/hr	BSFC	UnCorr HP	UnCorr Torque	UnCorr BMEP	Correct Factor	A/F Ratio	SCFM	VE%
3600	354.5	517.2	170.0	176.70	.4980	354.8	517.6	170.1	.9991	11.59	447.0	96.9
3700	378.8	537.7	176.7	175.90	.4640	379.1	538.1	176.8	.9992	12.21	469.0	99.0
3800	399.7	552.4	181.5	174.40	.4360	400.0	552.8	181.7	.9992	12.79	487.0	100.1
3900	413.5	556.8	183.0	172.30	.4170	413.2	556.4	182.9	1.0007	13.56	510.0	102.1
4000	429.6	564.1	185.4	180.40	.4200	429.5	564.0	185.3	1.0002	13.25	522.0	101.9
4100	445.0	570.0	187.3	189.90	.4270	444.7	569.7	187.2	1.0005	12.85	533.0	101.5
4200	457.3	571.9	187.9	196.90	.4310	456.8	571.3	187.7	1.0011	13.07	562.0	104.5
4300	468.6	572.4	188.1	198.00	.4230	468.1	571.7	187.9	1.0012	13.69	592.0	107.5
4400	478.7	571.4	187.8	213.00	.4450	478.7	571.3	187.8	1.0001	12.79	595.0	105.6
4500	485.0	566.1	186.0	213.00	.4390	485.2	566.3	186.1	.9997	13.33	620.0	107.6
4600	494.9	565.1	185.7	221.90	.4480	495.3	565.5	185.8	.9993	13.17	638.0	108.3
4700	510.5	570.5	187.5	223.20	.4370	510.8	570.7	187.6	.9996	13.65	665.0	110.5
4800	509.3	557.3	183.1	227.40	.4460	509.9	557.9	183.3	.9990	13.96	693.0	112.7
4900	513.5	550.4	180.9	236.00	.4600	513.0	549.9	180.7	1.0009	13.57	699.0	111.4
5000	522.2	548.5	180.3	230.60	.4420	521.7	548.0	180.1	1.0009	13.70	690.0	107.7
5100	526.4	542.1	178.2	243.00	.4620	526.0	541.7	178.0	1.0008	13.59	721.0	110.4
5200	520.3	525.5	172.7	251.40	.4830	520.5	525.7	172.8	.9996	13.03	715.0	107.4

5300	521.9	517.2	170.0	251.50	.4820	521.8	517.1	169.9	1.0003	12.93	710.0	104.6
5400	532.8	518.2	170.3	252.30	.4740	532.3	517.7	170.1	1.0010	13.02	717.0	103.7
5500	536.0	511.8	168.2	259.10	.4830	536.4	512.3	168.3	.9991	13.06	739.0	104.9
5600	529.6	496.7	163.2	251.90	.4760	529.2	496.3	163.1	1.0008	13.64	750.0	104.6
5700	522.7	481.6	158.3	255.00	.4880	522.5	481.5	158.2	1.0003	14.17	789.0	108.1
5800	530.2	480.1	157.8	258.60	.4880	529.9	479.8	157.7	1.0005	13.65	771.0	103.8
5900	526.8	468.9	154.1	254.50	.4830	526.9	469.0	154.1	.9997	13.78	766.0	101.4
6000	520.6	455.7	149.8	253.10	.4860	520.8	455.9	149.8	.9997	14.01	774.0	100.7
AVG:												
4800	485.1	534.8	175.7	222.40	.4575	485.1	534.7	175.7		13.28	647.0	105.1
MIN:												
3600	354.5	455.7	149.8	172.30	.4170	354.8	455.9	149.8		11.59	447.0	96.9
MAX:												
6000	536.0	572.4	188.1	259.10	.4980	536.4	571.7	187.9		14.17	789.0	112.7

Average based on = 25 points

NOTE: If **Nitrous Box is checked** this will let the User have different HP levels of Nitrous. Stage 1 will be shown in the Graphing of HP and Torque. All Stages will be used in the acceleration calculations.

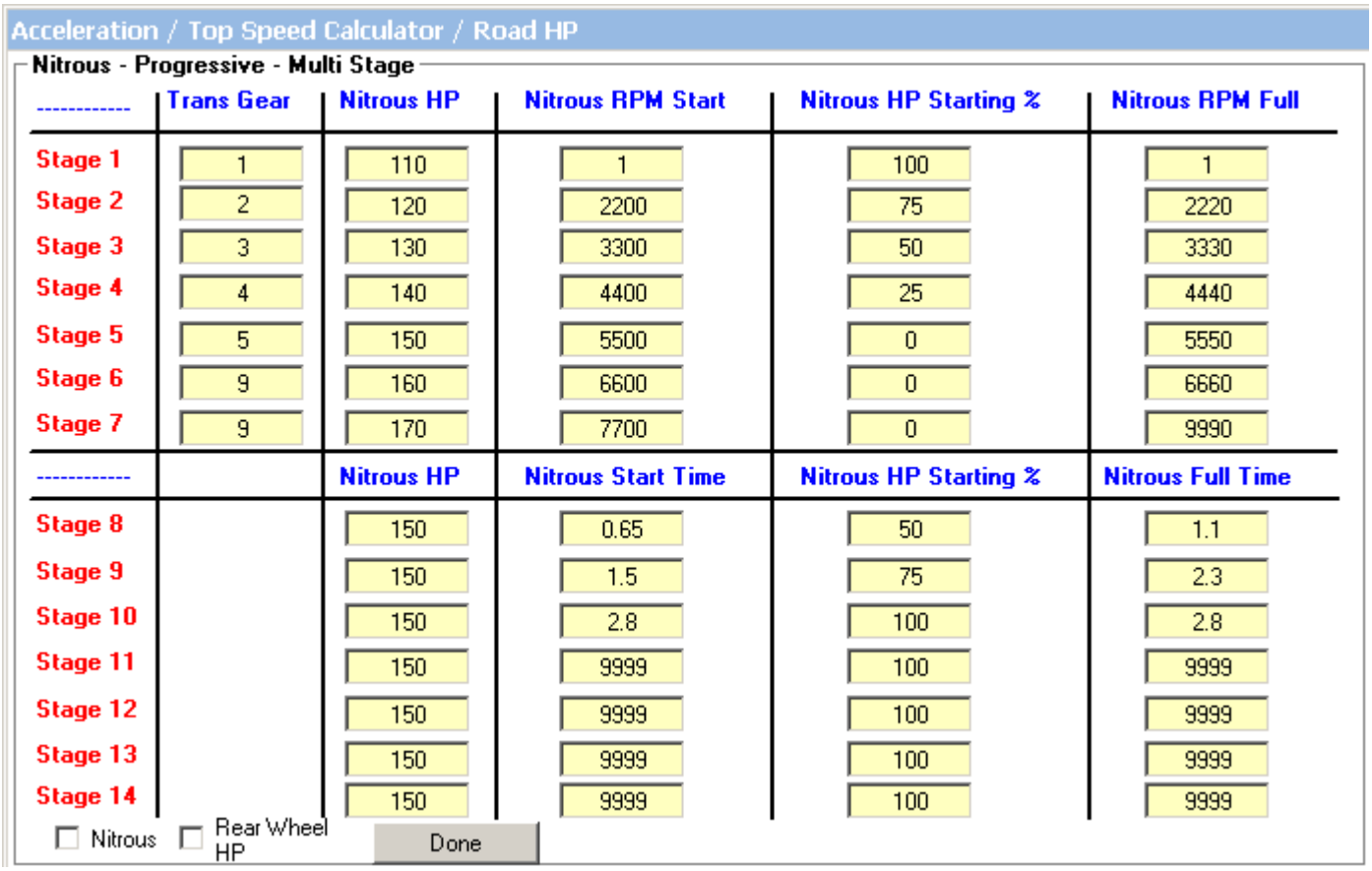
1) Set Trans Gear to 9 for any Trans based Stages you will not use and set Nitrous Start Time to 9999 for any Time based Stages you will not be using.
2) If you want a given Stage to start at the beginning of a Trans Gear set Nitrous RPM Start to 1.
3) For non-progressive (all on at once) set Nitrous HP Starting % to 100.
4) You can use both trans /RPM based and Time based Stages in the same simulation.
5) The Number of the Stage has nothing to do with the order in which it is applied during the simulation.

If the **Rear Wheel Box is checked** no power loss will be removed from the nitrous HP.

If you are using a duel ramp with lets say the first ramp pretty flat and the second ramp pretty steep and short then you need to approach this as two stages.

If you are using banking then you need to approach this as two stages also.

The acceleration run will use the data entered on the Nitrous Screen Only if the **Nitrous Box is checked.**



Acceleration and Top Speed Prediction Chart with 60 foot, 330 foot, 1/8 Mile, and 1/4 Mile ET using RPM and Torque from Acceleration = in Parameter File also Coefficient of Drag, Frontal Area, Tire Rolling Resistance (use 0.015 Concrete/0.017 Asphalt), Tire Diameter, Tire Rolling Radius, Launch RPM, % Rear End Power Loss, % Power Loss, Vehicle Weight with Driver, Dyno Correction Factor, Shift RPM's, Tire Growth Percentages, Trans Gear Ratios, Shift Time.

Acceleration and Top Speed Prediction Chart.

RPM	MPH	Velocity ft/sec	Motor Torque	Force @ Wheel	Aero dynamic Drag - HP	Rolling Resist. HP	Elapsed Time (ET)	Total Distance	Accele ration in G's
7999.3	0.00	.000	830.0	0.0	.000	.000	.0000	-1.000	.000
7999.3	5.00	7.334	830.0	6823.4	.005	.470	.0933	-.664	2.551
7999.3	8.75	12.833	830.0	6823.4	.025	.822	.1593	.000	2.623
>>>>--- RollOut Ends <-> 1/4 Mile Distance and ET Starts Now -- 0.1593									
7999.3	10.00	14.668	830.0	6823.4	.037	.940	.0217	.298	2.640
7999.3	15.00	22.002	830.0	6823.4	.126	1.410	.1071	1.863	2.694
7999.3	20.00	29.334	830.0	6823.4	.299	1.880	.1911	4.018	2.732
7999.3	25.00	36.668	830.0	6823.4	.583	2.350	.2740	6.756	2.761
7999.3	30.00	44.002	830.0	6823.4	1.008	2.820	.3562	10.071	2.785
7999.3	35.00	51.336	830.0	6823.4	1.601	3.290	.4378	13.958	2.804
7999.3	40.00	58.667	830.0	6823.4	2.389	3.760	.5188	18.414	2.821
7999.3	45.00	66.001	830.0	6823.4	3.402	4.230	.5994	23.438	2.835
7999.3	50.00	73.335	830.0	6823.4	4.667	4.700	.6797	29.027	2.847
7999.3	55.00	80.667	830.0	6823.4	6.211	5.170	.7595	35.179	2.857
8000.0	59.86	87.800	830.0	6823.4	8.009	5.627	.8370	41.705	2.866
8018.9	60.01	88.007	829.2	6816.5	8.066	5.640	.8393	41.902	2.863
8289.3	62.03	90.975	817.2	6718.2	8.910	5.831	.8717	44.807	2.820
8579.3	64.20	94.158	804.4	6612.7	9.878	6.035	.9071	48.082	2.773
8686.6	65.00	95.336	799.6	6573.7	10.253	6.110	.9203	49.337	2.756
8869.3	66.37	97.341	791.5	6507.2	10.914	6.239	.9431	51.527	2.726
9159.3	68.54	100.524	778.7	6401.7	12.020	6.443	.9797	55.148	2.680
9355.0	70.00	102.672	770.0	6330.5	12.807	6.580	1.0047	57.695	2.648
9449.3	70.71	103.706	765.9	6296.3	13.198	6.647	1.0169	58.951	2.633
9526.2	71.29	104.553	754.0	6197.9	13.524	6.701	1.0270	60.001	2.591
9560.0	71.54	104.922	748.7	6154.9	13.668	6.725	1.0314	60.465	2.572
9670.0	72.36	106.129	731.5	6013.7	14.145	6.802	1.0462	62.023	2.511
9780.0	73.18	107.336	714.3	5872.6	14.633	6.879	1.0613	63.637	2.451
9890.0	74.01	108.543	697.2	5731.4	15.133	6.957	1.0768	65.311	2.390
10000.0	74.83	109.751	680.0	5590.3	15.643	7.034	1.0927	67.047	2.329
>>>>--- Gear Change 1 -> 2									
7572.9	74.83	109.753	815.8	5078.6	15.644	7.034	1.1428	72.538	2.111
7590.0	75.00	110.000	816.3	5082.2	15.750	7.050	1.1464	72.939	2.113
7640.0	75.49	110.724	818.0	5092.5	16.063	7.096	1.1570	74.113	2.117
7820.0	77.27	113.333	824.0	5129.9	17.225	7.264	1.1952	78.390	2.131
8000.0	79.05	115.942	830.0	5167.2	18.443	7.431	1.2332	82.738	2.145
8096.4	80.00	117.339	825.7	5140.7	19.117	7.520	1.2535	85.106	2.133
8289.3	81.91	120.134	817.2	5087.6	20.516	7.699	1.2944	89.971	2.108
8579.3	84.78	124.337	804.4	5007.7	22.746	7.969	1.3569	97.613	2.071
8602.5	85.00	124.673	803.3	5001.3	22.931	7.990	1.3620	98.241	2.068
8869.3	87.64	128.540	791.5	4927.8	25.131	8.238	1.4206	105.659	2.034
9108.5	90.00	132.007	781.0	4861.9	27.220	8.460	1.4740	112.614	2.004
9159.3	90.51	132.743	778.7	4847.9	27.678	8.508	1.4854	114.127	1.997
9449.3	93.37	136.946	765.9	4768.0	30.391	8.777	1.5514	123.030	1.960
9560.0	94.47	138.550	748.7	4661.0	31.472	8.880	1.5772	126.578	1.913
9614.2	95.00	139.335	740.2	4608.3	32.010	8.930	1.5900	128.362	1.890
9670.0	95.55	140.144	731.5	4554.1	32.571	8.982	1.6034	130.233	1.866
9780.0	96.64	141.739	714.3	4447.2	33.695	9.084	1.6303	134.022	1.820
9890.0	97.73	143.333	697.2	4340.3	34.845	9.186	1.6579	137.955	1.773
10000.0	98.81	144.927	680.0	4233.4	36.021	9.289	1.6862	142.038	1.726
>>>>--- Gear Change 2 -> 3									
7724.1	98.82	144.934	820.8	3946.8	36.026	9.289	1.7363	149.305	1.604
7816.8	100.00	146.674	823.9	3961.7	37.339	9.400	1.7700	154.212	1.609

7820.0	100.05	146.733	824.0	3962.2	37.384	9.404	1.7711	154.379	1.609
8000.0	102.35	150.110	830.0	3991.0	40.025	9.621	1.8362	164.034	1.618
8207.4	105.00	154.001	820.8	3946.9	43.219	9.870	1.9114	175.474	1.596
8289.3	106.05	155.538	817.2	3929.5	44.526	9.969	1.9414	180.119	1.588
8579.3	109.76	160.980	804.4	3867.8	49.365	10.317	2.0490	197.148	1.556
8598.1	110.00	161.334	803.5	3863.8	49.691	10.340	2.0561	198.287	1.554
8869.3	113.47	166.421	791.5	3806.1	54.542	10.666	2.1588	215.120	1.525
8989.6	115.01	168.680	786.2	3780.5	56.792	10.811	2.2050	222.865	1.512
9159.3	117.18	171.863	778.7	3744.4	60.069	11.015	2.2709	234.076	1.494
9380.4	120.01	176.012	768.9	3697.4	64.525	11.281	2.3579	249.219	1.469
9449.3	120.89	177.304	765.9	3682.7	65.957	11.364	2.3853	254.060	1.462
9560.0	122.31	179.382	748.7	3600.0	68.303	11.497	2.4301	262.041	1.425
9670.0	123.71	181.446	731.5	3517.4	70.688	11.629	2.4757	270.274	1.387
9770.6	125.00	183.335	715.8	3441.9	72.918	11.750	2.5186	278.089	1.353
9780.0	125.12	183.510	714.3	3434.9	73.128	11.761	2.5226	278.829	1.350
9890.0	126.53	185.574	697.2	3352.3	75.623	11.894	2.5708	287.722	1.313
10000.0	127.94	187.638	680.0	3269.8	78.175	12.026	2.6204	296.975	1.275
>>>>--- Gear Change 3 -> 4									
7842.9	127.94	187.647	824.8	3110.3	78.186	12.026	2.6706	306.402	1.207
7969.4	130.00	190.673	829.0	3126.2	82.029	12.220	2.7484	321.112	1.211
8000.0	130.50	191.405	830.0	3130.0	82.978	12.267	2.7672	324.701	1.212
8044.2	131.24	192.480	828.0	3122.5	84.384	12.336	2.7948	330.005	1.207
8276.2	135.01	198.014	817.8	3083.9	91.873	12.691	2.9386	358.082	1.185
8289.3	135.22	198.326	817.2	3081.7	92.309	12.711	2.9468	359.706	1.184
8579.3	139.95	205.265	804.4	3033.4	102.340	13.156	3.1312	396.930	1.155
8582.2	140.00	205.334	804.2	3032.9	102.443	13.160	3.1331	397.313	1.155
8869.3	144.68	212.203	791.5	2985.0	113.072	13.600	3.3203	436.404	1.126
8888.9	145.00	212.671	790.7	2981.7	113.823	13.630	3.3333	439.152	1.124
9159.3	149.41	219.141	778.7	2936.6	124.530	14.045	3.5144	478.254	1.097
9195.5	150.01	220.009	777.1	2930.5	126.015	14.101	3.5390	483.660	1.093
9449.3	154.15	226.080	765.9	2888.2	136.738	14.490	3.7137	522.620	1.068
9501.7	155.00	227.334	757.8	2857.6	139.026	14.570	3.7504	530.957	1.053
9560.0	155.95	228.729	748.7	2823.3	141.601	14.659	3.7919	540.420	1.036
9670.0	157.75	231.361	731.5	2758.6	146.545	14.828	3.8721	558.854	1.005
9780.0	159.54	233.993	714.3	2693.8	151.603	14.997	3.9547	578.083	.974
9808.3	160.00	234.670	709.9	2677.2	152.924	15.040	3.9764	583.170	.966
9890.0	161.33	236.624	697.2	2629.1	156.777	15.165	4.0400	598.161	.943
10000.0	163.13	239.256	680.0	2564.3	162.066	15.334	4.1282	619.143	.912
>>>>--- Gear Change 4 -> 5									
7856.0	163.13	239.261	825.2	2444.7	162.075	15.334	4.1784	631.144	.861
7946.0	165.00	242.002	828.2	2453.6	167.709	15.510	4.2773	654.946	.861
7964.9	165.40	242.591	828.8	2455.5	168.938	15.548	4.2985	660.099	.861
8000.0	166.12	243.646	830.0	2458.9	171.152	15.616	4.3366	669.358	.861
8187.1	170.01	249.343	821.7	2434.4	183.440	15.981	4.5445	720.588	.843
8289.3	172.13	252.456	817.2	2421.0	190.398	16.180	4.6600	749.572	.833
8427.8	175.00	256.674	811.1	2402.8	200.100	16.450	4.8187	789.987	.819
8579.3	178.15	261.289	804.4	2383.0	211.088	16.746	4.9956	835.787	.803
8668.5	180.00	264.004	800.4	2371.3	217.739	16.920	5.1012	863.538	.794
8869.3	184.17	270.121	791.5	2344.9	233.226	17.312	5.3437	928.288	.774
8909.2	185.00	271.335	789.8	2339.7	236.385	17.390	5.3926	941.528	.770
9080.3	188.57	276.568	782.2	2317.2	250.328	17.726	5.6063	1000.093	.752
9150.6	190.01	278.688	779.1	2308.1	256.128	17.861	5.6944	1024.535	.745
9159.3	190.20	278.953	778.7	2306.9	256.859	17.878	5.7054	1027.620	.744
9391.3	195.01	286.019	768.4	2276.5	276.876	18.331	6.0056	1112.419	.720
9449.3	196.22	287.785	765.9	2268.9	282.038	18.444	6.0823	1134.406	.713
9560.0	198.52	291.157	748.7	2218.0	292.069	18.661	6.2320	1177.769	.686
9631.5	200.00	293.335	737.5	2184.9	298.671	18.800	6.3320	1206.977	.668
9670.0	200.80	294.507	731.5	2167.1	302.267	18.875	6.3869	1223.118	.659
9780.0	203.08	297.858	714.3	2116.2	312.700	19.090	6.5483	1270.926	.632
9872.4	205.00	300.672	699.9	2073.5	321.647	19.270	6.6894	1313.148	.609
9887.0	205.31	301.124	697.6	2066.6	323.101	19.299	6.7126	1320.119	.605
9890.0	205.37	301.208	697.2	2065.4	323.371	19.305	6.7169	1321.416	.604
10000.0	207.65	304.558	680.0	2014.5	334.281	19.519	6.8933	1374.842	.577

