4N6XPRT StifCalcs® Manual

INTRODUCTION:

The purpose of our writing the 4N6XPRT StifCalcs® program is to provide users easier access to the NHTSA Crash Test data. Part of the "easier access" concept is to allow the typical user to:

- Rapidly determine if NHTSA has a test for a certain vehicle with a certain impact location
- Search the database for all tests across the year range the vehicle is the "same", based upon identifying the desired vehicle Year, Make, and Model
- Search the database for all tests of "Sister" vehicles across the year range the vehicle is the "same" based upon identifying the desired vehicle Year, Make, and Model
- Display all the selected matches from the database broken into their general impact "classes" - Frontal impact, Side impact, Rear impact, and Other impact
- Easily search the database for similar class vehicles when there is no test for a desired vehicle

As a secondary consideration, the program provides some "base" calculations for stiffness values based upon the test data, with the realization that no one set of stiffness values will handle all situations, at least not well. Therefore, for each test we provide multiple sets of A-B-G stiffness values and leave it to the user to pick the appropriate values for their given collision analysis.

We hope that you find the program as useful as we do, and welcome your questions and suggestions for possible improvements.

FREQUENTLY ASKED QUESTIONS:

Why can't I find any tests when I use the BASIC VEHICLE SEARCH, yet the vehicle has been tested by NHTSA?? This is most likely due to an incompatibility in model name between the Sister/Clone list maintained by Greg Anderson and the model name used by NHTSA. Incompatibility can be ANYTHING which is different between the two names - spelling, characters, spacing, etc.

Why can't I find all of the available tests for a vehicle and its Sisters & Clones when I use the BASIC VEHICLE SEARCH?? This is most likely due to an incompatibility in model name(s) between the Sister/Clone list maintained by Greg Anderson and the model name(s) used by NHTSA. Incompatibility can be ANYTHING which is different between the two names - spelling, characters, spacing, etc.

Why can't I find the vehicle manufacturer or model when I use the BASIC VEHICLE SEARCH, yet the vehicle has been tested by NHTSA?? This is most likely due to the vehicle being outside of the year range covered by the Sister/Clone list maintained by Greg Anderson.

Why are there so many Stiffness Values for a given test? Several reasons. First, our presentation of stiffness values mirrors our belief that no one set of values will fit every situation. Second, our presentation allows you to quickly develop a range of damage speeds, in a manner that should be easily explainable to a judge and/or jury, based upon data from one test. Third, there are up to three different sets of crush depths and two crush widths from which to calculate stiffness values, as well as two different methods of calculating average crush. Depending upon which data set(s) you choose to use will determine how many calculated stiffness sheets you will end up with.

Which values do I use?? It depends upon the type of test, Front, Rear, or Side.

Front - The initial point to start at would be Vehicle Width, Trapezoidal Average Crush, 5 mph Rated No Damage Speed. Which set of crush measurements to use is determined by what NHTSA reported along with your preference.

Rear - The initial point to start at would be Vehicle Width, KE Equivalent Speed, Trapezoidal Average Crush, 5 mph Rated No Damage Speed. Which set of crush measurements to use is determined by what NHTSA reported along with your preference.

Side - The initial point to start at would be Indentation Length, KE Equivalent Speed, Trapezoidal Average Crush, 2 mph Rated No Damage Speed. Which set of crush measurements to use is determined by what NHTSA reported along with your preference.

Must I use the "Trapezoidal Average"? When dealing with equally spaced crush measurements, you CAN use a "Simple average", but it is still "more correct" to use a "Trapezoidal Average", and with the 4N6XPRT StifCalcs program determining the Trapezoidal Average is quite painless.

What **IS** a Trapezoidal Average? The trapezoidal average is determined by first calculating the area in each Crush Zone through the formula -

$$\text{Area} = (\text{distance between measurements } C_n \text{ \& } C_{n+1}) * (C_n + C_{n+1})/2$$

next, add each of the areas, and then divide that by the total Crush Length (L)

$$\text{Trapezoidal Average Crush Depth} = (\sum[\text{Area}]) / L$$

What **IS** a Simple Average? The "Simple Average" is determined/calculated by adding up all of the crush measurements and then dividing the total by the number of measurements.

What is the Tumbas method/Protocol? Nicholas Tumbas was a co-author of SAE # 880072 - Tumbas, Nicholas S. and Smith Russell A. - which set a number of "standards" for what and how crush is to be measured. CRASH3, together with SAE # 880072, defines three options for the crush measurements. Either two, four or six crush equally spaced measurements are taken which are labelled C1 through to C6 as appropriate. This gives either one, three or five crush zones which are designed to approximate the damage profile.

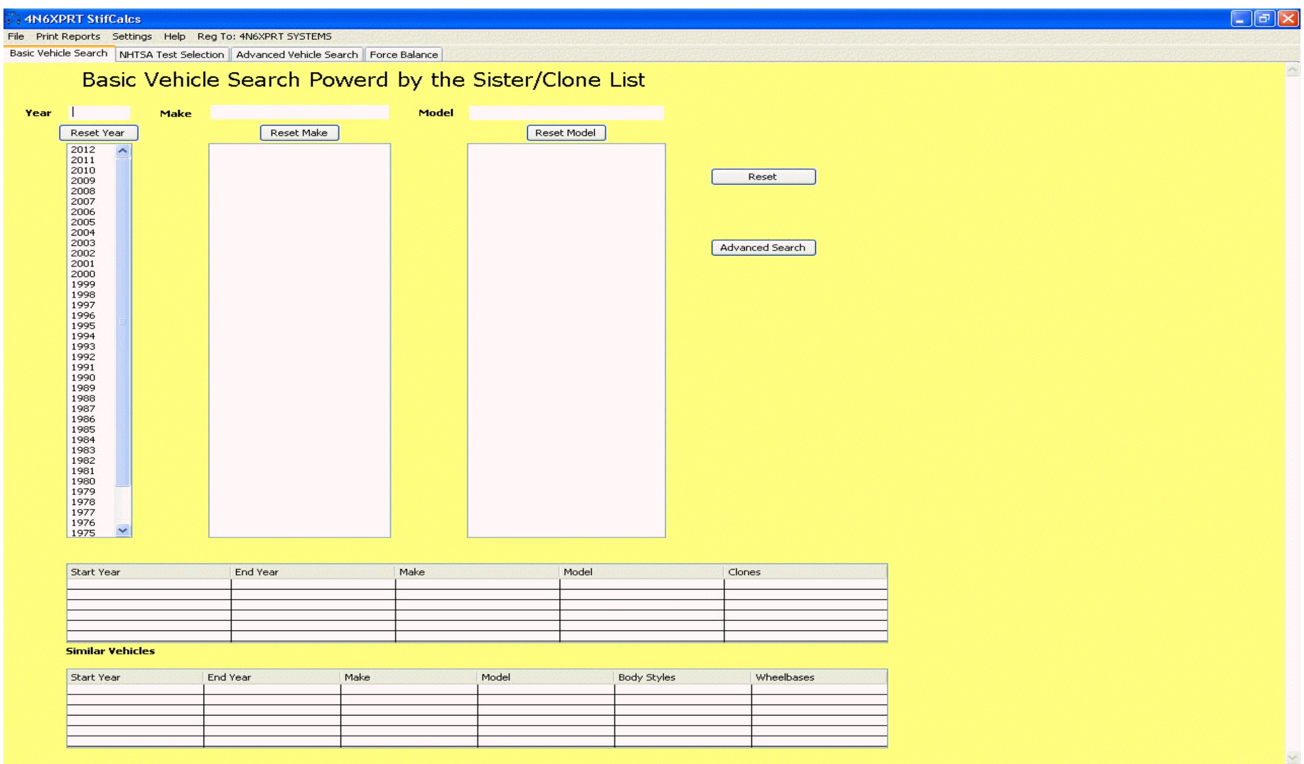
Which is better, EQUAL or NON-EQUAL spacing between Crush Measurements? Equally spaced crush measurements have the benefit of complying with the commonly accepted crush measurement techniques/protocols, along with fitting nicely into a set of predefined “short hand” equations for calculating Average Depth, Force, and Energy. Unfortunately, equally spaced crush depth measurements may not properly depict the crush profile, may require measurements to be taken in an area where they really don’t need to be taken due to the crush profile being a “straight line” at that point, or more commonly .... both. For that reason, we prefer to use non-equally spaced measurements for most cases.

What follows is a step-by-step walk through for this program. The user should also refer to the NHTSA Reference Manuals provided with this program. If they were loaded, they are accessible from the HELP menu. The NHTSA Reference Manuals discuss the various data points contained in the NHTSA database in detail.

ESSENTIAL FORMULAS:

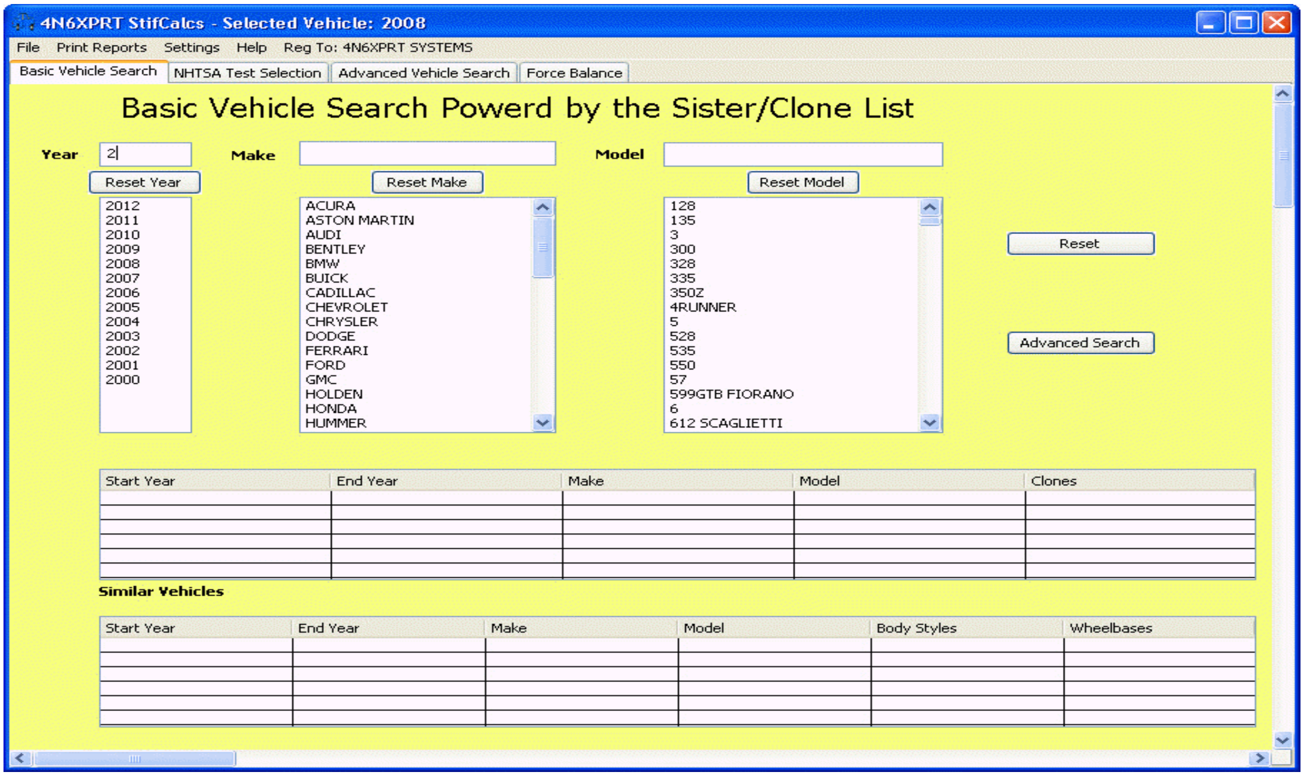
At the very end of ths manual (Starting around page 56) we detail a number of the formulas used to complete the various calculations in the 4N6XPRT StifCalcs® program.

BASIC SEARCH:

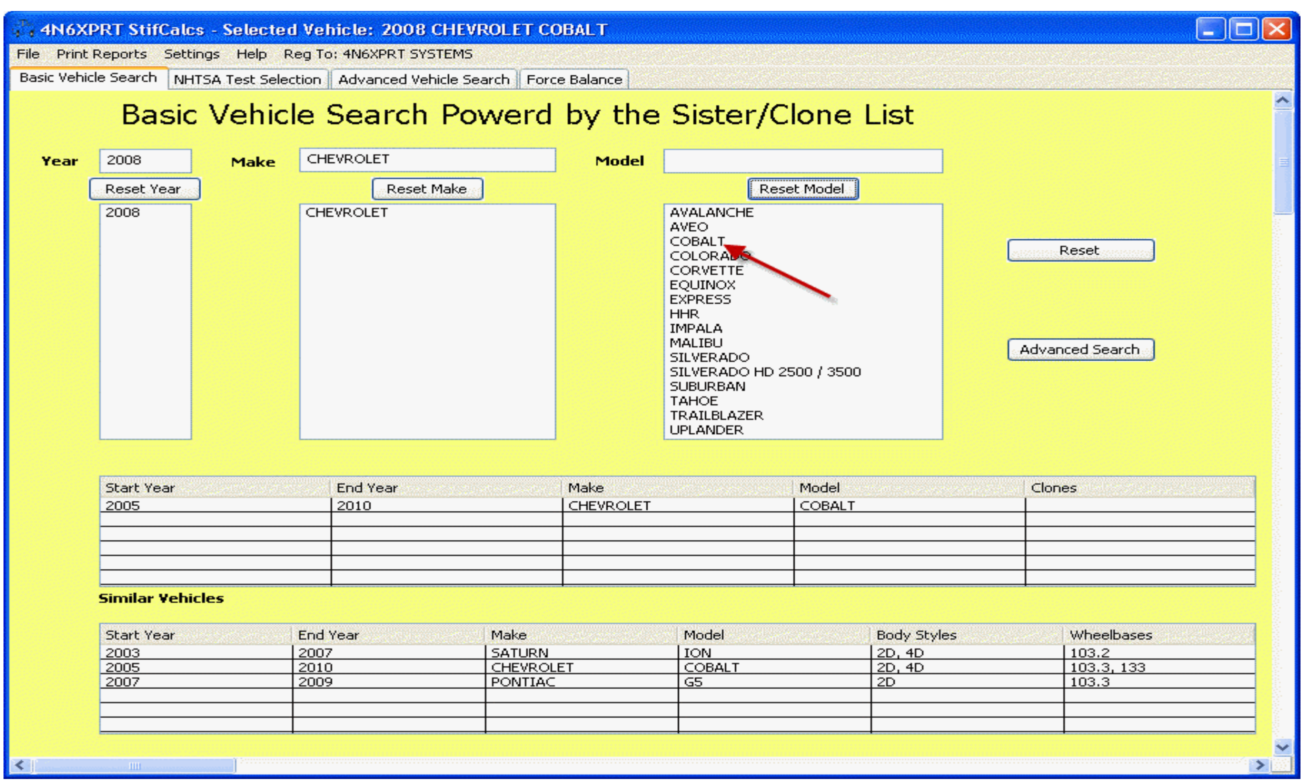


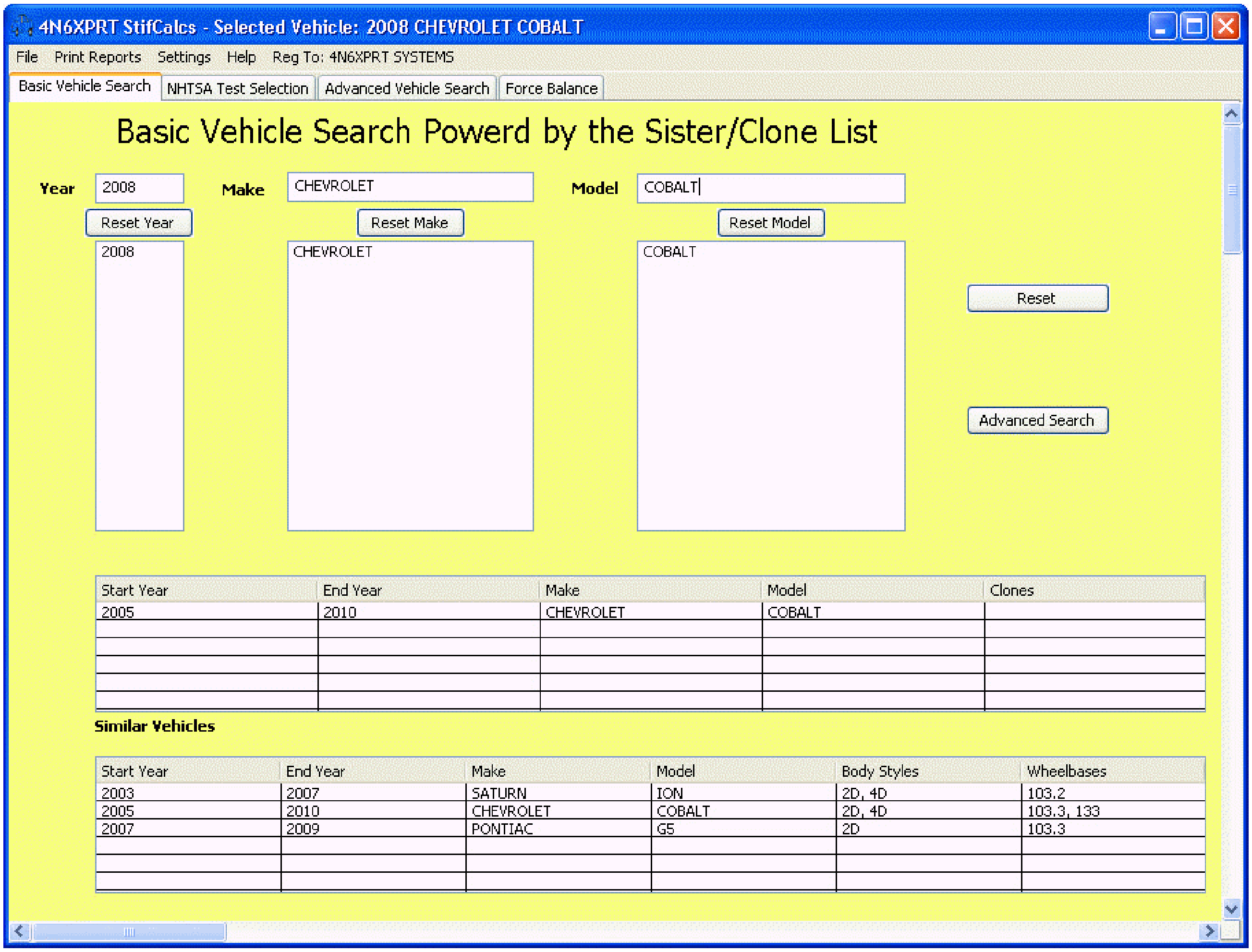
To retrieve data through the basic search method, simply 1) pick the year, 2) pick the make, 3) pick the model, and 4) click on the **NHTSA TEST SELECTION** tab.

When "picking" the Year, Make, and Model, they can either be picked off the drop down list, typed in directly, or a combination of the two.



As can be seen in the Year box, as you begin to type a entry, the "Pick List" box narrows appropriately. In this case, all of the 1900 years have "disappeared". This same approach can be used with the Make and Model entries.

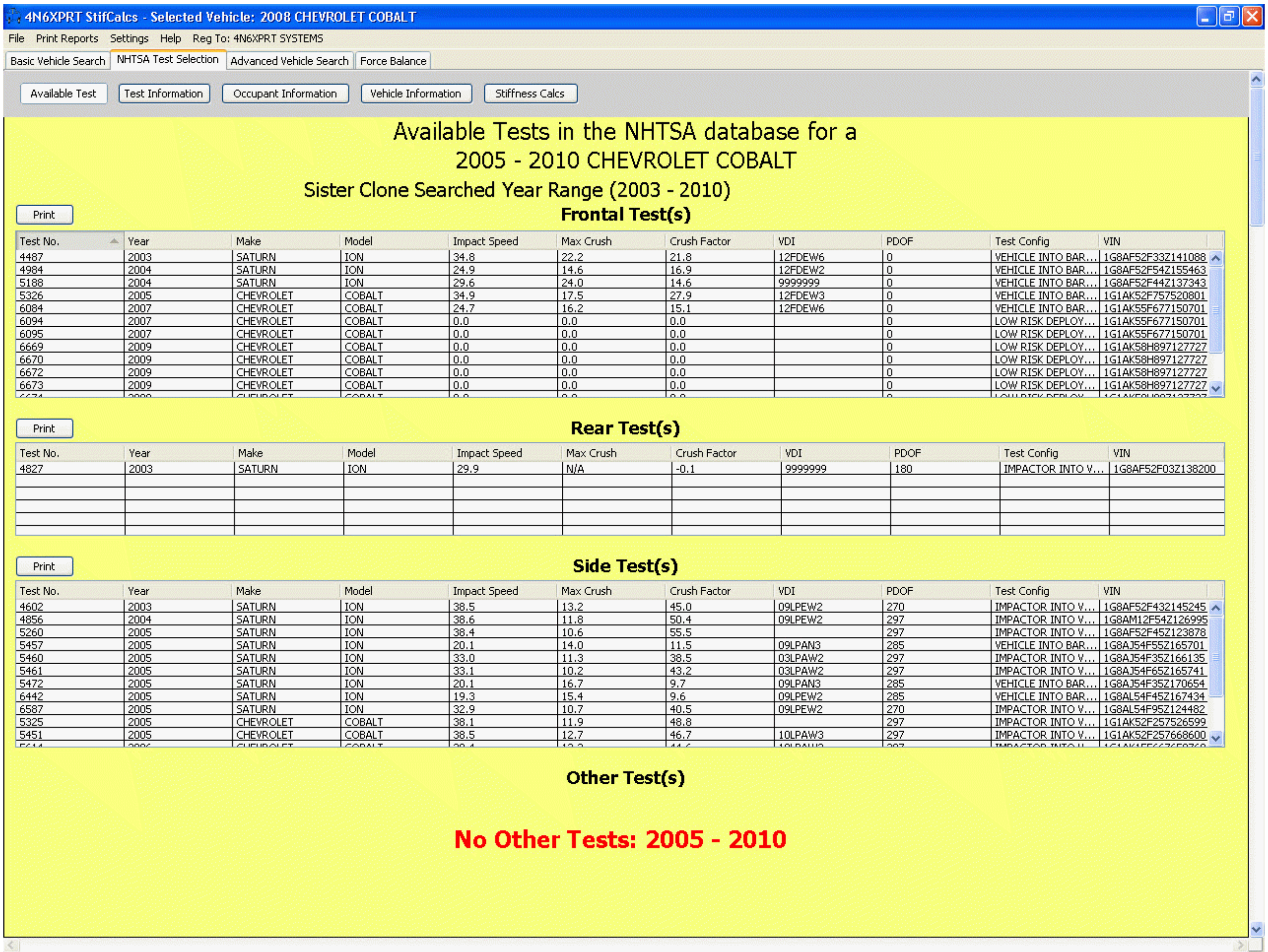




To change the Year, Make, and/or Model values you can begin typing in the new value, or click the appropriate **RESET** button.

As stated previously, when you have the appropriate Year, Make, and Model entered, click on the **NHTSA TEST SELECTION** tab to see which tests are available.

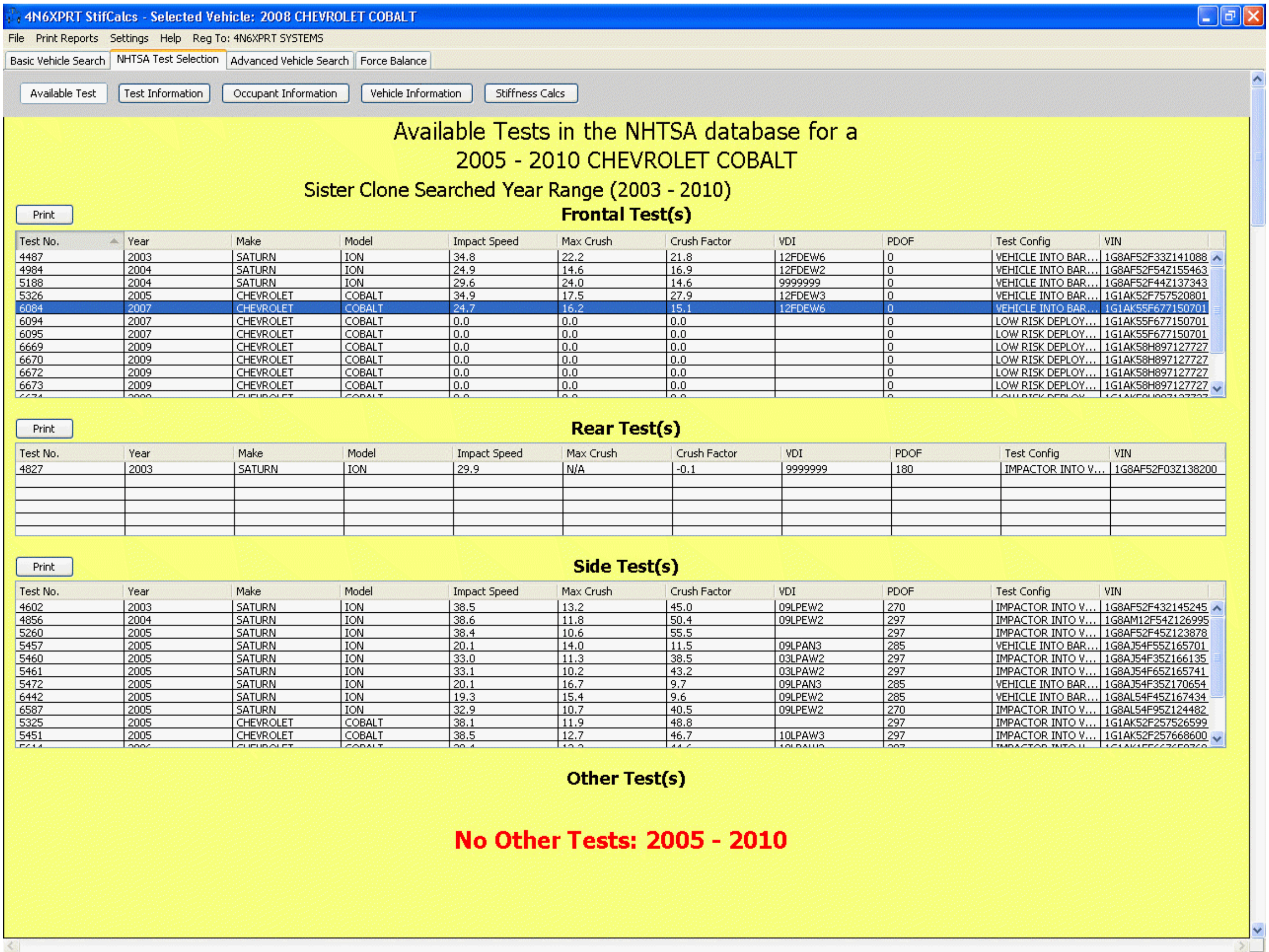
TEST SELECTION:



Once you are on the **NHTSA TEST SELECTION** tab, you can select a test for review.

The available tests come from matching the selected Year/Make/Model to the Sister/Clone (Vehicle Interchange) list which is maintained by Greg Anderson, then searching the NHTSA Crash Test database for the tests that meet the Start & End year constraints of the Sister/Clone list and also meet the Make/Model and similar vehicle constraints of the Sister/Clone list.

To select a test, click on the test. Make sure that the little hour glass shows up after clicking on the test. If the hourglass does not show, click on the test again.



Available Tests in the NHTSA database for a
2005 - 2010 CHEVROLET COBALT
Sister Clone Searched Year Range (2003 - 2010)

Frontal Test(s)

Test No.	Year	Make	Model	Impact Speed	Max Crush	Crush Factor	VDI	PDOF	Test Config	VIN
4487	2003	SATURN	ION	34.8	22.2	21.8	12FDEW6	0	VEHICLE INTO BAR...	1G8AF52F33Z141088
4984	2004	SATURN	ION	24.9	14.6	16.9	12FDEW2	0	VEHICLE INTO BAR...	1G8AF52F54Z155463
5188	2004	SATURN	ION	29.6	24.0	14.6	9999999	0	VEHICLE INTO BAR...	1G8AF52F44Z137343
5326	2005	CHEVROLET	COBALT	34.9	17.5	27.9	12FDEW3	0	VEHICLE INTO BAR...	1G1AK52F757520801
6084	2007	CHEVROLET	COBALT	24.7	16.2	15.1	12FDEW6	0	VEHICLE INTO BAR...	1G1AK55F677150701
6094	2007	CHEVROLET	COBALT	0.0	0.0	0.0		0	LOW RISK DEPLOY...	1G1AK55F677150701
6095	2007	CHEVROLET	COBALT	0.0	0.0	0.0		0	LOW RISK DEPLOY...	1G1AK55F677150701
6669	2009	CHEVROLET	COBALT	0.0	0.0	0.0		0	LOW RISK DEPLOY...	1G1AK58H897127727
6670	2009	CHEVROLET	COBALT	0.0	0.0	0.0		0	LOW RISK DEPLOY...	1G1AK58H897127727
6672	2009	CHEVROLET	COBALT	0.0	0.0	0.0		0	LOW RISK DEPLOY...	1G1AK58H897127727
6673	2009	CHEVROLET	COBALT	0.0	0.0	0.0		0	LOW RISK DEPLOY...	1G1AK58H897127727

Rear Test(s)

Test No.	Year	Make	Model	Impact Speed	Max Crush	Crush Factor	VDI	PDOF	Test Config	VIN
4827	2003	SATURN	ION	29.9	N/A	-0.1	9999999	180	IMPACTOR INTO V...	1G8AF52F03Z138200

Side Test(s)

Test No.	Year	Make	Model	Impact Speed	Max Crush	Crush Factor	VDI	PDOF	Test Config	VIN
4602	2003	SATURN	ION	38.5	13.2	45.0	09LPEW2	270	IMPACTOR INTO V...	1G8AF52F432145245
4856	2004	SATURN	ION	38.6	11.8	50.4	09LPEW2	297	IMPACTOR INTO V...	1G8AM12F54Z126995
5260	2005	SATURN	ION	38.4	10.6	55.5		297	IMPACTOR INTO V...	1G8AF52F45Z123878
5457	2005	SATURN	ION	20.1	14.0	11.5	09LPAN3	285	VEHICLE INTO BAR...	1G8AJ54F55Z165701
5460	2005	SATURN	ION	33.0	11.3	38.5	03LPAW2	297	IMPACTOR INTO V...	1G8AJ54F35Z166135
5461	2005	SATURN	ION	33.1	10.2	43.2	03LPAW2	297	IMPACTOR INTO V...	1G8AJ54F65Z165741
5472	2005	SATURN	ION	20.1	16.7	9.7	09LPAN3	285	VEHICLE INTO BAR...	1G8AJ54F35Z170654
6442	2005	SATURN	ION	19.3	15.4	9.6	09LPEW2	285	VEHICLE INTO BAR...	1G8AL54F45Z167434
6587	2005	SATURN	ION	32.9	10.7	40.5	09LPEW2	270	IMPACTOR INTO V...	1G8AL54F95Z124482
5325	2005	CHEVROLET	COBALT	38.1	11.9	48.8		297	IMPACTOR INTO V...	1G1AK52F257526599
5451	2005	CHEVROLET	COBALT	38.5	12.7	46.7	10LPAW3	297	IMPACTOR INTO V...	1G1AK52F257668600

Other Test(s)

No Other Tests: 2005 - 2010

When determining which test to select, items to be considered include:

Does the VDI (Vehicle Damage Indicator) clock position match the impact location? - 12 for front, 3 or 9 for side, and 6 for rear tests.

