Equal Spacing NOT Required for Speed from Crush Calculations

or

Equally Spaced Crush measurements - take them in the field or in the office which is the better location?

The background paper for the Poster Presentation given at WREX2016

by

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Equal Spacing NOT Required for Speed from Crush Calculations

(Equally spaced Crush measurements - in the field or in the office - which is the better location?)

In the Field which is easier ...

Measure to "critical points".... or ... Measure "Equally Spaced" crush points?





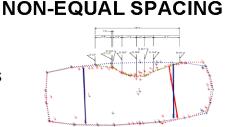




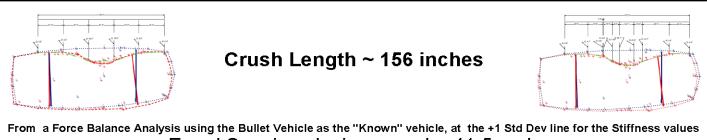
Given the above damage and final rest alignment, measurements of damage were made using photogrammetry. Using Force Balance, some Speed Calculations were made to compare the results of equal vs. non-equal spacing measurements.

EQUAL SPACING

Crush Length ~100 inches



From a Force Balance Analysis using the Bullet Vehicle as the "Known" vehicle, at the +1 Std Dev line for the Stiffness values Equal Spacing closing speed = 39.9 mph NON-Equal Spacing Closing speed = 39.3 mph



Equal Spacing closing speed = 41.5 mph NON-Equal Spacing Closing speed = 36.7 mph

In the field, which length do you choose? Why? Do you want to lose crush profile detail by taking only equal space measurements in the field, just because your software does not allow for non-equal spacing? Isn't it easier to simply measure to the "critical points" then use those same points for your crush measurement? If your software does not allow non-equal spacing, where should you do the equal spacing measurements ...

In the field or in the office?

Download the background paper at - www.4n6xprt.com/WREX2016-4N6XPRT-poster.pdf

OVERVIEW

There is a mode of thought that crush measurements must be taken at equally spaced points along a field indentation crush length. This thought process stems in large part from what is commonly referred to as "The Tumbas Protocol" - "Measuring Protocol for Quantifying Vehicle Damage from an Energy Point of View" Tumbas and Smith (SAE 880072) - which lays out a process for taking crush measurements. Another contributor to this thought process is that the commonly presented crush formulas for calculating A-B-G Stiffness values and Speed from Crush REQUIRE that the crush measurements be equally spaced. If these formulas are used when the crush measurements are not equally spaced, some of the simplifications in the formulas which are allowed with equally spaced measurements will create errors when the measurements ARE NOT equally spaced.

So, the first series of questions is, just because some formula's require equally spaced crush measurements, is it a good idea, or even required, to take the equally spaced measurements in the field? Or is the equal spaced measurement process better completed in the office? Why? When you are in the field, would it not be better to take crush measurements at the "critical"/bend/inflection points, which will almost certainly be non-equally spaced? Why? What are the positives, and negatives, of taking measurements at the critical points (non-equally spaced) vs. equally spaced measurements when you are in the field?

The second series of questions is the focus of the poster: are equally spaced crush measurements REQUIRED in order to complete speed from crush calculations? Why? Which yield the more accurate results, equally or non-equally spaced measurements? Why?

The following data and analysis will attempt to answer these, as well as a number of other questions.

DATA SOURCE FOR ANALYSIS

The data presented in the Poster Session and this background paper are a result of the second Crash Test conducted at the Institute of Police Technology and Management's Special Problems in Traffic Crash Reconstruction, May 20-24, 2013. This test had a 2006 Chevrolet Impala impacting a 1995 Cadillac Eldorado on the driver's side between the front axle and the 'B' pillar. Both vehicles were moving at the moment of impact.

Both pre-crash and post-crash photographs were taken of the vehicles and analyzed with iWitness photogrammetry software to provide before and after profiles of the two vehicles. An overlay of the pre-crash and post-crash profiles was completed in CAD Zone software, after which crush measurements and alignment measurements were taken.

Field measurements were taken of the crush to both vehicles after the crash test was completed and the vehicles were moved to the storage area. These measurements are provided in Appendix 1 for completeness and comparison purposes to the crush measurements obtained from photogrammetry. No analysis of these measurements was conducted for the poster or this paper.

The excerpted pertinent pages from the Crash Test Summary presentation (Appendix 2) indicate the speed of the Eldorado at impact was 19-21 mph and the speed of the Impala at impact was 40-45 mph. The post impact speed of the Eldorado was 22-23 mph with a crash impulse time of 150 milliseconds. The post impact speed of the Impala was 22-29 mph with a crash impulse time of 150 milliseconds.

The Impala X-vector delta-v was 22-23 mph and the Y-vector delta-v was 9-10 mph.

CRASHED VEHICLES

A quick look at the vehicles shows the potential for several measurement issues.

2006 Chevrolet Impala



What is your Field "L"? Where do you measure to on the vehicle to get your crush measurements? Bumper cover? Bumper support bar? Hood? If hood, where on the hood? How do you account for the missing material between the bumper support bar and the face of the bumper cover? Is the "twist" that seems to be present on the right front fender important, or just part of the normal fender shape? If you use an equal measurement process, what are you going to lose in the way of crush profile detail?

1995 Cadillac Eldorado





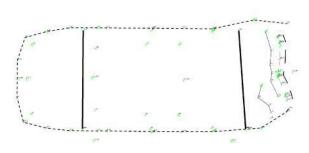
What is your Field "L"? Where does it Start? Stop? It looks like there may be hinge separation at the "A" pillar - do you average the door sill measurements with the maximum crush measurements? Do you average in the field, or do you measure at the sill line and maximum (~bumper level) crush line and record both depths? There appears to be a twist (or bowing) starting at the firewall, is this significant? Do you apply/use a bowing constant? If you use an equal measurement process, what are you going to lose in the way of crush profile detail?

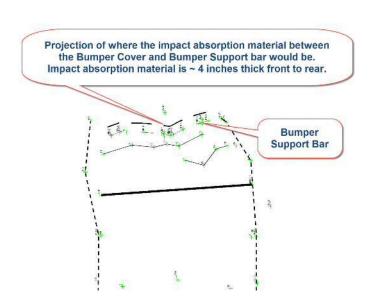
Finally, back to the REAL question, should you worry about the above questions in the field, or back in the office?

Through the use of photographs, which were then processed through Photogrammetry, what was deemed to be the "critical" crush features were documented in the field. The Photogrammetry data was then imported into CAD Zone, resulting in the following crush profiles

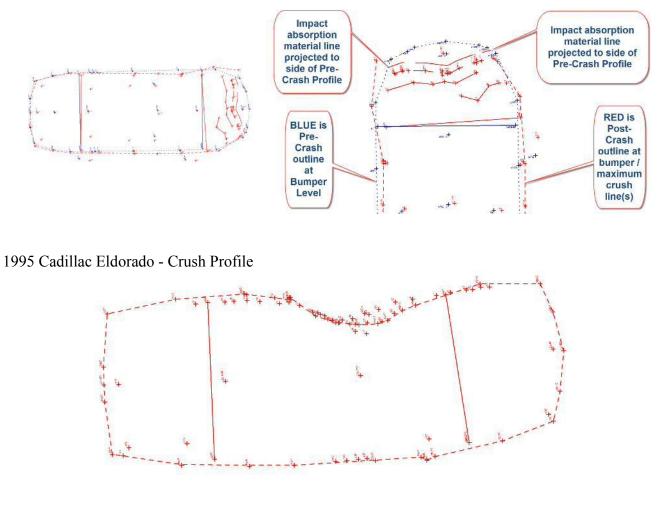
CRUSH PROFILES

2006 Chevrolet Impala - Crush Profile

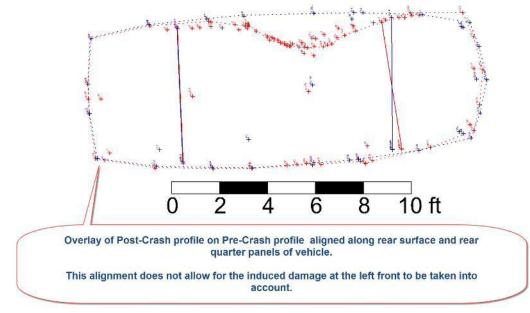


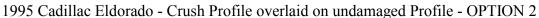


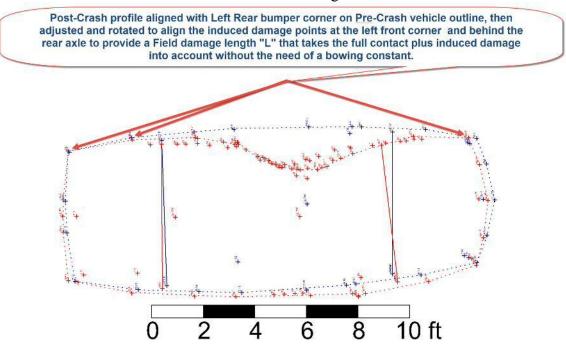
2006 Chevrolet Impala - Crush Profile overlaid on undamaged Profile



1995 Cadillac Eldorado - Crush Profile overlaid on undamaged Profile - OPTION 1







CRUSH PROFILES - DISCUSSION

Some of the answers are, perhaps, beginning to take shape at this point.

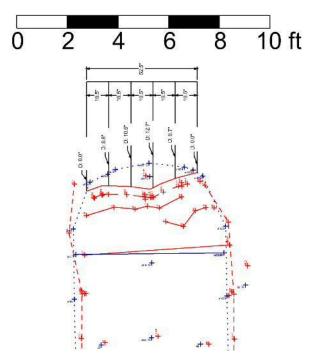
For the Chevrolet Impala (Bullet Vehicle), the most probable points we want to measure to are the bumper support bar, and then subtract out the depth of the energy absorption material. Our studies at various crash tests have found this material varies in depth/thickness between two - six inches, with the most common depth being three - four inches. For the purposes of the measurements for this test, a four-inch depth will be used. Additionally, the line formed by the projected four-inch measurement in front of the bumper support bar will be extended to the undamaged vehicle profile in our determination of the "Field L" Indentation Length for the Bullet Vehicle.

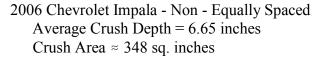
For the Cadillac Eldorado (Target Vehicle), it can be seen that (at least) two possible "Field L" Indentation Lengths could be chosen. We will explore the results of both of those possible lengths in this study.

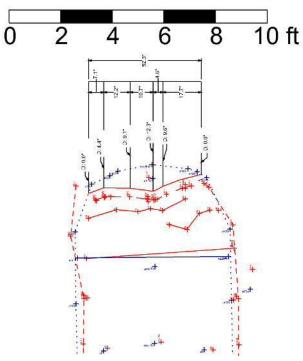
So, the next step is to determine what our Crush measurements are, both for an equally spaced profile as well as for a non-equally spaced profile, and what kind of a "measured" profile each spacing provides.

CRUSH MEASUREMENTS

2006 Chevrolet Impala - Equally Spaced Average Crush Depth = 7.36 inches Crush Area ≈ 386 sq. inches

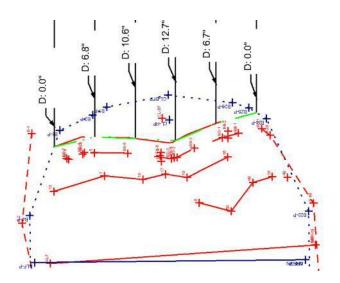




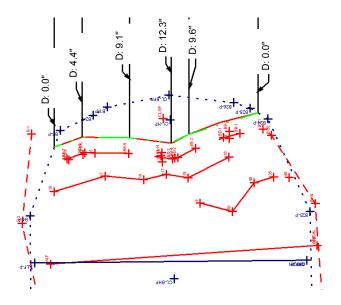


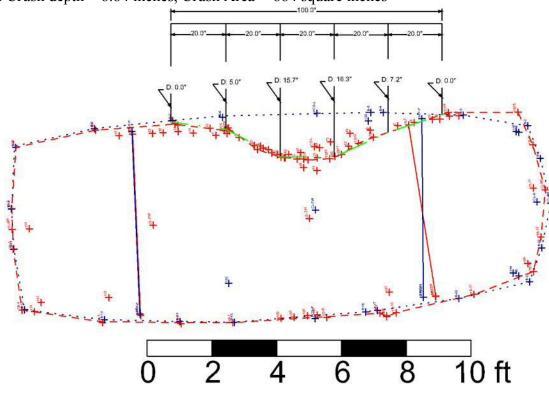
The corresponding MEASURED profiles represented by the GREEN line, can be seen and compared to the "actual" profile below.

2006 Chevrolet Impala - Equally Spaced



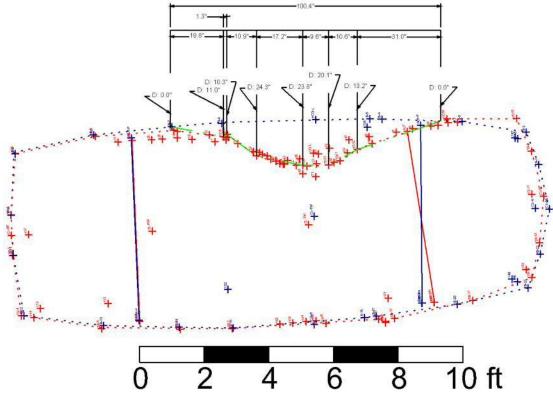
2006 Chevrolet Impala - Non - Equally Spaced



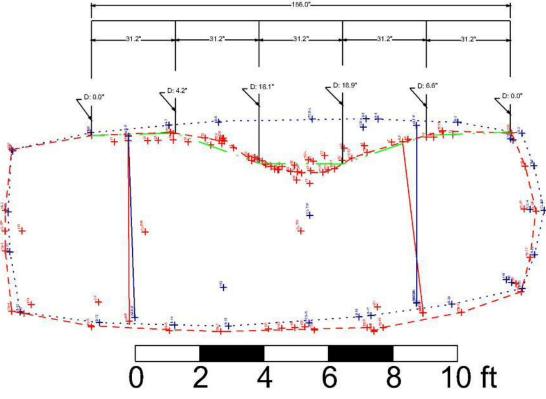


1995 Cadillac Eldorado - Option 1 - Equally Spaced Average Crush depth = 8.84 inches, Crush Area \approx 884 square inches

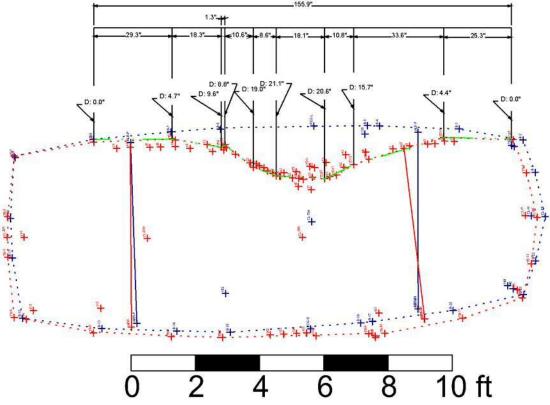
1995 Cadillac Eldorado - Option 1 - NON-Equally Spaced Average Crush depth = 13.12 inches, Crush Area \approx 1317 square inches



1995 Cadillac Eldorado - Option 2 - Equally Spaced Average Crush depth = 9.56 inches, Crush Area \approx 1491 square inches

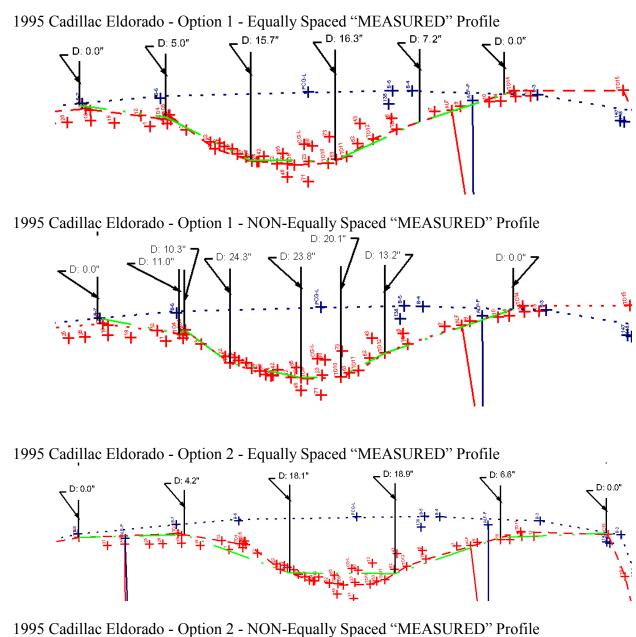


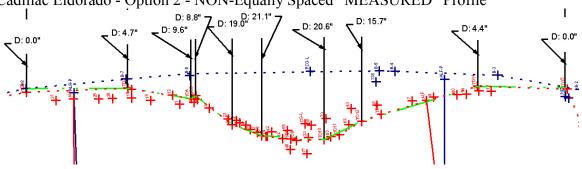
1995 Cadillac Eldorado - Option 2 - NON-Equally Spaced Average Crush depth = 9.61 inches, Crush Area \approx 1498 square inches



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As we did with the Chevrolet Impala, the corresponding MEASURED profiles for the Cadillac Eldorado represented by the GREEN line in each case, can be seen and compared to the "actual" profile below.





"MEASURED" PROFILE DISCUSSION

It is no surprise that the Non-Equally spaced profile measurements overlay the depicted crush profiles for both vehicles and for both options on the crush length for the Target Vehicle, since the points that are measured are the same points that were picked off from the photographs to create the profile.

One can see some deviation of "Measured" vs. "Actual" profile in the Equally spaced measurements for the Bullet vehicle between measurement points 1 & 2 and between 3 & 4, measuring from the Left (Driver) side toward the Right (Passenger) side. The Non-Equal space measured profile has slightly less crush area (volume) than does the Equal spaced measured profile. This equates to slightly less calculated force for the Bullet vehicle for a given set of A-B stiffness values.

For the Target Vehicle Option 1 it can be seen that the Equally spaced measurements shave off a bit of the crush volume between measurements 1 & 2, 2 & 3, and 3 & 4, with the measurements progressing from the rear toward the front. A reduction in crush volume will lead to a lower calculated speed from the crush to the Target Vehicle. While minor, this reduction of volume is consistent and cumulative.

When we examine the Target Vehicle Option 2 Equally spaced measurements, you can see some rather large discrepancies between the profile depicted from the Equally spaced measurements and the "actual" profile between the 1 & 2, 2 & 3, 4 & 5, and 5 & 6 measurement segments. The effect this has on the speed calculations will be discussed later. In addition to affecting the calculated speed results, profile detail is lost if one only looks at the Equally spaced profile.

FORCE BALANCE SPEED CALCULATIONS

The method we have chosen to test the measurement methods of Equally spaced vs. NON-Equally spaced crush measurements is through the application of a Force balance calculation, and then compare the results to the instrumented results.

The specific Force Balance calculation tool which will be used is the one contained with 4N6XPRT StifCalcs® which is based in part upon the work by Shigemura and Rich contained in the publication "Balancing Collision Forces in Crush/Energy Analysis" available from the IPTM bookstore. Another reason for using this specific tool is that it allows the user to look at the Force Balance results based on the stiffness values from all of the applicable NHTSA Crash Tests for the vehicle you have "the most confidence in."

The term/phrase "most confidence in" is based on a number of factors, including but not limited to, the NUMBER of available NHTSA tests, the quality of the results of those tests, and the quality of the measurements available from the crash being investigated. In this case, the quality of the measurements from the crash being investigated is good, but if you had good measurements for one of the vehicles, but few measurements of questionable quality for the other, the vehicle with good crush measurements is more likely to be the vehicle you have the most confidence in. In the same way, if one of the vehicles has only one or two tests, while the other vehicle has 7-10+ tests, the vehicle with more tests is a candidate for "most confidence in." Which vehicle to use as the "known" or "most confidence in" vehicle is just one more judgement call that the traffic accident investigator needs to make.

In this instance, the Impala is being used as the "Known" vehicle for the calculations because it is a

frontal collision and so has, as a general rule better data quality from the NHTSA Tests, and because there is less to question about the crush to the vehicle in this crash.

Within the NHTSA Crash Test data, there are several factors which must be decided upon as they affect the Stiffness values which are calculated for the "Known" vehicle. The variables which affect the calculations in a frontal test are - No Damage Speed, Crush Depth - Average or Maximum, and Crush Length - Indentation Length vs. Vehicle Width. In order to limit the variables for this discussion, we will be using a 5 mph No Damage speed, the reported Average Crush Depth calculated as a Trapezoidal Average, and the reported Vehicle Width for the Crush Length to be used in the calculations. The Appendices will, however, include the Force Balance results based on reported Maximum Crush from the tests for the "known" vehicle as well.

Within the NHTSA Crash Tests database, there are seven available tests for vehicles with a model year of 2006-2013 of same/similar body type to the 2006 Chevrolet Impala based on manufacturer, model, and year range of minimal changes to the body. The individual test stiffness values and statistical measurement of these tests calculated within the 4N6XPRT StifCalcs program are represented as:

Test Numbe	Vehicle r Info	No Damage Speed (mph)	Average Crush (inch)			ehicle iffness B			Crush Factor
5578	2006 CHEVROLET MONTE CARLO TWO DOOR C	5.0	26.3	35.0	250.4	57.1	549.0	77.7	18.6
7488	2012 CHEVROLET IMPALA FOUR DOOR SEDAN	5.0	23.9	34.9	282.3	70.7	563.5	96.4	20.4
5468	2006 PONTIAC GRAND PRIX FOUR DOOR SEDAN	5.0	23.5	35.1	283.3	72.5	553.6	98.6	20.9
5547	2006 CHEVROLET IMPALA FOUR DOOR SEDAN	5.0	23.8	35.2	286.3	72.4	565.9	98.5	20.7
5274	2005 BUICK LACROSSE FOUR DOOR SEDAN	5.0	23.4	35.1	287.8	74.2	558.3	100.9	21.1
6052	2007 CHEVROLET IMPALA FOUR DOOR SEDAN	5.0	12.4	24.7	382.5	121.6	601.5	191.1	19.7
7496	2012 CHEVROLET IMPALA FOUR DOOR SEDAN	5.0	6.5	20.0	494.8	229.5	533.3	407.7	24.8
		Average	AVG)		323.9	99.7	560.7	153.0	20.9
		Minimum	(MIN)		250.4	57.1	533.3	77.7	18.6
	Maximum (MAX)				494.8	229.5	601.5	407.7	24.8
	Standard Deviation (STDev-sample)				85.8	60.7	21.0	118.2	1.9
	Num	ber of Tes	sts (n)	7					

These values can then be imported into the Force Balance calculation module contained within the StifCalcs program for further analysis. The basic vehicle data for the "Known" vehicle looks like this -

2006 CHEVROLET IMPALA MSP POLICE PACKAGE - Front Impact									
Curb Weight (pounds): 3725 Occupant + Cargo Weight (pounds): 39 Total Weight (pounds): 3764	PDOF Lever Arm Distance (inches): 0.00 Yaw Moment of Inertia (lb-ft-sec ²) 2670.92								
Angle Coll Force to Normal (degrees): 0.0 No Damage Speed (mph): 5.0 Energy Crush Depth (inches): 7.36 Damage Length (inches): 52.5 Crush Profile Measurements: 6	Known" Stiffness Values A B Average 323.9 99.7 Minimum 250.4 57.1 Maximum 494.8 229.5 Std. Devation 85.8 60.7								

For the analysis, it was assumed that a user would either use equal crush measurement spacing for both

vehicles, or non-equal spacing for both, although one could mix-and-match if they were using their own, non-equally spaced measurements for one vehicle and someone else's equally spaced measurements for the other vehicle, or vice-versa.

The Force Balance was first analyzed with a lever arm of 0 inches for both vehicles and an Angle of the Collision Force off of Normal to the Collision Surface Face of 0 degrees. With these two variables at a value of "0", the calculated forces and speeds will be the minimum values for the given crush profiles. The results for each condition are as follows:

Target "L" = Option $1 \sim 100$ inches, Equal Crush Measurement Spacing, No Lever Arm or Angle off of Normal -

Desults			Average		KE		Closing
Results			Force	Damage	Speed	Delta V	Speed
	А	В	(poundsf)	Energy (ft*lbs)	(mph)	(mph)	(MPH)
Minimum	250.4	57.1	17604.72	18969.79	12.3	12.6	24.5
Avg - 2 Std. Deviations	152.3	-21.7	N/A	N/A	N/A	N/A	N/4
Avg - 1 Std. Deviations	238.1	39.0	13784.93	16655.57	11.5	11.5	22.4
Average	323.9	99.7	27764.42	27581.42	14.8	15.5	30.0
Avg + 1 Std. Deviations	409.7	160.4	41743.91	39372.58	17.7	18.7	36.2
Avg + 2 Std. Deviations	495.5	221.1	55723.40	51316.36	20.2	21.4	41.5
Maximum	494.8	229.5	57327.90	52449.46	20.4	21.6	42.1
Damage Centroid Depth (x)	(inches)	4.63			k²	3290.2	6
Damage Centroid Depth (y)	(inches)	25.99		Eff. Mass Ratio (gamma)	1.0	0
Area of Damage (in	ches ²):	386.40					

Target "L" = Option $1 \sim 100$ inches, Non-Equal Crush Measurement Spacing, No Lever Arm or Angle off of Normal -

Results			Average	11.92° m	KE		Closing
Results			Force	Damage	Speed	Delta V	Speed
	А	В	(poundsf)	Energy (ft*lbs)	(mph)	(mph)	(MPH)
Minimum	250.4	57.1	16477.51	16683.88	11.5	13.4	26.0
Avg - 2 Std. Deviations	152.3	-21.7	209.07	N/A	N/A	1.2	2.4
Avg - 1 Std. Deviations	238.1	39.0	13008.32	14872.59	10.9	12.2	23.8
Average	323.9	99.7	25807.57	23961.89	13.8	16.4	31.8
Avg + 1 Std. Deviations	409.7	160.4	38606.81	33913.19	16.4	19.7	38.4
Avg + 2 Std. Deviations	495.5	221.1	51406.06	44016.54	18.7	22.6	44.0
Maximum	494.8	229.5	52848.50	44935.85	18.9	22.9	44.5
Damage Centroid Depth (x)	(inches)	4.25			k²	3290.2	6
Damage Centroid Depth (y)	(inches)	23.94		Eff. Mass Ratio (gamma)	1.0	0
Area of Damage (ii	nches²):	347.79					

Target "L" = Option 2 \sim 156 inches, Equal Crush Measurement Spacing, No Lever Arm or Angle off of Normal -

P			Average		KE		Closing
Results			Force	Damage	Speed	Delta V	Speed
	А	В	(poundsf)	Energy (ft*lbs)	(mph)	(mph)	(MPH)
Minimum	250.4	57.1	17604.72	18969.79	12.3	13.0	25.4
Avg - 2 Std. Deviations	152.3	-21.7	N/A	N/A	N/A	N/A	N//
Avg - 1 Std. Deviations	238.1	39.0	13784.93	16655.57	11.5	11.9	23.
Average	323.9	99.7	27764.42	27581.42	14.8	16.0	31.
Avg + 1 Std. Deviations	409.7	160.4	41743.91	39372.58	17.7	19.3	37.
Avg + 2 Std. Deviations	495.5	221.1	55723.40	51316.36	20.2	22.2	43.
Maximum	494.8	229.5	57327.90	52449.46	20.4	22.5	43.0
Damage Centroid Depth (x) (inches)	4.63			k²	3290.2	5
Damage Centroid Depth (y) (inches)	25.99		Eff. Mass Ratio (gamma)	1.0	D
Area of Damage (in	ches ²):	386.40					

Target "L" = Option $2 \sim 156$ inches Non-Equal Crush Measurement Spacing, No Lever Arm or Angle off of Normal -

Desults			Average		KE		Closing
Results			Force	Damage	Speed	Delta V	Speed
	А	В	(poundsf)	Energy (ft*lbs)	(mph)	(mph)	(MPH)
Minimum	250.4	57.1	16477.51	16683.88	11.5	12.6	24.5
Avg - 2 Std. Deviations	152.3	-21.7	209.07	N/A	N/A	1.0	2.0
Avg - 1 Std. Deviations	238.1	39.0	13008.32	14872.59	10.9	11.5	22.4
Average	323.9	99.7	25807.57	23961.89	13.8	15.4	29.9
Avg + 1 Std. Deviations	409.7	160.4	38606.81	33913.19	16.4	18.5	36.0
Avg + 2 Std. Deviations	495.5	221.1	51406.06	44016.54	18.7	21.2	41.3
Maximum	494.8	229.5	52848.50	44935.85	18.9	21.5	41.8
Damage Centroid Depth (x)	(inches)	4.25			k²	3290.2	6
Damage Centroid Depth (y)	(inches)	23.94		Eff. Mass Ratio (gamma)	1.0	0
Area of Damage (inches²):	347.79					

In each case, these results are showing the instrumented closing speed is bracketed by the +1 and +2 Standard Deviation of the Stiffness Values for the Impala. It can also be seen that the AVERAGE stiffness values based on the seven available tests would indicate a closing speed of 29-32 mph. This is just the "first run" before trying to align the vehicles to obtain a Lever Arm and Collision Angle off of Perpendicular.

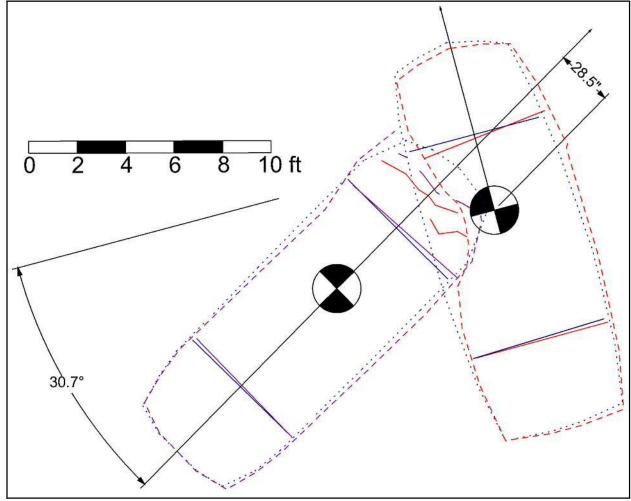
When we look at some of the Post Crash photographs of the vehicles at rest prior to being separated, we can see there is likely to be both a significant Lever Arm and an Angle component which will serve to increase the calculated speeds.





The post collision alignment finalized on for this study has a Lever Arm on the Target Vehicle of \sim 28.5 inches and a Collision Angle off of the Perpendicular of \sim 30 degrees.





Given this additional data, the Force Balance results are recalculated with the Lever Arm and Angle data input for the Target vehicle.

Target "L" = Option $1 \sim 100$ inches, Equal Crush Measurement Spacing, Lever Arm = 28.5 inches, Angle off of Normal = 30 degrees -

D lá .			Average		KE		Closing
Results			Force	Damage	Speed	Delta V	Speed
	А	В	(poundsf)	Energy (ft*lbs)	(mph)	(mph)	(MPH)
Minimum	250.4	57.1	17604.72	18969.79	12.3	12.4	27.0
Avg - 2 Std. Deviations	152.3	-21.7	N/A	N/A	N/A	N/A	N/A
Avg - 1 Std. Deviations	238.1	39.0	13784.93	16655.57	11.5	11.4	24.7
Average	323.9	99.7	27764.42	27581.42	14.8	15.2	33.1
Avg + 1 Std. Deviations	409.7	160.4	41743.91	39372.58	17.7	18.4	39.9
Avg + 2 Std. Deviations	495.5	221.1	55723.40	51316.36	20.2	21.1	45.8
Maximum	494.8	229.5	57327.90	52449.46	20.4	21.3	46.3
Damage Centroid Depth (x)	(inches)	4.63			k²	3290.20	;
Damage Centroid Depth (y)	(inches)	25.99		Eff. Mass Ratio (gamma)	1.00)
Area of Damage (ir	nches ²):	386.40					

Target "L" = Option $1 \sim 100$ inches, Non-Equal Crush Measurement Spacing, Lever Arm = 28.5 inches, Angle off of Normal = 30 degrees -

Results			Average		KE		Closing
Results			Force	Damage	Speed	Delta V	Speed
	А	В	(poundsf)	Energy (ft*lbs)	(mph)	(mph)	(MPH)
Minimum	250.4	57.1	25607.60	16683.88	11.5	12.2	26.5
Avg - 2 Std. Deviations	152.3	-21.7	N/A	N/A	N/A	N/A	N/#
Avg - 1 Std. Deviations	238.1	39.0	19244.29	14872.59	10.9	11.1	24.1
Average	323.9	99.7	41749.26	23961.89	13.8	15.0	32.5
Avg + 1 Std. Deviations	409.7	160.4	64254.23	33913.19	16.4	18.1	39.3
Avg + 2 Std. Deviations	495.5	221.1	86759.20	44016.54	18.7	20.7	45.0
Maximum	494.8	229.5	89544.77	44935.85	18.9	21.0	45.6
Damage Centroid Depth (x)	(inches)	4.25			k²	3290.2	6
Damage Centroid Depth (y)	(inches)	23.94		Eff. Mass Ratio (gamma)	1.0	0
Area of Damage (ir	nches²):	347.79					

Target "L" = Option $2 \sim 156$ inches, Equal Crush Measurement Spacing, Lever Arm = 28.5 inches, Angle off of Normal = 30 degrees -

Desults			Average		KE		Closing
Results			Force	Damage	Speed	Delta V	Speed
	А	В	(poundsf)	Energy (ft*lbs)	(mph)	(mph)	(MPH)
Minimum	250.4	57.1	17604.72	18969.79	12.3	12.9	28.0
Avg - 2 Std. Deviations	152.3	-21.7	N/A	N/A	N/A	N/A	N/A
Avg - 1 Std. Deviations	238.1	39.0	13784.93	16655.57	11.5	11.7	25.5
Average	323.9	99.7	27764.42	27581.42	14.8	15.8	34.3
Avg + 1 Std. Deviations	409.7	160.4	41743.91	39372.58	17.7	19.1	41.5
Avg + 2 Std. Deviations	495.5	221.1	55723.40	51316.36	20.2	21.9	47.6
Maximum	494.8	229.5	57327.90	52449.46	20.4	22.2	48.2
Damage Centroid Depth (x)	(inches)	4.63			k²	3290.2	6
Damage Centroid Depth (y)	(inches)	25.99		Eff. Mass Ratio (gamma)	1.0	0
Area of Damage (ir	nches²):	386.40					

Target "L" = Option $2 \sim 156$ inches, Non-Equal Crush Measurement Spacing, Lever Arm = 28.5 inches, Angle off of Normal = 30 degrees -

Desults			Average		KE		Closing
Results			Force	Damage	Speed	Delta V	Speed
	Α	В	(poundsf)	Energy (ft*lbs)	(mph)	(mph)	(MPH)
Minimum	250.4	57.1	25607.60	16683.88	11.5	11.5	24.9
Avg - 2 Std. Deviations	152.3	-21.7	N/A	N/A	N/A	N/A	N/A
Avg - 1 Std. Deviations	238.1	39.0	19244.29	14872.59	10.9	10.5	22.7
Average	323.9	99.7	41749.26	23961.89	13.8	14.0	30.4
Avg + 1 Std. Deviations	409.7	160.4	64254.23	33913.19	16.4	16.9	36.7
Avg + 2 Std. Deviations	495.5	221.1	86759.20	44016.54	18.7	19.4	42.0
Maximum	494.8	229.5	89544.77	44935.85	18.9	19.6	42.6
Damage Centroid Depth (x)	(inches)	4.25			k²	3290.20	5
Damage Centroid Depth (y)	(inches)	23.94		Eff. Mass Ratio (gamma)	1.00	D
Area of Damage (ir	nches²):	347.79					

When we review the Equally spaced measurement tables, it is seen that the Instrumented Closing Speed of ~ 40 mph is now between the calculated closing speed based on the AVERAGE and +1 Standard Deviation Stiffness Values for the Bullet (Chevrolet Impala) vehicle.