60 Foot ET = 1.0270

```
330 Foot ET  = 2.7948
1/8 Mile ET  = 4.2981
1/8 Mile MPH = 163.4496
1000 Foot ET = 5.6060
1/4 Mile ET  = 6.7122
1/4 Mile MPH = 204.6379
Try Using Rear Gear Ratio = 5.310
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1/2 Mile ET = 19.078 -- 1/2 Mile MPH = 182.92
1 KM ET = 21.402 -- 1 KM MPH = 192.58
1 Mile ET = 28.119 -- 1 Mile MPH = 211.74
2 KM ET = 32.171 -- 2 KM MPH = 219.15
3 KM ET = 42.124 -- 3 KM MPH = 228.79
2 Mile ET = 44.257 -- 2 Mile MPH = 229.87
4 KM ET = 51.816 -- 4 KM MPH = 232.25
5 KM ET = 58.498 -- 5 KM MPH = 233.17
3 Mile ET = 59.772 -- 3 Mile MPH = 233.27
6 KM ET = 70.997 -- 6 KM MPH = 233.72
4 Mile ET = 75.183 -- 4 Mile MPH = 233.78
7 KM ET = 80.566 -- 7 KM MPH = 233.82
8 KM ET = 90.132 -- 8 KM MPH = 233.85
5 Mile ET = 90.579 -- 5 Mile MPH = 233.85
9 KM ET = 99.699 -- 9 KM MPH = 233.86
6 Mile ET = 105.974 -- 6 Mile MPH = 233.86
10 KM ET = 109.264 -- 10 KM MPH = 233.86
11 KM ET = 118.829 -- 11 KM MPH = 233.86
7 Mile ET = 121.368 -- 7 Mile MPH = 233.86
12 KM ET = 128.394 -- 12 KM MPH = 233.86
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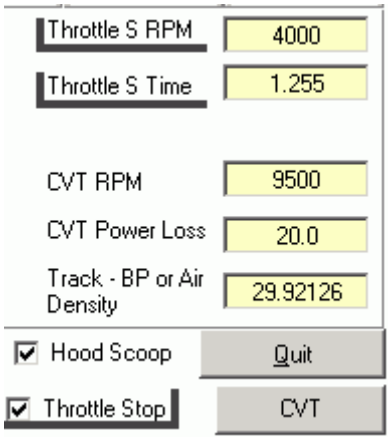
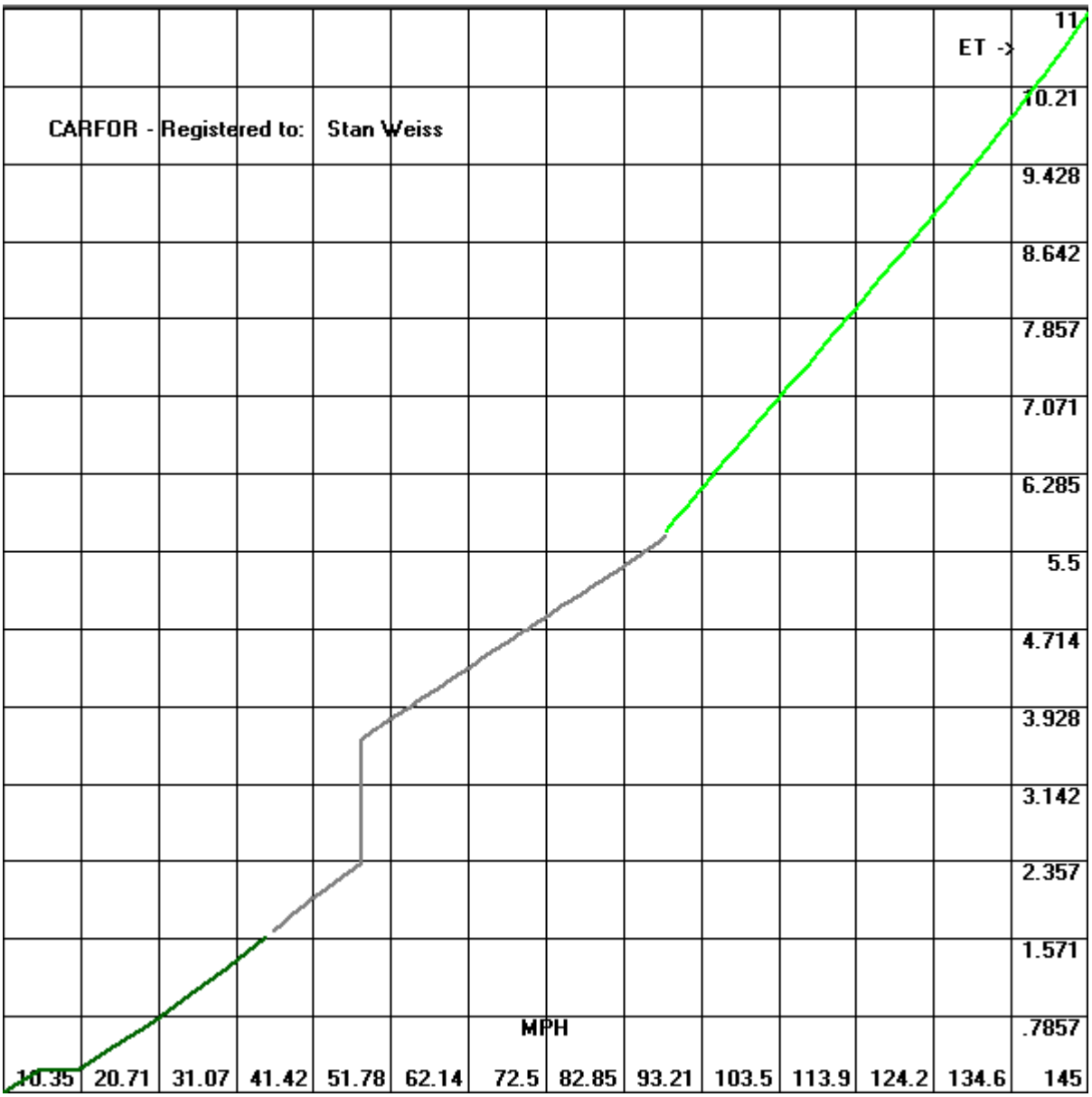
Acceleration and Top Speed Prediction Chart with Throttle Stop



Acceleration and Top Speed Prediction Chart.

RPM	MPH	Velocity ft/sec	Motor Torque	Force @ Wheel	Aero dynamic Drag - HP	Rolling Resist. HP	Elapsed Time (ET)	Total Distance	Accele ration in G's
3999.5	0.00	.000	585.9	0.0	.000	.000	.0000	-.979	.000
3999.5	5.00	7.337	585.9	2488.2	.006	.580	.2492	-.065	.915
3999.5	5.18	7.596	585.9	2488.2	.006	.601	.2580	.001	.915
>>>>--- RollOut Ends <-> 1/4 Mile Distance and ET Starts Now -- 0.25796									
3999.5	10.00	14.671	585.9	2488.2	.045	1.160	.2402	2.675	.915
3999.5	15.00	22.004	585.9	2488.2	.152	1.740	.4893	7.241	.915
3999.5	20.00	29.337	585.9	2488.2	.360	2.320	.7383	13.633	.915
3999.5	25.00	36.670	585.9	2488.2	.703	2.900	.9873	21.852	.915
3999.5	30.00	44.003	585.9	2488.2	1.215	3.480	1.2363	31.896	.915
3999.5	35.00	51.336	585.9	2488.2	1.929	4.060	1.4853	43.767	.915

3999.5	40.00	58.669	585.9	2488.2	2.879	4.640	1.7344	57.464	.915
3999.5	40.86	59.928	585.9	2488.2	3.069	4.740	1.7771	60.000	.915
3999.5	45.00	66.002	585.9	2488.2	4.100	5.220	1.9868	73.211	.873
>>>>--- Throttle Stop Start									
3999.5	47.87	70.215	585.9	2488.2	4.936	5.553	2.1405	83.679	.000
3999.5	47.87	70.215	585.9	2488.2	4.936	5.553	3.3955	171.798	.000
>>>>--- Throttle Stop End									
4100.0	49.07	71.970	597.0	2534.9	5.315	5.692	3.4606	176.429	.850
4177.8	50.00	73.335	605.6	2571.2	5.624	5.800	3.5102	180.030	.862
4200.0	50.27	73.726	608.0	2581.6	5.714	5.831	3.5243	181.064	.865
4300.0	51.46	75.481	619.0	2628.3	6.132	5.970	3.5868	185.726	.881
4400.0	52.66	77.236	630.0	2675.0	6.570	6.109	3.6482	190.413	.897
4500.0	53.86	78.992	641.0	2721.7	7.028	6.248	3.7085	195.126	.912
4595.5	55.00	80.668	646.3	2744.4	7.485	6.380	3.7655	199.674	.915
4600.0	55.05	80.747	646.6	2745.5	7.507	6.386	3.7681	199.890	.915
4700.0	56.25	82.502	652.2	2769.2	8.007	6.525	3.8278	204.756	.915
4800.0	57.45	84.258	657.8	2793.0	8.529	6.664	3.8874	209.726	.915
4900.0	58.65	86.013	663.4	2816.8	9.073	6.803	3.9470	214.801	.915
5000.0	59.84	87.768	669.0	2840.6	9.640	6.942	4.0066	219.981	.915

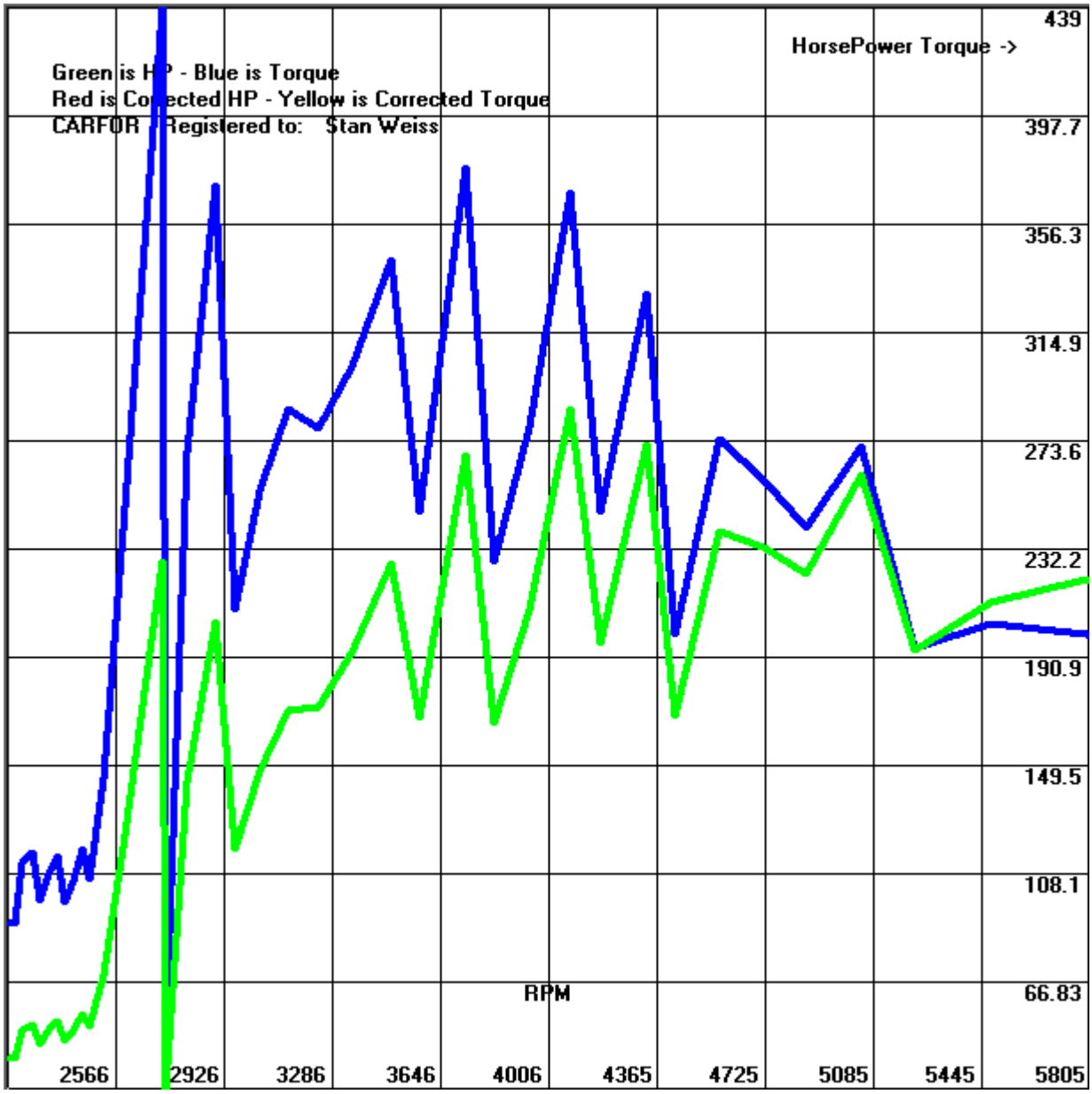


Horse Power (Rear Wheel) Prediction Chart using either MPH or RPM and Times from Parameter File also Coefficient of Drag, Frontal Area, Tire Rolling Resistance, Tire Growth, Tire Diameter, Vehicle Weight with Driver, Trans Gear.
I have use data collected using the data logging function of a SCT Xcalibrator 2.
The acceleration data needs to all be collected from a single transmission gear.
Excessive tire spin will result in a false (lower) HP calculation for that period of time / RPM range.

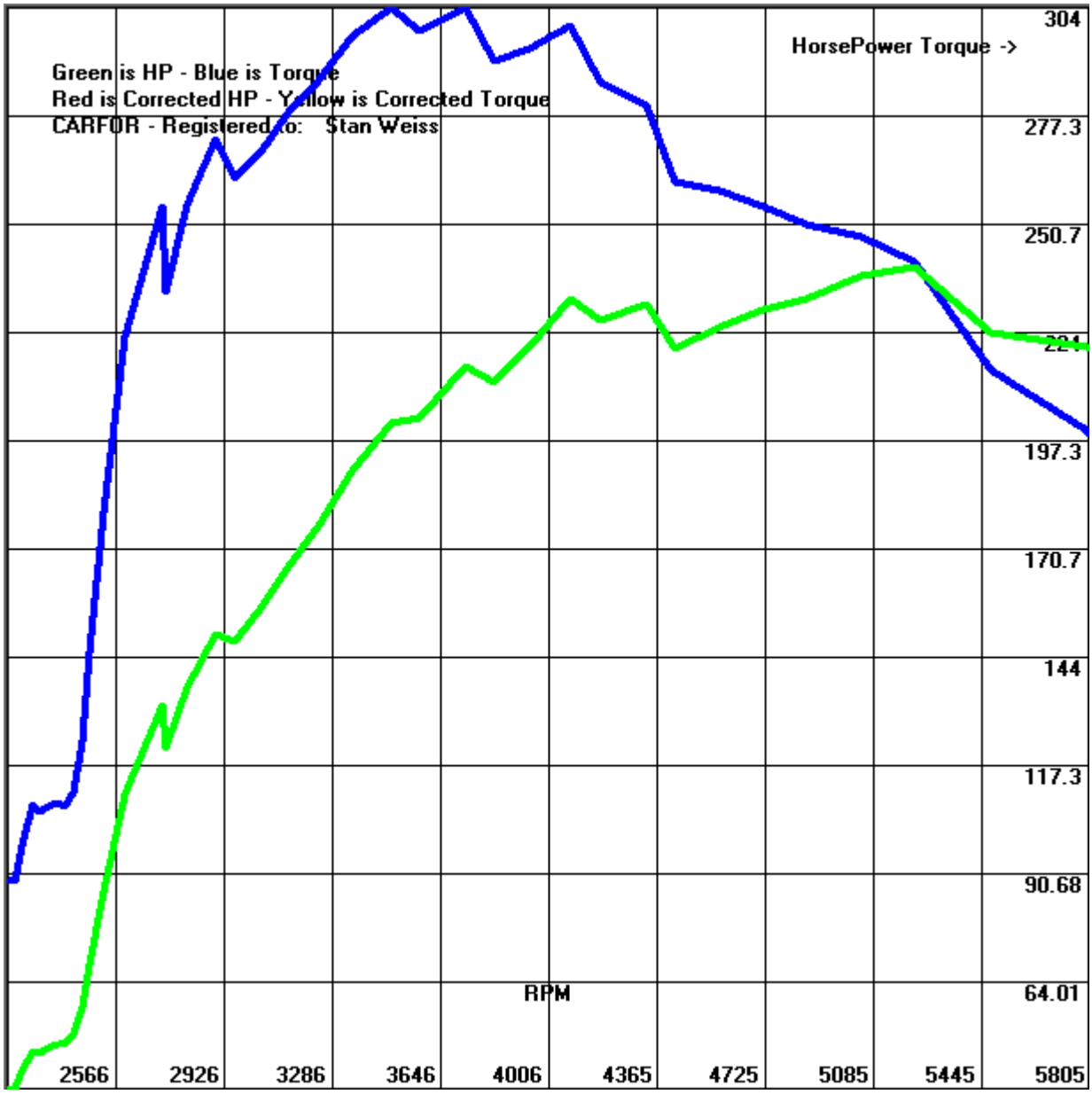
This is a Display of the Raw Data (Input) and Calculated (Output).

RPM	MPH	Velocity ft/sec	Rear Wheel Torque	Aero dynamic Drag - HP	Rolling Resist. HP	Elapsed Time	Rear W Horse Power	Accele ration in G's	Time Differ ential	Rate RPM Sec
2207.0	25.922	38.020	0.00	.918	3.837	.0000	0.00	0.0000	0.0000	0.0
2229.3	26.184	38.403	88.88	.946	3.875	.0935	37.73	.1274	0.0935	238.0
2256.3	26.501	38.868	112.48	.981	3.922	.1805	48.32	.1661	0.0870	310.3
2289.3	26.889	39.436	116.39	1.024	3.979	.2830	50.73	.1724	0.1025	322.0
2313.3	27.170	39.850	98.11	1.057	4.021	.3733	43.21	.1423	0.0903	265.8
2340.8	27.493	40.324	108.20	1.095	4.069	.4660	48.22	.1588	0.0927	296.6
2370.3	27.840	40.832	115.31	1.137	4.120	.5587	52.04	.1704	0.0927	318.2
2396.0	28.142	41.275	97.64	1.174	4.165	.6564	44.54	.1412	0.0976	263.8
2424.0	28.471	41.758	105.24	1.216	4.214	.7539	48.57	.1536	0.0976	286.9
2452.5	28.806	42.249	117.49	1.259	4.263	.8418	54.86	.1737	0.0879	324.4
2480.0	29.129	42.722	106.06	1.302	4.311	.9369	50.08	.1548	0.0951	289.1
2526.8	29.678	43.528	144.77	1.377	4.392	1.0516	69.65	.2182	0.1147	407.6
2598.8	30.524	44.768	248.58	1.498	4.518	1.1508	123.00	.3886	0.0992	725.7
2721.3	31.963	46.878	439.06	1.720	4.730	1.2444	227.49	.7012	0.0935	1309.6
2733.0	32.101	47.081	48.96	1.743	4.751	1.3493	25.48	.0600	0.1049	112.0
2804.8	32.943	48.317	269.23	1.884	4.876	1.4404	143.78	.4217	0.0911	787.6
2897.8	34.036	49.919	371.00	2.077	5.037	1.5250	204.70	.5886	0.0846	1099.3
2959.5	34.761	50.983	209.41	2.213	5.145	1.6275	118.00	.3227	0.1025	602.7
3046.3	35.780	52.477	254.57	2.413	5.295	1.7446	147.66	.3966	0.1171	740.7
3138.0	36.858	54.058	285.76	2.638	5.455	1.8544	170.74	.4474	0.1098	835.6
3238.3	38.035	55.785	278.39	2.899	5.629	1.9778	171.65	.4348	0.1234	812.1
3354.0	39.395	57.779	302.41	3.221	5.830	2.1086	193.12	.4737	0.1308	884.8
3481.8	40.895	59.979	342.51	3.604	6.052	2.2355	227.06	.5390	0.1269	1006.7
3574.8	41.987	61.582	246.59	3.900	6.214	2.3663	167.84	.3809	0.1307	711.3
3727.5	43.782	64.213	378.19	4.422	6.480	2.5034	268.41	.5963	0.1371	1113.8
3822.5	44.897	65.849	227.77	4.769	6.645	2.6493	165.78	.3486	0.1459	651.1
3939.0	46.266	67.856	278.80	5.218	6.847	2.7938	209.10	.4318	0.1445	806.5
4076.0	47.875	70.216	368.36	5.782	7.085	2.9207	285.88	.5782	0.1269	1079.9
4175.8	49.046	71.935	246.58	6.217	7.259	3.0622	196.05	.3774	0.1415	704.9
4330.3	50.861	74.596	330.05	6.932	7.527	3.2232	272.13	.5136	0.1611	959.3
4427.3	52.001	76.267	199.82	7.409	7.696	3.3969	168.44	.2990	0.1737	558.4
4573.0	53.712	78.778	274.52	8.165	7.949	3.5824	239.03	.4208	0.1855	785.9
4722.8	55.471	81.358	258.69	8.994	8.210	3.7860	232.63	.3937	0.2036	735.4
4863.8	57.127	83.787	240.32	9.823	8.455	3.9943	222.55	.3626	0.2082	677.1
5047.0	59.280	86.944	271.50	10.976	8.773	4.2322	260.90	.4125	0.2379	770.3
5222.8	61.344	89.971	194.52	12.163	9.079	4.5628	193.44	.2846	0.3306	531.6
5474.3	64.298	94.304	203.49	14.006	9.516	5.0156	212.10	.2974	0.4528	555.4
5795.8	68.074	99.842	200.01	16.622	10.075	5.6113	220.71	.2890	0.5957	539.7
5805.3	68.186	100.006	199.27	16.704	10.092	5.6290	220.26	.2877	0.0177	537.3
Averages			220.50				153.58		0.1481	630.5

This is the Raw Output Data Graphed.



The Output Data Smoothed and Graphed.

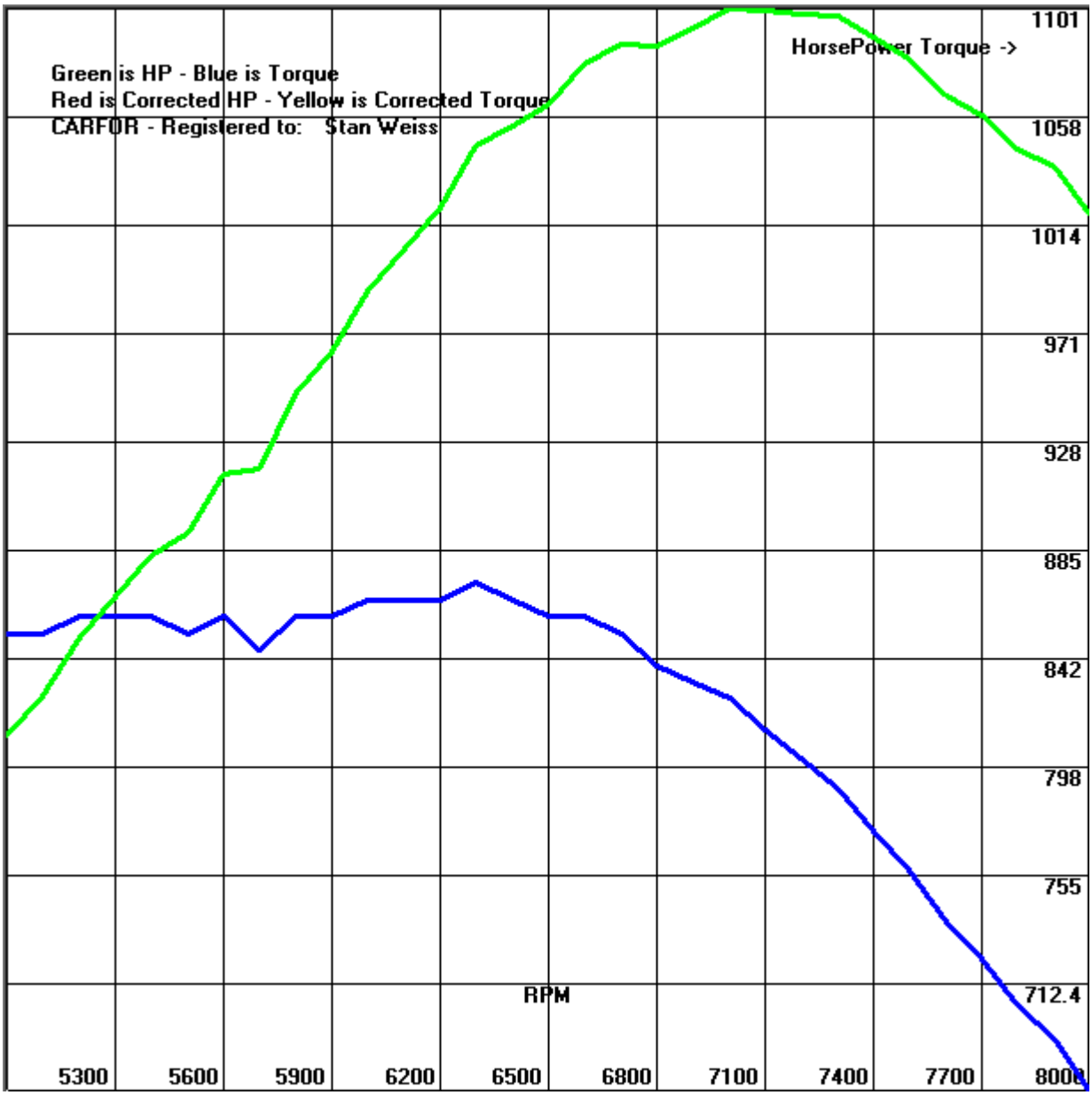


This is a Display of the Raw Data from an Inertia Dyno.

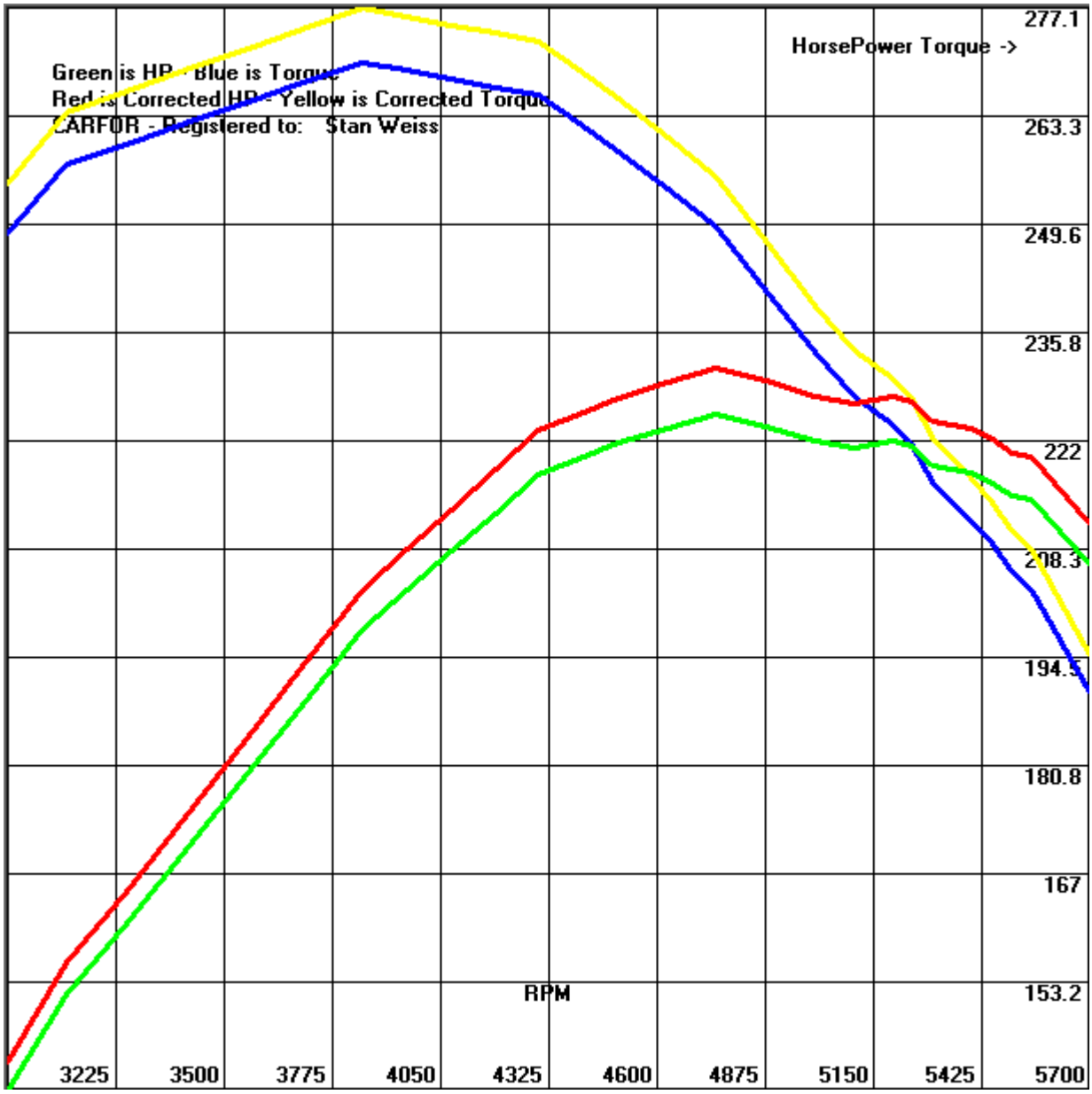
Road Horse Power Prediction Chart.
These numbers will be similar to a Chassis Dyno.

RPM	MPH	Velocity ft/sec	Rear Wheel Torque	Aero dynamic Drag - HP	Rolling Resist. HP	Elapsed Time	Rear W Horse Power	Accele ration in G's	Time Differ ential	Rate RPM Sec
5000.0	357.143	523.810	0.00	.000	.000	.0000	0.00	0.0000	0.0000	0.0
5100.0	364.286	534.286	852.18	.000	.000	.1280	827.52	2.5438	0.1280	781.3
5200.0	371.429	544.762	858.89	.000	.000	.2550	850.39	2.5639	0.1270	787.4
5300.0	378.571	555.238	858.89	.000	.000	.3820	866.74	2.5639	0.1270	787.4
5400.0	385.714	565.714	858.89	.000	.000	.5090	883.10	2.5639	0.1270	787.4
5500.0	392.857	576.190	852.18	.000	.000	.6370	892.42	2.5438	0.1280	781.3
5600.0	400.000	586.667	858.89	.000	.000	.7640	915.80	2.5639	0.1270	787.4
5700.0	407.143	597.143	845.58	.000	.000	.8930	917.70	2.5241	0.1290	775.2
5800.0	414.286	607.619	858.89	.000	.000	1.0200	948.51	2.5639	0.1270	787.4
5900.0	421.429	618.095	858.89	.000	.000	1.1470	964.86	2.5639	0.1270	787.4
6000.0	428.571	628.571	865.71	.000	.000	1.2730	989.00	2.5842	0.1260	793.7
6100.0	435.714	639.048	865.71	.000	.000	1.3990	1005.49	2.5842	0.1260	793.7
6200.0	442.857	649.524	865.71	.000	.000	1.5250	1021.97	2.5842	0.1260	793.7
6300.0	450.000	660.000	872.63	.000	.000	1.6500	1046.76	2.6049	0.1250	800.0
6400.0	457.143	670.476	865.71	.000	.000	1.7760	1054.94	2.5842	0.1260	793.7
6500.0	464.286	680.952	858.89	.000	.000	1.9030	1062.99	2.5639	0.1270	787.4
6600.0	471.429	691.429	858.89	.000	.000	2.0300	1079.34	2.5639	0.1270	787.4
6700.0	478.571	701.905	852.18	.000	.000	2.1580	1087.13	2.5438	0.1280	781.2
6800.0	485.714	712.381	839.07	.000	.000	2.2880	1086.38	2.5047	0.1300	769.2
6900.0	492.857	722.857	832.67	.000	.000	2.4190	1093.95	2.4856	0.1310	763.4
7000.0	500.000	733.333	826.36	.000	.000	2.5510	1101.39	2.4667	0.1320	757.6
7100.0	507.143	743.810	814.02	.000	.000	2.6850	1100.45	2.4299	0.1340	746.3
7200.0	514.286	754.286	802.05	.000	.000	2.8210	1099.54	2.3942	0.1360	735.3
7300.0	521.429	764.762	790.43	.000	.000	2.9590	1098.66	2.3595	0.1380	724.6
7400.0	528.571	775.238	773.61	.000	.000	3.1000	1090.01	2.3093	0.1410	709.2
7500.0	535.714	785.714	757.50	.000	.000	3.2440	1081.72	2.2612	0.1440	694.4
7600.0	542.857	796.190	737.02	.000	.000	3.3920	1066.52	2.2001	0.1480	675.7
7700.0	550.000	806.667	722.38	.000	.000	3.5430	1059.09	2.1564	0.1510	662.3
7800.0	557.143	817.143	703.74	.000	.000	3.6980	1045.15	2.1007	0.1550	645.2
7900.0	564.286	827.619	690.38	.000	.000	3.8560	1038.46	2.0608	0.1580	632.9
8000.0	571.429	838.095	669.20	.000	.000	4.0190	1019.34	1.9976	0.1630	613.5
Averages			818.91				1013.18		0.1340	750.7

This is the Raw Data Graphed from an Inertia Dyno.



Graph **Engine RPM (X-axis) / Torque (Y-axis)** (**BLUE**) / Corrected Torque (**YELLOW**) / **Horse Power (Y-axis)** (**GREEN**) / Corrected Horse Power (**RED**) using Torque and RPM inputs for Acceleration / Top Speed.

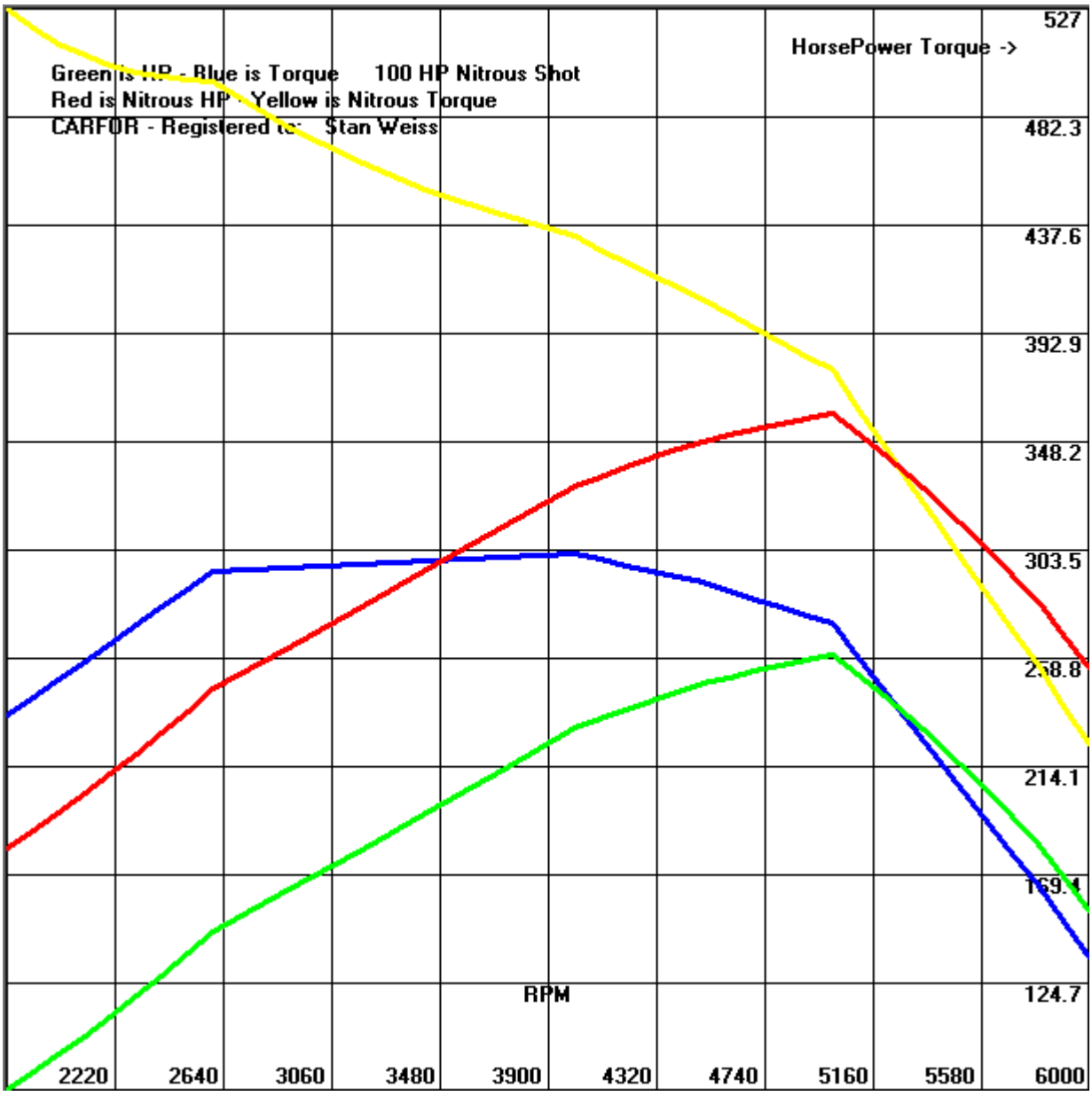


This graph was produced from the MUST00S.PRM file.

Graph **Engine RPM (X-axis) / Torque (Y-axis)** (**BLUE**) / Nitrous Torque (**YELLOW**) / **Horse Power (Y-axis)** (**GREEN**) / Nitrous Horse Power (**RED**) using Torque and RPM inputs for Acceleration / Top Speed.

Nitrous - Progressive - Multi Stage

----------	Trans Gear	Nitrous HP	Nitrous RPM Start	Nitrous HP Starting %	Nitrous RPM Full