Does the PDOF (Principal Direction of Force) match the impact location? - 0 for front, 90 or 270 for side, an 180 for rear tests. Keep in mind that the Frontal tests can have a PDOF of 180 depending upon the reporting agency.

On frontal tests the test specific CF (Crush Factor) is close to 21, on side or rear tests the CF is close to 27.

The Year/Make/Model of the test vehicle matches the Year/Make/Model of your subject vehicle.

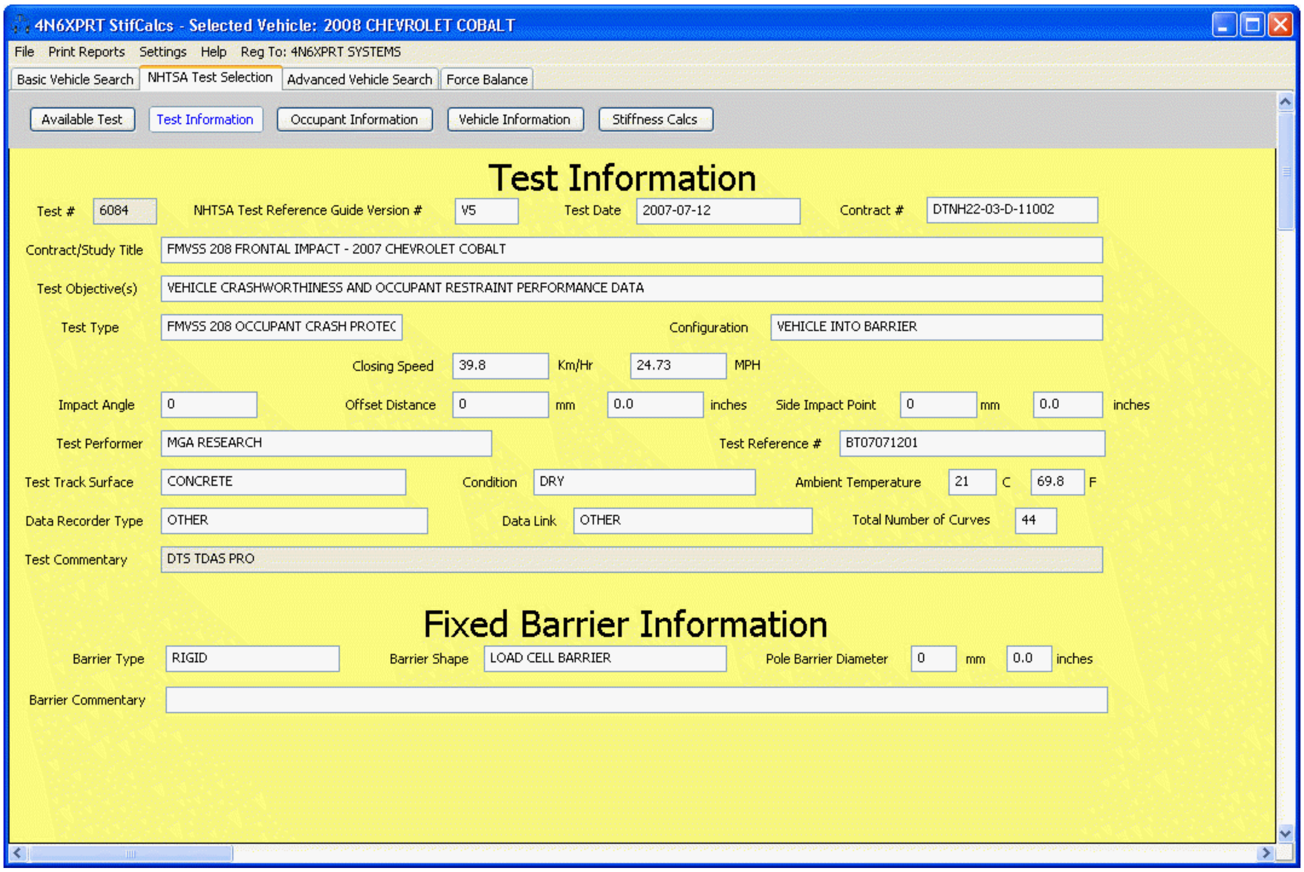
There are no errors in the crush measurements. You may have to check the **VEHICLE** tab after selecting the test to verify this.

The impact speed of the test is a close match to the suspected impact speed of your subject collision.

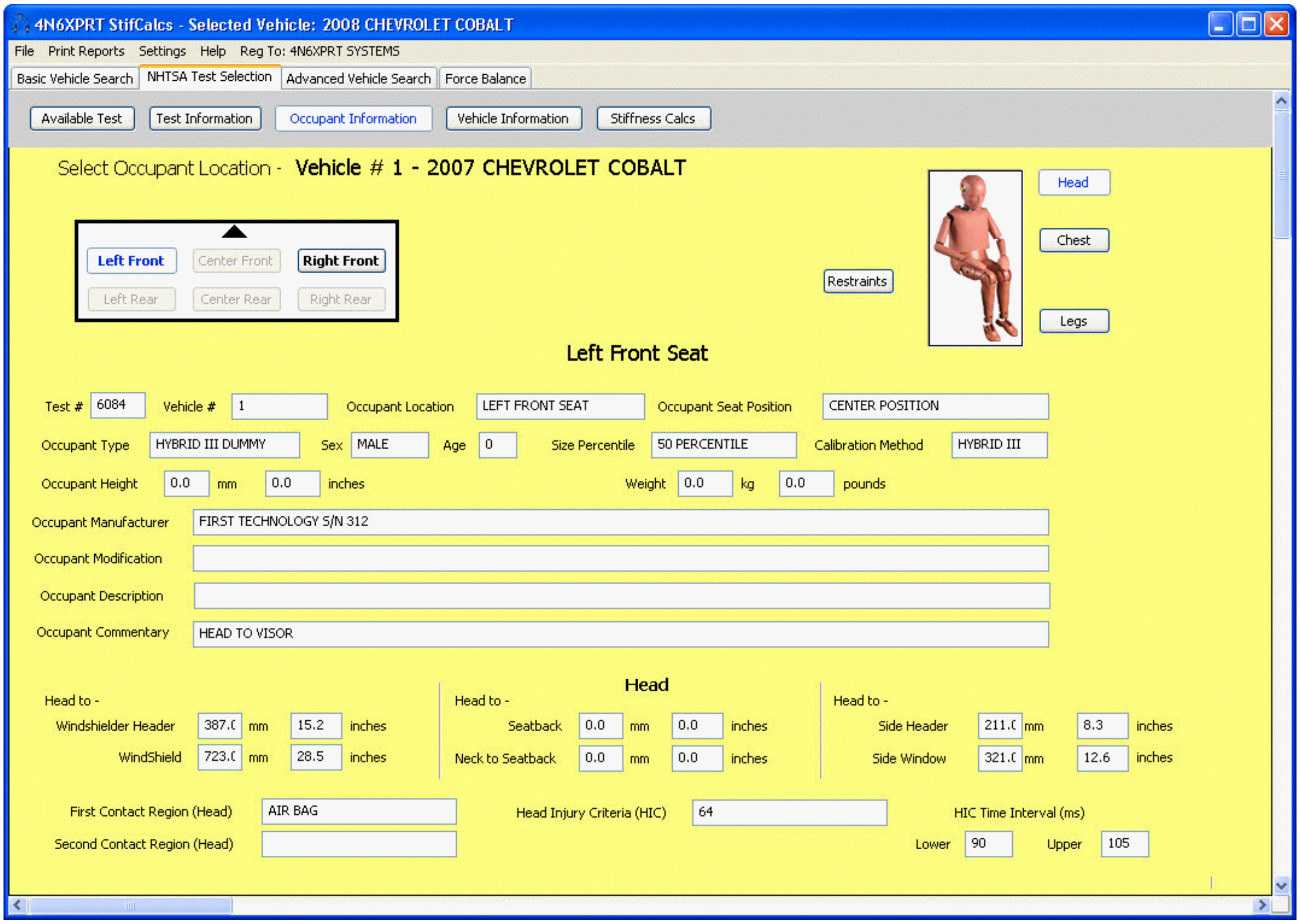
These are IDEAL guidelines!!! Unfortunately, it is difficult to get a test that matches all of these guidelines. This is the first area where you can apply your expertise. Review the available tests and determine which test(s) best meet your criteria for this collision.

RESULTS:

Once you have selected a test, you may examine the following tabs for selected information -



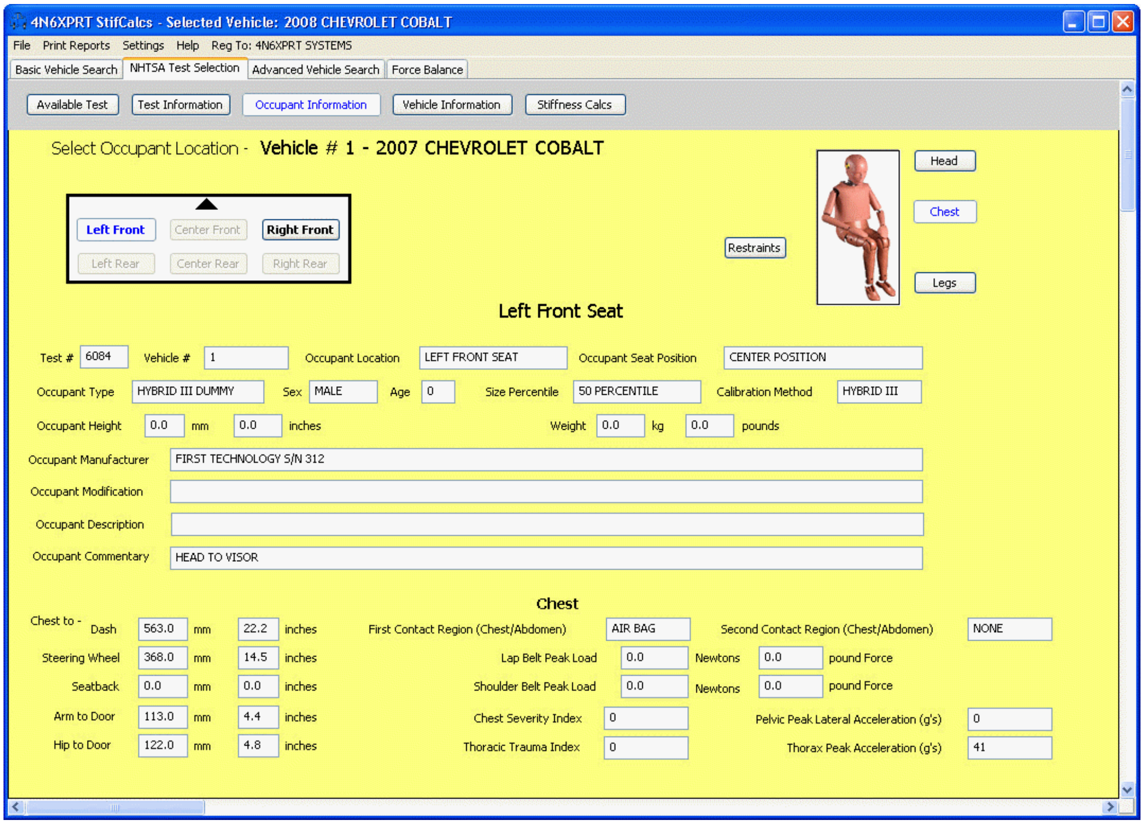
TEST INFORMATION - look for the following items - Contract/Study Title, Test Objective(s), Test Type, Closing Speed, and Test Commentary - are these consistent with your collision? Is there anything in these areas which raise questions? Is there something here that makes you want to look at a different test, provided it/they are available?

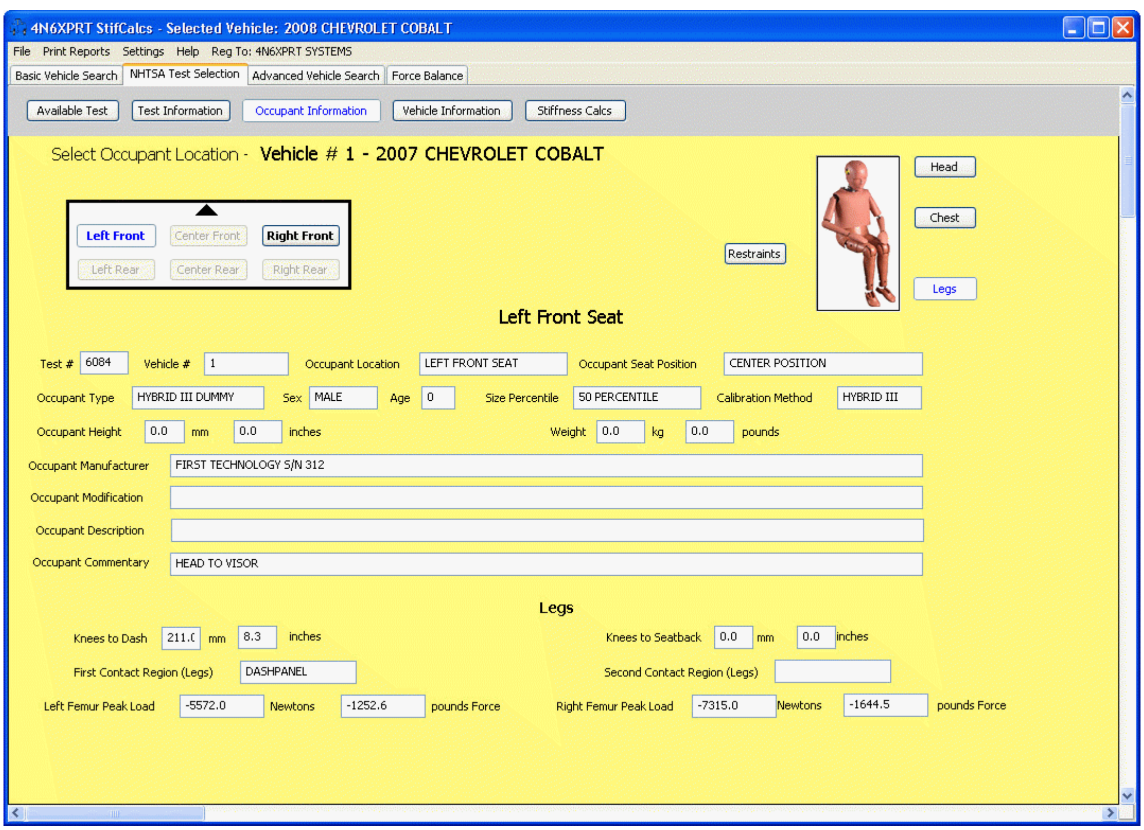


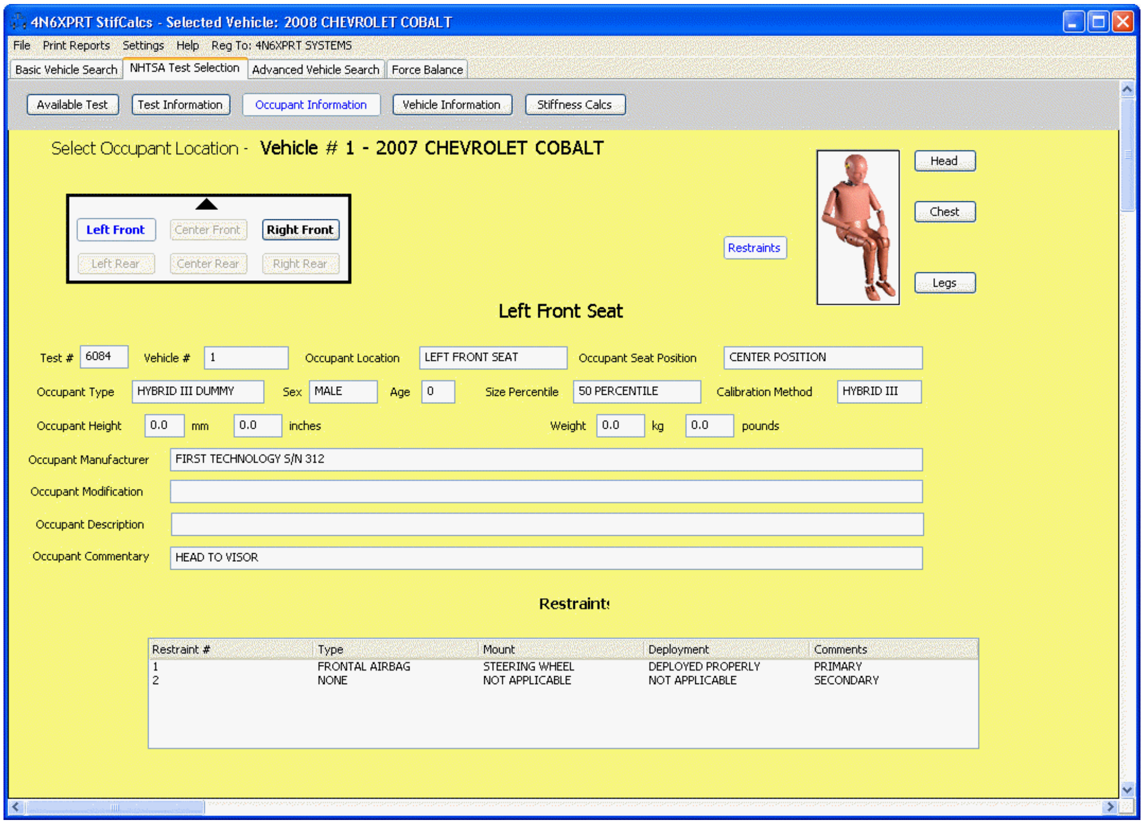
OCCUPANT INFORMATION - depending upon the case, multiple fields may be of interest, such as: contact region(s), position with respect to the vehicle, HIC, G's, or force loadings on the dummy, and restraints in use for the test.

The above Screen shows the HEAD information for the LEFT FRONT occupant. When more than one occupant is in the vehicle, you can switch between occupants by clicking on the appropriate non-greyed out occupant location.

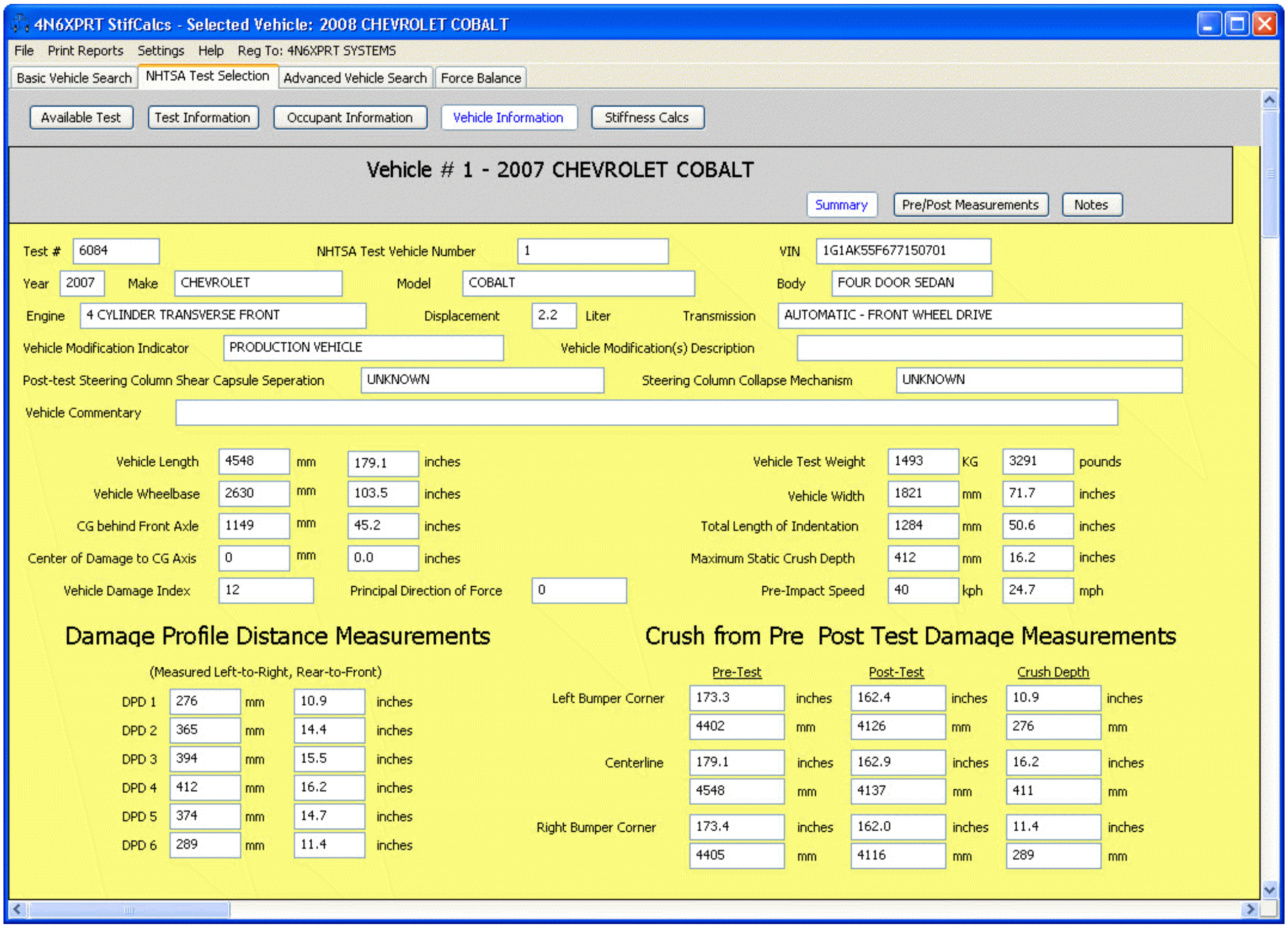
The following screens illustrate the CHEST, LEGS, and RESTRAINTS information, which you get to by clicking the appropriate button.


4N6XPRT StifCalcs - Selected Vehicle: 2008 CHEVROLET COBALT
File Print Reports Settings Help Reg To: 4N6XPRT SYSTEMS
Basic Vehicle Search | NHTSA Test Selection | Advanced Vehicle Search | Force Balance
Available Test | Test Information | Occupant Information | Vehicle Information | Stiffness Calcs
Select Occupant Location - Vehicle # 1 - 2007 CHEVROLET COBALT
Left Front | Center Front | Right Front
Left Rear | Center Rear | Right Rear
Restraints
Head
Chest
Legs
Left Front Seat
Test # 6084 Vehicle # 1 Occupant Location LEFT FRONT SEAT Occupant Seat Position CENTER POSITION
Occupant Type HYBRID III DUMMY Sex MALE Age 0 Size Percentile 50 PERCENTILE Calibration Method HYBRID III
Occupant Height 0.0 mm 0.0 inches Weight 0.0 kg 0.0 pounds
Occupant Manufacturer FIRST TECHNOLOGY S/N 312
Occupant Modification
Occupant Description
Occupant Commentary HEAD TO VISOR
Chest
Chest to - Dash 563.0 mm 22.2 inches First Contact Region (Chest/Abdomen) AIR BAG Second Contact Region (Chest/Abdomen) NONE
Steering Wheel 368.0 mm 14.5 inches Lap Belt Peak Load 0.0 Newtons 0.0 pound Force
Seatback 0.0 mm 0.0 inches Shoulder Belt Peak Load 0.0 Newtons 0.0 pound Force
Arm to Door 113.0 mm 4.4 inches Chest Severity Index 0 Pelvic Peak Lateral Acceleration (g's) 0
Hip to Door 122.0 mm 4.8 inches Thoracic Trauma Index 0 Thorax Peak Acceleration (g's) 41


4N6XPRT StifCalcs - Selected Vehicle: 2008 CHEVROLET COBALT
File Print Reports Settings Help Reg To: 4N6XPRT SYSTEMS
Basic Vehicle Search | NHTSA Test Selection | Advanced Vehicle Search | Force Balance
Available Test | Test Information | Occupant Information | Vehicle Information | Stiffness Calcs
Select Occupant Location - Vehicle # 1 - 2007 CHEVROLET COBALT
Left Front | Center Front | Right Front
Left Rear | Center Rear | Right Rear
Restraints
Head
Chest
Legs
Left Front Seat
Test # 6084 Vehicle # 1 Occupant Location LEFT FRONT SEAT Occupant Seat Position CENTER POSITION
Occupant Type HYBRID III DUMMY Sex MALE Age 0 Size Percentile 50 PERCENTILE Calibration Method HYBRID III
Occupant Height 0.0 mm 0.0 inches Weight 0.0 kg 0.0 pounds
Occupant Manufacturer FIRST TECHNOLOGY S/N 312
Occupant Modification
Occupant Description
Occupant Commentary HEAD TO VISOR
Legs
Knees to Dash 211.(mm 8.3 inches Knees to Seatback 0.0 mm 0.0 inches
First Contact Region (Legs) DASHPANEL Second Contact Region (Legs)
Left Femur Peak Load -5572.0 Newtons -1252.6 pounds Force Right Femur Peak Load -7315.0 Newtons -1644.5 pounds Force



4N6XPRT StifCalcs - Selected Vehicle: 2008 CHEVROLET COBALT
File Print Reports Settings Help Reg To: 4N6XPRT SYSTEMS
Basic Vehicle Search
NHTSA Test Selection
Advanced Vehicle Search
Force Balance
Available Test
Test Information
Occupant Information
Vehicle Information
Stiffness Calcs
Select Occupant Location - Vehicle # 1 - 2007 CHEVROLET COBALT
Left Front
Center Front
Right Front
Left Rear
Center Rear
Right Rear
Restraints
Head
Chest
Legs
Left Front Seat
Test # 6084
Vehicle # 1
Occupant Location LEFT FRONT SEAT
Occupant Seat Position CENTER POSITION
Occupant Type HYBRID III DUMMY
Sex MALE
Age 0
Size Percentile 50 PERCENTILE
Calibration Method HYBRID III
Occupant Height 0.0 mm 0.0 inches
Weight 0.0 kg 0.0 pounds
Occupant Manufacturer FIRST TECHNOLOGY S/N 312
Occupant Modification
Occupant Description
Occupant Commentary HEAD TO VISOR
Restraints
Restraint # Type Mount Deployment Comments
1 FRONTAL AIRBAG STEERING WHEEL DEPLOYED PROPERLY PRIMARY
2 NONE NOT APPLICABLE NOT APPLICABLE SECONDARY



VEHICLE INFO - For the purposes of calculating stiffness values, the following information is important:

Crush Depths - On front and rear tests, there is a possibility for three sets of crush depth measurements: Maximum Crush, Damage Profile Distances (DPD), and Pre test minus Post test measurements. These three sets of measurements can be seen on the top half of the vehicle printout, or on the Vehicle Summary page. Side impact tests may record the Pre test minus Post test measurements, but they are meaningless for the purposes of calculating stiffness values.

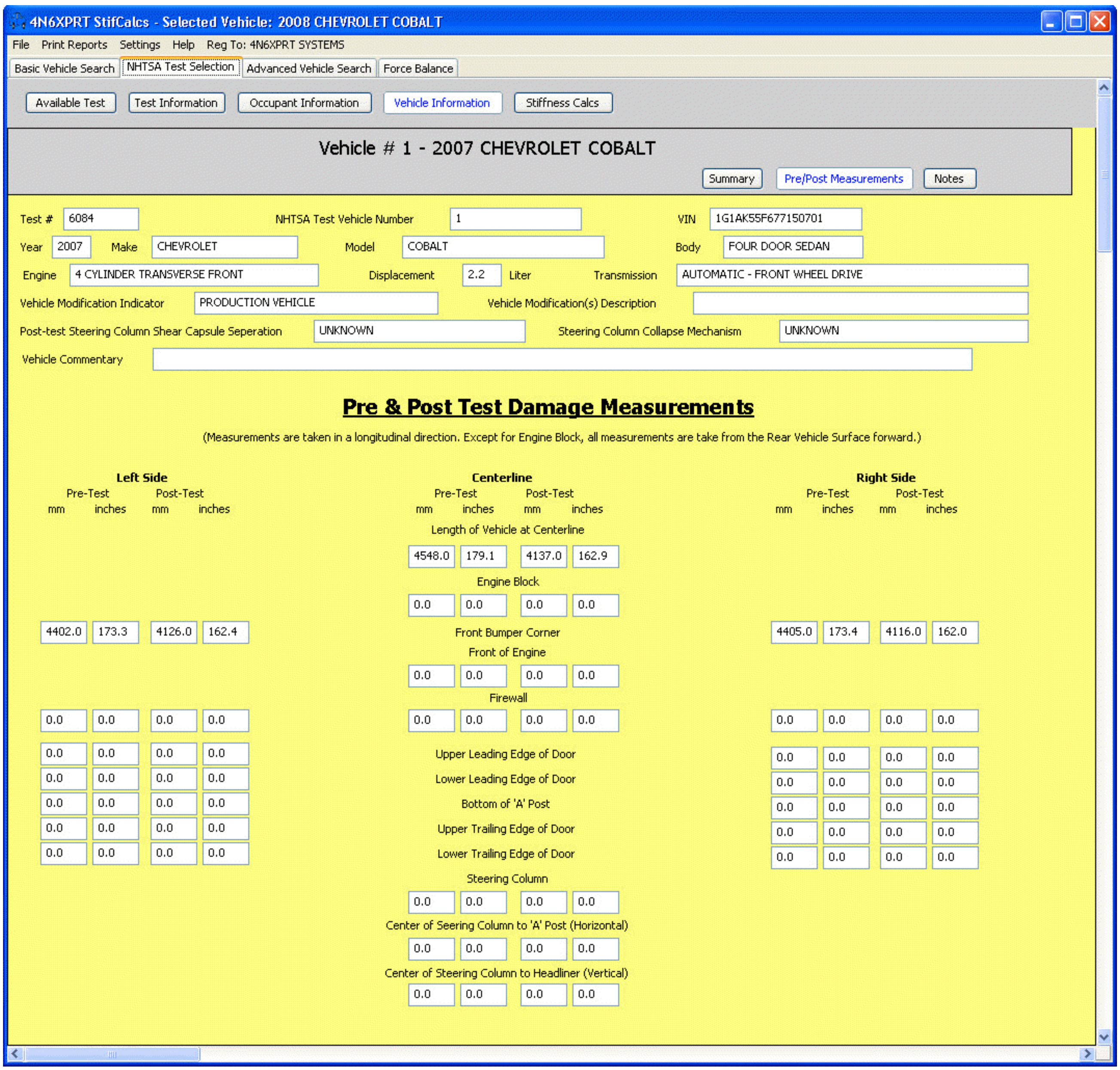
Damage Width - There are two possible damage width measurements, Vehicle Width and Total Length of Indentation. Both are applicable to front and rear tests, if present. For side tests, only the Total Length of Indentation is applicable.