When the Non-Equally spaced measurement tables are reviewed, the Instrumented Closing Speed of \sim 40 mph is still between the calculated closing speed based on the +1 and +2 Standard Deviation Stiffness Values for the Bullet (Chevrolet Impala) vehicle.

This is primarily an effect due to the Non-Equally spaced measurements more closely approximating the actual crush profile for both vehicles.

The Force Balance "tool" uses the Force calculated for the "Known" (more confidence) vehicle and then applies that force (equal but opposite force) to the "Unknown" (less confidence) vehicle to calculate the matching stiffness value pair for the "Unknown" vehicle in that collision. The calculation of A-B stiffness pair values is in large part dependant upon force, average crush depth, and crush length. Likewise, the Force calculated from an A-B pair can to a large extent be evaluated by the Crush Area the stiffness values are applied to.

Since the Equally spaced measurements for the "Known" (Bullet) vehicle result in a somewhat larger area than do the Non-Equally spaced measurements, the Equally spaced measurements will calculate a somewhat greater force for the same A-B stiffness value pair.

For the damage to the Target Vehicle in Option 1, the Average depth for the Equally spaced measurements is 8.84 inches vs. 13.12 inches for the Non-Equally spaced measurements. Given the same force, the shorter average depth will result in higher (stiffer) stiffness values. In the case of this crash, not only is the average crush depth for the Target vehicle significantly greater, but the Force calculated from Non-Equal spacing profile for the Bullet vehicle is somewhat less than for the bullet vehicle Equal spacing profile.

Within the 4N6XPRT StifCalcs Force Balance module, the calculations, the stiffness pair calculated for the "Unknown" vehicle are then used to calculate a damage energy and speed for the "Unknown" vehicle damage. And in the end, a CLOSING speed between the two vehicles is calculated.

In the case of this crash, given that the force for the Bullet vehicle is lower in the Non-Equally spaced profile, together with the significantly larger average crush depth for the Target vehicle in its Non-Equally spaced profile, it is not surprising that the resulting calculated closing speed is lower for a given starting value of A-B values for the Bullet vehicle, even with the larger crush area calculated for the Non-Equal spacing profile.

In the case of Field "L" Option 2 for the Target vehicle, the same explanation holds true for the Bullet vehicle as was given for Option 1. In Option 2, the Equal spacing vs. Non-Equal spacing crush areas are essentially identical. However, the Non-Equal spacing profile has a slightly larger average crush depth, which will again result in lower A-B stiffness values. Lower stiffness values, combined with a lower starting Force from the Bullet vehicle, mean that again the Non-Equal spacing profiles will render, IN THIS CRASH, a lower closing speed. However, this will NOT always be the case.

SUMMARY

Lets review the previously asked questions and see if we now have the answers.

For the Chevrolet Impala -

- Q What is your Field "L"?
 - A The Field "L" chosen for our calculations is an extrapolation of where the Bumper Absorption material would likely intersect the pre-crash vehicle outline. Alternatively, a Field "L" which is the length of the bumper support bar could be chosen, but that would then leave some of the damage to the Impala unaccounted for in the calculations. However, measuring to the right (passenger side) bumper support bar end could be problematical without removing the bumper cover, which brings up the potential for a number of other considerations outside of the realm of this study.
- Q Where do you measure to on the vehicle to get your crush measurements? Bumper cover? Bumper support bar? Hood? If hood, where on hood?
 - A For the crash in this study, the measurements were taken to the bumper support bar. The bumper cover was not anywhere close to "in place" after the vehicles were separated from each other so that measurements could be taken, so that is not a good candidate for crush measurements. The hood damage "creases" were measured, but not used since it was felt the bumper support bar measurements gave a better representation of the damage, and was less prone to "why" questions. However, the damage on the hood likely could be used if need be to get a conservative estimate of speed from crush. The biggest issue would be determining where the damage crease line locations would be on the pre-crash vehicle in order to get your crush depths. These distances would lend conservative speed estimates in a CRASH 3 analysis because they are not at a level of immediate direct contact, and so do not include the full crush energy expended on the Impala.
- Q How do you account for the missing material between the bumper support bar and the face of the bumper cover?
 - A Over the last two years we have been examining the dimensions of energy absorption material found between the bumper cover and the bumper support bar. At its maximum depth near the centerline of the vehicle, the material is 3-6 inches in depth, with the

typical measurement being 3-4 inches. The typical design then has the material taper down in depth so that it is in the neighborhood of 1-3 inches at the outside ends, with the typical measurement being 2-3 inches. For this crash the missing material was accounted for by extending the line of the bumper bar forward a uniform 4 inches and then outwards to intersect with the undamaged pre-crash profile.

- Q Is the "twist" that seems to be present on the right front fender important, or just part of the normal fender shape?
 - A Study of the pre-crash profile indicates the apparent "twist" is more or less the normal curvature of the fender leading from the firewall to the front of the vehicle.
- Q If you use an equal measurement process, what are you going to lose in the way of crush profile detail?
 - A In the case of THIS crash with THIS vehicle, it seems that little detail is lost

For the Cadillac Eldorado -

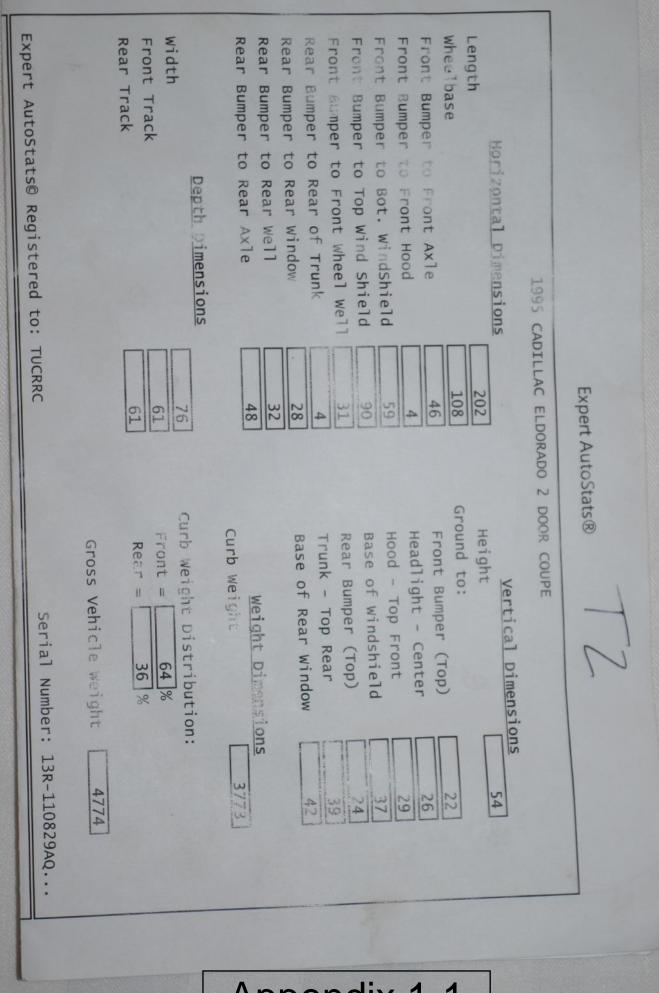
- Q What is your Field "L"?
 - A Two Field "L" measurements were examined. The field "L" which was the result of aligning the pre-crash and post-crash profiles gave the most consistent speed estimates between the two measurement processes.
- Q Where does it Start?
 - A In the case of Option 1, the Field "L" starts at the forward position of the Rear Wheel Well at the bumper level height. In the case of Option 2, the Field "L" starts at the rear of the Rear Wheel Well at the same bumper level height.
- Q Stop?
 - A In the case of Option 1, the Field Length "L" terminates at about the position of the front of the front tire. In the case of Option 2, at the left front bumper corner.
- Q It looks like there may be hinge separation at the "A" pillar do you average the door sill measurements with the maximum crush measurements? Do you average in the field, or do you measure at the sill line and maximum (~bumper level) crush line and record both depths?
 - A For the purposes of this study, Sill and Maximum Crush Depth Averaging was not used. In part that was due to our experience with applying the Force Balance tool to this type of damage, and our findings that the best results when compared to the instrumented speeds is obtained when the maximum crush depth profile is used for the "Unknown" vehicle. If a standard CRASH 3 analysis is to be used, the averaging method MAY be more appropriate. However, it is our experience that if only the average crush values are recorded in the field, too much profile detail is lost. So IF an averaging method is considered, both the Sill AND the Maximum crush depths should be recorded.
- Q There appears to be a twist (or bowing) starting at the firewall, is this significant? Do you apply/use a bowing constant?
 - A An examination of the pre-crash and post-crash profiles indicate that the bowing is a definite result of the collision. For this study, a bowing constant was not used as it was felt it was more straightforward to apply a straight line across the driver side damage

face and measure from that line. The analysis of the speeds calculated from the crush that was measured while accounting for the twist (Option 2) vs ignoring the twist outside of the pre-crash profile (Option 1) resulted in less than a 10% difference in closing speeds between the two methods at the Impala Stiffness value +1 Std Deviation line, as well as less than 10% off of the instrumented bullet vehicle speed.

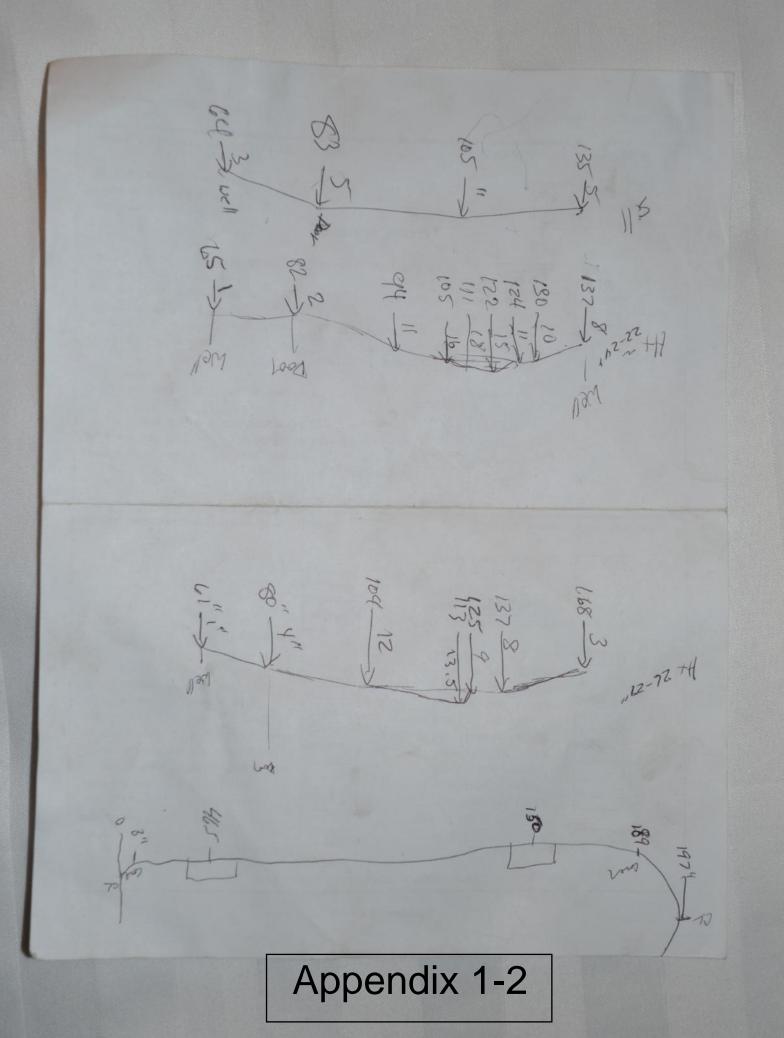
- Q If you use an equal measurement process, what are you going to lose in the way of crush profile detail?
 - A A close examination of the profile results of the two measurements methods reveals that there is some detail lost by the Equally Spaced measurement process in as compared to the Non-Equally spaced process in Field "L" Option 1, there is significantly more profile detail lost in the Equally Spaced process when applied to Field "L" Option 2. This loss of detail in the Field "L" Option 2 profile would make alignment of the post collision vehicles more difficult if only the six equally spaced depth measurements were recorded in the field.

Finally, the REAL question(s) are -

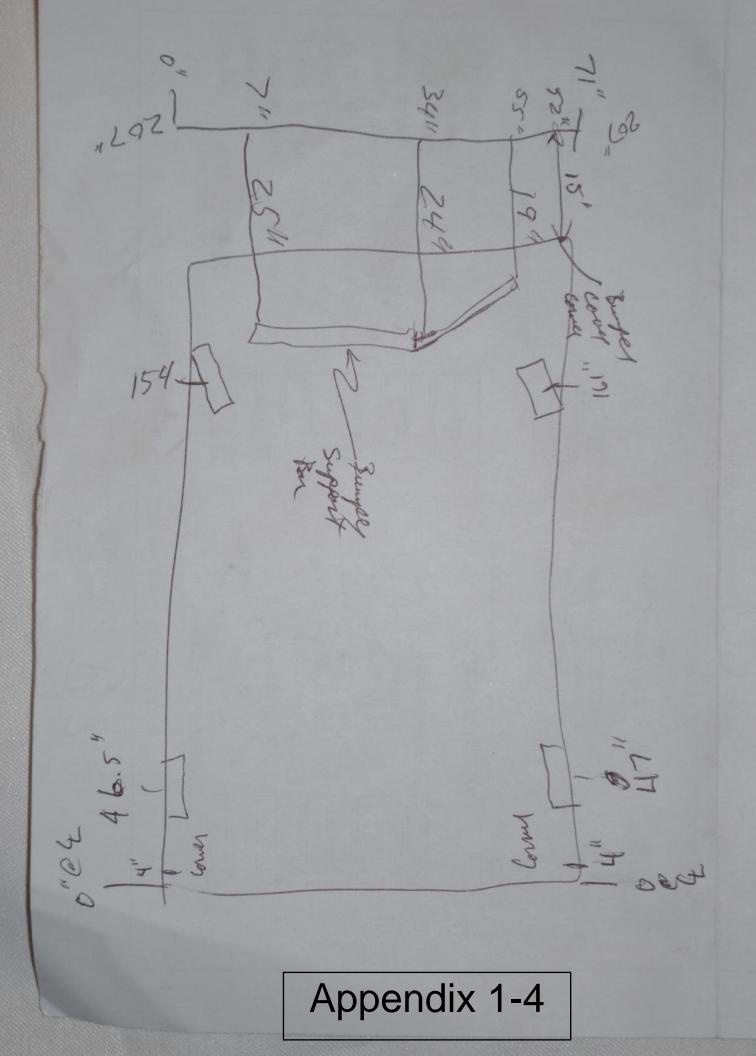
- Q Should you worry about the above questions in the field, or back in the office?
 - A It is felt that there are enough questions that come up while out in the field without any additional questions being added that do not have to be. If the vehicles and their damage are documented as any other piece of evidence i.e. if it looks like it may be important, document it and then processed back in the office, it lessens the load on the person(s) in the field, lessens the likelihood that something will be overlooked, and increases the likelihood that you will have answers to questions that you weren't even thinking about out in the field.
- Q Is Equal Spacing of crush measurements **required** for Speed from Crush Calculations?
 - A It has been illustrated through the application of the Force Balance tool to both crush measurement methods that <u>NO</u>, Equal spacing of crush measurements <u>IS NOT</u> required for (good) Speed from Crush Calculation results. Whether equal spacing is used for the calculations is based more on your calculation process Manual, spreadsheet, or "off the shelf" software and what the process/tools require.



Appendix 1-1



Expert AutoStats© Registered to: TUCRRC	Dode CHEVROLET IMPALA MSP PO Horizontal Dimensions Length Wheelbase 200 Front Bumper to Front Axle 200 Front Bumper to Front Axle 200 Front Bumper to Front Axle 42 Front Bumper to Front Hood 42 Front Bumper to Front Hood 42 Front Bumper to Rear of Trunk 42 Rear Bumper to Rear of Trunk 30 Rear Bumper to Rear Well 26 Rear Bumper to Rear Well 26 Go 33 Front Track 73 Midth 73 Front Track 61	Expert A
Gross Vehicle Weight 4678 serial Number: 13R-110829AQ	POLICE PACKAGE 4 DOOR SEDAN Vertical Dimensions Height Ground to: Front Bumper (Top) Head light - Center Hood - Top Front Base of Windshield Rear Bumper (Top) Trunk - Top Rear Base of Rear Windshield 28 13 20 20 20 20 20 20 20 20 20 20	Expert AutoStats® B2



IPTM Special Problems 2013 Crash Test Data



IPTM's Special Problems 2013

http://tucrrc.utulsa.edu

1

Appendix 2-1



- Jeremy Daily, Ph.D., P.E.
 - Associate Professor of Mechanical Engineering
 - Director of the Crash Reconstruction Research Consortium
- Jose Corcega
 - Graduate Student of Mechanical Engineering
 - Data acquisition with eDAQ system
- Andrew Kongs
 - Engineering Research Technician
 - All things electrical (Power Distribution, Brake Signals, and Wireless distribution system).

IPTM's Special Problems 2013

Appendix 2-2



James Johnson

- Ph.D. Student in Computer Science
- VBox Data and Heavy Truck Digital Forensics
- Amila Perera
 - Graduate Student in Engineering Physics
 - Steering measurements and HVE
- Richard Ruth,
 - IPTM Lead EDR Trainer
 - Crash data from factory and ride along EDRs

IPTM's Special Problems 2013

Appendix 2-3



- Alison Maskus, Electrical Engineering Graduate Student
- Skippy (and Paco)
- Olly, the dog (named after a computer program)

IPTM's Special Problems 2013

Appendix 2-4



White Impala into White Cadillac

CRASH TEST 2

IPTM's Special Problems 2013

Appendix 2-5



2006 Chevrolet Impala

- Bullet Vehicle
- 2G1WS551269435709

1995 Cadillac Eldorado

- Target Vehcile
- IG6EL12Y05U601252





IPTM's Special Problems 2013

http://tucrrc.utulsa.edu

Appendix 2-6



VEHICLE WEIGHT SUMMARY CRASH 2

Measurement	2006 Chevrolet Impala	Cadillac El Dorado
Right Front [lb]	1250	1203
Left Front [lb]	1132	1268
Right Rear [lb]	683	745
Left Rear [lb]	699	675
Total [lb]	3764	3891
Track width [in]	61	61
Wheel base [in]	111	108
Center of mass (X,Y) [inch]	(70.7,20.5)	(77.3,37.3)

IPTM's Special Problems 2013

Appendix 2-7



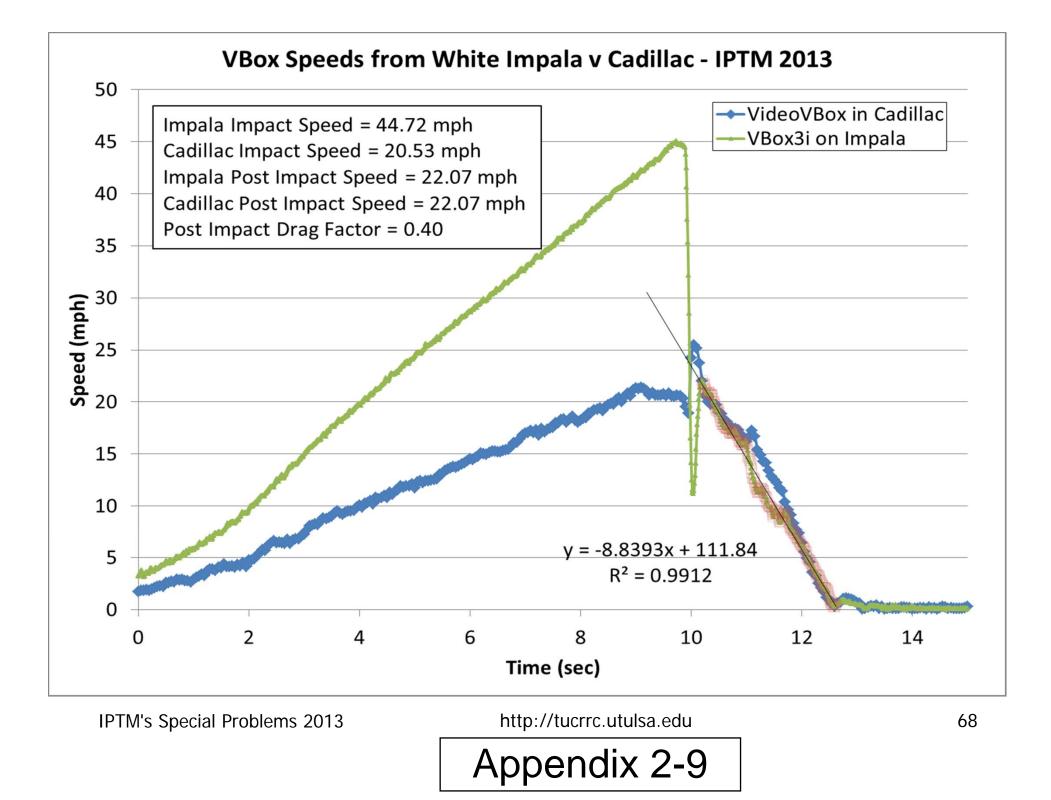
CRASH 2 SUMMARY

Measurement	2006 Chevrolet Impala	Cadillac El Dorado
Impact Speed [mph]	40.9	19.49
Impact Angle [deg (N)]	359.6	268.6
Delta V in X [mph]	-22.26	-
Delta V in Y [mph]	-9.67	-
Crash Pulse Time [ms]	150	150
Peak Angular Velocity [deg/sec]	-147	-
Post impact Speed [mph]	28.5	23.23

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http://tucrrc.utulsa.edu

Appendix 2-8



UNIVERSITY of TULSA Computing Drag Factor

- Given a time history of speed in mph
 - Determine the slope of the graph using the Trendline feature in Excel
 - The units of the slope are mph/s
 - Convert mph to ft/s by multiplying by 1.466
 - Divide by 32.2 to get g's
 - Example:

$$-8.8393 * \frac{1.466}{32.2} = 0.4026$$

IPTM's Special Problems 2013

Appendix 2-10

APPENDIX 3

NHTSA Tests for AVERAGE CRUSH Stiffness Value Determination

Appendix 3-1

4N6XPRT StifCalcs®

Available Test Results Front Impact Test Summary

Report Filter Settings

Year Range: 2006 - 2013 Make: CHEVROLET Model: IMPALA

5578 2006 CHEVROLET MONTE CARLO TWO DOOR C 5.0 26.3 35.0 250.4 57.1 549.0 77.7 18.6 7488 2012 CHEVROLET IMPALA FOUR DOOR SEDAN 5.0 23.9 34.9 282.3 70.7 563.5 96.4 20.4 5468 2006 PONTIAC GRAND PRIX FOUR DOOR SEDAN 5.0 23.5 35.1 283.3 72.5 553.6 98.6 20.9 5547 2006 CHEVROLET IMPALA FOUR DOOR SEDAN 5.0 23.8 35.2 286.3 72.4 565.9 98.5 20.7 5274 2005 BUICK LACROSSE FOUR DOOR SEDAN 5.0 23.4 35.1 287.8 74.2 558.3 100.9 21.1 6052 2007 CHEVROLET IMPALA FOUR DOOR SEDAN 5.0 12.4 24.7 382.5 121.6 601.5 191.1 19.7 7496 2012 CHEVROLET IMPALA FOUR DOOR SEDAN 5.0 6.5 20.0 494.8 229.5 533.3 407.7 24.8 Minimum (MIN) 250.4 57.1 533.3 77.7 18.6	Test Numbe	Vehicle r Info	No Damage Speed (mph)	Average Crush (inch)	0		ehicle iffnes B			Crush Factor
7488 2012 CHEVROLET IMPALA FOUR DOOR SEDAN 5.0 23.9 34.9 282.3 70.7 563.5 96.4 20.4 5468 2006 PONTIAC GRAND PRIX FOUR DOOR SEDAN 5.0 23.5 35.1 283.3 72.5 553.6 98.6 20.9 5547 2006 CHEVROLET IMPALA FOUR DOOR SEDAN 5.0 23.8 35.2 286.3 72.4 565.9 98.5 20.7 5274 2005 BUICK LACROSSE FOUR DOOR SEDAN 5.0 23.4 35.1 287.8 74.2 558.3 100.9 21.1 6052 2007 CHEVROLET IMPALA FOUR DOOR SEDAN 5.0 12.4 24.7 382.5 121.6 601.5 191.1 19.7 7496 2012 CHEVROLET IMPALA FOUR DOOR SEDAN 5.0 6.5 20.0 494.8 229.5 533.3 407.7 24.8 Minimum (MIN) Merage (AVG) 323.9 99.7 560.7 153.0 20.9 Minimum (MIN) 250.4 57.1 533.3 77.7 18.6			(mph)	(inch)	(mpn)				IXV	i actor
5468 2006 PONTIAC GRAND PRIX FOUR DOOR SEDAN 5.0 23.5 35.1 283.3 72.5 553.6 98.6 20.9 5547 2006 CHEVROLET IMPALA FOUR DOOR SEDAN 5.0 23.8 35.2 286.3 72.4 565.9 98.5 20.7 5274 2005 BUICK LACROSSE FOUR DOOR SEDAN 5.0 23.4 35.1 287.8 74.2 558.3 100.9 21.1 6052 2007 CHEVROLET IMPALA FOUR DOOR SEDAN 5.0 12.4 24.7 382.5 121.6 601.5 191.1 19.7 7496 2012 CHEVROLET IMPALA FOUR DOOR SEDAN 5.0 6.5 20.0 494.8 229.5 533.3 407.7 24.8 Minimum (MIN) Average (AVG) 323.9 99.7 560.7 153.0 20.9 Minimum (MIN) 250.4 57.1 533.3 77.7 18.6	5578	2006 CHEVROLET MONTE CARLO TWO DOOR C	5.0	26.3	35.0	250.4	57.1	549.0	77.7	18.6
5547 2006 CHEVROLET IMPALA FOUR DOOR SEDAN 5.0 23.8 35.2 286.3 72.4 565.9 98.5 20.7 5274 2005 BUICK LACROSSE FOUR DOOR SEDAN 5.0 23.4 35.1 287.8 74.2 558.3 100.9 21.1 6052 2007 CHEVROLET IMPALA FOUR DOOR SEDAN 5.0 12.4 24.7 382.5 121.6 601.5 191.1 19.7 7496 2012 CHEVROLET IMPALA FOUR DOOR SEDAN 5.0 6.5 20.0 494.8 229.5 533.3 407.7 24.8 Merage (AVG) Minimum (MIN) Average (AVG) 323.9 99.7 560.7 153.0 20.9 Minimum (MIN) Maximum (MAX) 494.8 229.5 601.5 407.7 24.8	7488	2012 CHEVROLET IMPALA FOUR DOOR SEDAN	5.0	23.9	34.9	282.3	70.7	563.5	96.4	20.4
5274 2005 BUICK LACROSSE FOUR DOOR SEDAN 5.0 23.4 35.1 287.8 74.2 558.3 100.9 21.1 6052 2007 CHEVROLET IMPALA FOUR DOOR SEDAN 5.0 12.4 24.7 382.5 121.6 601.5 191.1 19.7 7496 2012 CHEVROLET IMPALA FOUR DOOR SEDAN 5.0 6.5 20.0 494.8 229.5 533.3 407.7 24.8 Minimum (MIN) Average (AVG) 323.9 99.7 560.7 153.0 20.9 Minimum (MIN) 250.4 57.1 533.3 77.7 18.6 Maximum (MAX)	5468	2006 PONTIAC GRAND PRIX FOUR DOOR SEDAN	5.0	23.5	35.1	283.3	72.5	553.6	98.6	20.9
6052 2007 CHEVROLET IMPALA FOUR DOOR SEDAN 5.0 12.4 24.7 382.5 121.6 601.5 191.1 19.7 7496 2012 CHEVROLET IMPALA FOUR DOOR SEDAN 5.0 6.5 20.0 494.8 229.5 533.3 407.7 24.8 Average (AVG) Minimum (MIN) 250.4 57.1 533.3 77.7 18.6 Maximum (MAX) 494.8 229.5 601.5 407.7 24.8	5547	2006 CHEVROLET IMPALA FOUR DOOR SEDAN	5.0	23.8	35.2	286.3	72.4	565.9	98.5	20.7
7496 2012 CHEVROLET IMPALA FOUR DOOR SEDAN 5.0 6.5 20.0 494.8 229.5 533.3 407.7 24.8 Average (AVG) 323.9 99.7 560.7 153.0 20.9 Minimum (MIN) 250.4 57.1 533.3 77.7 18.6 Maximum (MAX) 494.8 229.5 601.5 407.7 24.8	5274	2005 BUICK LACROSSE FOUR DOOR SEDAN	5.0	23.4	35.1	287.8	74.2	558.3	100.9	21.1
Average (AVG)323.999.7560.7153.020.9Minimum (MIN)250.457.1533.377.718.6Maximum (MAX)494.8229.5601.5407.724.8	6052	2007 CHEVROLET IMPALA FOUR DOOR SEDAN	5.0	12.4	24.7	382.5	121.6	601.5	191.1	19.7
Minimum (MIN) 250.4 57.1 533.3 77.7 18.6 Maximum (MAX) 494.8 229.5 601.5 407.7 24.8	7496	2012 CHEVROLET IMPALA FOUR DOOR SEDAN	5.0	6.5	20.0	494.8	229.5	533.3	407.7	24.8
Minimum (MIN) 250.4 57.1 533.3 77.7 18.6 Maximum (MAX) 494.8 229.5 601.5 407.7 24.8			Average	(AVG)		323.9	99.7	560.7	153.0	20.9
Maximum (MAX) 494.8 229.5 601.5 407.7 24.8				. ,		250 4	E7 4	E22 2	77 7	10 6
			winnun	(101114)		250.4	57.1	533.3	11.1	10.0
Standard Deviation (STDevianmela) 95.9 CO.7 24.0 449.2 4.0		I	Maximum	(MAX)		494.8	229.5	601.5	407.7	24.8
Standard Deviation (STDev-sample) 85.8 60.7 21.0 118.2 1.9		Standard Deviation	(STDev-sa	ample)		85.8	60.7	21.0	118.2	1.9
Number of Tests (n) 7		Nun	nber of Tes	sts (n)	7					

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



Crush Length = OPTION 1

Impala Stiffness Values from NHTSA Tests = AVERAGE CRUSH

Crush Measurement Spacing = EQUAL

Lever Arm and Angle = NO

Page 1 = "KNOWN" = Bullet Page 2 = "UNKNOWN" = Target Page 3 = The two pages combined onto 1