Stage 1	1	100	1000	100	1000
Stage 2	9	200	7400	25	8300

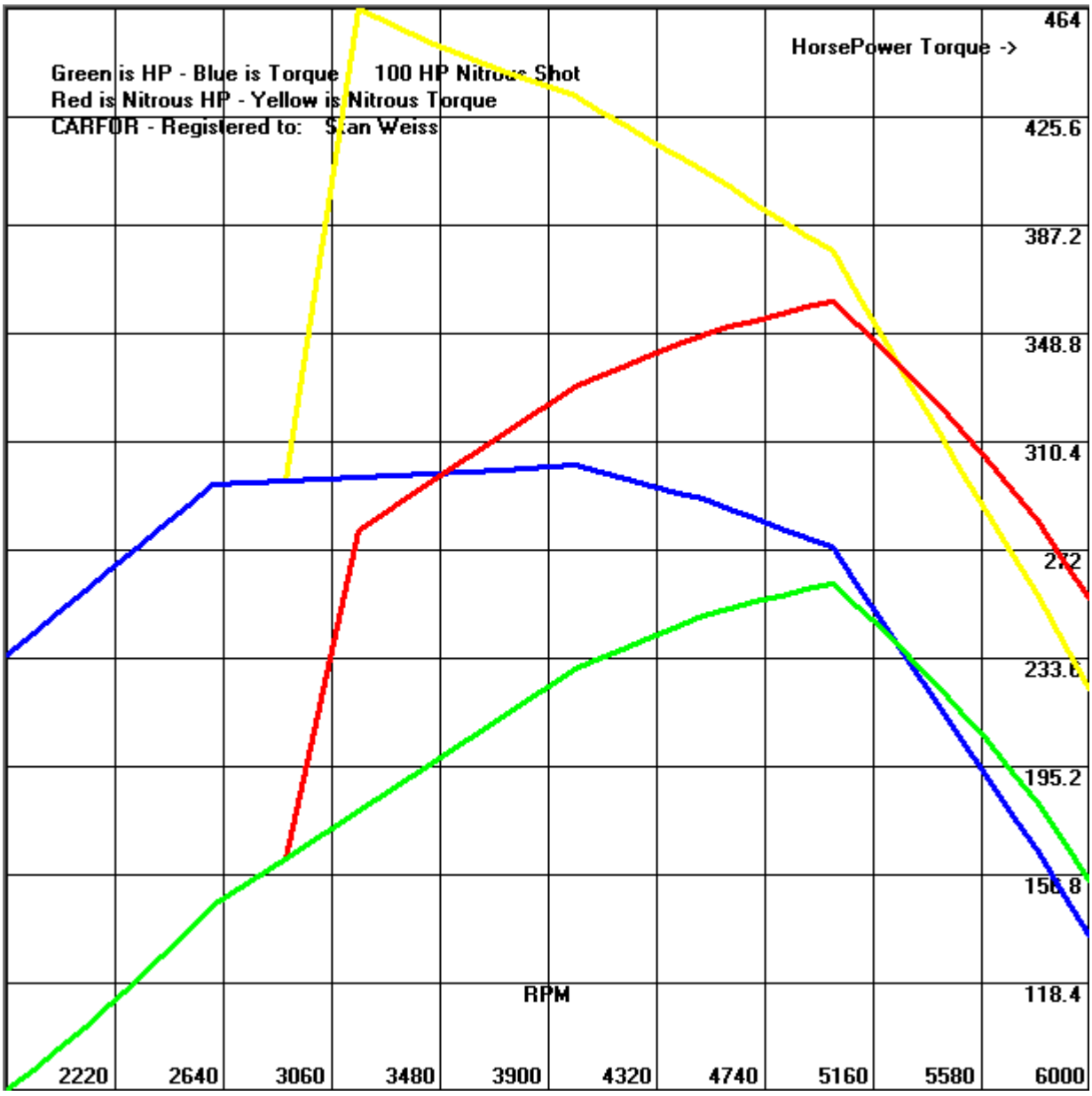


This graph was produced from the MUST00ME.PRM file.

Graph **Engine RPM (X-axis) / Torque (Y-axis)** (**BLUE**) / Nitrous Torque (**YELLOW**) / **Horse Power (Y-axis)** (**GREEN**) / Nitrous Horse Power (**RED**) using Torque and RPM inputs for Acceleration / Top Speed. This graph was produced from the MUST00ME.PRM file and using **Nitrous RPM** of 3000.

Nitrous - Progressive - Multi Stage

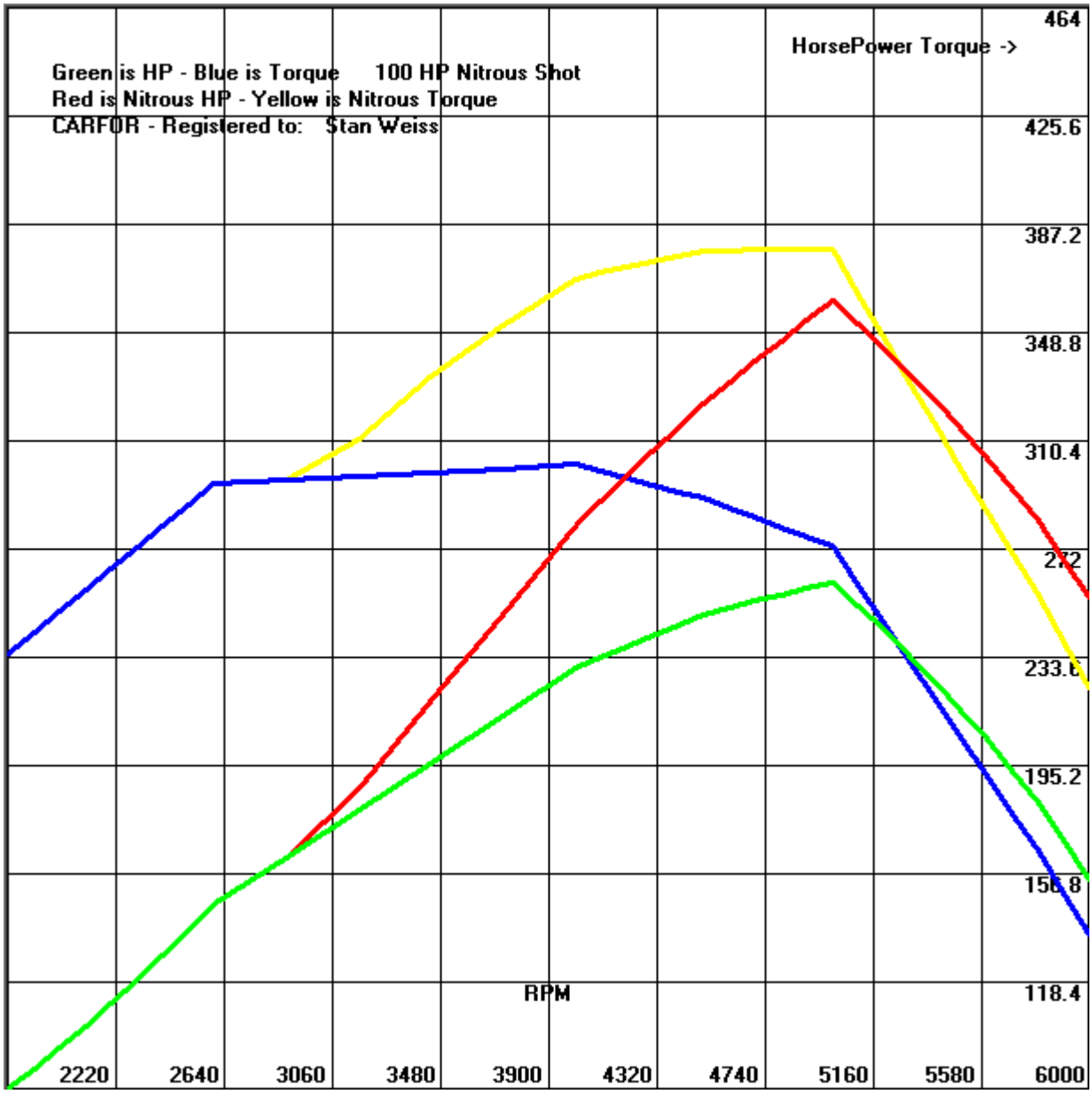
----------	Trans Gear	Nitrous HP	Nitrous RPM Start	Nitrous HP Starting %	Nitrous RPM Full
Stage 1	1	100	3000	100	3000
Stage 2	9	200	7400	25	8300



Graph **Engine RPM (X-axis) / Torque (Y-axis)** (**BLUE**) / Nitrous Torque (**YELLOW**) / **Horse Power (Y-axis)** (**GREEN**) / Nitrous Horse Power (**RED**) using Torque and RPM inputs for Acceleration / Top Speed. This graph was produced from the MUST00ME.PRM file and using **Nitrous RPM Start** of 3000 a **Nitrous HP Starting %** of 0.0
Nitrous RPM Full of 5000.

Nitrous - Progressive - Multi Stage

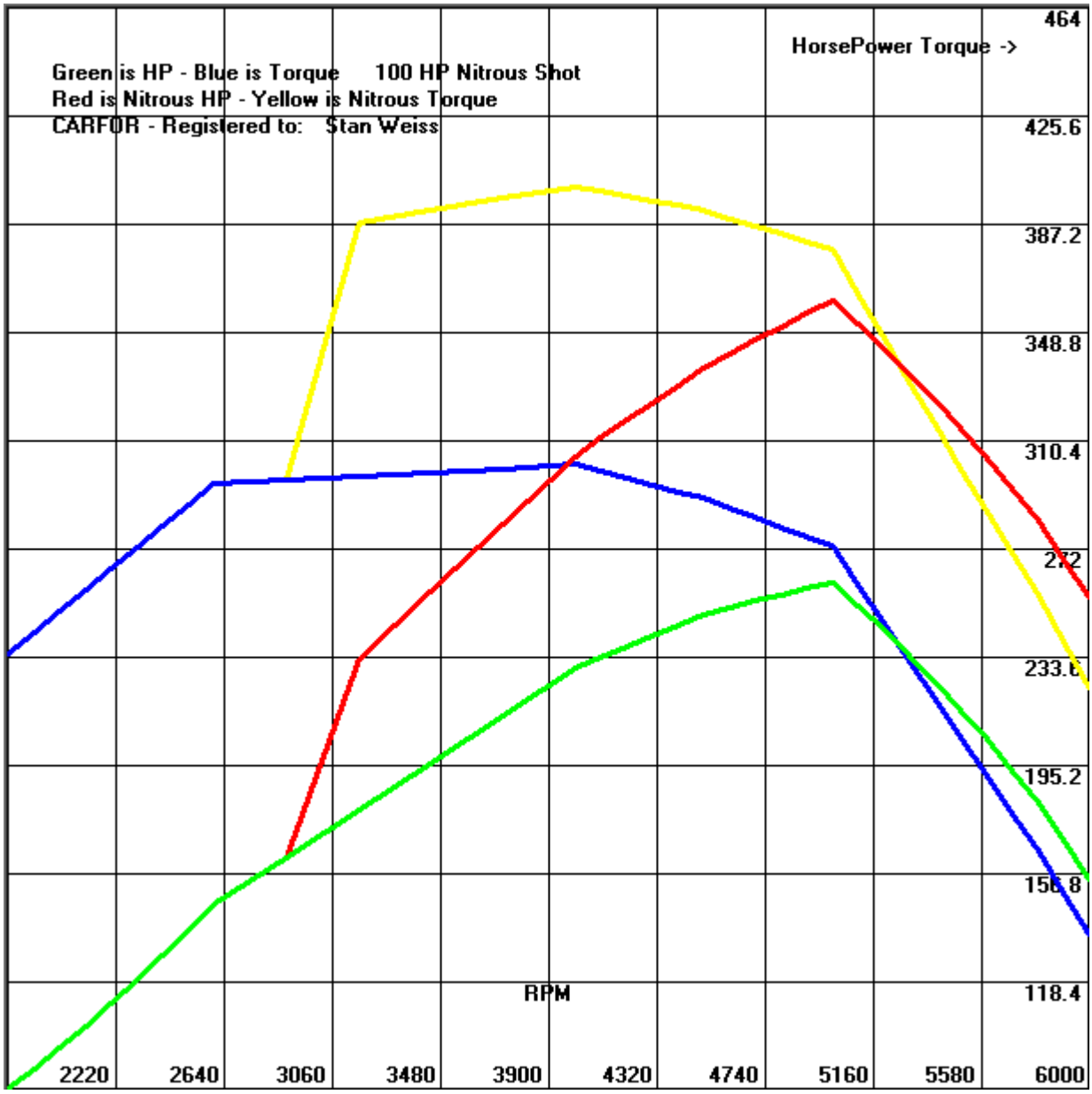
----------	Trans Gear	Nitrous HP	Nitrous RPM Start	Nitrous HP Starting %	Nitrous RPM Full
Stage 1	1	100	3000	0	5000
Stage 2	9	200	7400	25	8300



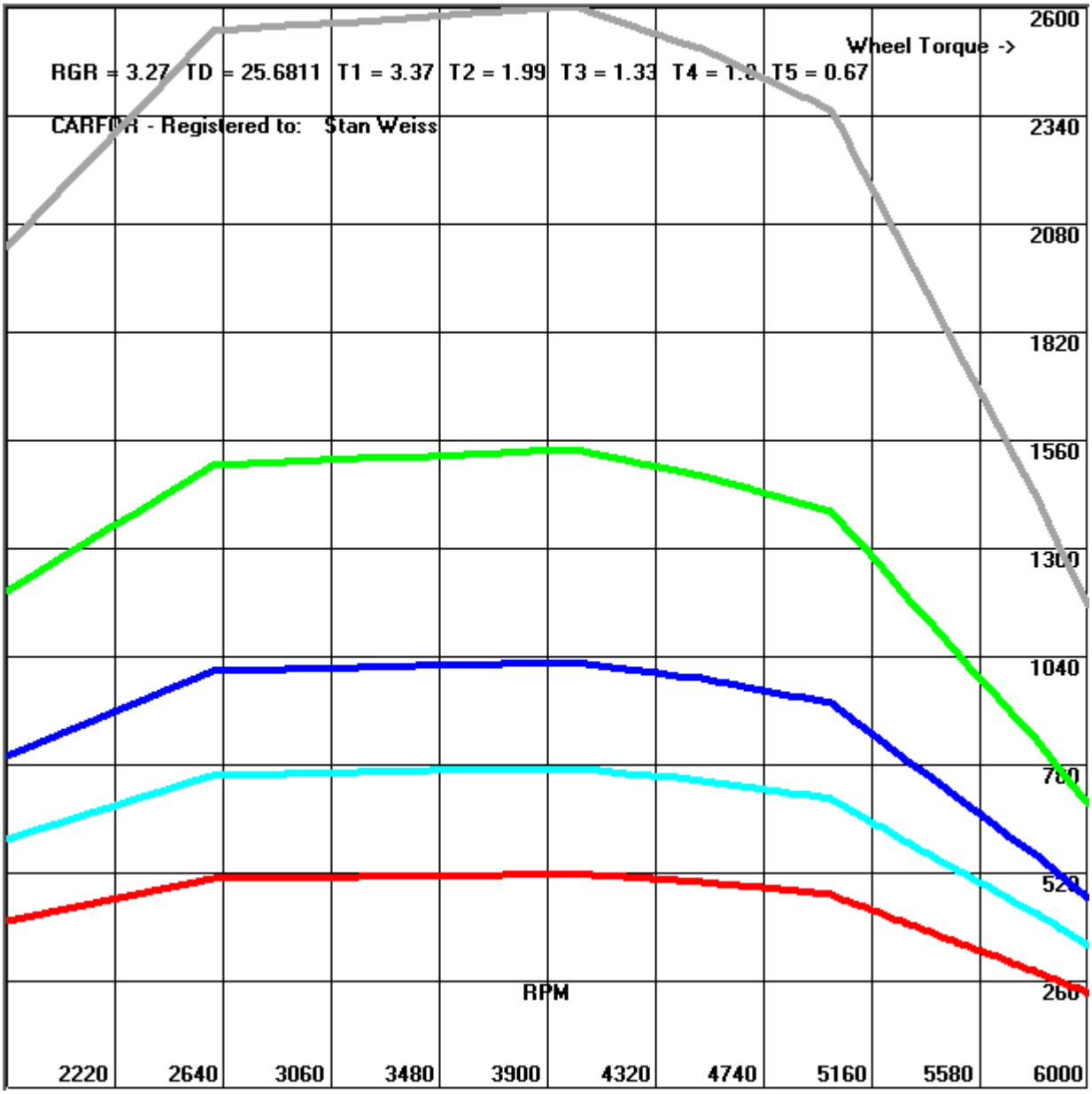
Graph **Engine RPM (X-axis) / Torque (Y-axis)** (**BLUE**) / Nitrous Torque (**YELLOW**) / **Horse Power (Y-axis)** (**GREEN**) / Nitrous Horse Power (**RED**) using Torque and RPM inputs for Acceleration / Top Speed. This graph was produced from the MUST00ME.PRM file and using **Nitrous RPM Start** of 3000 a **Nitrous HP Starting %** of 50.0
Nitrous RPM Full of 5000.

Nitrous - Progressive - Multi Stage

----------	Trans Gear	Nitrous HP	Nitrous RPM Start	Nitrous HP Starting %	Nitrous RPM Full
Stage 1	1	100	3000	50	5000
Stage 2	9	200	7400	25	8300



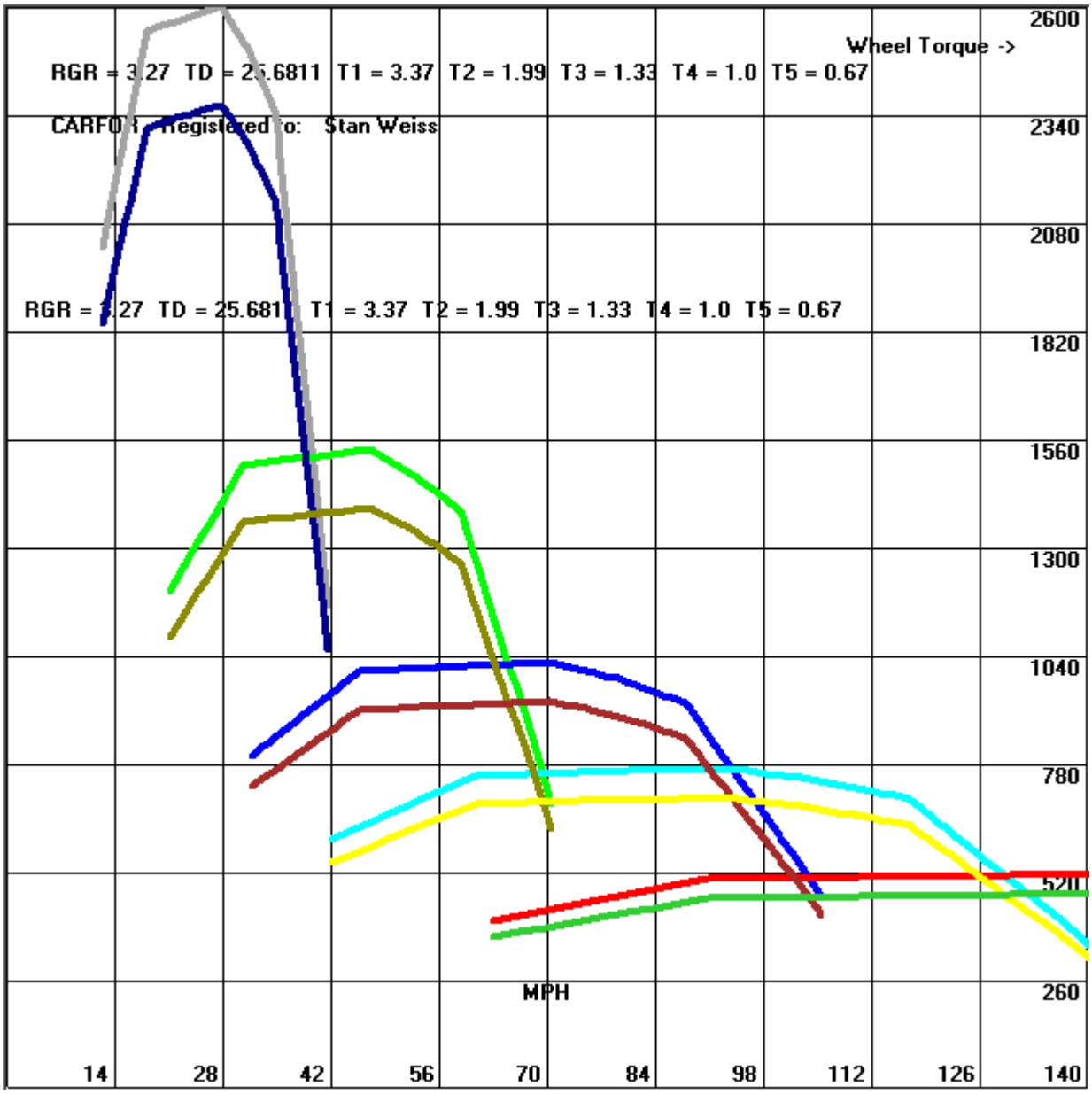
Graph Wheel Torque, **RPM on X-axis Wheel Torque on Y-axis** using same inputs as Acceleration / Top Speed.



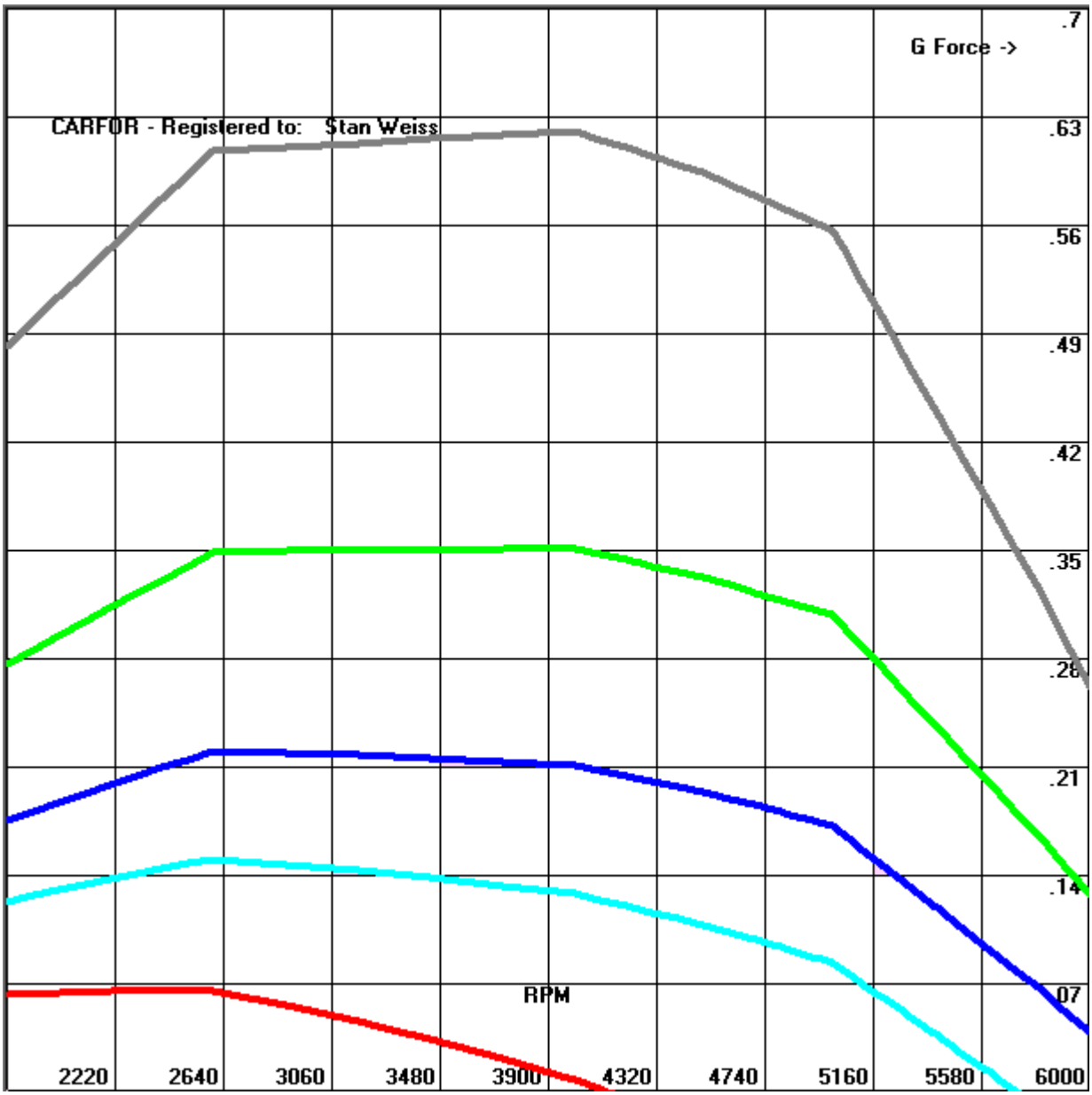
Graph Wheel Torque, **MPH on X-axis Wheel Torque on Y-axis** using same inputs as Acceleration / Top Speed.

Where the line for each gear crosses the line for the next gear that MPH (RPM) is where your ideal shift is for that gear.

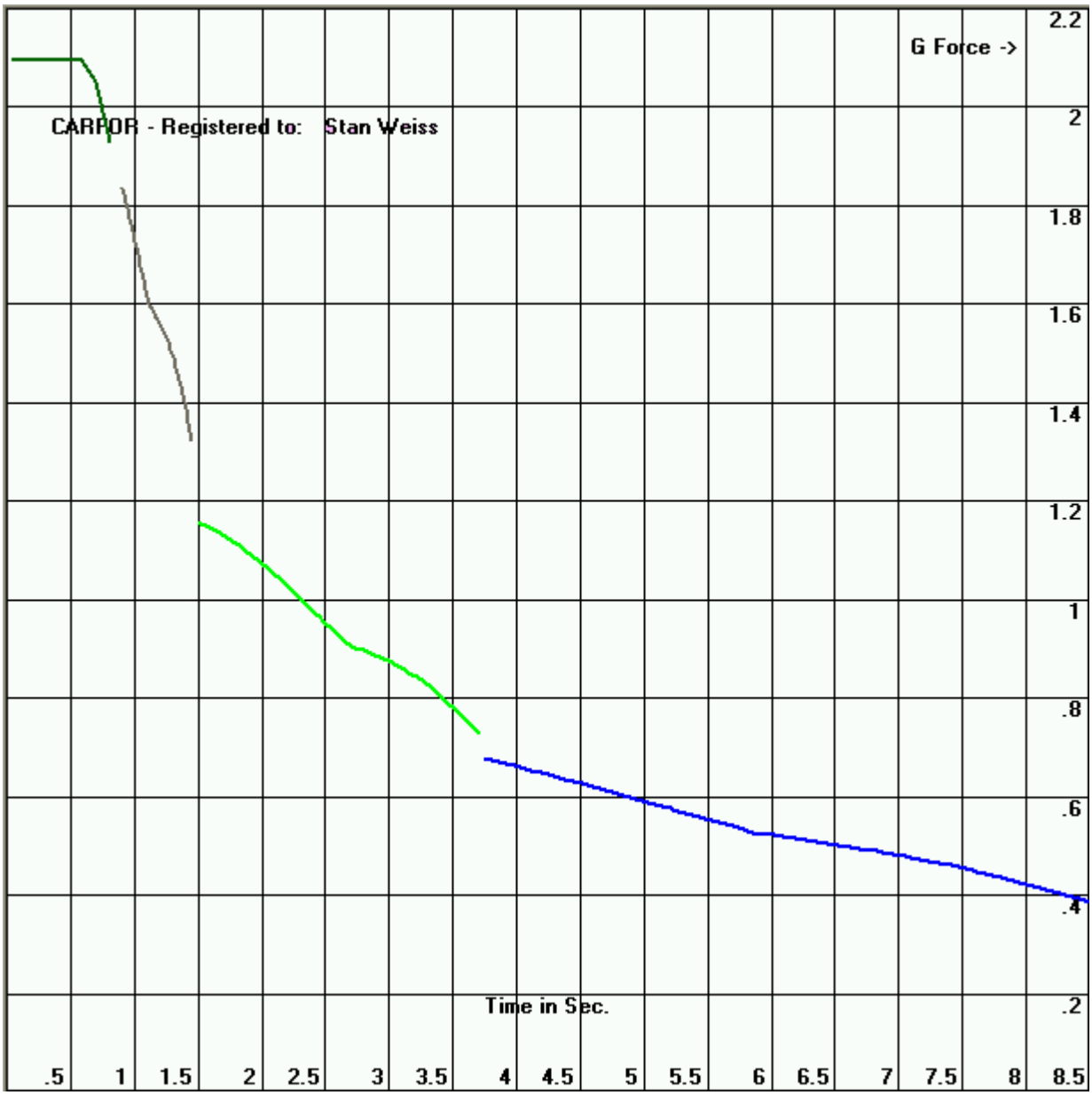
The first set (upper) lines is with a Dyno Correction Factor of 1.0 and the second set (lower) lines show the same setup with a Dyno Correction Factor of 1.1.



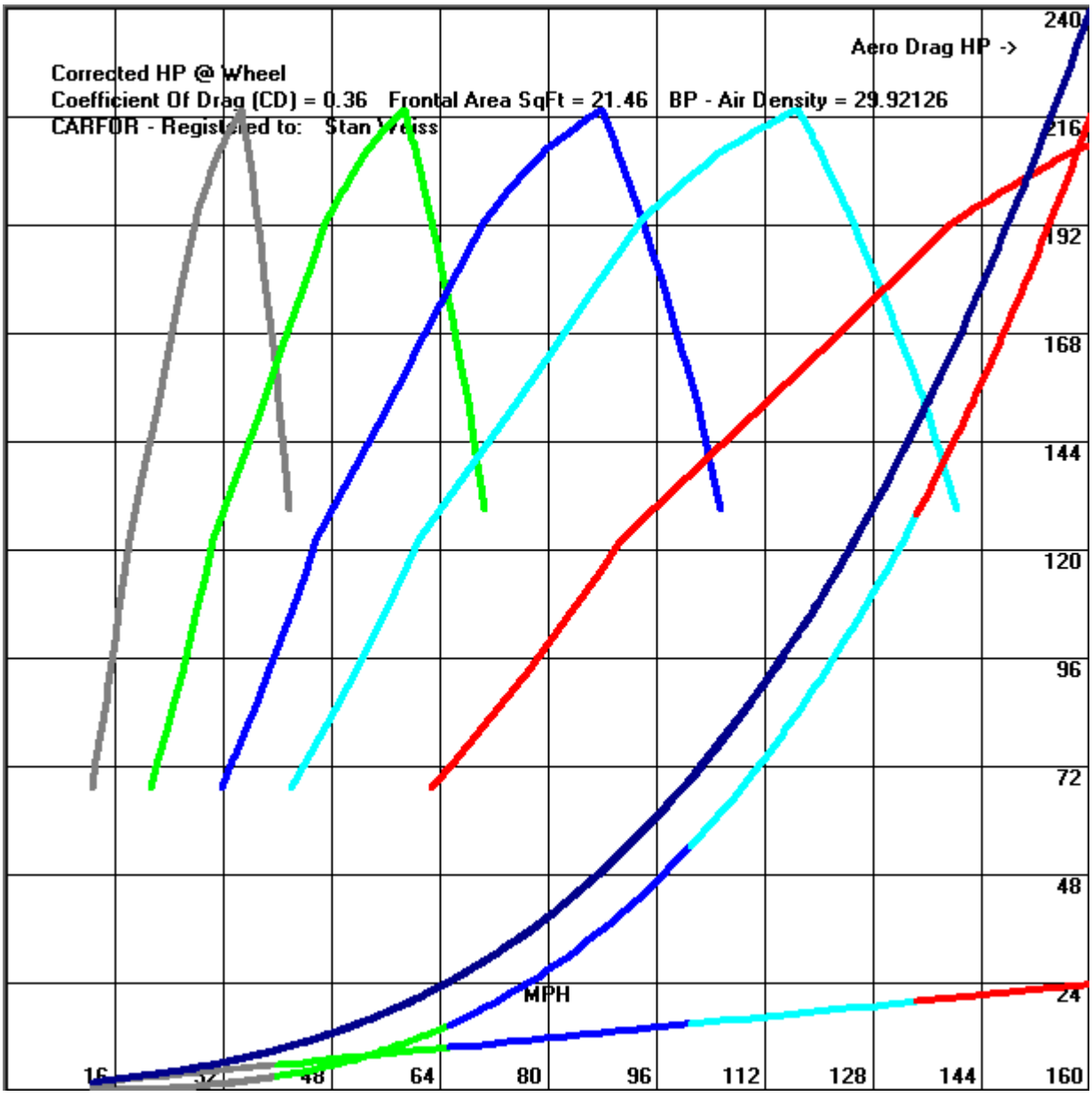
Graph G Forces **RPM on X-axis and G force on Y-axis** using same inputs as Acceleration / Top Speed.



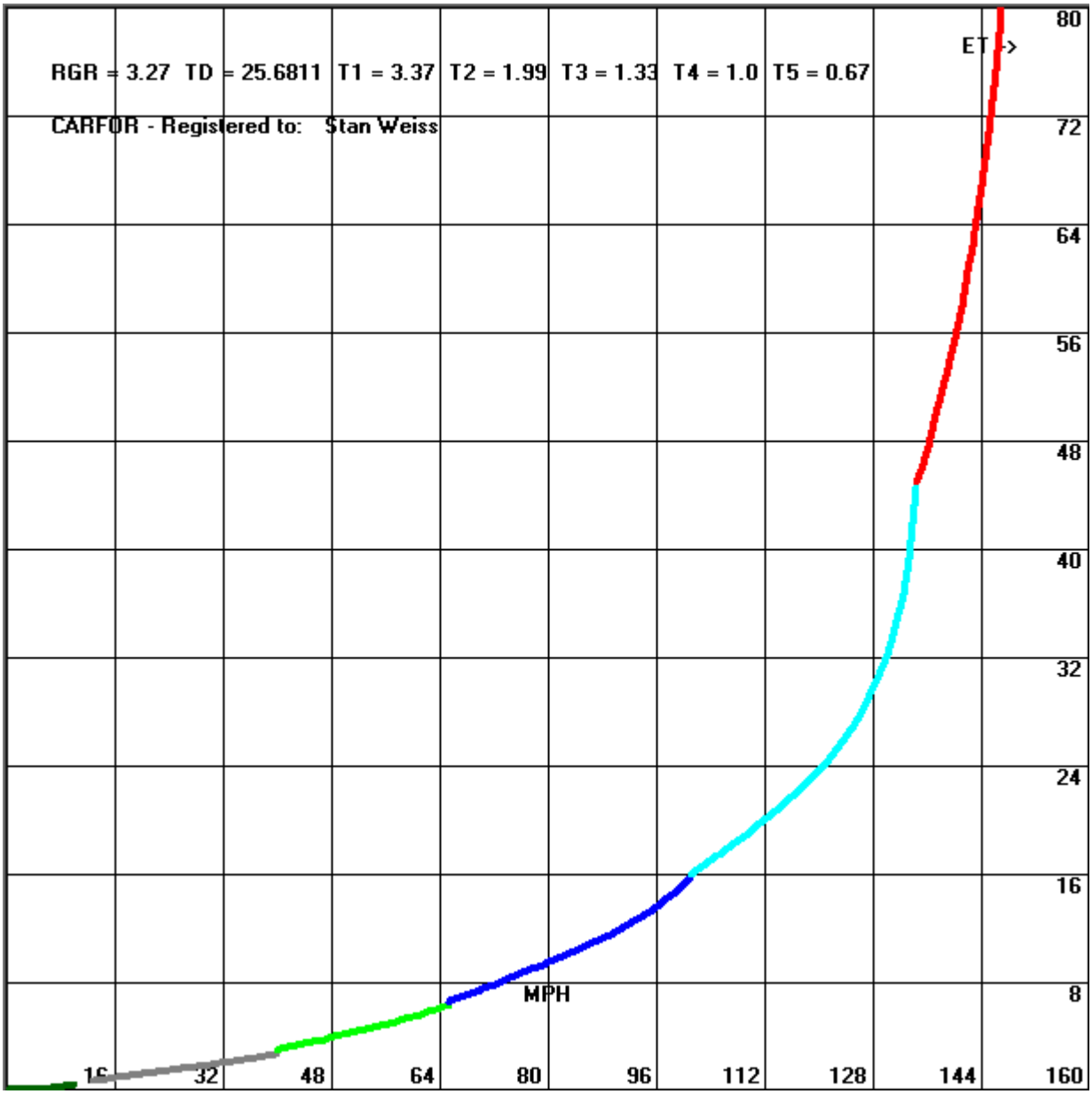
Graph G Forces **ET on X-axis and G force on Y-axis** using same inputs as Acceleration / Top Speed.



Graph **MPH on X-axis,** Aero Drag HP, Tire Rolling Resistance HP, Total HP Drag (DARK BLUE) and **Corrected HP at Drive Wheel(s) on Y-axis** using same inputs as Acceleration / Top Speed and Graph X high value / Graph Y high value.

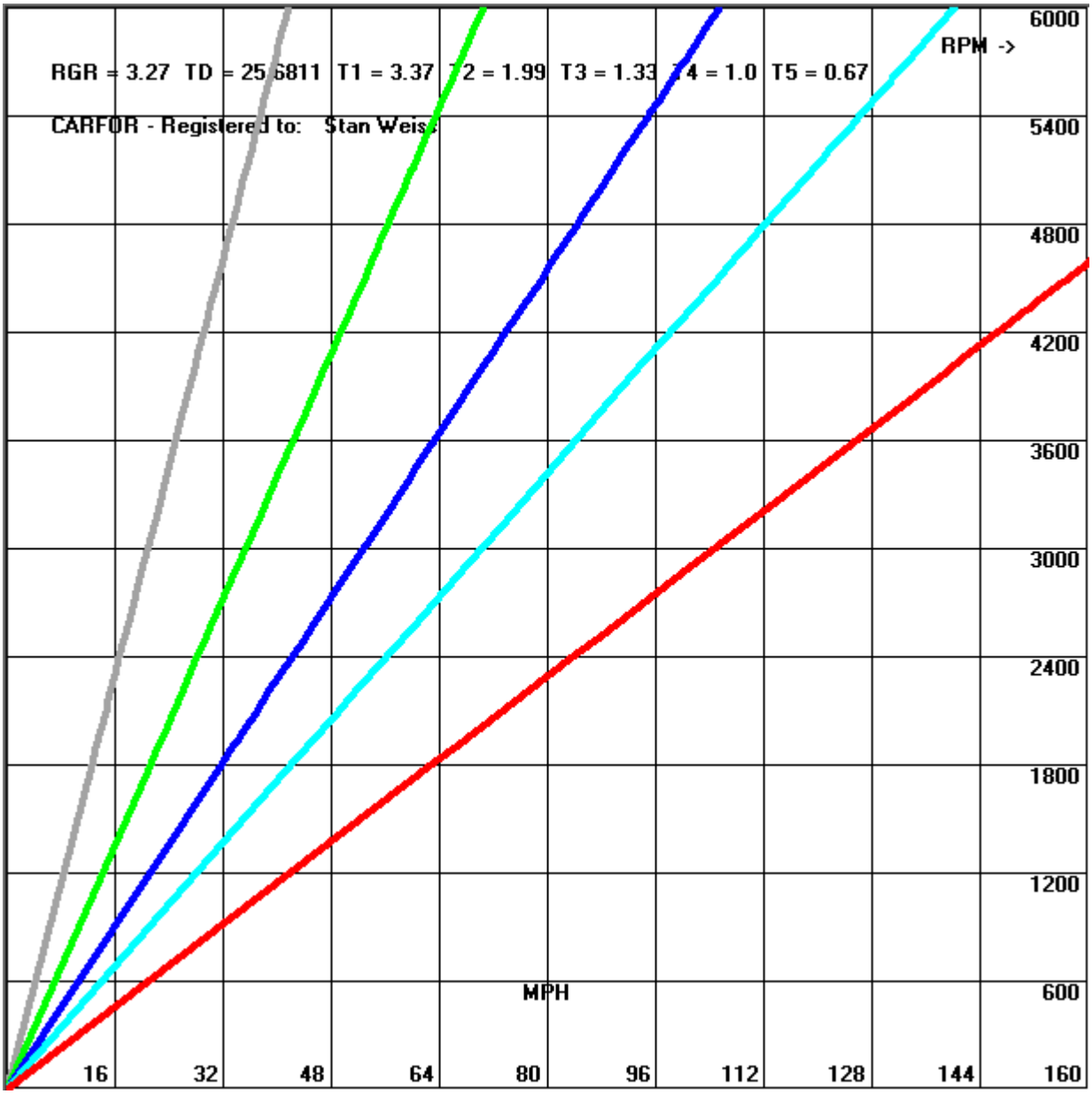


Graph **MPH on X-axis, ET on Y-axis** using same inputs as Acceleration / Top Speed and Graph X high value / Graph Y high value.



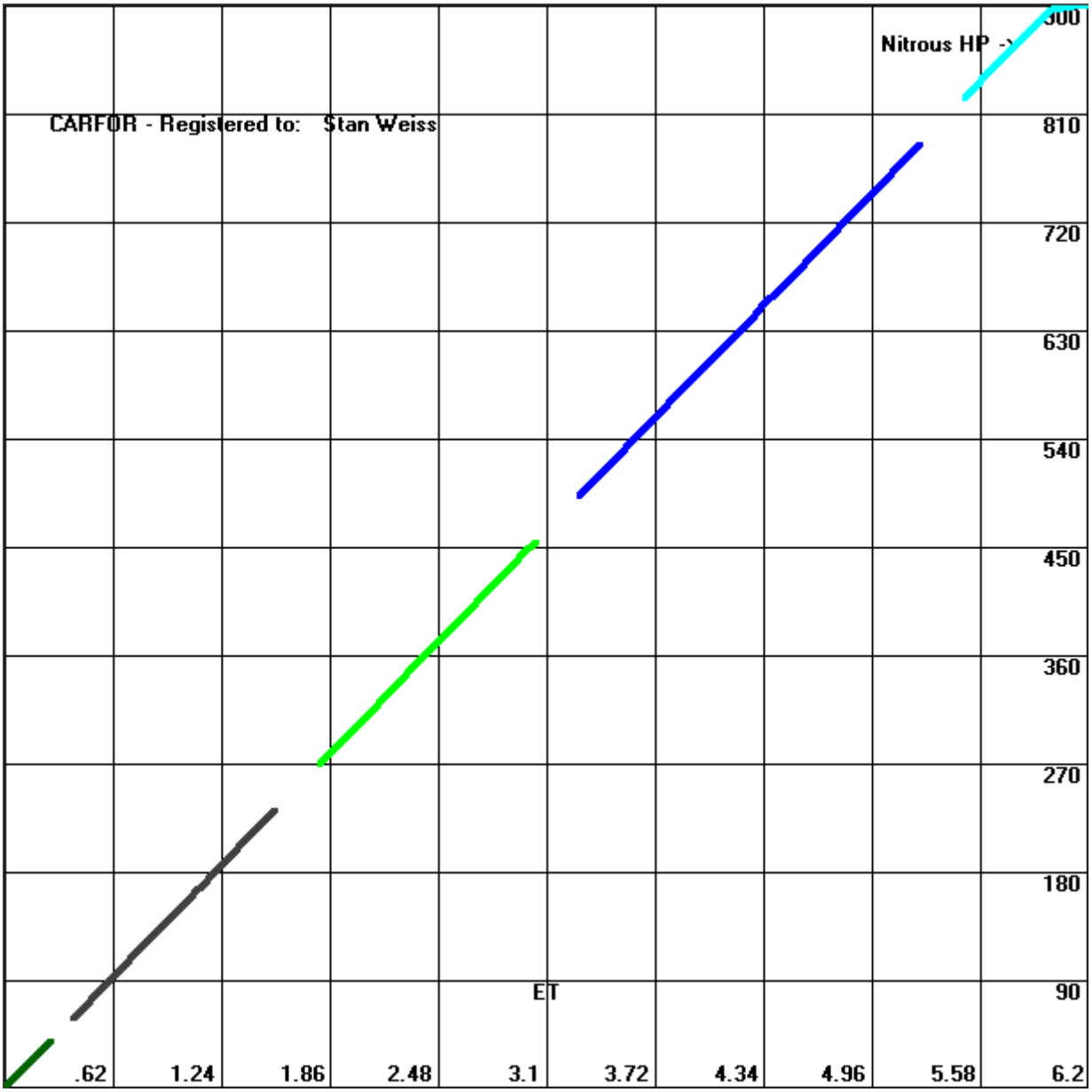
Graph Speed **MPH on X-axis and RPM on Y-axis** using same inputs as Acceleration / Top Speed.

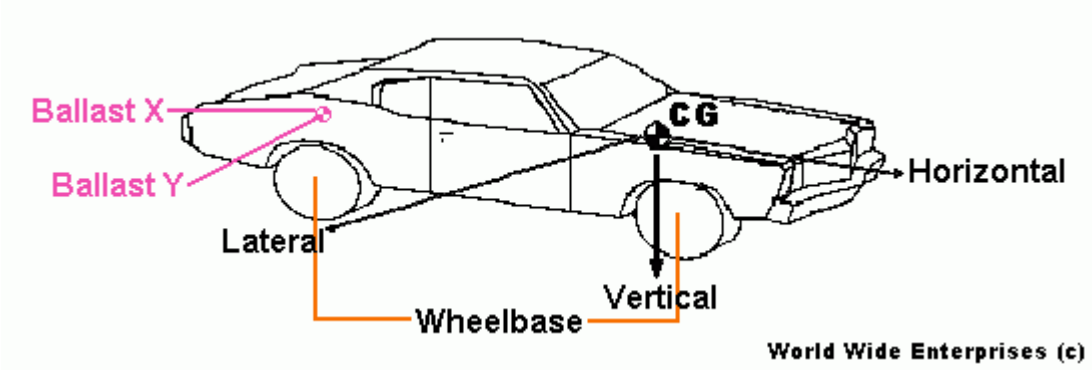
CS = Converter Slippage (Shown if Automatic Transmission)
PD = Primary Drive Ratio (Shown if used)
RGR = Rear Gear Ratio
TD = Tire Diameter
T1 – T10 Transmission Gear Ratios for 1st thru 10th Gear.



Graph **ET on X-axis, Nitrous HP on Y-axis** using same inputs as Acceleration / Top Speed and Graph X high value / Graph Y high value.

----------		Nitrous HP	Nitrous Start Time	Nitrous HP Starting %	Nitrous Full Time
Stage 8		900	0	0	6
Stage 9		150	9999	75	9999



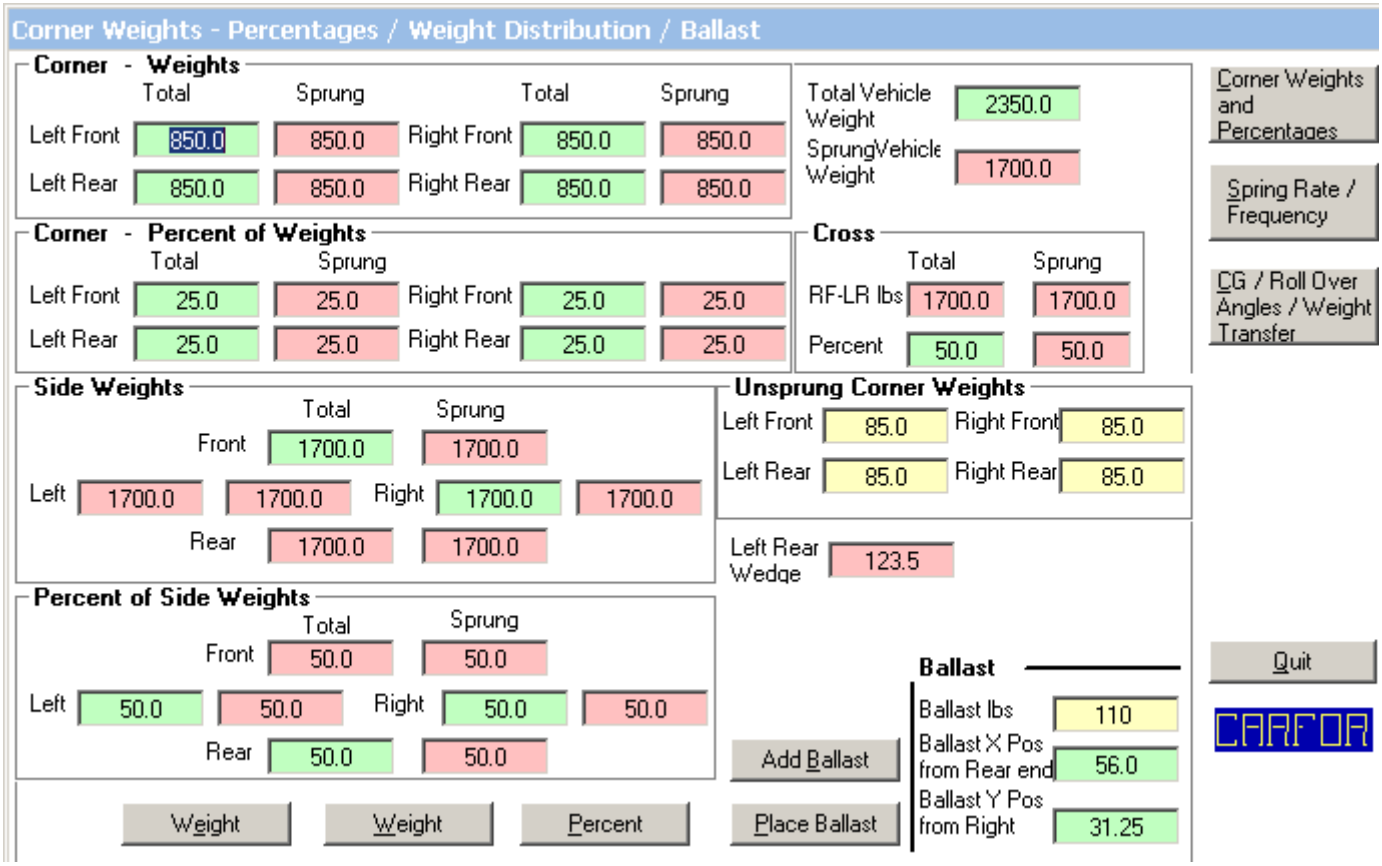


CHASSIS

Track Width - If the front and rear track widths are different then enter the average number in Track Width box.
Wheelbase - If the left and right wheelbases are different then enter the average number in Wheelbase box.
Unsprung Weight – Tires, rims, springs, shocks, brake rotors, fasteners.

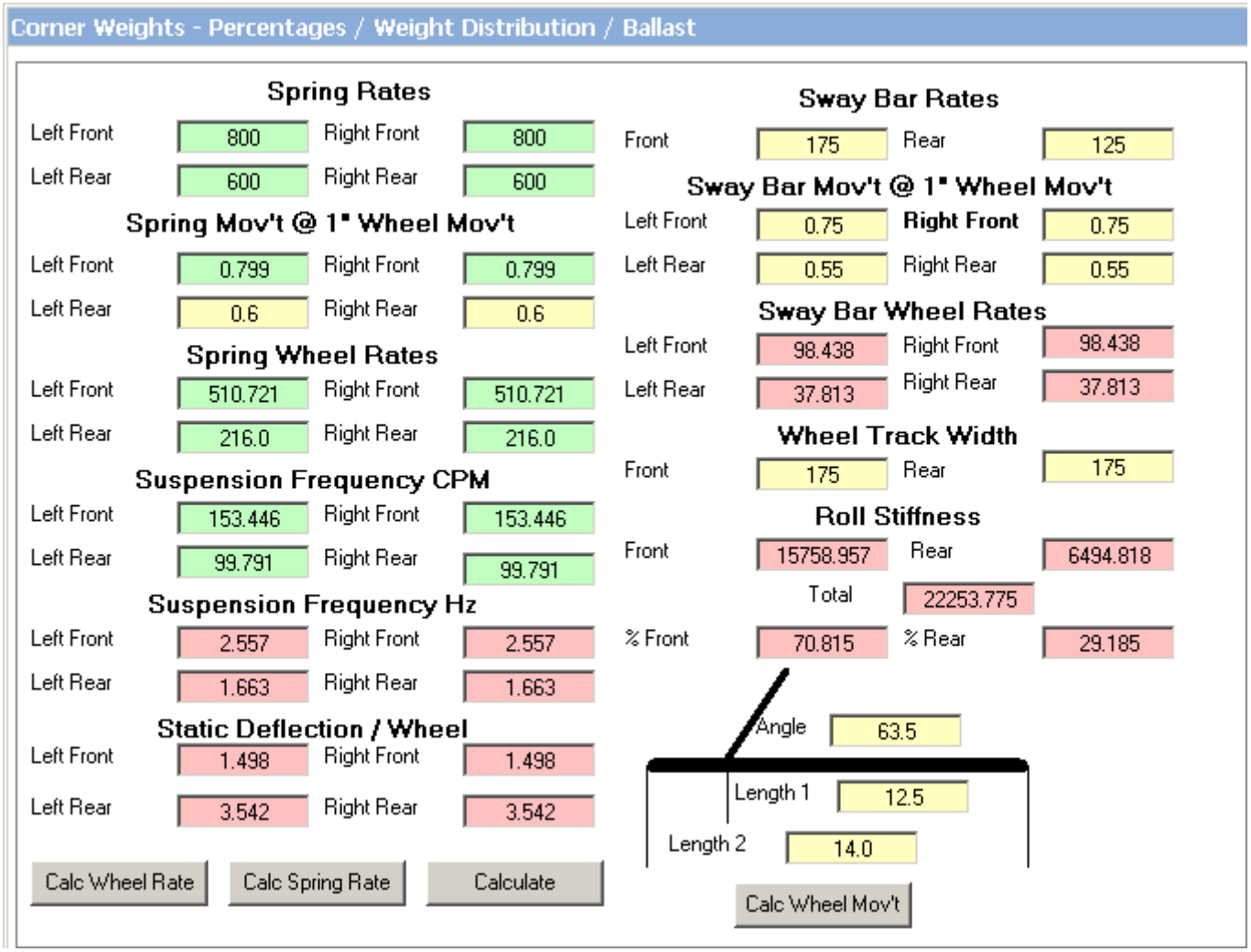
CG Procedure:
Set the car on scales
Set Tire Pressures and Ride Height
Measure the Radius of each of the tires / Height to the Spindle/Axle Center
Measure the Left and Right Wheel Base
Measure the Front and Track Width.
Weigh each corner of the vehicle with the driver inside and all fluids / Race ready
Raise the Rear Tires of the vehicle and place spacers of 10 inches or in height under the rear wheels.
Reweigh the front wheels of the car and enter the front weight obtained.

1) From corner percentages and vehicle weight -- Calculate all other percentages and weights.
2) From Weight on Each Corner -- Calculate all other percentages and weights.
3) Calculate Center of Gravity CG (Horizontal, Vertical, and Lateral) using Wheelbase, Front Weight / Front Weight when rear is raised, Height rear is raised, and Height Front Hub / Weight Right, Track Width.
4) From Desired Left, Rear, and Cross percentages and vehicle weight -- Calculate all other percentages and weights.
5) Calculate Amount of Ballast on each corner from Wheelbase, Track Width, Ballast, X and Y Position of Ballast.
6) Calculate X and Y position to Place Ballast from Wheelbase, Tack Width, Rear and Right Percentages.


Corner Weights - Percentages / Weight Distribution / Ballast
Corner - Weights
Total
Sprung
Total
Sprung
Left Front
850.0
850.0
Right Front
850.0
850.0
Left Rear
850.0
850.0
Right Rear
850.0
850.0
Total Vehicle Weight
2350.0
SprungVehicle Weight
1700.0
Corner Weights and Percentages
Spring Rate / Frequency
CG / Roll Over Angles / Weight Transfer
Corner - Percent of Weights
Total
Sprung
Left Front
25.0
25.0
Right Front
25.0
25.0
Left Rear
25.0
25.0
Right Rear
25.0
25.0
Cross
Total
Sprung
RF-LR lbs
1700.0
1700.0
Percent
50.0
50.0
Side Weights
Total
Sprung
Front
1700.0
1700.0
Left
1700.0
1700.0
Right
1700.0
1700.0
Rear
1700.0
1700.0
Unsprung Corner Weights
Left Front
85.0
Right Front
85.0
Left Rear
85.0
Right Rear
85.0
Left Rear Wedge
123.5
Percent of Side Weights
Total
Sprung
Front
50.0
50.0
Left
50.0
50.0
Right
50.0
50.0
Rear
50.0
50.0
Ballast
Ballast lbs
110
Ballast X Pos from Rear end
56.0
Ballast Y Pos from Right
31.25
Add Ballast
Place Ballast
Weight
Weight
Percent
Quit
CARFOR

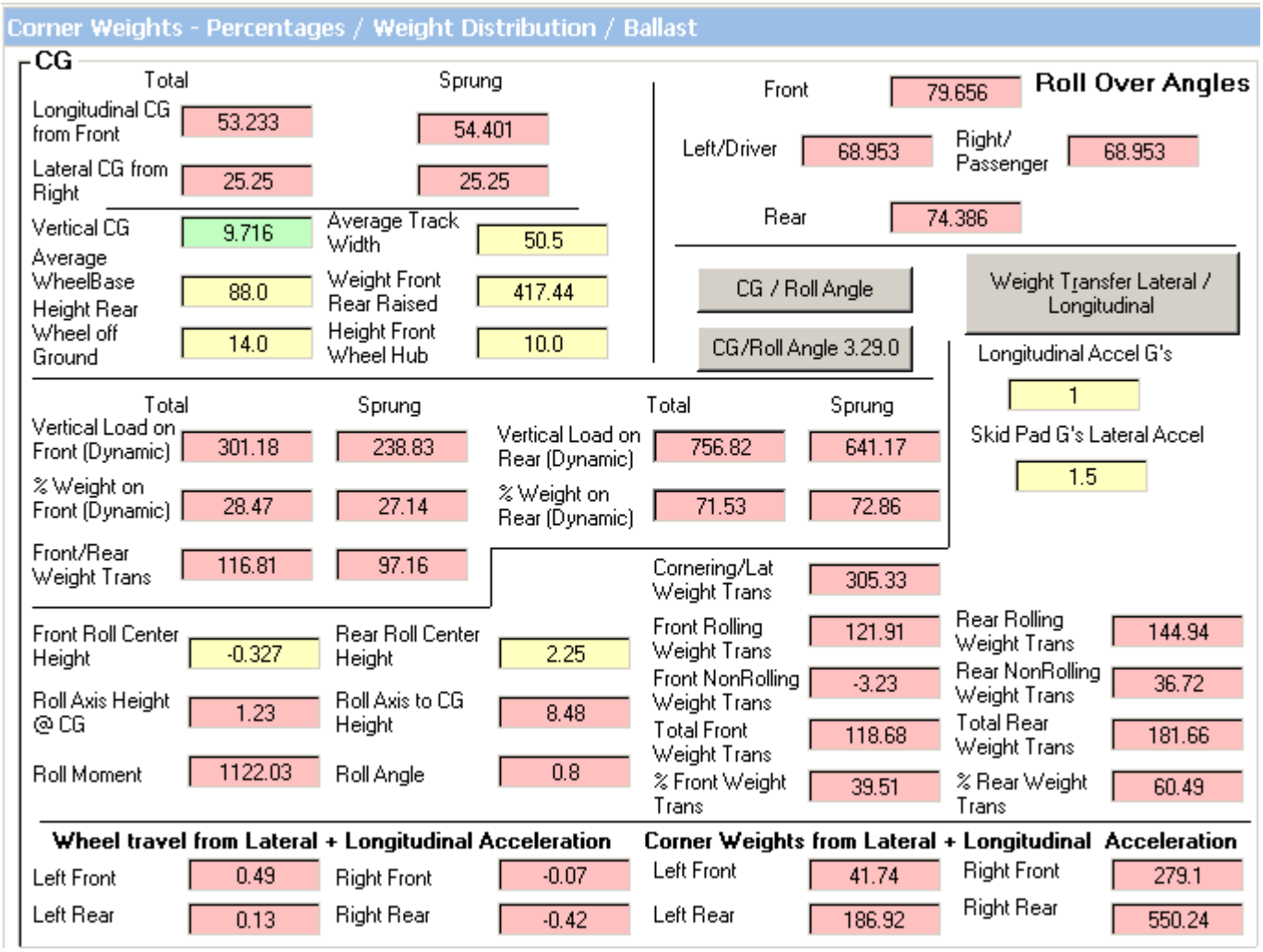
Roll Stiffness - When body roll occurs in a vehicle with suspension, something on the outside has to resist the body roll. That is the springs and sway bars. If the total rate of the front springs and sway bars is 823.64 and the total rate of the rear springs and sway bars is 960.02, the rear of the car has a stiffer roll resistance. The end of the car that has the most roll resistance handles that proportion of weight transfer caused by body roll. Or in other words, 46.16% of all inside to outside weight transfer caused by body roll is handled at the front due to the spring and sway bar rates installed there.

Calculate Spring Wheel Rates from Suspension Frequency CPM and Corner Sprung Weights (Previous Screen).
Calculate Spring Rates from Spring Wheel Rates and Spring Movement @ Wheel
Calculate Motion / Movement Ratio Using Length 1, Length 2 and Angle of Sock / Spring.



1) Calculate Cornering/Lateral Weight Transfer using Lateral Acceleration in G's, Track Width, Vertical CG, and Car Weight.
2) Calculate Front / Rear Weight Transfer using Longitudinal Acceleration in G's (+ Acceleration – Braking), Track Width, Vertical CG, and Car Weight.
3) Vertical Load on Front using Longitudinal acceleration in G's (+ Acceleration – Braking), Track Width, Vertical CG, Car Weight, and Front Weight.

Roll Centers - Every vehicle has a front and rear roll center. The roll center is a point about which that end of the vehicle rolls. A straight line running through them called the roll axis joins front and rear roll centers. During cornering, the car will roll about the roll axis. The relationship between the Vertical CG and roll axis (Roll axis to CG Height) determines body roll taking place during cornering. The greater the distance between the Vertical CG and the roll axis, the greater the body roll angle for a given lateral acceleration.



Note: Each screen uses values that are calculated on the previous screen so you must work from top to bottom when using this 3-screen set.

Handling – by Ted James

Handling is composed of 4 layers. First is the kinematics layer and must be addressed first as it is very easy to correct problems here with a higher layer. Second is the static stiffness due to springs, bars, and roll center moment arm. Third is the dynamic roll stiffness due to shocks. Forth is the aerodynamic layer. Each layer can be used to correct a problem in a layer above or below, but will narrow the setup window and be less drivable.

Roll stiffness as used here includes the moment arm from the roll center to the center of mass of that end of the car. This moment arm/lever loads the springs and bars. The rate at which this happens is controlled by the shock stiffness. This controls the weight on each tire patch during cornering. Stiffness as used here only includes springs, bars, roll center moment arm, and shocks. Tire stiffness, which is in series with the above, is not addressed except as follows. The higher the tire spring in relation to the other roll stiffness components the less tire pressure will affect the handling. Going from a low tire pressure to a higher pressure (+6psi min increase) will also cause more shock activity.

Static roll stiffness due to springs and bars will be in the range of 47% to 65% of the total on the front. A good starting point is front weight % +5%, if front weight % is 44 then front roll couple % should be 49% plus or minus 2%. This is a good starting point. This number is good for sports racers, TransAm, and formula cars on a road course. Oval tracks may need as much as 65% to the front. This assumes that the roll centers are close to where they want to be. The weight transfer splits between springs, bars, and roll moment arm are the true magic numbers.

Guide to spring rate selection. The following chart gives the wheel rate as a ratio to the corner weight for the front suspension. As you can see the higher down force potential the higher the ratio.