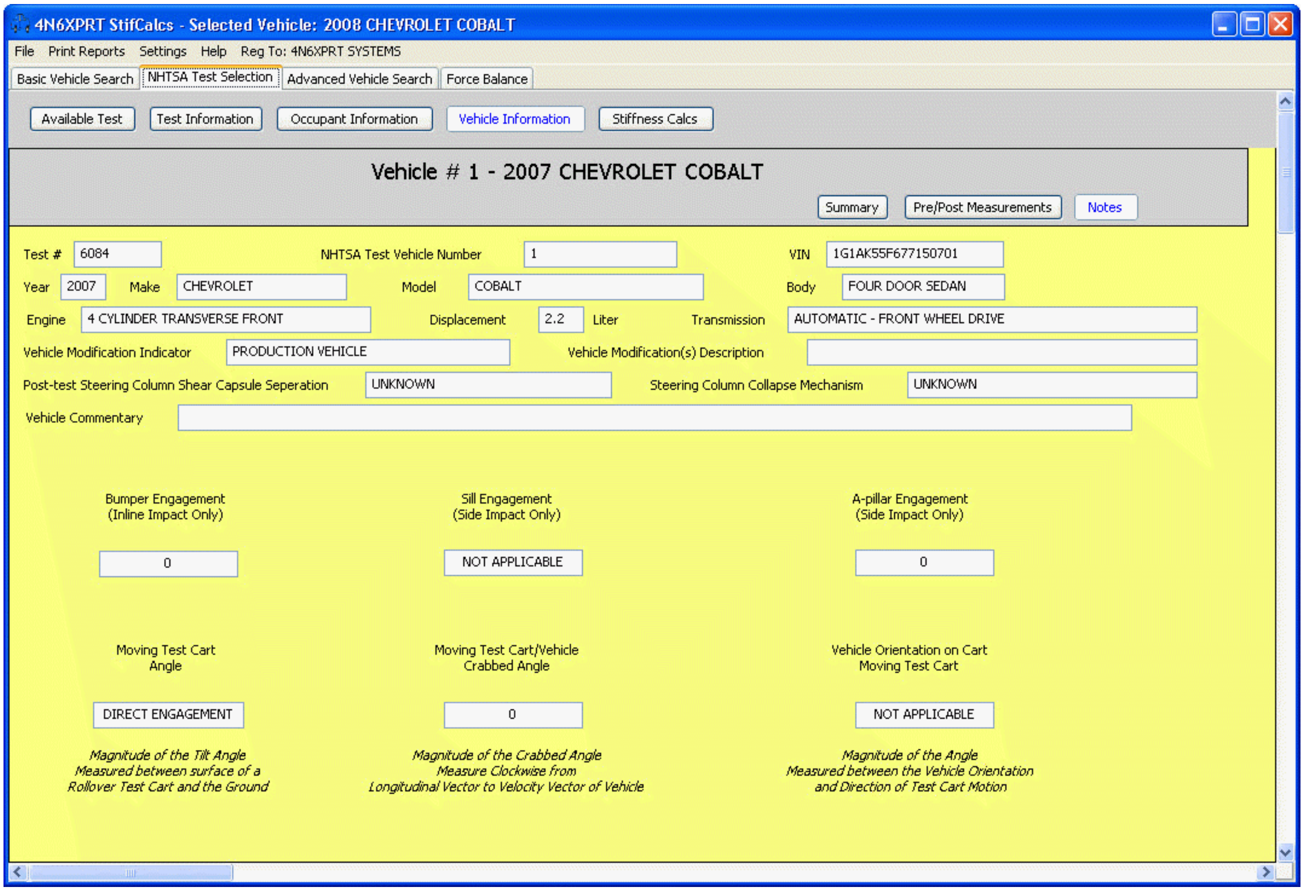
Weight - A Vehicle Test Weight is required, and if this is a side or a rear test, test weights are needed for both the impactor and the target.

Speed - A closing speed is needed.

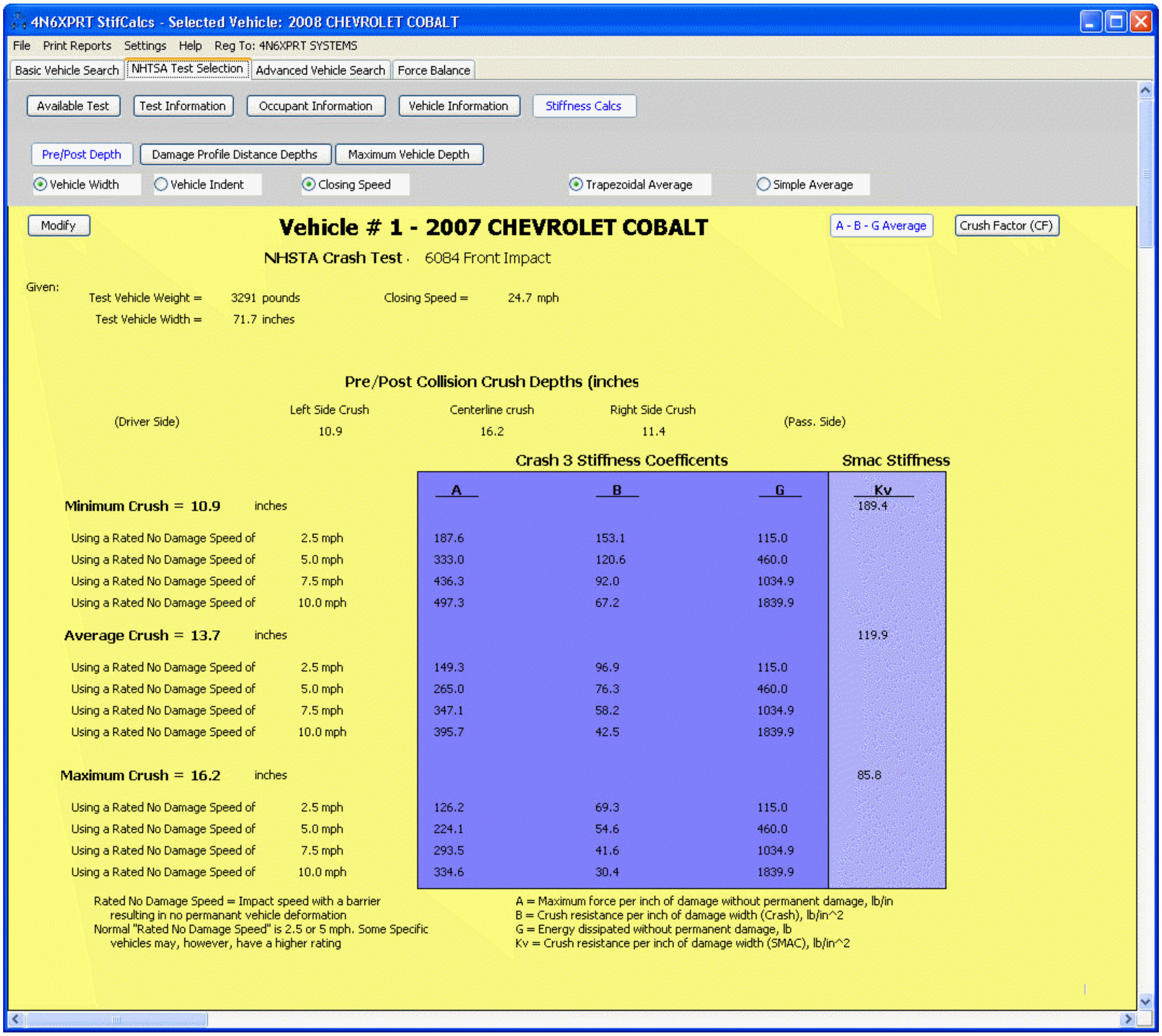
All of the required information is shown on the Vehicle SUMMARY screen.

The detailed Pre-Test and Post-Test dimensions are shown on the Vehicle PRE/POST MEASUREMENTS screen.





Any Test Notes are shown on the Vehicle NOTES screen.



STIFFNESS CALCS - From the damage depths and damage widths reported, we allow you to view stiffness values for each of the combinations. We also allow you to view the differences between the Trapezoidal and "Simple" methods of calculating the average crush depth when appropriate, by "toggling" between the two methods. Finally, we allow you to see the stiffness value change between using the closing speed and KE Equivalent Speed for side and rear tests.

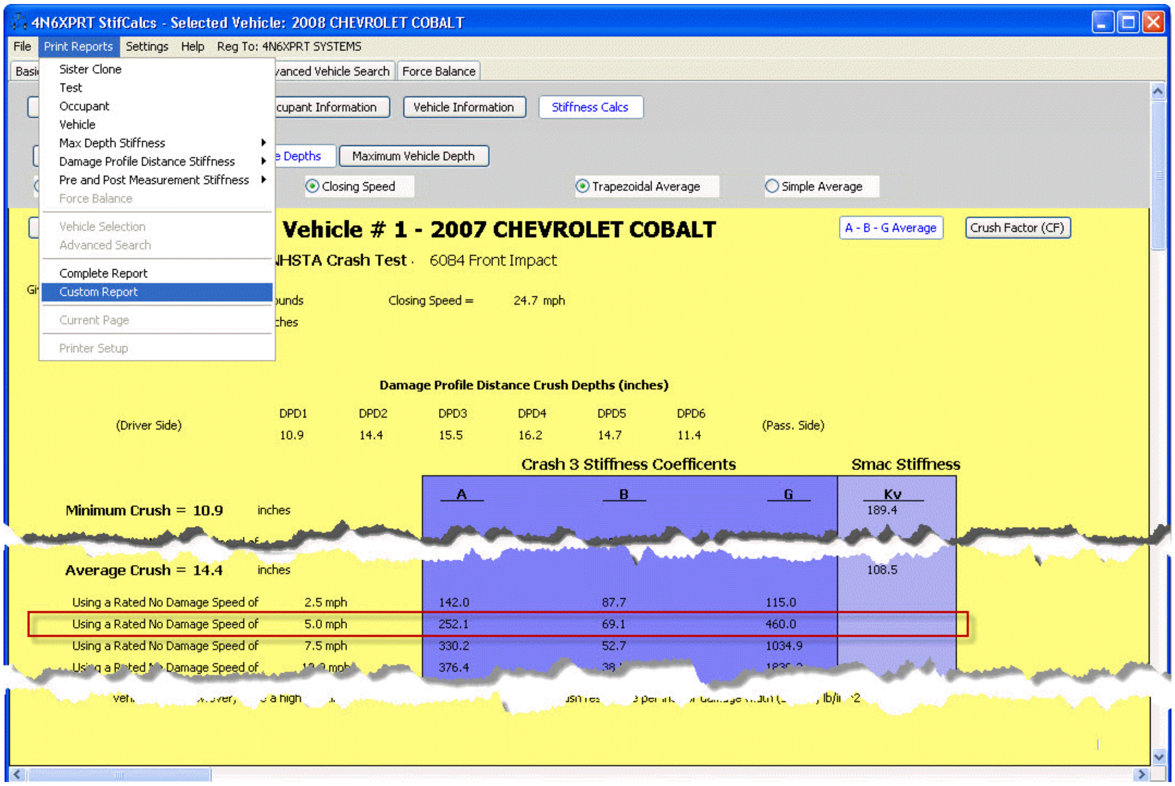
In addition to calculating the CRASH 3 A-B-G values and the Test Specific Crush Factor (CF) value, beginning in 2010 the program calculates the SMAC Kv stiffness value for each crush value - Minimum, Average, and Maximum.

When applying stiffness values to your collision, these are the values to use as your starting point depends upon the impact location:

Front - The initial starting point would be Vehicle Width, Trapezoidal Average Crush, 5 mph Rated No Damage Speed. Which set of crush measurements to use is determined by what NHTSA reported, along with your preference.

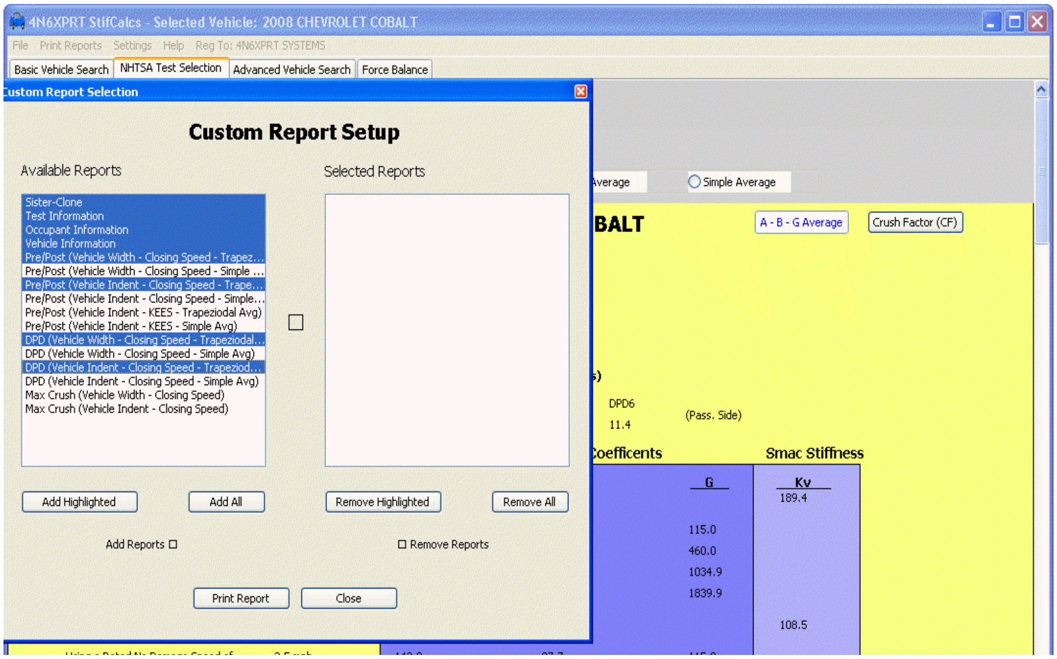
Rear - The initial starting point would be Vehicle Width, KE Equivalent Speed, Trapezoidal Average Crush, 5 mph Rated No Damage Speed. Which set of crush measurements to use is determined by what NHTSA reported, along with your preference.

Side - The initial starting point would be Indentation Length, KE Equivalent Speed, Trapezoidal Average Crush, 2 mph Rated No Damage Speed. Which set of crush measurements to use is determined by what NHTSA reported, along with your preference.

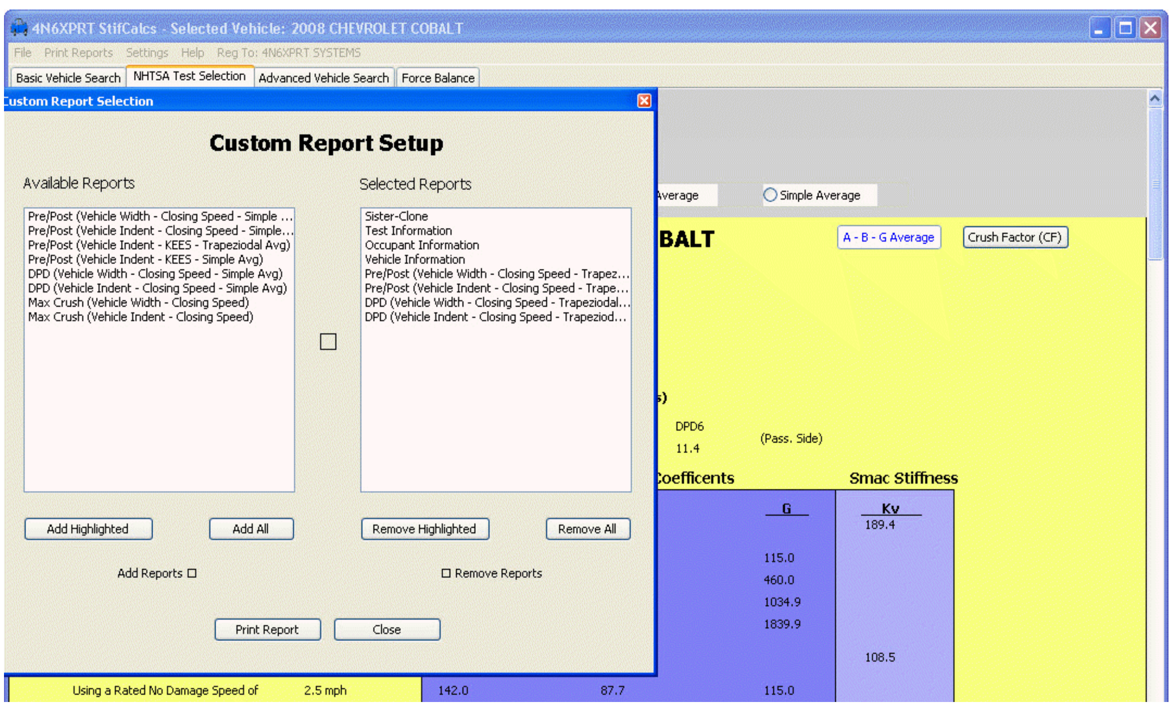


PRINTING:

To Print a report click on the PRINT REPORTS in the top Menu bar. Then, in order to get the pages you are concerned with, click on CUSTOM REPORT.



Next, Highlight the pages you would like to print. Multiple pages can be highlighted by holding the CTRL key down while clicking on the desired pages.

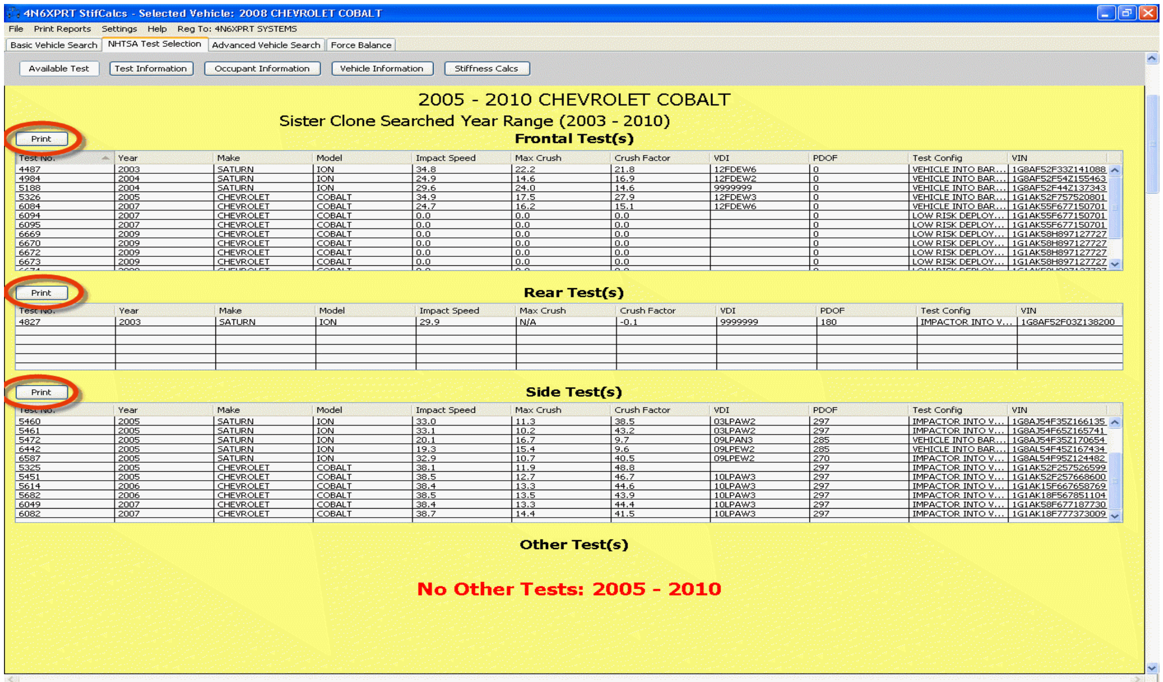


Once the desired pages are highlighted, click the ADD HIGHLIGHTED button.

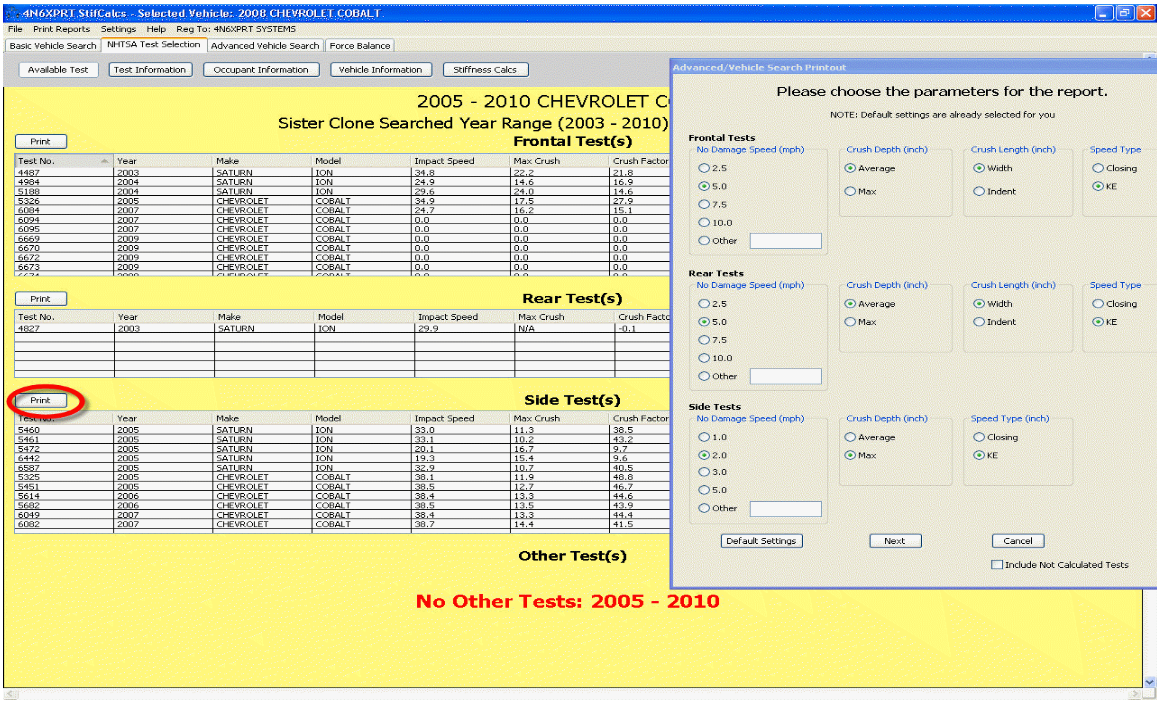
Finally, click the PRINT REPORT button.

To close the Custom Report box, click the CLOSE button or on the “X” in the upper right corner of the box.

TEST SUMMARY REPORT:



When you are on the AVAILABLE TESTS page of the NHTSA TEST RESULTS tab, you also have the opportunity to print out a TEST SUMMARY report by clicking on the PRINT button above each grouping of tests.



When one of the PRINT buttons is clicked, the REPORT PARAMETERS box where you set the parameters for the Test Summary Stiffness Calculations pops up.

NO DAMAGE SPEED - The default value for the Front and Rear tests is 5 mph. The default value for Side tests is 2 mph. The default can be changed by clicking the appropriate radio button, or by entering a speed in the OTHER box.

CRUSH DEPTH - The default value for all tests is AVERAGE, however this can be changed to MAXIMUM by clicking the radio button. Using the MAXIMUM crush depth will result in more conservative, i.e. - “softer”, Stiffness values.

CRUSH LENGTH - The default value for the Front and Rear tests is WIDTH, that is, the vehicle width. This can be changed to INDENT, the reported Indentation length, by clicking the radio button. Using the WIDTH for the Crush Length will result in more conservative, i.e. - “softer”, Stiffness values. The only possible Crush Length for Side tests is the reported Indentation Length, so no options are available for the Crush Length for Side tests.

SPEED TYPE - The default Speed Type is KE - Kinetic Energy Equivalent

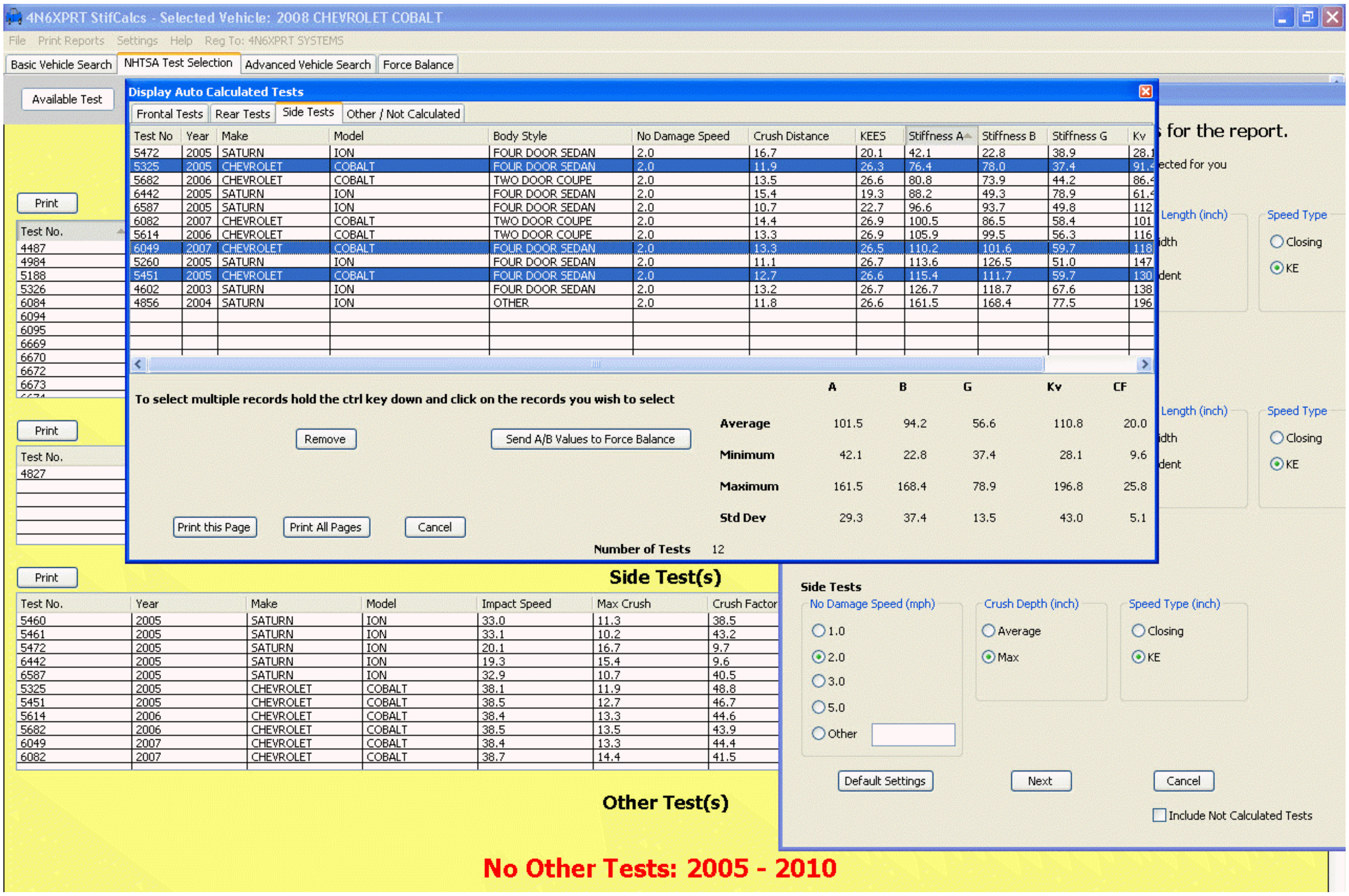
Speed - for all test types. The user is probably more familiar with using the CLOSING speed in Frontal tests, however, in the instance where a moving barrier is impacting the front of the vehicle, the CLOSING speed will give erroneously high Stiffness values for the same reason that the CLOSING speed will give high values for the Rear and Side tests .... not all of the moving barrier's Kinetic Energy is consumed in crushing the target vehicle. Some of the energy is retained by the barrier and is exhibited in post impact barrier movement, some is "expended" in crushing the target vehicle (and possibly the barrier), and some is transferred to the target vehicle and is exhibited in post impact barrier movement.

In the case of a vehicle running into a immovable barrier, with no post impact movement in the original direction of travel of the vehicle, the CLOSING speed and the KE speed will be the same.

It is suggested that the user begin using KE speed for all test types to avoid potential errors. With that as a given, there ARE case specific reasons for the user to use CLOSING speed for a Side or Rear test summary.

For this example we clicked the PRINT button for the SIDE tests, and have changed the Crush Depth to MAX.

When you have the parameters set for the test types you are interested in, click the NEXT button.



The tab displayed will be determined by the PRINT button which is clicked. Since the SIDE PRINT button was clicked for this example, the side Test Summary is displayed.

For this example we have further sorted the tests on the “A” value and highlighted the COBALT 4 door tests.

At this point you have the option to:

PRINT THIS PAGE - This button will print the Test Summary only for the page displayed.

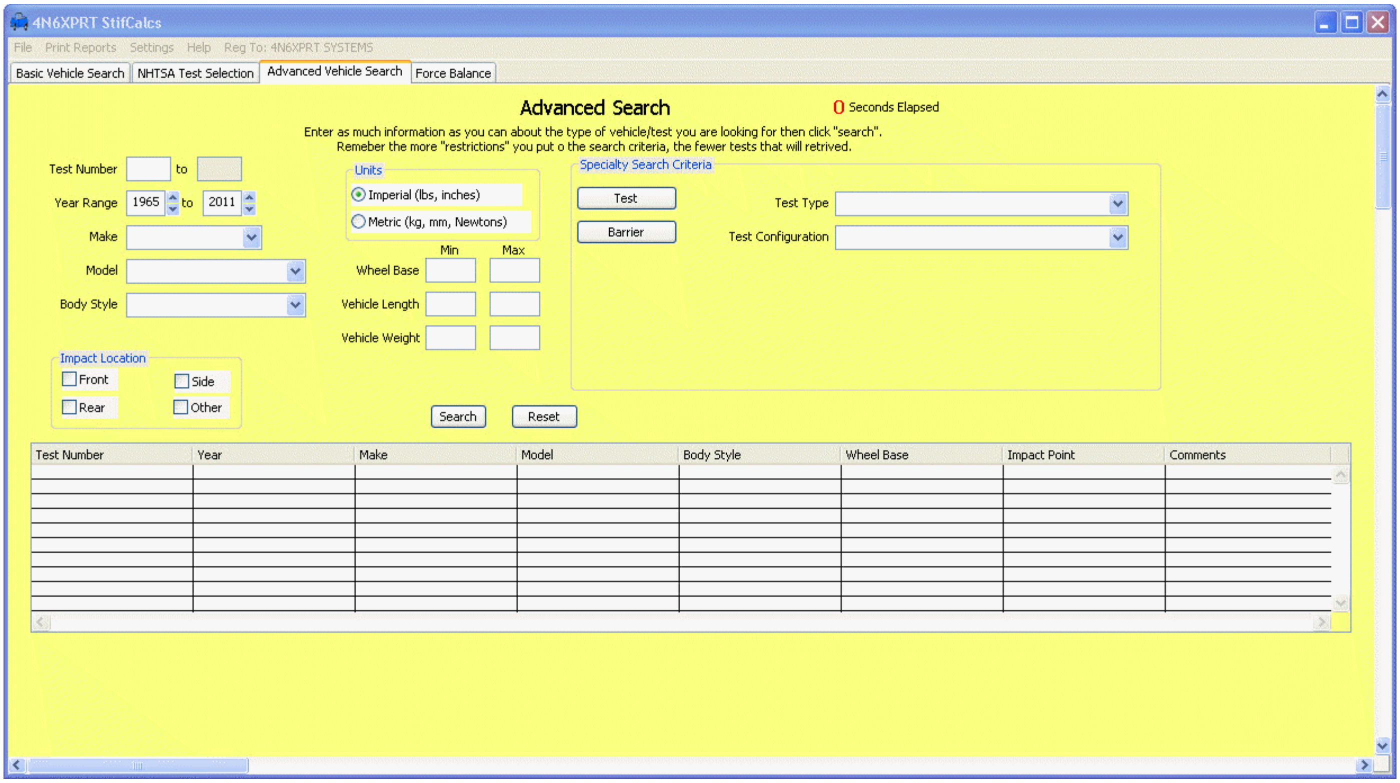
PRINT ALL PAGES - This button will print the Test Summary for each test type which has tests available to print.