Curb Weight (pou			PDOF	Lever Arm Distan	ce (inches)):	0.00
Occupant + Cargo Weight (pou Total Weight (pou		39 64	Yaw N	Noment of Inerti	a (lb-ft-sec	2)	2670.92
Angle Coll Force to Normal (degr	ees): 0	0.0	"Known"	Stiffness Values	Α		В
No Damage Speed (n	nph): 5	.0		Average	A 323.9		^D 99.7
Energy Crush Depth (inc	:hes): 7. :	36		Minimum	250.4		57.1
Damage Length (inc	ches): 52	2.5		Maximum	494.8		229.5
Crush Profile Measurem	ents:	6	S	td. Devation	85.8		60.7
	Equal		Zone	Area	Zone	e	Area
	Spacing	Zone Area	1 . , ,	Depth(x)	Depth		epth(y)
C1 (inches) 0.00	(inches)	(inches ²)		(inches ³)	(inche		inches ³)
C2 (inches) 6.70	10.50	35.18				7.00	246.23
C3 (inches) 12.70	10.50	101.85	_			6.29	1659.26
C4 (inches) 10.60	10.50	122.33				6.09	3191.74
C5 (inches) 6.80	10.50	91.35				6.37	3322.20
C6 (inches) 0.00	10.50	35.70	2.2	7 80.92		5.50	1624.35
C7 (inches)							
C8 (inches)							
C9 (inches)							
C10 (inches)							
Average Crush (inches):	7.36						
Results			Average		KE		Closing
Results		P	Force	Damage	Speed	Delta V	Speed
	A	B	(poundsf)	Energy (ft*lbs)	(mph)	(mph)	(MPH)
Minimum _	250.4	57.1	17604.72	18969.79	12.3	12.6	24.5
Avg - 2 Std. Deviations	152.3	-21.7	N/A	N/A	N/A	N/A	N/A
Avg - 1 Std. Deviations	238.1	39.0	13784.93	16655.57	11.5	11.5	22.4
Average	323.9	99.7	27764.42	27581.42	14.8	15.5	30.0
Avg + 1 Std. Deviations	409.7	160.4	41743.91	39372.58	17.7	18.7	36.2
Avg + 2 Std. Deviations	495.5	221.1	55723.40	51316.36	20.2	21.4	41.5
Maximum	494.8	229.5	57327.90	52449.46	20.4	21.6	42.1
Damage Centroid Depth (x)		4.63			k²	3290.20	_
Damage Centroid Depth (y)		25.99		Eff. Mass Ratio (g	gamma)	1.00	<u>」</u>
Area of Damage (ir	nches²):	386.40					

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Registered Owner: 4N6XPRT SYSTEMS

Appendix 3-4

Curb Weight (pounds): 3773	PDOF	ever Arm Distanc	e (inches):	0.00
Occupant + Cargo Weight (pounds): 218 Total Weight (pounds): 3991	Yaw N	Aoment of Inertia	(lb-ft-sec ²)	2904.73
Angle Coll Force to Normal (degrees): 0.0				
No Damage Speed (mph): 2.0				
Energy Crush Depth (inches): 8.84				
Damage Length (inches): 100.0				
Crush Profile Measurements: 6				
Equal	Zone	Area	Zone	Area
Spacing Zone Area	Depth(x)	Depth(x)	Depth(y)	Depth(y)
C1 (inches) 0.00 (inches) (inches ²)	(inches)	(inches ³)	(inches)	(inches ³)
C2 (inches) 5.00 20.00 50.00	1.67	7 83.33	13.33	666.67
20.00 207.00	5.64	1166.63	31.72	6566.67
C3 (inches) 15.70 20.00 320.00	8.00	2560.30	50.06	16020.00
C4 (inches) 16.30 20.00 235.00	6.17	7 1449.63	68.71	16146.67
C5 (inches) 7.20 20.00 72.00	2.40	172.80	86.67	6240.00
C6 (inches) 0.00				
C7 (inches)				
C8 (inches)				
C9 (inches)				
C10 (inches)				
Average Crush (inches): 8.84				
Results	Average	_	KE	
	Force poundsf)	Damage Energy (ft*lbs)	Speed Delta (mph) (mp	
Minimum 64.6 32.5	17604.72	20015.11		1.9 17.7
Avg - 2 Std. DeviationsN/AN/AAvg - 1 Std. Deviations56.424.8	N/A 13784.93	N/A		N/A N/A 0.9 15.5
	27764.42	30829.98		4.6 22.7
Avg + 1 Std. Deviations 103.0 82.8	41743.91	45603.03		7.6 28.3
Avg + 2 Std. Deviations 120.0 112.5	55723.40	60304.75		0.2 33.0
Maximum 121.9 115.9	57327.90	61988.91	21.6 2	0.4 33.5
Damage Centroid Depth (x) (inches) 6.15			k ² 33	74.76
Damage Centroid Depth (y) (inches) 51.63		Eff. Mass Ratio (ga	amma)	1.00
Area of Damage (inches ²): 884.00				

1995 CADILLAC ELDORADO - Side Impact

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Appendix 3-5

4N6XPRT StifCalcs® Force Balance - Page 1 of 2	4N6XPRT StifCalcs® Force Balance - Page 2 of 2
2006 CHEVROLET IMPALA MSP POLICE PACKAGE - Front Impact	1995 CADILLAC ELDORADO - Side Impact
Curb Weight (pounds): 3725 PDOF Lever Arm Distance (inches): 0.00	Curb Weight (pounds): 3773 PDOF Lever Arm Distance (inches): 0.00
Occupant + Cargo Weight (pounds): 39 Total Weight (pounds): 3764 Yaw Moment of Inertia (lb-ft-sec ²) 2670.92	Occupant + Cargo Weight (pounds): 218 Total Weight (pounds): 3991 Yaw Moment of Inertia (lb-ft-sec ²) 2904.73
Angle Coll Force to Normal (degrees): 0.0 "Known" Stiffness Values	Angle Coll Force to Normal (degrees): 0.0
No Damage Speed (mph): 5.0 Average 323.9 99.7	No Damage Speed (mph): 2.0
Energy Crush Depth (inches): 7.36 Minimum 250.4 57.1	Energy Crush Depth (inches): 8.84
Damage Length (inches): 52.5 Maximum 494.8 229.5	Damage Length (inches): 100.0
Crush Profile Measurements: 6 Std. Devation 85.8 60.7	Crush Profile Measurements: 6
Equal Zone Area Zone Area	Equal Zone Area Zone Area
Spacing Zone Area Depth(x) Depth(x) Depth(y) Depth(y)	Spacing Zone Area Depth(x) Depth(y) Depth(y) (inches) (inches ²) (inches ³) (inches ³) (inches ³)
C1 (inches) 0.00 10.50 35.18 2.23 78.56 7.00 246.23	C1 (inches) 0.00 20.00 50.00 1.67 83.33 13.33 666.67
C2 (inches) 6.70 101.85 5.00 509.72 16.29 1659.26	C2 (inches) 5.00 2000 207.00 5.64 1166.63 31.72 6566.67
C3 (inches) 12.70 10.50 122.33 5.84 714.47 26.09 3191.74	C3 (inches) 15.70 20.00 320.00 8.00 2560.30 50.06 16020.00
C4 (inches) 10.60 91.35 4.42 403.69 36.37 3322.20	C4 (inches) 16.30 20.00 235.00 6.17 1449.63 68.71 16146.67
C5 (inches) 6.80 35.70 2.27 80.92 45.50 1624.35	C5 (inches) 7.20 20.00 72.00 2.40 172.80 86.67 6240.00
C6 (inches)	C6 (inches) 0.00
C7 (inches)	C7 (inches)
C8 (inches)	C8 (inches)
C9 (inches)	C9 (inches)
C10 (inches)	C10 (inches)
Average Crush (inches): 7.36	Average Crush (inches): 8.84
Average KE Closing Results Force Damage Speed Delta V Speed	Average KE Results Force Damage Speed Delta V
A B (poundsf) Energy (ft*lbs) (mph) (mph) (MPH)	A B (poundsf) Energy (ft*lbs) (mph) (mph) bsub1
Minimum 250.4 57.1 17604.72 18969.79 12.3 12.6 24.5	Minimum 64.6 32.5 17604.72 20015.11 12.3 11.9 17.7
Avg - 2 Std. Deviations 152.3 -21.7 N/A N/A N/A N/A N/A	Avg - 2 Std. Deviations N/A N/A N/A N/A N/A N/A N/A
Avg - 1 Std. Deviations 238.1 39.0 13784.93 16655.57 11.5 22.4	Avg - 1 Std. Deviations 56.4 24.8 13784.93 15919.06 10.9 10.9 15.5
Average 323.9 99.7 27764.42 27581.42 14.8 15.5 30.0	Average 82.8 53.5 27764.42 30829.98 15.2 14.6 22.7
Avg + 1 Std. Deviations 409.7 160.4 41743.91 39372.58 17.7 18.7 36.2	Avg + 1 Std. Deviations 103.0 82.8 41743.91 45603.03 18.5 17.6 28.3
Avg + 2 Std. Deviations 495.5 221.1 55723.40 51316.36 20.2 21.4 41.5	Avg + 2 Std. Deviations 120.0 112.5 55723.40 60304.75 21.3 20.2 33.0
Maximum 494.8 229.5 57327.90 52449.46 20.4 21.6 42.1	Maximum 121.9 115.9 57327.90 61988.91 21.6 20.4 33.5
Damage Centroid Depth (x) (inches) 4.63 k ² 3290.26	Damage Centroid Depth (x) (inches) 6.15 k ² 3374.76
Damage Centroid Depth (y) (inches) 25.99 Eff. Mass Ratio (gamma) 1.00	Damage Centroid Depth (y) (inches) 51.63 Eff. Mass Ratio (gamma) 1.00
Area of Damage (inches ²): 386.40	Area of Damage (inches ²): 884.00
4N6XPRT StifCalcs® licensed by 4N6XPRT Systems (www.4N6XPRT.com) to: Registered Owner: 4N6XPRT SYSTEMS Serial Number: 15R-030201SC02301	4N6XPRT StifCalcs® licensed by 4N6XPRT Systems (www.4N6XPRT.com) to: Registered Owner: 4N6XPRT SYSTEMS Serial Number: 15R-0302015C02301

Crush Length = OPTION 1

Impala Stiffness Values from NHTSA Tests = AVERAGE CRUSH

Crush Measurement Spacing = NON-EQUAL

Lever Arm and Angle = NO

Page 1 = "KNOWN" = Bullet Page 2 = "UNKNOWN" = Target Page 3 = The two pages combined onto 1

Curb Weight (pour Occupant + Cargo Weight (pou	nds):	39		Lever Arm Distar Moment of Inert			0.00
Total Weight (pour Angle Coll Force to Normal (degre		.0		Stiffness Value	-		
No Damage Speed (m	nph): 5	.0			A 323.9		B 99.7
Energy Crush Depth (inc		55		Average			
Damage Length (inc		_		Minimum	250.4		57.1
				Maximum	494.8		229.5
Crush Profile Measureme	ents:	6	S	td. Devation	85.8		60.7
	Unequal Spacing (inches)	Zone Are (inches ²	1 ,	Area Depth(x) (inches ³)	Zon Depth (inch	(y) D	Area epth(y) nches³)
C1 (inches) 0.00	17.70	84.9	6 3.2	0 271.87] [1	1.80	1002.53
C2 (inches) 9.60	4.60	50.3	7 5.5	0 277.17	- 	6.99	352.31
C3 (inches) 12.30	10.70	114.4	9 5.3		2	6.48	3032.08
C4 (inches) 9.10	12.20	82.3	5 3.5	1 289.16	4	1.99	3458.05
C5 (inches) 4.40	7.10	15.6	2 1.4	7 22.91	3	0.77	480.58
C6 (inches) 0.00] [
C7 (inches)							
C8 (inches)] [
C9 (inches)							
C10 (inches)							
Average Crush (inches):	6.65						
Results			Average		KE		Closing
Results	А	В	Force (poundsf)	Damage Energy (ft*lbs)	Speed (mph)	Delta V (mph)	Speed (MPH)
Minimum	250.4	57.1	16477.51	16683.88	11.5	13.4	26.0
Avg - 2 Std. Deviations	152.3	-21.7	209.07	N/A	N/A	1.2	2.4
Avg - 1 Std. Deviations	238.1	39.0	13008.32	14872.59	10.9	12.2	23.8
Avg 1 Std. Deviations	323.9	99.7	25807.57	23961.89	13.8	16.4	31.8
Avg + 1 Std. Deviations \Box	409.7	160.4	38606.81	33913.19	16.4	19.7	38.4
Avg + 2 Std. Deviations \Box	495.5	221.1	51406.06	44016.54	18.7	22.6	44.0
Avg + 2 std. Deviations	493.3	229.5	52848.50	44935.85	18.9	22.0	44.5
Damage Centroid Depth (x)		4.25	52040.50	C0.CCCFT	<u> </u>	3290.26	_
				Eff Maca Datia (1.00	_
Damage Centroid Depth (y)		23.94		Eff. Mass Ratio (yamma)	1.00	<u></u>
Area of Damage (in	icnes=):	347.79					

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Registered Owner: 4N6XPRT SYSTEMS

Appendix 3-8

Curb Weight (pou	inds): 3773		PDOF	ever Arm Distan	ce (inches):	0.00
Occupant + Cargo Weight (pou Total Weight (pou				Ioment of Inertia		
Angle Coll Force to Normal (degr No Damage Speed (r Energy Crush Depth (in Damage Length (in	mph): 2.0 ches): 13.12					
Crush Profile Measurem	Unequal Spacing Zo	one Area	Zone Depth(x)	Area Depth(x)	Zone Depth(y) Depth(y)
C1 (inches) 0.00	(inches) (19.80	(inches ²) 108.90	(inches)	(inches ³) 7 399.30	(inche: 13	s) (inches ³) 3.20 1437.48
C2 (inches) 11.00 C3 (inches) 10.30	1.30	13.85	5.33	3 73.75	1	.94 26.90
C4 (inches) 24.30	10.90	188.57	9.12			7.99 5277.14
C5 (inches) 23.80	17.20	413.66	12.03			0.17 24890.01
C6 (inches) 20.10	9.60	210.72 176.49	8.44			8.07 9074.69 7.93 10224.76
C7 (inches) 13.20	31.00	204.60	4.40			
C8 (inches) 0.00						
C9 (inches)						
C10 (inches) Average Crush (inches):	13.12					
Results			Average Force (poundsf)	Damage Energy (ft*lbs)	KE Speed (mph)	Delta V (mph) bsub1
Minimum	51.8	21.1	16477.51	27072.24	14.3	12.6 14.3
Avg - 2 Std. Deviations	3.1	0.1	209.07	955.87	2.7	1.2 0.9
Avg - 1 Std. Deviations	45.6	16.3	13008.32	21644.05	12.8	11.5 12.6
Average	66.0	34.2	25807.57	41578.13	17.7	15.4 18.2
Avg + 1 Std. Deviations	81.8	52.4	38606.81	61351.14	21.5	18.6 22.6
Avg + 2 Std. Deviations	95.1	70.8	51406.06	81040.09	24.7	21.3 26.2
Maximum	96.4	72.9	52848.50	83255.22	25.0	21.6 26.6
Damage Centroid Depth (x)		9.02 9.18		Eff Mass Datis (a	k² [<u>3374.76</u> 1.00
Damage Centroid Depth (y) Area of Damage (i	、 ,			Eff. Mass Ratio (g		1.00

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Appendix 3-9

Serial Number: 15R-030201SC02301

1995 CADILLAC ELDORADO - Side Impact

4N6XPRT StifCalcs® Force Balance - Page 1 of 2	4N6XPRT StifCalcs® Force Balance - Page 2 of 2
2006 CHEVROLET IMPALA MSP POLICE PACKAGE - Front Impact	1995 CADILLAC ELDORADO - Side Impact
Curb Weight (pounds): 3725 Occupant + Cargo Weight (pounds): 39 Total Weight (pounds): 3764 PDOF Lever Arm Distance (inches): Output Yaw Moment of Inertia (lb-ft-sec ²)	Curb Weight (pounds): 3773 Occupant + Cargo Weight (pounds): 218 Total Weight (pounds): 3991 PDOF Lever Arm Distance (inches): Yaw Moment of Inertia (lb-ft-sec ²)
Angle Coll Force to Normal (degrees): 0.0 "Known" Stiffness Values No Damage Speed (mph): 5.0 A B No Damage Speed (mph): 5.0 A B Energy Crush Depth (inches): 6.65 Minimum 250.4 57.1 Damage Length (inches): 52.3 Maximum 494.8 229.5 Crush Profile Measurements: 6 Std. Devation 85.8 60.7 Unequal Zone Area Zone Area Spacing Zone Area Depth(x) Depth(y) Depth(y) (inches) 0.00 17.70 84.96 32.0 271.87 11.80 1002.53 C2 (inches) 9.60 17.70 84.96 32.0 271.87 11.80 1002.53 C3 (inches) 12.30 10.70 114.49 53.9 617.09 26.48 3032.08 C4 (inches) 9.10 12.20 82.35 3.51 289.16 41.99 3458.05 C5 (inches) 0.00 71.10 15.62 1.47 22.91 30.77 480.58 <t< th=""><th>Angle Coll Force to Normal (degrees): 0.0 No Damage Speed (mph): 2.0 Energy Crush Depth (inches): 13.12 Damage Length (inches): 100.4 Crush Profile Measurements: 8 Unequal Zone Area Spacing Zone Area Depth(x) Depth(x) Olimitation 19.80 106.90 3.677 399.30 13.20 1437.48 C2 (inches) 11.00 1.30 13.85 5.33 73.75 1.94 26.90 C3 (inches) 10.30 13.85 5.33 73.75 1.94 26.90 C5 (inches) 20.10 10.90 188.57 9.12 1720.15 27.99 5277.14 C4 (inches) 20.10 10.60 176.49 8.44 1490.31 57.93 10224.76 C7 (inches) 13.20 31.00 204.60 440 900.24 196.33 40169.80 C6 (inches) 0.00 10.60 176.49 8.44 1490.31 57.93 10224.76 C7 (inches) 0.00 0.00 0.00 <</th></t<>	Angle Coll Force to Normal (degrees): 0.0 No Damage Speed (mph): 2.0 Energy Crush Depth (inches): 13.12 Damage Length (inches): 100.4 Crush Profile Measurements: 8 Unequal Zone Area Spacing Zone Area Depth(x) Depth(x) Olimitation 19.80 106.90 3.677 399.30 13.20 1437.48 C2 (inches) 11.00 1.30 13.85 5.33 73.75 1.94 26.90 C3 (inches) 10.30 13.85 5.33 73.75 1.94 26.90 C5 (inches) 20.10 10.90 188.57 9.12 1720.15 27.99 5277.14 C4 (inches) 20.10 10.60 176.49 8.44 1490.31 57.93 10224.76 C7 (inches) 13.20 31.00 204.60 440 900.24 196.33 40169.80 C6 (inches) 0.00 10.60 176.49 8.44 1490.31 57.93 10224.76 C7 (inches) 0.00 0.00 0.00 <
C10 (inches)	C10 (inches)
Average KE Closing Force Damage Speed Delta V Speed A B (poundsf) Energy (ft*lbs) (mph) (MPH)	Average KE Results Force Damage Speed Delta V A B (poundsf) Energy (ft*lbs) (mph) (mph) bsub1
Minimum 250.4 57.1 16477.51 16683.88 11.5 13.4 26.0 Avg - 2 Std. Deviations 152.3 -21.7 209.07 N/A N/A 1.2 2.4 Avg - 1 Std. Deviations 238.1 39.0 13008.32 14872.59 10.9 12.2 23.8 Avg - 1 Std. Deviations 233.9 99.7 25807.57 23961.89 13.8 16.4 31.8 Avg + 1 Std. Deviations 409.7 160.4 38606.81 33913.19 16.4 19.7 38.4 Avg + 2 Std. Deviations 495.5 221.1 51406.06 44016.54 18.7 22.6 44.0 Maximum 494.8 229.5 52848.50 44935.85 18.9 22.9 44.5 Damage Centroid Depth (x) (inches) 4.25 k² 3290.26 347.79 347.79 4N6XPRT StifCaks@ licensed by 4N6XPRT Systems (www.4N6XPRT.com) to: Serial Number: 15R-0302015C02301	Minimum 51.8 21.1 16477.51 27072.24 14.3 12.6 14.3 Avg - 2 Std. Deviations 3.1 0.1 209.07 955.87 2.7 1.2 0.9 Avg - 1 Std. Deviations 45.6 16.3 13008.32 21644.05 12.8 11.5 12.6 Avg + 1 Std. Deviations 45.6 16.3 13008.32 21644.05 12.8 11.5 12.6 Avg + 1 Std. Deviations 81.8 52.4 38606.81 61351.14 21.5 18.6 22.6 Avg + 2 Std. Deviations 95.1 70.8 51406.06 81040.09 24.7 21.3 26.2 Maximum 96.4 72.9 52848.50 83255.22 25.0 21.6 26.6 Damage Centroid Depth (x) (inches) 9.02 k² 3374.76 Damage Centroid Depth (y) (inches) 69.18 Eff. Mass Ratio (gamma) 1.00 4N62PRT StifCalse® licensed by 4N6XPRT Systems (www.4N6XPRT.com) to: Registered Owner: 4N6XPRT SYSTEMS Serial Number: 15R-0302015C02301
Registered Owner, 4100APRT 3151EN/3 Senai Number: 15K-0302015C02301	Negisieled Owner. 41407/KT 5151EWS Serial Number: 15K-0302015C02301

Crush Length = OPTION 2

Impala Stiffness Values from NHTSA Tests = AVERAGE CRUSH

Crush Measurement Spacing = EQUAL

Lever Arm and Angle = NO

Page 1 = "KNOWN" = Bullet Page 2 = "UNKNOWN" = Target Page 3 = The two pages combined onto 1

Curb Weight (pour Occupant + Cargo Weight (pou		25	PDOF	Lever Arm Distar	ce (inches):	0.00
Total Weight (pour			Yaw N	Moment of Inert	a (lb-ft-sec	2 ²)	2670.92
Angle Coll Force to Normal (degree	ees): 0	.0	"Known"	Stiffness Values	A A		В
No Damage Speed (m	nph): 5	.0		Average	323.9		99.7
Energy Crush Depth (inc	hes): 7. 3	36		Minimum	250.4		57.1
Damage Length (inc	:hes): 52	.5		Maximum	494.8		229.5
Crush Profile Measureme	ents:	6	s	td. Devation	85.8		60.7
	Equal		Zone	Area	Zon	e	Area
	Spacing	Zone Are		Depth(x)	Depth	•	epth(y)
C1 (inches) 0.00	(inches)	(inches ²		(inches ³)	(inche		nches ³)
C2 (inches) 6.70	10.50	35.1	8 2.2	3 78.56		7.00	246.23
C3 (inches) 12.70	10.50	101.8	5 5.0	0 509.72		6.29	1659.26
C4 (inches) 10.60	10.50	122.3	3 5.8	4 714.47	2	6.09	3191.74
C5 (inches) 6.80	10.50	91.3	5 4.4	2 403.69	3	6.37	3322.20
C6 (inches) 0.00	10.50	35.7	0 2.2	7 80.92		5.50	1624.35
C7 (inches)							
C8 (inches)							
C9 (inches)							
C10 (inches)							
Average Crush (inches):	7.36						
Results			Average	-	KE		Closing
	А	В	Force (poundsf)	Damage Energy (ft*lbs)	Speed (mph)	Delta V (mph)	Speed (MPH)
Minimum	250.4	57.1	17604.72	18969.79	12.3	13.0	25.4
Avg - 2 Std. Deviations	152.3	-21.7	N/A	N/A	N/A	N/A	N/A
Avg - 1 Std. Deviations	238.1	39.0	13784.93	16655.57	11.5	11.9	23.1
Average	323.9	99.7	27764.42	27581.42	14.8	16.0	31.1
Avg + 1 Std. Deviations \Box	409.7	160.4	41743.91	39372.58	17.7	19.3	37.6
Avg + 2 Std. Deviations	495.5	221.1	55723.40	51316.36	20.2	22.2	43.1
Maximum	494.8	229.5	57327.90	52449.46	20.4	22.5	43.6
 Damage Centroid Depth (x)	(inches)	4.63			k²	3290.26	5
Damage Centroid Depth (y)	(inches)	25.99		Eff. Mass Ratio (gamma)	1.00)
Area of Damage (ir	nches²):	386.40					

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Registered Owner: 4N6XPRT SYSTEMS

Appendix 3-12

Curb Weight (pou Occupant + Cargo Weight (po		73 18		Lever Arm Distan			0.00
Total Weight (pou	unds): 39 9	91	Yaw N	Moment of Inerti	a (lb-ft-sec		2904.73
Angle Coll Force to Normal (deg No Damage Speed (.0					
Energy Crush Depth (in		56					
Damage Length (in	ches): 156	.0					
Crush Profile Measurem	ients:	6					
	Equal Spacing	Zone Area	1 ()	Area Depth(x)	Zon Depth	(y) D	Area epth(y)
C1 (inches) 0.00	(inches)	(inches ²)		(inches ³)	(inch		nches ³)
C2 (inches) 4.20	31.20	65.52					1362.82
C3 (inches) 18.10	31.20	347.88			-		17408.35
C4 (inches) 18.90	<u>31.20</u> 31.20	577.20					45086.50
C5 (inches) 6.60		397.80					42441.98
C6 (inches) 0.00	31.20	102.96	5 2.2	0 226.51] [3	5.20	13920.19
C7 (inches)					」 」		
C8 (inches)] [¬] [] [」 」		
C9 (inches)							
C10 (inches)							
Average Crush (inches):	9.56						
Results			Average	_	KE	D 1	
	А	В	Force (poundsf)	Damage Energy (ft*lbs)	Speed (mph)	Delta V (mph)	bsub1
Minimum [39.9	19.4	17604.72	22631.80	13.0	12.3	17.1
Avg - 2 Std. Deviations	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Avg - 1 Std. Deviations	34.9	14.8	13784.93	17953.25	11.6	11.2	15.0
Average	51.2	31.9	27764.42	35005.49	16.2	15.1	21.9
Avg + 1 Std. Deviations	63.6	49.3	41743.91	51936.36	19.8	18.2	27.3
Avg + 2 Std. Deviations	74.2	67.0	55723.40	68804.44	22.7	20.9	31.8
Maximum [75.3	69.0	57327.90	70737.64	23.1	21.2	32.3
- Damage Centroid Depth (x)	(inches)	7.10			k²	3374.76	5
Damage Centroid Depth (y)		80.61		Eff. Mass Ratio (gamma)	1.00	
Area of Damage (inches²):	1491.36					
4N	6XPRT StifCalcs	® licensed b	by 4N6XPRT Syst	tems (www.4N6XP	RT.com) to:		

1995 CADILLAC ELDORADO - Side Impact

Registered Owner: 4N6XPRT SYSTEMS

Appendix 3-13

4N6XPRT StifCalcs® Force Balance - Page 1 of 2	4N6XPRT StifCalcs® Force Balance - Page 2 of 2
2006 CHEVROLET IMPALA MSP POLICE PACKAGE - Front Impact	1995 CADILLAC ELDORADO - Side Impact
Curb Weight (pounds): 3725 Occupant + Cargo Weight (pounds): 39 Total Weight (pounds): 3764 PDOF Lever Arm Distance (inches): 0.00 Yaw Moment of Inertia (lb-ft-sec ²) 2670.92	Curb Weight (pounds): 3773 Occupant + Cargo Weight (pounds): 218 Total Weight (pounds): 3991 PDOF Lever Arm Distance (inches): ① 0.00 Yaw Moment of Inertia (lb-ft-sec ²) ② 2904.73
Angle Coll Force to Normal (degrees): 0.0	Angle Coll Force to Normal (degrees): 0.0 No Damage Speed (mph): 2.0 Energy Crush Depth (inches): 9.56 Damage Length (inches): 156.0 Crush Profile Measurements: 6 Equal Zone Area Spacing Zone Area Depth(x) Depth(y) C1 (inches) 0.00 31.20 65.52 1.40 91.73 20.80 1362.82 C2 (inches) 4.20 31.20 347.88 6.30 2190.60 50.04 17408.35 G3 (inches) 18.10 31.20 577.20 9.25 5339.93 78.11 45086.50 C4 (inches) 18.90 31.20 102.96 2.20 22.651 135.20 13920.19 G6 (inches) 0.00 0 0 0
Average Crush (inches): 7.36	Average Crush (inches): 9.56
Average KE Closing Force Damage Speed Delta V Speed A B (poundsf) Energy (ft*lbs) (mph) (MPH)	Average KE Results Force Damage Speed Delta V A B (poundsf) Energy (ft*lbs) (mph) (mph) bsub1
Minimum 250.4 57.1 17604.72 18969.79 12.3 13.0 25.4 Avg - 2 Std. Deviations 152.3 -21.7 N/A N/A N/A N/A Avg - 1 Std. Deviations 238.1 39.0 13784.93 16655.57 11.5 11.9 23.1 Average 323.9 99.7 27764.42 27581.42 14.8 16.0 31.1 Avg + 1 Std. Deviations 409.7 160.4 41743.91 39372.58 17.7 19.3 37.6 Avg + 2 Std. Deviations 495.5 221.1 55723.40 51316.36 20.2 22.2 43.1 Maximum 494.8 229.5 57327.90 52449.46 20.4 22.5 43.6 Damage Centroid Depth (x) (inches) 4.63 k² 3290.26 3290.26 3290.26 Damage Centroid Depth (y) (inches) 25.99 Eff. Mass Ratio (gamma) 1.00 1.00 Area of Damage (inches²): 386.40 386.40 386.40 360.41 360.41	Minimum 39.9 19.4 17604.72 22631.80 13.0 12.3 17.1 Avg - 2 Std. Deviations N/A N/A N/A N/A N/A N/A N/A N/A Avg - 1 Std. Deviations 34.9 14.8 13784.93 17953.25 11.6 11.2 15.0 Average 51.2 31.9 27764.42 35005.49 16.2 15.1 21.9 Avg + 1 Std. Deviations 63.6 49.3 41743.91 51936.36 19.8 18.2 27.3 Avg + 2 Std. Deviations 74.2 67.0 55723.40 68804.44 22.7 20.9 31.8 Maximum 75.3 69.0 57327.90 70737.64 23.1 21.2 32.3 Damage Centroid Depth (x) (inches) 7.10 k² 3374.76 Damage Centroid Depth (y) (inches) 80.61 Eff. Mass Ratio (gamma) 1.00 Area of Damage (inches²): 1491.36 1491.36 1400
Registered Owner: 4N6XPRT SYSTEMS	Registered Owner: 4N6XPRT SYSTEMS Serial Number: 15R-030201SC02301

Crush Length = OPTION 2

Impala Stiffness Values from NHTSA Tests = AVERAGE CRUSH

Crush Measurement Spacing = NON-EQUAL

Lever Arm and Angle = NO

Page 1 = "KNOWN" = Bullet Page 2 = "UNKNOWN" = Target Page 3 = The two pages combined onto 1

Curb Weight (pour Occupant + Cargo Weight (pou Total Weight (pour	nds):	39		Lever Arm Distan Moment of Inerti	-		0.00 2670.92
Angle Coll Force to Normal (degre No Damage Speed (m Energy Crush Depth (inc Damage Length (inc	nph): 5 hes): 6.6		"Known"	Stiffness Values Average Minimum Maximum	A 323.9 250.4 494.8		B 99.7 57.1 229.5
Crush Profile Measureme	ents: Unequal Spacing (inches)	6 Zone Are (inches ²	Zone a Depth(x)	td. Devation Area Depth(x) (inches ³)	85.8 Zone Depth (inche	e (y) D	60.7 Area epth(y) nches ³)
C1 (inches) 0.00 C2 (inches) 9.60 C3 (inches) 12.30	17.70 4.60	84.9 50.3	6 <u>3.2</u> 7 <u>5.5</u>	0 271.87 0 277.17		1.80 6.99	1002.53 352.31
C4 (inches) 9.10 C5 (inches) 4.40	10.70 12.20 7.10	114.4 82.3 15.6	5 3.5	1 289.16	4	6.48 1.99 0.77	3032.08 3458.05 480.58
C6 (inches) 0.00 C7 (inches)							
C9 (inches) C10 (inches) Average Crush (inches):	6.65						
Results	A	В	Average Force (poundsf)	Damage Energy (ft*lbs)	KE Speed (mph)	Delta V (mph)	Closing Speed (MPH)
Minimum Avg - 2 Std. Deviations	250.4	-21.7	16477.51 209.07	16683.88	11.5 N/A	12.6 1.0	24.5 2.0
Avg - 1 Std. Deviations	238.1	39.0	13008.32	14872.59	10.9	11.5	22.4
Average	323.9	99.7	25807.57	23961.89	13.8	15.4	29.9
Avg + 1 Std. Deviations	409.7	221.1	38606.81 51406.06	33913.19 44016.54	16.4 18.7	<u>18.5</u> 21.2	36.0 41.3
Avg + 2 Std. Deviations Maximum	493.3	229.5	52848.50	44010.34	18.7	21.2	41.3
Damage Centroid Depth (x) (4.25			k²	3290.26	_
Damage Centroid Depth (y) ((inches)	23.94		Eff. Mass Ratio (gamma)	1.00)
Area of Damage (in	ches²):	347.79					