```
Starting wheel Rate/Corner Weight for the front wheel rate.
Car Type
CART/IRL:          2.3-4+
ALMS LMP:          2.0-3+
Formula Atlantic: 1.9
DSR/CSR            1.7
Formula 2000:      1.6
S2000              1.4
Trans-Am:          1.2-1.3
Formula Ford:      1-1.1

You might go as high as these with experienced drivers.
```
F. Atlantic: 3-5/1 (high end of range on ovals)
CART/IRL Ovals : 4-6/1
FF: 1.75-2/1
FC: 2-3/1
S2: 2/1
```
Then using the above paragraph on static roll stiffness set the bars and
springs for the rear springs and bars.
```

Wedge, static roll stiffness, and dynamic roll stiffness, and roll moment arm together determine the weight on each of the tire contact patches as the car corners. Static wedge is determined by static weight distribution and setup adjustments to add weight to one corner. Roll stiffness is determined by springs, bars, and the moment arm (the roll center to the center of mass of the car). Dynamic roll stiffness will add or subtract from the corner weight during roll or de-roll and is controlled by the actions of the shocks. Dynamic roll couple will vary the weight on each of the tire patches as the car rolls or de rolls. In the middle of the corner the shocks job is to maintain a smooth pressure on the tire patch and will not affect over or understeer. You could look at shocks operating in two modes. First is the roll stiffness added during roll and deroll. Second is the shock trying to maintain an even load on the tire patch during steady state cornering.

Adding wedge is defined as greater **inside** weight at the rear. This causes more understeer/less oversteer. If the front has more roll resistance than the rear, the car wedges itself more as it corners harder (it will tend to understeer).

De-wedging is defined as greater **inside** weight at the front. Gives oversteer/less understeer. If the rear has more roll resistance than the front the car de-wedges itself more as it corners harder (it will tend to oversteer).

Wedge/de-wedge will cause increased cornering force on the end with increased weight on the inside wheel. The end with the increased outside weight will have less cornering force.

Anti squat at the rear will de-wedge the car the more power applied. It will also decrease the weight transfer to the front during braking and allow more rear brake bias.

Cars with low front roll center and beam axle or high roll center in the rear have the following. Front-stiff due to springs/bars and rear stiff due to the geometry of the high roll center. The high roll center is closer to the center of mass so has a short moment arm between the center of mass and the roll center. This makes the roll geometrically very stiff. The rear spring rates will be a much lower rate than expected due to the high roll center but the total roll stiffness will be a normal roll couple distribution (about 54%)

Dynamic roll stiffness can be affected by shocks, raising rate suspension, and roll center migration during roll.

Shocks adjustments are the most common method of adjusting dynamic roll stiffness. Springs roll center moment arm, and bars determine HOW FAR the chassis rolls. Shocks determine how rapidly the roll occurs. Shocks also can affect the total roll stiffness (static+dynamic roll stiffness) distribution during roll and de-roll. Keep in mind that if the static roll stiffness is not correct you can cover up the problem by adjusting shocks to bring total roll stiffness during corner entry and exit back to where it should be. On a 90deg or less corner you may not notice the problem. A 90 deg or more corner the car will show its static roll stiffness handling in the middle of the corner. For example the problem may show itself as "turns in great and washes out in the middle".
The shocks affect the dynamic roll stiffness much the same way that springs and bars do. Bump adjustment is similar to changing spring rate when that shock is compressing (resists spring compression). Rebound adjustment is similar to changing sway bar as the shock extends (the bar resists spring extension).

The following are guidelines for dynamic roll stiffness adjustments:
When trying to correct corner exit use rebound changes on the front and bump changes on rear first.
When trying to correct corner entry use compression adjustments on the front and rebound on the rear.
Corner entry oversteer increase bump on the front and/or decrease rebound in the rear.
Corner entry understeer decrease bump on the front and/or increase rebound in the rear.
Corner exit oversteer decrease rebound on the front and/or decrease bump on the rear.
Corner exit understeer increase rebound on the front and/or increase bump on the rear.

Oval track only.
To change corner entry only change low speed rebound distribution front to rear on the left side only. To change exit only change right rebound or left bump front to rear distribution. Oversteer on exit coming off the banking add rebound to the left front only.

Raising rate suspensions will cause the static roll stiffness to be changed during the middle of the corner due to increased wheel rate. Steepness of the curve and where the suspension is on the curve will determine what the shift in wheel rate and static roll stiffness will be. Do not use raising rate on both ends of the car as the roll stiffness can be come uncontrollable.

Allowing the *front* roll center to move laterally but within the track width will cause the roll stiffness to change during roll or de-roll. Allowing it to move to the outside loaded wheel will add front roll stiffness, more understeer. Allowing it to move to the unloaded wheel side will decrease front roll stiffness, less understeer. This is due to the increase or decrease moment arm from the roll center to the center of mass. Do not allow both ends to have migrating roll centers.

Note: To see the static and dynamic roll stiffness create a math channel in the data system.
RF suspension position minus LR suspension and another channel LF suspension position minus RR suspension position and plot the two signals on top of each other. On corner entry when the signals are increasing/decreasing the angle between horizontal and the signal represent dynamic roll couple. A good handling car will have the same angle for both channels. Static roll stiffness is the middle of the corner where one signal is horizontal above and below the centerline. Corner exit is the next stage and should be read the same as corner entry.
Note: Look at the comparison of front and rear roll signals. The difference in the front and rear rolls is caused mainly by the effective radius change of the tire due to slip angle changes.
Note: Look at a comparison of yaw rate and steering to see who is causing the reaction, the car or the driver. Normally the steering is a yaw rate change request device. If the steering is followed by a change of yaw rate the driver is causing the change. If the yaw rate change is followed by a steering change the car is causing the yaw rate change.
The throttle will have similar reactions. Also look at steering rate (differentiate steered angle) as compared to throttle and oversteer/understeer for a more complete picture of driver interactions with the car.

Aerodynamics is the forth part of the handling equation. Set the center of pressure just behind the center of weight distribution for a stable car. If the first two layers, static roll stiffness distribution, and dynamic roll stiffness are correct. There will be a range of several % when the car is pronounced as "good". You can adjust within this range increase the efficiency of the car (remove some rear down force or front down force).

Note to display the aero in the data system create a math channel for the front ride height and another for the rear ride height. Create another channel for each end, which is ride height times, the ride rate (ride rate is wheel rate x2). This will give you down force at each end. Make another channel to find the % on the rear wheels.

A stiff car is very sensitive to speed, tire condition, and track condition. It will be fast if setup correctly but you will have to chase the setup as the track and tires change. It will have a much narrower line that can be driven around a corner.

Slick conditions or low track grip:

1- Less static roll stiffness distribution (+1%on the front) when cornering forces are modest (less bar both ends but remove less from the front) as well as less total roll stiffness. Oval track only, decrease static wedge. Make overall roll resistance distribution more front-stiff (both ends softer but remove less from the front).
2- Less dynamic roll stiffness. Remove low speed bump both ends and rebound both ends.

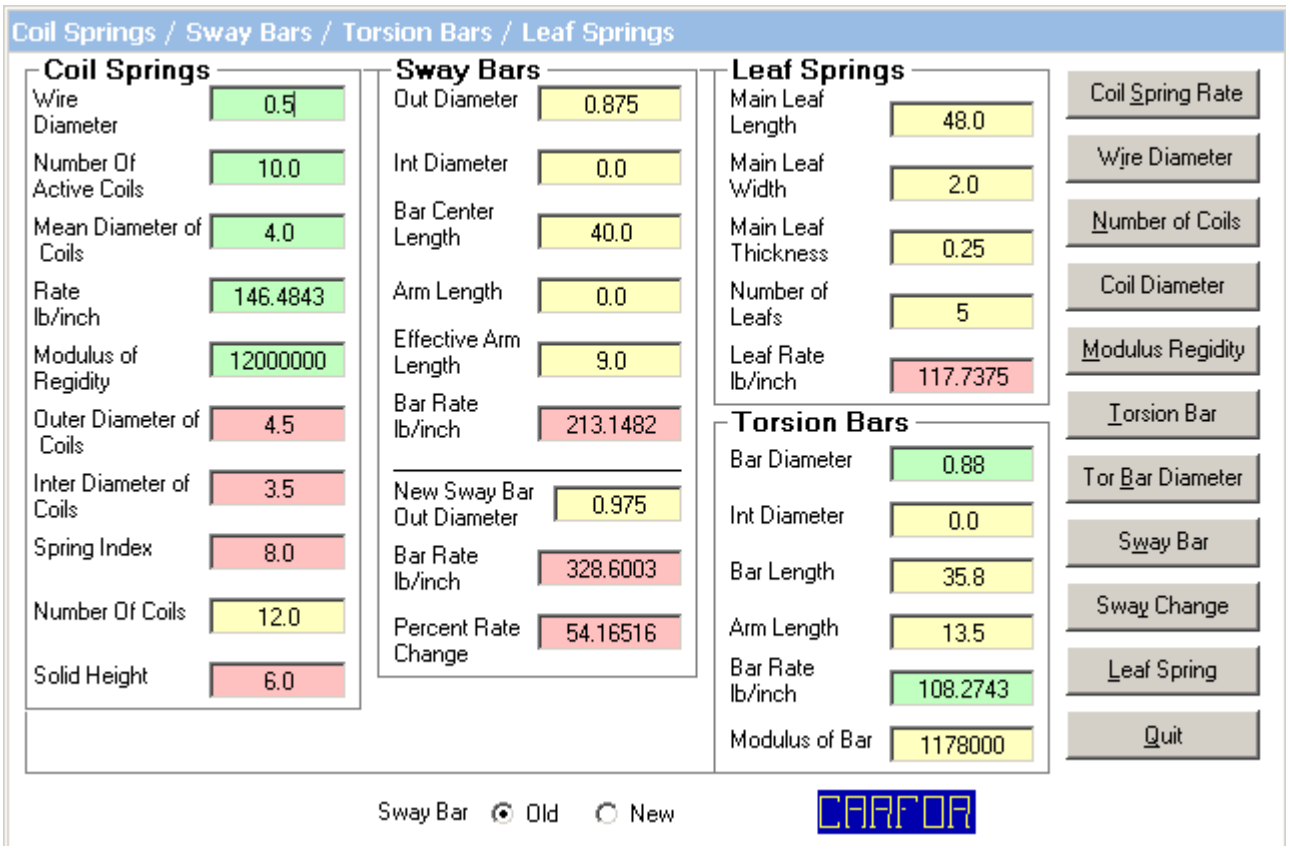
High grip needs stiffer roll resistance at both ends but proportionally softer at the front or stiffer at the back (1%). The shocks can also be stiffer but with less added to the front. This is just the opposite of the slick track.

Gas shock going hot:
Will cause wedge or de-wedge in the car if at one corner only. Will change ride height or rake if both shocks at one end have the higher pressure. Will change spring rate only a little. Watch for changes in shock velocity during a run that can be caused by a heat source near a shock.

To increase tire temperatures on a cold track raise the virtual swing arm heights to increase scrub to increase tire temps or use more toe on both ends.

Conclusions

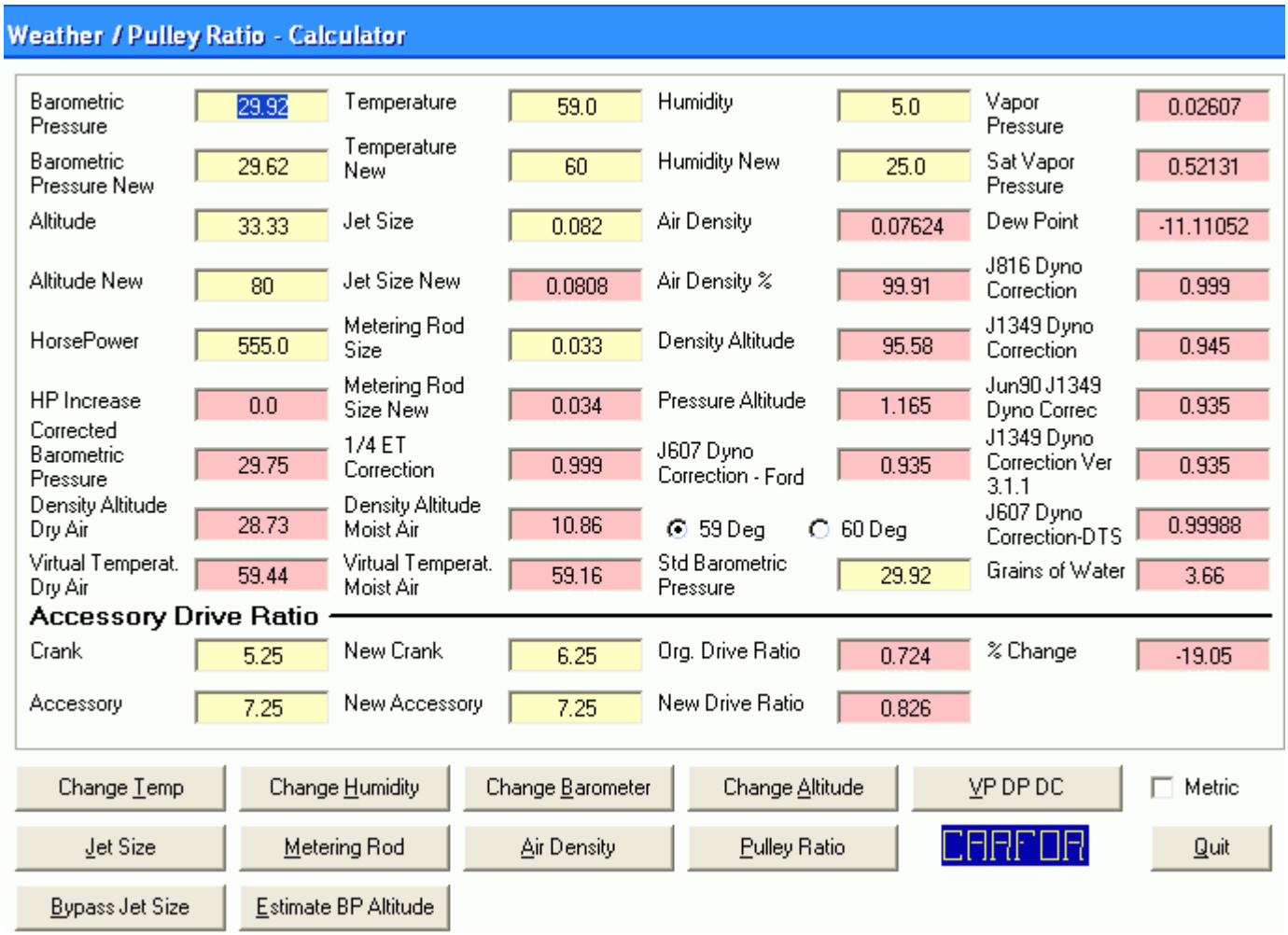
It is very easy to correct static roll stiffness problems by using shocks. It is also easy to correct total roll stiffness not correct with the aero layer. The closer each layer is to correct the more efficient and easier to drive at the limit. If you really get them crossed up the driver will have a very hard time giving a good assessment of the handling. I have seen some very professional drivers diagnose understeer as snap oversteer.



SPRINGS

NOTE: The **Modulus of Rigidity** is based on the material the spring is made of, and can be gotten from many physics books.
NOTE: The **Modulus of Bar** is based on the material the Torsion Bar is made of.

1) Calculate Coil Spring Rate from Wire Diameter, Number of Active Coils, Modulus of Rigidity, and the Diameter of the Coils (from wire center to wire center).
2) Calculate Wire Diameter from Coil Spring Rate, Number of Active Coils, Modulus of Rigidity, and the Diameter of the Coils (from wire center to wire center).
3) Calculate Number of Active Coils needed from Coil Spring Rate, Wire Diameter, Modulus of Rigidity, and the Diameter of the Coils (from wire center to wire center).
4) Calculate Diameter of the Coils (from wire center to wire center) from Coil Spring Rate, Wire Diameter, Number of Active Coils, and Modulus of Rigidity.
5) Calculate Modulus of Rigidity from Coil Spring Rate, Wire Diameter, Number of Active Coils, and the Diameter of the Coils (from wire center to wire center).
6) Calculate Torsion Bar Rate from Bar Diameter, Bar Int Diameter, Length of Bar, Arm Length and Modulus of Bar.
7) Calculate Bar Diameter from Bar Int Diameter, Torsion Bar Rate, Length of Bar, Arm Length and Modulus of Bar.
8) Calculate Sway Bar Rate from Bar Outer Diameter, Bar Inter Diameter (If bar is solid use zero), Length of Center Bar, Arm Length, and Effective Arm Length.
9) Calculate Sway Bar Rate Change from change in Bar Outer Diameter.
10) Calculate Leaf Spring Rate from Main Leaf Length, Main Leaf Width, Main Leaf Thickness, and number of Leafs.

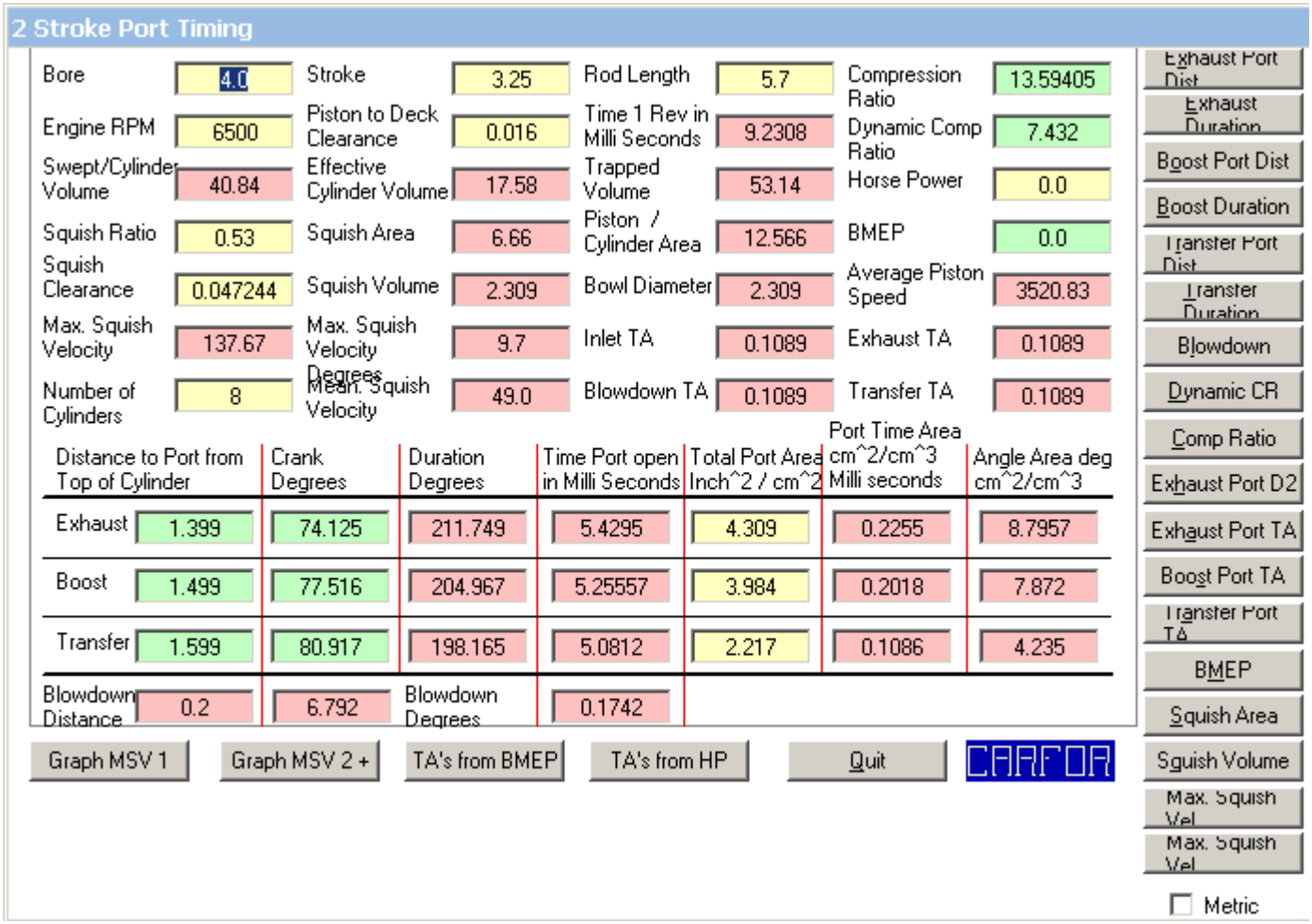


WEATHER

1) Estimate the Change in Horsepower from the change in Temperature.
2) Estimate the Change in Horsepower from the change in Humidity.
3) Estimate the Change in Horsepower from the change in Barometric Pressure.
4) Estimate the Change in Horsepower from the change in Altitude.
5) Calculate Vapor Pressure, Saturation Vapor Pressure, Dew Point, Dyno Correction Factory, Air Density, and Density Altitude.
6) Estimate the Change in Jet Size from the change in Barometric Pressure, Humidity, and Temperature.
7) Estimate the Change in Metering Rod Size from the change in Barometric Pressure, Humidity, and Temperature.
8) Estimate the Change in Bypass Jet Size for FI from the change in Barometric Pressure, Humidity, and Temperature. Note this function backwards from a carburetor jet.
9) Estimate Barometric Pressure from Altitude.
10) Calculate Pulley Drive Ratio and % Change in Drive Ratio from the Diameters of Crank Pulley, Accessory Pulley, New Crank Pulley, New Accessory Pulley.
    a. To get Accessory RPM multiple Crank RPM by Drive Ratio.

User can select 59 or 60 Degrees as standard temperature used.

Barometric Pressure - Is the actual or Station Pressure reading.
Vapor Pressure - Is the amount of water in the air.
Saturation Vapor Pressure - Is the maximum amount of water (vapor pressure) the air can hold.
Dyno Correction Factor – So that horsepower and torque numbers can be compared when measured at different temperatures, humidity and Barometer reading. The problem is there is more than one SAE "Standard Day" or rather they have changed what a Standard Day is.



2-Stroke Port Timing

1) Calculate Exhaust Piston Travel, using Stroke, Rod Length and Crank Degrees Rotation.
2) Calculate Exhaust Duration in Degrees / Crank Degrees ATDC it Opens / Time Port Open in Milliseconds, using RPM, Stroke, Rod Length, Deck Clearance and the Distance the Top of the Exhaust Port is from The Top of the Cylinder.
3) Calculate Boost Piston Travel, using Stroke, Rod Length and Crank Degrees Rotation.
4) Calculate Boost Duration in Degrees / Crank Degrees ATDC it Opens / Time Port Open in Milliseconds, using RPM, Stroke, Rod Length, Deck Clearance and the Distance the Top of the Boost Port is from The Top of the Cylinder.
5) Calculate Transfer Piston Travel, using Stroke, Rod Length and Crank Degrees Rotation.
6) Calculate Transfer Duration in Degrees / Crank Degrees ATDC it Opens / Time Port Open in Milliseconds, using RPM, Stroke, Rod Length, Deck Clearance and the Distance the Top of the Transfer Port is from The Top of the Cylinder.
7) Calculate Blowdown Degrees / Time in Milliseconds, using RPM, Exhaust Degrees ATDC and Transfer Degrees ATDC.
8) Calculate Dynamic Compression Ratio and Trapped Volume from Compression Ratio, Bore, Stroke, Distance of Exhaust Port from top of Cylinder, and Piston to Deck Clearance.
9) Calculate Compression Ratio from Dynamic Compression Ratio, Stroke, Distance of Exhaust Port from top of Cylinder, and Piston to Deck Clearance.
10) Calculate Distance to Exhaust Port from top of Cylinder from Compression Ratio from Dynamic Compression Ratio, Stroke, and Piston to Deck Clearance.

11) Calculate Exhaust Port Time Area and Angle Area, using Stroke, Bore, Time Port open in Milliseconds and Total Port Area.
12) Calculate Boost Port Time Area and Angle Area, using Stroke, Bore, Time Port open in Milliseconds and Total Port Area.
13) Calculate Transfer Port Time Area and Angle Area, using Stroke, Bore, Time Port open in Milliseconds and Total Port Area.
14) Calculate Average Piston Speed, and BMEP from Horsepower, number of cylinders, Bore, Stroke and RPM.
15) Calculate Squish and Piston areas from Bore and Squish Ratio.
16) Calculate Squish Volume from Squish Areas and Squish Clearance.

NOTE: These next 2 Functions ONLY Works in Metric Mode.

17) Calculate Max Squish Velocity and at what Degrees by every .01 Degrees from Bore, Stroke, Rod Length, Compression Ratio, RPM, Exhaust Crank Degrees ATDC - Open, Squish Ratio, and Squish Clearance.
18) Calculate Max Squish Velocity and at what Degree by every Degree from Bore, Stroke, Rod Length, Compression Ratio, RPM, Exhaust Crank Degrees ATDC - Open, Squish Ratio, and Squish Clearance.

NOTE: MSV is a function of combustion chamber / squish geometry. Some factors, which will increase MSV, are:

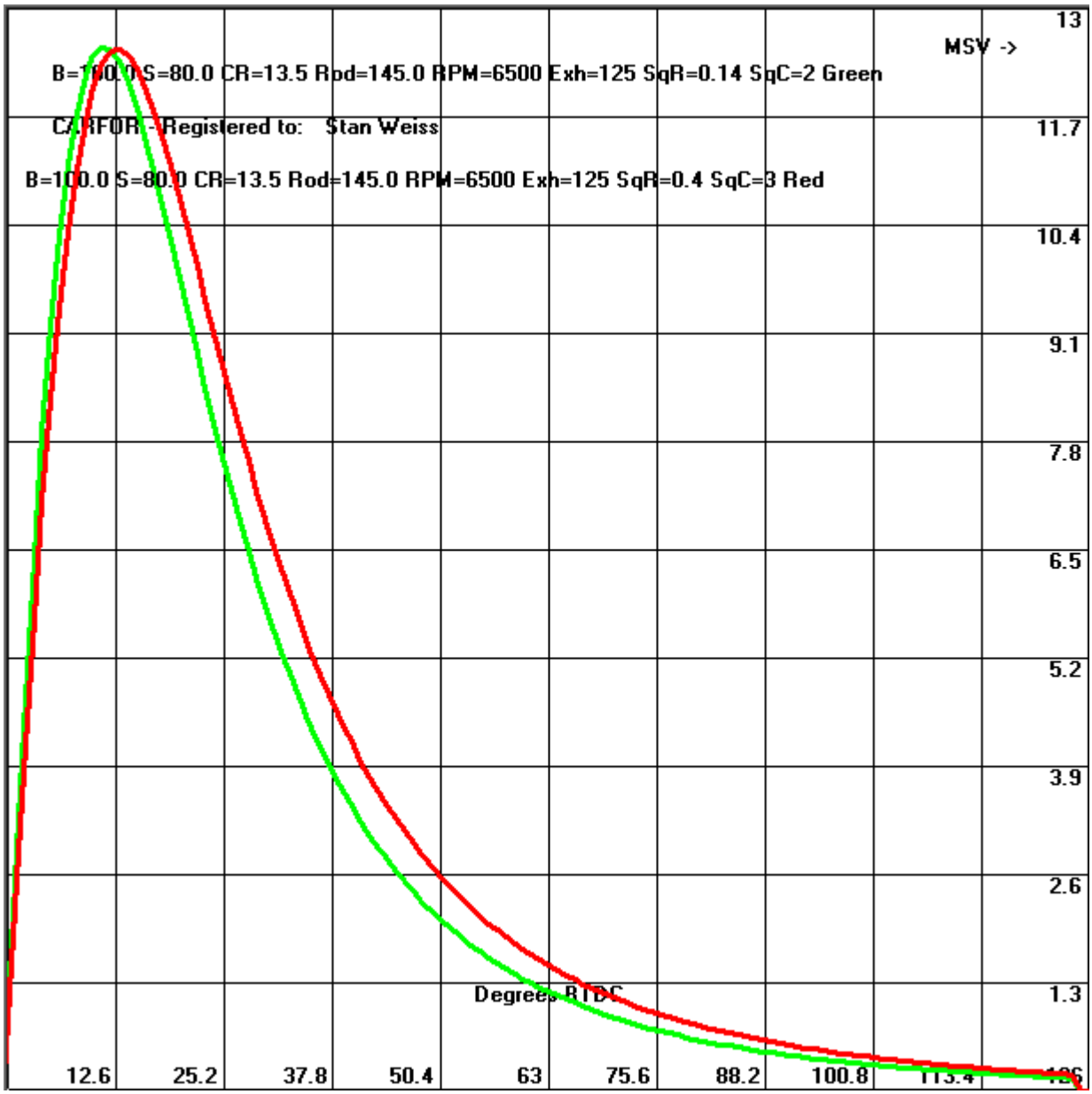
a) **Increase in RPM**
b) **Increase squish area ratio**
c) **Decrease squish clearance**
d) **Lower CR**
e) **Shorter Rod**
f) **Lower Intake Port**

The reverse of these will decrease MSV. N/A engines will want more MSV than engines that have had boost or N2O added to them and the more boost or N2O added the lower MSV should be.

19) Estimate Inlet, Exhaust, Transfer, and Blowdown TA's from BMEP.
20) Estimate Inlet, Exhaust, Transfer, and Blowdown TA's from HP, RPM, number of cylinders, and Engine Size.
21) Graph (MVS 1) Squish Velocity by Degree from Bore, Stroke, Rod Length, Compression Ratio, RPM, Exhaust Crank Degrees ATDC - Open, Squish Ratio, and Squish Clearance.
22) Graph (MVS 2 +) Squish Velocity by Degree from Bore, Stroke, Rod Length, Compression Ratio, RPM, Exhaust Crank Degrees ATDC - Open, Squish Ratio, and Squish Clearance. This lets the user graph second or more MVS on the same graph started by MVS 1.

Note – **Compression Ratio is also known as Uncorrected Compression Ratio.**
This method compares the volume above the piston at Bottom Dead Center (BDC) to the volume above the piston at Top Dead Center (TDC).

Note – **Dynamic Compression Ratio is also known as Corrected Compression Ratio or Trapped Compression Ratio.**
This method compares the volume above the piston at the point on the upstroke that the exhaust port is fully closed to the volume above the piston at Top Dead Center (TDC).


MSV ->
B=100.0 S=80.0 CR=13.5 Rod=145.0 RPM=6500 Exh=125 SqR=0.14 SqC=2 Green
CARFOR - Registered to: Stan Weiss
B=100.0 S=80.0 CR=13.5 Rod=145.0 RPM=6500 Exh=125 SqR=0.4 SqC=3 Red
13
11.7
10.4
9.1
7.8
6.5
5.2
3.9
2.6
1.3
Degrees BTDC
12.6
25.2
37.8
50.4
63
75.6
88.2
100.8

GRAPHER

User Commands

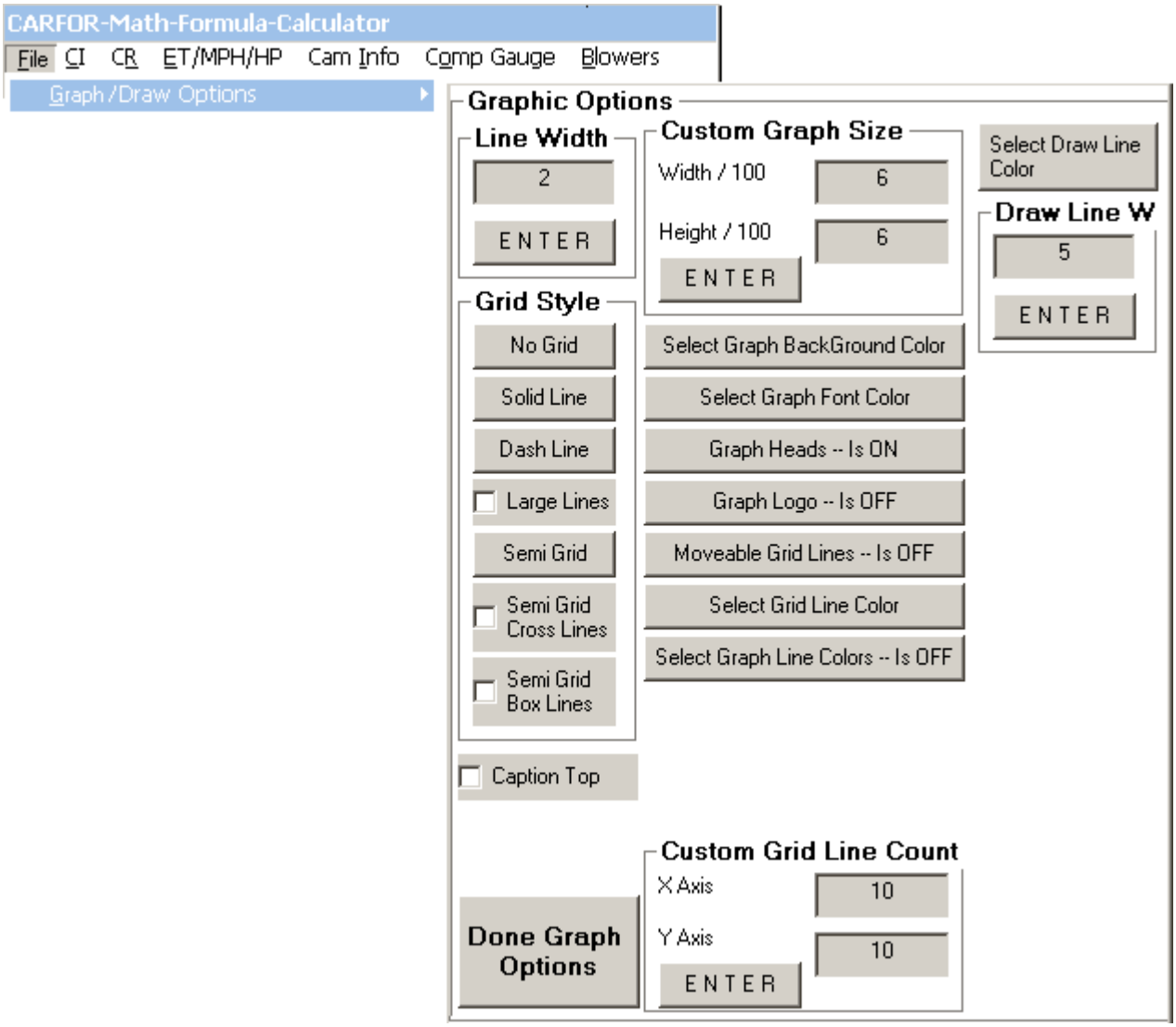
Graph – The user enters the horsepower and RPM and then selects different curve types to find which one best matches his engine. The curve is displayed with a baseline line curve. The + plus lets the user zoom in and the – minus lets the user zoom out.

Save as BMP – Will save the graph to disc in BMP format.

Read BMP – Will Read in (Open) a BMP graph from the disc.

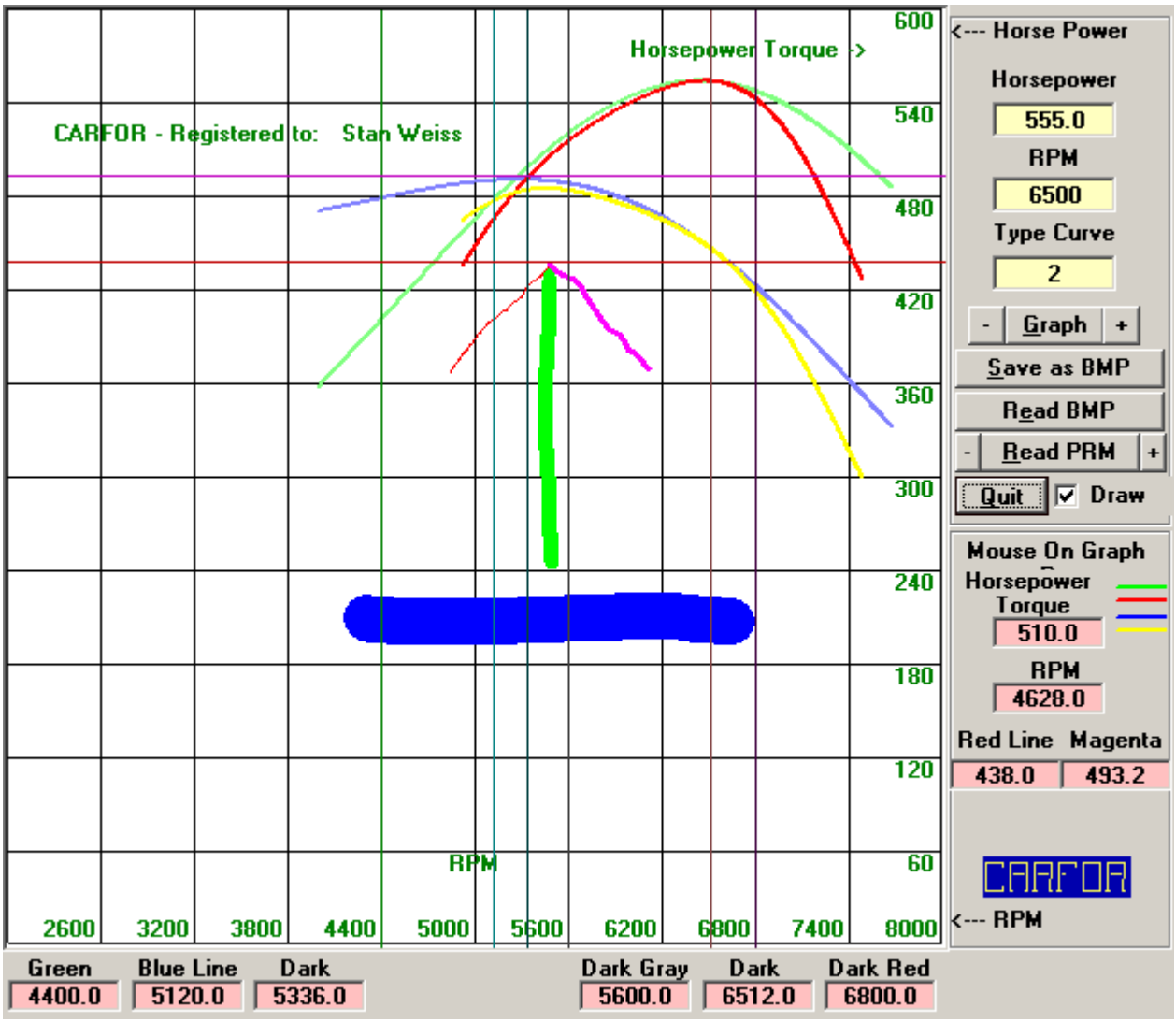
Read PRM – Will Read in (open) a parameter file that has graphing commands – see next page (User drawn graphics).

The user can customize the Graph and Draw Functions.



Placing the mouse on the graph will let the user get the Horse Power or Torque and RPM values for that position on the graph, these valves will be updated as the user moves the mouse along the curve.

If the **Draw Box is checked** you can use the mouse to draw on the Graph. Using different size and color lines to create shapes, like the arrow below – next page.



User Drawn Graphics

The Green line is the Torque curve and the Yellow line is the Horse Power curve from data extracted from a *.dyn file. There is a **sample file** included called "graph.prm".

User Commands - Note commands maybe in either upper or lower case.

Overlay - If used the overlay keyword MUST be the first line in the parameter file - it means to plot these points without cleaning the graph screen.

Grid x l = 18 - This will set the number of grid line on the X Axis to 18 the default is 10.

Grid y l = 14 - This will set the number of grid line on the Y Axis to 14 the default is 10.

Xlow = 0 - This is the lowest x value which will show on the graph.

Xhigh = 10500 - This is the highest x value which will show on the graph.

Ylow = 0 - This is the lowest y value which will show on the graph

Yhigh = 550 - This is the highest y value which will show on the graph

These will be ignored if you use the overlay parameter. They are also used to calculate the x and y display numbers

Reset = -- sets the current position on the graph to xlow, ylow

Color = red - sets the current drawing color which can have a value of white, black, green, blue, cyan, magenta, yellow - brown, chocolate, dark blue, dark cyan, dark gray, dark green, dark red, light blue, light cyan, light gray, light green, light yellow, orange

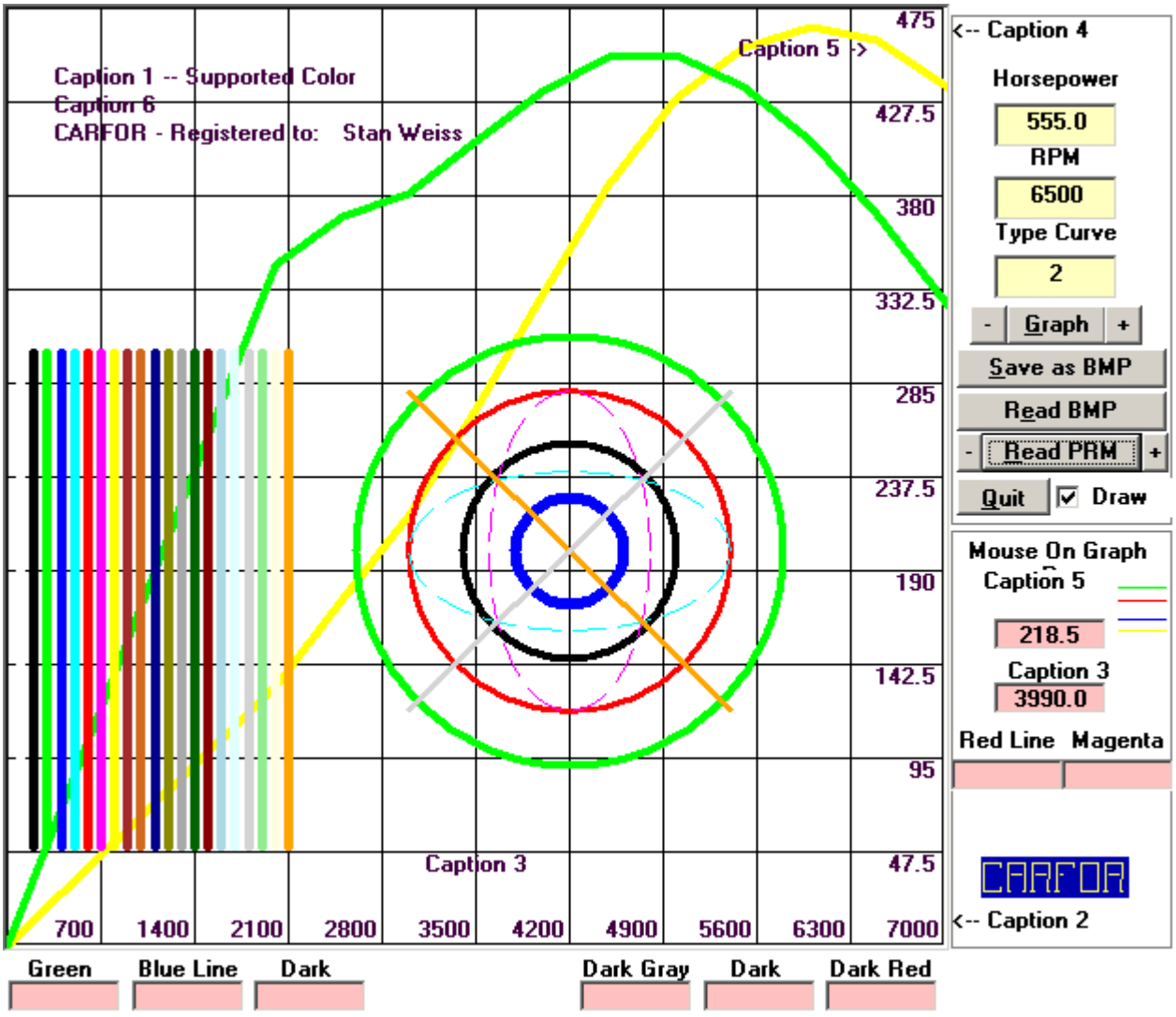
Drawwidth = 1 - This sets the width of the line in pixels.

Drawstyle = 2 - This sets the style of the line, but only works when drawwidth = 1. Values maybe 0 = solid, 1 = Dash, 2 = Dot, 3 = Dash-Dot, 4 = Dash-Dot-Dot,

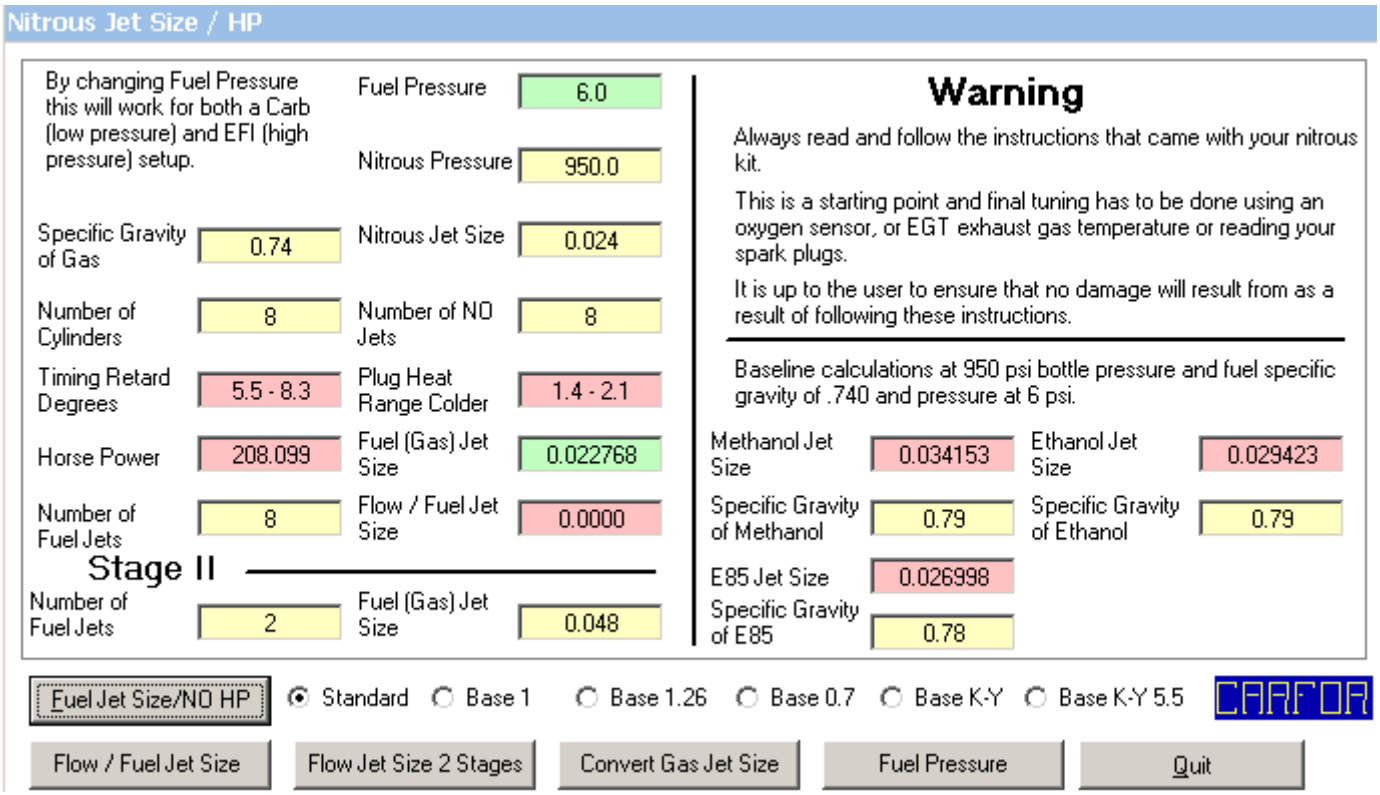
Caption1 = Caption1 -- Supported Color - This lets the user print a caption on the graph.

Caption6 = Caption6 - This lets the user print a second caption line on the graph.
Caption2 = ← Caption 2 - This lets the user print a caption for the x-axis on the graph.
Caption3 = Caption 3 - This lets the user print a caption for the x-axis mouse readout on the graph.
Caption4 = ← Caption 4 - This lets the user print a caption for the y-axis on the graph.
Caption5 = Caption 5 - This lets the user print a caption for the y-axis mouse readout on the graph.
Line to = 5000,700.0 - draw a line to x, y from the current position and set the current position to x, y
Line = 30,50,5621.7,500 - draw a line from x, y, to x1, y1
Circle = 5250,425,800[, 1] - draw a circle at x, y, radius [, height width ratio]
Check graph below to see **ellipses** that was drawn
Color = cyan
Circle = 5250,425,2400,5 - ellipse
Color = magenta
Circle = 5250,425,2400,2 - ellipse

x scale
y scale
x shift
y shift