SEND A/B VALUES TO FORCE BALANCE - This will send the Statistical Summary of the A-B values to the Force Balance module, and allow you the chance to print the Test Summary page if you have not already done so.

Printing the Test Summary page is important so that you document what data went into the Force Balance calculations.

CANCEL - Allows you to close the Test Summary without doing anything else.

ADVANCED SEARCH:



If you do not find a test of the type you want/need (i.e. - side impact), you need to do a **ADVANCED VEHICLE SEARCH** in order to create a CLASS vehicle.

Any of the fields in the ADVANCED VEHICLE SEARCH page can be used singly, or in combination. One must remember, however, that the fields are combined as an AND search .... which means that all of the criteria input on the page must be met in order for the test to be retrieved. Therefore, it is suggested that the user starts with a BROAD search (though not TOO broad - start with two or three fields/field ranges, such as body style and a weight range), and then narrow the search down depending upon the number of tests retrieved.

One approach - duplicate your basic vehicle search by selecting the appropriate MODEL and then click the SEARCH button.

When you click the SEARCH button, the tests which meet your search criteria show up in the box along the bottom of the window. When you see a test which you want to look at more closely, note the test number, then click on that test. This will then put you on the **NHTSA TEST SELECTION** tab, at which point you proceed as you would if you were conducting a BASIC SEARCH.

If NO tests come up for the model you are looking for, or the similar model(s) as identified in the Sister/Clone list, you have the capability to build your own "CLASS" of similar vehicle.

Class based on WEIGHT. The weights contained in the NHTSA Crash Test database are **loaded weights**, not curb. Generally, the additional load is comprised of dummies and test recording instrumentation. This load generally ranges from 500-800 pounds over the curb weight.

The best way to find a base test weight for your search is to look at the weight of the vehicle in some other test. If there are no tests for your desired vehicle in the database, use a curb weight from a published source, such as Expert AutoStats®, and add your guess of what the load weight desired is. One way of estimating the load weight is.... use your best estimate of the load weight in your collision.

When inputting the weight MIN and MAX values, where you start your range depends upon what type of test you are trying to retrieve.

- For FRONTAL Tests, it is suggested that you start your range as +/- 20 pounds, due to the large number of frontal tests in the database, then expand or contract the range as you find necessary to get a valid number of tests in your search results.
- For REAR Tests, it is suggested that you start your range as +/- 200 pounds, due to the small number of rear tests in the database, then expand or contract the range as you find necessary to get a valid number of tests in your search results.
- For SIDE Tests, it is suggested that you start your range as +/- 100 pounds, then expand or contract the range as you find necessary to get a valid number of tests in your search results.

Class based on WHEELBASE. Determine the wheelbase of your desired class vehicle based upon a test of your desired vehicle, or from a published source, such as Expert AutoStats®.

Class based on LENGTH. Determine the wheelbase of your desired class vehicle based upon a test of your desired vehicle, or from a published source, such as Expert AutoStats®.

Class based on BODYSTYLE. Select the body style you want to search for within the database.

Class based on IMPACT LOCATION. Select the Impact location(s) you want to search for within the database.

The more criteria used for the “CLASS” the more similar the tests will be to your subject vehicle, but the less likely it will be that you find any tests.

You can also start with one, or two, criteria, search the database, then add criteria and re-search the database to narrow the number of tests to review.

When you click the SEARCH button, the tests which meet your search criteria show up in the box along the bottom of the window. When you see a test which you want to look at more closely, note the test number, then click on that test. This will then put you on the **NHTSA TEST SELECTION** tab, at which point you proceed as you would if you were conducting a BASIC SEARCH.

You also have the opportunity to print a TEST SUMMARY REPORT of the search results.

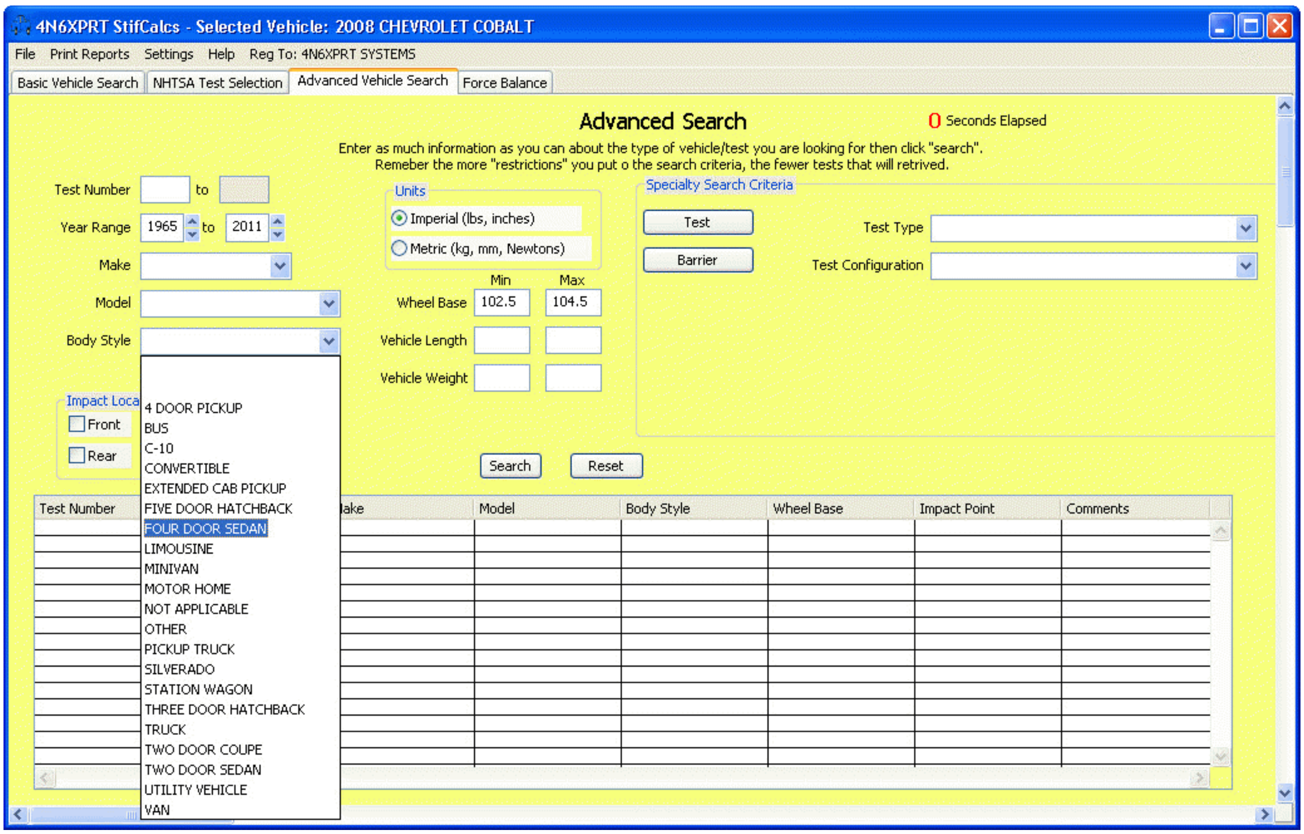
“CLASS” VEHICLE:

You, the user, should create a CLASS report every time you do vehicle stiffness research. Why?? Several Reasons -

(1) - Practice, Practice, PRACTICE! The more often you create a CLASS vehicle advanced search, the more easily the process will come to you. As with many skills, if you don’t use them, you lose them.

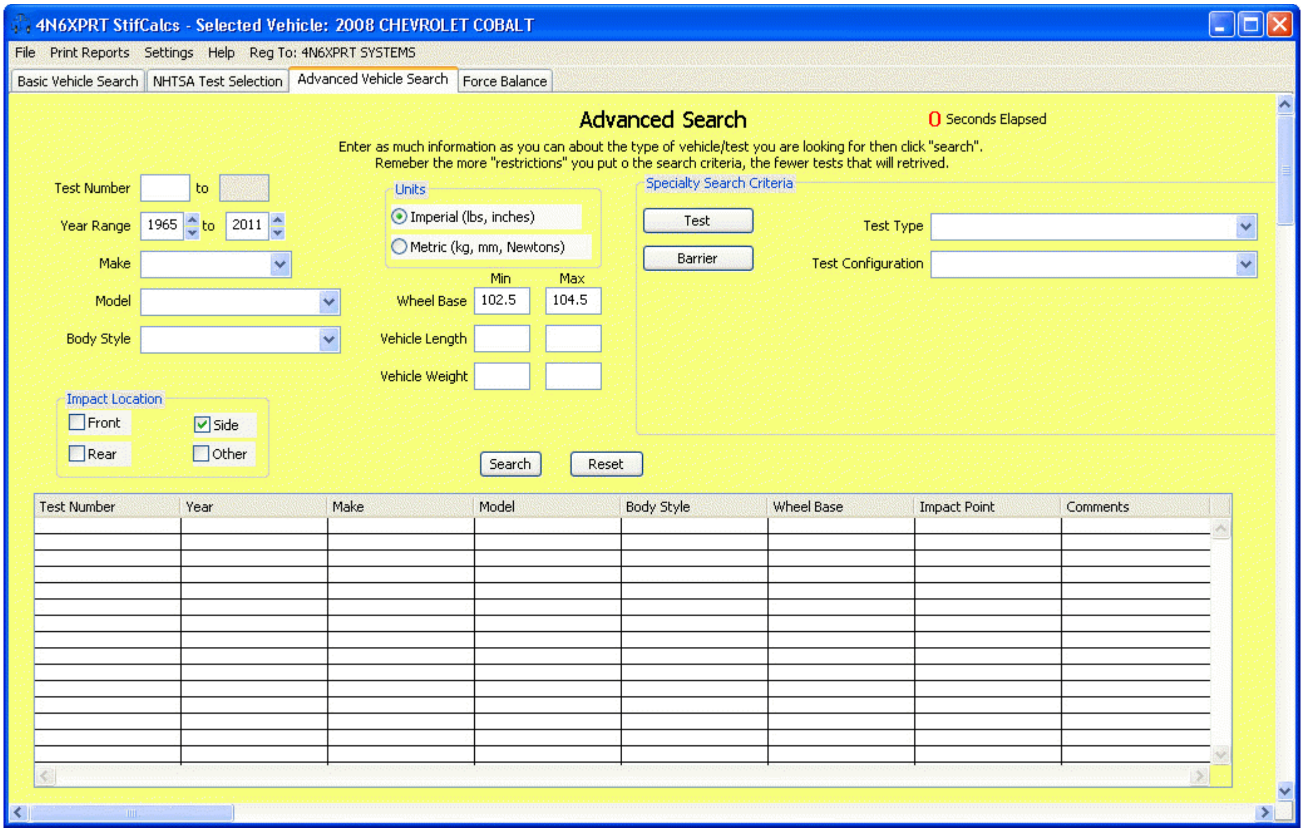
(2) - Confirmation of findings. As you gain experience in creating CLASS vehicles, you will:
(A) confirm in your own mind that this is a valid method, and
(B) build confidence in the method for when you only have the CLASS vehicle upon which to rely for stiffness values.

(3) - Comfort. With the points mentioned in 1 and 2 above, you don't have to be afraid that you will not be able to do your normal outstanding reconstruction due to the lack of stiffness values.



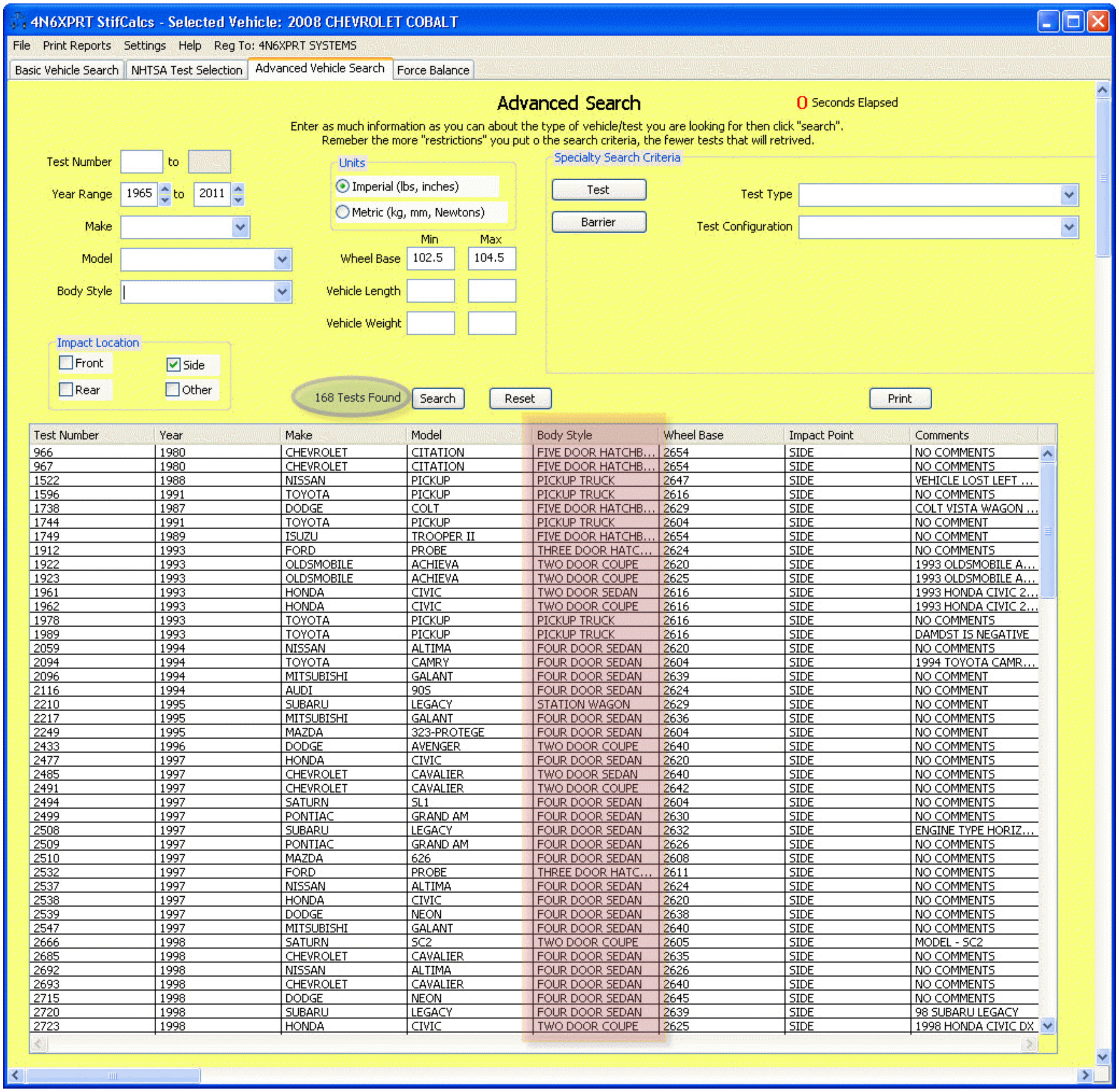
For this CLASS, we will be looking at a COBALT FOUR DOOR SEDAN impacted on the Side.

When we look at the available Body Types, we see there are three car body types which have 4 doors - FIVE DOOR HATCHBACK, FOUR DOOR SEDAN, and STATION WAGON. In order to get the widest exposure, and to create the "best" class vehicle, a Body Style will not be designated at this point, but will be sorted for in future steps.



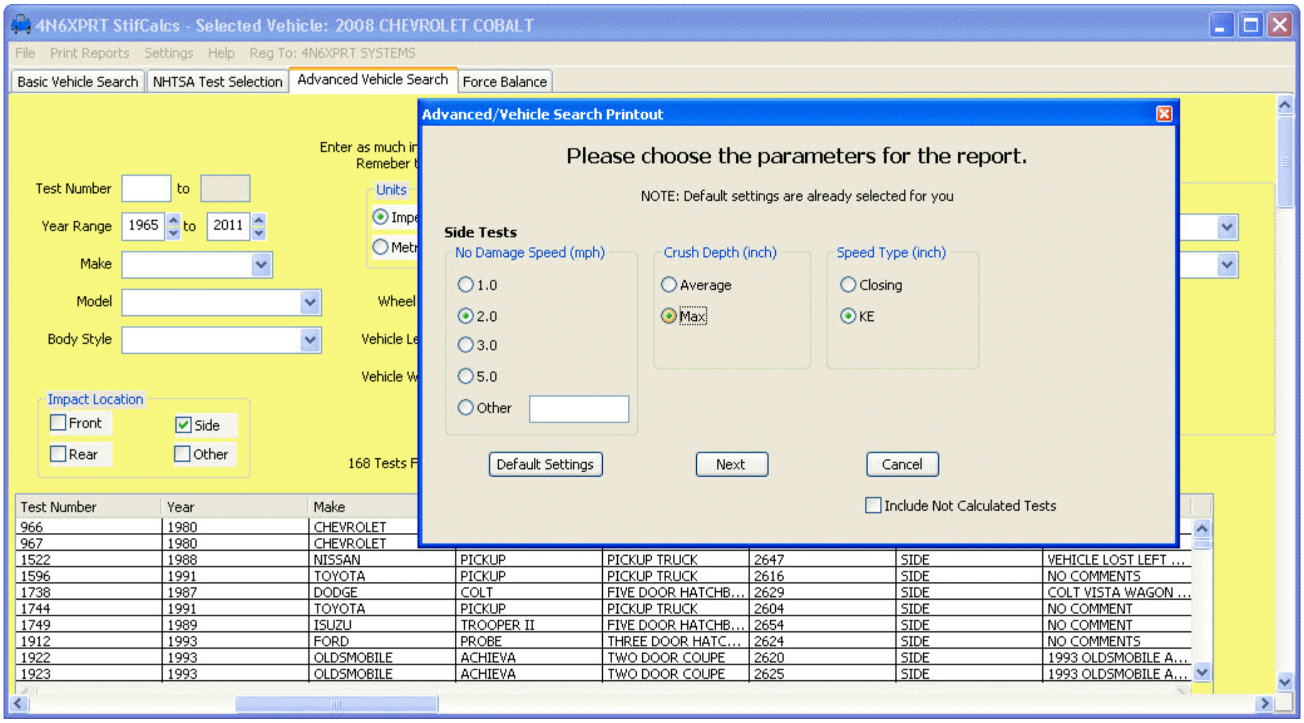
Therefore, our ADVANCED SEARCH example consists of looking for SIDE impact tests for vehicles which have a wheelbase range of 102.5 to 104.5 inches, which is +/- 1 inch of the wheelbase we found in test # 6084 (See page 14 of this manual).

Once the Search criteria is set, click the SEARCH button.



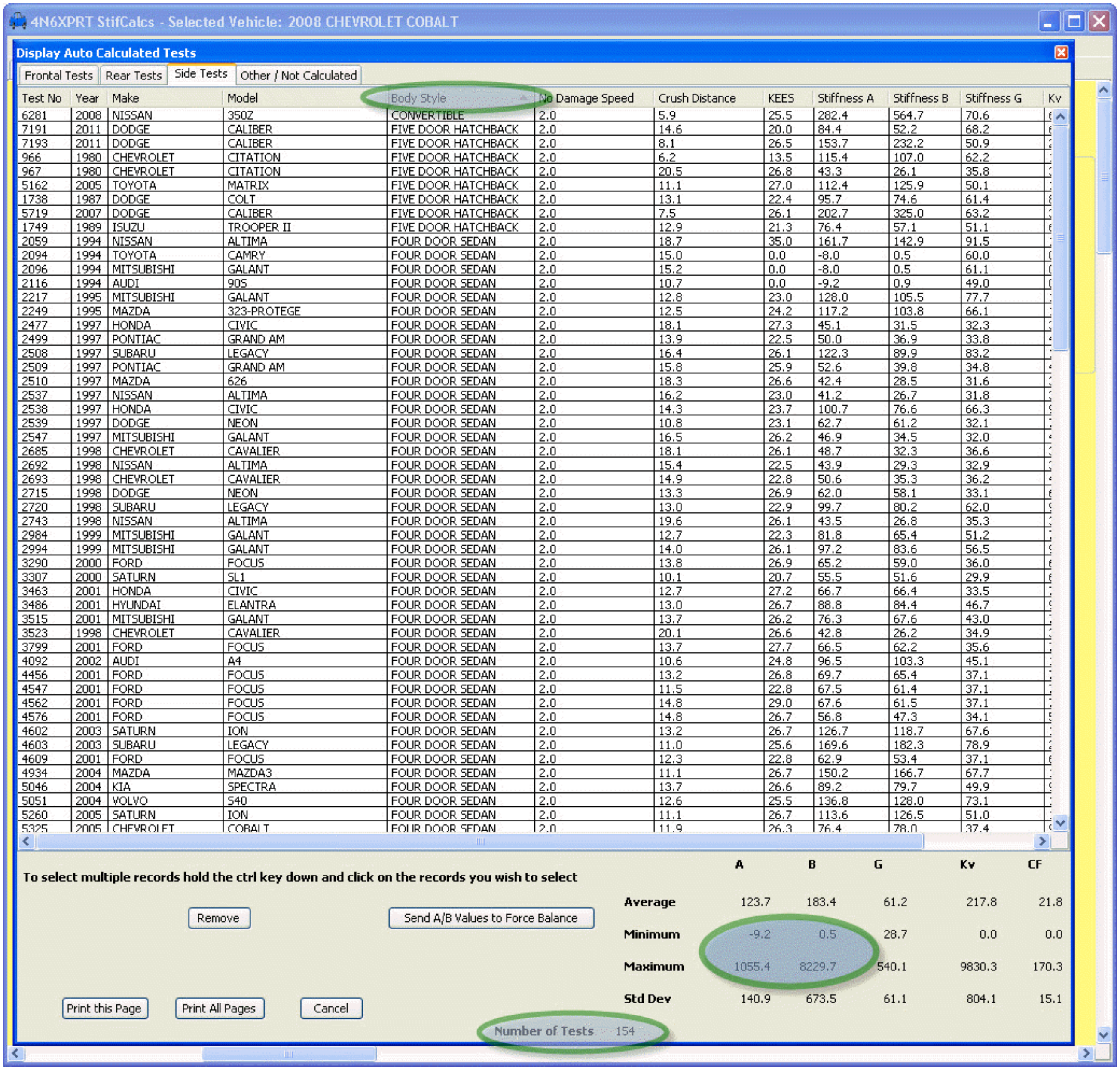
Our SEARCH found 168 tests which matched the search criteria of SIDE tests on a vehicle with a reported wheelbase between 102.5 and 104.5 inches.

Multiple Body Styles meet this criteria - 2 door, Pickup, 4 door, Utility, Station Wagon .... we are looking for cars which have 4 doors - Click the PRINT button to get to a Test Summary Report where the extraneous (non-4 door car tests, in this case) tests can be removed.



When the PRINT button is clicked, the Report Parameters screen pops up. Set the Test Summary Report Stiffness parameters. Since only SIDE tests have been retrieved, you are only setting for the Side Test parameters.

For this example, and in order to match the COBALT Side Test Sister/Clone Summary we previously looked at, the Crush Depth is set to MAX.



4N6XPRT StifCalcs - Selected Vehicle: 2008 CHEVROLET COBALT

Display Auto Calculated Tests

Frontal Tests | Rear Tests | Side Tests | Other / Not Calculated

Test No	Year	Make	Model	Body Style	No Damage Speed	Crush Distance	KEES	Stiffness A	Stiffness B	Stiffness G	Kv
6281	2008	NISSAN	350Z	CONVERTIBLE	2.0	5.9	25.5	282.4	564.7	70.6	
7191	2011	DODGE	CALIBER	FIVE DOOR HATCHBACK	2.0	14.6	20.0	84.4	52.2	68.2	
7193	2011	DODGE	CALIBER	FIVE DOOR HATCHBACK	2.0	8.1	26.5	153.7	232.2	50.9	
966	1980	CHEVROLET	CITATION	FIVE DOOR HATCHBACK	2.0	6.2	13.5	115.4	107.0	62.2	
967	1980	CHEVROLET	CITATION	FIVE DOOR HATCHBACK	2.0	20.5	26.8	43.3	26.1	35.8	
5162	2005	TOYOTA	MATRIX	FIVE DOOR HATCHBACK	2.0	11.1	27.0	112.4	125.9	50.1	
1738	1987	DODGE	COLT	FIVE DOOR HATCHBACK	2.0	13.1	22.4	95.7	74.6	61.4	
5719	2007	DODGE	CALIBER	FIVE DOOR HATCHBACK	2.0	7.5	26.1	202.7	325.0	63.2	
1749	1989	ISUZU	TROOPER II	FIVE DOOR HATCHBACK	2.0	12.9	21.3	76.4	57.1	51.1	
2059	1994	NISSAN	ALTIMA	FOUR DOOR SEDAN	2.0	18.7	35.0	161.7	142.9	91.5	
2094	1994	TOYOTA	CAMRY	FOUR DOOR SEDAN	2.0	15.0	0.0	-8.0	0.5	60.0	
2096	1994	MITSUBISHI	GALANT	FOUR DOOR SEDAN	2.0	15.2	0.0	-8.0	0.5	61.1	
2116	1994	AUDI	90S	FOUR DOOR SEDAN	2.0	10.7	0.0	-9.2	0.9	49.0	
2217	1995	MITSUBISHI	GALANT	FOUR DOOR SEDAN	2.0	12.8	23.0	128.0	105.5	77.7	
2249	1995	MAZDA	323-PROTEGE	FOUR DOOR SEDAN	2.0	12.5	24.2	117.2	103.8	66.1	
2477	1997	HONDA	CIVIC	FOUR DOOR SEDAN	2.0	18.1	27.3	45.1	31.5	32.3	
2499	1997	PONTIAC	GRAND AM	FOUR DOOR SEDAN	2.0	13.9	22.5	50.0	36.9	33.8	
2508	1997	SUBARU	LEGACY	FOUR DOOR SEDAN	2.0	16.4	26.1	122.3	89.9	83.2	
2509	1997	PONTIAC	GRAND AM	FOUR DOOR SEDAN	2.0	15.8	25.9	52.6	39.8	34.8	
2510	1997	MAZDA	626	FOUR DOOR SEDAN	2.0	18.3	26.6	42.4	28.5	31.6	
2537	1997	NISSAN	ALTIMA	FOUR DOOR SEDAN	2.0	16.2	23.0	41.2	26.7	31.8	
2538	1997	HONDA	CIVIC	FOUR DOOR SEDAN	2.0	14.3	23.7	100.7	76.6	66.3	
2539	1997	DODGE	NEON	FOUR DOOR SEDAN	2.0	10.8	23.1	62.7	61.2	32.1	
2547	1997	MITSUBISHI	GALANT	FOUR DOOR SEDAN	2.0	16.5	26.2	46.9	34.5	32.0	
2685	1998	CHEVROLET	CAVALIER	FOUR DOOR SEDAN	2.0	18.1	26.1	48.7	32.3	36.6	
2692	1998	NISSAN	ALTIMA	FOUR DOOR SEDAN	2.0	15.4	22.5	43.9	29.3	32.9	
2693	1998	CHEVROLET	CAVALIER	FOUR DOOR SEDAN	2.0	14.9	22.8	50.6	35.3	36.2	
2715	1998	DODGE	NEON	FOUR DOOR SEDAN	2.0	13.3	26.9	62.0	58.1	33.1	
2720	1998	SUBARU	LEGACY	FOUR DOOR SEDAN	2.0	13.0	22.9	99.7	80.2	62.0	
2743	1998	NISSAN	ALTIMA	FOUR DOOR SEDAN	2.0	19.6	26.1	43.5	26.8	35.3	
2984	1999	MITSUBISHI	GALANT	FOUR DOOR SEDAN	2.0	12.7	22.3	81.8	65.4	51.2	
2994	1999	MITSUBISHI	GALANT	FOUR DOOR SEDAN	2.0	14.0	26.1	97.2	83.6	56.5	
3290	2000	FORD	FOCUS	FOUR DOOR SEDAN	2.0	13.8	26.9	65.2	59.0	36.0	
3307	2000	SATURN	SL1	FOUR DOOR SEDAN	2.0	10.1	20.7	55.5	51.6	29.9	
3463	2001	HONDA	CIVIC	FOUR DOOR SEDAN	2.0	12.7	27.2	66.7	66.4	33.5	
3486	2001	HYUNDAI	ELANTRA	FOUR DOOR SEDAN	2.0	13.0	26.7	88.8	84.4	46.7	
3515	2001	MITSUBISHI	GALANT	FOUR DOOR SEDAN	2.0	13.7	26.2	76.3	67.6	43.0	
3523	1998	CHEVROLET	CAVALIER	FOUR DOOR SEDAN	2.0	20.1	26.6	42.8	26.2	34.9	
3799	2001	FORD	FOCUS	FOUR DOOR SEDAN	2.0	13.7	27.7	66.5	62.2	35.6	
4092	2002	AUDI	A4	FOUR DOOR SEDAN	2.0	10.6	24.8	96.5	103.3	45.1	
4456	2001	FORD	FOCUS	FOUR DOOR SEDAN	2.0	13.2	26.8	69.7	65.4	37.1	
4547	2001	FORD	FOCUS	FOUR DOOR SEDAN	2.0	11.5	22.8	67.5	61.4	37.1	
4562	2001	FORD	FOCUS	FOUR DOOR SEDAN	2.0	14.8	29.0	67.6	61.5	37.1	
4576	2001	FORD	FOCUS	FOUR DOOR SEDAN	2.0	14.8	26.7	56.8	47.3	34.1	
4602	2003	SATURN	ION	FOUR DOOR SEDAN	2.0	13.2	26.7	126.7	118.7	67.6	
4603	2003	SUBARU	LEGACY	FOUR DOOR SEDAN	2.0	11.0	25.6	169.6	182.3	78.9	
4609	2001	FORD	FOCUS	FOUR DOOR SEDAN	2.0	12.3	22.8	62.9	53.4	37.1	
4934	2004	MAZDA	MAZDA3	FOUR DOOR SEDAN	2.0	11.1	26.7	150.2	166.7	67.7	
5046	2004	KIA	SPECTRA	FOUR DOOR SEDAN	2.0	13.7	26.6	89.2	79.7	49.9	
5051	2004	VOLVO	S40	FOUR DOOR SEDAN	2.0	12.6	25.5	136.8	128.0	73.1	
5260	2005	SATURN	ION	FOUR DOOR SEDAN	2.0	11.1	26.7	113.6	126.5	51.0	
5325	2005	CHEVROLET	COBALT	FOUR DOOR SEDAN	2.0	11.9	26.3	76.4	78.0	37.4	