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

Registered Owner: 4N6XPRT SYSTEMS

Appendix 3-16

1995 CADILLAC EL	DORADO -	Side Im	ραςτ				
Curb Weight (pc			PDOF	ever Arm Distan	ce (inches)	: 0.00	
Occupant + Cargo Weight (po Total Weight (po			Yaw M	loment of Inerti	a (lb-ft-sec	²) 2904.73	
		_					
Angle Coll Force to Normal (de		_					
No Damage Speed	(mph): 2.	0					
Energy Crush Depth (i	nches): 9.6 2	1					
Damage Length (i	nches): 155.	9					
Crush Profile Measure	nents: 1	0					
	Unequal	<u> </u>	Zone	Area	Zone	e Area	
	Spacing	Zone Area	Depth(x)	Depth(x)	Depth(
C1 (inches) 0.00	(inches)	(inches²)	(inches)	(inches ³)	(inche	s) (inches ³)	1
C2 (inches) 4.70	29.30	68.86	1.57	107.87	19	9.53 1344.9	7
C3 (inches) 9.60	18.30	130.85	3.71	486.08	28	3.50 3728.4	4
C4 (inches) 8.80	1.30	11.96	4.60	55.05		3.24 38.7	6
	10.60	147.34	7.26	1069.96	37	7.75 5561.8	2
	8.60	172.43	10.03	1730.19	38	3.78 6685.9	8
C6 (inches) 21.10	18.10	377.39	10.43	3934.43	99	9.51 37555.03	3
C7 (inches) 20.60	10.80	196.02	9.13	1789.69	69	9.96 13712.98	8
C8 (inches) 15.70	33.60	337.68	5.55	1875.61	248	8.85 84032.20	6
C9 (inches) 4.40	25.30	55.66	1.47	81.63	210	0.83 11734.98	8
C10 (inches) 0.00							
Average Crush (inches):	9.61						
Results			Average Force	Damage	KE Speed	Delta V	
	А	В (Energy (ft*lbs)	(mph)	(mph) bsub1	1
Minimum	38.5	18.0	16477.51	22025.79	12.9	11.9 16.	5
Avg - 2 Std. Deviations	2.1	0.1	209.07	853.41	2.5	1.0 0.	.9
Avg - 1 Std. Deviations	33.7	13.9	13008.32	17596.68	11.5	10.9 14.	5
Average	49.1	29.3	25807.57	33880.05	16.0	14.5 21.	0
Avg + 1 Std. Deviations	60.9	45.2	38606.81	50063.60	19.4	17.5 26.	1
Avg + 2 Std. Deviations	70.9	61.2	51406.06	66194.99	22.3	20.0 30.	4
Maximum	72.0	63.1	52848.50	68010.62	22.6	20.3 30.	8
Damage Centroid Depth (>	(inches)	7.43			k²	3374.76	
Damage Centroid Depth (y	v) (inches)	109.73	I	Eff. Mass Ratio (g	gamma)	1.00	
Area of Damage	(inches²): 1	498.18					
	ACTION Stiff alco	R licensed by	ANIGYDDT Such	ame (www.ANIGVD	RT com) to:		

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

Registered Owner: 4N6XPRT SYSTEMS

Appendix 3-17

Serial Number: 15R-030201SC02301

1995 CADILLAC ELDORADO - Side Impact

4N6XPRT StifCalcs® Force Balance - Page 1 of 2	4N6XPRT StifCalcs® Force Balance - Page 2 of 2
2006 CHEVROLET IMPALA MSP POLICE PACKAGE - Front Impact	1995 CADILLAC ELDORADO - Side Impact
Curb Weight (pounds): 3725 Occupant + Cargo Weight (pounds): 39 Total Weight (pounds): 3764 PDOF Lever Arm Distance (inches): 0.00 Yaw Moment of Inertia (lb-ft-sec ²)	Curb Weight (pounds): 3773 Occupant + Cargo Weight (pounds): 218 Total Weight (pounds): 3991 PDOF Lever Arm Distance (inches): 900 Yaw Moment of Inertia (lb-ft-sec ²)
Angle Coll Force to Normal (degrees): 0.0 "Known" Stiffness Values No Damage Speed (mph): 5.0 A B Energy Crush Depth (inches): 6.65 Minimum 250.4 57.1 Damage Length (inches): 52.3 Maximum 494.8 229.5 Crush Profile Measurements: 6 Std. Devation 85.8 60.7 Unequal Zone Area Zone Area Spacing Zone Area Depth(x) Depth(y) Depth(y) (inches) 0.00 17.70 84.96 320 271.87 11.80 1002.53 C1 (inches) 9.60 4.60 50.37 5.50 277.17 6.99 352.31 C3 (inches) 12.30 10.70 114.49 5.39 617.09 264.8 3032.08 C4 (inches) 9.10 12.20 82.35 3.51 289.16 41.99 3458.05 C5 (inches) 0.00 112.49 54.29 1.47 22.91 30.77 480.58 C6 (inches) 0.00 114.49 1.41 1.41 1.	Angle Coll Force to Nomal (degrees): 0.0 No Damage Speed (mph): 2.0 Energy Crush Depth (inches): 9.61 Damage Length (inches): 155.9 Crush Profile Measurements: 10 Unequal Zone Area Spacing Zone Area Depth(x) Depth(y) (inches) 0.00 29.30 68.86 1.57 107.87 19.53 1344.97 C2 (inches) 4.70 18.30 130.85 3.71 486.08 28.50 3728.44 C3 (inches) 9.60 1.30 11.96 4.60 55.05 3.24 38.76 C4 (inches) 8.80 10.60 147.34 7.26 1069.96 37.75 5561.82 C5 (inches) 19.00 8.60 172.43 10.03 1730.19 38.78 6685.98 C6 (inches) 21.10 18.10 377.39 10.43 3934.43 99.51 3755.03 C7 (inches) 15.70 33.60 337.68 5.55 1875.61 248.85 84032.26 C9 (inches) 0.00 <t< th=""></t<>
Average Crush (inches): 6.65 Average KE Closing	Average Crush (inches): 9.61 Average KE
Results Speed Delta V Speed Speed Minimum Speed Speed Minimum Minimum Speed Speed Minimum Speed Speed Minimum Minimum Speed Speed Minimum Minimum Speed Speed Minimum Minimum Speed Speed Minimum Minimum Speed Minimum Minimum Speed Minimum Minimum Speed Minimum Speed Speed Minimim	Results Force Damage Spec Delta V A B (poundsf) Energy (ft*lbs) (mph) (mph) bsub1 Minimum 38.5 18.0 16477.51 22025.79 12.9 11.9 16.5 Avg - 2 Std. Deviations 2.1 0.1 209.07 853.41 2.5 1.0 0.9 Avg - 1 Std. Deviations 33.7 13.9 13008.32 17596.68 11.5 10.9 14.5 Average 49.1 29.3 25807.57 33880.05 16.0 14.5 21.0 Avg + 1 Std. Deviations 60.9 45.2 38606.81 50063.60 19.4 17.5 26.1 Avg + 2 Std. Deviations 70.9 61.2 51406.06 66194.99 22.3 20.0 30.4 Maximum 72.0 63.1 52848.50 68010.62 22.6 20.3 30.8
Maximum 494.8 229.3 32848.30 44953.83 18.9 21.5 41.8 Damage Centroid Depth (x) (inches) 4.25 k² 3290.26 Damage Centroid Depth (y) (inches) 23.94 Eff. Mass Ratio (gamma) 1.00 Area of Damage (inches²): 347.79 4N6XPRT StifCalcs® licensed by 4N6XPRT Systems (www.4N6XPRT.com) to: Registered Owner: 4N6XPRT SYSTEMS Serial Number: 15R-030201SC02301	Maximum 12.0 63.1 52848.30 68010.62 22.6 20.3 30.8 Damage Centroid Depth (x) (inches) 7.43 k² 3374.76 Damage Centroid Depth (y) (inches) 109.73 Eff. Mass Ratio (gamma) 1.00 Area of Damage (inches²): 1498.18 4N6XPRT StifCalcs® licensed by 4N6XPRT Systems (www.4N6XPRT.com) to: Registered Owner: 4N6XPRT SYSTEMS Serial Number: 15R-0302015C02301

Crush Length = OPTION 1

Impala Stiffness Values from NHTSA Tests = AVERAGE CRUSH

Crush Measurement Spacing = EQUAL

Lever Arm and Angle = YES

Page 1 = "KNOWN" = Bullet Page 2 = "UNKNOWN" = Target Page 3 = The two pages combined onto 1

Curb Weight (pour Occupant + Cargo Weight (pour	nds):	39		Lever Arm Distar Moment of Inert			0.00
Total Weight (pour		0.0		Stiffness Value			
Angle Coll Force to Normal (degr			KIOWI	Stirmess value.	A		В
No Damage Speed (n		5.0		Average	323.9		99.7
Energy Crush Depth (inc	hes): 7.	36		Minimum	250.4	۱	57.1
Damage Length (inc	:hes): 52	2.5		Maximum	494.8	3	229.5
Crush Profile Measureme	ents:	6	S	td. Devation	85.8	3	60.7
	Equal		Zone	Area	Zon		Area
	Spacing	Zone Are (inches ²	1	Depth(x)	Depth		epth(y)
C1 (inches) 0.00	(inches)	` <u> </u>	, <u>,</u> ,	(inches ³)	(inch		nches ³)
C2 (inches) 6.70	10.50	35.1				7.00	246.23
C3 (inches) 12.70	10.50	101.8				6.29	1659.26
C4 (inches) 10.60	10.50	122.3	5.8	4 714.47	2	6.09	3191.74
C5 (inches) 6.80	10.50	91.3				6.37	3322.20
C6 (inches) 0.00	10.50	35.7	2.2	7 80.92		5.50	1624.35
C7 (inches)							
C8 (inches)							
C9 (inches)							
C10 (inches)							
	7.26						
Average Crush (inches):	7.36						
Results			Average Force	Damage	KE Speed	Delta V	Closing Speed
	А	В	(poundsf)	Energy (ft*lbs)	(mph)	(mph)	(MPH)
Minimum	250.4	57.1	17604.72	18969.79	12.3	12.4	27.0
Avg - 2 Std. Deviations	152.3	-21.7	N/A	N/A	N/A	N/A	N/A
Avg - 1 Std. Deviations	238.1	39.0	13784.93	16655.57	11.5	11.4	24.7
Average	323.9	99.7	27764.42	27581.42	14.8	15.2	33.1
Avg + 1 Std. Deviations	409.7	160.4	41743.91	39372.58	17.7	18.4	39.9
Avg + 2 Std. Deviations	495.5	221.1	55723.40	51316.36	20.2	21.1	45.8
Maximum	494.8	229.5	57327.90	52449.46	20.4	21.3	46.3
Damage Centroid Depth (x)	(inches)	4.63			k²	3290.26	5
Damage Centroid Depth (y)	(inches)	25.99		Eff. Mass Ratio (gamma)	1.00)
Area of Damage (ir	nches²):	386.40					

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

Registered Owner: 4N6XPRT SYSTEMS

Appendix 3-20

Curb Weight (pounds): 3773 218 Total Weight (pounds): 9911 Ever Am Distance (inches): 28.50 Yaw Moment of Inertia (lb-ft-sec ²) Angle Coll Force to Normal (degrees): 30.0 Yaw Moment of Inertia (lb-ft-sec ²) 2904.73 Angle Coll Force to Normal (degrees): 30.0 Yaw Moment of Inertia (lb-ft-sec ²) 2904.73 No Damage Speed (mph): 2.0 Energy Crush Depth (inches): 8.84 Damage Length (inches): 100.0 Equal Zone Area Crush Profile Measurements: 6 Equal Zone Area Depth(y) Depth(y) C1 (inches) 0.00 120.00 564 1166.63 33.172 656.67 C3 (inches) 15.70 20.00 235.00 6.17 1449.63 68.71 16146.67 C5 (inches) 7.20 20.00 72.00 2.40 172.80 86.67 6240.00 C6 (inches) 0.00 20.00 72.00 2.40 172.80 86.67 6240.00 C6 (inches) 0.00 20.00 72.00 2.40 172.80 86.67 6240.00 63 (inches) C10 (inches)		
Total Weight (pounds): 3991 Yaw Moment of Inertia (lb-ft-sec ²) 2904.73 Angle Coll Force to Normal (degrees): 300 No Damage Speed (mph): 20 Energy Crush Depth (inches): 8.84 Damage Length (inches): 100.0 Crush Profile Measurements: 6 Equal Zone Area Spacing Zone Area Depth(x) (inches) 0.00 50.00 1.677 C1 (inches) 500 20.00 30.00 C2 (inches) 500 20.00 320.00 2000 20.00 320.00 8.00 2560.30 C3 (inches) 7.20 20.40 172.80 86.67 C4 (inches) 0.00 20.00 72.00 2.40 172.80 86.67 C4 (inches) 0.00 20.00 72.00 2.40 172.80 86.67 6240.00 C6 (inches) 0.00 20.00 72.00 2.40 172.80 86.67 6240.00 C9 (inches)		Lever Arm Distance (inches): 28.50
Angle Coll Force to Normal (degrees): 300 No Damage Speed (mph): 20 Energy Crush Depth (inches): 8.84 Damage Length (inches): 10000 Crush Profile Measurements: 6 Equal Zone Area Zone Area Spacing Zone Area Depth(x) Depth(y) Depth(y) C1 (inches) 0.00 20.00 50.00 1.67 83.33 13.33 666.67 C2 (inches) 5.000 20.00 20.00 50.00 1.67 83.33 1.333 666.67 C3 (inches) 15.70 20.00 320.00 80.00 2560.30 50.06 16020.00 C4 (inches) 16.30 20.00 72.00 2.40 172.80 86.67 6240.00 C6 (inches) 0.000 72.00 2.40 172.80 86.67 6240.00 C9 (inches) 0.000 72.00 2.40 172.80 86.67 6240.00 C9 (inches) 0.000 72.00 2.40 172.80 86.67 6240.00 0 0 <		Yaw Moment of Inertia (lb-ft-sec ²) 2904.73
No Damage Speed (mph): 20 Energy Crush Depth (inches): 884 Damage Length (inches): 1000 Crush Profile Measurements: 6		
Energy Crush Depth (inches): 8.84 Damage Length (inches): 1000 Crush Profile Measurements: 6	, , <u> </u>	
Damage Length (inches): 100.0 Crush Profile Measurements: 6	5 · · · · · · · ·	
Crush Profile Measurements: 6 Equal Zone Area Zone Area Spacing Zone Area Depth(x) Depth(x) Depth(y) Depth(y) C1 (inches) 0.00 20.00 50.00 1.67 83.33 13.33 666.67 C2 (inches) 5.00 20.00 20.00 56.41 1166.63 31.72 6566.67 C3 (inches) 15.70 20.00 220.00 61.71 1449.63 68.71 16146.67 C5 (inches) 7.20 20.00 72.00 2.40 172.80 86.67 6240.00 C6 (inches) 0.00 0.00 72.00 2.40 172.80 86.67 6240.00 C6 (inches) 0.00 <		
Equal Spacing (inches) Zone Depth(x) Area Depth(x) Zone Depth(x) Area Depth(y) Area Depth(y) C1 (inches) 0.00 20.00 50.00 1.67 83.33 13.33 666.67 C2 (inches) 5.00 20.00 207.00 5.64 1166.63 31.72 6566.67 C3 (inches) 15.70 20.00 320.00 8.00 2560.30 50.06 16020.00 C4 (inches) 16.30 20.00 235.00 6.17 1449.63 68.71 16146.67 C5 (inches) 7.20 20.00 72.00 2.40 172.80 86.67 6240.00 C6 (inches) 0.00 20.00 72.00 2.40 172.80 86.67 6240.00 C9 (inches) 0.00 20.00 72.00 2.40 172.80 86.67 6240.00 C9 (inches) 0.00 20.00 72.00 2.40 172.80 86.67 6240.00 C9 (inches) 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 </td <td>Damage Length (inches): 100.0</td> <td></td>	Damage Length (inches): 100.0	
Equal Zone Area Zone Area Spacing Zone Area Depth(x) Depth(x) Depth(y) Depth(y) C1 (inches) 0.00 20.00 50.00 1.67 83.33 13.33 666.7 C2 (inches) 5.00 20.00 207.00 5.64 1166.63 31.72 6566.67 C3 (inches) 15.70 20.00 20.00 20.00 6.617 1449.63 68.71 16146.67 C5 (inches) 7.20 20.00 72.00 2.40 172.80 86.67 6240.00 C6 (inches) 0.00 20.00 72.00 2.40 172.80 86.67 6240.00 C9 (inches) 0.00 20.00 72.00 2.40 172.80 86.67 6240.00 C9 (inches) 0.00 <	Crush Profile Measurements: 6	
C1 (inches) 0.00 20.00 50.00 1.67 83.33 13.33 666.67 C2 (inches) 5.00 20.00 207.00 5.64 1166.63 31.72 6566.67 C3 (inches) 15.70 20.00 20.00 8.00 2560.30 50.06 16020.00 C4 (inches) 16.30 20.00 235.00 6.17 1449.63 68.71 16146.67 C5 (inches) 7.20 2.40 172.80 86.67 6240.00 C6 (inches) 0.00 20.00 72.00 2.40 172.80 86.67 6240.00 C6 (inches) 0.00 20.00 72.00 2.40 172.80 86.67 6240.00 C7 (inches)	Equal	Zone Area Zone Area
C1 (inches) 0.00 20.00 50.00 1.67 83.33 13.33 666.67 C2 (inches) 5.00 20.00 207.00 5.64 1166.63 31.72 5566.67 C3 (inches) 15.70 20.00 320.00 8.00 2560.30 50.06 16020.00 C4 (inches) 16.30 20.00 235.00 6.17 1449.63 68.71 16146.67 C5 (inches) 7.20 20.00 72.00 2.40 172.80 86.67 6240.00 C6 (inches) 0.00 72.00 2.40 172.80 86.67 6240.00 C6 (inches) 0.00 72.00 2.40 172.80 86.67 6240.00 C6 (inches) 0.00 72.	Spacing Zone Area	Depth(x) Depth(x) Depth(y) Depth(y)
20.00 50.00 1.67 83.33 13.33 666.67 C2 (inches) 5.00 20.00 207.00 5.64 1166.63 31.72 6566.67 C3 (inches) 15.70 20.00 320.00 8.00 2560.30 50.06 16020.00 C4 (inches) 16.30 20.00 235.00 6.17 1449.63 68.71 16146.67 C5 (inches) 7.20 20.00 72.00 2.40 172.80 86.67 6240.00 C6 (inches) 0.00 20.00 72.00 2.40 172.80 86.67 6240.00 C6 (inches) 0.00 20.00 72.00 2.40 172.80 86.67 6240.00 C6 (inches) 0.00 20.00 72.00 2.40 172.80 86.67 6240.00 C9 (inches) 0 <td< td=""><td>(inches) (inches) (inches) (inches²)</td><td>(inches) (inches³) (inches) (inches³)</td></td<>	(inches) (inches) (inches) (inches ²)	(inches) (inches³) (inches) (inches³)
C3 (inches) 15.70 20.00 207.00 5.64 1166.63 31.72 65566.67 C3 (inches) 15.70 20.00 320.00 8.00 2560.30 50.06 16020.00 C4 (inches) 16.30 20.00 235.00 6.17 1449.63 68.71 16146.67 C5 (inches) 7.20 20.00 72.00 2.40 172.80 86.67 6240.00 C6 (inches) 0.00 20.00 72.00 2.40 172.80 86.67 6240.00 C7 (inches)	20.00 50.00	1.67 83.33 13.33 666.67
C4 (inches) 16.30 20.00 320.00 8.00 2560.30 50.06 16020.00 C4 (inches) 16.30 20.00 235.00 6.17 1449.63 68.71 16146.67 C5 (inches) 7.20 20.00 72.00 2.40 172.80 86.67 6240.00 C6 (inches) 0.00 72.00 2.40 172.80 86.67 6240.00 C7 (inches)	20.00 207.00	5.64 1166.63 31.72 6566.67
C5 (inches) 7.20 235.00 6.17 1449.63 68.71 16146.67 C5 (inches) 7.20 20.00 72.00 2.40 172.80 86.67 6240.00 C6 (inches) 0.00 20.00 72.00 2.40 172.80 86.67 6240.00 C6 (inches) 0.00 20.00 72.00 2.40 172.80 86.67 6240.00 C7 (inches)	20.00 320.00	8.00 2560.30 50.06 16020.00
20.00 72.00 2.40 172.80 86.67 6240.00 C6 (inches) 0.00	20.00 235.00	6.17 1449.63 68.71 16146.67
C7 (inches)	C5 (inches) 7.20 20.00 72.00	2.40 172.80 86.67 6240.00
C8 (inches) C8 (inches) C9 (inches) C9 (inches) C10 (inches) C10 (inches) Average Crush (inches): 8.84 Results Average KE Force Average KE Force Damage Average KE (poundsf) Energy (ft*lbs) Minimum 59.6 27.7 17604.72 23318.14 13.2		
C9 (inches)	C7 (inches)	
C10 (inches) Average Crush (inches): 8.84 Results Average Average Average Force Damage Speed Delta V A B (poundsf) Energy (ft*lbs) (mph) (mph) bsub1 Minimum 59.6 27.7 17604.72 23318.14 13.2 11.7 16.4	C8 (inches)	
Average Crush (inches): 8.84 Average KE Results Force Damage Speed Delta V A B (poundsf) Energy (ft*lbs) (mph) bsub1 Minimum 59.6 27.7 17604.72 23318.14 13.2 11.7 16.4	C9 (inches)	
Average KE Force Damage Speed Delta V A B (poundsf) Energy (ft*lbs) (mph) (mph) bsub1 Minimum 59.6 27.7 17604.72 23318.14 13.2 11.7 16.4	C10 (inches)	
Average KE Force Damage Speed Delta V A B (poundsf) Energy (ft*lbs) (mph) (mph) bsub1 Minimum 59.6 27.7 17604.72 23318.14 13.2 11.7 16.4	Average Crush (inches): 8.84	
A B (poundsf) Energy (ft*lbs) (mph) (mph) bsub1 Minimum 59.6 27.7 17604.72 23318.14 13.2 11.7 16.4	Δ	verage KE
Minimum 59.6 27.7 17604.72 23318.14 13.2 11.7 16.4	I	5
	A B (po	oundsf) Energy (ft*lbs) (mph) (mph) bsub1
Avg - 2 Std. Deviations N/A 0.0 N/A 510.68 2.0 N/A N/A	Minimum 59.6 27.7	17604.72 23318.14 13.2 11.7 16.4
	Avg - 2 Std. Deviations N/A 0.0	N/A 510.68 2.0 N/A N/A
Avg - 1 Std. Deviations 52.0 21.1 13784.93 18572.82 11.8 10.7 14.3	Avg - 1 Std. Deviations 52.0 21.1	13784.93 18572.82 11.8 10.7 14.3
Average 76.5 45.7 27764.42 35840.94 16.4 14.4 21.0	Average 76.5 45.7	27764.42 35840.94 16.4 14.4 21.0
Avg + 1 Std. Deviations 95.4 71.0 41743.91 52938.28 19.9 17.3 26.2	Avg + 1 Std. Deviations 95.4 71.0	41743.91 52938.28 19.9 17.3 26.2
Avg + 2 Std. Deviations 111.2 96.6 55723.40 69947.21 22.9 19.9 30.6	Avg + 2 Std. Deviations 111.2 96.6	55723.40 69947.21 22.9 19.9 30.6
Maximum 112.9 99.5 57327.90 71895.40 23.2 20.1 31.0	Maximum 112.9 99.5	57327.90 71895.40 23.2 20.1 31.0
Damage Centroid Depth (x) (inches)6.15k²3374.76	Damage Centroid Depth (x) (inches) 6.15	k ² 3374.76
Damage Centroid Depth (y) (inches) 51.63 Eff. Mass Ratio (gamma) 0.81	Damage Centroid Depth (y) (inches) 51.63	Eff. Mass Ratio (gamma) 0.81
Area of Damage (inches ²): 884.00	Area of Damage (inches ²): 884.00	

1995 CADILLAC ELDORADO - Side Impact

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Appendix 3-21

4N6XPRT StifCalcs® Force Balance - Page 1 of 2	4N6XPRT StifCalcs® Force Balance - Page 2 of 2
2006 CHEVROLET IMPALA MSP POLICE PACKAGE - Front Impact	1995 CADILLAC ELDORADO - Side Impact
Curb Weight (pounds): 3725 Occupant + Cargo Weight (pounds): 39 Total Weight (pounds): 3764 PDOF Lever Arm Distance (inches): 0.00 Yaw Moment of Inertia (lb-ft-sec ²)	Curb Weight (pounds): 3773 PDOF Lever Arm Distance (inches): 28.50 Occupant + Cargo Weight (pounds): 218 Yaw Moment of Inertia (lb-ft-sec ²) 2904.73
Angle Coll Force to Normal (degrees): 0.0 "Known" Stiffness Values No Damage Speed (mph): 5.0 A B Energy Crush Depth (inches): 7.36 Minimum 250.4 57.1 Damage Length (inches): 52.5 Maximum 494.8 229.5 Crush Profile Measurements: 6 Std. Devation 85.8 60.7 Equal Zone Area Zone Area Spacing Zone Area Depth(x) Depth(y) Depth(y) (inches) 0.00 10.50 35.18 223 78.56 7.00 246.23 C1 (inches) 0.00 10.50 101.85 5.00 509.72 16.29 1659.26 C3 (inches) 12.70 10.50 122.33 5.84 714.47 26.09 3191.74 C4 (inches) 10.50 35.70 22.7 80.92 45.50 1624.35 C6 (inches) 0.00 10.50 35.70 22.7 80.92 45.50 1624.35 C6 (inches) 0.00 10.50 35.70 22.7 80.92 45.	Angle Coll Force to Normal (degrees): 30.0 No Damage Speed (mph): 2.0 Energy Crush Depth (inches): 8.84 Damage Length (inches): 100.0 Crush Profile Measurements: 6 Equal Zone Area Spacing Zone Area Depth(x) Depth(y) (inches) 0.00 20.00 50.00 1.67 83.33 13.33 666.67 C1 (inches) 5.00 20.00 20.00 5.64 1166.63 31.72 6566.67 C3 (inches) 15.70 20.00 235.00 6.17 1449.63 68.71 16146.67 C5 (inches) 7.20 20.00 72.00 2.40 172.80 86.67 6240.00 C6 (inches) 0.00 72.00 2.40 172.80 86.67 6240.00 C9 (inches) 1
Average Crush (inches): 7.36	Average Crush (inches): 8.84
Average KE Closing Results Force Damage Speed Delta V Speed A B (poundsf) Energy (ft*lbs) (mph) (MPH)	Average KE Results Force Damage Speed Delta V A B (poundsf) Energy (ft*lbs) (mph) (mph) bsub1
Minimum 250.4 57.1 17604.72 18969.79 12.3 12.4 27.0 Avg - 2 Std. Deviations 152.3 -21.7 N/A N/A N/A N/A Avg - 1 Std. Deviations 238.1 39.0 13784.93 16655.57 11.5 11.4 24.7 Average 323.9 99.7 27764.42 27581.42 14.8 15.2 33.1 Avg + 1 Std. Deviations 409.7 160.4 41743.91 39372.58 17.7 18.4 39.9 Avg + 2 Std. Deviations 495.5 221.1 55723.40 51316.36 20.2 21.1 45.8 Maximum 494.8 229.5 57327.90 52449.46 20.4 21.3 46.3 Damage Centroid Depth (x) (inches) 4.63 k² 3290.26 32	Minimum 59.6 27.7 17604.72 23318.14 13.2 11.7 16.4 Avg - 2 Std. Deviations N/A 0.0 N/A 510.68 2.0 N/A N/A Avg - 1 Std. Deviations 52.0 21.1 13784.93 18572.82 11.8 10.7 14.3 Avg - 1 Std. Deviations 52.0 21.1 13784.93 18572.82 11.8 10.7 14.3 Avg + 1 Std. Deviations 95.4 71.0 41743.91 52938.28 19.9 17.3 26.2 Avg + 2 Std. Deviations 111.2 96.6 55723.40 69947.21 22.9 19.9 30.6 Maximum 112.9 99.5 57327.90 71895.40 23.2 20.1 31.0 Damage Centroid Depth (x) (inches) 6.15 k² 3374.76 Damage Centroid Depth (y) (inches) 51.63 Eff. Mass Ratio (gamma) 0.81 Area of Damage (inches²): 884.00 4N6XPRT StifCalcs® licensed by 4N6XPRT Systems (www.4N6XPRT.com) to: Satis Numbers 15E 0202015C023201
Registered Owner: 4N6XPRT SYSTEMS Serial Number: 15R-030201SC02301	Registered Owner: 4N6XPRT SYSTEMS Serial Number: 15R-030201SC02301

Crush Length = OPTION 1

Impala Stiffness Values from NHTSA Tests = AVERAGE CRUSH

Crush Measurement Spacing = NON-EQUAL

Lever Arm and Angle = YES

Page 1 = "KNOWN" = Bullet Page 2 = "UNKNOWN" = Target Page 3 = The two pages combined onto 1

Curb Weight (pour			PDOF	Lever Arm Distan	ce (inches):	:	0.00
Occupant + Cargo Weight (pou Total Weight (pou		39 64	Yaw M	Moment of Inerti	a (lb-ft-sec ²	²)	2670.92
Angle Coll Force to Normal (degre	ees): 0	.0	"Known"	Stiffness Values			
No Damage Speed (n	nph): 5	.0		Average	A 323.9	י ר ר	³ 99.7
Energy Crush Depth (inc	hes): 12.7	76		Minimum	250.4]	57.1
Damage Length (inc	:hes): 52	.3		Maximum	494.8		229.5
Crush Profile Measureme	ents:	6	S	td. Devation	85.8		60.7
	Unequal		Zone	Area	Zone	9	Area
	Spacing	Zone Are	a Depth(x)	Depth(x)	Depth(y) D	epth(y)
C1 (inches) 0.00	(inches)	(inches ²) (inches)	(inches³)	(inche	s) (i	nches³)
C2 (inches) 9.60	17.70	84.9	6 3.2	0 271.87] 11	L.80	1002.53
C3 (inches) 12.30	4.60	50.3	7 5.5	0 277.17	6	5.99	352.31
C4 (inches) 9.10	10.70	114.4	9 5.3	9 617.09	26	5.48	3032.08
C5 (inches) 4.40	12.20	82.3				L.99	3458.05
C6 (inches) 0.00	7.10	15.6	2 1.4	7 22.91]30).77	480.58
C7 (inches)							
C8 (inches)							
C9 (inches)							
C10 (inches)	6.65						
Average Crush (inches):	6.65						
Results			Average Force	Damage	KE Speed	Delta V	Closing Speed
	А	В	(poundsf)	Energy (ft*lbs)	(mph)	(mph)	(MPH)
Minimum	250.4	57.1	25607.60	16683.88	11.5	12.2	26.5
Avg - 2 Std. Deviations	152.3	-21.7	N/A	N/A	N/A	N/A	N/A
Avg - 1 Std. Deviations	238.1	39.0	19244.29	14872.59	10.9	11.1	24.1
Average	323.9	99.7	41749.26	23961.89	13.8	15.0	32.5
Avg + 1 Std. Deviations	409.7	160.4	64254.23	33913.19	16.4	18.1	39.3
Avg + 2 Std. Deviations	495.5	221.1	86759.20	44016.54	18.7	20.7	45.0
Maximum	494.8	229.5	89544.77	44935.85	18.9	21.0	45.6
Damage Centroid Depth (x)	(inches)	4.25			k²	3290.26	
Damage Centroid Depth (y)	(inches)	23.94		Eff. Mass Ratio (gamma)	1.00	
Area of Damage (ir	nches²):	347.79					

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Appendix 3-24

Curb Weight (po Occupant + Cargo Weight (po Total Weight (po	ounds): 2	18		.ever Arm Distan Ioment of Inerti		
Angle Coll Force to Normal (deg No Damage Speed (Energy Crush Depth (ir Damage Length (ir	(mph): 2 nches): 30.	0.0 2.0 56 0.4				
Crush Profile Measurer C1 (inches) 0.00 C2 (inches) 11.00 C3 (inches) 10.30	nents: Unequal Spacing (inches) 19.80 1.30 10.90	8 Zone Are (inches ² 108.9 13.8 188.5) (inches) 0 3.67 5 5.33	3 73.75		y) Depth(y)
C4 (inches) 24.30 C5 (inches) 23.80 C6 (inches) 20.10 C7 (inches) 13.20 C8 (inches) 0.00	17.20 9.60 10.60 31.00	413.6 210.7 176.4 204.6	6 12.03 2 11.00 9 8.44	3 4974.44 0 2318.13 4 1490.31	60 60 43 57	0.17 24890.01 8.07 9074.69 7.93 10224.76 6.33 40169.80
C9 (inches) C10 (inches) Average Crush (inches):	13.12					
Results	A	B	Average Force (poundsf)	Damage Energy (ft*lbs)	(mph)	Delta V (mph) bsub1
Minimum	40.9	13.1	25607.60	24007.84	13.4	11.5 11.3
Avg - 2 Std. Deviations	N/A	N/A	N/A	N/A	N/A	N/A N/A
Avg - 1 Std. Deviations	35.2	9.7	19244.29	18678.59	11.8	10.5 9.7
Average	52.8	21.8	41749.26	37258.03	16.7	14.1 14.6
Avg + 1 Std. Deviations	66.0	34.1	64254.23	55383.45	20.4	17.1 18.2
Avg + 2 Std. Deviations	77.0	46.5	86759.20	73285.21	23.5	19.6 21.2
Maximum	78.3	48.0	89544.77	75490.18	23.8	19.8 21.6
Damage Centroid Depth (x) (inches)	9.02			k²	3374.76
Damage Centroid Depth (y) (inches)	69.18		Eff. Mass Ratio (g	gamma) [0.81
Area of Damage	(inches²):	1316.79				

1995 CADILLAC ELDORADO - Side Impact

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Registered Owner: 4N6XPRT SYSTEMS