These only work when using the "overlay" parameter. I changed the Logic so the x and y points will be scaled and or shifted by these amounts.



NOTE: reading in the file GRAPHN.PRM generated this graph



Nitrous Jet Size / HP

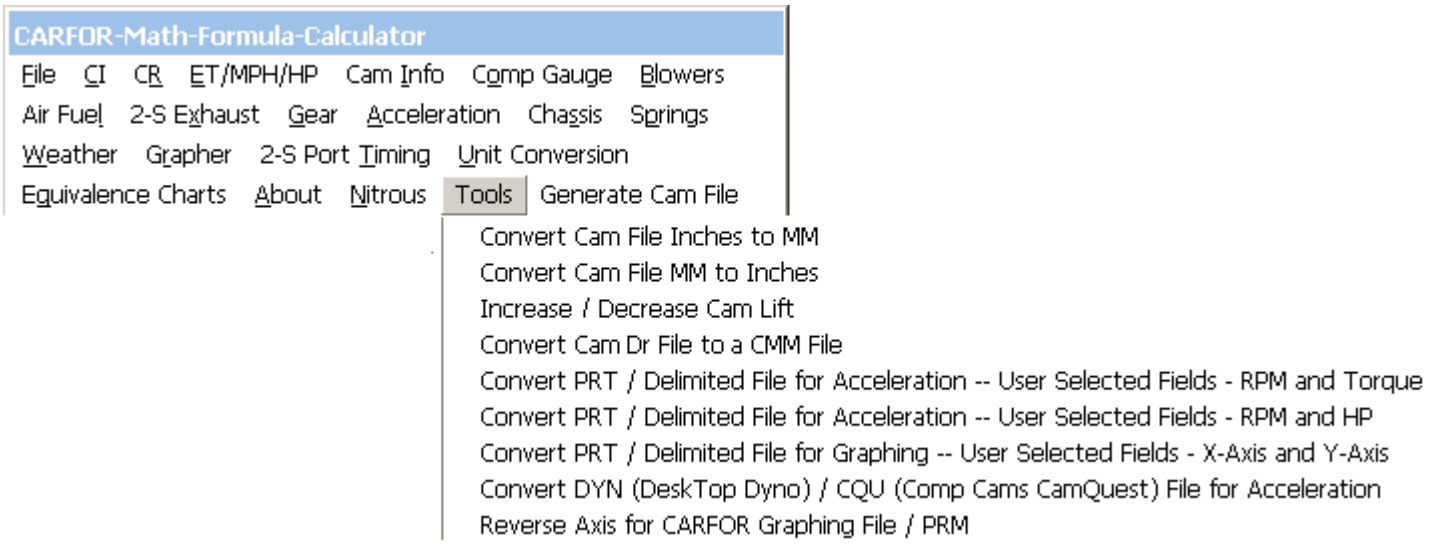
1) Calculate Horse Power, Timing Retard in Degrees, Plug Heat Range Change, and Fuel Jet Size using Fuel Pressure, Nitrous Pressure, Nitrous Jet Size, and Number of Nitrous Jets used.
   Note: - The number of Cylinders in ONLY used in Calculating Timing Retard in Degrees and Spark Plug Heat Range Change.
2) Calculate Flow / Fuel Jet Size needed to simulate the flow at your Jets / Nozzles so that fuel pressure can be set, using Fuel (Gas) Jet Size and Number of Fuels Jets.
3) Calculate Flow / Fuel Jet Size needed to simulate the flow at your Jets / Nozzles for TWO Stages so that fuel pressure can be set, using Fuel (Gas) Jet Size and Number of Fuels Jets Plus 'Stage II' Fuel (Gas) Jet Size and Number of Fuels Jets.
4) Convert Gas Jet Size using Specific Gravity of Gas, Specific Gravity of E85, Specific Gravity of Ethanol, and Specific Gravity of Methanol giving E85, Ethanol, and Methanol Fuel Jet Sizes.
5) Calculate Fuel Pressure from Fuel Jet Size and Nitrous Jet Size and Nitrous Pressure.

NOTE: For #2 and #3 above - This one jet will have the same area as all of your fuel jets combined. You can only use this method if your set up has a dedicated fuel pump for the nitrous system(s).

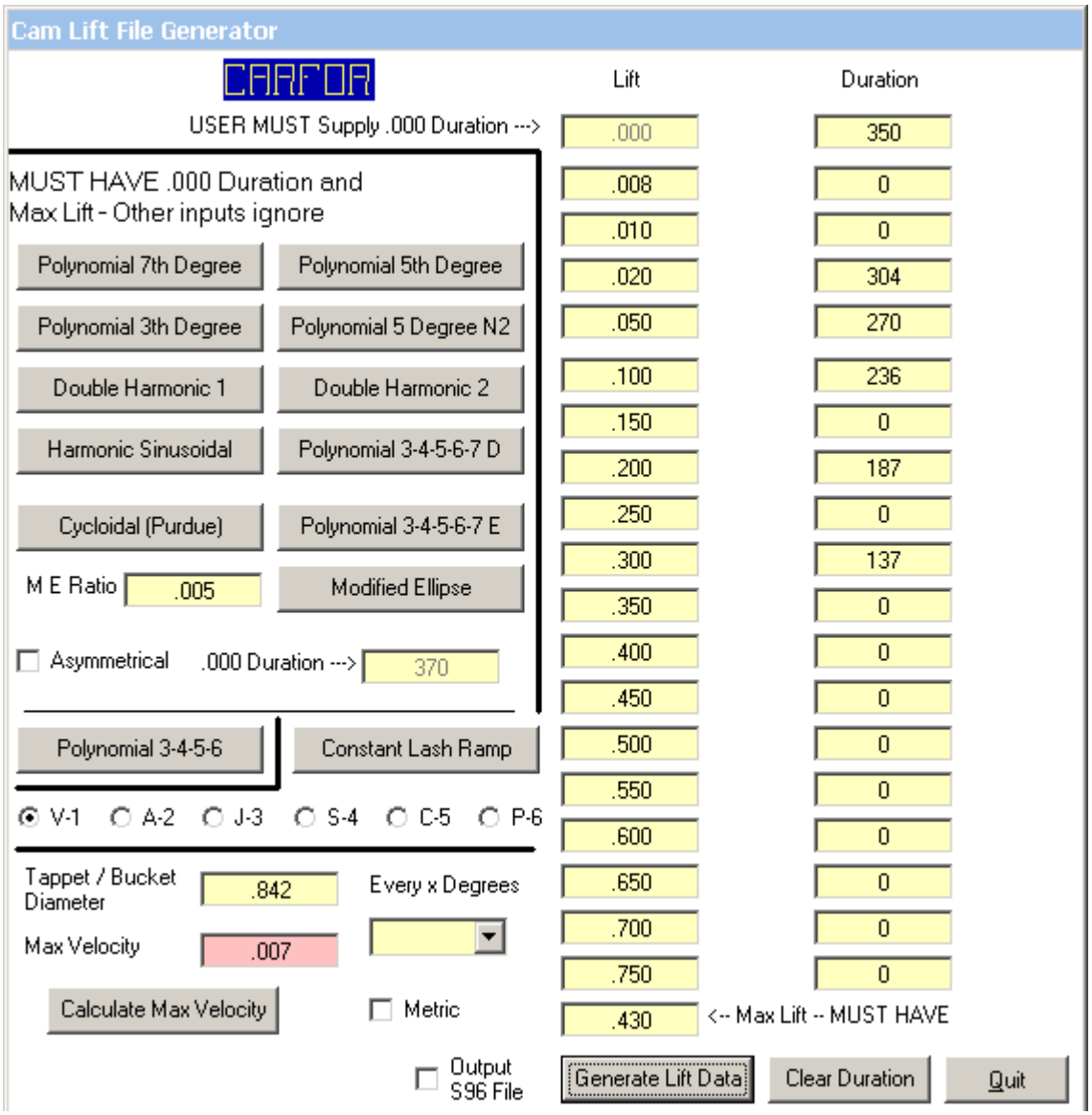
Select the Radio Button for the type of Nitrous System that you have.
Standard - This will calculate values that are the same as most web calculator.
Base 1 - This will calculate values that are like many NOS Fogger systems also Nitrous Express (NX) plate, Speedtech plate and Nitrous Pro-Flow plate.
Base 1.26 - This will calculate values that are like many Nitrous-Oxide Systems (NOS) Cheater systems.
Base 0.7 - This will calculate values that are like some Cheater systems Nitrous Works plate and ZEX plate.
Base K-Y - This will calculate values that can be on the lean **use great care.**
Base K-Y 5.5 - This will calculate values that can be on the lean **use great care.**

By changing Fuel Pressure this will work for both a Carburetor (low pressure) and EFI (high pressure) setup.
Always read and follow the instructions that came with your nitrous kit.
It is up to the user to ensure that no damage will result from as a result of following these instructions.

TOOLS

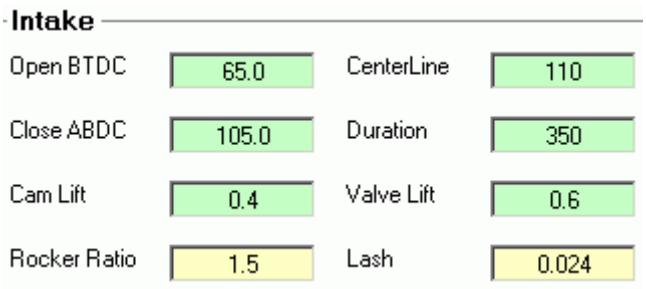

CARFOR-Math-Formula-Calculator
File CI CR ET/MPH/HP Cam Info Comp Gauge Blowers
Air Fuel 2-S Exhaust Gear Acceleration Chassis Springs
Weather Grapher 2-S Port Timing Unit Conversion
Equivalence Charts About Nitrous Tools Generate Cam File
Convert Cam File Inches to MM
Convert Cam File MM to Inches
Increase / Decrease Cam Lift
Convert Cam Dr File to a CMM File
Convert PRT / Delimited File for Acceleration -- User Selected Fields - RPM and Torque
Convert PRT / Delimited File for Acceleration -- User Selected Fields - RPM and HP
Convert PRT / Delimited File for Graphing -- User Selected Fields - X-Axis and Y-Axis
Convert DYN (DeskTop Dyno) / CQU (Comp Cams CamQuest) File for Acceleration
Reverse Axis for CARFOR Graphing File / PRM

GENERATE CAM LIFT FILE



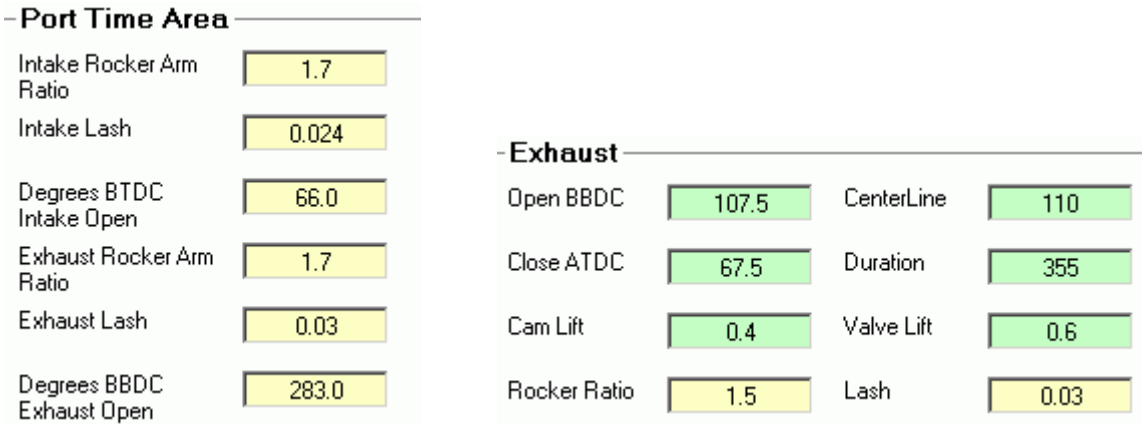
Generate Lift Data - This option will generate a Cam Lift data File "CMM" from a limited number of data point. This is in no way able to reverse engineer the true measured cam lift / degree data but, does let some comparison be done between different lobes. This is **NOT** a Cam Lobe Design Tool and it does not replace measuring the actual Cam with something like a Cam Doctor or a Dial Indicator and Degree Wheel.

Calculate Max Velocity - This option will calculate the max velocity measured at the lifter measured in inch per degree of cam rotation.



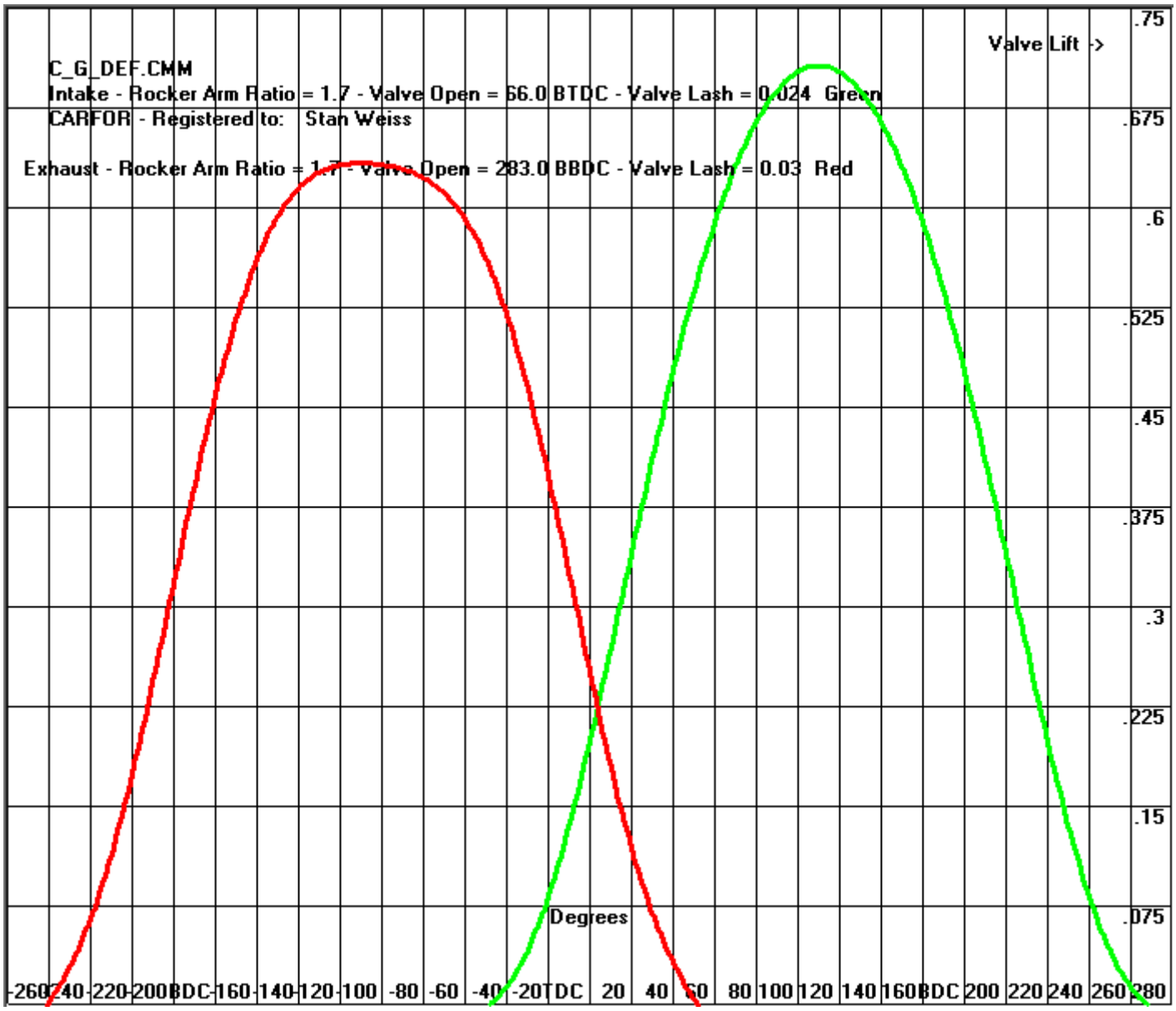
Using the Camshaft screen with the .000 duration and wanted ICL we can get a starting point for Degrees BTDC Intake Open of 65.
If you entered these values and generated an exhaust lobe, you would need to edit the generated CMM file by removing the "every x degrees = 1" line and changing the word "intake" to "exhaust". You would then append this file to the end of the file that you generated for the intake lobe.

Using the following Intake and Exhaust point will produce a 110 LSA with a 110 ICL.



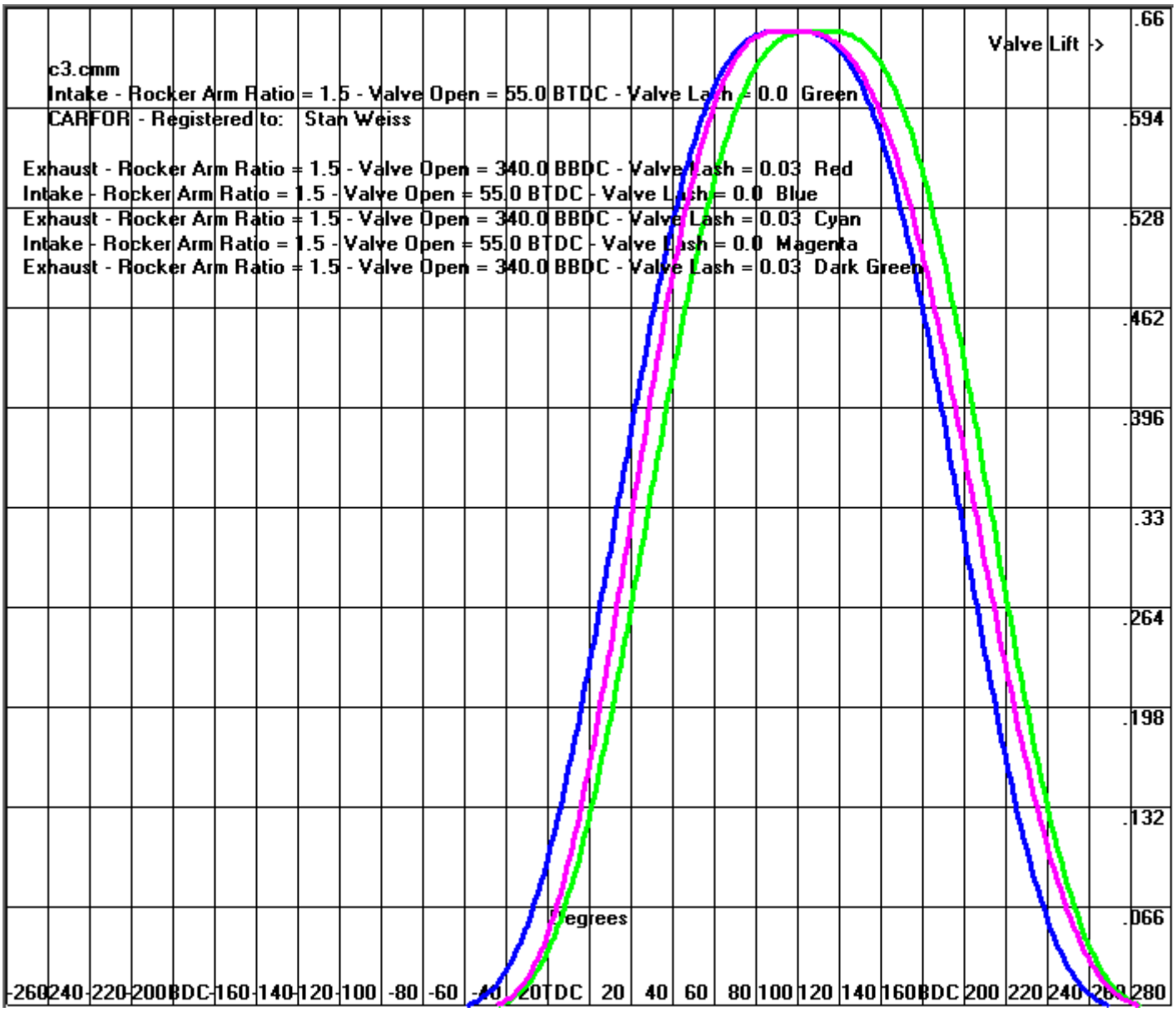
Using the Camshaft screen with the .000 duration and wanted ECL we can get a starting point for Degrees BBDC Exhaust Open by taking the 107.7 and adding 180.
► 107.5 + 180 = 287.5.

Constant Lash Ramp - This option will generate an open and close lash ramp. The .000 duration will be the length of the ramp and max lift will be the height of the ramp. There are 6 different styles based on which radio button is clicked. V-1 is a Constant Velocity, A-2 is a constant Acceleration and so on.



Produced using cam file - C_G_DEF.CMM

Example of Asymmetrical Cam



Produced using cam files – C3.CMM and C300_360

The Green line from a "CMM" file produced using a 330 .000 Duration and .430 max lift with the Cycloidal option. The Blue line is the same "CMM" file advanced 15 degrees. The Magenta line a "CMM" file produced using a 300 .000 Duration with the Asymmetric Box checked and 360 Asymmetric .000 Duration and .430 max lift with the Cycloidal option. While this curve has the same opening and closing points as the Green line, it has the centerline as the Blue line.

Using .450" max lift What .000" lift duration is needed to product 280 degrees @ 0.050" lift for each different type.

Note all are displayed using a 110 ICL

Polynomial 7th Degree - 391.5 - 86.25

Cam Lift	Opens Deg BTDC	Closes Deg ABDC	Duration	Area
0.00600	56.09	96.59	332.68	44.34
0.01000	51.42	91.92	323.34	44.31
0.02000	43.67	84.17	307.83	44.19
0.04000	33.70	74.20	287.90	43.90
0.05000	29.86	70.36	280.22	43.72
0.10000	15.15	55.65	250.80	42.61
0.15000	3.66	44.16	227.82	41.23
0.20000	-6.64	33.86	207.22	39.50
0.25000	-16.61	23.89	187.28	37.27
0.30000	-26.91	13.59	166.69	34.24
0.35000	-38.40	2.10	143.70	30.65
0.40000	-53.11	-12.61	114.28	25.00
0.45000	-108.75	-68.25	3.00	0.90

Minor Intensity 43.11
Major Intensity 27.61

Polynomial 5th Degree - 375 - 78.5

Cam Lift	Opens Deg BTDC	Closes Deg ABDC	Duration	Area
0.00600	56.57	96.57	333.13	42.61
0.01000	52.16	92.16	324.32	42.57
0.02000	44.54	84.54	309.08	42.47
0.04000	34.33	74.33	288.66	42.14
0.05000	30.30	70.30	280.60	41.96
0.10000	14.46	54.46	248.91	40.76
0.15000	1.79	41.79	223.58	39.27
0.20000	-9.68	30.32	200.64	37.17
0.25000	-20.82	19.18	178.36	34.68
0.30000	-32.29	7.71	155.42	31.65
0.35000	-44.96	-4.96	130.08	27.43
0.40000	-60.80	-20.80	98.40	21.40
0.45000	-108.97	-68.97	2.06	0.45

Minor Intensity 43.72
Major Intensity 28.48

Polynomial 3th Degree - 353 - 66.5

Cam Lift	Opens Deg BTDC	Closes Deg ABDC	Duration	Area
0.00600	54.46	94.46	328.92	39.69
0.01000	50.85	90.85	321.69	39.66
0.02000	44.05	84.05	308.10	39.56
0.04000	34.07	74.07	288.14	39.26
0.05000	29.91	69.91	279.83	39.08
0.10000	12.68	52.68	245.37	37.84
0.15000	-1.80	38.20	216.40	35.97
0.20000	-15.20	24.80	189.60	33.70
0.25000	-28.30	11.70	163.40	30.79
0.30000	-41.70	-1.70	136.60	26.93
0.35000	-56.18	-16.18	107.63	22.37
0.40000	-73.41	-33.41	73.18	16.00

Minor Intensity 41.87
Major Intensity 28.27

Polynomial 5th Degree N2 - 345 - 62.5

Cam Lift	Opens Deg BTDC	Closes Deg ABDC	Duration	Area
0.00600	51.56	91.56	323.12	43.11
0.01000	48.35	88.35	316.70	43.07
0.02000	42.39	82.39	304.78	42.98
0.04000	33.78	73.78	287.57	42.74
0.05000	30.24	70.24	280.47	42.57

0.10000	15.70	55.70	251.39	41.53
0.15000	3.57	43.57	227.14	40.06
0.20000	-7.68	32.32	204.65	37.96
0.25000	-18.78	21.22	182.44	35.47
0.30000	-30.37	9.63	159.27	32.45
0.35000	-43.30	-3.30	133.41	28.23
0.40000	-59.62	-19.62	100.76	21.83

Minor Intensity 36.23
Major Intensity 24.31

Double Harmonic 1 - 458 - 119.5

Cam	Lift	Opens Deg BTDC	Closes Deg ABDC	Duration	Area
	0.00600	68.96	108.96	357.92	38.81
	0.01000	61.71	101.71	343.43	38.75
	0.02000	49.96	89.96	319.92	38.58
	0.04000	35.29	75.29	290.59	38.14
	0.05000	29.77	69.77	279.55	37.91
	0.10000	9.17	49.17	238.35	36.37
	0.15000	-6.32	33.68	207.36	34.51
	0.20000	-19.77	20.23	180.46	32.07
	0.25000	-32.39	7.61	155.23	29.38
	0.30000	-44.96	-4.96	130.08	25.81
	0.35000	-58.36	-18.36	103.28	21.59
	0.40000	-74.30	-34.30	71.41	15.59
	0.45000	-109.50	-69.50	1.00	0.45

Minor Intensity 63.88
Major Intensity 40.37

Double Harmonic 2 - 330 - 55

Cam	Lift	Opens Deg BTDC	Closes Deg ABDC	Duration	Area
	0.00600	46.41	87.41	313.83	46.61
	0.01000	43.88	84.88	308.76	46.59
	0.02000	39.20	80.20	299.40	46.53
	0.04000	32.43	73.43	285.86	46.33
	0.05000	29.64	70.64	280.27	46.19
	0.10000	18.15	59.15	257.31	45.39
	0.15000	8.50	49.50	238.00	44.15
	0.20000	-0.56	40.44	219.88	42.58
	0.25000	-9.65	31.35	201.70	40.56
	0.30000	-19.34	21.66	182.31	37.80
	0.35000	-30.51	10.49	159.98	34.21
	0.40000	-45.35	-4.35	130.30	28.56
	0.45000	-109.00	-68.00	3.00	0.90

Minor Intensity 28.49
Major Intensity 19.12

Harmonic Sinusoidal - 356 - 68.5

Cam	Lift	Opens Deg BTDC	Closes Deg ABDC	Duration	Area
	0.00600	55.39	95.39	330.78	40.25
	0.01000	51.55	91.55	323.09	40.22
	0.02000	44.43	84.43	308.86	40.10
	0.04000	34.20	74.20	288.39	39.80
	0.05000	29.99	69.99	279.99	39.62
	0.10000	12.88	52.88	245.75	38.37
	0.15000	-1.24	38.76	217.51	36.64
	0.20000	-14.19	25.81	191.62	34.38
	0.25000	-26.81	13.19	166.38	31.45
	0.30000	-39.76	0.24	140.49	27.86
	0.35000	-53.88	-13.88	112.25	23.30
	0.40000	-70.99	-30.99	78.01	16.90
	0.45000	-109.50	-69.50	1.00	0.45

Minor Intensity 43.11
Major Intensity 28.88

Cycloidal (Prudue) - 382 - 81.5

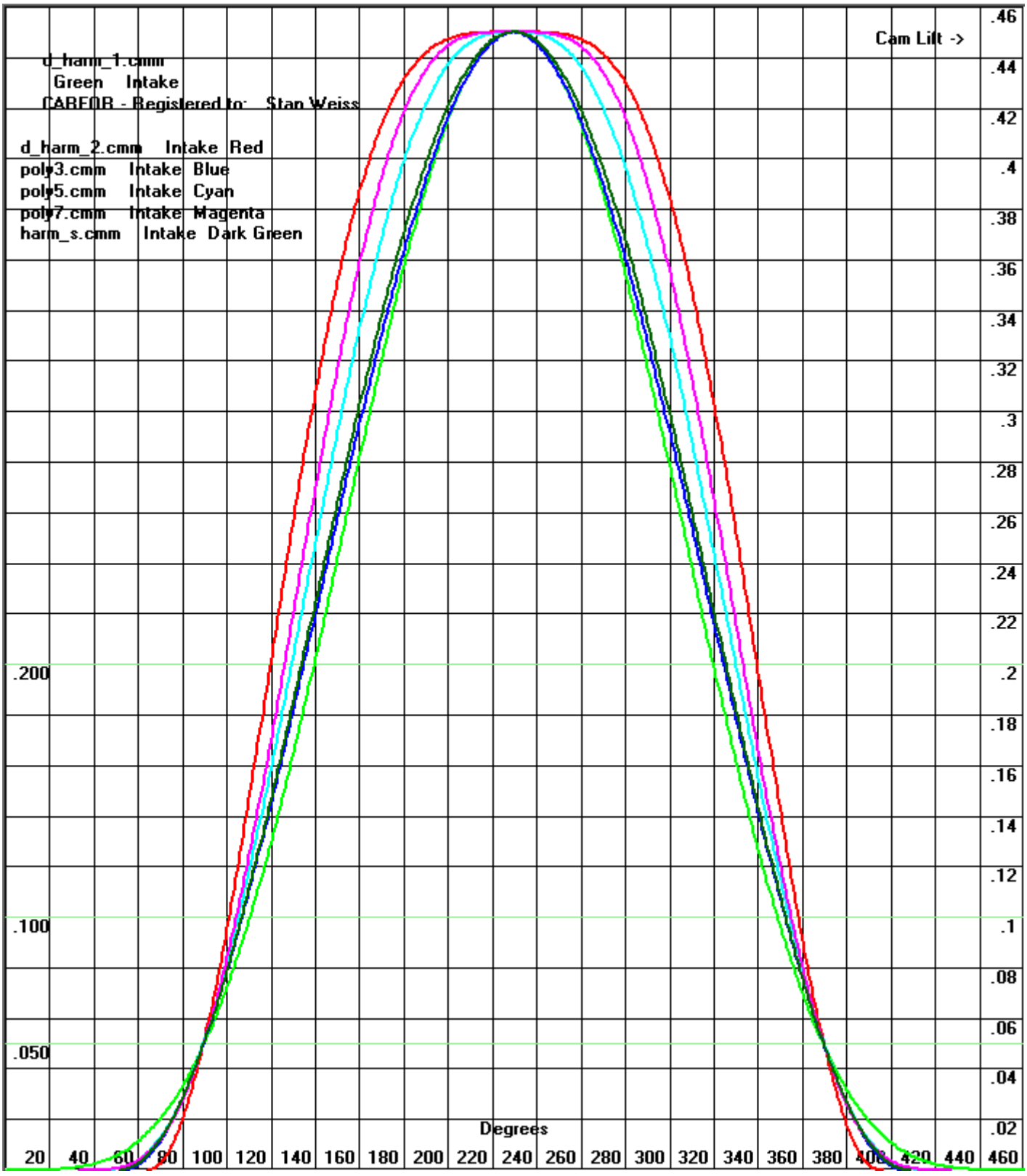
Cam Lift	Opens Deg BTDC	Closes Deg ABDC	Duration	Area
0.00600	57.08	97.08	334.16	43.16
0.01000	52.40	92.40	324.81	43.12
0.02000	44.49	84.49	308.98	43.00
0.04000	34.13	74.13	288.26	42.70
0.05000	30.10	70.10	280.20	42.52
0.10000	14.53	54.53	249.06	41.43
0.15000	2.30	42.30	224.60	39.81
0.20000	-8.68	31.32	202.64	37.88
0.25000	-19.32	20.68	181.36	35.63
0.30000	-30.30	9.70	159.40	32.61
0.35000	-42.53	-2.53	134.94	28.38
0.40000	-58.10	-18.10	103.80	22.72
0.45000	-109.50	-69.50	1.00	0.45

Minor Intensity 44.61
Major Intensity 28.78

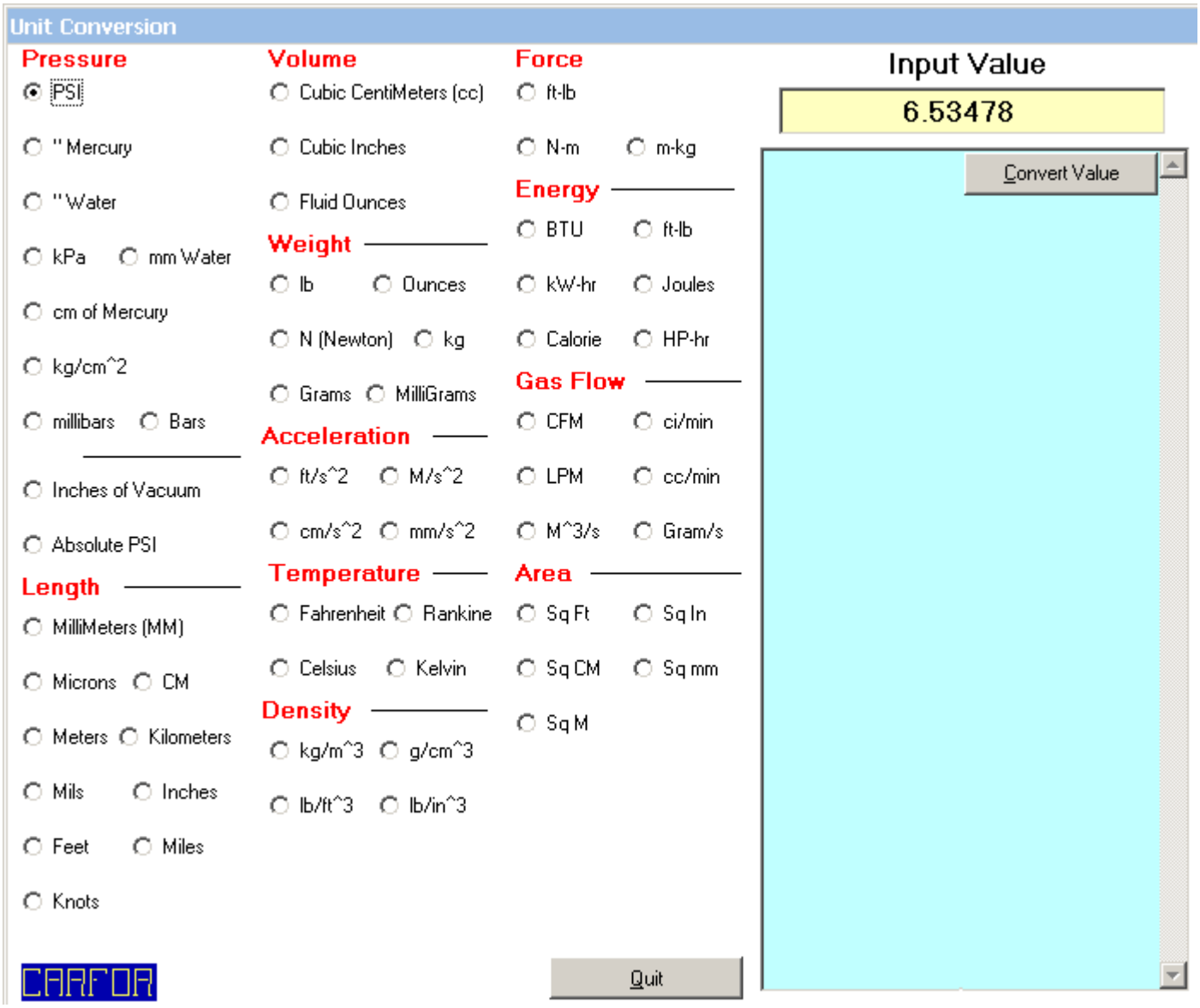
Polynomial 3-4-5-6 - 388.5 - 84.5

Cam Lift	Opens Deg BTDC	Closes Deg ABDC	Duration	Area
0.00600	59.92	99.42	339.34	39.92
0.01000	54.95	94.45	329.40	39.88
0.02000	46.35	85.85	312.21	39.75
0.04000	34.80	74.30	289.09	39.42
0.05000	30.23	69.73	279.95	39.21
0.10000	12.23	51.73	243.95	37.89
0.15000	-2.18	37.32	215.13	36.08
0.20000	-15.21	24.29	189.08	33.81
0.25000	-27.81	11.69	163.88	31.00
0.30000	-40.68	-1.18	138.13	27.42
0.35000	-54.69	-15.19	110.13	22.86
0.40000	-71.64	-32.14	76.23	16.46

Minor Intensity 49.45
Major Intensity 32.25

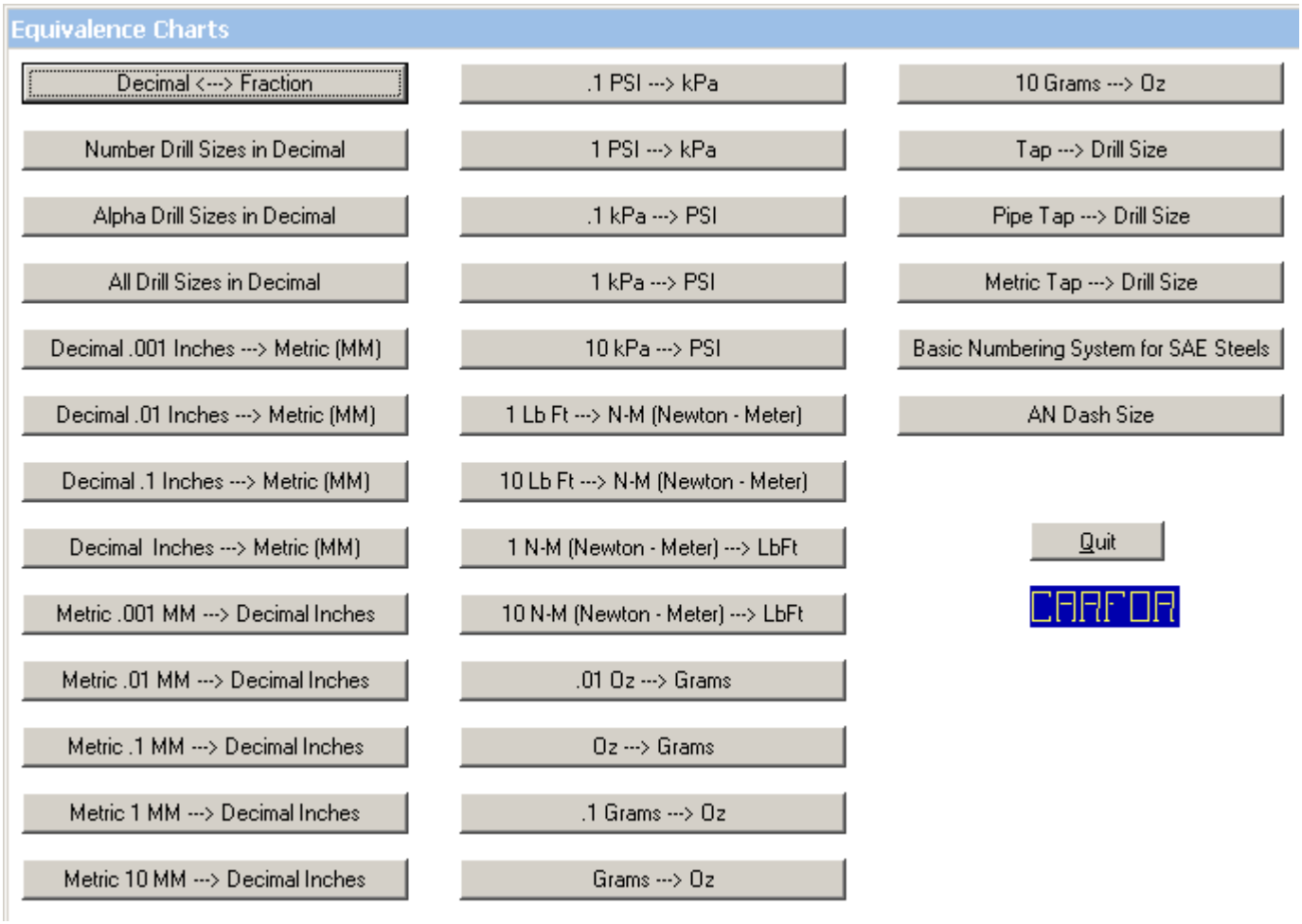

Cam Lift ->
d_harm_1.cmm
Green Intake
CARFOR - Registered to: Stan Weiss
d_harm_2.cmm Intake Red
poly3.cmm Intake Blue
poly5.cmm Intake Cyan
poly7.cmm Intake Magenta
harm_s.cmm Intake Dark Green
.46
.44
.42
.4
.38
.36
.34
.32
.3
.28
.26
.24
.22
.200
.2
.18
.16
.14
.12
.100
.1
.08
.06
.050
.04
.02
Degrees
20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420 440 460

UNIT CONVERSION



NOTE: Gram/sec Air Density was set using a Barometric Pressure of 29.92, Temperature 70 Degree F, Humidity 30%

EQUIVALENCE CHARTS



T r o u b l e S h o o t i n g:

This program is written in Microsoft's Visual Basic (VB) programming language. This means you must have the VB runtime DLL on you system. I have found only a small number of people have not had this file. If you need this file it can be found on my web site.

If you get the error –
Component 'comdlg32.oxc' or one of its dependencies not correctly registered: a file is missing or invalid

You can download the ocx from my web site - http://users.erols.com/srweiss/comdlg32.zip.
You need to unzip and copy the comdlg32.ocx file into the c:\windows\system32 folder.
You then need to register comdlg32.ocx with windows - START > RUN - > Then type the following:
REGSVR32 c:\windows\system32\comdlg32.ocx. . . . and hit the Enter key.
For this command to work -
"c:" must equal the drive where you placed comdlg32.ocx
"\windows\system32\" must equal the path to the folder where you placed comdlg32.ocx
If you are running VISTA or Windows 7 because of their increased security try selecting "Run as Administrator".

- License for the registered version is not transferable.
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E-mail: srweiss@erols.com

You can always get the latest User's Manual from my Web Site in PDF format
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You can always see what the latest version has added at my Web Site.
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1. The program must not be modified in any way.

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Glossary / Definitions / Abbreviations

ABDC - After Bottom Dead Center
ABS - Anti-Lock Braking System - A system that is designed to stop the wheels from locking up when you apply the brake.
Absolute Pressure - Pressure measured from a starting point of zero in perfect vacuum. **Atmospheric Pressure** is 14.696 PSI or 29.92 inches of mercury (in-Hg) at Sea level.
Absolute Zero - The point at which there is a total absence of heat, minus 459.67°F (-273.15°C).
Acceleration - The rate of change of velocity with time.
Advance Cam - The act of changing the cam position so that the IVO occurs earlier in the cycle.
Aerodynamic Drag - The resistance of the air to forward movement. This is a factor of the shape of the vehicle (coefficient of drag and frontal area).
Air-Fuel Ratio (A/F) - Is the weight of fuel divided by the weight of air fed to the engine, in the same period of time.
Air Pressure (Tires) - You can adjust a car's handling by raising or lowering air pressure in the tires. Flex in the sidewall acts like another spring in the suspension. Increasing the air pressure makes the overall spring rate stiffer, while lowering the pressure will make it softer.
Ambient Air Temperature - The temperature of the surrounding air.
Aspect Ratio - Is the ratio of a tires width to its height.
ATDC - After Top Dead Center, The position of the piston on its way down.
Back Pressure - Resistance of an exhaust system to the passage of exhaust gases. Amount of pressure that holds back the flow of the exhaust system.
Barometer - An instrument for measuring atmospheric pressure, usually in inches of mercury column.
Barometric Pressure – In this program it means uncorrected to sea level (absolute), or as read from a column of mercury. The higher the barometric pressure the more oxygen there is available for combustion.
BBDC - Before Bottom Dead Center
BDC - Bottom Dead Center
Blower - A device that forces additional air into the engine to increase its efficiency and horsepower.
Boost - The amount of pressure generated by the compressor of a turbo- or supercharger. Boost pressure is adjustable by a Waste Gate (turbocharger) or pulley size belt driven supercharger.
Boost Pressure - Pressure of air above atmospheric pressure, measured in PSI, or Bar. One bar is equal to the atmospheric pressure.
Bore - Is the diameter of the cylinder that the piston moves up and down in.
Bore Stroke Ratio - The ratio between the diameter of the cylinder bore and the length of the stroke.
Brake Bias - In most cars, pressing on the brake pedal applies a little more force to the front brakes than the rear. This is designed to take advantage of the fact that under braking, weight transfers to the front of the car.
Brake Fade - Brakes transform motion into heat. When the fluid in the brake system exceeds its boiling point due to hard use, bubbles can form and the brakes do not work properly.
BSFC – Brake Specific Fuel Consumption. Is the amount of fuel in lbs / hr to produce 1 Horse Power. **Gasoline =** Pro Stock / Competition Eliminator 0.35-0.45 – High Compression 0.45-0.55 – Low Compression 0.50-0.60 – Super Charged / Turbo Charged 0.55-0.65. **Alcohol =** High Compression 0.90-1.10 – Low Compression 1.00-1.20 – Super Charged / Turbo Charged 1.10-1.30
BTDC - Before Top Dead Center.
BTU - British Thermal Unit - The quantity of heat required to raise one pound of water from 59°F to 60°F.
By Pass Valve - A pressure-release valve that relieves un-needed and potentially hazardous pressures created by the supercharger by recirculating it through the supercharger
Cam Advance / Retard - Is the number of degrees the Intake centerline has been moved. Advancing the camshaft will reduce the centerline and improve mid range torque. Retarding will increase the centerline and improve high-end horsepower.
Camber - The outward (positive) or inward (negative) tilt of the wheels in degrees.
Cam Profile - The shape of each lobe on a camshaft. The profile determines the amount, of duration, or time the valve is open. It also largely determines the valve's maximum lift.
Camshaft - A shaft whose lobes push on valve lifters, rocker arms or the valves themselves to convert rotary motion into linear motion.
Carbon Fiber - Is a man made very expensive material that is lighter than aluminum, and stronger than steel.
Caster - The forward (negative) or rearward (positive) tilt of the wheels in degrees.
CC (cc) - Cubic centimeter
Center of Gravity (CG) - It is the center point of the vehicle's mass. That point in an object, if through which an imaginary pivot line were drawn, would leave the object in balance. The closer the weight is to the ground, the lower the center of gravity.
CFM - Cubic Feet per Minute, Indicates how many Cubic Feet of air pass by a point in one Minute.
Chassis Dynamometer - A test stand to determine the power output at the wheels
CI (ci) - Cubic Inch
CNC - Computerized Numerical Control
Coefficient of Drag (CD) - The coefficient of drag is a function of factors like the shape of the vehicle. The number is determined in a wind tunnel or by a coast down test performed on the vehicle.
Coefficient of Friction - the drag factor of a vehicle or other object sliding on a surface, also designated by the Greek letter Mu.

Coil Bind - When a spring is compressed to the point that the coils touch.
Combustion Chamber -The space within the cylinder when the piston is ATDC. The top of the piston and a cavity in the cylinder head forms it.
Combustion Chamber Volume - The volume contained within the chamber of the cylinder head
Compressor Efficiency - is a measure of how well the compressor is able to compress air and how much heat it adds to the compressed charge.
Compression Gauge - Used to measure how much pressure a cylinder can create. Used in a Compression Test.
Compression Ratio (Static) - The ratio of the total volume enclosed in a cylinder when the piston is located at BDC compared to the volume enclosed when the piston is at TDC.
Compression Test - A test to see how much pressure a cylinder can create at cranking RPM. Also sometimes called **Cranking Pressure**.
Corner Weights - Is the distribution of a vehicle's weight among the four wheels. Adjustment of corner weights is very important to handling.
-Corrected Barometric Pressure – In this program it means the observed Barometric Pressure that has had the Vapor Pressure subtracted from it.
Cross Weight - Refers to diagonally static loading of the tires.
Curtain Area – Is the area defined by the valve diameter * PI * valve lift.
Data Acquisition - The use of sophisticated sensors, transmitters, computers and software to provide information on what the car and the driver are doing. The information is analyzed to improve vehicle performance.
Density - The weight per unit volume.
Density Ratio (DR) - This is a number computed from the pressure ratio, compressor efficiency and intercooler efficiency to show the actual increase in pressure.
Detonation - A condition in which, after the spark plug fires, some of the unburned air-fuel mixture in the combustion chamber explodes spontaneously, set off only by the heat and pressure of air-fuel mixture.
Dew Point - Is the temperature at which the air will be saturated (100% RH).
Discharge Coefficient - A ratio of the actual / measured flow to the theoretical flow through the **Curtain / Window Area**. Also called **Coefficient of Discharge**.
Distributor - A part of the ignition system that sends the high voltage to the correct cylinder / spark plug.
DOHC - Double Overhead Camshaft, A DOHC engine has two camshafts for each cylinder head. One camshaft operates the intake valves; the other actuates the exhaust valves.
DOT - (Federal) Department Of Transportation
Down Force - the use of aerodynamics to create downward pressure on the car's tires for improved traction.
Duration (Camshaft) - The number of degrees of crankshaft rotation, that a valve remains open.
Duty Cycle - The percentage of the time that the injectors are open is called the injector duty cycle.
Dynamic Compression Ratio – The ratio of the total volume enclosed in a cylinder when the piston is located at the point that the Intake valve closes compared to the volume enclosed when the piston is at TDC.
Dyno / Dynamometer - An engine testing device that measures power and simulates the loads and environment of a racing engine (engine dyno) or full vehicle (chassis dyno).