To select multiple records hold the ctrl key down and click on the records you wish to select

	A	B	G	Kv	CF
Average	123.7	183.4	61.2	217.8	21.8
Minimum	-9.2	0.5	28.7	0.0	0.0
Maximum	1055.4	8229.7	540.1	9830.3	170.3
Std Dev	140.9	673.5	61.1	804.1	15.1

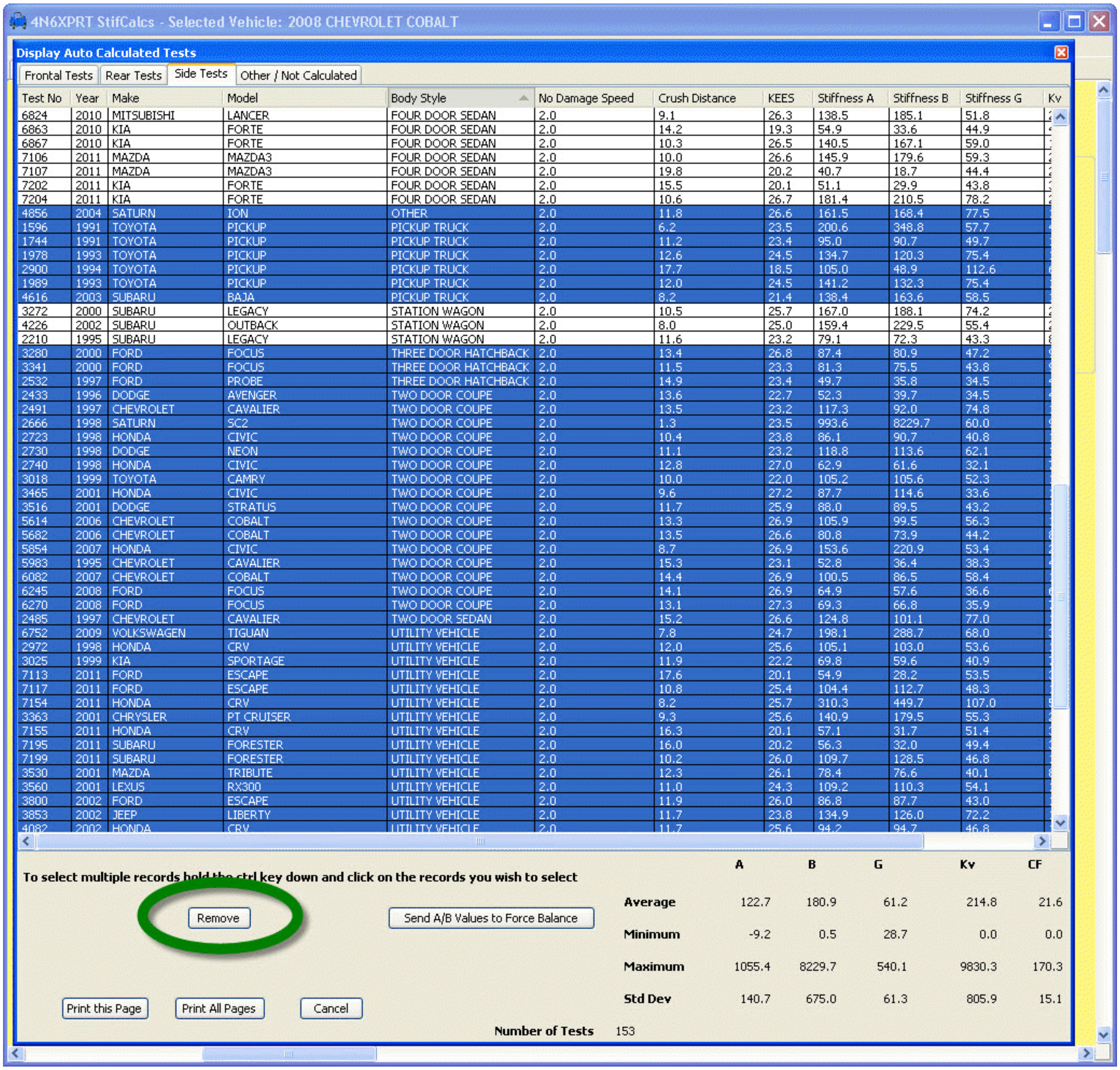
Remove | Send A/B Values to Force Balance

Print this Page | Print All Pages | Cancel

Number of Tests 154

154 of the 168 tests found in the database SEARCH had sufficient information to calculate some sort of A-B Stiffness values. As can be seen from the Minimum and Maximum values, some of the tests have rather extreme values.

The extreme values come from, for the most part, crush measurement data which is reported, and contained in the database, but is "in error".

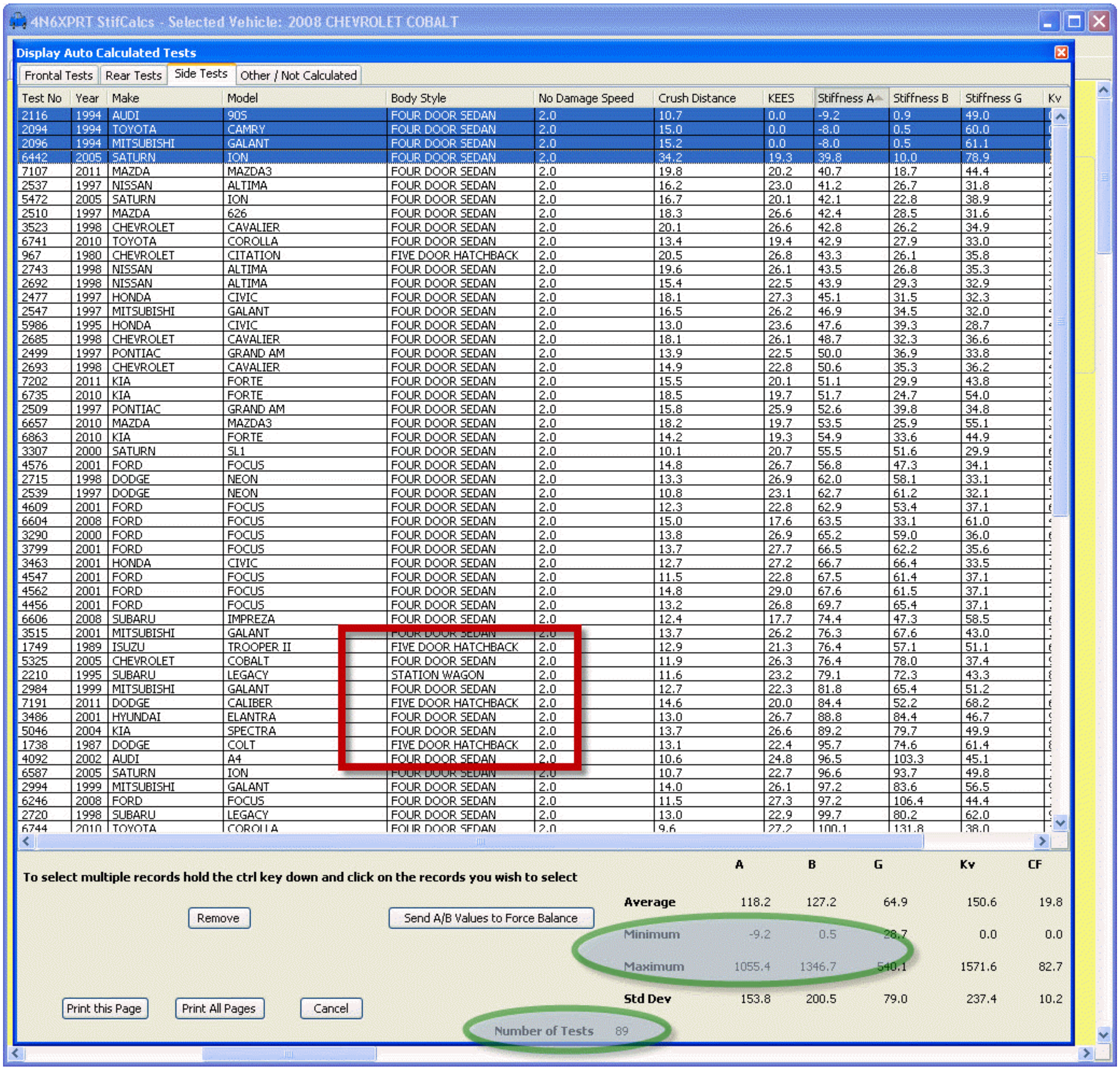


Test No	Year	Make	Model	Body Style	No Damage Speed	Crush Distance	KEES	Stiffness A	Stiffness B	Stiffness G
6824	2010	MITSUBISHI	LANCER	FOUR DOOR SEDAN	2.0	9.1	26.3	138.5	185.1	51.8
6863	2010	KIA	FORTE	FOUR DOOR SEDAN	2.0	14.2	19.3	54.9	33.6	44.9
6867	2010	KIA	FORTE	FOUR DOOR SEDAN	2.0	10.3	26.5	140.5	167.1	59.0
7106	2011	MAZDA	MAZDA3	FOUR DOOR SEDAN	2.0	10.0	26.6	145.9	179.6	59.3
7107	2011	MAZDA	MAZDA3	FOUR DOOR SEDAN	2.0	19.8	20.2	40.7	18.7	44.4
7202	2011	KIA	FORTE	FOUR DOOR SEDAN	2.0	15.5	20.1	51.1	29.9	43.8
7204	2011	KIA	FORTE	FOUR DOOR SEDAN	2.0	10.6	26.7	181.4	210.5	78.2
4856	2004	SATURN	ION	OTHER	2.0	11.8	26.6	161.5	168.4	77.5
1596	1991	TOYOTA	PICKUP	PICKUP TRUCK	2.0	6.2	23.5	200.6	348.8	57.7
1744	1991	TOYOTA	PICKUP	PICKUP TRUCK	2.0	11.2	23.4	95.0	90.7	49.7
1978	1993	TOYOTA	PICKUP	PICKUP TRUCK	2.0	12.6	24.5	134.7	120.3	75.4
2900	1994	TOYOTA	PICKUP	PICKUP TRUCK	2.0	17.7	18.5	105.0	48.9	112.6
1989	1993	TOYOTA	PICKUP	PICKUP TRUCK	2.0	12.0	24.5	141.2	132.3	75.4
4616	2003	SUBARU	BAJA	PICKUP TRUCK	2.0	8.2	21.4	138.4	163.6	58.5
3272	2000	SUBARU	LEGACY	STATION WAGON	2.0	10.5	25.7	167.0	188.1	74.2
4226	2002	SUBARU	OUTBACK	STATION WAGON	2.0	8.0	25.0	159.4	229.5	55.4
2210	1995	SUBARU	LEGACY	STATION WAGON	2.0	11.6	23.2	79.1	72.3	43.3
3280	2000	FORD	FOCUS	THREE DOOR HATCHBACK	2.0	13.4	26.8	87.4	80.9	47.2
3341	2000	FORD	FOCUS	THREE DOOR HATCHBACK	2.0	11.5	23.3	81.3	75.5	43.8
2532	1997	FORD	PROBE	THREE DOOR HATCHBACK	2.0	14.9	23.4	49.7	35.8	34.5
2433	1996	DODGE	AVENGER	TWO DOOR COUPE	2.0	13.6	22.7	52.3	39.7	34.5
2491	1997	CHEVROLET	CAVALIER	TWO DOOR COUPE	2.0	13.5	23.2	117.3	92.0	74.8
2666	1998	SATURN	SC2	TWO DOOR COUPE	2.0	1.3	23.5	993.6	8229.7	60.0
2723	1998	HONDA	CIVIC	TWO DOOR COUPE	2.0	10.4	23.8	86.1	90.7	40.8
2730	1998	DODGE	NEON	TWO DOOR COUPE	2.0	11.1	23.2	118.8	113.6	62.1
2740	1998	HONDA	CIVIC	TWO DOOR COUPE	2.0	12.8	27.0	62.9	61.6	32.1
3018	1999	TOYOTA	CAMRY	TWO DOOR COUPE	2.0	10.0	22.0	105.2	105.6	52.3
3465	2001	HONDA	CIVIC	TWO DOOR COUPE	2.0	9.6	27.2	87.7	114.6	33.6
3516	2001	DODGE	STRATUS	TWO DOOR COUPE	2.0	11.7	25.9	88.0	89.5	43.2
5614	2006	CHEVROLET	COBALT	TWO DOOR COUPE	2.0	13.3	26.9	105.9	99.5	56.3
5682	2006	CHEVROLET	COBALT	TWO DOOR COUPE	2.0	13.5	26.6	80.8	73.9	44.2
5854	2007	HONDA	CIVIC	TWO DOOR COUPE	2.0	8.7	26.9	153.6	220.9	53.4
5983	1995	CHEVROLET	CAVALIER	TWO DOOR COUPE	2.0	15.3	23.1	52.8	36.4	38.3
6082	2007	CHEVROLET	COBALT	TWO DOOR COUPE	2.0	14.4	26.9	100.5	86.5	58.4
6245	2008	FORD	FOCUS	TWO DOOR COUPE	2.0	14.1	26.9	64.9	57.6	36.6
6270	2008	FORD	FOCUS	TWO DOOR COUPE	2.0	13.1	27.3	69.3	66.8	35.9
2485	1997	CHEVROLET	CAVALIER	TWO DOOR SEDAN	2.0	15.2	26.6	124.8	101.1	77.0
6752	2009	VOLKSWAGEN	TIGUAN	UTILITY VEHICLE	2.0	7.8	24.7	198.1	288.7	68.0
2972	1998	HONDA	CRV	UTILITY VEHICLE	2.0	12.0	25.6	105.1	103.0	53.6
3025	1999	KIA	SPORTAGE	UTILITY VEHICLE	2.0	11.9	22.2	69.8	59.6	40.9
7113	2011	FORD	ESCAPE	UTILITY VEHICLE	2.0	17.6	20.1	54.9	28.2	53.5
7117	2011	FORD	ESCAPE	UTILITY VEHICLE	2.0	10.8	25.4	104.4	112.7	48.3
7154	2011	HONDA	CRV	UTILITY VEHICLE	2.0	8.2	25.7	310.3	449.7	107.0
3363	2001	CHRYSLER	PT CRUISER	UTILITY VEHICLE	2.0	9.3	25.6	140.9	179.5	55.3
7155	2011	HONDA	CRV	UTILITY VEHICLE	2.0	16.3	20.1	57.1	31.7	51.4
7195	2011	SUBARU	FORESTER	UTILITY VEHICLE	2.0	16.0	20.2	56.3	32.0	49.4
7199	2011	SUBARU	FORESTER	UTILITY VEHICLE	2.0	10.2	26.0	109.7	128.5	46.8
3530	2001	MAZDA	TRIBUTE	UTILITY VEHICLE	2.0	12.3	26.1	78.4	76.6	40.1
3560	2001	LEXUS	RX300	UTILITY VEHICLE	2.0	11.0	24.3	109.2	110.3	54.1
3800	2002	FORD	ESCAPE	UTILITY VEHICLE	2.0	11.9	26.0	86.8	87.7	43.0
3853	2002	JEEP	LIBERTY	UTILITY VEHICLE	2.0	11.7	23.8	134.9	126.0	72.2
4082	2002	HONDA	CRV	UTILITY VEHICLE	2.0	11.7	25.6	94.2	94.7	46.8

	A	B	G	Kv	CF
Average	122.7	180.9	61.2	214.8	21.6
Minimum	-9.2	0.5	28.7	0.0	0.0
Maximum	1055.4	8229.7	540.1	9830.3	170.3
Std Dev	140.7	675.0	61.3	805.9	15.1

The CLASS we are looking to develop is for a 4 door "sedan" (4 door COBALT). Therefore, having already set the wheelbase, the next (two) critical criteria is that the vehicle be a **car** which has **4 doors** (so that the "B" pillar hard point is in the CLASS vehicle). Body Styles which meet this criteria are FIVE DOOR HATCHBACK, FOUR DOOR SEDAN, and STATION WAGON.

Therefore, we sort on Body Type, highlight the body types which do not meet the 4 door Car criteria, and click the REMOVE button. This step can be taken in several steps so that only the appropriate tests are removed.



4N6XPRT StifCalcs - Selected Vehicle: 2008 CHEVROLET COBALT

Display Auto Calculated Tests

Frontal Tests | Rear Tests | Side Tests | Other / Not Calculated

Test No	Year	Make	Model	Body Style	No Damage Speed	Crush Distance	KEES	Stiffness A	Stiffness B	Stiffness G
2116	1994	AUDI	90S	FOUR DOOR SEDAN	2.0	10.7	0.0	-9.2	0.9	49.0
2094	1994	TOYOTA	CAMRY	FOUR DOOR SEDAN	2.0	15.0	0.0	-8.0	0.5	60.0
2096	1994	MITSUBISHI	GALANT	FOUR DOOR SEDAN	2.0	15.2	0.0	-8.0	0.5	61.1
6442	2005	SATURN	ION	FOUR DOOR SEDAN	2.0	34.2	19.3	39.8	10.0	78.9
7107	2011	MAZDA	MAZDA3	FOUR DOOR SEDAN	2.0	19.8	20.2	40.7	18.7	44.4
2537	1997	NISSAN	ALTIMA	FOUR DOOR SEDAN	2.0	16.2	23.0	41.2	26.7	31.8
5472	2005	SATURN	ION	FOUR DOOR SEDAN	2.0	16.7	20.1	42.1	22.8	38.9
2510	1997	MAZDA	626	FOUR DOOR SEDAN	2.0	18.3	26.6	42.4	28.5	31.6
3523	1998	CHEVROLET	CAVALIER	FOUR DOOR SEDAN	2.0	20.1	26.6	42.8	26.2	34.9
6741	2010	TOYOTA	COROLLA	FOUR DOOR SEDAN	2.0	13.4	19.4	42.9	27.9	33.0
967	1980	CHEVROLET	CITATION	FIVE DOOR HATCHBACK	2.0	20.5	26.8	43.3	26.1	35.8
2743	1998	NISSAN	ALTIMA	FOUR DOOR SEDAN	2.0	19.6	26.1	43.5	26.8	35.3
2692	1998	NISSAN	ALTIMA	FOUR DOOR SEDAN	2.0	15.4	22.5	43.9	29.3	32.9
2477	1997	HONDA	CIVIC	FOUR DOOR SEDAN	2.0	18.1	27.3	45.1	31.5	32.3
2547	1997	MITSUBISHI	GALANT	FOUR DOOR SEDAN	2.0	16.5	26.2	46.9	34.5	32.0
5986	1995	HONDA	CIVIC	FOUR DOOR SEDAN	2.0	13.0	23.6	47.6	39.3	28.7
2685	1998	CHEVROLET	CAVALIER	FOUR DOOR SEDAN	2.0	18.1	26.1	48.7	32.3	36.6
2499	1997	PONTIAC	GRAND AM	FOUR DOOR SEDAN	2.0	13.9	22.5	50.0	36.9	33.8
2693	1998	CHEVROLET	CAVALIER	FOUR DOOR SEDAN	2.0	14.9	22.8	50.6	35.3	36.2
7202	2011	KIA	FORTE	FOUR DOOR SEDAN	2.0	15.5	20.1	51.1	29.9	43.8
6735	2010	KIA	FORTE	FOUR DOOR SEDAN	2.0	18.5	19.7	51.7	24.7	54.0
2509	1997	PONTIAC	GRAND AM	FOUR DOOR SEDAN	2.0	15.8	25.9	52.6	39.8	34.8
6657	2010	MAZDA	MAZDA3	FOUR DOOR SEDAN	2.0	18.2	19.7	53.5	25.9	55.1
6863	2010	KIA	FORTE	FOUR DOOR SEDAN	2.0	14.2	19.3	54.9	33.6	44.9
3307	2000	SATURN	SL1	FOUR DOOR SEDAN	2.0	10.1	20.7	55.5	51.6	29.9
4576	2001	FORD	FOCUS	FOUR DOOR SEDAN	2.0	14.8	26.7	56.8	47.3	34.1
2715	1998	DODGE	NEON	FOUR DOOR SEDAN	2.0	13.3	26.9	62.0	58.1	33.1
2539	1997	DODGE	NEON	FOUR DOOR SEDAN	2.0	10.8	23.1	62.7	61.2	32.1
4609	2001	FORD	FOCUS	FOUR DOOR SEDAN	2.0	12.3	22.8	62.9	53.4	37.1
6604	2008	FORD	FOCUS	FOUR DOOR SEDAN	2.0	15.0	17.6	63.5	33.1	61.0
3290	2000	FORD	FOCUS	FOUR DOOR SEDAN	2.0	13.8	26.9	65.2	59.0	36.0
3799	2001	FORD	FOCUS	FOUR DOOR SEDAN	2.0	13.7	27.7	66.5	62.2	35.6
3463	2001	HONDA	CIVIC	FOUR DOOR SEDAN	2.0	12.7	27.2	66.7	66.4	33.5
4547	2001	FORD	FOCUS	FOUR DOOR SEDAN	2.0	11.5	22.8	67.5	61.4	37.1
4562	2001	FORD	FOCUS	FOUR DOOR SEDAN	2.0	14.8	29.0	67.6	61.5	37.1
4456	2001	FORD	FOCUS	FOUR DOOR SEDAN	2.0	13.2	26.8	69.7	65.4	37.1
6606	2008	SUBARU	IMPREZA	FOUR DOOR SEDAN	2.0	12.4	17.7	74.4	47.3	58.5
3515	2001	MITSUBISHI	GALANT	FOUR DOOR SEDAN	2.0	13.7	26.2	76.3	67.6	43.0
1749	1989	ISUZU	TROOPER II	FIVE DOOR HATCHBACK	2.0	12.9	21.3	76.4	57.1	51.1
5325	2005	CHEVROLET	COBALT	FOUR DOOR SEDAN	2.0	11.9	26.3	76.4	78.0	37.4
2210	1995	SUBARU	LEGACY	STATION WAGON	2.0	11.6	23.2	79.1	72.3	43.3
2984	1999	MITSUBISHI	GALANT	FOUR DOOR SEDAN	2.0	12.7	22.3	81.8	65.4	51.2
7191	2011	DODGE	CALIBER	FIVE DOOR HATCHBACK	2.0	14.6	20.0	84.4	52.2	68.2
3486	2001	HYUNDAI	ELANTRA	FOUR DOOR SEDAN	2.0	13.0	26.7	88.8	84.4	46.7
5046	2004	KIA	SPECTRA	FOUR DOOR SEDAN	2.0	13.7	26.6	89.2	79.7	49.9
1738	1987	DODGE	COLT	FIVE DOOR HATCHBACK	2.0	13.1	22.4	95.7	74.6	61.4
4092	2002	AUDI	A4	FOUR DOOR SEDAN	2.0	10.6	24.8	96.5	103.3	45.1
6587	2005	SATURN	ION	FOUR DOOR SEDAN	2.0	10.7	22.7	96.6	93.7	49.8
2994	1999	MITSUBISHI	GALANT	FOUR DOOR SEDAN	2.0	14.0	26.1	97.2	83.6	56.5
6246	2008	FORD	FOCUS	FOUR DOOR SEDAN	2.0	11.5	27.3	97.2	106.4	44.4
2720	1998	SUBARU	LEGACY	FOUR DOOR SEDAN	2.0	13.0	22.9	99.7	80.2	62.0
6744	2010	TOYOTA	COROLLA	FOUR DOOR SEDAN	2.0	9.6	27.2	100.1	131.8	38.0

To select multiple records hold the ctrl key down and click on the records you wish to select

	A	B	G	Kv	CF
Average	118.2	127.2	64.9	150.6	19.8
Minimum	-9.2	0.5	28.7	0.0	0.0
Maximum	1055.4	1346.7	540.1	1571.6	82.7
Std Dev	153.8	200.5	79.0	237.4	10.2

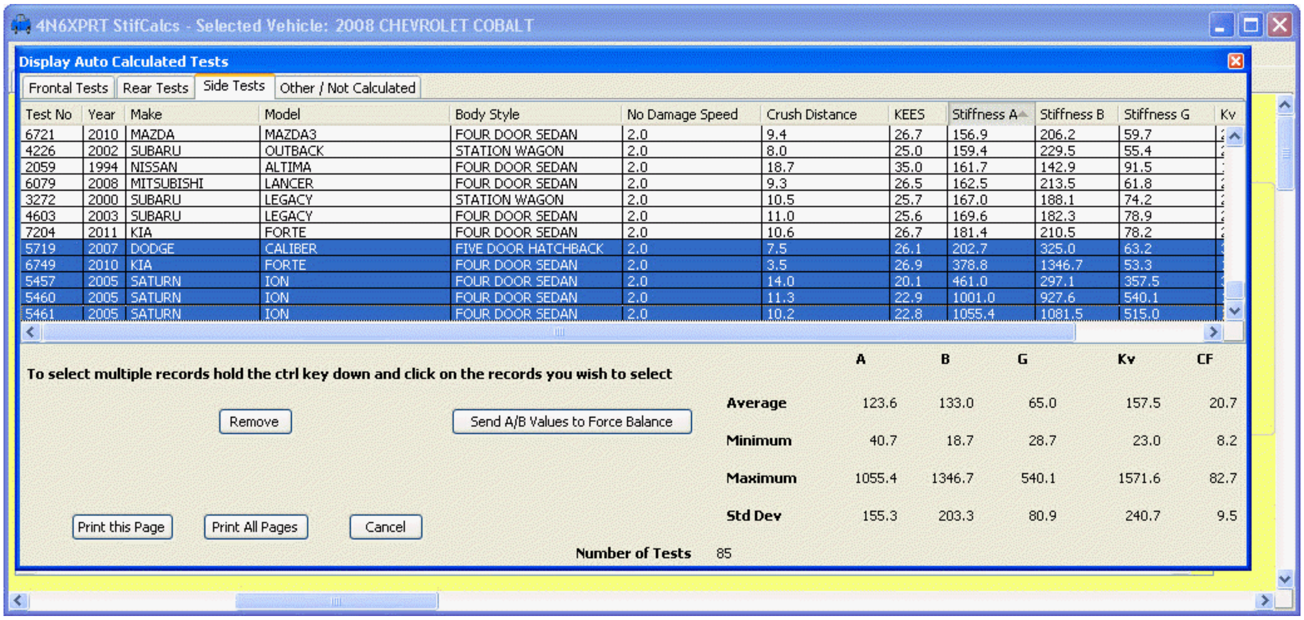
Remove | Send A/B Values to Force Balance

Print this Page | Print All Pages | Cancel

Number of Tests 89

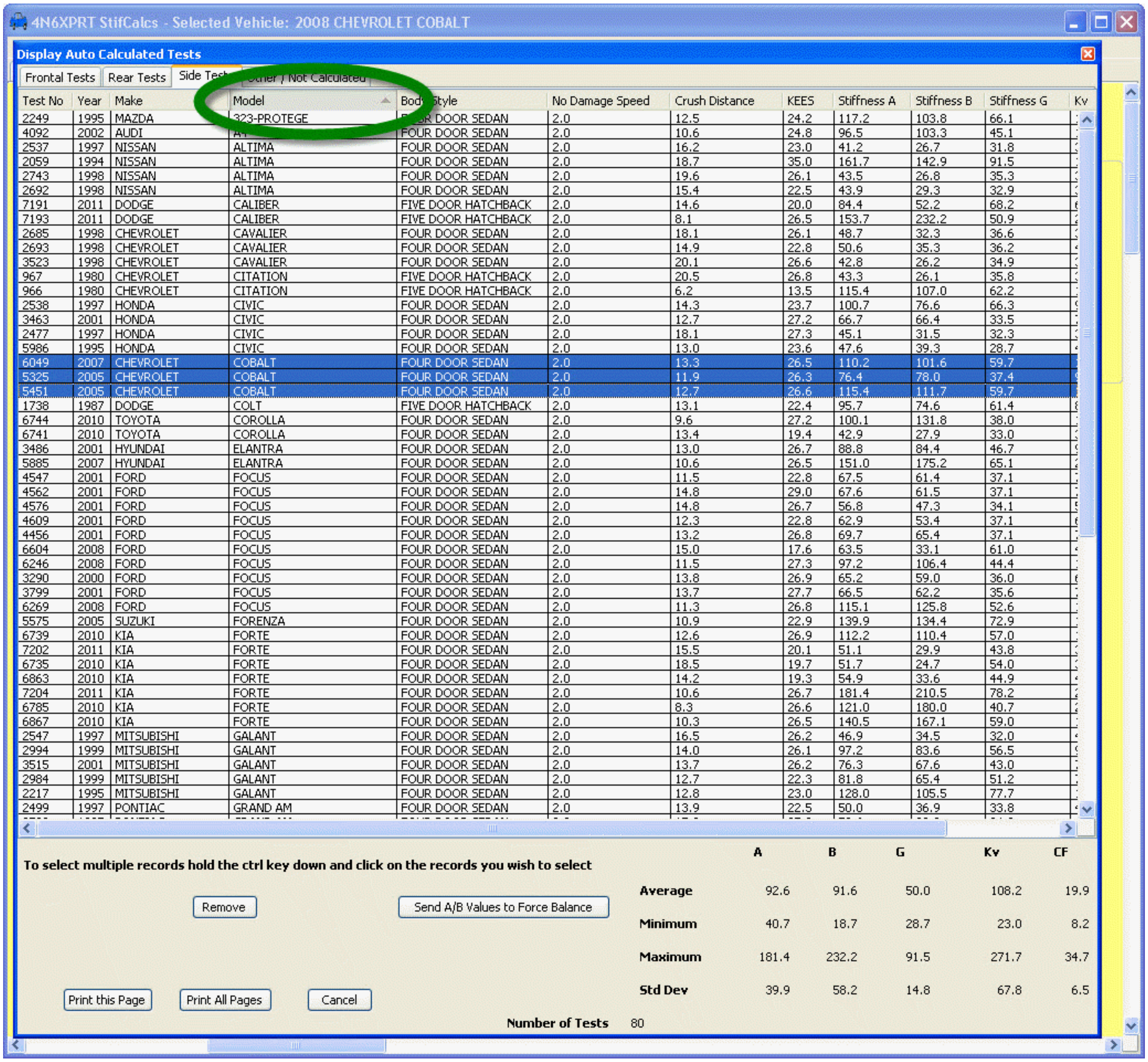
When the tests are reduced to cars with 4 door Body types, we now have 89 tests. However, there are still some tests with “extreme” stiffness values.