Appendix 3-25

4N6XPRT StifCalcs® Force Balance - Page 1 of 2	4N6XPRT StifCalcs® Force Balance - Page 2 of 2
2006 CHEVROLET IMPALA MSP POLICE PACKAGE - Front Impact	1995 CADILLAC ELDORADO - Side Impact
Curb Weight (pounds): 3725 Occupant + Cargo Weight (pounds): 39 Total Weight (pounds): 3764 PDOF Lever Arm Distance (inches): 0.00 Yaw Moment of Inertia (lb-ft-sec ²)	Curb Weight (pounds): 3773 Occupant + Cargo Weight (pounds): 218 Total Weight (pounds): 3991 PDOF Lever Arm Distance (inches): 28.50 Yaw Moment of Inertia (lb-ft-sec ²)
Angle Coll Force to Normal (degrees): 0.0	Angle Coll Force to Normal (degrees): 30.0 No Damage Speed (mph): 2.0 Energy Crush Depth (inches): 30.56 Damage Length (inches): 100.4 Crush Profile Measurements: 8 Unequal Zone Area Zone Area Spacing Zone Area Depth(x) Depth(y) (inches ³) C1 (inches) 0.00 19.80 108.90 3.67 399.30 13.20 1437.48 C2 (inches) 11.00 1.30 13.85 5.33 73.75 1.94 26.90 C3 (inches) 10.30 10.90 188.57 9.12 1720.15 27.99 5277.14 C4 (inches) 24.30 17.20 413.66 12.03 4974.44 60.17 24890.01 C5 (inches) 23.80 9.60 210.72 11.00 2318.13 43.07 9074.69 C6 (inches) 20.10 10.60 176.49 84.4 1490.31 57.93 10224.76 C7 (inches) 0.00 10.60 176.49 84.4 1490.31 57.93
C9 (inches)	C9 (inches)
Average Crush (inches): 6.65	Average Crush (inches): 13.12
Average KE Closing Force Damage Speed Delta V Speed A B (poundsf) Energy (ft*lbs) (mph) (MPH)	Average KE Force Damage Speed Delta V A B (poundsf) Energy (ft*lbs) (mph) (mph) bsub1
Minimum 250.4 57.1 25607.60 16683.88 11.5 12.2 26.5 Avg - 2 Std. Deviations 152.3 -21.7 N/A N/A N/A N/A Avg - 1 Std. Deviations 238.1 39.0 19244.29 14872.59 10.9 11.1 24.1 Average 323.9 99.7 41749.26 23961.89 13.8 15.0 32.5 Avg + 1 Std. Deviations 409.7 160.4 64254.23 33913.19 16.4 18.1 39.3 Avg + 2 Std. Deviations 495.5 221.1 86759.20 44016.54 18.7 20.7 45.0 Maximum 494.8 229.5 89544.77 44935.85 18.9 21.0 45.6 Damage Centroid Depth (x) (inches) 4.25 k² 3290.26 3290.26 347.79 Maximum 1.00 Area of Damage (inches ²): 347.79 34935.85 1.00 1.00 Area of Damage (inches ²): 347.79 4405XPRT Stystems (www.4N6XPRT.com) to: 406XPRT StifCalcs® licensed by 4N6XPRT Systems (www.4N6XPRT.com) to:	Minimum 40.9 13.1 25607.60 24007.84 13.4 11.5 11.3 Avg - 2 Std. Deviations N/A N/A N/A N/A N/A N/A N/A Avg - 1 Std. Deviations 35.2 9.7 19244.29 18678.59 11.8 10.5 9.7 Average 52.8 21.8 41749.26 37258.03 16.7 14.1 14.6 Avg + 1 Std. Deviations 66.0 34.1 64254.23 55383.45 20.4 17.1 18.2 Avg + 2 Std. Deviations 77.0 46.5 86759.20 73285.21 23.5 19.6 21.2 Maximum 78.3 48.0 89544.77 75490.18 23.8 19.8 21.6 Damage Centroid Depth (x) (inches) 9.02 k² 3374.76 3374.76 Damage Centroid Depth (y) (inches) 69.18 Eff. Mass Ratio (gamma) 0.81 Area of Damage (inches ²): 1316.79 1316.79 340.05208 Isotemed by 4N6XPRT Systems (www.4N6XPRT.com) to:
Registered Owner: 4N6XPRT SYSTEMS Serial Number: 15R-030201SC02301	Registered Owner: 4N6XPRT SYSTEMS Serial Number: 15R-030201SC02301

Crush Length = OPTION 2

Impala Stiffness Values from NHTSA Tests = AVERAGE CRUSH

Crush Measurement Spacing = EQUAL

Lever Arm and Angle = YES

Page 1 = "KNOWN" = Bullet Page 2 = "UNKNOWN" = Target Page 3 = The two pages combined onto 1

Curb Weight (pound			PDOF	Lever Arm Distar	ce (inches):	0.00
Occupant + Cargo Weight (poun Total Weight (pound		39 64	Yaw N	Moment of Inert	a (lb-ft-sec	2 ²)	2670.92
Angle Coll Force to Normal (degree	es): 0	.0	"Known"	Stiffness Values			
No Damage Speed (mp	oh): 5	.0		Average	A 323.9		B 99.7
Energy Crush Depth (inch	es): 7.3	6		Minimum	250.4		57.1
Damage Length (inch	es): 52	.5		Maximum	494.8		229.5
Crush Profile Measuremer	nts:	6	S	td. Devation	85.8		60.7
	Equal		Zone	Area	Zon	e	Area
	Spacing	Zone Area	a Depth(x)	Depth(x)	Depth	(y) D	epth(y)
C1 (inches) 0.00	(inches)	(inches ²) (inches)	(inches ³)	(inche	es) (i	nches ³)
	10.50	35.1	8 2.2	3 78.56		7.00	246.23
	10.50	101.8	5 5.0	0 509.72] 1	6.29	1659.26
C3 (inches) 12.70	10.50	122.3	3 5.8	4 714.47	2	6.09	3191.74
C4 (inches) 10.60	10.50	91.3	5 4.4	2 403.69	3	6.37	3322.20
C5 (inches) 6.80	10.50	35.7	0 2.2	7 80.92	4	5.50	1624.35
C6 (inches) 0.00] []		
C7 (inches)					1		
C8 (inches)					」 1		
C9 (inches)					」 」		
C10 (inches)							
Average Crush (inches):	7.36						
Results			Average	_	KE		Closing
Results	А	В	Force (poundsf)	Damage Energy (ft*lbs)	Speed (mph)	Delta V (mph)	Speed (MPH)
		,	•			· · ·	
Minimum	250.4	57.1	17604.72	18969.79	12.3	12.9	28.0
Avg - 2 Std. Deviations	152.3	-21.7	N/A	N/A	N/A	N/A	N/A
Avg - 1 Std. Deviations	238.1	39.0	13784.93	16655.57	11.5	11.7	25.5
Average	323.9	99.7	27764.42	27581.42	14.8	15.8	34.3
Avg + 1 Std. Deviations	409.7	160.4	41743.91	39372.58	17.7	19.1	41.5
Avg + 2 Std. Deviations	495.5	221.1	55723.40	51316.36	20.2	21.9	47.6
Maximum	494.8	229.5	57327.90	52449.46	20.4	22.2	48.2
Damage Centroid Depth (x) (ii	nches)	4.63			k²	3290.26	5
Damage Centroid Depth (y) (ii	nches)	25.99		Eff. Mass Ratio (gamma)	1.00)
Area of Damage (inc	hes²):	386.40					

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Appendix 3-28

Curb Weight (pou Occupant + Cargo Weight (pou Total Weight (pou	unds): 2	18		ever Arm Distan Ioment of Inertia		28.50 2904.73
Angle Coll Force to Normal (deg No Damage Speed (Energy Crush Depth (in Damage Length (ir	mph): 2 ches): 9.5	.0				
Crush Profile Measuren C1 (inches) 0.00 C2 (inches) 4.20 C3 (inches) 18.10 C4 (inches) 18.90 C5 (inches) 6.60 C6 (inches) 0.00 C7 (inches) 0.00 C9 (inches) 0.00 C10 (inches) 0.00	ents: Equal Spacing (inches) 31.20 31.20 31.20 31.20 31.20 () 31.20 () () () () () () () () () () () () ()	6 Zone Area (inches ²) 65.52 347.88 577.20 397.80	(inches) (in	2190.60 5339.93 2732.65	Zone Depth(y) (inches) 20.8 50.0 50.0 78.1 106.6 135.2	(inches ³) 1362.82 17408.35 1 45086.50 9 42441.98
Average Crush (inches):	9.30		Average Force	Damage	KE Speed D	elta V
	А	В	(poundsf)	Energy (ft*lbs)	(mph) (mph) bsub1
Minimum	36.9	16.6	17604.72	26327.06	14.1	12.2 15.8
Avg - 2 Std. Deviations	N/A	N/A	N/A	N/A	N/A	N/A N/A
Avg - 1 Std. Deviations	32.2	12.6	13784.93	20910.99	12.5	11.1 13.8
Average	47.3	27.3	27764.42	40645.67	17.5	14.9 20.3
Avg + 1 Std. Deviations	58.9	42.3	41743.91	60229.99	21.3	18.0 25.3
Avg + 2 Std. Deviations	68.7	57.5	55723.40	79736.48	24.5	20.7 29.5
Maximum	69.8	59.3	57327.90	81971.82	24.8	20.9 29.9
Damage Centroid Depth (x)	(inches)	7.10			k²	3374.76
Damage Centroid Depth (y		80.61	E	Eff. Mass Ratio (g	jamma)	0.81
Area of Damage (1491.36				

1995 CADILLAC ELDORADO - Side Impact

Registered Owner: 4N6XPRT SYSTEMS

Appendix 3-29

4N6XPRT StifCalcs® Force Balance - Page 1 of 2	4N6XPRT StifCalcs® Force Balance - Page 2 of 2
2006 CHEVROLET IMPALA MSP POLICE PACKAGE - Front Impact	1995 CADILLAC ELDORADO - Side Impact
Curb Weight (pounds): 3725 PDOF Lever Arm Distance (inches): 0.00	Curb Weight (pounds): 3773 PDOF Lever Arm Distance (inches): 28.50
Occupant + Cargo Weight (pounds): 39 Total Weight (pounds): 3764 Yaw Moment of Inertia (lb-ft-sec ²) 2670.92	Occupant + Cargo Weight (pounds): 218 Total Weight (pounds): 3991 Yaw Moment of Inertia (lb-ft-sec ²) 2904.73
Angle Coll Force to Normal (degrees): 0.0 "Known" Stiffness Values	Angle Coll Force to Normal (degrees): 30.0
No Damage Speed (mph): 5.0 Average 323.9 99.7	No Damage Speed (mph): 2.0
Energy Crush Depth (inches): 7.36 Minimum 250.4 57.1	Energy Crush Depth (inches): 9.56
Damage Length (inches): 52.5 Maximum 494.8 229.5	Damage Length (inches): 156.0
Crush Profile Measurements: 6 Std. Devation 85.8 60.7	Crush Profile Measurements: 6
Equal Zone Area Zone Area	Equal Zone Area Zone Area
Spacing Zone Area Depth(x) Depth(x) Depth(y) Depth(y) (inches) (inches²) (inches³) (inches³) (inches³)	Spacing Zone Area Depth(x) Depth(y) Depth(y) (inches ²) (inches ³) (inches ³) (inches ³)
C1 (inches) 0.00 35.18 2.23 78.56 7.00 246.23	C1 (inches) 0.00 31.20 65.52 1.40 91.73 20.80 1362.82
C2 (inches) 6.70 101.85 5.00 509.72 16.29 1659.26	C2 (inches) 4.20 31.20 347.88 6.30 2190.60 50.04 17408.35
C3 (inches) 12.70 10.50 122.33 5.84 714.47 26.09 3191.74	C3 (inches) 18.10 31.20 577.20 9.25 5339.93 78.11 45086.50
C4 (inches) 10.60 91.35 4.42 403.69 36.37 3322.20	C4 (inches) 18.90 31.20 397.80 6.87 2732.65 106.69 42441.98
C5 (inches) 6.80 35.70 2.27 80.92 45.50 1624.35	C5 (inches) 6.60 31.20 102.96 2.20 226.51 135.20 13920.19
C6 (inches) 0.00	C6 (inches) 0.00
C7 (inches)	C7 (inches)
C8 (inches)	C8 (inches)
C9 (inches)	C9 (inches)
C10 (inches)	
Average Crush (inches): 7.36	Average Crush (inches): 9.56
Average KE Closing Results Force Damage Speed Delta V Speed	Average KE Results Force Damage Speed Delta V
A B (poundsf) Energy (ft*lbs) (mph) (MPH)	A B (poundsf) Energy (ft*lbs) (mph) (mph) bsub1
Minimum 250.4 57.1 17604.72 18969.79 12.3 12.9 28.0	Minimum 36.9 16.6 17604.72 26327.06 14.1 12.2 15.8
Avg - 2 Std. Deviations 152.3 -21.7 N/A N/A N/A N/A N/A	Avg - 2 Std. Deviations N/A N/A N/A N/A N/A N/A N/A
Avg - 1 Std. Deviations 238.1 39.0 13784.93 16655.57 11.5 11.7 25.5	Avg - 1 Std. Deviations 32.2 12.6 13784.93 20910.99 12.5 11.1 13.8
Average 323.9 99.7 27764.42 27581.42 14.8 15.8 34.3	Average 47.3 27.3 27764.42 40645.67 17.5 14.9 20.3
Avg + 1 Std. Deviations 409.7 160.4 41743.91 39372.58 17.7 19.1 41.5	Avg + 1 Std. Deviations 58.9 42.3 41743.91 60229.99 21.3 18.0 25.3
Avg + 2 Std. Deviations 495.5 221.1 55723.40 51316.36 20.2 21.9 47.6	Avg + 2 Std. Deviations 68.7 57.5 55723.40 79736.48 24.5 20.7 29.5
Maximum 494.8 229.5 57327.90 52449.46 20.4 22.2 48.2	Maximum 69.8 59.3 57327.90 81971.82 24.8 20.9 29.9
Damage Centroid Depth (x) (inches) 4.63 k ² 3290.26	Damage Centroid Depth (x) (inches) 7.10 k ² 3374.76
Damage Centroid Depth (y) (inches) 25.99 Eff. Mass Ratio (gamma) 1.00	Damage Centroid Depth (y) (inches) 80.61 Eff. Mass Ratio (gamma) 0.81
Area of Damage (inches ²): 386.40	Area of Damage (inches ²): 1491.36
4N6XPRT StifCalcs® licensed by 4N6XPRT Systems (www.4N6XPRT.com) to: Registered Owner: 4N6XPRT SYSTEMS Serial Number: 15R-030201SC02301	4N6XPRT StifCalcs® licensed by 4N6XPRT Systems (www.4N6XPRT.com) to: Registered Owner: 4N6XPRT SYSTEMS Serial Number: 15R-0302015C02301

Crush Length = OPTION 2

Impala Stiffness Values from NHTSA Tests = AVERAGE CRUSH

Crush Measurement Spacing = NON-EQUAL

Lever Arm and Angle = YES

Page 1 = "KNOWN" = Bullet Page 2 = "UNKNOWN" = Target Page 3 = The two pages combined onto 1

Curb Weight (pour			PDOF	Lever Arm Distar	ice (inches)):	0.00
Occupant + Cargo Weight (pou Total Weight (pour		39 54	Yaw N	Moment of Inert	ia (lb-ft-sec	²)	2670.92
Angle Coll Force to Normal (degree	ees): 0	.0	"Known"	Stiffness Value	5		
No Damage Speed (m		.0		A	A 323.9		B 99.7
Energy Crush Depth (inc		76		Average			
Damage Length (inc				Minimum	250.4		57.1
Danage Lengar (inc				Maximum	494.8		229.5
Crush Profile Measureme	ents:	6	S	td. Devation	85.8		60.7
	Unequal		Zone	Area	Zone		Area
	Spacing (inches)	Zone Area (inches ²)	1 ()	Depth(x) (inches³)	Depth (inche	•	epth(y) inches ³)
C1 (inches) 0.00	17.70	84.9				1.80	1002.53
C2 (inches) 9.60							
C3 (inches) 12.30	4.60	50.37				6.99	352.31
C4 (inches) 9.10	10.70	114.49				6.48	3032.08
C5 (inches) 4.40	12.20	82.3				1.99	3458.05
C6 (inches) 0.00	7.10	15.62	2 1.4	7 22.91	30	0.77	480.58
C7 (inches)							
C8 (inches)							
C9 (inches)							
C10 (inches)							
· · · · · · · · · · · · · · · · · · ·	6.65						
Average Crush (inches):	6.65						
Results			Average Force	Damage	KE Speed	Delta V	Closing Speed
	А	В	(poundsf)	Energy (ft*lbs)	(mph)	(mph)	(MPH)
Minimum	250.4	57.1	25607.60	16683.88	11.5	11.5	24.9
Avg - 2 Std. Deviations	152.3	-21.7	N/A	N/A	N/A	N/A	N/A
Avg - 1 Std. Deviations	238.1	39.0	19244.29	14872.59	10.9	10.5	22.7
Average	323.9	99.7	41749.26	23961.89	13.8	14.0	30.4
Avg + 1 Std. Deviations	409.7	160.4	64254.23	33913.19	16.4	16.9	36.7
Avg + 2 Std. Deviations	495.5	221.1	86759.20	44016.54	18.7	19.4	42.0
Maximum	494.8	229.5	89544.77	44935.85	18.9	19.6	42.6
Damage Centroid Depth (x)	(inches)	4.25			k²	3290.26	5
Damage Centroid Depth (y)	(inches)	23.94		Eff. Mass Ratio (gamma)	1.00	ס
Area of Damage (in	ches²):	347.79					

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Registered Owner: 4N6XPRT SYSTEMS

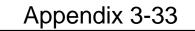
Appendix 3-32

Curb Weight (poun	ids): 377	73	PDOF	Lever Arm Distar	nce (inches	<u>۱</u> .	28.50
Dccupant + Cargo Weight (pour	nds): 2 1	18					
Total Weight (poun	ids): 399	91	Yaw	Moment of Inert	ia (ID-tt-sec	(²)	2904.73
ngle Coll Force to Normal (degre	es): 30	.0					
No Damage Speed (m	ph): 2	.0					
Energy Crush Depth (incl	nes): 23.2	29					
Damage Length (incl	nes): 155	.9					
Crush Profile Measureme	nts:	10					
	Unequal		Zone	Area	Zon	e	Area
	Spacing	Zone Area		Depth(x)	Depth		Depth(y)
	(inches)	(inches²)	(inches)	(inches ³)	(inch	•	(inches ³)
C1 (inches) 0.00	29.30	68.86	1.5	7 107.87] 1	9.53	1344.97
C2 (inches) 4.70	18.30	130.85	3.7	1 486.08	2	8.50	3728.44
C3 (inches) 9.60	1.30	11.96	4.6	0 55.05		3.24	38.76
C4 (inches) 8.80	10.60	147.34	7.2	6 1069.96	3	7.75	5561.82
C5 (inches) 19.00	8.60	172.43	10.0	3 1730.19	3	8.78	6685.98
C6 (inches) 21.10	18.10	377.39	10.4	3 3934.43	9	9.51	37555.03
C7 (inches) 20.60	10.80	196.02	9.1	3 1789.69	6	9.96	13712.98
C8 (inches) 15.70	33.60	337.68	5.5	5 1875.61	24	8.85	84032.26
C9 (inches) 4.40	25.30	55.66	1.4	7 81.63	21	0.83	11734.98
C10 (inches) 0.00							
Average Crush (inches):	9.61						
Results			Average Force	Damage	KE Speed	Delta V	
	А	В	(poundsf)	Energy (ft*lbs)	(mph)	(mph)	bsub1
Minimum	30.0	10.9	25607.60	19218.06	12.0	10.8	12.8
Avg - 2 Std. Deviations	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Avg - 1 Std. Deviations	25.8	8.1	19244.29	14986.33	10.6	9.9	11.0
Average	38.7	18.3	41749.26	29735.18	15.0	13.2	16.6
Avg + 1 Std. Deviations	48.5	28.6	64254.23	44116.15	18.2	15.9	20.8
Avg + 2 Std. Deviations	56.6	39.0	86759.20	58315.84	20.9	18.3	24.2
Maximum	57.5	40.3	89544.77	60064.63	21.2	18.5	24.6
Damage Centroid Depth (x) (inches)	7.43			k²	3374.7	/6
	in choc)	109.73		Eff. Mass Ratio (asmms)	0.8	21
Damage Centroid Depth (y) (109.75			gannna)	0.0	<u>'</u>

1995 CADILLAC ELDORADO - Side Impact

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

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4N6XPRT StifCalcs® Force Balance - Page 1 of 2	4N6XPRT StifCalcs® Force Balance - Page 2 of 2						
2006 CHEVROLET IMPALA MSP POLICE PACKAGE - Front Impact	1995 CADILLAC ELDORADO - Side Impact						
Curb Weight (pounds): 3725 Occupant + Cargo Weight (pounds): 39 Total Weight (pounds): 3764 PDOF Lever Arm Distance (inches): 0.00 Yaw Moment of Inertia (lb-ft-sec ²)	Curb Weight (pounds): 3773 Occupant + Cargo Weight (pounds): 218 Total Weight (pounds): 3991 PDOF Lever Arm Distance (inches): Yaw Moment of Inertia (lb-ft-sec ²) 2904.73						
Angle Coll Force to Normal (degrees): 0.0 "Known" Stiffness Values No Damage Speed (mph): 5.0 Energy Crush Depth (inches): 12.76 Damage Length (inches): 52.3 Crush Profile Measurements: 6 Spacing Zone Spacing Zone Area Spacing Zone Area Depth(x) Depth(x) Depth(x) Depth(x) Of (inches) 12.30 G1 (inches) 10.70 Station 50.37 Spacing 50.37 Spacing 50.37 Spacing 50.37 Spacing 11.449 Spacing 50.37 Spacing 50.37 <th>Angle Coll Force to Normal (degrees): 30.0 No Damage Speed (mph): 2.0 Energy Crush Depth (inches): 23.29 Damage Length (inches): 135.9 Crush Profile Measurements: 10 Unequal Zone Area Zone Area Spacing Zone Area Depth(x) Depth(y) Depth(y) Depth(y) (inches) 0.00 29.30 68.86 1.57 107.87 19.53 1344.97 C2 (inches) 4.70 18.30 130.85 3.71 486.08 28.50 3728.44 C3 (inches) 9.600 1.30 11.96 4.60 55.05 3.24 38.76 C4 (inches) 8.80 10.60 147.34 7.26 1069.96 37.75 5561.82 C5 (inches) 19.00 8.60 172.43 10.03 1730.19 38.78 6685.98 C6 (inches) 21.10 18.10 377.39 10.43 3934.43 99.51 3755.03 C7 (inches) 15.70 33.60 337.68 5.55 1875.61 248.85</th>	Angle Coll Force to Normal (degrees): 30.0 No Damage Speed (mph): 2.0 Energy Crush Depth (inches): 23.29 Damage Length (inches): 135.9 Crush Profile Measurements: 10 Unequal Zone Area Zone Area Spacing Zone Area Depth(x) Depth(y) Depth(y) Depth(y) (inches) 0.00 29.30 68.86 1.57 107.87 19.53 1344.97 C2 (inches) 4.70 18.30 130.85 3.71 486.08 28.50 3728.44 C3 (inches) 9.600 1.30 11.96 4.60 55.05 3.24 38.76 C4 (inches) 8.80 10.60 147.34 7.26 1069.96 37.75 5561.82 C5 (inches) 19.00 8.60 172.43 10.03 1730.19 38.78 6685.98 C6 (inches) 21.10 18.10 377.39 10.43 3934.43 99.51 3755.03 C7 (inches) 15.70 33.60 337.68 5.55 1875.61 248.85						
Average Crush (inches):Average KE Closing	Average Crush (inches): 9.61 Average KE						
Average KE Closing A B (poundsf) Energy (ft*lbs) (mph) (mph) Minimum 250.4 57.1 25607.60 16683.88 11.5 11.5 24.9 Avg - 2 Std. Deviations 152.3 -21.7 N/A N/A N/A N/A Avg - 1 Std. Deviations 238.1 39.0 19244.29 14872.59 10.9 10.5 22.7 Average 323.9 99.7 41749.26 23961.89 13.8 14.0 30.4 Avg + 1 Std. Deviations 409.7 160.4 64254.23 33913.19 16.4 16.9 36.7 Avg + 2 Std. Deviations 495.5 221.1 86759.20 44016.54 18.7 19.4 42.0 Maximum 494.8 229.5 89544.77 44935.85 18.9 19.6 42.6 Damage Centroid Depth (x) (inches) 42.5 k² 3290.26 10.0 400.4 Damage Centroid Depth (y) (inches) 23.94 Eff. Mass Ratio (gamma) 1.00 40.2 Area of Damage (inches²): 347.79 4406X	Average KE Force Damage Speed Delta V A B (poundsf) Energy (ft*lbs) (mph) (mph) bsub1 Minimum 30.0 10.9 25607.60 19218.06 12.0 10.8 12.8 Avg - 2 Std. Deviations N/A N/A N/A N/A N/A N/A N/A Avg - 1 Std. Deviations 25.8 8.1 19244.29 14986.33 10.6 9.9 11.0 Average 38.7 18.3 41749.26 29735.18 15.0 13.2 16.6 Avg + 1 Std. Deviations 48.5 28.6 64254.23 44116.15 18.2 15.9 20.8 Avg + 2 Std. Deviations 56.6 39.0 86759.20 58315.84 20.9 18.3 24.2 Maximum 57.5 40.3 89544.77 60064.63 21.2 18.5 24.6 Damage Centroid Depth (x) (inches) 109.73 Eff. Mass Ratio (gamma) 0.81 Area of Damage (inches ²): 1498.18 4N6XPRT StySTEMS Serial Number: 15R-0302015C02301						

NHTSA Tests for MAXIMUM CRUSH Stiffness Value Determination

4N6XPRT StifCalcs®

Available Test Results Front Impact Test Summary

Report Filter Settings

Year Range: 2006 - 2013 Make: CHEVROLET Model: IMPALA

Test Numbe	Vehicle r Info	No Damage Speed (mph)	Max Crush (inch)	•	V S t A			•	Crush Factor
7496	2012 CHEVROLET IMPALA FOUR DOOR SEDAN	5.0	15.4	20.0	207.6	40.4	533.3	71.8	10.4
5578	2006 CHEVROLET MONTE CARLO TWO DOOR C	5.0	28.0	35.0	235.7	50.6	549.0	68.9	17.5
5547	2006 CHEVROLET IMPALA FOUR DOOR SEDAN	5.0	28.3	35.2	240.8	51.2	565.9	69.6	17.4
5468	2006 PONTIAC GRAND PRIX FOUR DOOR SEDAN	5.0	26.7	35.1	249.3	56.1	553.6	76.3	18.4
7488	2012 CHEVROLET IMPALA FOUR DOOR SEDAN	5.0	26.5	34.9	253.9	57.2	563.5	77.9	18.4
5274	2005 BUICK LACROSSE FOUR DOOR SEDAN	5.0	24.9	35.1	269.7	65.2	558.3	88.6	19.8
6052	2007 CHEVROLET IMPALA FOUR DOOR SEDAN	5.0	13.9	24.7	340.6	96.4	601.5	151.5	17.6
Average (AVG)				256.8	59.6	560.7	86.4	17.1	
Minimum (MIN)				207.6	40.4	533.3	68.9	10.4	
Maximum (MAX)				340.6	96.4	601.5	151.5	19.8	
Standard Deviation (STDev-sample)				41.6	17.9	21.0	29.5	3.1	
Number of Tests (n)			7						

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



Crush Length = OPTION 1

Impala Stiffness Values from NHTSA Tests = MAXIMUM CRUSH

Crush Measurement Spacing = EQUAL

Lever Arm and Angle = NO

Page 1 = "KNOWN" = Bullet Page 2 = "UNKNOWN" = Target Page 3 = The two pages combined onto 1