Dyno Correction Factor – So that horsepower and torque numbers can be compared when measured at different temperatures, humidity and Barometer reading. The problem is there is more than one SAE “Standard Day” or rather they have changed what a Standard Day is.
ECM - Electronic Control Module, The on-board computer that controls a vehicle's engine management systems.
ECU - Electronic Control Unit
EFI - Electronic Fuel Injection system.
EGR - Exhaust Gas Recirculation, A small portion of exhaust gases is recycled into the combustion chamber.
EGT - Exhaust Gas Temperature
EVC - Exhaust Valve Closing, The point at which the exhaust valve returns to its seat.
EVO - Exhaust Valve Opening, The point at which the exhaust valve lifts off of its seat.
Feet per second per second - the English unit of acceleration or deceleration.
Final Drive - Transmitting power to the driven wheel, usually by chain, shaft, or belt.
Flow Rate - The amount (mass, weight, or volume) of fluid flowing through a valve body per unit of time.
FMU - Fuel Management Unit
Four Link Suspension - Uses two upper and two lower link/control arms to connect the solid axle.
Fuel Cell - A bladder like container to hold the fuel and containing foam baffling. It is designed to be virtually puncture-proof, thus reducing the change of a fire.
Fuel Injection - A system that sprays fuel under pressure into the intake manifold or directly into the cylinder intake ports.
Fuel Injector - A mechanical or electro-mechanical device that meters fuel into an engine.
Fuel Pressure - the pressure of the fuel in the line / rails between the regulator (if present) and the injectors.
Fuel Pressure Regulator - A device used to control the delivery of fuel at a constant pressure. The fuel pressure regulator is also adjusted based on the engine's boost pressure. As boost pressure rises by 1 PSI, the fuel pressure regulator causes the fuel pressure to rise by 1 PSI. This is done to stop the A/F fixture from leaning out.
Fuel Rails - A conduit to deliver fuel to the injectors.
G Force - The inertial force exerted as the car changes direction. One "G" is equal to the force of gravity. Which will produce an acceleration of 32.17 feet per second per second

Gear Ratio - The number of turns made by a driving gear to complete one full turn of the driven gear or the cumulative ratios for a series of gears.
GVWR - Gross Vehicle Weight Rating
H-Pipe - Two exhaust pipes, which have a tube going across in the shape of an H.
Head Gasket - Seals the cylinder head to the engine block.
Headers – Are constructed from steel tubing, they provide a smooth flow path from the exhaust port and replace the stock exhaust manifold.
Hertz - A frequency of one cycle per second.
Horizontally Opposed Engine - A layout in which the cylinders are placed at 180° to one another. It is also described as a **flat or a boxer engine**.
Humidity - Water Vapor content of the air.
IFS - Independent Front Suspension, with this type of suspension, the wheels travel independently of each other.
Ignition Timing - Spark timing expressed in crankshaft degrees, relative to top dead center.
Inch of Water - The pressure required to support a column of water one inch high. 27.68 inches of water is equal to one PSI.
Intake Centerline - Is the number of degrees ATDC at which maximum lift occurs.
Intake Charge - The mixture of fuel and air that flows into the engine.
Intercooler - is a device used to reduce the charge temperature between the compressor and the engine, and uses either outside air (**Air to Air**) or water (**Air to Water**) to lower the temperature of the intake flow.
Intercooler Efficiency - The measure of how well the intercooler reduces the charge temperature.
IRS - Independent Rear Suspension, with this type of suspension, the wheels travel independently of each other.
IVC - Intake Valve Closing, The point at which the intake valve returns to its seat.
IVO - Intake Valve Opening, The point at which the intake valve lifts off of its seat.
Jerk - The rate of change of acceleration with time. In some applications it is expressed in units of inch /deg3 or thousandths/deg3.
Jet - An orifice who's inside diameter meters fuel.
Lateral Acceleration - The sideward acceleration of a vehicle in a horizontal plane. Because of centrifugal force, the vehicle is pushed outward in the corner / turn.
Lateral Load Transfer - The vertical load transfer from one of the front tires (or rear tires) to the other.
LCD - Liquid crystal display
Leaf Spring - Is an assembly of one or more long, thin, pieces of flat or slightly curved material.
Leak Down Test - Each cylinder is tested to see how well it holds pressure, and is used to find excessive wear in an engine.
Limited Slip Differential - A differential having special friction mechanisms to keep both rear-axle shafts rotating at the same speed.
Linear Acceleration - is the acceleration of a vehicle in a straight line.
Linear Coil Spring Rate - A coil spring that by design has a constant deflection rate under load.
Lobe Separation Angle (LSA) / Lobe Centerline (LC) - Is the amount of degrees between the exhaust centerline and the intake centerline and is the only measurement here in camshaft degrees. In a single camshaft engine this angle is set at the time the camshaft is ground and cannot be changed. This angle will normally vary between 100 to 120 degrees.
Locking the Brakes - Engaging the brakes so hard that one or more wheels stops turning completely.
Longitudinal Load Transfer - The vertical load transferred from a front tire to the corresponding rear tire or vice versa.
Loose - When in a turn the vehicles rear tires lose traction before the front tires.
Mach Number - Is the ratio of the actual velocity of the airflow to the velocity sound in the same medium.
Magneto - A high-voltage generator for the ignition system that does not require an external power source.
MAP - Manifold Absolute Pressure
Motion Ratio - The relationship between the motion of the wheel and the motion of the spring. A motion ratio of 4:1 would make a spring rate of 400 lb./in. produce a wheel rate of 100 lb./in.
MSV - Maximum Squish Velocity see **Squish Velocity.** If MSV is to low the flame front will not burn the fuel air mixture effectively.
Multi Plate Clutch - A clutch assembly that uses more than one driving plate and more than one driven plate to connect the engine to the transmission. Normally more compact in size than a single disc unit.
Naturally Aspirated - An engine in which the charge air enters the cylinders because of atmospheric pressure.
Neutral Steer - When the front & rear tires give up traction at an equal rate.
NPT - National Pipe Thread
O2 / Oxygen Sensor - A device found in the exhaust system, which generates a small voltage dependent on the amount of oxygen present in the exhaust gases.
OEM - Original Equipment Manufacturer.
OHC – OverHead Camshaft
OHV - OverHead Valve. The valves are located over the piston.
Oil Temperature - The temperature of the oil circulating through the engine.
Overlap - When both the exhaust valve and the intake valve are open, measured in crank degrees. The intake is starting to open while the exhaust is not yet closed.
Over Square - An engine with a greater bore than stroke.
Over Steer - When in a turn the vehicles rear tires lose traction before the front tires.
PCV - Positive Crankcase Ventilation, Relieves pressure and fumes from the crankcase.

Piston - A cylindrical part inside the cylinder that moves up and down, transferring the force of combustion to the connecting rod.
Piston Position – Is the distance from the top of the cylinder to the top of the piston.
Piston To Valve Clearance (PVC) - The distance between the intake and exhaust valves to the top of the piston.
Posi / Positraction - A differential having special friction mechanisms to keep both rear-axle shafts rotating at the same speed
Pulse Width - The amount of time that an injector stays open is called the injector pulse width
Port Area - The cross-section area of the port.
Port Time Area - The amount of time and area required for a port to flow the necessary air at a specific rpm and BMEP. The area of a port, divided by the displacement of one cylinder, and multiplied by the time that the port is open.
Port Timing - In 2-stroke engines the amount of time when ports are covered or uncovered by the piston in crankshaft degrees.
Pound Foot - The unit of measurement for torque.
Pounds Per Square Inch (PSI) - English unit of pressure.
Pounds Per Square Inch Absolute (PSIA) - Absolute pressure equals gauge pressure plus atmospheric pressure.
Pounds Per Square Inch Gauge (PSIG) - The "g" indicates that it is gauge pressure and not absolute pressure.
Pressure Differential - The difference in pressure between two points in a system.
Pressure Drop - The difference between the inlet and outlet pressures.
Pressure Ratio (PR) - The ratio of outlet pressure over inlet pressure.
Primary Drive – This is mostly for Motorcycles where there is a chain or gear drive between the engine and transmission.
Pulse Width - The number of engine revolution degrees that an injector is open to deliver fuel also stated in Milliseconds.
Push - When in a turn the vehicles front tires lose traction before the rear tires.
Quench - See **Squish**
Quench Clearance - See **Squish Clearance**
Rake – When one end of the vehicle is lower than the other.
Ram Air - When fresh air is fed through the hood or underneath the vehicle and sent to the intake system.
Relative Humidity (RH) - Is the ratio (%) of the amount of water vapor in the air to the maximum amount of water vapor that the air can hold at that temperature.
Restrictor Plate - A plate that sits between the carburetor and the intake manifold of a motor with holes of a specific diameter cut through it. It restricts the amount of air entering the engine.
Retard Cam - The act of changing the cam position so that the IVO occurs later in the cycle.
Rev Limiter - Is used to keep the engine from exceeding its maximum RPM and exploding.
Ride Height - The distance from the bottom of the vehicle to the road.
Road Horsepower - The amount of power at the driving wheels needed to move a vehicle. This power varies according to the vehicle's speed, aerodynamic drag, mechanical friction, and the tires' rolling resistance.
Rocker Arm - A pivoting arm that acts as a lever to the open valves.
Rocker Arm Ratio – Is the distance from the fulcrum to the valve end center point divided by the distance from the fulcrum to the pushrod seat center point.
Rod Angle / Angularity – The angle formed by the connecting rod centerline and the bore centerline as the crankshaft rotates.
Rod Length - Is the distance from the centerline of the wrist pin hole to the centerline of the crank journal hole. A longer rod will reduce the maximum **Rod Angle** while at the same time reducing the side loading of the piston against the cylinder wall.
Rod Stroke Ratio - The ratio between the Rod Length and the length of the Stroke.
Roll Axis – A line through the front and rear roll centers.
Roll Center – The vehicle has a front and rear roll center. The roll center is a point about which that end of the vehicle rolls. A straight line running through them called the **Roll Axis** joins front and rear roll centers.
Roll Stiffness - The resistance, measured in pounds per inch of spring travel, of a suspension system to the rolling of the vehicle's mass.
Roll Stiffness Distribution - The distribution of the vehicle roll stiffness between front and rear suspension expressed as percentage of the vehicle roll stiffness.
Roller Cam - A camshaft that uses either hydraulic or mechanical roller lifters
RPM - Revolutions Per Minute
Run Out - The amount that a rotating part is out-of-round.
Saturation Vapor Pressure - Is the maximum amount of water (**vapor pressure**) the air can hold.
Scan Tool - A device that interfaces with a vehicle's computer, and communicates information to and from the computer.
Shock Absorber - A device used to help control the up, down, and rolling motion by dampening the oscillations the spring.
Short Track - An oval track that is less than one mile in length.
Slicks - A racing tire with no tread.
SOHC - Single Overhead Camshaft, A SOHC engine has one camshaft for each cylinder head. This camshaft operates both the intake and exhaust valves.
Sonic Velocity - The **Speed of Sound** for a particular gas at a given inlet pressure and temperature.
Specific Gravity - Weight of a given volume of substance compared to that of an equal volume of water, which is assigned value of 1.0.
Speed of Sound - Is dependent on the temperature of the air or exhaust. In air on a standard day, the speed of sound is about 340 m/sec (~1110 ft/sec).
Speed Trap - A places where timing sensors are placed to detect cars passing by them. By measuring the distance between the timing sensors and the time it takes for a car to pass by them, speed can be calculated.
Spoiler - A strip on the rear deck lid. It is designed to create down force on the rear of the vehicle, to help increase traction.

Spring Rate - The relationship between load and deflection normally in pounds per inch.
Sprung Weight - The mass of the vehicle that is supported by the springs.
Squish - As the piston approaches top dead center on the compression stroke, the mixture is pushed out of the **Squish Area** and this promotes increased turbulence, and more efficient combustion. But too much turbulence can also create a problem.
Squish Clearance - Distance between the top of piston and the deck of the cylinder head.
Squish Ratio - Is the ratio of the squish area to bore area and normally Varies from 30% - 60% of Bore area.
Squish Velocity - Is the speed with which the mixture is pushed out of the squish area as the piston moves to TDC, normally this is shown in m/s. **MSV** is the **Maximum Squish Velocity**, which normally is between 5 and 10 degrees before TDC.
Standard Day – There are 2 in use.
29.92 inches of Mercury at 60 degrees F and zero humidity (SAE J816) that was used back in the muscle car era.
29.23 inches of Mercury at 77 degrees F and zero humidity (SAE J1349) started being used in the early '70s.
Static Compression Ratio – See **Compression Ratio**
Static Ride Height - The distance from the bottom of the vehicle to the road when the vehicle is not moving.
STP - Standard Temperature and Pressure See **Standard Day**
Stroke - The distance the piston moves from top dead center (TDC) to bottom dead center (BDC). The stroke is controlled by the rod journal throw of the crankshaft.
Sway Bar - A suspension component, intended to prevent side-to-side body movement in relation to the axles and wheels.
Swept Volume - The volume displaced by a piston's travel.
TDC - Top Dead Center
Telemetry - The recording of time coded data from a racecar.
Throttle Body Fuel Injection - The fuel injection(s) are located at the engine's throttle body thereby feeding fuel to more than one cylinder.
Tight - When in a turn the vehicles front tires lose traction before the rear tires.
Tire Growth - The amount that a tire will increase in size / diameter with speed.
Tire Pressure - The measure of air (gas) pressure within a tire. It is adjusted to change handling, as the flexible sidewall serve as an additional spring rate. Increasing tire pressure serves to stiffen the overall rate, while lowering the pressure will soften the overall rate.
Tire Radius - The distance from the axle center to the road surface of a loaded tire.
Tire Temperature - Tires are designed to provide optimal grip within a certain tire temperature range.
Torque Curve - A graph that shows the engine torque against RPM.
Torque Multiplication - Increasing engine torque by using a torque converter.
Torsion Bar - Is a long straight rod secured at one end to the chassis of the vehicle and at the other end to a lever arm, which is free to twist.
Total (Chamber) Volume – This is the volume measured with the piston ATDC with the head installed with a head gasket and the valves closed thru the spark plug hole.
Track Width - Distance between the centerline of front or rear tires measured at the ground.
Transmission – Contains gears used to deliver power from the engine to the rear wheels.
TSB - Technical Service Bulletin
Turbocharger - An exhaust driven centrifugal-flow compressor
Two Stroke / Cycle - An engine which accomplishes the intake, compression, power and exhaust phases in two strokes of the piston (one down and one up).
Underdrive Pulleys - Replaces the stock accessory drive pulley with a lighter version that has a smaller diameter, the accessories now turns slower than normal. This frees up a few horsepower.
Under Steer - When in a turn the vehicles front tires lose traction before the rear tires.
Unsprung Weight - The vehicle weight not supported by the springs / suspension system. i.e. wheels, brakes, tires, and half of the suspension.
V-Twin – A Two-cylinder engine layout in which the cylinders form a "V".
Valve Stem - The portion of valve that slides in valve guide.
Vapor Pressure - Is the amount of water in the air measured in inches of mercury or millibars.
VDC - Volts Direct Current.
Vehicle Roll Stiffness - Sum of the separate suspension roll stiffness.
Velocity - is the rate of change of distance with respect to time. In many applications it is expressed in miles per hour (MPH), feet per second (FPS), etc.
Volumetric Efficiency - A comparison between the actual volume of fuel mixture drawn in on the intake stroke and what would be drawn in if the cylinder were to be completely filled.
Waste Gate - A valve used to limit the boost developed in a turbocharger system. It is user adjustable and it lets off excess pressure when it opens, which controls max HP.
Water Temperature - The temperature of the coolant circulating through the radiator.
Watts Link - A device used to control side-to-side motion in a ladder bar, torque-tube, or 4-link rear suspension.
Wear Limit - The minimum acceptable size of a component after use.
Weight Transfer - The transfer of load from one end or side of the vehicle to the other when accelerating, braking, or cornering.
Wet Clutch - A multi-plate clutch that runs in an oil bath and is part of the primary drive.
Wheel Base - The distance from the center of the front wheels to the center of the rear wheels.
Wheel Rate - The combined effect of spring rate, motion ratio, and other suspension components measured at the wheel.
Window Area – Is the area defined by the valve diameter * PI * valve lift.

Wire Gauge - A precisely sized wire that is used for measuring clearances.
WOT - Wide Open Throttle.
Wrist Pin Offset – Is when the wrist pin centerline is offset from the connecting rod centerline. Offsetting the piston pin will alter rod angularity. Offsetting the pin so that **Rod Angularity** is decreased will cause the piston movement to behave exactly as it does with a longer rod.
X-Pipe - An X-shaped exhaust pipe that converges two pipes into one and then back into two.
Y-Pipe - A Y-shaped exhaust pipe, where two pipes are merged into one.
ZF – An acronym for "Zahnradfabrik Friedrichshafen," who manufactures transmissions and transaxle.

UNITS Used Standard / Metric

Inches / mm

Accessory Pulley
Actual Stroke
Air Filter Diameter
Altitude
Altitude New
Ballast X Position from Rear End
Ballast Y Position from Right
Block Deck Height
Bore
Bore Increase
Cam Lift (Intake)
Collector Diameter
Collector Length
Deck Clearance
Depth First Ring
Diameter 1
Diameter 3
Distance to Port from top of Cylinder Boost
Distance to Port from top of Cylinder Exhaust
Distance to Port from top of Cylinder Transfer
Effective Arm Length
Exhaust Cam Lift
Exhaust Valve Lift
Filter Diameter
Filter Height
Head Gasket
Head Gasket Bore
Height Front Wheel Hub
Height Rear Wheel off Ground
Horizontal CG
Intake Runner Length
Inter Diameter of Coils
Jet Size
Journal Diameter
Lateral CG
Length 3
Length 7
Main Leaf Length
Main Leaf Thickness
Main Leaf Width
Mean Diameter of Coils
Metering Rod Size
New Accessory Pulley
New Crank Pulley
New Jet Size
New Metering Rod Size
New Sway Bar Outer Diameter
New Tire Diameter
Outer Diameter of Coils
Piston Compression Height
Piston Depth
Piston Travel
Port Diameter
Rod Length
Roll Out Distance
Spring Wire Diameter
Squish Clearance
Stroke
Sway Bar Arm Length
Sway Bar Center Length
Sway Bar Interior Diameter
Sway Bar Outer Diameter
Tire Diameter
Tire Rolling Radius
Top Land Diameter
Torsion Arm Length
Torsion Bar Diameter
Torsion Bar Length
Track Width
Tube Diameter
Tube Length
Turn Radius
Valve Lift (Intake)
Vehicle Height
Vehicle Width
Vertical CG
Wheel Base
Wheel Diameter
Wire Diameter
Wrist Pin Offset

Atmospheric Pressure Inches of Mercury / MilliBars

Barometric Pressure
New Barometric Pressure
Saturated Vapor Pressure
Vapor Pressure

CC's

CC's Poured
Combustion Chamber Volume

Cylinder Volume
Dome Volume
Effective Cylinder Volume
Head Gasket CC's
Ring CC's
Squish Volume
Total Volume
Trapped Volume

Degrees Fahrenheit / Celsius

Dew Point
Inter Cooler Inlet Temperature
Inter Cooler Outlet Temperature
New Temperature
Running Inlet Temperature
Temperature
Water Temperature

Grams

Piston Weight
Rod Weight

Sample Parameter File