To find and eliminate the EXTREME outliers, we sort the “A” value column, and remove any negative values.



Then we scroll to the bottom of the page and eliminate the values above 200. Alternatively, you could click on the “A” column again, which would change the sort order from “Low to High” to “High to Low” .... and then eliminate the “high” values.

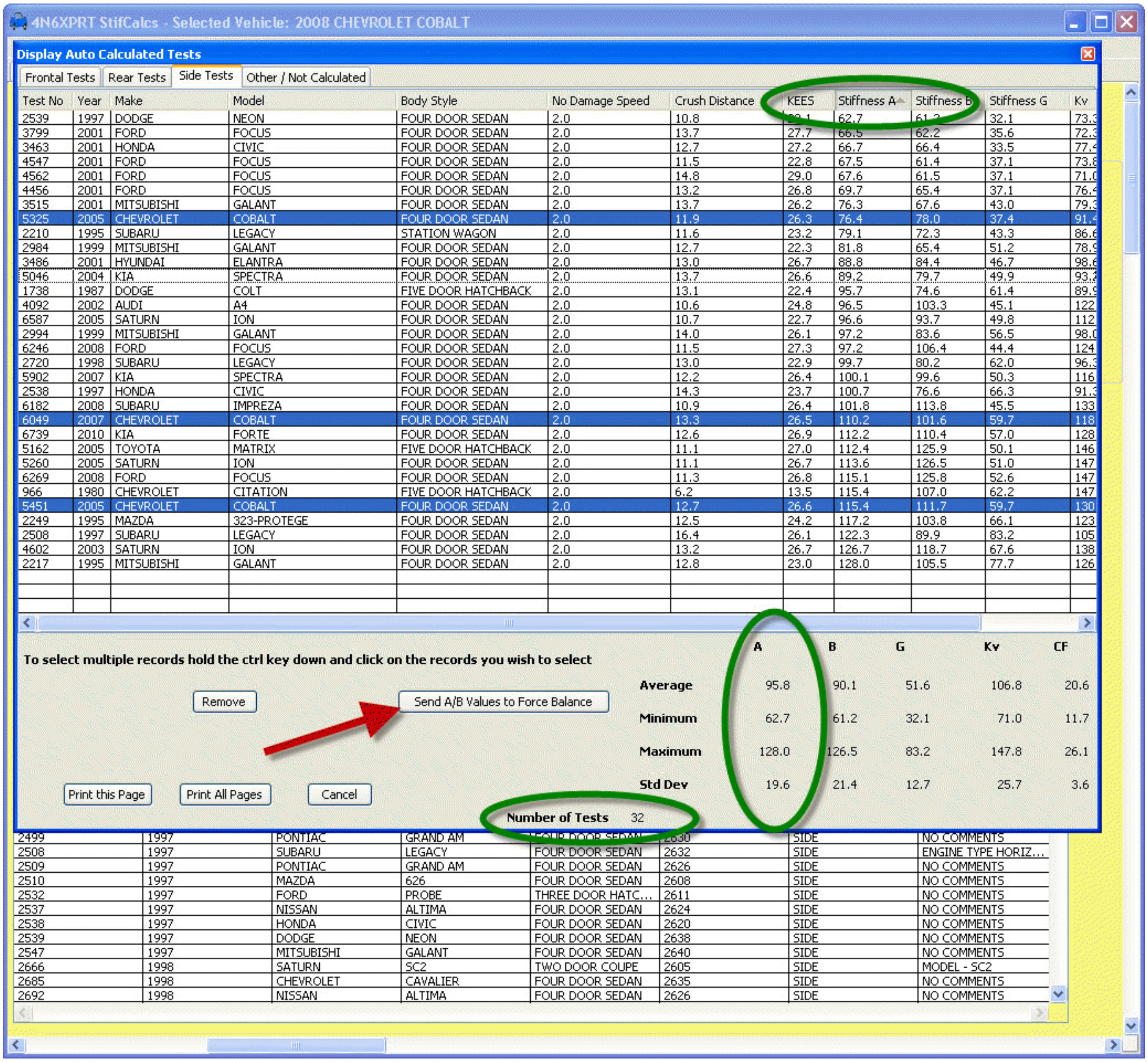
The “A” value of 200 and above was picked due to experience of working with Side impact tests and familiarity of “normal” side stiffness “A” values. Your criteria may be different.



There are still 80 “valid” tests which meet our CLASS requirements of 4 door Car with a wheelbase between 102.5-104.5 inches.

The physical constraints of the program is that 34 tests fit on one printed page. More than 34 tests cause the statistical summary to partially, or wholly, “spill over” to an additional page. 80 tests would require 3 printed pages.

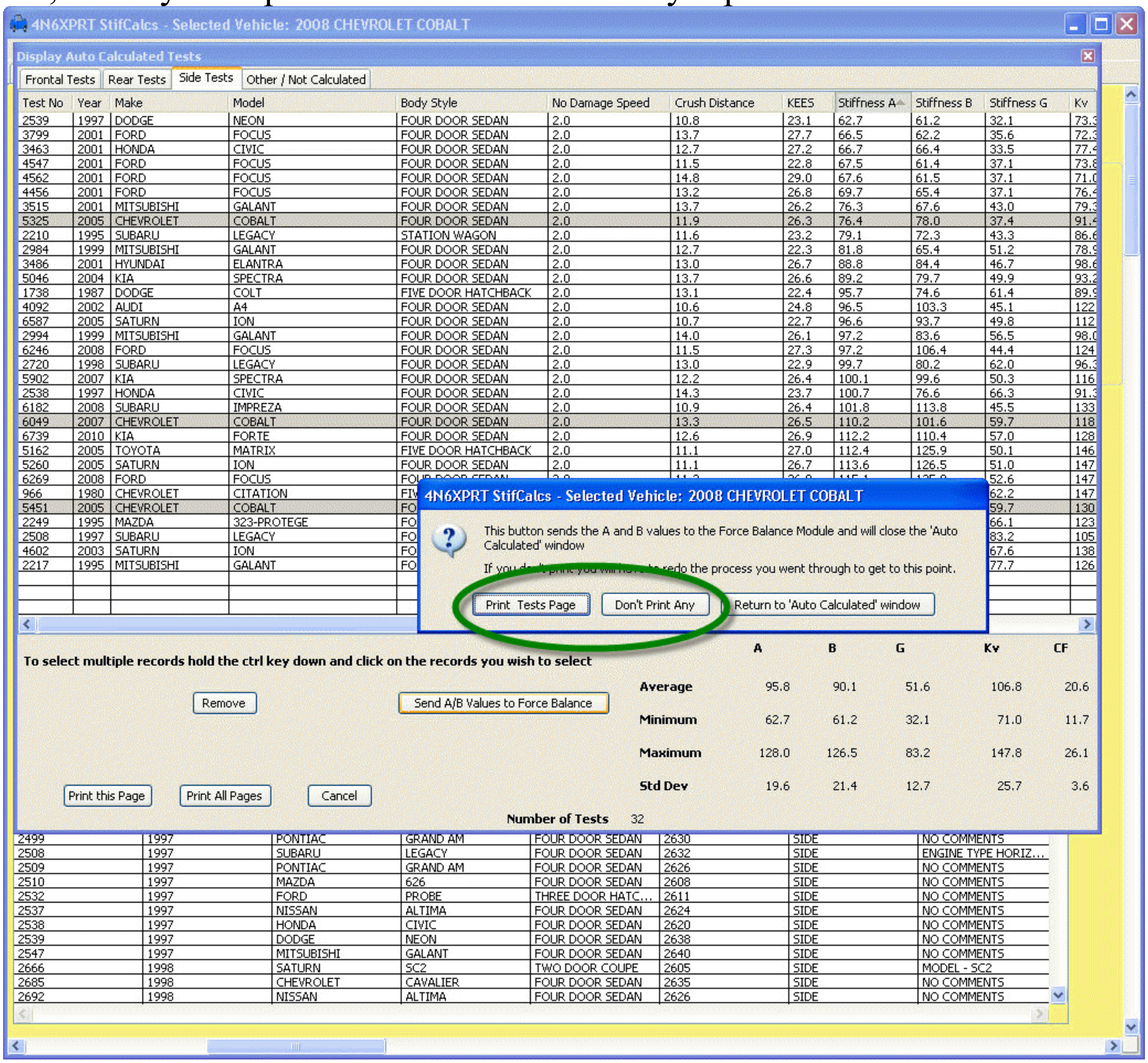
Sorting the remaining tests on the MODEL name, we can see the three COBALT tests have an “A” stiffness value range of ~76 to ~115.



Sorting on the "A" value again, and removing all tests with an "A" value less than 60 or above 130 (+/- 15 "points" of the Min/Max Cobalt values) reduces the number of tests to 32. Since this is a number of tests which will fit on a single page, it is a test selection which we can use without generating too much paper.

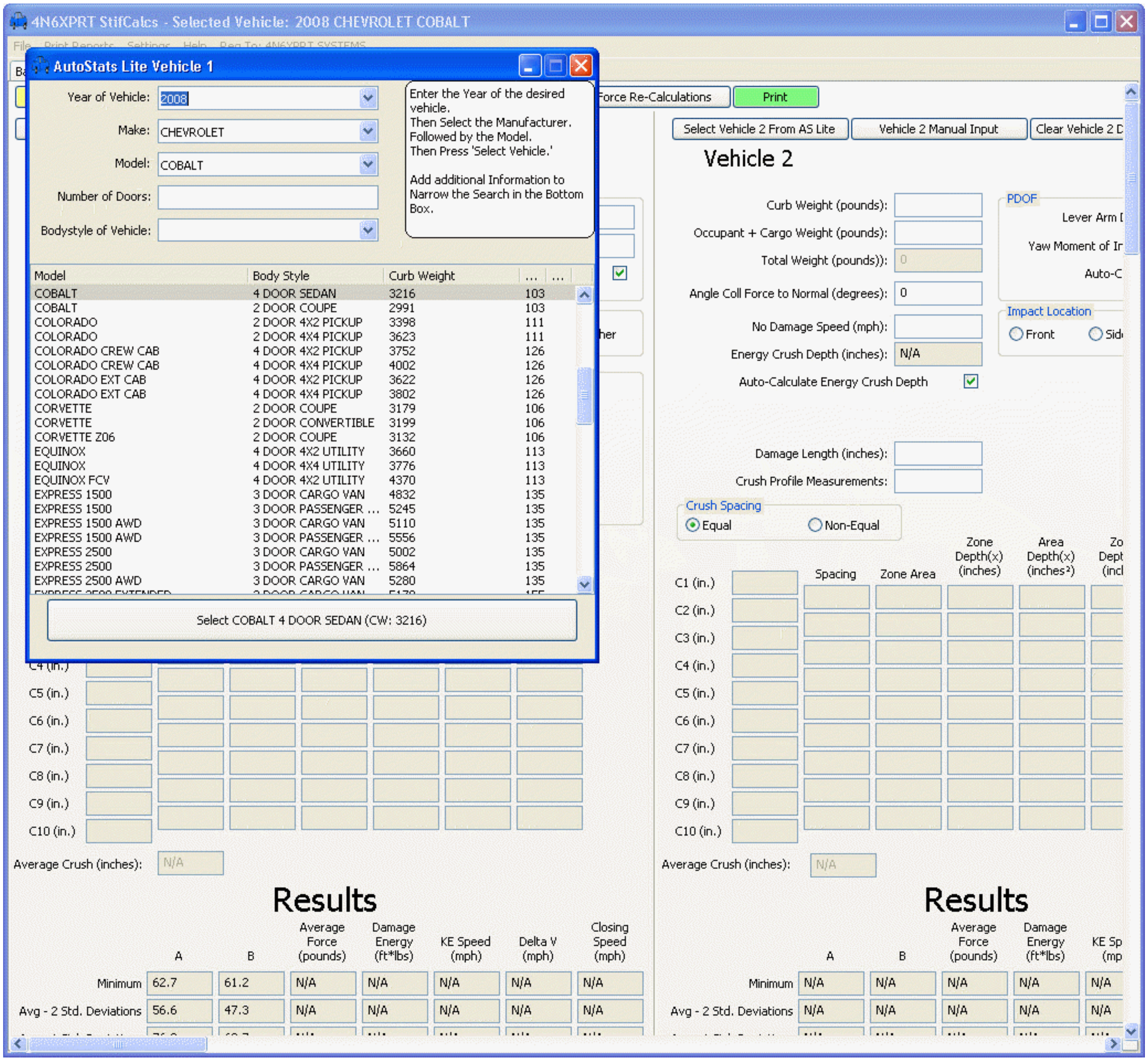
This grouping has the added advantage of being a "tight" grouping of tests which incorporate the three COBALT 4 door sedans tested by NHTSA and a "fair" +/- number of tests above and below those tests.

At this point, we can click one of the two PRINT buttons, or click the SEND A/B VALUES TO FORCE BALANCE button, which will, as previously stated, allow you to print out this Test Summary report.



If you have not already printed the Test Summary report for the CLASS vehicle you have created, do so at this point.

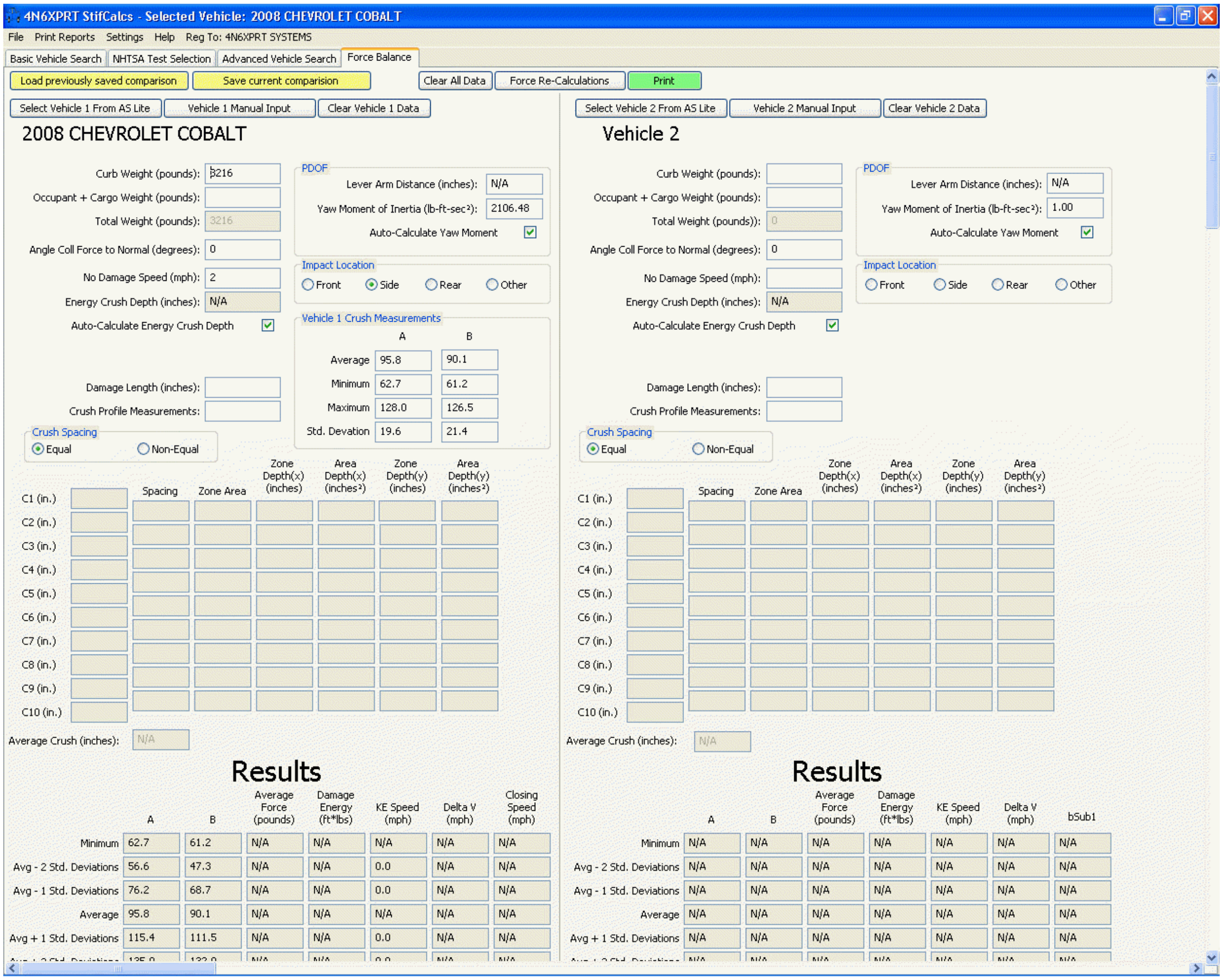
FORCE BALANCE:



When you send the A/B values from a Test Summary to the Force Balance module, the first thing that comes up is AS (AutoStats) Lite for the vehicle identified by the basic search.

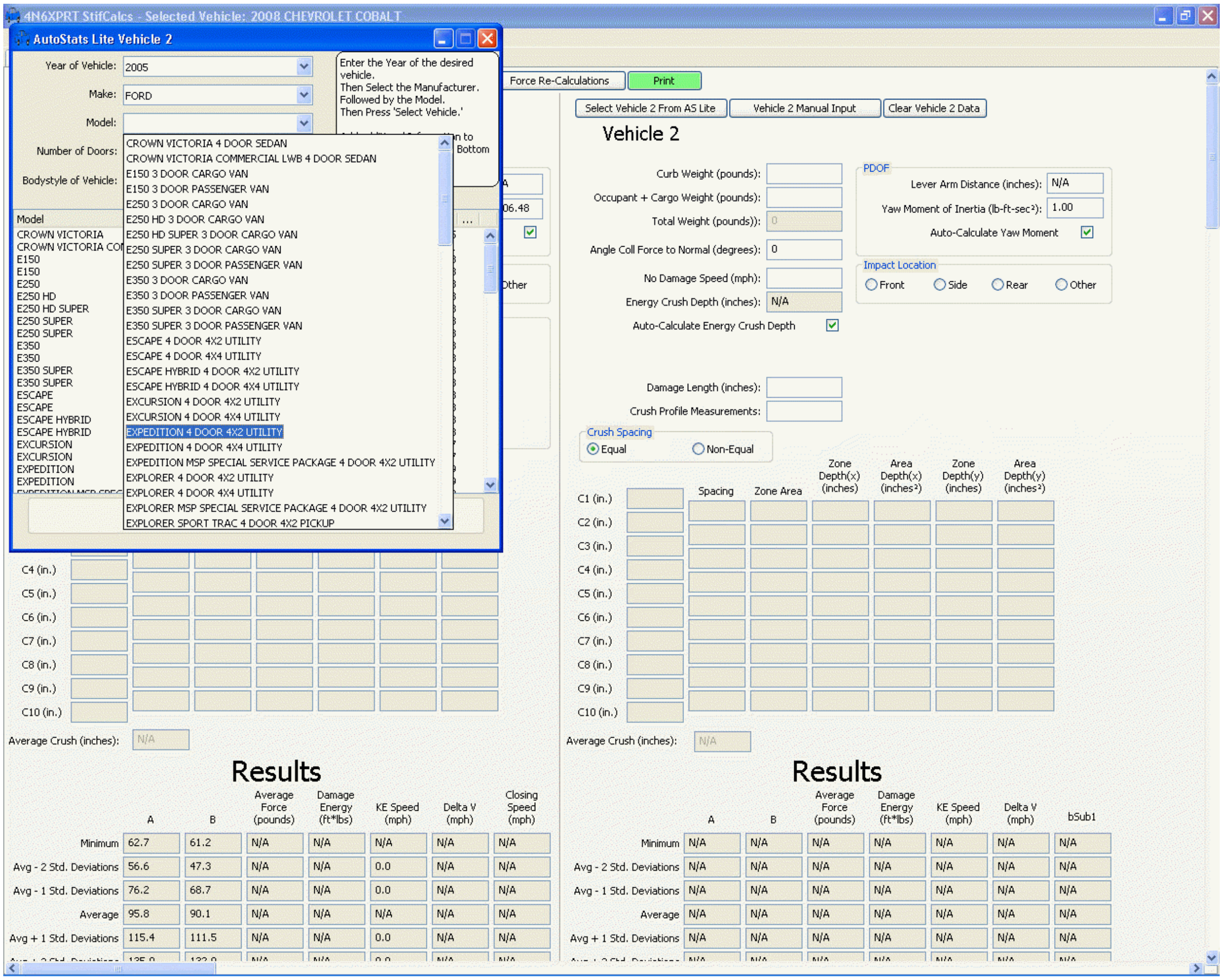
If you have not completed a Basic Search prior to the Force Balance module, the Year, Make, and Model fields will be blank.

Once you have that data input into the appropriate fields, click the SELECT button at the bottom of the form.

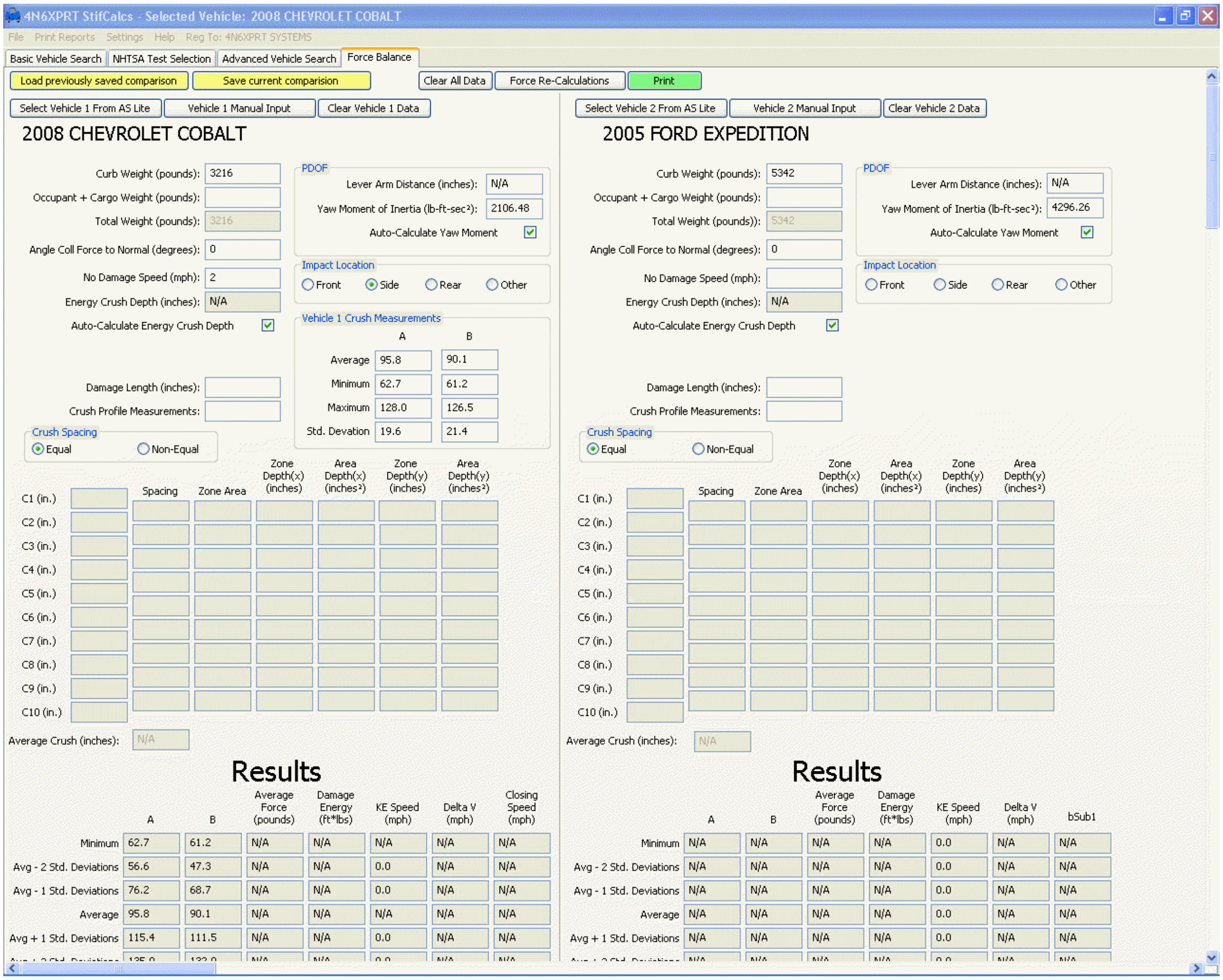


This is what the Force Balance page looks like after entering the AS Lite information and A-B values for Vehicle 1 (your KNOWN vehicle with "Good" Stiffness values).

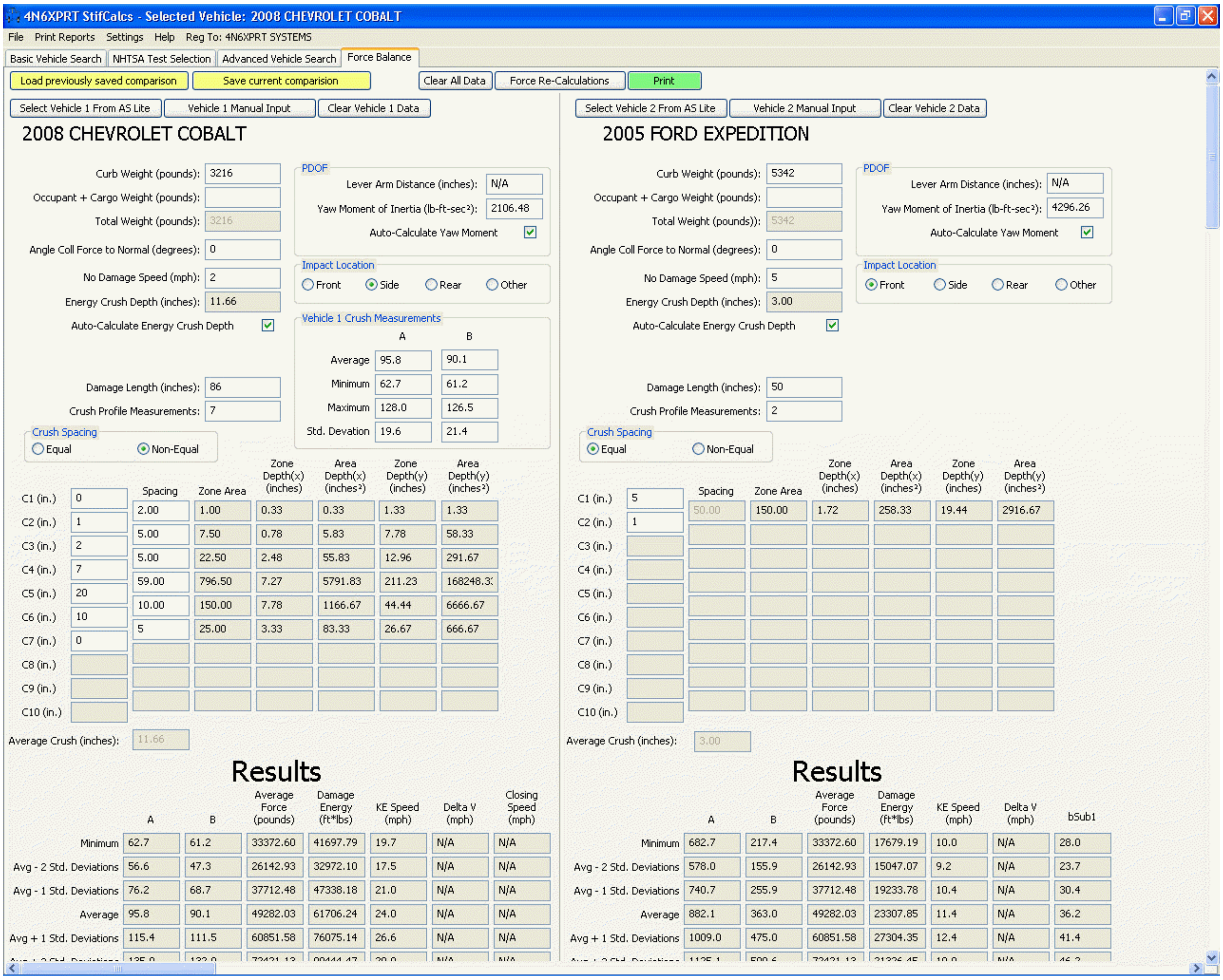
This can also be reached without any data imports by just clicking on the Force Balance tab and filling in all the fields manually.



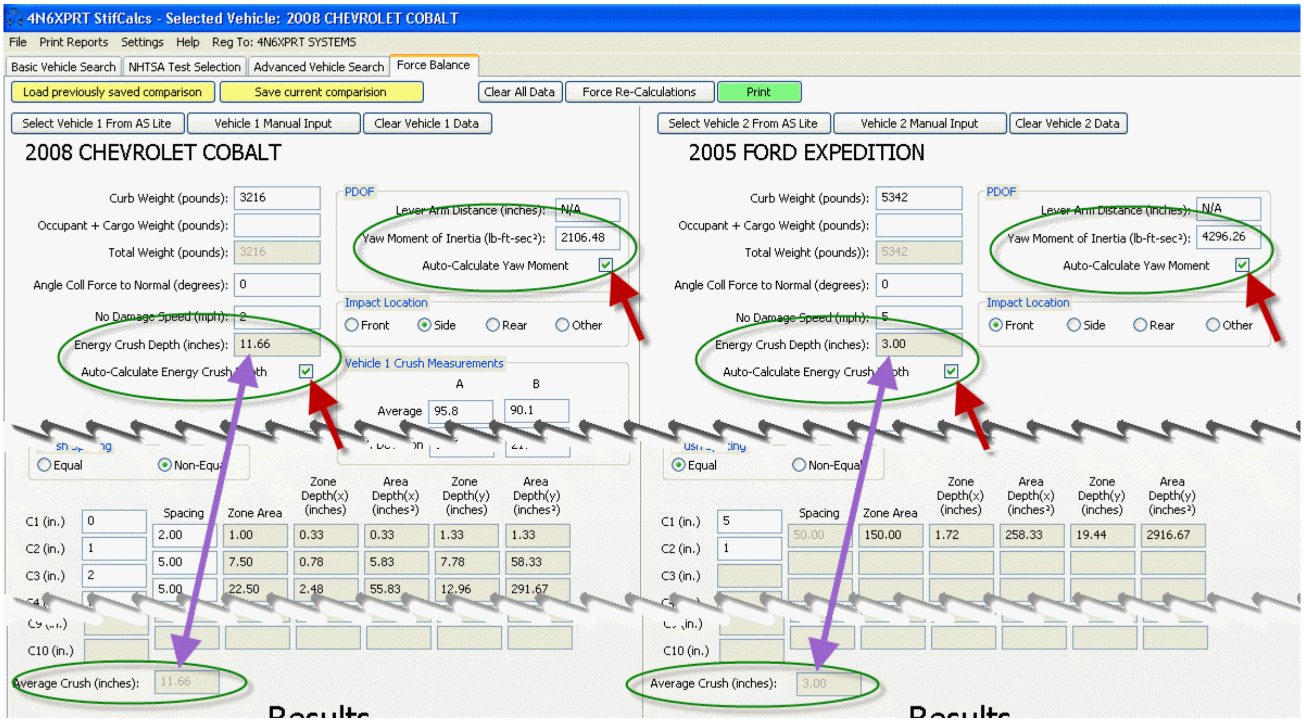
Enter the vehicle data for Vehicle 2, either using AS LITE as shown, or via MANUAL INPUT.