Angle Coll Force to Normal (degrees): 0.0 No Damage Speed (mph): 5.0 Energy Crush Depth (inches): 7.36 Damage Length (inches): 52.5 Crush Profile Measurements: 6 Spacing Zone Area Spacing Zone Area Depth(x) Depth(x) Depth(x) Depth(x) Outloss 5.00 10.50 35.18 2.23 78.56 7.00 246.23 C3 (inches) 10.50 10.50 35.18 2.23 78.56 7.00 246.23 C3 (inches) 10.50 10.50 10.50 10.50 35.18 2.23 78.56 7.00 246.23 C3 (inches) 10.50 10.50 10.50 10.50 35.70 2.27 80.92 45.50 1624.35 C4 (inches) 0.00 C5 (inches) 0.00 C6 (inches) 0.00 C9 (inches)	Curb Weight (pou Occupant + Cargo Weight (pou Total Weight (pou	ınds):	39		ever Arm Distand		0.00
No Damage Speed (mph): 5.0 Energy Crush Depth (inches): 7.36 Damage Length (inches): 52.5 Crush Profile Measurements: 6 Equal Zone Area Zone Area Zone Area C1 (inches) 6.70 10.50 35.18 2.23 78.56 7.00 246.23 C2 (inches) 6.70 10.50 101.85 5.00 509.72 16.29 1659.26 C3 (inches) 10.50 112.233 5.84 714.47 26.09 3191.74 C4 (inches) 0.00 10.50 112.233 5.84 714.47 26.09 3191.74 C4 (inches) 0.00 10.50 112.233 5.84 714.47 26.09 3191.74 C4 (inches) 0.00 10.50 91.35 4.44.2 403.69 36.37 33222.00 C5 (inches) 0.00 10.50 35.70 2.27 80.92 45.50 1624.33 C6 (inches) 0.00 0.50 91.35 4.42 403.69 36.37 3322.20		/	_	"Known"	Stiffness Values	Δ	B
Energy Crush Depth (inches): 7.36 Damage Length (inches): 5225 Crush Profile Measurements: 6 Equal Zone Spacing Zone Area (inches) (inches) (inches) 0.00 (1) (inches) 0.00 (2) (inches) 0.00 </td <td>No Damage Speed (n</td> <td>nph): 5</td> <td>.0</td> <td></td> <td>Average</td> <td></td> <td></td>	No Damage Speed (n	nph): 5	.0		Average		
Damage Length (inches): \$22.5 Maximum 340.6 \$64. Crush Profile Measurements: 6 \$16.0 \$17.9 Equal Zone Area Depth(x) Depth(y) Depth(y) C1 (inches) 0.00 (inches) ² (inches) ² 0.00 20.6 Area C2 (inches) 6.70 10.50 35.18 223 78.55 7.00 24623 C3 (inches) 10.50 101.85 5.00 509.72 16.29 1659.26 C3 (inches) 10.50 1123.33 5.84 714.47 26.09 3191.74 C4 (inches) 10.60 10.50 91.35 4.42 403.66 36.37 3322.20 C5 (inches) 6.80 10.50 35.70 2.27 80.92 45.50 1624.35 C6 (inches) 0.00 10.50 35.70 2.27 80.92 45.50 1624.35 C6 (inches) 0.00 10.50 35.70 2.27 80.92 45.50 1624.35 C6 (inches) 0.00 10.50 35.70 <	Energy Crush Depth (inc	:hes): 7.	86			207.6	40.4
Crush Profile Measurements 6 Zone Area Zone Area Equal Spacing Zone Area Depth(x) Depth(x) Depth(y) (inches) C1 (inches) 0.00 10.50 35.18 2.23 78.56 7.00 246.23 C2 (inches) 6.70 10.50 101.85 5.00 509.72 16.29 1659.26 C3 (inches) 12.70 10.50 122.33 5.84 714.47 26.09 31191.74 C4 (inches) 10.60 10.50 91.35 4.42 403.69 36.37 3322.20 C5 (inches) 6.80 10.50 35.70 2.27 80.92 45.50 1624.35 C6 (inches) 0.00 0.50 35.70 2.27 80.92 45.50 1624.35 C7 (inches) 0.00 0.50 35.70 2.27 80.92 45.50 1624.35 C10 (inches) 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	Damage Length (ind	ches): 52	.5				
Spacing (inches) Zone Area (inches) ² Depth(x) (inches) ³ Depth(x) (inches) ⁴ Depth(y) (inches) ⁴ Depth(y) (inches) ⁴ Depth(y) (inches) ⁴ C1 (inches) 6.70 10.50 35.18 2.23 78.55 7.00 246.23 C2 (inches) 6.70 10.50 101.85 5.00 509.72 16.29 1659.26 C3 (inches) 127.00 10.50 122.33 5.84 714.47 26.09 3191.74 C4 (inches) 10.60 10.50 91.35 4.42 403.69 36.37 3322.20 C5 (inches) 6.80 10.50 35.70 2.27 80.92 45.50 1624.35 C6 (inches) 0.00 0 <t< td=""><td>Crush Profile Measurem</td><td>ents:</td><td>6</td><td>St</td><td>td. Devation</td><td>41.6</td><td>17.9</td></t<>	Crush Profile Measurem	ents:	6	St	td. Devation	41.6	17.9
C1 (inches) (inches) (inches ²) (inches ³) (inches ³) (inches ³) C2 (inches) 6.70 10.50 35.18 2.23 78.56 7.00 246.23 C3 (inches) 12.70 10.50 101.85 5.00 599.72 16.29 1659.26 C3 (inches) 10.60 10.50 122.33 5.84 714.47 26.09 3191.74 C4 (inches) 10.60 10.50 91.35 4.42 403.69 36.37 3322.20 C5 (inches) 6.80 10.50 35.70 2.27 80.92 45.50 1624.35 C7 (inches)		Equal		Zone	Area	Zone	Area
C1 (inches) 0.00 10.50 35.18 2.23 78.56 7.00 24623 C2 (inches) 6.70 10.50 101.85 5.00 599.72 16.29 1659.26 C3 (inches) 12.70 10.50 122.33 5.84 714.47 26.09 3191.74 C4 (inches) 10.60 10.50 91.35 4.42 403.69 36.37 3322.20 C5 (inches) 6.80 10.50 35.70 2.27 80.92 45.50 1624.35 C6 (inches) 0.00 10.50 35.70 2.27 80.92 45.50 1624.35 C6 (inches) 0.00 10.50 35.70 2.27 80.92 45.50 1624.35 C7 (inches) 10.50 57.70 2.27 80.92 45.50 1624.35 C7 (inches) 10.50 57.70 2.27 80.92 45.50 1624.35 C9 (inches) 10.50 57.70 2.27 80.92 45.50 1624.35 C10 (inches) 10.50 57.70 2.27 80.92 45.50 1624.35 C10 (inches) 10.50 10.50 10.50 10.50 10.50 10.50 Average Crush (inches): 7.36 Results KE Closing Force Damage Speed Delta V Speed A B (poundsf) Energy (ft*lbs) (mph) (mPH) (MPH) Minimum 207.6 40.4 13254.78 15035.75 10.9 11.2 21.7 Avg - 2 Std. Deviations 173.6 23.8 9155.16 11904.80 9.7 9.7 18.8 Avg - 1 Std. Deviations 215.2 41.7 13705.44 15569.91 11.1 11.3 22.0 Average 256.8 59.6 18255.72 19566.62 12.5 12.8 24.9 Avg + 1 Std. Deviations 298.4 77.5 22806.00 23665.16 13.7 14.2 27.6 Avg + 2 Std. Deviations 298.4 77.5 22806.00 23665.16 13.7 14.2 27.6 Avg + 2 Std. Deviations 298.4 77.5 22806.00 23665.16 13.7 14.2 27.6 Avg + 2 Std. Deviations 298.4 77.5 22806.00 23665.16 13.7 14.2 27.6 Avg + 2 Std. Deviations 298.4 77.5 22806.00 23665.16 13.7 14.2 27.6 Avg + 2 Std. Deviations 298.4 77.5 22806.00 23665.16 13.7 14.2 27.6 Avg + 2 Std. Deviations 298.4 77.5 22806.00 23665.16 13.7 14.2 27.6 Avg + 2 Std. Deviations 298.4 77.5 22806.00 23665.16 13.7 14.2 27.6 Avg + 2 Std. Deviations 298.4 77.5 22806.00 23665.16 13.7 14.2 27.6 Avg + 2 Std. Deviations 298.4 2756.28 27908.21 14.9 15.4 30.0 Maximum 340.6 96.4 27565.23 27958.25 14.9 15.5 30.1 Damage Centroid Depth (y) (inches) 4.63 k ²				•			
10.50 35.18 2.23 78.56 7.00 246.23 C2 (inches) 6.70 10.50 101.85 5.00 509.72 16.29 1659.26 C3 (inches) 10.60 10.50 122.33 5.84 714.47 26.09 3191.74 C4 (inches) 10.60 10.50 91.35 4.42 403.69 36.37 3322.20 C5 (inches) 6.80 10.50 35.70 2.27 80.92 45.50 1624.35 C6 (inches) 0.00 0.50 35.70 2.27 80.92 45.50 1624.35 C6 (inches) 0.00 0.50 35.70 2.27 80.92 45.50 1624.35 C6 (inches) 0.00 0.50 35.70 2.27 80.92 45.50 1624.35 C9 (inches) 0.00	C1 (inches) 0.00	(inches)	(inches²)	(inches)	(inches ³)	(inches)	(inches ³)
10.50 101.85 5.00 509.72 16.29 1659.26 C3 (inches) 12.70 10.50 122.33 5.84 714.47 26.09 3191.74 C4 (inches) 10.60 10.50 91.35 4.42 403.69 36.37 3322.20 C5 (inches) 6.80 10.50 35.70 2.27 80.92 45.50 1624.35 C6 (inches) 0.00 35.70 2.27 80.92 45.50 1624.35 C6 (inches) 0.00 35.70 2.27 80.92 45.50 1624.35 C6 (inches) 0.00 0		10.50	35.18	2.23	3 78.56	7.00	246.23
10.50 122.33 5.84 714.47 26.09 3191.74 C4 (inches) 10.60 10.50 91.35 442 403.69 36.37 33222.20 C5 (inches) 6.80 10.50 35.70 2.27 80.92 45.50 1624.35 C6 (inches) 0.00		10.50	101.85	5.00	509.72	16.29	1659.26
C5 (inches) 6.80 10.50 91.35 4.42 403.69 36.37 3322.20 C5 (inches) 6.80 10.50 35.70 2.27 80.92 45.50 1624.35 C6 (inches) 0.00 0 0 0 0 0 0 C7 (inches) 0 0 0 0 0 0 0 0 C8 (inches) 0 0 0 0 0 0 0 0 0 0 C9 (inches) 0 <t< td=""><td></td><td>10.50</td><td>122.33</td><td>5.84</td><td>4 714.47</td><td>26.09</td><td>3191.74</td></t<>		10.50	122.33	5.84	4 714.47	26.09	3191.74
C6 (inches) 0.00 35.70 2.27 80.92 45.50 1624.35 C6 (inches) 0.00 0		10.50	91.35	4.42	2 403.69	36.37	3322.20
C7 (inches) C8 (inches) C9 (inches) C9 (inches) C10 (inches) Average Crush (inches): 7.36 Results A B A B A C7 (inches) C10 (inches) A A C10 (inches) C10 (inches)		10.50	35.70	2.27	7 80.92	45.50	1624.35
C8 (inches)							
C9 (inches) C10 (inches) Average Crush (inches): 7.36	C7 (inches)						
C10 (inches) 7.36 Average Crush (inches): 7.36 Results Average A B Average Force (poundsf) KE Energy (ft*lbs) Closing Speed (mph) Minimum 207.6 40.4 13254.78 15035.75 10.9 11.2 21.7 Avg - 2 Std. Deviations 173.6 23.8 9155.16 11904.80 9.7 9.7 18.8 Avg - 1 Std. Deviations 215.2 41.7 13705.44 15569.91 11.1 11.3 22.0 Average 256.8 59.6 18255.72 19566.62 12.5 12.8 24.9 Avg + 1 Std. Deviations 298.4 77.5 22806.00 23665.16 13.7 14.2 27.6 Avg + 2 Std. Deviations 340.0 95.4 27356.28 27808.21 14.9 15.4 30.0 Maximum 340.6 96.4 27565.23 27958.25 14.9 15.5 30.1 Damage Centroid Depth (x) (inches) 4.63 K ² 3290.26 1.00 1.00	C8 (inches)						
Average Crush (inches): 7.36 Results Average Force (poundsf) KE Energy (ft*lbs) KE (mph) Closing Delta V (mph) Minimum 207.6 40.4 13254.78 15035.75 10.9 11.2 21.7 Avg - 2 Std. Deviations 173.6 23.8 9155.16 11904.80 9.7 9.7 18.8 Avg - 1 Std. Deviations 215.2 41.7 13705.44 15569.91 11.1 11.3 22.0 Avg + 1 Std. Deviations 298.4 77.5 22806.00 23665.16 13.7 14.2 27.6 Avg + 2 Std. Deviations 340.0 95.4 27356.28 27808.21 14.9 15.4 30.0 Maximum 340.6 96.4 27565.23 27958.25 14.9 15.5 30.1 Damage Centroid Depth (x) (inches) 4.63 K2 K2 3290.26 3290.26 Damage Centroid Depth (y) (inches) 25.99 Eff. Mass Ratio (gamma) 1.00 1.00	C9 (inches)						
Average KE Closing A B Force Damage Speed Delta V Speed Minimum 207.6 40.4 13254.78 15035.75 10.9 11.2 21.7 Avg - 2 Std. Deviations 173.6 23.8 9155.16 11904.80 9.7 9.7 18.8 Avg - 1 Std. Deviations 215.2 41.7 13705.44 15569.91 11.1 11.3 22.0 Average 256.8 59.6 18255.72 19566.62 12.5 12.8 24.9 Avg + 1 Std. Deviations 298.4 77.5 22806.00 23665.16 13.7 14.2 27.6 Avg + 2 Std. Deviations 340.0 95.4 27356.28 27808.21 14.9 15.4 30.0 Maximum 340.6 96.4 27565.23 27958.25 14.9 15.5 30.1 Damage Centroid Depth (x) (inches) 4.63 K² 3290.26 2320.26 23290.26 Damage Centroid Depth (y) (inches) 25.99 <td>C10 (inches)</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	C10 (inches)						
Results Force Damage Speed Delta V Speed A B (poundsf) Energy (ft*lbs) (mph) (mph) (MPH) Minimum 207.6 40.4 13254.78 15035.75 10.9 11.2 21.7 Avg - 2 Std. Deviations 173.6 23.8 9155.16 11904.80 9.7 9.7 18.8 Avg - 1 Std. Deviations 215.2 41.7 13705.44 15569.91 11.1 11.3 22.0 Average 256.8 59.6 18255.72 19566.62 12.5 12.8 24.9 Avg + 1 Std. Deviations 298.4 77.5 22806.00 23665.16 13.7 14.2 27.6 Avg + 2 Std. Deviations 340.0 95.4 27356.28 27808.21 14.9 15.4 30.0 Maximum 340.6 96.4 27565.23 27958.25 14.9 15.5 30.1 Damage Centroid Depth (x) (inches) 4.63 K² 3290.26 Eff. Mass Ratio (gamma) 1.00	Average Crush (inches):	7.36					
A B (poundsf) Energy (ft*lbs) (mph) (mph) (MPH) Minimum 207.6 40.4 13254.78 15035.75 10.9 11.2 21.7 Avg - 2 Std. Deviations 173.6 23.8 9155.16 11904.80 9.7 9.7 18.8 Avg - 1 Std. Deviations 215.2 41.7 13705.44 15569.91 11.1 11.3 22.0 Average 256.8 59.6 18255.72 19566.62 12.5 12.8 24.9 Avg + 1 Std. Deviations 298.4 77.5 22806.00 23665.16 13.7 14.2 27.6 Avg + 2 Std. Deviations 340.0 95.4 27356.28 27808.21 14.9 15.4 30.0 Maximum 340.6 96.4 27565.23 27958.25 14.9 15.5 30.1 Damage Centroid Depth (x) (inches) 4.63 k² 3290.26 Eff. Mass Ratio (gamma) 1.00	Results			-	_		0
Minimum 207.6 40.4 13254.78 15035.75 10.9 11.2 21.7 Avg - 2 Std. Deviations 173.6 23.8 9155.16 11904.80 9.7 9.7 18.8 Avg - 1 Std. Deviations 215.2 41.7 13705.44 15569.91 11.1 11.3 22.0 Average 256.8 59.6 18255.72 19566.62 12.5 12.8 24.9 Avg + 1 Std. Deviations 298.4 77.5 22806.00 23665.16 13.7 14.2 27.6 Avg + 2 Std. Deviations 340.0 95.4 27356.28 27808.21 14.9 15.4 30.0 Maximum 340.6 96.4 27565.23 27958.25 14.9 15.5 30.1 Damage Centroid Depth (x) (inches) 4.63 k² 3290.26 Eff. Mass Ratio (gamma) 1.00	Results	Δ	B		-	•	•
Avg - 2 Std. Deviations 173.6 23.8 9155.16 11904.80 9.7 9.7 18.8 Avg - 1 Std. Deviations 215.2 41.7 13705.44 15569.91 11.1 11.3 22.0 Average 256.8 59.6 18255.72 19566.62 12.5 12.8 24.9 Avg + 1 Std. Deviations 298.4 77.5 22806.00 23665.16 13.7 14.2 27.6 Avg + 2 Std. Deviations 340.0 95.4 27356.28 27808.21 14.9 15.4 30.0 Maximum 340.6 96.4 27565.23 27958.25 14.9 15.5 30.1 Damage Centroid Depth (x) (inches) 4.63 k² 3290.26 23290.26 Damage Centroid Depth (y) (inches) 25.99 Eff. Mass Ratio (gamma) 1.00	Minimum			· ·			
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Avg + 1 Std. Deviations 298.4 77.5 22806.00 23665.16 13.7 14.2 27.6 Avg + 2 Std. Deviations 340.0 95.4 27356.28 27808.21 14.9 15.4 30.0 Maximum 340.6 96.4 27565.23 27958.25 14.9 15.5 30.1 Damage Centroid Depth (x) (inches) 4.63 k² 3290.26 Damage Centroid Depth (y) (inches) 25.99 Eff. Mass Ratio (gamma) 1.00	-						
Avg + 2 Std. Deviations 340.0 95.4 27356.28 27808.21 14.9 15.4 30.0 Maximum 340.6 96.4 27565.23 27958.25 14.9 15.5 30.1 Damage Centroid Depth (x) (inches) 4.63 k² 3290.26 Damage Centroid Depth (y) (inches) 25.99 Eff. Mass Ratio (gamma) 1.00	-				,		
Maximum 340.6 96.4 27565.23 27958.25 14.9 15.5 30.1 Damage Centroid Depth (x) (inches) 4.63 k² 3290.26 Damage Centroid Depth (y) (inches) 25.99 Eff. Mass Ratio (gamma) 1.00	-						
Damage Centroid Depth (x) (inches) 4.63 k ² 3290.26 Damage Centroid Depth (y) (inches) 25.99 Eff. Mass Ratio (gamma) 1.00	-						
Damage Centroid Depth (y) (inches) 25.99 Eff. Mass Ratio (gamma) 1.00	_			21303.23	2/330.23		
					Eff Mass Ratio (a		
	5		386.40		111055 Natio (9		

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

Registered Owner: 4N6XPRT SYSTEMS

Appendix 3-38

		•			
	773	PDOF	ever Arm Distanc	e (inches):	0.00
	218 991	Yaw M	loment of Inertia	(lb-ft-sec ²)	2904.73
Angle Coll Force to Normal (degrees):	2.0				
No Damage Speed (mph):					
	3.84				
Damage Length (inches): 10	0.0				
Crush Profile Measurements:	6				
Equal		Zone	Area	Zone	Area
Spacing	Zone Area	Depth(x)	Depth(x)	Depth(y)	Depth(y)
C1 (inches) 0.00 (inches)	(inches ²)	(inches)	(inches ³)	(inches)	(inches ³)
C2 (inches) 5.00 20.00	50.00	1.67		13.33	666.67
C3 (inches) 15.70		5.64		31.72	6566.67
C4 (inches) 16.30	320.00	8.00		50.06	16020.00
C5 (inches) 7.20 20.00	235.00	6.17		68.71	16146.67
C6 (inches) 0.00 20.00	72.00	2.40	172.80	86.67	6240.00
C7 (inches)	」 [ㅋ ┌────] []			
C8 (inches)					
C9 (inches)					
C10 (inches)					
Average Crush (inches): 8.84					
		Average		KE	
Results	_	Force	0	Speed Delta	
A			Energy (ft*lbs)	(mph) (mpl	
Minimum 55.2	23.7	13254.78	15348.68	10.7 10	0.5 15.2
Avg - 2 Std. Deviations 44.8	15.6	9155.16	10916.41	9.1 9	9.1 12.3
Avg - 1 Std. Deviations 56.2	24.7	13705.44	15833.58	10.9 10	0.7 15.4
Average 65.9	33.9	18255.72	20711.14	12.5 12	2.1 18.1
Avg + 1 Std. Deviations 74.4	43.2	22806.00	25563.22	13.9 13	3.4 20.4
Avg + 2 Std. Deviations 82.1	52.6	27356.28	30397.13	15.1 14	1.6 22.6
Maximum 82.4	53.0	27565.23	30618.74	15.2 14	1.6 22.6
Damage Centroid Depth (x) (inches)	6.15			k ² 337	74.76
Damage Centroid Depth (y) (inches)	51.63	E	ff. Mass Ratio (ga	amma)	1.00
Area of Damage (inches²):	884.00				
	@ l' d h	ANGVERT Such	MARCHINE AND	T com) to:	

1995 CADILLAC ELDORADO - Side Impact

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

Registered Owner: 4N6XPRT SYSTEMS

Appendix 3-39

4N6XPRT StifCalcs® Force Balance - Page 1 of 2	4N6XPRT StifCalcs® Force Balance - Page 2 of 2
2006 CHEVROLET IMPALA MSP POLICE PACKAGE - Front Impact	1995 CADILLAC ELDORADO - Side Impact
Curb Weight (pounds): 3725 Occupant + Cargo Weight (pounds): 39 Total Weight (pounds): 3764 PDOF Lever Arm Distance (inches): 0.00 Yaw Moment of Inertia (lb-ft-sec ²)	Curb Weight (pounds): 3773 Occupant + Cargo Weight (pounds): 218 Total Weight (pounds): 3991 PDOF Lever Arm Distance (inches): Yaw Moment of Inertia (lb-ft-sec ²) 2904.73
Angle Coll Force to Normal (degrees): 0.0 "Known" Stiffness Values No Damage Speed (mph): 5.0 A B Energy Crush Depth (inches): 7.36 Minimum 207.6 40.4 Damage Length (inches): 52.5 Minimum 340.6 96.4 Crush Profile Measurements: 6 Zone Area Zone Area Spacing Zone Area Depth(x) Depth(y) Depth(y) Gepth(y) C1 (inches) 0.00 10.50 35.18 223 78.56 7.00 246.23 C2 (inches) 6.70 10.50 132.33 5.84 714.47 26.09 3191.74 C4 (inches) 10.60 10.50 132.33 5.84 714.47 26.09 3191.74 C5 (inches) 6.80 10.50 35.70 2.27 80.92 45.50 1624.35 C6 (inches) 0.000 10.50 35.70 2.27 80.92 45.50 1624.35 C6 (inches) 0.000 10.50 35.70 2.27 80.92 45.50 1624.35 C	Angle Coll Force to Normal (degrees): 0.0 No Damage Speed (mph): 2.0 Energy Crush Depth (inches): 8.84 Damage Length (inches): 100.0 Crush Profile Measurements: 6 Equal Zone Area Spacing Zone Area Depth(x) Depth(y) (inches) 0.00 20.00 50.00 1.67 C1 (inches) 5.00 20.00 5.04 1166.63 31.72 6566.67 C2 (inches) 5.00 20.00 320.00 8.00 2560.30 50.06 16020.00 C4 (inches) 16.30 20.00 235.00 6.17 1449.63 68.71 16146.67 C5 (inches) 7.20 20.00 72.00 2.40 172.80 86.67 6240.00 C6 (inches) 0.00 0
Average Crush (inches): 7.36 Average KE Closing	Average Crush (inches):
Results Force Damage Force Damage Speed Delta V Speed A B (poundst) Energy (ft*lbs) (mph) (mph) (MPH) Minimum 207.6 40.4 13254.78 15035.75 10.9 11.2 21.7 Avg - 2 Std. Deviations 173.6 23.8 9155.16 11904.80 9.7 9.7 18.8 Avg - 1 Std. Deviations 215.2 41.7 13705.44 15569.91 11.1 11.3 22.0 Average 256.8 59.6 18255.72 19566.62 12.5 12.8 24.9 Avg + 1 Std. Deviations 298.4 77.5 22806.00 23665.16 13.7 14.2 27.6 Avg + 2 Std. Deviations 340.0 95.4 27356.28 27958.25 14.9 15.5 30.1 Damage Centroid Depth (x) (inches) 4.63 k² 3290.26 1.00 2366.40 1.00 Area of Damage (inches ²): 386.40 1.00 1.00 1.00 1.00 1.00 Ange YPRT StifCalcs® licensed by 4N6XPRT Systems (www.	Results Force Damage Spect Delta V A B (poundsf) Energy (ft*lbs) (mph) (mph) bsub1 Minimum 55.2 23.7 13254.78 15348.68 10.7 10.5 15.2 Avg - 2 Std. Deviations 44.8 15.6 9155.16 10916.41 9.1 9.1 12.3 Avg - 1 Std. Deviations 56.2 24.7 13705.44 15833.58 10.9 10.7 15.4 Average 65.9 33.9 18255.72 20711.14 12.5 12.1 18.1 Avg + 1 Std. Deviations 74.4 43.2 22806.00 25563.22 13.9 13.4 20.4 Avg + 2 Std. Deviations 82.1 52.6 27356.28 30397.13 15.1 14.6 22.6 Damage Centroid Depth (x) (inches) 6.15 k² 3374.76 2374.76 Damage Centroid Depth (y) (inches) 51.63 Eff. Mass Ratio (gamma) 1.00 Area of Damage (inches²): 884.00 884.00

Crush Length = OPTION 1

Impala Stiffness Values from NHTSA Tests = MAXIMUM CRUSH

Crush Measurement Spacing = NON-EQUAL

Lever Arm and Angle = NO

Page 1 = "KNOWN" = Bullet Page 2 = "UNKNOWN" = Target Page 3 = The two pages combined onto 1

Curb Weight (pou Occupant + Cargo Weight (pou Total Weight (pou	inds):	39		Lever Arm Distan Moment of Inerti			0.00 2670.92
Angle Coll Force to Normal (degr No Damage Speed (n Energy Crush Depth (inc Damage Length (inc	nph): 5 :hes): 6.6		"Known"	Stiffness Values Average Minimum Maximum	A 256.8 207.6 340.6		B 59.6 40.4 96.4
Crush Profile Measurem	ents: Unequal Spacing	6 Zone Area	Zone a Depth(x)	td. Devation Area Depth(x)	41.6 Zone Depth	e (y) D	17.9 Area epth(y)
C1 (inches) 0.00 C2 (inches) 9.60	(inches) 17.70 4.60	(inches ² 84.9 50.3	6 3.2			es) (i 1.80 6.99	nches ³) 1002.53 352.31
C3 (inches) 12.30 C4 (inches) 9.10 C5 (inches) 4.40	10.70 12.20 7.10	114.49 82.39 15.62	5 3.5	1 289.16	4	6.48 1.99 0.77	3032.08 3458.05 480.58
C6 (inches) 0.00 C7 (inches) C8 (inches)							
C9 (inches) C10 (inches) Average Crush (inches):	6.65]		
Results	A	В	Average Force (poundsf)	Damage Energy (ft*lbs)	KE Speed (mph)	Delta V (mph)	Closing Speed (MPH)
Minimum	207.6	40.4	12454.20	13318.06	10.3	11.8	23.0
Avg - 2 Std. Deviations	173.6	23.8	8678.40	10722.52	9.2	10.2	19.9
Avg - 1 Std. Deviations	215.2	41.7	12879.01	13793.92	10.5	12.0	23.3
Average	256.8	59.6	17079.61	17195.65	11.7	13.6	26.4
Avg + 1 Std. Deviations	298.4 340.0	95.4	21280.22 25480.82	20698.82 24246.34	12.8 13.9	15.0 16.4	29.2 31.8
Avg + 2 Std. Deviations Maximum	340.0	95.4	25480.82	24246.34	13.9	16.4	31.8
Damage Centroid Depth (x)		4.25	20070.11		k ²	3290.26	
Damage Centroid Depth (y)		23.94		Eff. Mass Ratio (1.00	_
Area of Damage (ir		347.79			- · ·		

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Registered Owner: 4N6XPRT SYSTEMS

Appendix 3-42

Curb Weight (pou			PDOF	ever Arm Distan	ce (inches):	0.00
Occupant + Cargo Weight (pou Total Weight (pou			Yaw M	loment of Inertia	a (lb-ft-sec ²)	2904.73
Angle Coll Force to Normal (degr No Damage Speed (r Energy Crush Depth (ind Damage Length (ind	nph): 2.0 :hes): 13.12					
Crush Profile Measurem	Unequal Spacing Zo	one Area ïnches²)	Zone Depth(x) (inches)	Area Depth(x) (inches ³)	Zone Depth(y) (inches)	Area Depth(y) (inches³)
C1 (inches) 0.00	19.80	108.90	3.67		13.20	1437.48
C2 (inches) 11.00	1.30	13.85	5.33		1.94	26.90
C3 (inches) 10.30	10.90	188.57	9.12		27.99	5277.14
C4 (inches) 24.30	17.20	413.66	12.03	4974.44	60.17	24890.01
C5 (inches) 23.80	9.60	210.72	11.00	2318.13	43.07	9074.69
C6 (inches) 20.10	10.60	176.49	8.44	1490.31	57.93	10224.76
C7 (inches) 13.20	31.00	204.60	4.40	900.24	196.33	40169.80
C8 (inches) 0.00						
C9 (inches)						
C10 (inches)						
Average Crush (inches):	13.12					
Results	A		Average Force poundsf)	Damage Energy (ft*lbs)	KE Speed Delta (mph) (mph	
Minimum	44.5	15.5	12454.20	20774.50	12.5 11	·
Avg - 2 Std. Deviations	36.4	10.4	8678.40	14823.96	10.6 9	.6 10.0
Avg - 1 Std. Deviations	45.3	16.1	12879.01	21441.20	12.7 11	.3 12.5
Average	52.9	21.9	17079.61	28011.96	14.5 12	.8 14.6
Avg + 1 Std. Deviations	59.5	27.8	21280.22	34552.63	16.1 14	.2 16.4
Avg + 2 Std. Deviations	65.6	33.7	25480.82	41071.77	17.6 15	.4 18.1
Maximum	65.8	34.0	25670.41	41365.59	17.6 15	.5 18.2
Damage Centroid Depth (x)	(inches)	9.02			k ² 337	4.76
Damage Centroid Depth (y)	(inches) 69	9.18	E	Eff. Mass Ratio (g	jamma)	1.00
Area of Damage (i	nches²): 1316	5.79				

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Appendix 3-43

Serial Number: 15R-030201SC02301

1995 CADILLAC ELDORADO - Side Impact

4N6XPRT StifCalcs® Force Balance - Page 1 of 2	4N6XPRT StifCalcs® Force Balance - Page 2 of 2			
2006 CHEVROLET IMPALA MSP POLICE PACKAGE - Front Impact	1995 CADILLAC ELDORADO - Side Impact			
Curb Weight (pounds): 3725 Occupant + Cargo Weight (pounds): 39 Total Weight (pounds): 3764 PDOF Lever Arm Distance (inches): 0.00 Yaw Moment of Inertia (lb-ft-sec ²) 2670.92	Curb Weight (pounds): 3773 PDOF Lever Arm Distance (inches): 0.00 Occupant + Cargo Weight (pounds): 218 Yaw Moment of Inertia (lb-ft-sec ²) 2904.73 Total Weight (pounds): 3991 Yaw Moment of Inertia (lb-ft-sec ²) 2904.73			
Angle Coll Force to Normal (degrees): 0.0 "Known" Stiffness Values No Damage Speed (mph): 5.0 Energy Crush Depth (inches): 6.65 Damage Length (inches): 52.3 Crush Profile Measurements: 6 Unequal Zone Area Spacing Zone Area Spacing Zone Area C1 (inches) 9.60 17.70 84.96 32.0 271.87 C1 (inches) 9.60 4.60 50.37 55.0 277.17 G3 (inches) 12.20 82.33 G4 (inches) 0.00 114.49 539 617.09 26.48 G6 (inches) 0.00 10.70 G1 (inches) 0.00 114.49 539 617.09 26.48 3032.08 44.0 12.20 G6 (inches) 0.00 116.62 G7 (inches) 0.00 0.00 G6 (inches) 0.00 0.00 G6 (inches) 0.00 0.00 G9 (inches) 0.00	Angle Coll Force to Normal (degrees): 0.0 No Damage Speed (mph): 2.0 Energy Crush Depth (inches): 13.12 Damage Length (inches): 100.4 Crush Profile Measurements: 8 Unequal Zone Area Zone Depth(x) C1 (inches) 0.00 19.80 108.90 3.67 399.30 13.20 1437.48 C2 (inches) 10.00 13.0 13.85 5.33 73.75 1.94 26.90 C3 (inches) 10.30 13.85 5.33 73.75 1.94 26.90 C5 (inches) 10.30 13.85 5.33 73.75 1.94 26.90 C3 (inches) 10.30 13.85 5.33 73.75 1.94 26.90 C5 (inches) 23.80 9.60 210.72 11.00 2318.13 43.07 9074.69 C6 (inches) 20.10 10.60 176.49 8.44 1490.31 57.93 10224.76 C7 (inches) 13.20 31.00 204.60 4.440 900.24 196.33 40169.80			
Average KE Closing A B Force Damage Speed Delta V Speed Minimum 207.6 40.4 12454.20 13318.06 10.3 11.8 23.0 Avg - 2 Std. Deviations 173.6 23.8 8678.40 10722.52 9.2 10.2 19.9 Avg - 1 Std. Deviations 215.2 41.7 12879.01 13793.92 10.5 12.0 23.3 Average 256.8 59.6 17079.61 17195.65 11.7 13.6 26.4 Avg + 1 Std. Deviations 298.4 77.5 21280.22 20698.82 12.8 15.0 29.2 Avg + 2 Std. Deviations 340.0 95.4 25480.82 24246.34 13.9 16.4 31.8 Maximum 340.6 96.4 25670.41 24368.75 13.9 16.4 31.9 Damage Centroid Depth (x) (inches) 23.94 Eff. Mass Ratio (gamma) 1.00 Area of Damage (inches ²): 347.79 MAXEXPRT StifCakes B licensed by 4N6XPRT Systems (www.4N6XPRT.com) to: 1.00 1.00 1.00 1.00	Average KE A B (poundsf) Energy (ft*lbs) (mph) (mph) bsub1 Minimum 44.5 15.5 12454.20 20774.50 12.5 11.1 12.3 Avg - 2 Std. Deviations 36.4 10.4 8678.40 14823.96 10.6 9.6 10.0 Avg - 1 Std. Deviations 45.3 16.1 12879.01 21441.20 12.7 11.3 12.5 Average 52.9 21.9 17079.61 28011.96 14.5 12.8 14.6 Avg + 1 Std. Deviations 59.5 27.8 21280.22 34552.63 16.1 14.2 16.4 Avg + 2 Std. Deviations 65.6 33.7 25480.82 41071.77 17.6 15.4 18.1 Maximum 65.8 34.0 25670.41 41365.59 17.6 15.5 18.2 Damage Centroid Depth (x) (inches) 9.02 k² 3374.76 18.1 1.00 Area of Damage (inches ²): 1316.79 1316.79			
Registered Owner: 4N6XPRT SYSTEMS Serial Number: 15R-030201SC02301	Registered Owner: 4N6XPRT SYSTEMS Serial Number: 15R-030201SC02301			

Crush Length = OPTION 2

Impala Stiffness Values from NHTSA Tests = MAXIMUM CRUSH

Crush Measurement Spacing = EQUAL

Lever Arm and Angle = NO

Page 1 = "KNOWN" = Bullet Page 2 = "UNKNOWN" = Target Page 3 = The two pages combined onto 1

Curb Weight (pounds	s): 372	:5	PDOF	Lever Arm Distan	ce (inches)· [0.00
Occupant + Cargo Weight (pound		89		Aoment of Inerti			2670.92
Total Weight (pounds		_				,	
Angle Coll Force to Normal (degrees	,, <u> </u>	.0	"Known"	Stiffness Values	A A		В
No Damage Speed (mph	n): 5 .	.0		Average	256.8	3	59.6
Energy Crush Depth (inche	s): 7.3	6		Minimum	207.6	i	40.4
Damage Length (inche	s): 52 .	.5		Maximum	340.6	j	96.4
Crush Profile Measurement	s:	6	S	td. Devation	41.6	6	17.9
	Equal		Zone	Area	Zon	e	Area
	Spacing	Zone Are	1 . ,	Depth(x)	Depth	•	epth(y)
C1 (inches) 0.00	(inches)	(inches ²		(inches ³)	(inche	, 	nches ³)
C2 (inches) 6.70	10.50	35.1				7.00	246.23
C3 (inches) 12.70	10.50	101.8	_			6.29	1659.26
C4 (inches) 10.60	10.50	122.3		_		6.09	3191.74
C5 (inches) 6.80	10.50	91.3				6.37	3322.20
C6 (inches) 0.00	10.50	35.7	0 2.2	7 80.92		5.50	1624.35
C7 (inches)							
C8 (inches)							
C9 (inches)							
C10 (inches)							
Average Crush (inches):	7.36						
Poculto			Average		KE		Closing
Results		-	Force	Damage	Speed	Delta V	Speed
	A	B	(poundsf)	Energy (ft*lbs)	(mph)	(mph)	(MPH)
Minimum	207.6	40.4	13254.78	15035.75	10.9	14.3	27.8
Avg - 2 Std. Deviations	173.6	23.8	9155.16	11904.80	9.7	12.2	23.7
Avg - 1 Std. Deviations	215.2	41.7	13705.44	15569.91	11.1	14.6	28.3
Average	256.8	59.6	18255.72	19566.62	12.5	16.6	32.3
Avg + 1 Std. Deviations	298.4	77.5	22806.00	23665.16	13.7	18.4	35.8
Avg + 2 Std. Deviations	340.0	95.4	27356.28	27808.21	14.9	20.1	39.1
Maximum	340.6	96.4	27565.23	27958.25	14.9	20.2	39.2
Damage Centroid Depth (x) (ind	ches)	4.63			k²	3290.26	5
Damage Centroid Depth (y) (ind	ches)	25.99		Eff. Mass Ratio (gamma)	1.00)
Area of Damage (inch	es²):	386.40					