```
; A ';' in the first position of a line means that line is a
comment and will be ignored when read by the program
;
; The following parameters maybe in any order
;
; If for some reason a parameter is in the list more than
once then the last one will be used
;
Bore = 4.0
Stroke = 3.25
Rod Length = 5.7
Cubic Inches = 326.7256
RPM = 6500
Bore Increase = 0.060
Compression Ratio = 13.59405
New Compression Ratio = 0.0
Number of Cylinders = 8
Rod Stroke Ratio = 1.75385
Bore Stroke Ratio = 1.23077
Stroke Bore Ratio = 0.8125
Average Piston Speed = 3520.833
Block Deck Height = 9.245
Piston Compression Height = 1.904
Cubicin Option = 2
Piston Weight = 600.25
Rod Weight = 700.5
Small End Rod Weight = 233.5
Horse Power = 555.0
Horse Power Increase = 0.0
Crank Degrees = 74.123
Piston Travel = 1.399
Wrist Pin Offset = 0.0
Torque = 444.0
BMEP = 0.0
Journal Diameter = 2.5
Show 3 Decimals = Yes
;   Data for CR
Deck Clearance = .016
Head Gasket = .021
Head Gasket Bore = 4.01
Head Gasket CC = 4.347
Comb Chamber Vol = 65.0
Dome Vol = 19.5
Total Vol = 75.3
Depth First Ring = 0.250
Top Land Diameter = 3.965
Ring CC = 0.897
Piston Depth = 1.0
CCs Poured = 197.1
Dish Depth = 0.060
Dish Bore = 3.880
Dish CC = 11.63
;   Data for ET/MPH/HP
MPH = 192.453
MPH8 = 156.466
MPH60 = 73.4916
ET = 7.105
ET8 = 4.554
ET60 = 1.1133
Hook Factor = 1320.0
Car Weight = 2350.0
;   Data for Blowers
Max Compression Ratio = 9.5
Effective Compression Ratio = 0.0
Blower Pressure = 0.0
Blower Efficiency = .75
Blower Gear = 35
Blower Ratio = 1.0
Blower RPM = 6500
Crank Gear = 35
IC In Temp = 175.5
IC Out Temp = 82.5
IC Pressure Loss = 1.5
Blower Density Ratio = 1.5
Pressure Ratio = 0.0
Number of Turbos = 1
Blower Option = 0
Rotary 2-Stroke = No
Blower Graph = No
Use VE RPM Table = No
VE RPM = 0.75
VE RPM = 0.75
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VE RPM = 0.75
VE RPM = 0.75
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VE RPM = 0.75
;   Data for Camshafts
```

Intake Open = 42.5
Intake Close = 95.5
Intake Duration = 318.0
Intake CL = 116.5
Exhaust Open = 95.5
Exhaust Close = 40.5
Exhaust Duration = 320.0
Exhaust CL = 117.5
Lobe Sep Angle = 117.5
Advance Retard = 0.0
Cam LIft = 0.4
Valve LIft = 0.6
Rocker Arm Ratio = 1.5
Exhaust Cam LIft = 0.4
Exhaust Valve LIft = 0.6
Exhaust Rocker Arm Ratio = 1.5
; Data for Air Flow / Fuel / Exhaust
Old Depression = 5.0
New Depression = 28.0
Old AirFlow = 105.0
BSFC = .5
Number Injectors = 8
Duty Cycle = .85
Pulse Width = 15.6923
Lbs Hour = 18.0
New Lbs Hour = 20.23994
Old Fuel Pressure = 43.5
New Fuel Pressure = 55.0
Injector Dead Time = 0.0
Fuel Pump Flow = 19.5
Intake Flow = 300.0
Exhaust Flow = 210.0
Intake Exhaust Ratio = .7
RPM Max Horse Power = 6500
Air Fuel Ratio = 12.5
Volumetric Efficiency = 0.85
Fuel Flow = 225.3
Carb Size = 650
Peak Torque RPM = 5900
Port Diameter = 2.25
Tube Length = 28.0
Tube Diameter = 1.75
Affected RPM = 7500
Collector Length = 18.0
Collector Diameter = 4.00
Air Filter Diameter = 14.0
AirFuel Option2 = 0
Intake Valve Size = 2.02
Intake Valve Stem Diameter = 0.3415
Intake Bowl CSA Percent = 0.91
AirFuel Option1 = 0
IntakeFlow = 0.1 85.0
IntakeFlow = 0.2 166.0
IntakeFlow = 0.3 229.0
IntakeFlow = 0.4 294.0
IntakeFlow = 0.5 350.0
IntakeFlow = 0.55 400.0
IntakeFlow = 0.6 425.0
IntakeFlow = 0.65 430.0
IntakeFlow = 0.7 435.0
IntakeFlow = 0.75 437.0
IntakeFlow = 0.8 439.0
IntakeFlow = 0.85 440.0
IntakeFlow = 0.9 438.0
IntakeFlow = 1.0 0.0
IntakeFlow = 1.1 0.0
IntakeFlow = 1.2 0.0
Exhaust Valve Size = 1.60
Exhaust Valve Stem Diameter = 0.3415
Exhaust Bowl CSA Percent = 0.91
ExhaustFlow = 0.1 66.0
ExhaustFlow = 0.2 114.0
ExhaustFlow = 0.3 168.0
ExhaustFlow = 0.4 215.0
ExhaustFlow = 0.5 238.0
ExhaustFlow = 0.55 255.0
ExhaustFlow = 0.6 266.0
ExhaustFlow = 0.65 280.0
ExhaustFlow = 0.7 285.0
ExhaustFlow = 0.75 290.0
ExhaustFlow = 0.8 292.0
ExhaustFlow = 0.85 291.0
ExhaustFlow = 0.9 0.0
ExhaustFlow = 1.0 0.0
ExhaustFlow = 1.1 0.0
ExhaustFlow = 1.2 0.0
IntakeLift = 0.008 288.0
IntakeLift = 0.05 235.0
IntakeLift = 0.1 210.0
IntakeLift = 0.15 190.0
IntakeLift = 0.2 175.0
IntakeLift = 0.25 155.0
IntakeLift = 0.3 135.0
IntakeLift = 0.35 115.0
IntakeLift = 0.4 95.0
IntakeLift = 0.45 85.0
IntakeLift = 0.5 70.0
IntakeLift = 0.6 58.0
IntakeLift = 0.7 44.0
IntakeLift = 0.8 30.0
IntakeLift = 0.9 22.0
IntakeLift = 1.0 5.0
ExhaustLift = 0.008 300.0
ExhaustLift = 0.05 250.0
ExhaustLift = 0.1 235.0
ExhaustLift = 0.15 205.0
ExhaustLift = 0.2 190.0
ExhaustLift = 0.25 175.0
ExhaustLift = 0.3 155.0
ExhaustLift = 0.35 135.0
ExhaustLift = 0.4 115.0
ExhaustLift = 0.45 95.0

ExhaustLift = 0.5 75.0
ExhaustLift = 0.6 63.0
ExhaustLift = 0.7 47.0
ExhaustLift = 0.8 33.0
ExhaustLift = 0.9 22.0
ExhaustLift = 1.0 5.0
Degree TDC = 222
User DC = 0.5
Number of Intake Valves = 1
Number of Exhaust Valves = 1
Test Depression = 28
Graph Max Lift = 1.20
User Velocity fps = 280
Calculate Every x.xx lift = 0.025
Intake Valve Angle = 23.0
Exhaust Valve Angle = 23.0
Intake MCSA = 0.0
Exhaust MCSA = 0.0
A-F Advance Retard = 0.0
Exh Advance Retard = 0.0
A-F Lobe Sep Angle = 0.0
Valve to Piston Cl = 0.0
Lift Table = 0.0
Lift Table = 0.006
Lift Table = 0.01
Lift Table = 0.02
Lift Table = 0.04
Lift Table = 0.05
Lift Table = 0.1
Lift Table = 0.15
Lift Table = 0.2
Lift Table = 0.25
Lift Table = 0.3
Lift Table = 0.35
Lift Table = 0.4
Lift Table = 0.45
Lift Table = 0.5
Lift Table = 0.55
Lift Table = 0.6
Lift Table = 0.65
Lift Table = 0.7
Lift Table = 0.75
Lift Table = 0.8
Lift Table = 0.85
Lift Table = 0.9
Lift Table = 0.95
Lift Table = 1.0
Lift Table = 1.05
Lift Table = 1.1
Lift Table = 1.15
H Factor = 77
AirFuel Option5 = 0
Show Dots = No
Show Large Grouping = No
Circle = No
Line = No
DOHC = No
Intake Lash = 0.024
Intake Open BTDC = 120.0
Exhaust Lash = 0.03
Exhaust Open BBDC = 340.0
Mach Valve Diameter = 2.02
Mach Valve Lift = 0.888
Mach Number = .4321
; Data for Weather
Barometric Pressure = 29.92
Barometric Pressure New = 29.62
Temperature = 59.0
Temperature New = 60
Humidity = 5.0
Humidity New = 25.0
Altitude = 33.33
Altitude New = 80
Crank Pulley = 5.25
Accessory Pulley = 7.25
New Crank Pulley = 6.25
New Accessory Pulley = 7.25
Jet Size = 0.082
Metering Rod Size = 0.033
Compression Gauge = 165.5
; Data for Gears
Front Sprocket = 12
Rear Sprocket = 24
Rear Gear Ratio = 4.1
Ring Gear = 41
Pinion Gear = 10
New Rear Gear Ratio = 4.56
Tire Diameter = 24.0
New Tire Diameter = 29.75
Tire Width = 195.0
Wheel Diameter = 16.0
Aspect Ratio = 75.0
; Trans Gear Ratios
T Gear1 = 3.25
T Gear2 = 2.25
T Gear3 = 1.25
T Gear4 = 1.0
T Gear5 = 0.87
T Gear6 = 0.0
T Gear7 = 0.0
T Gear8 = 0.0
T Gear9 = 0.0
T Gear10 = 0.0
Track Size = 1.366
Track Time = 29.56
Turn Radius = 100.0
; Data for Acceleration / Top Speed
Tire Rolling Resistance = 0.015
Coefficient of Drag = 0.34
Frontal Area = 19.4
Veh Width = 74.5
Track BP = 29.92126

Shift Torque = 2350.0
Veh Height = 55.75
Skid Pad Gs = 1.54321
Long Acel Gs = 1.2
; Data for Springs / Torsion Bars / Sway Bars
Spring Wire Diameter = 0.5
Number Active Coils = 10.0
Number Coils = 12.0
Diameter Coils = 4.0
Spring Rate = 146.48
Modulus of Rigidity = 12000000
Torsion Bar Diameter = 0.88
Torsion Bar Length = 35.8
Torsion Arm Length = 13.5
Torsion Bar Rate = 108.27
Sway Bar Out Diameter = 0.875
Sway Bar Int Diameter = 0.0
Sway Bar Center Length = 40.0
Sway Bar Arm Length = 0.0
Effective Arm Length = 9.0
New Sway Bar Out Diameter = 0.975
Main Leaf Length = 48.0
Main Leaf Width = 2.0
Main Leaf Thickness = 0.25
Number Leafs = 5
; Data for Chassis
Weight Left Front = 850.0
Weight Left Rear = 850.0
Weight Right Front = 850.0
Weight Right Rear = 850.0
Percent Weight Left Front = 25.0
Percent Weight Left Rear = 25.0
Percent Weight Right Front = 25.0
Percent Weight Right Rear = 25.0
Cross Weight = 1700.0
Percent Cross Weight = 50.0
Weight Front = 1700.0
Weight Rear = 1700.0
Weight Left = 1700.0
Weight Right = 1700.0
Percent Weight Front = 50.0
Percent Weight Rear = 50.0
Percent Weight Left = 50.0
Percent Weight Right = 50.0
Wheel Base = 112.0
Raised Weight Front = 1800.0
Height Front Wheel Hub = 13.0
Height Rear Wheel = 14.0
Horizontal CG = 50.0
Vertical CG = 63.5
Track Width = 62.5
Weight Transfer = 123.5
Ballast = 110
Ballast X = 56.0
Ballast Y = 31.25
Unsprung Weight Left Front = 85.0
Unsprung Weight Left Rear = 85.0
Unsprung Weight Right Front = 85.0
Unsprung Weight Right Rear = 85.0
Left Front Spring Rate = 800
Right Front Spring Rate = 800
Left Rear Spring Rate = 600
Right Rear Spring Rate = 600
Front Sway Bar Rate = 175
Rear Sway Bar Rate = 125
Left Front Spring Move = 0.8
Right Front Spring Move = 0.8
Left Rear Spring Move = 0.6
Right Rear Spring Move = 0.6
Left Front Sway Bar Move = 0.75
Right Front Sway Bar Move = 0.75
Left Rear Sway Bar Move = 0.55
Right Rear Sway Bar Move = 0.55
Front Track Width = 175
Rear Track Width = 175
Front Roll Center Height = 6.0
Rear Roll Center Height = 12.0
; --
Type Curve = 2
Start Degrees = 0
End Degrees = 360.0
Every X Degrees = 5.0
Start Seconds = 23.0
End Seconds = 30.0
Every X Seconds = 0.025
; Acceleration / Top Speed
Tire Rolling Resistance = 0.015
Coefficient of Drag = 0.34
Frontal Area = 19.4
Veh Width = 74.5
Track BP = 29.92126
Shift Torque = 2350.0
Veh Height = 55.75
Percent Drive Train Power Loss = 12.5
Percent Rear End Power Loss = 6.5
Tire Rolling Radius = 12.0
Dyno Correction = 1.00
Launch RPM = 5200
Shift RPM 1-2 = 10000
Shift RPM 2-3 = 10000
Shift RPM 3-4 = 10000
Shift RPM 4-5 = 9850
Shift RPM 5-6 = 10000
Shift RPM 6-7 = 9777
Shift RPM 7-8 = 9777
Shift RPM 8-9 = 9777
Shift Time 1-2 = 0.05
Shift Time 2-3 = 0.05
Shift Time 3-4 = 0.05
Shift Time 4-5 = 0.05
Shift Time 5-6 = 0.05
Shift Time 6-7 = 0.05

Shift Time 7-8 = 0.05
Shift Time 8-9 = 0.05
Tire Growth 1 = 0.0
Tire Growth 2 = 0.0
Tire Growth 3 = 0.0
Tire Growth 4 = 0.0
Tire Growth 5 = 0.0
Tire Growth 6 = 0.0
Tire Growth 7 = 0.0
Tire Growth 8 = 0.0
Tire Growth 9 = 0.0
Power Loss 1 = 6.0
Power Loss 2 = 6.0
Power Loss 3 = 6.0
Power Loss 4 = 6.0
Power Loss 5 = 6.0
Power Loss 6 = 6.0
Power Loss 7 = 6.0
Power Loss 8 = 6.0
Power Loss 9 = 6.0
Trans Gear = 1
RollOut = 11.75
Smooth HP Graph = N
Coefficient of Mu = 5.0
Converter Stall Speed = 2350
Torque Multiplier = 1.6
Automatic Trans = No
Converter Slippage = 3.25
Dyno BP = 29.92
Dyno VP = 0.45
Dyno Temp = 95.5
Primary Drive = 2.0
Use Primary Drive = No
Hood Scoop = No
; Acceleration / Top Speed - CVT Constant Velocity Trans
CVT RPM = 9500
CVT Power Loss = 20.0
; Acceleration / Top Speed - Nitrous Data
Nitrous MS = 1 110 1 100 1
Nitrous MS = 2 120 2200 75 2220
Nitrous MS = 3 130 3300 50 3330
Nitrous MS = 4 140 4400 25 4440
Nitrous MS = 5 150 5500 0 5550
Nitrous MS = 9 160 6600 0 6660
Nitrous MS = 9 170 7700 0 9990
Nitrous MS = 0 150 0.65 50 1.1
Nitrous MS = 0 150 1.5 75 2.3
Nitrous MS = 0 150 2.8 100 2.8
Nitrous MS = 0 150 9999.0 100 9999.0
Nitrous MS = 0 150 9999.0 100 9999.0
Nitrous MS = 0 150 9999.0 100 9999.0
Nitrous MS = 0 150 9999.0 100 9999.0
Nitrous = No
Nitrous RWHP = No
; Acceleration / Top Speed - Throttle Stop
Throttle Stop = No
Throttle Stop RPM = 4000
Throttle Stop Time = 0.3
; 2 Stroke Exhaust
Exhaust Port Width = 19.5
Exhaust Port Height = 9.25
Exhaust Gas Temp = 381.856
Speed of Sound = 518.15
Power KW = 3.71
Konstant K0 = 0.7
Konstant K1 = 1.125
Konstant K2 = 2.25
Horn Coeff = 2
Angel 1 = 8.5
Angel 2 = 17.0
Length 3 = 8.0
Length 7 = 12.0
Diameter 1 = 12.5
Diameter 3 = 0.6
; 2 stroke Port Timing Form
2 S Exhaust Distance = 1.399
2 S Boost Distance = 1.499
2 S Transfer Distance = 1.599
2 S Exhaust Degrees = 74.125
2 S Boost Degrees = 77.516
2 S Transfer Degrees = 80.917
2 S Exhaust Port Area = 4.309
2 S Boost Port Area = 3.984
2 S Transfer Port Area = 2.217
Squish Ratio = 0.53
Squish Clearance = 0.047244
Dynamic Compression Ratio = 7.432
; Nitrous
Fuel Pressure = 6.0
Nitrous Pressure = 950
Nitrous Jet Size = 0.024
Number Nitrous Jets = 8
Nitrous Option = 0
Specific Gravity Gas = 0.740
Specific Gravity Methanol = 0.790
Specific Gravity Ethanol = 0.790
Specific Gravity E85 = 0.780
Fuel Jet Size = 0.0
Number Fuel Jets = 8
Fuel Jet Size S2 = 0.048
Number Fuel Jets S2 = 2
; User Selected Graph Options
Graph Heads = Yes
Graph Logo = No
Move Grid Lines = No
Graph Line Color = No
Grid Switch = 1
Large Lines = No
Caption Top = No
Semi Grid Cross Lines = No
Semi Grid Box Lines = No