At this point, we have Vehicle Year, Make, Model information, Curb Weight, and Yaw Moment of Inertia values entered for both vehicles. We also have the No Damage Value and Impact surface indicated for Vehicle 1.



We now see that the No-Damage value and impact surface for Vehicle 2 have been input. Also input are the Crush Profile information for both Vehicle 1 and Vehicle 2.



There are two check boxes for each vehicle that may raise questions

AUTO-CALCULATE YAW MOMENT - When this box is checked, the Yaw Moment of Inertia is calculated based on the following formulas and the Total weight of Vehicle + Occupant(s) & Cargo.

If the Vehicle is a Van, SUV, Pickup, or has a curb weight greater than 8000 pounds, the Yaw Moment will be calculated as:

1.03 * Total Weight - 1343

Otherwise, the Yaw Moment will be calculated as:

1.03 * Total Weight - 1206

AUTO-CALCULATE ENERGY CRUSH DEPTH - When this box is checked, the "ENERGY CRUSH DEPTH" field equals the AVERAGE CRUSH field. When it is unchecked, you can enter some other value, allowing you to quickly complete a "rough check" on someone elses numbers without having to enter their crush profile.

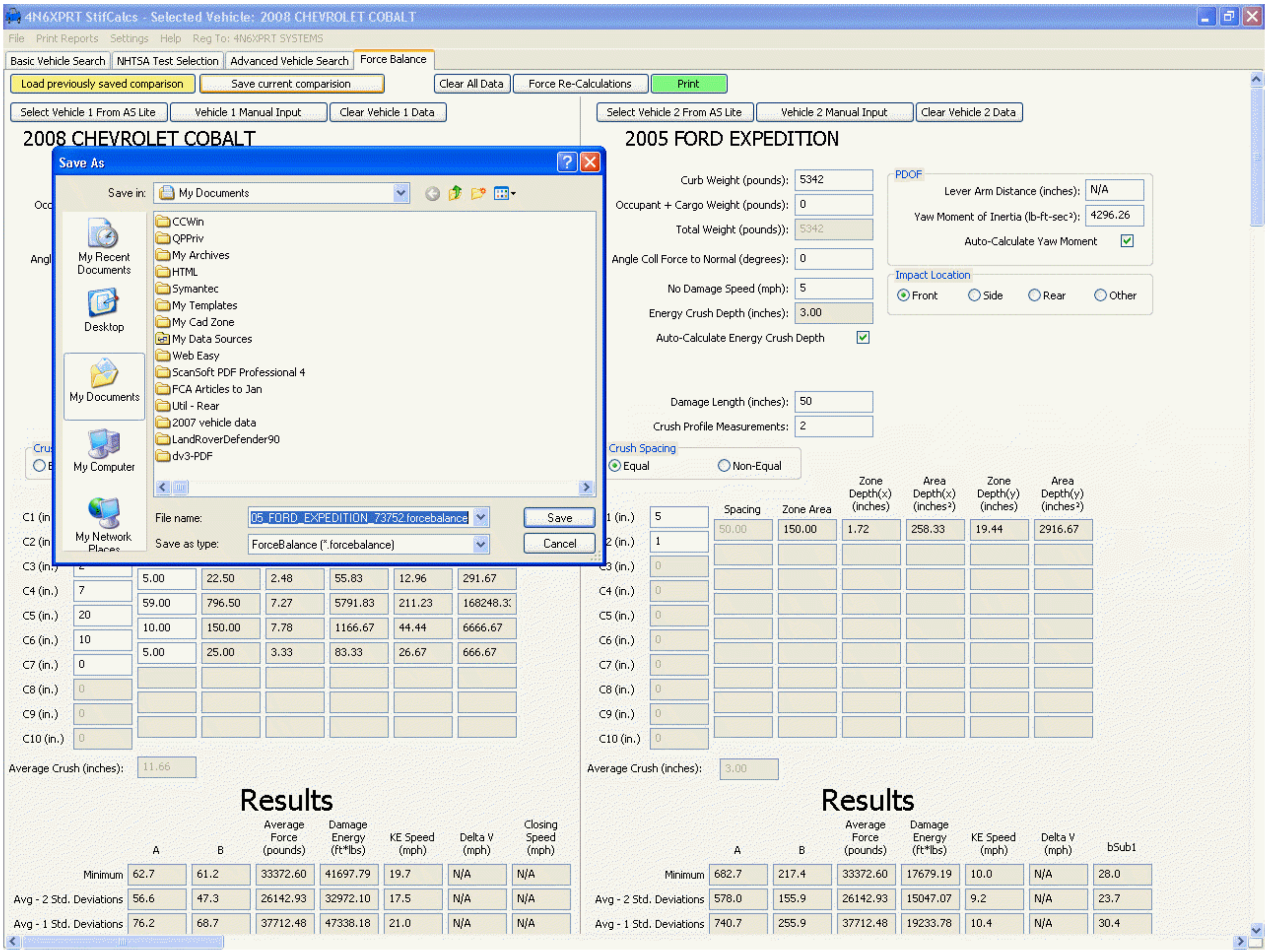
ENERGY CRUSH DEPTH - This is the Crush Depth (C_{avg}) data field used for the "RESULTS" calculations of b_1 (bSub1) and F_{avg} (Average Force). When the Auto-Calculate box is checked, it is equal to the calculated Average Crush from the crush profile you entered.

Note that in this example the Crush Profile CRUSH SPACING for vehicle 1 is based on NON-Equal spacing, where the CRUSH SPACING for Vehicle 2 is based on Equal spacing.

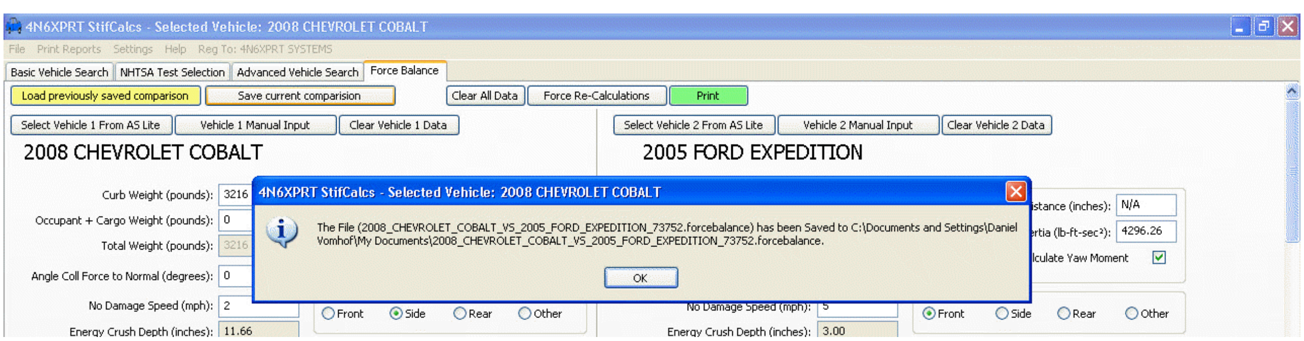
The advantage of NON-Equal spacing over Equal Crush spacing is that the measurements are better able to “describe” the crush profile of the vehicle by catching the “inflection points” in the crush profile.

Something else to note is that the Delta V and Closing Speed values are N/A ... in order to calculate these values, you MUST input values for the LEVER ARM for both vehicles, and have a value in place for ANGLE COL FORCE TO NORMAL (DEGREES) for both vehicles.

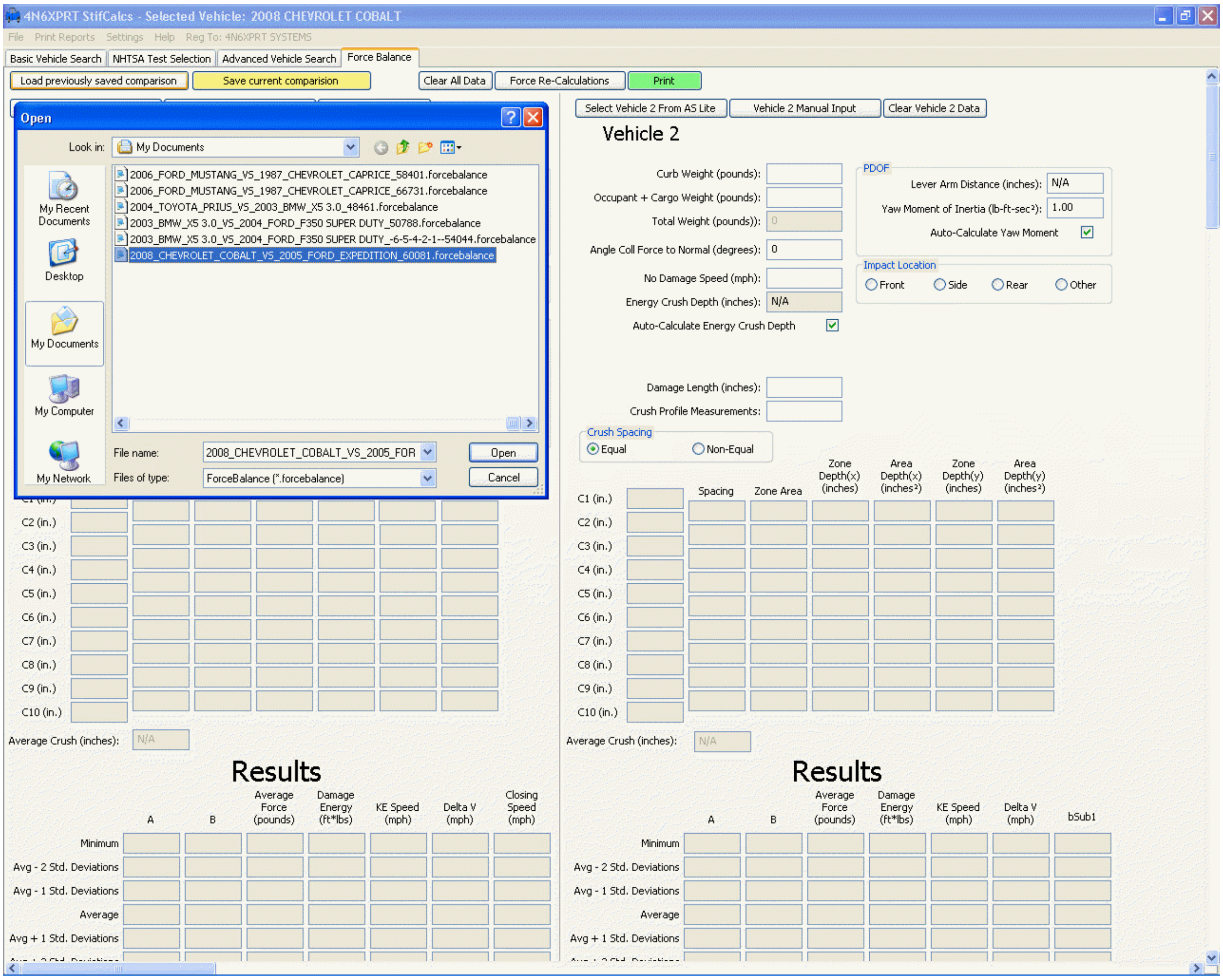
Both of these values can be found in a variety of ways, one of which is through the use of a CRASH 3 program.



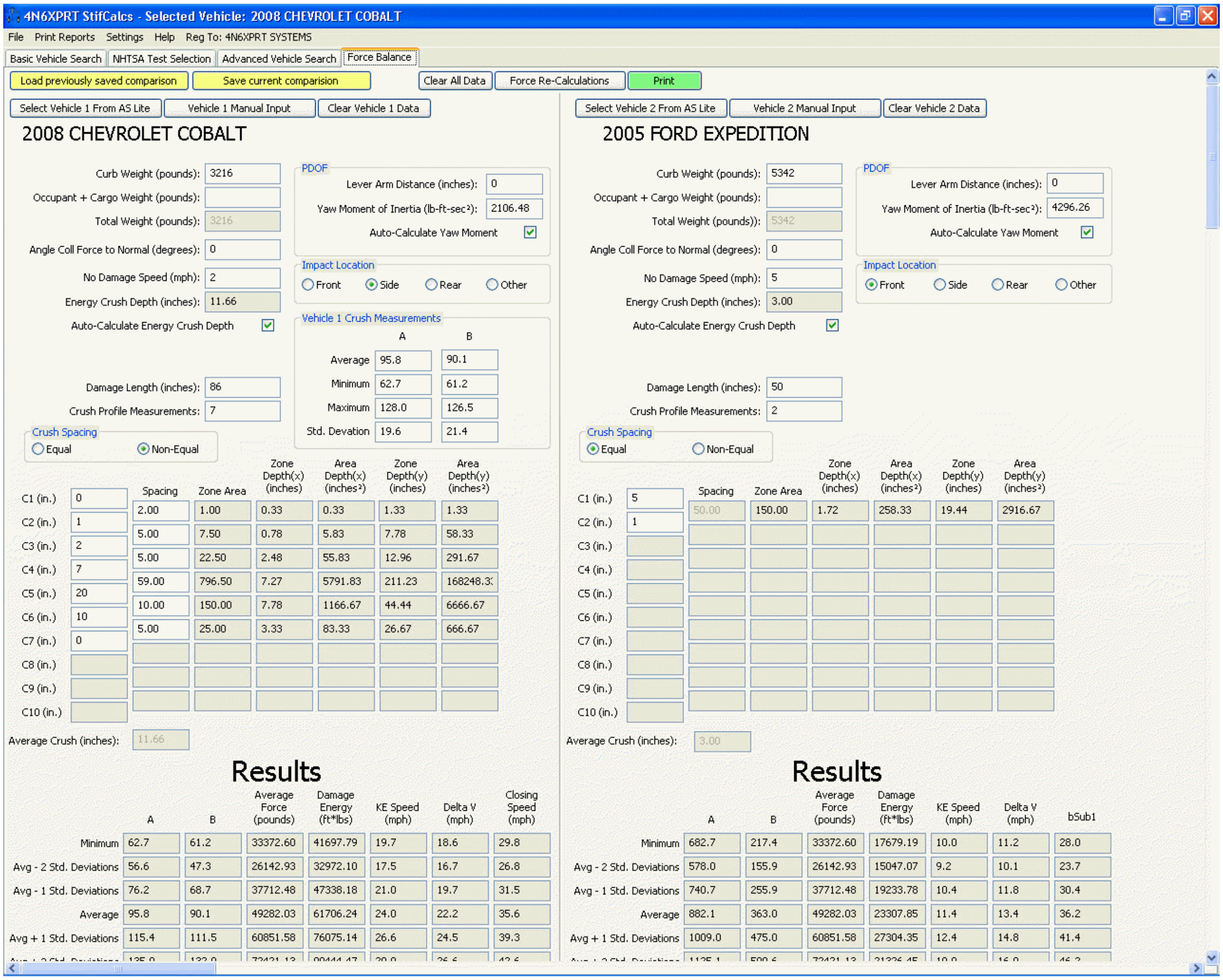
At this point, you have the A-B values necessary for a CRASH 3 analysis. Saying that you have enough Post Impact information to complete a CRASH 3 analysis, it is suggested that you SAVE CURRENT COMPARISON and complete your CRASH 3 analysis.



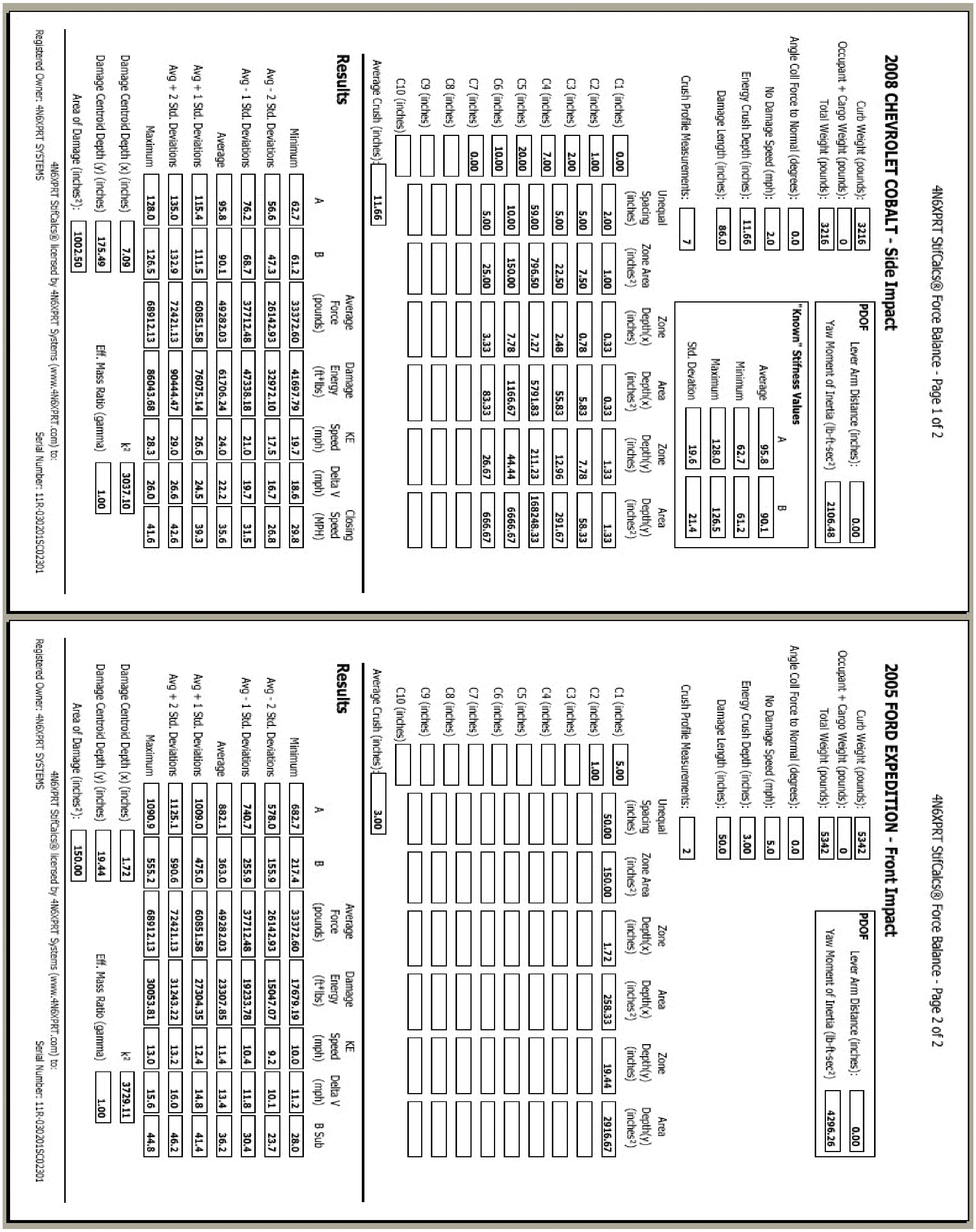
As part of the SAVE you receive a confirmation that the data file has been saved.



Once you complete your CRASH 3 analysis, you can come back, LOAD PREVIOUSLY SAVED COMPARISON, and enter Values for the Lever Arm for both vehicles, and change the Angle Col Force to Normal from “0" to some other value if appropriate.



This shows the Force Balance analysis with Lever Arm and Angle Col Force to Normal values of “0", which will give the most conservative numbers for the Delta V and Closing Speed values.



4N6XPRT StifCalcs® Force Balance - Page 1 of 2

2008 CHEVROLET COBALT - Side Impact

Curb Weight (pounds):	3216
Occupant + Cargo Weight (pounds):	0
Total Weight (pounds):	3216
Angle Coll Force to Normal (degrees):	0.0
No Damage Speed (mph):	2.0
Energy Crush Depth (inches):	11.66
Damage Length (inches):	86.0
Crush Profile Measurements:	7

PDOF

Lever Arm Distance (inches):	0.00
Yaw Moment of Inertia (lb-ft-sec²):	2106.48

"Known" Stiffness Values

	A	B
Average	95.8	90.1
Minimum	62.7	61.2
Maximum	128.0	126.5
Std. Deviation	19.6	21.4

		Unequal Spacing (inches)	Zone Area (inches²)	Zone Depth(x) (inches)	Area Depth(x) (inches²)	Zone Depth(y) (inches)	Area Depth(y) (inches²)
C1 (inches)	0.00	2.00	1.00	0.33	0.33	1.33	1.33
C2 (inches)	1.00	5.00	7.50	0.78	5.83	7.78	58.33
C3 (inches)	2.00	5.00	22.50	2.48	55.83	12.96	291.67
C4 (inches)	7.00	59.00	796.50	7.27	5791.83	211.23	168248.33
C5 (inches)	20.00	10.00	150.00	7.78	1166.67	44.44	6666.67
C6 (inches)	10.00	5.00	25.00	3.33	83.33	26.67	666.67
C7 (inches)	0.00						
C8 (inches)							
C9 (inches)							
C10 (inches)							

Average Crush (inches): 11.66

Results

	A	B	Average Force (pounds)	Damage Energy (ft*lbs)	KE Speed (mph)	Delta V (mph)	Closing Speed (MPH)
Minimum	62.7	61.2	33372.60	41697.79	19.7	18.6	29.8
Avg - 2 Std. Deviations	56.6	47.3	26142.93	32972.10	17.5	16.7	26.8
Avg - 1 Std. Deviations	76.2	68.7	37712.48	47338.18	21.0	19.7	31.5
Average	95.8	90.1	49282.03	61706.24	24.0	22.2	35.6
Avg + 1 Std. Deviations	115.4	111.5	60851.58	76075.14	26.6	24.5	39.3
Avg + 2 Std. Deviations	135.0	132.9	72421.13	90444.47	29.0	26.6	42.6
Maximum	128.0	126.5	68912.13	86043.68	28.3	26.0	41.6

Damage Centroid Depth (x) (inches)	7.09	k²	3037.10
Damage Centroid Depth (y) (inches)	175.49	Eff. Mass Ratio (gamma)	1.00
Area of Damage (inches²):	1002.50		

Registered Owner: 4N6XPRT SYSTEMS
4N6XPRT StifCalcs® licensed by 4N6XPRT Systems (www.4N6XPRT.com) to:
Serial Number: 11R-030201SC02301

4N6XPRT StifCalcs® Force Balance - Page 2 of 2

2005 FORD EXPEDITION - Front Impact

Curb Weight (pounds):	5342
Occupant + Cargo Weight (pounds):	0
Total Weight (pounds):	5342
Angle Coll Force to Normal (degrees):	0.0
No Damage Speed (mph):	5.0
Energy Crush Depth (inches):	3.00
Damage Length (inches):	50.0
Crush Profile Measurements:	2

PDOF

Lever Arm Distance (inches):	0.00
Yaw Moment of Inertia (lb-ft-sec²):	4296.26

		Unequal Spacing (inches)	Zone Area (inches²)	Zone Depth(x) (inches)	Area Depth(x) (inches²)	Zone Depth(y) (inches)	Area Depth(y) (inches²)
C1 (inches)	5.00	50.00	150.00	1.72	258.33	19.44	2916.67
C2 (inches)	1.00						
C3 (inches)							
C4 (inches)							
C5 (inches)							
C6 (inches)							
C7 (inches)							
C8 (inches)							
C9 (inches)							
C10 (inches)							

Average Crush (inches): 3.00

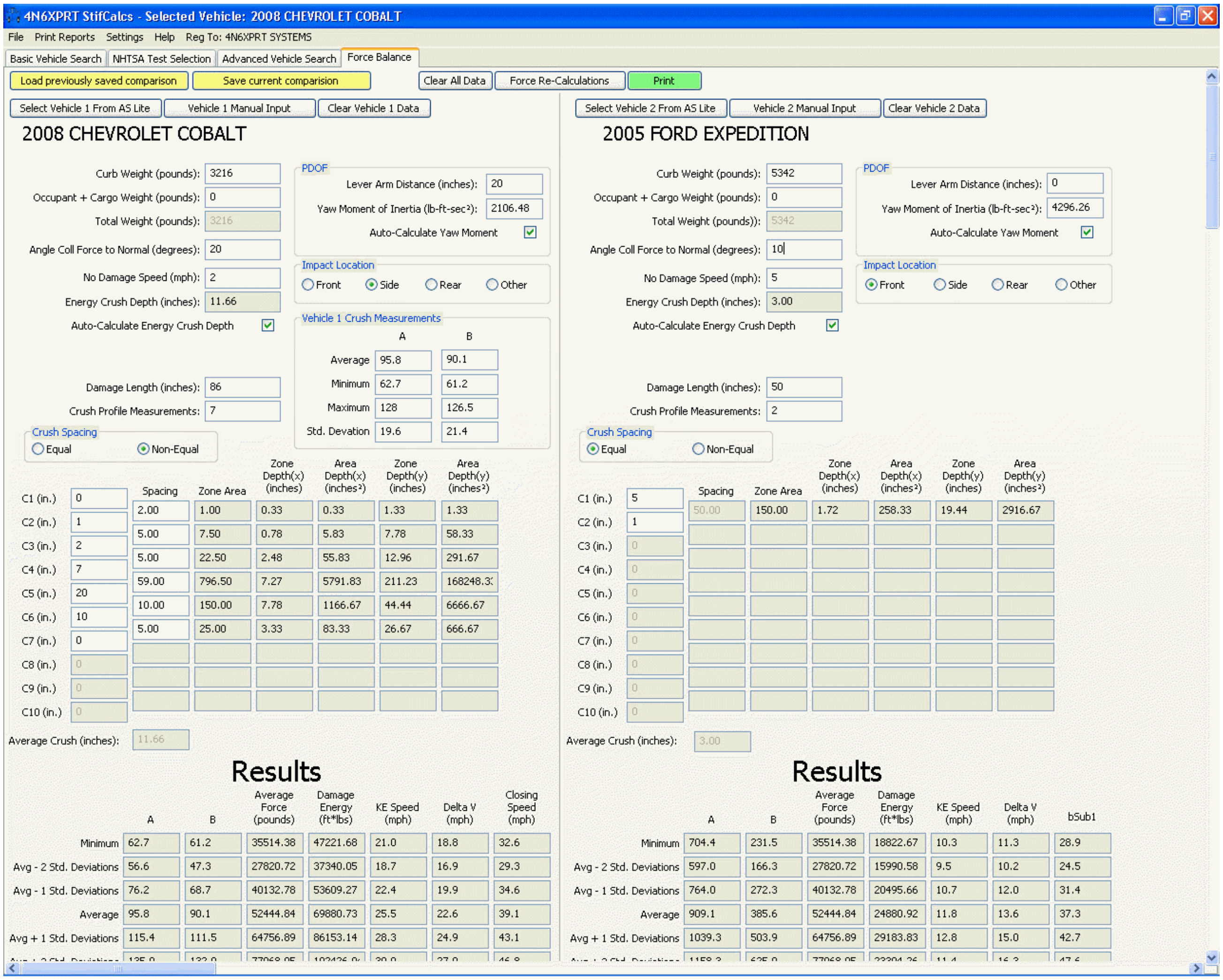
Results

	A	B	Average Force (pounds)	Damage Energy (ft*lbs)	KE Speed (mph)	Delta V (mph)	B Sub
Minimum	682.7	217.4	33372.60	17679.19	10.0	11.2	28.0
Avg - 2 Std. Deviations	578.0	155.9	26142.93	15047.07	9.2	10.1	23.7
Avg - 1 Std. Deviations	740.7	255.9	37712.48	19233.78	10.4	11.8	30.4
Average	882.1	363.0	49282.03	23307.85	11.4	13.4	36.2
Avg + 1 Std. Deviations	1009.0	475.0	60851.58	27304.35	12.4	14.8	41.4
Avg + 2 Std. Deviations	1125.1	590.6	72421.13	31243.22	13.2	16.0	46.2
Maximum	1090.9	555.2	68912.13	30053.81	13.0	15.6	44.8

Damage Centroid Depth (x) (inches)	1.72	k²	3729.11
Damage Centroid Depth (y) (inches)	19.44	Eff. Mass Ratio (gamma)	1.00
Area of Damage (inches²):	150.00		

Registered Owner: 4N6XPRT SYSTEMS
4N6XPRT StifCalcs® licensed by 4N6XPRT Systems (www.4N6XPRT.com) to:
Serial Number: 11R-030201SC02301

The printed output appears as shown above.



An illustration of what happens to the Delta V and Closing Speeds when the Lever Arm and Angle Col Force are values other than “0" appear above. These values should be compared to the printout previously discussed.

In short, the speeds are higher.