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Appendix 3-46

Curb Weight (por			PDOF	Lever Arm Distar	ice (inches):	0.00
Occupant + Cargo Weight (po Total Weight (po		=	Yaw N	Moment of Inert	ia (lb-ft-sec ²)	2904.73
Angle Coll Force to Normal (deg No Damage Speed (Energy Crush Depth (in Damage Length (ir	mph): 2 ches): 19.5					
Crush Profile Measuren	nents: Equal Spacing	6 Zone Are	Zone a Depth(x)	Area Depth(x)	Zone Depth(y)	Area Depth(y)
C1 (inches) 0.00 C2 (inches) 54.20 C3 (inches) 18.10	(inches) 31.20 31.20 31.20 31.20	(inches ² 845.5 1127.8 577.2) (inches) 2 18.0 8 19.5	(inches ³) 7 15275.73 8 22080.60	(inches) 20.80 44.20 78.11	(inches ³) 17586.82 49856.35
C4 (inches) 18.90 C5 (inches) 6.60 C6 (inches) 0.00	31.20 31.20	397.8 102.9	0 6.8	7 2732.65	106.69 135.20	42441.98
C7 (inches) C8 (inches) C9 (inches) C10 (inches) Average Crush (inches):						
Results	A	В	Average Force (poundsf)	Damage Energy (ft*lbs)	•	lta V nph) bsub1
Minimum	24.7	7.4	13254.78	35063.44	16.2	13.5 10.6
Avg - 2 Std. Deviations	20.2	5.0	9155.16 13705.44	24571.46 36214.09	13.6 16.5	11.5 8.7 13.7 10.8
Avg - 1 Std. Deviations Average	29.3	10.5	13703.44	47810.77	19.0	15.7 12.6
Avg + 1 Std. Deviations	33.0	13.3	22806.00	59377.98	21.1	17.4 14.1
Avg + 2 Std. Deviations	36.3	16.1	27356.28	70924.20	23.1	19.0 15.6
Maximum	36.5	16.2	27565.23	71453.99	23.2	19.0 15.6
Damage Centroid Depth (x) Damage Centroid Depth (y) Area of Damage ((inches)	14.96 55.35 3051.36		Eff. Mass Ratio (3374.76 1.00

1995 CADILLAC ELDORADO - Side Impact

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4N6XPRT StifCalcs® Force Balance - Page 1 of 2	4N6XPRT StifCalcs® Force Balance - Page 2 of 2
2006 CHEVROLET IMPALA MSP POLICE PACKAGE - Front Impact	1995 CADILLAC ELDORADO - Side Impact
Curb Weight (pounds): 3725 PDOF Lever Arm Distance (inches): 0.00	Curb Weight (pounds): 3773 PDOF Lever Arm Distance (inches): 0.00
Occupant + Cargo Weight (pounds): 39 Total Weight (pounds): 3764 Yaw Moment of Inertia (lb-ft-sec ²) 2670.92	Occupant + Cargo Weight (pounds): 218 Total Weight (pounds): 3991 Yaw Moment of Inertia (lb-ft-sec ²) 2904.73
Angle Coll Force to Normal (degrees): 0.0 "Known" Stiffness Values	Angle Coll Force to Normal (degrees): 0.0
No Damage Speed (mph): 5.0 Average 256.8 59.6	No Damage Speed (mph): 2.0
Energy Crush Depth (inches): 7.36 Minimum 207.6 40.4	Energy Crush Depth (inches): 19.56
Damage Length (inches): 52.5 Maximum 340.6 96.4	Damage Length (inches): 156.0
Crush Profile Measurements: 6 Std. Devation 41.6 17.9	Crush Profile Measurements: 6
Equal Zone Area Zone Area	Equal Zone Area Zone Area
Spacing Zone Area Depth(x) Depth(x) Depth(y) Depth(y) (inches) (inches ²) (inches) (inches ³) (inches ³)	Spacing Zone Area Depth(x) Depth(y) Depth(y) (inches) (inches ²) (inches) (inches ³) (inches ³)
C1 (inches) 0.00 10.50 35.18 2.23 78.56 7.00 246.23	C1 (inches) 0.00 31.20 845.52 18.07 15275.73 20.80 17586.82
C2 (inches) 6.70 10.50 101.85 5.00 509.72 16.29 1659.26	C2 (inches) 54.20 31.20 1127.88 19.58 22080.60 44.20 49856.35
C3 (inches) 12.70 10.50 122.33 5.84 714.47 26.09 3191.74	C3 (inches) 18.10 31.20 577.20 9.25 5339.93 78.11 45086.50
C4 (inches) 10.60 91.35 4.42 403.69 36.37 3322.20	C4 (inches) 18.90 31.20 397.80 6.87 2732.65 106.69 42441.98
C5 (inches) 6.80	C5 (inches) 6.60 31.20 102.96 2.20 226.51 135.20 13920.19
C6 (inches) 0.00	C6 (inches) 0.00
C7 (inches)	C7 (inches)
C8 (inches)	C8 (inches)
C9 (inches)	C9 (inches)
C10 (inches)	C10 (inches)
Average Crush (inches): 7.36	Average Crush (inches): 19.56
Average KE Closing Results Force Damage Speed Delta V Speed	Average KE Results Force Damage Speed Delta V
A B (poundsf) Energy (ft*lbs) (mph) (MPH)	A B (poundsf) Energy (ft*lbs) (mph) (mph) bsub1
Minimum 207.6 40.4 13254.78 15035.75 10.9 14.3 27.8	Minimum 24.7 7.4 13254.78 35063.44 16.2 13.5 10.6
Avg - 2 Std. Deviations 173.6 23.8 9155.16 11904.80 9.7 12.2 23.7	Avg - 2 Std. Deviations 20.2 5.0 9155.16 24571.46 13.6 11.5 8.7
Avg - 1 Std. Deviations 215.2 41.7 13705.44 15569.91 11.1 14.6 28.3	Avg - 1 Std. Deviations 25.1 7.7 13705.44 36214.09 16.5 13.7 10.8
Average 256.8 59.6 18255.72 19566.62 12.5 16.6 32.3	Average 29.3 10.5 18255.72 47810.77 19.0 15.7 12.6
Avg + 1 Std. Deviations 298.4 77.5 22806.00 23665.16 13.7 18.4 35.8	Avg + 1 Std. Deviations 33.0 13.3 22806.00 59377.98 21.1 17.4 14.1
Avg + 2 Std. Deviations 340.0 95.4 27356.28 27808.21 14.9 20.1 39.1	Avg + 2 Std. Deviations 36.3 16.1 27356.28 70924.20 23.1 19.0 15.6
Maximum 340.6 96.4 27565.23 27958.25 14.9 20.2 39.2	Maximum 36.5 16.2 27565.23 71453.99 23.2 19.0 15.6
Damage Centroid Depth (x) (inches) 4.63 k ² 3290.26	Damage Centroid Depth (x) (inches) 14.96 k ² 3374.76
Damage Centroid Depth (y) (inches) 25.99 Eff. Mass Ratio (gamma) 1.00	Damage Centroid Depth (y) (inches) 55.35 Eff. Mass Ratio (gamma) 1.00
Area of Damage (inches ²): 386.40	Area of Damage (inches ²): 3051.36
4NGXPRT StifCalcs® licensed by 4NGXPRT Systems (www.4NGXPRT.com) to: Registered Owner: 4NGXPRT SYSTEMS Serial Number: 15R-030201SC02301	4N6XPRT StifCalcs® licensed by 4N6XPRT Systems (www.4N6XPRT.com) to: Registered Owner: 4N6XPRT SYSTEMS Serial Number: 15R-030201SC02301

Crush Length = OPTION 2

Impala Stiffness Values from NHTSA Tests = MAXIMUM CRUSH

Crush Measurement Spacing = NON-EQUAL

Lever Arm and Angle = NO

Page 1 = "KNOWN" = Bullet Page 2 = "UNKNOWN" = Target Page 3 = The two pages combined onto 1

Curb Weight (pou Occupant + Cargo Weight (pou Total Weight (pou	nds):	39		Lever Arm Distar Moment of Inert			0.00 2670.92
Angle Coll Force to Normal (degr No Damage Speed (n Energy Crush Depth (inc Damage Length (inc	nph): 5		"Known"	Stiffness Values Average Minimum	A 256.8 207.6		B 59.6 40.4
Crush Profile Measurem	, <u> </u>	6 Zone Are	Zone a Depth(x)	Maximum L td. Devation C Area Depth(x)	340.6 41.6 Zon Depth	e (y) D	96.4 17.9 Area epth(y)
C1 (inches) 0.00 C2 (inches) 9.60	(inches) 17.70 4.60	(inches ² 84.9 50.3	6 3.2			es) (i 1.80 [6.99 [nches ³) 1002.53 352.31
C3 (inches) 12.30 C4 (inches) 9.10 C5 (inches) 4.40	10.70 12.20 7.10	114.4 82.3 15.6	5 3.5	1 289.16		6.48 1.99 0.77	3032.08 3458.05 480.58
C6 (inches) 0.00 C7 (inches) C8 (inches)							
C9 (inches)	6.65] [
Average Crush (inches):	A	В	Average Force (poundsf)	Damage Energy (ft*lbs)	KE Speed (mph)	Delta V (mph)	Closing Speed (MPH)
Minimum	207.6	40.4	12454.20	13318.06	10.3	11.1	21.6
Avg - 2 Std. Deviations	173.6	23.8	8678.40	10722.52	9.2	9.7	18.8
Avg - 1 Std. Deviations	215.2	41.7	12879.01	13793.92	10.5	11.3	22.0
Average	256.8	59.6	17079.61	17195.65	11.7	12.8	24.9
Avg + 1 Std. Deviations	298.4	77.5	21280.22	20698.82	12.8	14.1	27.5
Avg + 2 Std. Deviations	340.0	95.4	25480.82	24246.34	13.9	15.4	29.9
Maximum	340.6	96.4	25670.41	24368.75	13.9	15.4	30.0
Damage Centroid Depth (x)		4.25			k²	3290.20	_
Damage Centroid Depth (y)		23.94		Eff. Mass Ratio (gamma)	1.00	
Area of Damage (ir	nches ²):	347.79					

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Registered Owner: 4N6XPRT SYSTEMS

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1995 CADILLAC ELDO			PDOF			
Curb Weight (poun Occupant + Cargo Weight (poun	-	_		ever Arm Distan	ce (inches):	0.00
Total Weight (poun	,		Yaw N	Ioment of Inerti	a (lb-ft-sec ²) 2904.73
ale Cell Ferres to Normal (degra		0				
igle Coll Force to Normal (degree		_				
No Damage Speed (m						
Energy Crush Depth (inch						
Damage Length (inch	nes): 155.	9				
Crush Profile Measureme	nts: 1	.0				
	Unequal		Zone	Area	Zone	Area
	Spacing	Zone Area	Depth(x)	Depth(x)	Depth(y	
C1 (inches) 0.00	(inches)	(inches²)	(inches)	(inches ³)	(inches	s) (inches ³)
C2 (inches) 4.70	29.30	68.86	1.57	107.87	19	.53 1344.97
C3 (inches) 9.60	18.30	130.85	3.71	486.08	28	.50 3728.44
	1.30	11.96	4.60	55.05	3.	.24 38.76
	10.60	147.34	7.26	5 1069.96	37.	.75 5561.82
C5 (inches) 19.00	8.60	172.43	10.03	8 1730.19	38	.78 6685.98
C6 (inches) 21.10	18.10	377.39	10.43	3934.43	99	.51 37555.03
C7 (inches) 20.60	10.80	196.02	9.13	1789.69	69	.96 13712.98
C8 (inches) 15.70	33.60	337.68	5.55		248	
C9 (inches) 4.40	25.30	55.66	1.47		210	
C10 (inches) 0.00	23.30	55.00	1.47	01.05		.05 11754.56
Average Crush (inches):	9.61					
Results			Average		KE	
Results			Force	Damage	•	Delta V
_	A		poundsf)	Energy (ft*lbs)	(mph)	(mph) bsub1
Minimum	32.9	13.2	12454.20	16887.68	11.3	10.5 14.1
Avg - 2 Std. Deviations	26.9	8.8	8678.40	12040.79	9.5	9.1 11.5
Avg - 1 Std. Deviations	33.6	13.7	12879.01	17431.27	11.4	10.7 14.4
Average	39.2	18.7	17079.61	22793.02	13.1	12.1 16.8
Avg + 1 Std. Deviations	44.2	23.8	21280.22	28136.14	14.5	13.3 18.9
	48.8	28.9	25480.82	33465.93	15.9	14.5 20.9
Avg + 2 Std. Deviations				33706.22	15.9	14.5 21.0
Avg + 2 Std. Deviations Maximum	49.0	29.2	25670.41	55700.22	13.5	
		29.2 7.43	25670.41	53700.22	k² [3374.76
Maximum	inches)	,		Eff. Mass Ratio (c	k² [

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Registered Owner: 4N6XPRT SYSTEMS

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Serial Number: 15R-030201SC02301

1995 CADILLAC ELDORADO - Side Impact

2006 CHEVROLET IMPALA MSP POLICE PACKAGE - Front Impact	1995 CADILLAC ELDORADO - Side Impact
Curb Weight (pounds): 3725 Occupant + Cargo Weight (pounds): 39 Total Weight (pounds): 3764 PDOF Lever Arm Distance (inches): 0.00 Yaw Moment of Inertia (lb-ft-sec ²)	Curb Weight (pounds): 3773 Occupant + Cargo Weight (pounds): 218 Total Weight (pounds): 3991 PDOF Lever Arm Distance (inches): Yaw Moment of Inertia (lb-ft-sec ²) 2904.73
Angle Coll Force to Normal (degrees): 0.0 "Known" Stiffness Values No Damage Speed (mph): 5.0 A B Energy Crush Depth (inches): 6.65 Minimum 207.6 40.4 Damage Length (inches): 52.3 Minimum 340.6 96.4 Crush Profile Measurements: 6 Std. Devation 41.6 17.9 Vinequal Zone Area Depth(x) Depth(x) Depth(y) Depth(y) C1 (inches) 0.00 17.70 84.96 320 271.87 11.80 1002.53 C2 (inches) 9.60 4.60 50.37 5.50 277.17 6.99 352.31 C3 (inches) 12.30 10.70 114.49 5.39 617.09 26.48 3032.08 C4 (inches) 9.10 12.20 82.35 3.51 289.16 41.99 3458.05 C5 (inches) 4.40 7.10 15.62 1.47 22.91 30.77 480.58 C6 (inches) 0.00 11.49 5.39 617.09 26.48 3032.08 26.68 3032.08 27.10	Angle Coll Force to Normal (degrees): 0.0 No Damage Speed (mph): 2.0 Energy Crush Depth (inches): 9.61 Damage Length (inches): 155.9 Crush Profile Measurements: 10 Unequal Zone Area Spacing Zone Area Depth(x) Depth(y) (inches) 0.00 29.30 68.86 1.57 107.87 19.53 1344.97 C2 (inches) 0.00 29.30 68.86 1.57 107.87 19.53 1344.97 C2 (inches) 9.60 1.30 11.96 4.60 55.05 3.24 38.76 C4 (inches) 9.60 1.30 11.96 4.60 55.05 3.24 38.76 C4 (inches) 19.00 8.60 172.43 10.03 1730.19 38.78 6685.98 C6 (inches) 21.00 18.10 377.39 10.43 3934.43 99.51 3755.503 C7 (inches) 10.80 196.02 9.13 1789.69 69.96 13712.98 C6 (inches) 15.70 33.60 337.
Average Crush (inches): 6.65	Average Crush (inches): 9.61
Average KE Closing Force Damage Speed Delta V Speed A B (poundsf) Energy (ft*lbs) (mph) (MPH)	Average KE Force Damage Speed Delta V A B (poundsf) Energy (ft*lbs) (mph) (mph)
Minimum 207.6 40.4 12454.20 13318.06 10.3 11.1 21.6 Avg - 2 Std. Deviations 173.6 23.8 8678.40 10722.52 9.2 9.7 18.8 Avg - 1 Std. Deviations 215.2 41.7 12879.01 13793.92 10.5 11.3 22.0 Average 256.8 59.6 17079.61 17195.65 11.7 12.8 24.9 Avg + 1 Std. Deviations 298.4 77.5 21280.22 20698.82 12.8 14.1 27.5 Avg + 2 Std. Deviations 340.0 95.4 25480.82 24246.34 13.9 15.4 29.9 Maximum 340.6 96.4 25670.41 24368.75 13.9 15.4 30.0 Damage Centroid Depth (x) (inches) 4.25 k² 3290.26 3290.26 347.79 340.0 1.00 Area of Damage (inches²): 347.79 347.79 340.277.9 347.79 340.277.9 347.79 340.277.9 Serial Number: 15R-0302015C02301	Minimum 32.9 13.2 12454.20 16887.68 11.3 10.5 14.1 Avg - 2 Std. Deviations 26.9 8.8 8678.40 12040.79 9.5 9.1 11.5 Avg - 1 Std. Deviations 33.6 13.7 12879.01 17431.27 11.4 10.7 14.4 Average 39.2 18.7 17079.61 22793.02 13.1 12.1 16.8 Avg + 1 Std. Deviations 44.2 23.8 21280.22 28136.14 14.5 13.3 18.9 Avg + 2 Std. Deviations 48.8 28.9 25480.82 33465.93 15.9 14.5 20.9 Maximum 49.0 29.2 25670.41 33706.22 15.9 14.5 21.0 Damage Centroid Depth (x) (inches) 7.43 k² 3374.76 Damage Centroid Depth (y) (inches) 109.73 Eff. Mass Ratio (gamma) 1.00 4N6XPRT Stiffcalcs® licensed by 4N6XPRT Systems (www.4N6XPRT.com) to: Registered Owner: 4N6XPRT StySTEMS

Crush Length = OPTION 1

Impala Stiffness Values from NHTSA Tests = MAXIMUM CRUSH

Crush Measurement Spacing = EQUAL

Lever Arm and Angle = YES

Page 1 = "KNOWN" = Bullet Page 2 = "UNKNOWN" = Target Page 3 = The two pages combined onto 1

Curb Weight (poun Occupant + Cargo Weight (pour		25	PDOF	Lever Arm Distan	ce (inches):	0.00
Total Weight (pour			Yaw N	Noment of Inerti	a (lb-ft-seo	2 ²)	2670.92
Angle Coll Force to Normal (degre	es): 0	.0	"Known"	Stiffness Values			
No Damage Speed (m	ph): 5	.0		Average	A 256.8		B 59.6
Energy Crush Depth (inch	nes): 7. 3	6		Minimum	207.6		40.4
Damage Length (incl	nes): 52	.5		Maximum	340.6		96.4
Crush Profile Measureme	nts [.]	6	S	td. Devation	41.6	5	17.9
	Equal	<u> </u>	Zone	Area	Zon	e	Area
	Spacing	Zone Are		Depth(x)	Depth		epth(y)
C1 (inches) 0.00	(inches)	(inches ²) (inches)	(inches ³)	(inche	es) (i	inches ³)
C2 (inches) 6.70	10.50	35.1	8 2.2	3 78.56		7.00	246.23
C3 (inches) 12.70	10.50	101.8	5 5.0	509.72		6.29	1659.26
C4 (inches) 10.60	10.50	122.3	3 5.84	4 714.47	2	6.09	3191.74
C5 (inches) 6.80	10.50	91.3	5 4.42	2 403.69	3	6.37	3322.20
C6 (inches) 0.00	10.50	35.7	0 2.2	7 80.92	4	5.50	1624.35
C7 (inches)							
C8 (inches)							
C9 (inches)							
C10 (inches)							
Average Crush (inches):	7.36						
			Average		KE		Closing
Results			Force	Damage	Speed	Delta V	Speed
	A	В	(poundsf)	Energy (ft*lbs)	(mph)	(mph)	(MPH)
Minimum	207.6	40.4	13254.78	15035.75	10.9	11.0	23.8
Avg - 2 Std. Deviations	173.6	23.8	9155.16	11904.80	9.7	9.5	20.6
Avg - 1 Std. Deviations	215.2	41.7	13705.44	15569.91	11.1	11.2	24.2
Average	256.8	59.6	18255.72	19566.62	12.5	12.7	27.5
Avg + 1 Std. Deviations	298.4	77.5	22806.00	23665.16	13.7	14.0	30.4
Avg + 2 Std. Deviations	340.0	95.4	27356.28	27808.21	14.9	15.2	33.0
Maximum	340.6	96.4	27565.23	27958.25	14.9	15.3	33.1
Damage Centroid Depth (x) (i	inches)	4.63			k²	3290.26	5
Damage Centroid Depth (y) (i	nches)	25.99		Eff. Mass Ratio (gamma)	1.00	\mathbf{D}
Area of Damage (in	ches²):	386.40					

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Appendix 3-54

Curb Weight (pour Occupant + Cargo Weight (pour Total Weight (pour Angle Coll Force to Normal (degre No Damage Speed (m Energy Crush Depth (inch	nds): 211 nds): 3991 ees): 30.0 ph): 2.0			ever Arm Distand		28.50) 2904.73
Damage Length (incl Crush Profile Measureme		o 6 Zone Area	Zone Depth(x)	Area Depth(x)	Zone Depth(y	Area /) Depth(y)
C1 (inches) 0.00 C2 (inches) 5.00 C3 (inches) 15.70 C4 (inches) 16.30 C5 (inches) 7.20 C6 (inches) 0.00 C7 (inches) 0.00 C8 (inches) 0.00 C10 (inches) 0.00	(inches) 20.00 20.00 20.00 20.00 20.00 20.00 8.84	(inches ²) 50.00 207.00 320.00 235.00 72.00	(inches) 1.67 1.77 1.67 1.77 1.67 1.77 1.67 1.77 1.	1166.63 2560.30 11449.63	31.	.33 666.67 .72 6566.67 .06 16020.00 .71 16146.67
Results	A 50.9	B 20.2	Average Force (poundsf) 13254.78	Damage Energy (ft*lbs) 17911.88	KE Speed I (mph) 11.6	Delta V (mph) bsub1 10.4 14.0
Avg - 2 Std. Deviations	41.2	13.3	9155.16	12774.23	9.8	9.0 11.3
Avg - 1 Std. Deviations	51.9	21.0	13705.44	18473.77	11.8	10.5 14.2
Average	60.8	28.9	18255.72	24124.34	13.5	11.9 16.7
Avg + 1 Std. Deviations	68.8	36.9	22806.00	29743.35	15.0	13.2 18.9
Avg + 2 Std. Deviations	75.9	45.0	27356.28	35339.86	16.3	14.3 20.9
Maximum	76.3	45.4	27565.23	35596.41	16.4	14.4 21.0
Damage Centroid Depth (x) (inches)	6.15			k²	3374.76
Damage Centroid Depth (y) (Area of Damage (in		51.63 884.00		Eff. Mass Ratio (g	amma)	0.81

1995 CADILLAC ELDORADO - Side Impact

Registered Owner: 4N6XPRT SYSTEMS

Appendix 3-55

4N6XPRT StifCalcs® Force Balance - Page 1 of 2	4N6XPRT StifCalcs® Force Balance - Page 2 of 2
2006 CHEVROLET IMPALA MSP POLICE PACKAGE - Front Impact	1995 CADILLAC ELDORADO - Side Impact
Curb Weight (pounds): 3725 PDOF Lever Arm Distance (inches): 0.00	Curb Weight (pounds): 3773 PDOF Lever Arm Distance (inches): 28.50
Occupant + Cargo Weight (pounds): 39 Total Weight (pounds): 3764 Yaw Moment of Inertia (lb-ft-sec ²) 2670.92	Occupant + Cargo Weight (pounds): 218 Total Weight (pounds): 3991 Yaw Moment of Inertia (lb-ft-sec ²) 2904.73
Angle Coll Force to Normal (degrees): 0.0 "Known" Stiffness Values	Angle Coll Force to Normal (degrees): 30.0
No Damage Speed (mph): 5.0 Average 256.8 59.6	No Damage Speed (mph): 2.0
Energy Crush Depth (inches): 7.36 Minimum 207.6 40.4	Energy Crush Depth (inches): 8.84
Damage Length (inches): 52.5 Maximum 340.6 96.4	Damage Length (inches): 100.0
Crush Profile Measurements: 6 Std. Devation 41.6 17.9	Crush Profile Measurements: 6
Equal Zone Area Zone Area	Equal Zone Area Zone Area
Spacing Zone Area Depth(x) Depth(x) Depth(y) Depth(y) (inches) (inches²) (inches³) (inches³) (inches³)	Spacing Zone Area Depth(x) Depth(y) Depth(y) (inches ²) (inches ³) (inches ³) (inches ³)
C1 (inches) 0.00 35.18 2.23 78.56 7.00 246.23	C1 (inches) 0.00 20.00 50.00 1.67 83.33 13.33 666.67
C2 (inches) 6.70 101.85 5.00 509.72 16.29 1659.26	C2 (inches) 5.00 20.00 207.00 5.64 1166.63 31.72 6566.67
C3 (inches) 12.70 10.50 122.33 5.84 714.47 26.09 3191.74	C3 (inches) 15.70 20.00 320.00 8.00 2560.30 50.06 16020.00
C4 (inches) 10.60 91.35 4.42 403.69 36.37 3322.20	C4 (inches) 16.30 20.00 235.00 6.17 1449.63 68.71 16146.67
C5 (inches) 6.80 35.70 2.27 80.92 45.50 1624.35	C5 (inches) 7.20 20.00 72.00 2.40 172.80 86.67 6240.00
C7 (inches)	C7 (inches)
C9 (inches)	
C10 (inches)	C10 (inches)
Average Crush (inches): 7.36	Average Crush (inches): 8.84
Average KE Closing Results Force Damage Speed Delta V Speed	Average KE Results Force Damage Speed Delta V
A B (poundsf) Energy (ft*lbs) (mph) (MPH)	Force Damage Speed Delta V A B (poundsf) Energy (ft*lbs) (mph) (mph) bsub1
Minimum 207.6 40.4 13254.78 15035.75 10.9 11.0 23.8	Minimum 50.9 20.2 13254.78 17911.88 11.6 10.4 14.0
Avg - 2 Std. Deviations 173.6 23.8 9155.16 11904.80 9.7 9.5 20.6	Avg - 2 Std. Deviations 41.2 13.3 9155.16 12774.23 9.8 9.0 11.3
Avg - 1 Std. Deviations 215.2 41.7 13705.44 15569.91 11.1 11.2 24.2	Avg - 1 Std. Deviations 51.9 21.0 13705.44 18473.77 11.8 10.5 14.2
Average 256.8 59.6 18255.72 19566.62 12.5 12.7 27.5	Average 60.8 28.9 18255.72 24124.34 13.5 11.9 16.7
Avg + 1 Std. Deviations 298.4 77.5 22806.00 23665.16 13.7 14.0 30.4	Avg + 1 Std. Deviations 68.8 36.9 22806.00 29743.35 15.0 13.2 18.9
Avg + 2 Std. Deviations 340.0 95.4 27356.28 27808.21 14.9 15.2 33.0	Avg + 2 Std. Deviations 75.9 45.0 27356.28 35339.86 16.3 14.3 20.9
Maximum 340.6 96.4 27565.23 27958.25 14.9 15.3 33.1	Maximum 76.3 45.4 27565.23 35596.41 16.4 14.4 21.0
Damage Centroid Depth (x) (inches) 4.63 k ² 3290.26	Damage Centroid Depth (x) (inches) 6.15 k ² 3374.76
Damage Centroid Depth (y) (inches) 25.99 Eff. Mass Ratio (gamma) 1.00	Damage Centroid Depth (y) (inches) 51.63 Eff. Mass Ratio (gamma) 0.81
Area of Damage (inches ²): 386.40	Area of Damage (inches ²): 884.00
4N6XPRT StifCalcs® licensed by 4N6XPRT Systems (www.4N6XPRT.com) to: Registered Owner: 4N6XPRT SYSTEMS Serial Number: 15R-030201SC02301	4N6XPRT StifCalcs® licensed by 4N6XPRT Systems (www.4N6XPRT.com) to: Registered Owner: 4N6XPRT SYSTEMS Serial Number: 15R-030201SC02301
Registered Owner, HNOAPPET STSTERIS Serial Number, 158-0302015C02301	Registered Owner, 4140/PPU 3131E143

Crush Length = OPTION 1

Impala Stiffness Values from NHTSA Tests = MAXIMUM CRUSH

Crush Measurement Spacing = NON-EQUAL

Lever Arm and Angle = YES

Page 1 = "KNOWN" = Bullet Page 2 = "UNKNOWN" = Target Page 3 = The two pages combined onto 1

Curb Weight (poun Occupant + Cargo Weight (pour	nds):	39		Lever Arm Distan Noment of Inerti			0.00
Total Weight (poun Angle Coll Force to Normal (degre		.0		Stiffness Values		- /	
No Damage Speed (m	,-	.0	_		А		В
				Average	256.8		59.6
Energy Crush Depth (inch				Minimum	207.6	5 L	40.4
Damage Length (incl	nes): 52	.3		Maximum	340.6	i	96.4
Crush Profile Measureme	nts:	6	S	td. Devation	41.6	5	17.9
	Unequal		Zone	Area	Zon		Area
	Spacing (inches)	Zone Area (inches ²		Depth(x) (inches³)	Depth (inche		epth(y) nches³)
C1 (inches) 0.00	·				· · · · · · · · · · · · · · · · · · ·	, 	1002.53
C2 (inches) 9.60	17.70	84.9				1.80	
C3 (inches) 12.30	4.60	50.3				6.99	352.31
C4 (inches) 9.10	10.70	114.49		_		6.48	3032.08
C5 (inches) 4.40	12.20	82.3				1.99	3458.05
C6 (inches) 0.00	7.10	15.62	2 1.4	7 22.91	3	0.77	480.58
C7 (inches)							
C8 (inches)							
C9 (inches)							
C10 (inches)							
Average Crush (inches):	6.65						
Results			Average Force	Damaga	KE Speed	Delta V	Closing Speed
	А	В	(poundsf)	Damage Energy (ft*lbs)	(mph)	(mph)	(MPH)
Minimum	207.6	40.4	12454.10	13318.06	10.3	9.8	21.3
Avg - 2 Std. Deviations	173.6	23.8	8678.34	10722.52	9.2	8.6	18.7
Avg - 1 Std. Deviations	215.2	41.7	12878.90	13793.92	10.5	10.0	21.6
Average	256.8	59.6	17079.46	17195.65	11.7	11.2	24.2
Avg + 1 Std. Deviations	298.4	77.5	21280.02	20698.82	12.8	12.3	26.6
Avg + 2 Std. Deviations	340.0	95.4	25480.58	24246.34	13.9	13.3	28.8
Maximum	340.6	96.4	25670.17	24368.75	13.9	13.3	28.9
Damage Centroid Depth (x) (i	nches)	4.25			k²	3290.26	5
Damage Centroid Depth (y) (i		23.94		Eff. Mass Ratio (gamma)	1.00)
Area of Damage (in	ches²):	347.79					

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Appendix 3-58

			r				
Curb Weight (pou			PDOF	ever Arm Distan	ce (inches):	28.50
Dccupant + Cargo Weight (por	Ý	18	Yaw N	Ioment of Inerti	a (lb-ft-sec	2 ²)	2904.73
Total Weight (pou	inds): 39	<u>51</u>			•		
ngle Coll Force to Normal (deg	rees): 30	0.0					
No Damage Speed (I	mph): 2	2.0					
Energy Crush Depth (in	ches): 30.	56					
Damage Length (in	ches): 100).4					
	. [
Crush Profile Measurem		8	7	A	7	_	A
	Unequal Spacing	Zone Area	Zone Depth(x)	Area Depth(x)	Zon Depth		Area Depth(y)
	(inches)	(inches ²)	(inches)	(inches ³)	(inche	•	(inches ³)
C1 (inches) 0.00	19.80	108.90	-		` _	3.20	1437.48
C2 (inches) 11.00	1.30	13.85				1.94	26.90
C3 (inches) 10.30							
C4 (inches) 24.30	10.90	188.57	9.12			7.99	5277.14
C5 (inches) 23.80	17.20	413.66				0.17	24890.01
C6 (inches) 20.10	9.60	210.72	_			3.07	9074.69
C7 (inches) 13.20	10.60	176.49	8.44	1490.31	5	7.93	10224.76
C8 (inches) 0.00	31.00	204.60	4.40	900.24	19	6.33	40169.80
C9 (inches)							
C10 (inches)							
Average Crush (inches):	13.12						
Results			Average	_	KE		
	А	В	Force (poundsf)	Damage Energy (ft*lbs)	Speed (mph)	Delta V (mph)	bsub1
Мана (1997)			-				
Minimum [27.9	6.1	12454.10	12870.74	9.8	9.2	
	22011		8678 34	9548.98	8.5	8.1	6.3
Avg - 2 Std. Deviations	23.0	4.1	8678.34				
Avg - 2 Std. Deviations	28.4	6.3	12878.90	13239.32	10.0	9.4	7.8
-							7.8
Avg - 1 Std. Deviations	28.4	6.3	12878.90	13239.32	10.0	9.4	 7.8 9.1
Avg - 1 Std. Deviations [Average [28.4	6.3	12878.90 17079.46	13239.32	10.0 11.3	9.4	7.8 9.1 10.2
Avg - 1 Std. Deviations [Average [Avg + 1 Std. Deviations [28.4 33.1 37.1	6.3 8.6 10.8	12878.90 17079.46 21280.02	13239.32 16843.81 20392.84	10.0 11.3 12.4	9.4 10.5	7.8 9.1 10.2 11.3
Avg - 1 Std. Deviations [Average [Avg + 1 Std. Deviations [Avg + 2 Std. Deviations [28.4] 33.1] 37.1] 40.8] 41.0]	6.3 8.6 10.8 13.0	12878.90 17079.46 21280.02 25480.58	13239.32 16843.81 20392.84 23902.22	10.0 11.3 12.4 13.4	9.4 10.5 11.6 12.5	7.8 9.1 10.2 11.3
Avg - 1 Std. Deviations Average Avg + 1 Std. Deviations Avg + 2 Std. Deviations Maximum	28.4 33.1 37.1 40.8 41.0 (inches)	6.3 8.6 10.8 13.0 13.2	12878.90 17079.46 21280.02 25480.58 25670.17	13239.32 16843.81 20392.84 23902.22	10.0 11.3 12.4 13.4 13.4 k ²	9.4 10.5 11.6 12.5 12.6 3374.	7.8 9.1 10.2 11.3