```
Grid Color = 16777215
Solid Switch = 1
Graph Line Width = 2
Graph Font Color = 12632319
Graph BackGround Color = 0
;   The following 2 parameters must be in THIS Order
Custom Graph Width = 6
Custom Graph Height = 6
Custom Grid Line Count x = 10
Custom Grid Line Count y = 10
Draw Line Color = 99999
Draw Line Width = 5
Draw Switch = No
;   User Selected GUI Options -- Keep This Order
Quit BackGround Color = -2147483633
BackGround Color = -2147483633
Option Check Box Style = 1
Large Screen = No
Full Screen = No
Entry Box Font Name = MS Sans Serif
Entry Box Font Size = 8
Entry Box Font Bold = 0
Entry Box Font Italic = 0
Entry Box Alignment = 2
Entry Box Style = 1
Label Box Font Name = MS Sans Serif
Label Box Font Size = 8
Label Box Font Bold = 0
Label Box Font Italic = 0
Label Box Color = -2147483640
Command Button Font Name = MS Sans Serif
Command Button Font Size = 8
Command Button Font Bold = 0
Command Button Font Italic = 0
Help Box Font Name = MS Sans Serif
Help Box Font Size = 10
Help Box Font Bold = -1
Help Box Font Italic = 0
Help Box Font Color = -2147483630
Help BackGround Color = 65535
Metric Mode = OFF
;   Data for Acceleration / Top speed calculator
;   The following parameters must be in Ascending Order
by RPM
;            RPM  Torque  Fuel  BSFC  A/F
;                         lb/hr      Ratio
Acceleration = 5000 700.0
Acceleration = 5500 720.0
Acceleration = 6000 750.0
Acceleration = 6500 780.0
Acceleration = 7000 810.0
Acceleration = 7500 840.0
Acceleration = 8000 820.0
Acceleration = 8500 815.0
Acceleration = 9000 780.0
Acceleration = 9500 737.0
Acceleration = 10000 685.0
; Data for Road Horse Power
; The following parameters must be in Ascending Order by
MPH
;         MPH    Time
Road HP = 21.51 1.6829
Road HP = 23.47 1.8356
Road HP = 25.67 2.0061
Road HP = 28.11 2.192
Road HP = 30.0 2.3341
Road HP = 32.27 2.5083
Road HP = 34.22 2.6635
Road HP = 36.67 2.8677
Road HP = 39.11 3.0899
Road HP = 40.09 3.1848
Road HP = 42.05 3.3879
; Data for ROad Horse Power
; The following parameters must be in Ascending Order by
RPM
;         RPM    Time
ROad HP = 2200.0 1.6829
ROad HP = 2400.0 1.8356
Comp CamROad HP = 2625.0 2.0061
ROad HP = 2875.0 2.192
ROad HP = 3068.3 2.3341
ROad HP = 3300.0 2.5083
ROad HP = 3500.0 2.6635
ROad HP = 3750.0 2.8677
ROad HP = 4000.0 3.0899
ROad HP = 4100.0 3.1848
ROad HP = 4300.0 3.3879
```

CMM (extension) File format

This is an example of data that was measured by me in the ‘70s using a dial indicator and degree wheel.
Every x degrees = number
    I_Lash = Intake Valve Lash - Optional
    E_Lash = Exhasut Valve Lash - Optional
intake – start of intake figures
lift lines - as many are needed
exhaust – start of exhaust figures
lift lines - as many are needed
A “;” semi-colon at the start of the line means that line is a comment
Version 3.15.0 - can also read in “C1” files from Cam Doctor or exported from Cam Pro Plus
Version 3.15.5 - For cam lift – piston travel mapping you really need lift data for every 1 degrees

Sample Cam File

every x degrees = 10 - I_Lash = 0.028 - E_Lash = 0.030
intake Crane Roller R-278/427-2S-8-NC Lash .028 .030
0.002
0.005
0.008
0.013
0.021
0.033
0.052
0.077
0.108
0.143
0.181
0.219
0.258
0.295
0.328
0.358
0.383
0.401
0.415
0.423
0.425
0.422
0.413
0.397
0.377
0.349
0.318
0.285
0.248
0.208
0.170
0.131
0.096
0.068
0.046
0.028
0.018
0.011
0.008
0.005
0.002
0.000
exhaust 10.01 ← Version 3.25.0 Added can have Every value
; Crane Roller
0.001
0.004
0.007
0.01
0.013
0.016
0.029
0.045
0.06
0.078
0.104
0.138
0.174
0.21
0.242
0.27
0.296
0.322
0.344
0.359
0.371
0.378
0.381
0.379
0.374
0.367
0.349
0.331
0.307
0.279
0.252
0.22
0.186
0.153
0.12
0.089
0.063
0.042
0.027
0.017
0.012
0.009
0.006
0.003
0.0

What's New – In This Version

— 3.30.0 —

ACCELER - Added 10th Transmission Gear
- Made change so that Zero Roll Out works correctly
- Added Elapsed Time and MPH on Acceleration and Top Speed Prediction for 1/2 Mile, and then each KiloMeter or Mile thereafter up to 10 miles
- Graphing Screen - Added Graph RPM (X-axis) / MPH (Y-axis)
- Added some heading /information on some Graphs
- Fixed problem when using Graph Plus with the "Select Graph Line Color". When doing another Graph it had the wrong colors

AIRFUEL - Port Time Area 2 Graphing - Added option to Scale Piston Velocity

BLOWERS - Added kg/hr and m^3 /hr options
- On present tables for large values reduced number of decimal places so values do not run together.
- Added option so User can set X and Y limits for the Graphs
- Added option so User can set Max RPM for the Tables and Graphs
- Added option so User can set RPM Step for the Tables and Graphs
- Increased VE table to '27500' RPM

Cam_Gen - Added Generate Six different types of Constant Lash Ramps, Polynomial 3-4-5-6-7 'D' and 'E', Modified Ellipse.

— 3.29.0 —

ACCELER - Graphing Screen - Graph MPH/RPM now starts at 0 RPM / 0 MPH instead of using lowest RPM in HP / Torque Table.
- Add Transmission Gear ratios to Graphs with MPH
On Graphing Screen - Text Report - Added - If we have SCFM and Fuel lb/hr and no A/F Ratio – Will now Calculate A/F Ratio

AIRFUEL - Sub Screen - Calculators
- Added Calculator for Port Taper from Small End Diameter, Large End Diameter and Port Length
- Added Calculator for Port Length from Small End Diameter, Large End Diameter and Port Taper
- Added Calculator for Large End Diameter from Small End Diameter, Port Length and Port Taper
- Port Time Area 2 Graphing - Cam Lift Duration - Add DR CPP Skip Check Box.
- Added Show Cam Advance / Retard

CARFOR - Made changes so that program will read in Cam Dr "C2" thru "C8" files

Cam_Gen - Increased the number of Lift / Duration points from 13 to 19
- Modified so there is a User selectable every 10.0 option.
- Added Option to write generated data to an S96 type file for use with other software packages.

CAM_INFO - Added Dots Check Box This will added dots to the Graph at each data point.

CHASSIS - Added second CG / Roll Angle Button with changes for Vertical CG and Roll Over Angles
- Calculate Spring Wheel Rates from Suspension Frequency CPM and Corner Sprung Weights
- Calculate Spring Rates from Spring Wheel Rates and Spring Movement @ Wheel
- Calculate Motion / Movement Ratio Using Length 1, Length 2 and Angle of Shock / Spring.

COMPGAUG - On Graph Cylinder Pressure against Crank Rotational Angle rewrote it and added user selectable k exponent to Calculation
- Added Graph Piston Pressure against Crank Rotational Angle
- Added Graph Turning Force against Crank Rotational Angle

CUBICIN - Added Graph Piston Demand - Port Velocity. Using Bore, Stroke, Wrist Pin Offset, Rod Length, RPM, Port Diameter and Volumetric Efficiency.
- Added Graph Cylinder Volume Change cc's. Using Bore, Stroke, Wrist Pin Offset, Rod Length.

ET_MPH - When Generating a Digital HP / Acceleration File, Added 2 options
10 - This is based on a high flat torque curve type engine and uses peak torque instead of peak HP as its input.
11 - This is based on a turbo charged type or Diesel engine and uses peak torque instead of peak HP as its input.

GRAPH - Added way for User to Select a different color for any of the Moveable Grid Lines. Move the Mouse to the line and when the point changes shape click the right Mouse Button.

Springs - Add Old / New Radio Buttons for calculating Sway Bar Rates.

- Torsion Bars Added can have Inter Diameter (Hollow Bar).
- Torsion Bars Added Modulus so User can change the default value.

Main - Graph / Draw Options - Changed logic so that Grid Lines can be any Color
- Adjusted some colors when graphing multiple lines on same Graph
- Added option so User can select the color of each line after the first line (group) on a Graph
- Added Mouse Over Button / CheckBox - Help Box with explanation at the Bottom on the screen

Tools - Added - Convert Cam Dr C"x" File to a CMM File / Format

— 3.28.0 —

ACCELER - Graphing Screen - Change color of First Gear from White to Gray so it will show on a White Background

CAM_INFO - 0.040 Check Box now has Background color changed to user selected Color

AIRFUEL - Port Flow / CSA - On Graph - Change color of Circle from White to Gray so it will show on a White Background
- Port Time Area 2 Graphing - Added options for Curtain Area Velocity, Throat Area velocity, Min CSA Velocity and Piston Velocity

CARGRAPH - Top caption head is now set to Black like all other captions

CD_FA - Added a few new Coefficient of Drag and Frontal Areas

CUBICIN - Changed Graphing of Piston Travel so that with Pin Offset it set the Y axis to the correct value.

Major Update to Documentation:
- Changed it so that most graphics and screen prints have a white or lighter colored background which save on toner.
- Fixed a problem where sometimes parts of a page on both side and top margins maybe cutoff a small amount of data when printed.
- Adjusted margins so that printed pages can be hole punched to fit into a 3 ring binder

— 3.27.0 —

ACCELER - On Graphing Screen - Text Report - Added Calculate Uncorrected HP, Torque, BMEP, and Correction Factor from Fuel lb/hr, BSFC and Corrected Torque.
- Text Report - Added Calculate SCFM and VE, from Fuel lb/hr and A/F plus Dyno BP, Dyno VP and Dyno Temp.
- Fixed Bug went Track BP was set and Hood Scoop was checked it gave wrong results / different than when air density was used.

Cam_Gen - Modified so it will generate Cam Lift data Files "CMM" using user selected every x value.

Main - Graph / Draw Options - Changed logic so that changing Line Width will not Clear / Reset the Graph screen.
- Added a new Grid option Semi Grid
- Added option for Cross (Hair) Lines with Semi Grid Option
- Added option for Box Lines with Semi Grid Option

— 3.26.0 —

AIRFUEL - Valve Mach Sizing - Modified Helmholtz Tuning calculations. I use 77 in my Helmholtz calculations. There are a number of online calculators and spreadsheets that use 80. I have added an option so the user can use 80 or any other number they want.

CARGRAPH - For Read PRM file Added the "x scale" and "y scale" and "x shift" and "y shift" parameters.
These only work when using the "overlay" parameter. I changed the Logic so the x and y points will be scaled and or shifted by these amounts.

CR - Added Calculate Dish Volume from Dish Bore and Dish Depth
- Added Calculate Dish Depth from Dish Volume and Dish Bore

Main - Fixed problem - When the parameter file was read in the Notes data was converted to all Lower Case.

UNITCONV - Made very small changes in value of CFM_TO_LPM, CFM_TO_CMS, CFM_TO_CMM, and CFM_TO_CCM was 0.02831682 to .02831684659

— 3.25.0 —

AIRFUEL - CAM_INFO - CMM files can now have a number of degrees value on the exhaust statement - ex. exhaust 2.3456789

AIRFUEL - Calculate RPM Using VE / Volumetric Efficiency Engine Mass Air Flow, Engine Size, Inlet Temperature, Barometric Pressure.
- Port Flow / CSA - On Graph with lines (RPM) changed from 4 to 6 lines

Main - Added option so User can Enter / Updates Notes and have them written to the Parameter File

Tools - Added - Logic so that Header Records in PRT / Delimited files are now Skipped.
- Added - Logic so that Non-numeric fields are now skipped and do not hang program
- Added Convert DYN (DeskTop Dyno) / CQU (Comp Cams CamQuest) File for Acceleration

— 3.24.0 —

ACCELER - Graphing Screen – Added Graph Plus, works for all Graph types

AIRFUEL - Made changes to Graphing on Analyze Flow Data so that Graph Plus works for all Graph Types

COMPGAUG - Added Graph Cylinder Pressure against Crank Rotational Angle

CD_FA - Added some NEW Coefficient of Drag and Frontal Area for a number of different vehicle

TRANS - Added some new gear ratios

— 3.23.1 —

COMPGAUG - Added Graph CR against IVC for a Fixed CGP
- Added Graph CGP against IVC for a fixed CR

GRAPH - Added a 5th and 6th Vertical Moveable Grid Lines.
- Fixed a few Problems where sometimes no all of a headings Text would be shown.

Tools - Added - Increase / Decrease Cam Lift

— 3.23.0 —

ACCELER - On Graphing Screen - Added a Text Report which shows RPM / HP / Torque / BMEP with Average, Minimum and Maximum lines.

AIRFUEL - Port Flow / CSA - On Graph with lines remove decimal from RPM's

GRAPH - Added a Third and Forth Vertical Moveable Grid Lines.
- Added a Second Horizontal Moveable Grid Line.

Main - Fixed a problem where under rare conditions the incorrect lash values were written to the Parameter File

Tools - This new Tab Was Added - Contains
Convert Cam File from Inches to MM
Convert cam File from MM to Inches
Convert PRT / Delimited File for Acceleration -- User Selected Fields RPM and Torque
Convert PRT / Delimited File for Acceleration -- User Selected Fields RPM and HP
Convert PRT / Delimited File for Graphing -- User Selected Fields X-Axis and Y-Axis
Reverse Axis for CARFOR Graphing File / PRM

— 3.22.0 —

AIRFUEL - Added Lift Table for Port Time 2 Report so Users have control of Lift / Duration points. Increased max from 18 to 28. These can be entered in any order and the program will sort them.

GRAPH - There are 1 Horizontal and 2 Vertical Moveable Grid Lines.
Each of these has their own position display box.
When over the Vertical Moveable Grid Lines the cross hair cursor will change to an I-Beam to let you know you are over the line.
When over the Horizontal Moveable Grid Line the cross hair cursor will change to an Up Arrow to let you know you are over the line.

MAIN - User can now select to have 3 Moveable Grid lines displayed on the Graph display screen.

— 3.21.6 —

AIRFUEL - Calculate VE / Volumetric Efficiency Using Engine Mass Air Flow, Engine Size, RPM, Inlet Temperature, Barometric Pressure.

CARGRAPH - Changed Logic so x and y point of mouse cursor on graph is more accurate

CD_FA - Added some NEW Coefficient of Drag and Frontal Area for a number of different vehicle

Engine Specs - Added some new Engine Size, Bore, Stroke, Rod Lengths

TRANS - Added some new gear ratios.

— 3.21.5 —

AIRFUEL - Made changes to Port Time Area 2 Text Report - If reading in a "C1" file that has header information this will now be displayed.
- Made changes on EFI screen so Injector Size and Injector Size 2 will now calculate Pulse Width

TRANS - Added some new Motorcycle gear ratios as well as primary and secondary tooth counts.
- Changed program so it will pick up the primary and secondary tooth counts if they are present.

UNITCONV - Made very small changes in value of BTU_TO_JOULES and FTLB_TO_JOULES

Fixed a problem with reading in some "C1" files from Cam Doctor or exported from Cam Pro Plus

— 3.21.4 —

AIRFUEL - Made changes to speed up Graphing of cams and Port Time Area 2 Text Report when you have a large number of data points

CAM_INFO - Fixed a problem in Graph Plus. When every degree was not an integer the Graphs will not align properly.

------- Increased the number of data point a cam can have to 3600.

— 3.21.3 —

ACCELER - Fixed a problem in Graphing G Force - Time. Sometimes it did not shift to the next gear at the correct RPM.

TRANS - Added some new Motorcycle gear ratios as well as a few new manufacturers

— 3.21.2 —

CAM_INFO – Fixed - With 0.040 Check Box and Metric Check Box both Checked the line is in the correct place (it is moved) but was miss labeled 1.27 when it should be 1.016

— 3.21.1 —

AIRFUEL - Added 0.040", .900" and 1.0" lift to Port Time calculates Report

CAM_INFO - Added 0.040 Check Box. When Checked this will draw line at 0.040" lift instead of 0.050" lift

— 3.21.0 —

AIRFUEL - Valve Mach Sizing - Added Helmholtz Tuning which calculates RPM (Peak Torque) From Bore, Stroke, Length - Port + Runner, CSA, Compression Ratio, and Speed of Sound.
- Added Calculate Length - Port + Runner From Bore, Stroke, RPM (Peak Torque), CSA, Compression Ratio, and Speed of Sound.
- Added Graph Length - Port + Runner Varying CSA From Bore, Stroke, RPM (Peak Torque), CSA, Compression Ratio, and Speed of Sound.
- Added to Mach Number (CSA) calculate CSA from Velocity, RPM, Bore, and Stroke
- Sub Screen - Added Calculators
- Calculate port CSA from its width, height, and corner radius
- Calculate port ACSA from its Volume in cc's and the port centerline length
- Calculate port FPS from its CFM and CSA
- Calculate port CFM from its FPS and CSA
- Calculate port CSA from its CFM and FPS

CR - Added Graph CR against Total Volume

— 3.20.3 —

AIRFUEL - Fixed a problem where RPM Max Horse Power was not correctly written to Parameter File
- Valve Mach Sizing - Internally I have redone part of math for the Mach calculation so that I can now show velocity.
- Added Mach Number (CSA) which calculates Mach Number and Velocity from RPM, Bore, Stroke, and CSA
- Added Mach Number (CD) which calculates Mach Number and Velocity from RPM, Bore, Stroke, Valve Size and CD
- Added Graph Mach Number (CD) over RPM and CD range.
- Added Graph Velocity (CD) over RPM and CD range.

— 3.20.2 —

MAIN - Added Menu that lets User Select Alignment of Entry Text
- Added Menu that lets User Select Entry Text Border Style
- Added Menu that lets User Select Option/Check Box Border Style

- Made adjustments in processing the new parameters that should increase the speed with which the parameter file is read.

— 3.20.1 —

MAIN - Added Menu that lets User Select Color of All Labels and Lines
- Fixed a place where the User Selected Frame background color was not set
- Fixed a place where the User Selected Quit / Done background color was not set

— 3.20.0 —

ACCELER - Changed when Hoop Scoop is checked that calculation uses User entered TrackBP instead of STD Density
- Graph Wheel Torque will now include any added by Nitrous
- Graph MPH / Wheel Torque will now include any added by Nitrous

AIRFUEL - Port Flow / CSA - Intake and Exhaust CSA - FPS - Choke RPM – VE Line and Circle were at a fixed position (290 FPS). They will now appear at the USER Velocity - fps
- Port Time Area - Added Graphing of Piston Flow CFM

MAIN - Added Menu that lets User Select Font properties for All Data Fields
- Added Menu that lets User Select Font properties for All Labels
- Added Menu that lets User Select Font properties for All Command Buttons
- Fixed a number of places where the User Selected Frame background color was not set

— 3.19.2 —

Cam_Gen - Added 2 new option to generate Cam Lift data Files "CMM" using only Max Lift and .000 Duration
- Added Asymmetrical option. On most Max Lift and .000 Duration options this will let the User have a different First half and second half duration.

— 3.19.1 —

MAIN - Added Menu item to Clear Data Fields on all forms, so blank forms can be printed.

Engine Specs - Added new tab – Air Craft

— 3.19.0 —

AIRFUEL - Port Time Area - On Area2
- Added DOHC Switch so Exhaust can be Advance / Retard separate of Intake
- Added Metric Switch - most items will be Display or Graph in Metric
- Added Valve to Piston Clearance @ TDC entry field - This let you see on the graphs how valve to piston clearance is at minimum point and how it changes by advancing or retarding the cam or changing LSA

Cam_Gen - Added 7 option to generate Cam Lift data Files "CMM" using only Max Lift and .000 Duration
- Added some error checking for blank fields
- Added Metric Switch
- Added Clear Duration
- Added Calculate Max Lifter / Bucket Velocity

CAM_INFO - Added Graph Acceleration Valve Inch/Deg/Deg
- In some cases the scale for Acceleration Cam Inch/Deg/Deg will be changed
- On the Graphs of cam and valve lift added lines will be adjusted to their metric value of the Metric Button is checked
- Fixed problem and Metric switch will convert Valve Lash

TRANS - Added some new Motorcycle gear ratios as well as primary and secondary gear ratios.
Changed program so it will pick up the primary and secondary gear ratios if they are present.

— 3.18.1 —

MAIN - Fixed Problem with Graph Screen Resizing algorithm and Screen Resizing - For sometime there has been a rare bug which will cause the program to resize the screens to have a width of about 1/2 inch. I believe that I traced this back to version 3.16.1 and the Rewrite of the Graph Screen resizing algorithm.

— 3.18.0 —

ACCELER - Added Estimate Top Speed track HP.

AIRFUEL - Port Time Area - On Area2 Added Calculation of Cam Area
- Added Total for User Air Flow
- Analyze Flow Data - Added Graph CFM per Sq Inch

BLOWERS - On VE RPM Table Added Reset button to reset ALL VE values to VE Value on main screen.

- Air Flow map - PR Graph will now use VE Table if Checked – because of rewrite it now draws a line instead of the dots.

Cam_Gen - Added option to generate Cam Lift data Files "CMM"
This is NOT a Cam Lobe Design Tool and it does not replace measuring the Cam with something like a Cam doctor or a Dial Indicator and Degree Wheel.

CUBICIN - Added Graphing Crank Rod Angle

TRANS - Added some new gear ratios as well as the Tremec TR6060 and Isuzu's

— 3.17.2 —

ACCELER - Added Throttle Stop RPM and Time.
- Move Graph Options to separate Sub Screen

CARGRAPH - Changed Heading Alignment to reduce overset
- The User can drag the logo to where on the Graph they wants it to appear

MAIN - Added on Print Forms the Printing of the Graphs Form
- The User can now select a Logo which he wants to appear on the Graphs

— 3.17.1 —

AIRFUEL - Port Time Area - On Area2 Text Report and graphing Added TDC and BDC in place of 0, 360, -360 and 180, -180
On Area2 Text Report and Graphing Added Advance / Retard Cam and Increase and Decrease LSA

COMPGAUG - Added Graph CGP against BP as In HG
- Added Graph change in Intake Valve Closing for change in Barometric Pressure (In Hg) with a fixed Cranking Compression Pressure. Using Bore, Rod Length, Stroke, Compression Ratio

CUBICIN - On Graphs Add TDC and BDC in place of 360, and 180