CLASS vs SISTER/CLONE Summary Comparison:

One of the purposes of going through building the CLASS vehicle, even though there were Sister/Clone tests for the Cobalt, was to compare the CLASS values to Sister/Clone values. Another purpose was to restrict the CLASS vehicle to a 4 door vehicle only, and thus incorporate the B-Pillar “hard point”

Looking at the two Force Balance analysis results again, we have -

Sister/Clone -

4N6XPRT StifCalcs® Force Balance - Page 1 of 2

2008 CHEVROLET COBALT - Side Impact

Curb Weight (pounds):	3216
Occupant + Cargo Weight (pounds):	0
Total Weight (pounds):	3216
Angle Coll Force to Normal (degrees):	0.0
No Damage Speed (mph):	2.0
Energy Crush Depth (inches):	11.66
Damage Length (inches):	86.0
Crush Profile Measurements:	7

PDOF

Lever Arm Distance (inches):	0.00
Yaw Moment of Inertia (lb-ft-sec²)	2106.48

"Known" Stifness Values

	A	B
Average	101.5	94.2
Minimum	42.1	22.8
Maximum	161.5	168.4
Std. Devation	29.3	37.4

		Unequal Spacing (inches)	Zone Area (inches²)	Zone Depth(x) (inches)	Area Depth(x) (inches²)	Zone Depth(y) (inches)	Area Depth(y) (inches²)
C1 (inches)	0.00	2.00	1.00	0.33	0.33	1.33	1.33
C2 (inches)	1.00	5.00	7.50	0.78	5.83	7.78	58.33
C3 (inches)	2.00	5.00	22.50	2.48	55.83	12.96	291.67
C4 (inches)	7.00	59.00	796.50	7.27	5791.83	211.23	168248.33
C5 (inches)	20.00	10.00	150.00	7.78	1166.67	44.44	6666.67
C6 (inches)	10.00	5.00	25.00	3.33	83.33	26.67	666.67
C7 (inches)	0.00						
C8 (inches)							
C9 (inches)							
C10 (inches)							

Average Crush (inches): 11.66

Results

	A	B	Average Force (pounds)	Damage Energy (ft*lbs)	KE Speed (mph)	Delta V (mph)	Closing Speed (MPH)
Minimum	42.1	22.8	13238.80	17292.95	12.7	12.6	20.2
Avg - 2 Std. Deviations	42.9	19.4	11568.95	15408.41	12.0	12.0	19.3
Avg - 1 Std. Deviations	72.2	56.8	31575.60	39985.38	19.3	18.2	29.2
Average	101.5	94.2	51582.25	64636.46	24.6	22.7	36.4
Avg + 1 Std. Deviations	130.8	131.6	71588.90	89298.47	28.9	26.4	42.3
Avg + 2 Std. Deviations	160.1	169.0	91595.55	113964.15	32.6	29.7	47.6
Maximum	161.5	168.4	91355.00	113737.44	32.6	29.7	47.5

Damage Centroid Depth (x) (inches)	7.09
Damage Centroid Depth (y) (inches)	175.49
Area of Damage (inches²):	1002.50
k^2	3037.10
Eff. Mass Ratio (gamma)	1.00

4N6XPRT StifCalcs® licensed by 4N6XPRT Systems (www.4N6XPRT.com) to:
Registered Owner: 4N6XPRT SYSTEMS Serial Number: 11R-030201SC02301

4N6XPRT StifCalcs® Force Balance - Page 2 of 2

2005 FORD EXPEDITION - Front Impact

Curb Weight (pounds):	5342
Occupant + Cargo Weight (pounds):	0
Total Weight (pounds):	5342
Angle Coll Force to Normal (degrees):	0.0
No Damage Speed (mph):	5.0
Energy Crush Depth (inches):	3.00
Damage Length (inches):	50.0
Crush Profile Measurements:	2

PDOF

Lever Arm Distance (inches):	0.00
Yaw Moment of Inertia (lb-ft-sec²)	4296.26

		Unequal Spacing (inches)	Zone Area (inches²)	Zone Depth(x) (inches)	Area Depth(x) (inches²)	Zone Depth(y) (inches)	Area Depth(y) (inches²)
C1 (inches)	5.00	50.00	150.00	1.72	258.33	19.44	2916.67
C2 (inches)	1.00						
C3 (inches)							
C4 (inches)							
C5 (inches)							
C6 (inches)							
C7 (inches)							
C8 (inches)							
C9 (inches)							
C10 (inches)							

Average Crush (inches): 3.00

Results

	A	B	Average Force (pounds)	Damage Energy (ft*lbs)	KE Speed (mph)	Delta V (mph)	B Sub
Minimum	354.1	58.5	13238.80	10150.68	7.6	7.6	14.5
Avg - 2 Std. Deviations	319.7	47.7	11568.95	9488.35	7.3	7.2	13.1
Avg - 1 Std. Deviations	657.7	201.8	31575.60	17030.31	9.8	11.0	27.0
Average	908.4	385.0	51582.25	24107.82	11.6	13.7	37.3
Avg + 1 Std. Deviations	1117.1	582.2	71588.90	30961.51	13.2	15.9	45.9
Avg + 2 Std. Deviations	1299.7	788.1	91595.55	37676.36	14.5	17.9	53.4
Maximum	1297.6	785.5	91355.00	37596.26	14.5	17.9	53.3

Damage Centroid Depth (x) (inches)	1.72
Damage Centroid Depth (y) (inches)	19.44
Area of Damage (inches²):	150.00
k^2	3729.11
Eff. Mass Ratio (gamma)	1.00

4N6XPRT StifCalcs® licensed by 4N6XPRT Systems (www.4N6XPRT.com) to:
Registered Owner: 4N6XPRT SYSTEMS Serial Number: 11R-030201SC02301

and then we have

CLASS -

4N6XPRT StifCalcs® Force Balance - Page 1 of 2

2008 CHEVROLET COBALT - Side Impact

Curb Weight (pounds):	3216
Occupant + Cargo Weight (pounds):	0
Total Weight (pounds):	3216
Angle Coll Force to Normal (degrees):	0.0
No Damage Speed (mph):	2.0
Energy Crush Depth (inches):	11.66
Damage Length (inches):	86.0
Crush Profile Measurements:	7

PDOF

Lever Arm Distance (inches):	0.00
Yaw Moment of Inertia (lb-ft-sec²):	2106.48

"Known" Stifness Values

	A	B
Average	95.8	90.1
Minimum	62.7	61.2
Maximum	128.0	126.5
Std. Devation	19.6	21.4

	Crush	Unequal Spacing (inches)	Zone Area (inches²)	Zone Depth(x) (inches)	Area Depth(x) (inches²)	Zone Depth(y) (inches)	Area Depth(y) (inches²)
C1 (inches)	0.00						
		2.00	1.00	0.33	0.33	1.33	1.33
C2 (inches)	1.00						
		5.00	7.50	0.78	5.83	7.78	58.33
C3 (inches)	2.00						
		5.00	22.50	2.48	55.83	12.96	291.67
C4 (inches)	7.00						
		59.00	796.50	7.27	5791.83	211.23	168248.33
C5 (inches)	20.00						
		10.00	150.00	7.78	1166.67	44.44	6666.67
C6 (inches)	10.00						
		5.00	25.00	3.33	83.33	26.67	666.67
C7 (inches)	0.00						
C8 (inches)							
C9 (inches)							
C10 (inches)							

Average Crush (inches): 11.66

Results

	A	B	Average Force (pounds)	Damage Energy (ft*lbs)	KE Speed (mph)	Delta V (mph)	Closing Speed (MPH)
Minimum	62.7	61.2	33372.60	41697.79	19.7	18.6	29.8
Avg - 2 Std. Deviations	56.6	47.3	26142.93	32972.10	17.5	16.7	26.8
Avg - 1 Std. Deviations	76.2	68.7	37712.48	47338.18	21.0	19.7	31.5
Average	95.8	90.1	49282.03	61706.24	24.0	22.2	35.6
Avg + 1 Std. Deviations	115.4	111.5	60851.58	76075.14	26.6	24.5	39.3
Avg + 2 Std. Deviations	135.0	132.9	72421.13	90444.47	29.0	26.6	42.6
Maximum	128.0	126.5	68912.13	86043.68	28.3	26.0	41.6

Damage Centroid Depth (x) (inches) 7.09 k^2 3037.10

Damage Centroid Depth (y) (inches) 175.49 Eff. Mass Ratio (gamma) 1.00

Area of Damage (inches²): 1002.50

4N6XPRT StifCalcs® licensed by 4N6XPRT Systems (www.4N6XPRT.com) to:

Registered Owner: 4N6XPRT SYSTEMS Serial Number: 11R-030201SC02301

4N6XPRT StifCalcs® Force Balance - Page 2 of 2

2005 FORD EXPEDITION - Front Impact

Curb Weight (pounds):	5342
Occupant + Cargo Weight (pounds):	0
Total Weight (pounds):	5342
Angle Coll Force to Normal (degrees):	0.0
No Damage Speed (mph):	5.0
Energy Crush Depth (inches):	3.00
Damage Length (inches):	50.0
Crush Profile Measurements:	2

PDOF

Lever Arm Distance (inches):	0.00
Yaw Moment of Inertia (lb-ft-sec²):	4296.26

	Crush	Unequal Spacing (inches)	Zone Area (inches²)	Zone Depth(x) (inches)	Area Depth(x) (inches²)	Zone Depth(y) (inches)	Area Depth(y) (inches²)
C1 (inches)	5.00						
		50.00	150.00	1.72	258.33	19.44	2916.67
C2 (inches)	1.00						
C3 (inches)							
C4 (inches)							
C5 (inches)							
C6 (inches)							
C7 (inches)							
C8 (inches)							
C9 (inches)							
C10 (inches)							

Average Crush (inches): 3.00

Results

	A	B	Average Force (pounds)	Damage Energy (ft*lbs)	KE Speed (mph)	Delta V (mph)	B Sub
Minimum	682.7	217.4	33372.60	17679.19	10.0	11.2	28.0
Avg - 2 Std. Deviations	578.0	155.9	26142.93	15047.07	9.2	10.1	23.7
Avg - 1 Std. Deviations	740.7	255.9	37712.48	19233.78	10.4	11.8	30.4
Average	882.1	363.0	49282.03	23307.85	11.4	13.4	36.2
Avg + 1 Std. Deviations	1009.0	475.0	60851.58	27304.35	12.4	14.8	41.4
Avg + 2 Std. Deviations	1125.1	590.6	72421.13	31243.22	13.2	16.0	46.2
Maximum	1090.9	555.2	68912.13	30053.81	13.0	15.6	44.8

Damage Centroid Depth (x) (inches) 1.72 k^2 3729.11

Damage Centroid Depth (y) (inches) 19.44 Eff. Mass Ratio (gamma) 1.00

Area of Damage (inches²): 150.00

4N6XPRT StifCalcs® licensed by 4N6XPRT Systems (www.4N6XPRT.com) to:

Registered Owner: 4N6XPRT SYSTEMS Serial Number: 11R-030201SC02301

Close examination of these two reports shows that, because the CLASS vehicle was "tighter", we have a narrower Closing Speed range with the CLASS vehicle (26.8-42.6 mph) vs the Sister/Clone vehicle (19.3-47.6 mph). Yet the Closing Speed based on the AVERAGE A-B values are very close

(Class = 35.6 mph vs. Sister/Clone = 36.4 mph)

You can, and will, achieve this agreement in data with practice. Further, the confidence and experience you will gain with the Force Balance Module, and input of the A-B values into your CRASH 3 program, will allow you to testify with confidence when you have to rely solely upon a CLASS vehicle for stiffness data.

ESSENTIAL FORMULAS:

CRASH 3 Stiffness Value Calculations:

1 mph	= 17.6 inch/sec
gravity = g	= acceleration due to gravity
g = 32.3 feet/sec^2	= 386.4 inch/sec^2
KEES	= Kinetic Energy Equivalent Speed (mph)
Δv_{test}	= Speed(mph) * 17.6 = inch/second
Crush = C	= crush depth used for calculations, in 4N6XPRT StifCalcs® the Crush depth used could be the minimum, average, or maximum depth = inches
$Crush_{avg} = C_{avg}$	= calculated average crush = inches
Weight = W	= vehicle weight = pounds
b_0	= "No Damage Speed" - For FRONT and REAR Tests initial assumption is 5 mph = 88 inch/second, for SIDE Tests initial assumption is 2 mph = 35.2 inch/sec.
L	= damage length (inch)

The KEES speed is calculated with the following formula:

$$KEES = ([W_{Barrier} * SPEED^2_{Closing}] / [W_{Barrier} + W_{Vehicle}])^{0.5}$$

b_1 = slope = inches / [inch*sec]

Note - depending upon the author the unit notation could also appear as [inch/second]/inch or 1/second.

$$b_1 = (\Delta v_{test} - b_0) / Crush$$

<u>"A" coefficient = pound/inch</u>

A = Maximum force per inch of damage without permanent damage

$$A = (W * b_0 * b_1) / (g * L_{test})$$

"B" coefficient = pound/inch^2

B = Crush resistance per inch of damage width

$B = (W * b_1 * b_1) / (g * L_{test})$

"G" coefficient = pound

G = Energy dissipated without permanent damage

$G = (A * A) / (2 * B)$

SMAC Stiffness Value Calculation:

"Kv" coefficient = pound/inch^2

Kv = The linear spring constant for the increasing/decreasing loads of a collision

$Kv = (W * b_1 * b_1) / (g * L_{test})$

Test Specific Crush Factor (CF) Stiffness Value Calculation:

"CF" = unitless

CF = Crush Factor = Resistance to crush

$CF = \Delta v_{test(mph)} * \Delta v_{test(mph)} / (30 * Crush/12)$

Force Balance Calculations:

To perform an accurate Force Balance crush analysis, four things are needed: 1) "good" stiffness coefficients for one of the vehicles, Crush profile measurements from which the 2) area of damage and 3) depth of the damage centroid from the damage face can be calculated, and 4) the angle the collision force makes with respect to the damage face.

Additionally, to calculate Closing Speed and Delta-V's, a PDOF Lever Arm distance for each vehicle is needed.

Variables to be used in the formula notation are:

E	=	total damage energy (inch-pound)
A	=	stiffness coefficient (pound/inch)
B	=	stiffness coefficient (pound/inch^2)
G	=	stiffness coefficient (pound)
$\bar{x}$	=	depth of the damage centroid from the undamaged surface
A_D	=	area of damage (inch^2)
L	=	damage length (inch)
F	=	collision force (pounds)
F_x	=	collision force normal (perpendicular) to the undamaged surface (pounds)
α	=	angle the collision force makes with a line normal (perpendicular) to the collision surface face (degrees)
$(1 + \tan^2\alpha)$	=	magnification factor to adjust for a collision force that is not normal to the undamaged surface (unitless)
F_{avg}	=	average collision force (pounds)
C_{avg}	=	average crush depth (inches)
F_1	=	average collision force for Vehicle 1 (pounds) - *This is the vehicle with the "best" set of A-B Stiffness values. It may be EITHER the bullet or the target vehicle*
$C_{2\,avg}$	=	average crush depth for Vehicle 2 (inches)
A_2	=	stiffness coefficient for Vehicle 2 (pound/inch)- *This is to be solved for by balancing against the calculated average collision Force exerted on Vehicle 1*
B_2	=	stiffness coefficient for Vehicle 2 (pound/inch^2)- *This is to be solved for by balancing against the calculated average collision Force exerted on Vehicle 1*
L_2	=	damage length for Vehicle 2 (inch)
α_2	=	angle the collision force makes with a line normal (perpendicular) to the collision surface face for Vehicle 2 (degrees)
I_z	=	Yaw Moment of Inertia (pound-foot-second^2)
k	=	Radius of Gyration (feet)
h	=	PDOF Lever Arm Distance (inches)
γ	=	Effective mass ratio - Gamma (unitless)
Delta V	=	The change in velocity experienced by the vehicle in a Linear Direction based purely upon the damage sustained (mph)

Closing Speed = The speed at which the two "damage surfaces" approached each other just before impact in a Linear Direction based purely upon the damage sustained (mph)

The general equation for calculating damage energy is:

$$E = [\ (A + B\bar{x})*A_D + (A^2*L)/(2*B)\ ] * (1 + \tan^2\alpha)$$

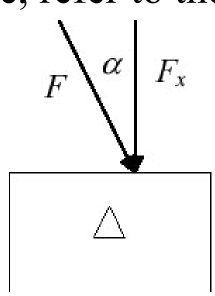
One of the foundations of the Force Balance model is that collision forces adhere to Newton's Third Law which states: *For every force exerted on a body by another body, there is an equal but opposite force reacting on the first body by the second.* The **average** collision force can be calculated by:

$$F_{avg} = [\ (A + B*C_{avg}) * L\ ] / 2$$

where C_{avg} can be calculated by:

$$C_{avg} = A_D / L$$

Crush measurements and energy calculations are based on a normal collision force. When the collision force is not normal to the original undamaged surface, the angle between the collision force and the normal (perpendicular) component needs to be determined. To visualize this angle, refer to the diagram below.



The angle acts as a "magnification" factor on the calculated force, and is accounted for in the $(1 + \tan^2\alpha)$ portion of the damage energy calculation. The good thing about this angle is that use of a 0 degree angle (as in, no angle) results in the most conservative energy values and thus conservative resulting speeds.

$$F = F_x / \cos\alpha$$

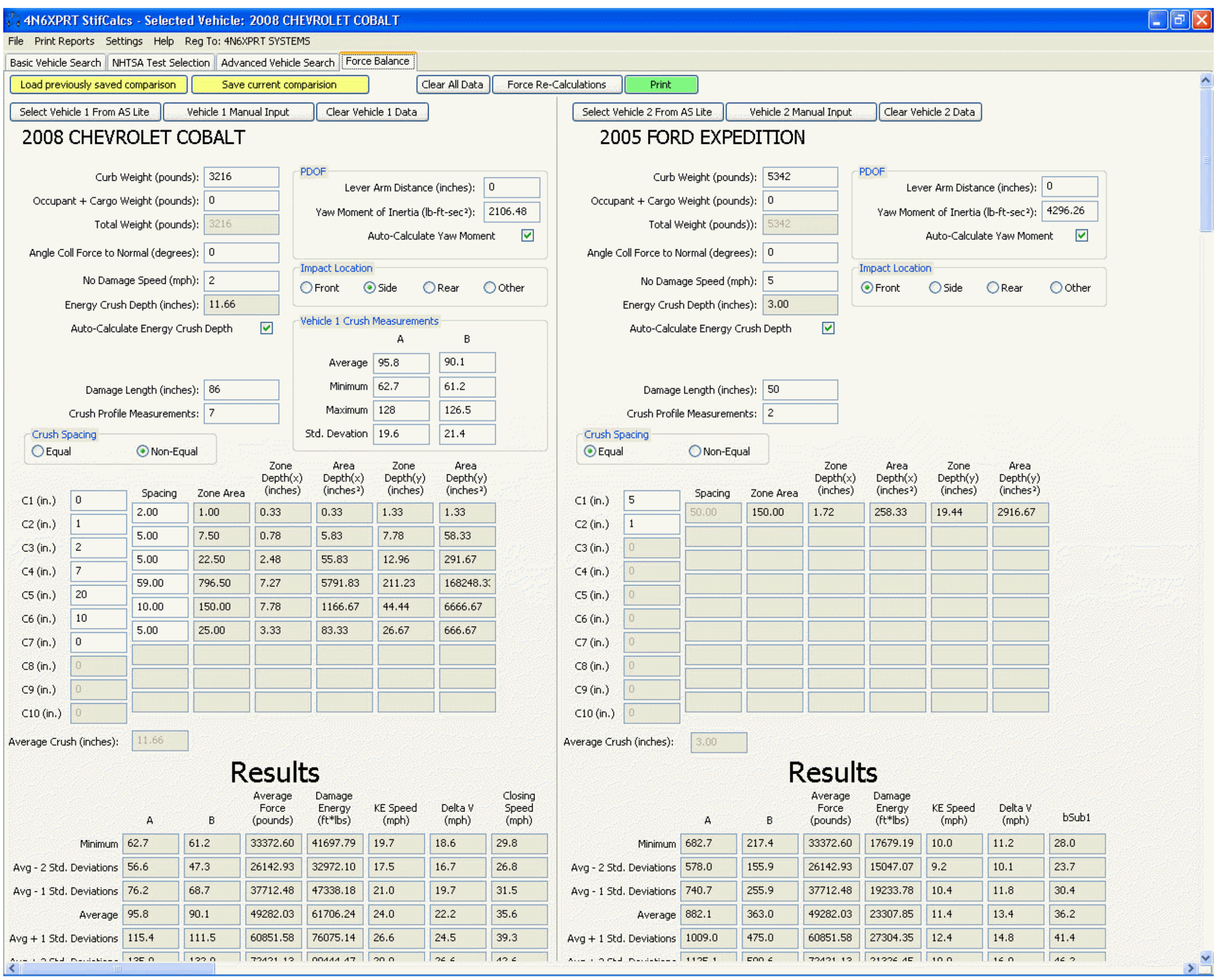
In terms of our A-B Stiffness values, the Force can be calculated as:

$$F = [\,(A + B^*C_{avg}) * L] / (2^*\cos\alpha)$$

The b_0 value for Vehicle 2 is assumed. The Force on Vehicle 1 has been calculated, and because of Newton's Third Law, is known to be the Force acting on Vehicle 2 as well. The weight, average crush, and Force angle α for vehicle 2 are all known. Calculation of the b_1 is all that remains to be done in order for the A and B stiffness values for Vehicle 2 to be calculated.

$$b_1 = -1^*(W_2{}^*b_0) \pm [\,(W_2{}^*b_0)^2 - 4^*(W_2{}^*C_{2avg})^*(-2^*g^*F_1{}^*\cos\alpha)\,]^{0.5} \,/\, [\,2^*(W_2{}^*C_{2avg})\,]$$

Once b_1 for Vehicle 2 has been determined, the appropriate values are plugged in to the formulas displayed in the CRASH 3 section above to calculate the A-B-G stiffness values.



Zone Area = Each **Zone Area** segment is calculated as

$$[\,(C_n + C_{n+1}) / 2\,] * \text{Spacing}$$

Zone Depth(x) = Each **Zone Depth(x)** segment is calculated as

$$[(C_n)^2 + (C_n * C_{n+1}) + (C_{n+1})^2\,] / [3 * (C_n + C_{n+1})]$$

Area Depth(x) = Each **Area Depth(x)** segment is calculated as

Zone Area * Zone Depth(x)

Zone# = The number of the zone segment - i.e. - the segment between C_1 and C_2 would be 1, between C_7 and C_8 would be 7.

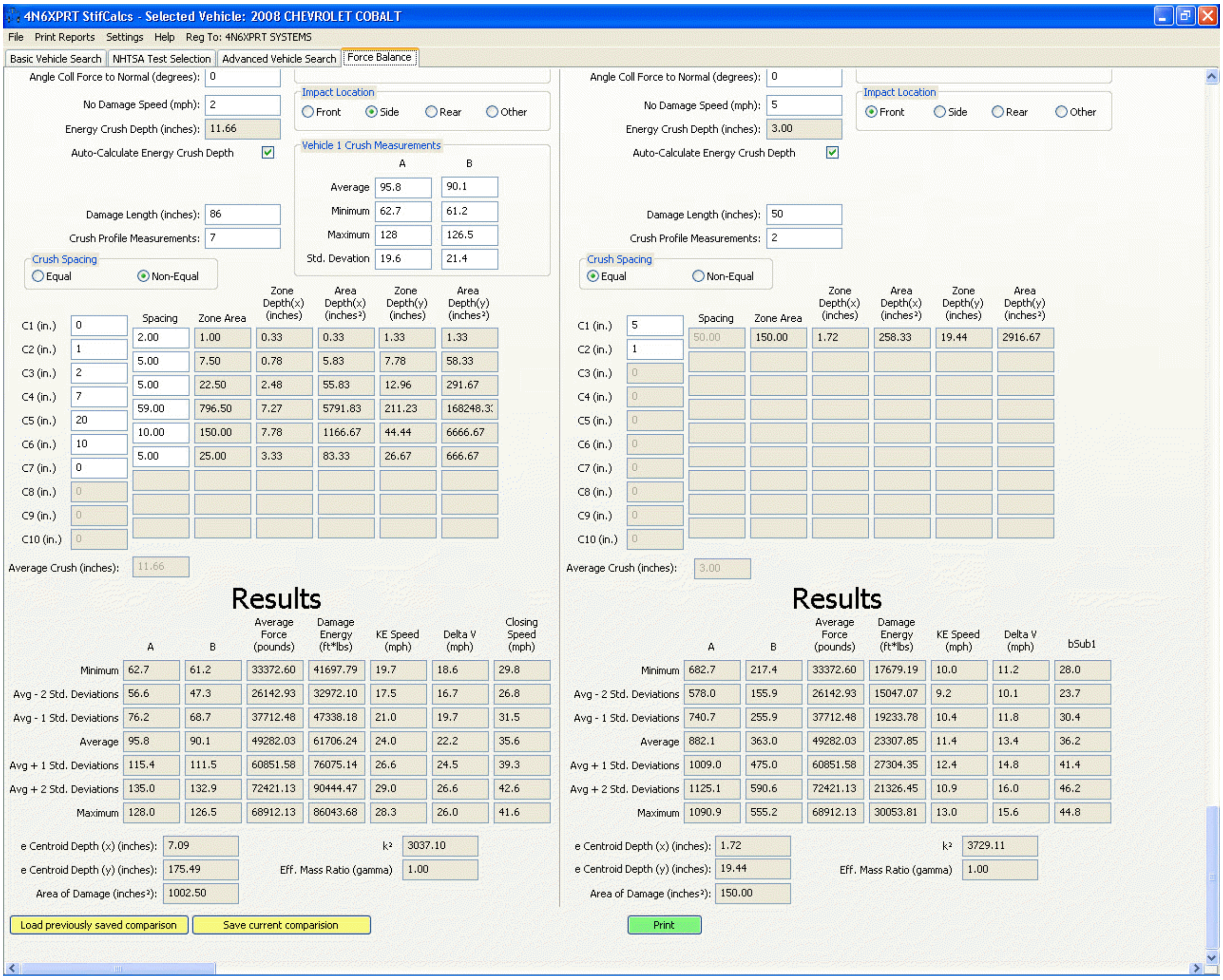
Zone Depth(y) = Each **Zone Depth(y)** segment is calculated as

$$\text{Spacing} * [(-1)*(C_{n+1}) + (-2)*(C_n) + 3*\text{Zone\#}*C_n + 3*\text{Zone\#}*(C_{n+1})\,] / [3 * (C_n + C_{n+1})]$$

Area Depth(y) = Each **Area Depth(y)** segment is calculated as

Zone Area * Zone Depth(x)

Average $\text{Crush}_{\text{Trapezoidal}}$ = C_{avg} = $\sum$[Zone Area] / L



For Each KNOWN A-B pair, the Following is calculated:

$$\text{Average Force}_1 = F = [\,(A + B*C_{avg}) * L] / (2*\cos\alpha)$$

$$E_1 = [\,(A_1 + B_1\,\bar{x}_1)*A_{D1} + (A_1{}^2*L_1)/(2*B_1)\,] * (1 + \tan^2\alpha_1)$$

$$\text{KE Speed}_1 = [(30 * E_1) / w_1\,]^{0.5}$$

$$k_1{}^2 = [\,(\,[I_{z1} / (W_1 / g)]^{0.5})*12\,]^2$$

$$\gamma_1 = k_1{}^2 / (k_1{}^2 + h_1{}^2)$$

$$\text{Average Force}_2 = \text{Average Force}_1$$

$$\text{Vehicle 2 } b_1 =$$

$$-1*(W_2*b_0) \pm [\,(W_2*b_0)^2 - 4*(W_2*C_{2avg})*(-2*g*F_1*\cos\alpha)\,]^{0.5} \,/\, [\,2*(W_2*C_{2avg})\,]$$

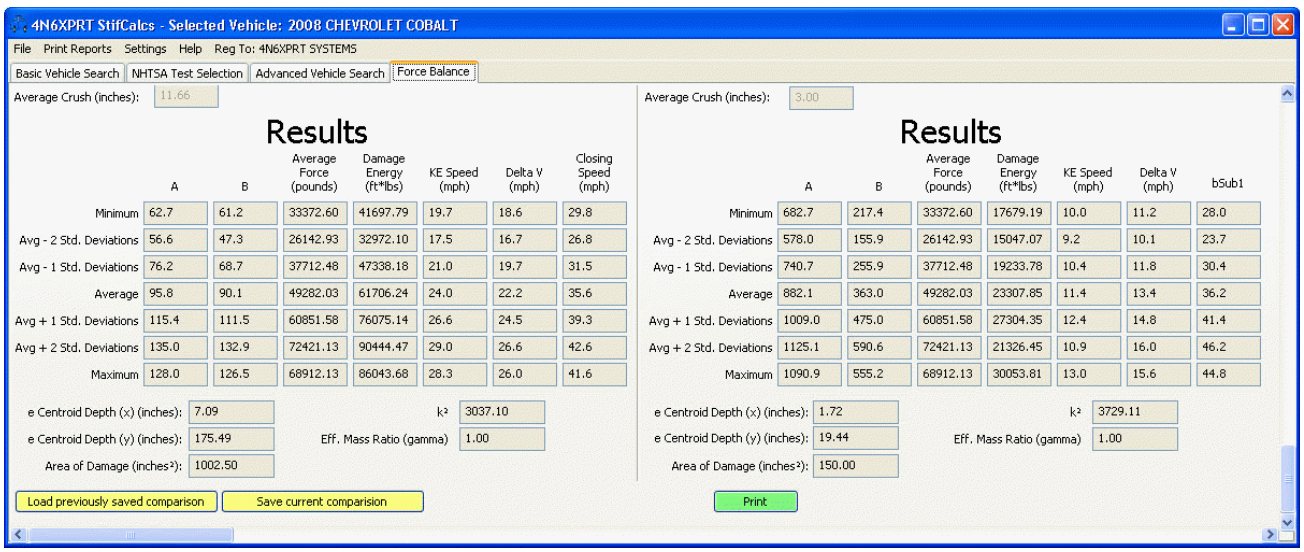
$$A_2 = (\,W_2 * b_0 * b_1\,) / (\,g * L_{2\,test}\,)$$

$$B_2 = (\,W_2 * b_1 * b_1\,) / (\,g * L_{2\,test}\,)$$

$$G_2 = (A_2 * A_2) / (2 * B_2)$$
$$E_2 = [(A_2 + B_2 \bar{x}_2)*A_{D2} + (A_2^{\,2}*L_2)/(2*B_2)] * (1 + \tan^2\alpha_2)$$
$$\text{KE Speed}_2 = [(30 * E_2) / w_2]^{0.5}$$
$$k_2^{\,2} = [([I_{z2} / (w_2 / g)]^{0.5})*12]^2$$
$$\gamma_2 = k_2^2 / (k_2^2 + h_2^2)$$

If a PDOF Lever Arm distance and Angle between the Collision Force and Normal Force have been entered, the following speeds can be calculated:

$$\text{Delta } V_1 = [2*\gamma_1*(E_1 + E_2) / ((W_1/g)*(1+((\gamma_1*W_1/g) / (\gamma_2*W_2/g))))]^{0.5} * 3600/5280$$
$$\text{Delta } V_2 = [\text{Delta } V_1 * (W_1/g) / (W_2/g)]$$
$$\text{Closing Speed} = [(\text{Delta } V_1 * (5280/3600) / \gamma_1) + (\text{Delta } V_2 * (5280/3600) / \gamma_2)] * 3600/5280$$



$$\text{Damage Centroid depth}(x) = \bar{x} = \sum[\text{Area Depth}(x)] / \sum[\text{Zone Area}]$$
$$\text{Damage Centroid depth}(y) = \bar{y} = \sum[\text{Area Depth}(y)] / \sum[\text{Zone Area}]$$
$$\text{Area of Damage} = L * C_{avg}$$

Selected References:

For the formulas used to calculate the Yaw Moment of Inertia, we refer you to SAE # 881767, "**Vehicle Inertial parameters - measured values and approximations**" by W.R. Garrott, M. W. Monk, and J. P. Chrstos

For more information on the Force Balance process, we refer you to: "**Balancing Collision Forces in Crush / Energy Analysis**" by Nathan Shigemura and Andrew Rich available from the IPTM Webstore http://www.iptm.org/webstore/ under Crash Investigation Publications.

Several SAE papers discuss the Force Balance method, among them - **970942** / **1999-01-0079** / **2005-01-1188** and **2005-01-1205**.

For more information on Crush Energy calculations, as well as Accident Investigation and Reconstruction calculations in general, we refer you to: **Fundamentals of Traffic Crash Reconstruction Volume 2 of the Traffic Crash Reconstruction Series** by John Daily, Nathan Shigemura, and Jeremy Daily available from the IPTM Webstore http://www.iptm.org/webstore/ under Crash Investigation Publications.