1995 CADILLAC ELDORADO - Side Impact

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4N6XPRT StifCalcs® Force Balance - Page 1 of 2	4N6XPRT StifCalcs® Force Balance - Page 2 of 2
2006 CHEVROLET IMPALA MSP POLICE PACKAGE - Front Impact	1995 CADILLAC ELDORADO - Side Impact
Curb Weight (pounds): 3725 Occupant + Cargo Weight (pounds): 39 Total Weight (pounds): 3764 PDOF Lever Arm Distance (inches): 0.00 Yaw Moment of Inertia (lb-ft-sec ²)	Curb Weight (pounds): 3773 PDOF Lever Arm Distance (inches): 28.50 Occupant + Cargo Weight (pounds): 218 Yaw Moment of Inertia (lb-ft-sec ²) 2904.73 Total Weight (pounds): 3991 Yaw Moment of Inertia (lb-ft-sec ²) 2904.73
Angle Coll Force to Normal (degrees): 0.0 "Known" Stiffness Values No Damage Speed (mph): 5.0 A B Energy Crush Depth (inches): 6.65 Minimum 207.6 40.4 Damage Length (inches): 52.3 Minimum 340.6 96.4 Crush Profile Measurements: 6 Cunequal Zone Area Zone Spacing Zone Area Depth(x) Depth(x) Depth(y) Depth(y) (inches ³) C1 (inches) 9.60 17.70 84.96 320 271.87 11.80 1002.53 C2 (inches) 9.60 4.60 50.37 5.50 277.17 6.99 352.31 C3 (inches) 12.30 10.70 114.49 5.39 617.09 26.48 3032.08 C5 (inches) 4.40 7.10 15.62 1.47 22.91 30.77 480.58 C6 (inches) 0.00 11.20 82.35 3.51 289.16 41.99 3458.05 C4 (inches) 0.00 11.49 5.39 617.09 26.48 3032.08	Angle Coll Force to Normal (degrees): 30.0 No Damage Speed (mph): 2.0 Energy Crush Depth (inches): 30.56 Damage Length (inches): 100.4 Crush Profile Measurements: 8 Unequal Zone Area Zone Area Spacing Zone Area Depth(x) Depth(y) Depth(y) C1 (inches) 0.00 1.980 108.90 3.67 399.30 13.20 1437.48 C2 (inches) 10.00 1.30 13.85 5.33 73.75 1.94 26.90 G3 (inches) 10.30 13.85 5.33 73.75 1.94 26.90 C4 (inches) 20.10 1.090 188.57 9.12 1720.15 27.99 5277.14 C4 (inches) 20.10 10.60 176.49 8.44 1490.31 57.93 10224.76 C7 (inches) 13.20 131.00 204.60 4.40 900.24 196.33 40169.80 C9 (inches) 0.00 10.60 176.49 8.44 1490.31 57.93 10224.76 <t< th=""></t<>
Average Crush (inches): 6.65	Average Crush (inches): 13.12
Average KE Closing Force Damage Speed Delta V Speed A B (poundsf) Energy (ft*lbs) (mph) (MPH) Minimum 207.6 40.4 12454.10 13318.06 10.3 9.8 21.3	Average KE Results Force Damage Speed Delta V A B (poundsf) Energy (ft*lbs) (mph) bsub1
Minimum 207.6 40.4 12454.10 13318.06 10.3 9.8 21.3 Avg - 2 Std. Deviations 173.6 23.8 8678.34 10722.52 9.2 8.6 18.7 Avg - 1 Std. Deviations 215.2 41.7 12878.90 13793.92 10.5 10.0 21.6 Average 256.8 59.6 17079.46 17195.65 11.7 11.2 24.2 Avg + 1 Std. Deviations 298.4 77.5 21280.02 20698.82 12.8 12.3 26.6 Avg + 2 Std. Deviations 340.0 95.4 25648.58 24246.34 13.9 13.3 28.8 Maximum 340.6 96.4 25670.17 24368.75 13.9 13.3 28.9 Damage Centroid Depth (x) (inches) 4.25 k² 3290.26 3290.26 340.0 1.00 Area of Damage (inches²): 347.79 347.79 4N6XPRT StifCakst elicensed by 4N6XPRT Systems (www.4N6XPRT.com) to: 4N6XPRT StifCakst elicensed by 4N6XPRT Systems (www.4N6XPRT.com) to:	Minimum 27.9 6.1 12454.10 12870.74 9.8 9.2 7.7 Avg - 2 Std. Deviations 23.0 4.1 8678.34 9548.98 8.5 8.1 6.3 Avg - 1 Std. Deviations 28.4 6.3 12878.90 13239.32 10.0 9.4 7.8 Avg - 1 Std. Deviations 28.4 6.3 12878.90 13239.32 10.0 9.4 7.8 Avg + 1 Std. Deviations 37.1 10.8 21280.02 20392.84 12.4 11.6 10.2 Avg + 2 Std. Deviations 40.8 13.0 25480.58 23902.22 13.4 12.5 11.3 Maximum 41.0 13.2 25670.17 24059.85 13.4 12.6 11.3 Damage Centroid Depth (x) (inches) 9.02 k² 3374.76 10.81 136.79 Area of Damage (inches ²): 1316.79 1316.79 1316.79 1316.79 1406XPRT Systems (www.4N6XPRT.com) to:
Registered Owner: 4N6XPRT SYSTEMS	Registered Owner: 4N6XPRT SYSTEMS Serial Number: 15R-030201SC02301

Crush Length = OPTION 2

Impala Stiffness Values from NHTSA Tests = MAXIMUM CRUSH

Crush Measurement Spacing = EQUAL

Lever Arm and Angle = YES

Page 1 = "KNOWN" = Bullet Page 2 = "UNKNOWN" = Target Page 3 = The two pages combined onto 1

Curb Weight (pou	nds): 37 2	25	PDOF	ever Arm Distan	ce (inches):	0.00
Occupant + Cargo Weight (pou Total Weight (pou	, -	<u>39</u> 54		Ioment of Inerti			2670.92
Angle Coll Force to Normal (degr	,	.0	"Known" s	Stiffness Values			
5					Α		В
No Damage Speed (n	-	.0		Average	256.8		59.6
Energy Crush Depth (inc	ches): 7.	36		Minimum	207.6		40.4
Damage Length (ind	ches): 52	.5		Maximum	340.6		96.4
Crush Profile Measurem	ents:	6	St	d. Devation	41.6		17.9
	Equal		Zone	Area	Zone	9	Area
	Spacing	Zone Area		Depth(x)	Depth	•	Depth(y)
C1 (inches) 0.00	(inches)	(inches²)		(inches ³)	(inche	·	(inches³)
C2 (inches) 6.70	10.50	35.18				7.00	246.23
C3 (inches) 12.70	10.50	101.85				6.29	1659.26
C4 (inches) 10.60	10.50	122.33				6.09	3191.74
C5 (inches) 6.80	10.50	91.35				6.37	3322.20
C6 (inches) 0.00	10.50	35.70	2.27	7 80.92] [4	5.50	1624.35
C7 (inches)							
C8 (inches)							
C9 (inches)							
C10 (inches)							
Average Crush (inches):	7.36						
Results			Average		KE		Closing
Nesuris			Force	Damage	Speed	Delta V	Speed
F	A	B	(poundsf)	Energy (ft*lbs)	(mph)	(mph)	(MPH)
Minimum	207.6	40.4	13254.78	15035.75	10.9	14.3	
Avg - 2 Std. Deviations	173.6	23.8	9155.16	11904.80	9.7	12.2	
Avg - 1 Std. Deviations	215.2	41.7	13705.44	15569.91	11.1	14.5	
Average	256.8	59.6	18255.72	19566.62	12.5	16.6	36.0
Avg + 1 Std. Deviations	298.4	77.5	22806.00	23665.16	13.7	18.4	40.0
Avg + 2 Std. Deviations	340.0	95.4	27356.28	27808.21	14.9	20.1	43.6
Maximum	340.6	96.4	27565.23	27958.25	14.9	20.1	43.7
Damage Centroid Depth (x)	(inches)	4.63			k²	3290.	26
Damage Centroid Depth (y)	(inches)	25.99		Eff. Mass Ratio (g	gamma)	1.	00
Area of Damage (ir	nches²):	386.40					

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

Registered Owner: 4N6XPRT SYSTEMS

Appendix 3-62

Curb Weight (por Occupant + Cargo Weight (por Total Weight (por	unds): 2	18		ever Arm Distanc		28.50 2904.73
Angle Coll Force to Normal (deg No Damage Speed (Energy Crush Depth (in Damage Length (in	mph):					
Crush Profile Measuren C1 (inches) 0.00 C2 (inches) 54.20 C3 (inches) 18.10 C4 (inches) 18.90 C5 (inches) 6.60 C6 (inches) 0.00 C7 (inches) 0.00 C9 (inches) 0.00 C10 (inches) 0.00	Equal Spacing (inches) 31.20 31.20 31.20 31.20 31.20	 6 Zone Area (inches²) 845.52 1127.88 577.20 397.80 102.96 102.96 102.10 	Zone Depth(x) (inches) 18.07 19.58 9.25 6.87 6.87	Area Depth(x) (inches ³) 15275.73 22080.60 5339.93 2732.65 226.51	Zone Depth(y) (inches) 20.80 44.20 78.11 106.69 135.20	Area Depth(y) (inches ³) 17586.82 49856.35 45086.50 42441.98 13920.19
Average Crush (inches):	19.56		Average Force	5	KE Speed Delta	V
	A	B		inergy (ft*lbs)	(mph) (mph	
Minimum	22.8	6.4	13254.78	40699.54		9.8
Avg - 2 Std. Deviations	23.3	6.6	9155.16	28561.51 42030.49		.5 8.0
Avg - 1 Std. Deviations Average	23.3	9.0	13705.44	55442.56		5.7 10.0
Avg + 1 Std. Deviations	30.6	11.4	22806.00	68818.08		/.4 13.1
Avg + 2 Std. Deviations	33.7	13.8	27356.28	82167.59		3.9 14.4
Maximum	33.8	13.9	27565.23	82780.09		0.0 14.5
Damage Centroid Depth (x		14.96	I [4.76
Damage Centroid Depth (y Area of Damage () (inches)	55.35 3051.36	Ef	ff. Mass Ratio (ga		0.81

1995 CADILLAC ELDORADO - Side Impact

6XPRI Systems (www.4N6XPRT.con 'RT StifCalcs® license

Registered Owner: 4N6XPRT SYSTEMS

Appendix 3-63

4N6XPRT StifCalcs® Force Balance - Page 1 of 2	4N6XPRT StifCalcs® Force Balance - Page 2 of 2
2006 CHEVROLET IMPALA MSP POLICE PACKAGE - Front Impact	1995 CADILLAC ELDORADO - Side Impact
Curb Weight (pounds): 3725 Occupant + Cargo Weight (pounds): 39 Total Weight (pounds): 3764 PDOF Lever Arm Distance (inches): Output Yaw Moment of Inertia (lb-ft-sec ²)	Curb Weight (pounds): 3773 Occupant + Cargo Weight (pounds): 218 Total Weight (pounds): 3991 PDOF Lever Arm Distance (inches): 218 Yaw Moment of Inertia (lb-ft-sec ²)
Angle Coll Force to Normal (degrees): 0.0	Angle Coll Force to Normal (degrees): 30.0 No Damage Speed (mph): 2.0 Energy Crush Depth (inches): 19.56 Damage Length (inches): 156.0 Crush Profile Measurements: 6 Equal Zone Area Zone Area Spacing Zone Area Depth(x) Depth(y) Depth(y) C1 (inches) 0.00 31.20 845.52 18.07 15275.73 20.80 17586.82 C2 (inches) 54.20 31.20 1127.88 19.58 22080.60 44.20 49856.35 G3 (inches) 18.10 31.20 577.20 9.25 5339.93 78.11 45086.50 C4 (inches) 18.99 31.20 102.96 22.20 226.51 135.20 13920.19 G6 (inches) 0.000 102.96 22.20 226.51 135.20 13920.19 G6 (inches) 0.000 102.96 22.20 226.51 135.20 13920.19 G6 (inches) 0.000 102.96 22.20 226.51 135.20 13920.19 G6 (inches)
Average Crush (inches): 7.36	Average Crush (inches): 19.56
Average KE Closing Force Damage Speed Delta V Speed A B (poundsf) Energy (ft*lbs) (mph) (MPH)	Average KE Results Force Damage Speed Delta V A B (poundsf) Energy (ft*lbs) (mph) (mph) bsub1
Minimum 207.6 40.4 13254.78 15035.75 10.9 14.3 31.0 Avg - 2 Std. Deviations 173.6 23.8 9155.16 11904.80 9.7 12.2 26.4 Avg - 1 Std. Deviations 215.2 41.7 13705.44 15569.91 11.1 14.5 31.5 Average 256.8 59.6 18255.72 19566.62 12.5 16.6 36.0 Avg + 1 Std. Deviations 298.4 77.5 22806.00 23665.16 13.7 18.4 40.0 Avg + 2 Std. Deviations 340.0 95.4 27356.28 27808.21 14.9 20.1 43.6 Maximum 340.6 96.4 27565.23 27958.25 14.9 20.1 43.7 Damage Centroid Depth (x) (inches) 4.63 k² 3290.26 3290.26 386.40 1.00 Area of Damage (inches ²): 386.40 386.40 1.00 1.00 406XPRT StySTEMS 1.00 567.0302015C02301	Minimum 22.8 6.4 13254.78 40699.54 17.5 13.5 9.8 Avg - 2 Std. Deviations 18.7 4.2 9155.16 28561.51 14.7 11.5 8.0 Avg - 1 Std. Deviations 23.3 6.6 13705.44 42030.49 17.8 13.7 10.0 Average 27.1 9.0 18255.72 55442.56 20.4 15.6 11.6 Avg + 1 Std. Deviations 30.6 11.4 22806.00 68818.08 22.7 17.4 13.1 Avg + 2 Std. Deviations 33.7 13.8 27356.28 82167.59 24.9 18.9 14.4 Maximum 33.8 13.9 27565.23 82780.09 24.9 19.0 14.5 Damage Centroid Depth (x) (inches) 14.96 k² 3374.76 Damage Centroid Depth (y) (inches) 55.35 Eff. Mass Ratio (gamma) 0.81 Area of Damage (inches²): 3051.36 3051.36 3051.36 3641 302015C02301 Registered Owner: 4N6XPRT StySTEMS Serial Number: 15R-0302015C02301

Crush Length = OPTION 2

Impala Stiffness Values from NHTSA Tests = MAXIMUM CRUSH

Crush Measurement Spacing = NON-EQUAL

Lever Arm and Angle = YES

Page 1 = "KNOWN" = Bullet Page 2 = "UNKNOWN" = Target Page 3 = The two pages combined onto 1

Curb Weight (pour Occupant + Cargo Weight (pour Tatel Weight (pour	nds):	39		Lever Arm Distar Moment of Inert			0.00
Total Weight (pour Angle Coll Force to Normal (degre		.0		Stiffness Values			
No Damage Speed (m	,-	.0		. –	Α		B
Energy Crush Depth (incl		_		Average	256.8		59.6
				Minimum	207.6	<u>نا</u>	40.4
Damage Length (inc	nes): 52	.3		Maximum	340.6	<u> </u>	96.4
Crush Profile Measureme	ents:	6	S	td. Devation	41.6	5	17.9
	Unequal		Zone	Area	Zon		Area
	Spacing	Zone Are	1 ()	Depth(x)	Depth (in a b		epth(y)
C1 (inches) 0.00	(inches)	(inches ²		(inches ³)	(inche	, 	nches ³)
C2 (inches) 9.60	17.70	84.9				1.80	1002.53
C3 (inches) 12.30	4.60	50.3	5.5	0 277.17		6.99	352.31
C4 (inches) 9.10	10.70	114.4	9 5.3	9 617.09	2	6.48	3032.08
C5 (inches) 4.40	12.20	82.3	5 3.5	1 289.16	4	1.99	3458.05
C6 (inches) 0.00	7.10	15.6	2 1.4	7 22.91	3	0.77	480.58
C7 (inches)							
C8 (inches)							
C9 (inches)							
C10 (inches)							
Average Crush (inches):	6.65						
	0.05		Average		KE		Closing
Results			Average Force	Damage	Speed	Delta V	Closing Speed
	А	В	(poundsf)	Energy (ft*lbs)	(mph)	(mph)	(MPH)
Minimum	207.6	40.4	12454.10	13318.06	10.3	11.0	23.9
Avg - 2 Std. Deviations	173.6	23.8	8678.34	10722.52	9.2	9.5	20.7
Avg - 1 Std. Deviations	215.2	41.7	12878.90	13793.92	10.5	11.2	24.3
Average	256.8	59.6	17079.46	17195.65	11.7	12.7	27.5
Avg + 1 Std. Deviations	298.4	77.5	21280.02	20698.82	12.8	14.0	30.4
Avg + 2 Std. Deviations	340.0	95.4	25480.58	24246.34	13.9	15.2	33.0
Maximum	340.6	96.4	25670.17	24368.75	13.9	15.3	33.1
Damage Centroid Depth (x) (inches)	4.25			k²	3290.20	5
Damage Centroid Depth (y) (inches)	23.94		Eff. Mass Ratio (gamma)	1.00)
Area of Damage (in	ches²):	347.79					

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Registered Owner: 4N6XPRT SYSTEMS

Appendix 3-66

Curb Weight (pounds): 2773 218 PDOF Lever Am Distance (inches): 2850 2850 Occupant + Cargo Weight (pounds): 2391 Yaw Moment of Inertia (lb-ft-sec?) 2994/23 Ingle Coll Force to Nomal (degrees): 300 Yaw Moment of Inertia (lb-ft-sec?) 2994/23 No Damage Speed (mph): 20 Energy Crush Depth (inches): 1559 Area Zone Area Depth (y)	1995 CADILLAC ELD		- Side II					
Occupant + Cargo Weight (pounds): 238 Yaw Moment of Inertia (Ib-ft-sec ²) 2904.73 Ingle Coll Force to Normal (degrees): 300 No Damage Speed (mph): 20 Energy Crush Depth (inches): 951 Damage Length (inches): 955 Damage Length (inches): 1055 Crush Profile Measurements: 10 Vaw Moment of Inertia (Ib-ft-sec ²) Depth(y) (inches) C1 (inches) 0.00 (inches)' Inches) Depth(x) (inches)' Depth(y) (inches)' Depth(y) (inches)' C2 (inches) 470 23.30 68.86 1.57 107.87 19.53 134497 C3 (inches) 18.30 130.85 3.71 486.08 28.50 3728.44 C3 (inches) 9.60 147.34 7.26 1069.96 377.75 5561.82 C6 (inches) 11.00 137.34 10.03 137.01.93 3.87.8 669.55 1377.12.96 C3 (inches) 10.30 13.06 147.34 120.33 137.12.96 69.96 1371.22.86 C3 (inches) 10.30 1366	Curb Weight (pou	nds): 37	73	PDOF	Lever Arm Distar	ice (inches	5):	28.50
Inclain Weight (pounds). 222 Ingle Coll Force to Normal (degrees): 300 No Damage Speed (mph): 20 Energy Crush Depth (inches): 9.61 Damage Length (inches): 155.9 Crush Profile Measurements: 10 Unequal Zone Area Depth(x) Depth(y) Depth(y) (Inches) (inches') (inches') 107.877 19.53 1344.977 (2 (inches) (inches) (inches') 107.877 19.53 1344.977 (2 (inches) 4.70 23.30 68.86 1.57 107.877 19.53 1344.977 (2 (inches) 4.70 18.30 130.85 3.711 486.08 28.50 372.844 (3 (inches) 9.60 147.34 7.26 1069.96 37.75 556.13 (2 (inches) 13.10 137.13 10.43 139.13 3755.50 248.85 44032.26 (2 (inches) 13.10 137.23 10.43 137.12.98 44032.26 23.0 55.66 1.47 81.63 21.03 1177.128.8		ý					·	
No Damage Speed (mph): 20 Energy Crush Depth (inches): 361 Damage Length (inches): 1559 Crush Profile Measurements: 10 Yonequal Zone Area Spacing Zone Area Depth(x) (inches) 000 (inches') C1 (inches) 000 (inches') (inches) 130 11.96 C2 (inches) 4.70 18.30 C3 (inches) 9.60 1.30 C4 (inches) 130 11.96 C5 (inches) 19.00 8.60 172.43 C6 (inches) 110 18.10 377.39 C6 (inches) 110 18.10 377.39 C6 (inches) 15.70 33.60 337.68 5.55 C9 (inches) 0.00 25.30 55.66 1.47 81.63 210.83 11734.98 C9 (inches) 0.00 25.30 55.66 1.47 81.63 210.83 11734.98 C9 (inches) 0.00 25.30 55.66 1.47 81.63 210.83 11734.98 </td <td>Total Weight (pou</td> <td>nds): 399</td> <td>91</td> <td>14001</td> <td></td> <td></td> <td>~ / L</td> <td></td>	Total Weight (pou	nds): 39 9	91	14001			~ / L	
Energy Crush Depth (inches): 361 Damage Length (inches): 13559 Crush Profile Measurements: 10 Vinequal Zone Area Zone Depth(x) Depth(y) Merely C1 (inches) 0.00 (inches) 0.03 68.86 1.57 107.87 195.3 1344.97 C2 (inches) 4.70 18.30 130.85 3.71 486.08 28.50 3728.44 G3 (inches) 9.66 1.30 11.96 4.60 55.05 3.24 38.76 C4 (inches) 19.00 8.60 172.43 10.03 1730.19 38.78 6685.98 C5 (inches) 19.00 8.60 172.43 10.03 1730.19 38.78 6685.98 C6 (inches) 21.10 18.10 377.39 10.43 3934.43 99.51 3755.03 C9 (inches) 0.00 25.30 55.66 1.47 81.63 210.83 11734.98 C9 (inches) 0.00 25.30 55.66 1.47 81.63 210.83 11734.98 C9 (inches)	Angle Coll Force to Normal (degr	rees): 30).0					
Damage Length (inches): 155.9 Crush Profile Measurements: 10 Namage Length (inches): 10 Linches) 0.00 29.30 68.86 157 107.87 12 (inches) 0.00 29.30 68.86 130.85 3.71 486.08 28.50 3728.44 33 (inches) 18.30 130.85 3.71 486.08 28.50 377.5 5561.82 (3 (inches) 9.60 130.0 147.34 7.26 1069.96 37.75 5561.82 (3 (inches) 10.00 18.10 377.39 10.33 1730.19 38.78 6685.98 (3 (inches) 10.30 19.00 8.60 172.43 10.30 1730.19 38.78 6685.98 (37.75 5561.82 (4 (inches) 0.00 23.30 55.55 (10.60 0.30 173.178.98 (20 (inches)<	No Damage Speed (n	nph): 2	2.0					
Crush Profile Measurements: 10 Unequal Spacing Zone Area Spacing Zone Area Depth(x) Zone Depth(x) Area Depth(x) Zone Depth(x) Area Depth(y) Area Depth(y) Area Depth(y) C1 (inches) 0.00 29.30 68.86 1.57 107.87 19.53 1344.97 C2 (inches) 4.70 18.30 130.85 3.71 486.08 28.50 3728.44 C3 (inches) 9.60 1.30 11.96 4.60 55.05 3.24 38.76 C4 (inches) 8.80 10.60 147.34 7.26 1069.96 37.75 5561.82 C5 (inches) 19.00 8.60 172.43 10.03 1730.19 38.78 6685.98 C6 (inches) 21.10 18.10 377.39 10.43 3934.43 99.51 37555.03 C7 (inches) 0.00 23.30 55.66 1.47 81.63 210.83 11734.98 C0 (inches) 0.00 25.30 55.66 1.47 81.63 210.83 11734.98 C1 (inches) 0.00 26.1 1.22 1.04 1.00 <td>Energy Crush Depth (inc</td> <td>ches): 9.</td> <td>61</td> <td></td> <td></td> <td></td> <td></td> <td></td>	Energy Crush Depth (inc	ches): 9.	61					
Unequal Spacing Zone Zone Area (inches) Area Depth(x) (inches) Zone Depth(y) (inches) Area Depth(y) (inches) Depth(y) (inches) Area Depth(y) (inches) C2 (inches) 4.70 18.30 130.85 3.71 486.08 28.50 3728.44 C3 (inches) 9.60 13.0 11.96 4.60 55.05 3.24 38.76 C4 (inches) 8.80 10.60 147.34 7.26 1069.96 37.75 5561.82 C5 (inches) 21.10 18.10 377.39 10.43 3934.43 99.51 3755.03 C7 (inches) 20.60 10.80 196.02 9.13 1789.69 69.96 13712.98 C8 (inches) 5.70 33.60 337.68 5.55 1875.61 248.85 84032.26 <t< td=""><td>Damage Length (ind</td><td>ches): 155</td><td>5.9</td><td></td><td></td><td></td><td></td><td></td></t<>	Damage Length (ind	ches): 155	5.9					
Unequal Spacing Zone Zone Area Depth(x) Area Depth(x) Zone Depth(y) Area Depth(y) Area Depth(y) Area Depth(y) Area Depth(y) C1 (inches) 0.00 29.30 68.86 1.57 107.87 19.53 1344.97 C2 (inches) 4.70 18.30 130.85 3.71 486.08 28.50 3728.44 C3 (inches) 9.60 1.30 11.96 4.60 55.05 3.24 38.76 C4 (inches) 8.80 10.60 147.34 7.26 1069.96 37.75 5561.82 C5 (inches) 19.00 8.60 172.43 10.03 1730.19 38.78 6685.98 C6 (inches) 21.10 18.10 377.39 10.43 3934.43 99.51 37555.03 C7 (inches) 20.60 10.80 196.02 9.13 1789.69 69.96 1371.298 C8 (inches) 5.50 1875.61 248.85 84032.26 C9 (inches) 10.0 1371.298 C10 (inches) 0.00								
Spacing (inches) Zone Area (inches) Depth(x) (inches) Depth(x) (inches) Depth(y) (inches) Depth(y) (inches) Depth(y) (inches) Depth(y) (inches) C1 (inches) 0.00 29.30 68.86 1.57 107.87 19.53 1344.97 C2 (inches) 4.70 18.30 130.85 3.71 486.08 28.50 3728.44 C3 (inches) 9.60 1.30 11.96 4.60 55.05 3.24 38.76 C4 (inches) 8.80 10.60 147.34 7.26 1069.96 37.75 5561.82 C5 (inches) 19.00 8.60 172.43 10.03 1730.19 38.78 6685.98 C6 (inches) 21.10 18.10 377.39 10.43 3934.43 99.51 3755.03 C7 (inches) 20.60 10.80 196.02 9.13 1789.69 69.96 13712.98 C8 (inches) 15.70 33.60 337.68 5.55 1875.61 248.85 84032.26 C9 (inches) 0	Crush Profile Measurem		10					
C1 (inches) (inches) (inches) (inches) (inches) (inches) C2 (inches) 4.70 18.30 130.85 3.71 486.08 28.50 3728.44 C3 (inches) 9.60 1.30 11.96 4.60 55.05 3.24 38.76 C4 (inches) 8.80 10.60 147.34 7.26 1069.96 37.75 5561.82 C5 (inches) 19.00 8.60 172.43 10.03 1730.19 38.78 6685.98 C6 (inches) 21.10 8.60 172.43 10.03 1730.19 38.78 6685.98 C7 (inches) 20.60 10.80 196.02 9.13 1789.69 69.96 13712.98 C8 (inches) 15.70 33.60 337.68 5.55 1875.61 248.85 84032.26 C9 (inches) 0.00 25.30 55.66 1.47 81.63 210.83 11734.98 C10 (inches) 0.00 24.8 7.5 8678.34 14054.87 10.3 9.0 10.6 Average Crush (inches): 9.61 11.2		•	7					
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C10 (inches) 0.00 Average Crush (inches): 9.61 Average Crush (inches): 9.61 Average Crush (inches): 9.61 Average Crush (inches): 9.61 Average KE Force Damage Speed Delta V A B (poundsf) Energy (ft*lbs) (mph) bsub1 Minimum 30.4 11.2 12454.10 19666.11 12.2 10.4 13.0 Avg - 2 Std. Deviations 24.8 7.5 8678.34 14054.87 10.3 9.0 10.6 Avg - 1 Std. Deviations 31.0 11.7 12878.90 20295.29 12.4 10.5 13.3 Average 36.2 16.0 17079.46 26500.18 14.1 11.9 15.5 Avg + 1 Std. Deviations 40.9 20.3 21280.02 32682.01 15.7 13.2 17.5 Avg + 2 Std. Deviations 45.1 24.8 25480.58 38847.32 17.1 14.3 19.3 Maximum 45.3 25.0 <t< td=""><td>· · /</td><td>33.60</td><td>337.68</td><td>8 5.5</td><td>5 1875.61</td><td>24</td><td>8.85</td><td>84032.26</td></t<>	· · /	33.60	337.68	8 5.5	5 1875.61	24	8.85	84032.26
Average Crush (inches): 9.61 Results Average Force (poundsf) Damage Energy (ft*lbs) KE (mph) Delta V (mph) A B 0.00000000000000000000000000000000000		25.30	55.66	5 1.4	7 81.63	21	.0.83	11734.98
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Kesults Force Damage Speed Delta V A B (poundsf) Energy (ft*lbs) (mph) (mph) bsub1 Minimum 30.4 11.2 12454.10 19666.11 12.2 10.4 13.0 Avg - 2 Std. Deviations 24.8 7.5 8678.34 14054.87 10.3 9.0 10.6 Avg - 1 Std. Deviations 31.0 11.7 12878.90 20295.29 12.4 10.5 13.3 Average 36.2 16.0 17079.46 26500.18 14.1 11.9 15.5 Avg + 1 Std. Deviations 40.9 20.3 21280.02 32682.01 15.7 13.2 17.5 Avg + 2 Std. Deviations 45.1 24.8 25480.58 38847.32 17.1 14.3 19.3 Maximum 45.3 25.0 25670.17 39125.26 17.1 14.4 19.4 Damage Centroid Depth (x) (inches) 7.43 Eff. Mass Ratio (gamma) 0.81	Average Crush (inches):	9.61						
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Avg - 2 Std. Deviations 24.8 7.5 8678.34 14054.87 10.3 9.0 10.6 Avg - 1 Std. Deviations 31.0 11.7 12878.90 20295.29 12.4 10.5 13.3 Average 36.2 16.0 17079.46 26500.18 14.1 11.9 15.5 Avg + 1 Std. Deviations 40.9 20.3 21280.02 32682.01 15.7 13.2 17.5 Avg + 2 Std. Deviations 45.1 24.8 25480.58 38847.32 17.1 14.3 19.3 Maximum 45.3 25.0 25670.17 39125.26 17.1 14.4 19.4 Damage Centroid Depth (x) (inches) 7.43 k² 3374.76 Damage Centroid Depth (y) (inches) 109.73 Eff. Mass Ratio (gamma) 0.81	м Г			•			-	
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Maximum 45.3 25.0 25670.17 39125.26 17.1 14.4 19.4 Damage Centroid Depth (x) (inches) 7.43 k² 3374.76 Damage Centroid Depth (y) (inches) 109.73 Eff. Mass Ratio (gamma) 0.81	Avg + 1 Std. Deviations	40.9	20.3	21280.02	32682.01	15.7	13.2	17.5
Damage Centroid Depth (x) (inches) 7.43 k² 3374.76 Damage Centroid Depth (y) (inches) 109.73 Eff. Mass Ratio (gamma) 0.81	Avg + 2 Std. Deviations	45.1	24.8	25480.58	38847.32	17.1	14.3	19.3
Damage Centroid Depth (y) (inches) 109.73 Eff. Mass Ratio (gamma) 0.81	Maximum	45.3	25.0	25670.17	39125.26	17.1	14.4	19.4
	Damage Centroid Depth (x)	(inches)	7.43			k²	3374.	.76
Area of Damage (inches ²), 140919	Damage Centroid Depth (y)	(inches)	109.73		Eff. Mass Ratio (gamma)	0.	.81
Area of Damage (incres). 1 1470.10	Area of Damage (ir		1498.18			_ `		

1995 CADILLAC ELDORADO - Side Impact

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

Registered Owner: 4N6XPRT SYSTEMS

Appendix 3-67

2006 CHEVROLET IMPALA MSP POLICE PACKAGE - Front Impact	1995 CADILLAC ELDORADO - Side Impact
Curb Weight (pounds): 3725 Occupant + Cargo Weight (pounds): 39 Total Weight (pounds): 3764 PDOF Lever Arm Distance (inches): 0.00 Yaw Moment of Inertia (lb-ft-sec ²)	Curb Weight (pounds): 3773 Occupant + Cargo Weight (pounds): 218 Total Weight (pounds): 3991 PDOF Lever Arm Distance (inches): 28.50 Yaw Moment of Inertia (lb-ft-sec ²)
Angle Coll Force to Normal (degrees): 0.0 "Known" Stiffness Values No Damage Speed (mph): 5.0 Energy Crush Depth (inches): 6.65 Damage Length (inches): 52.3 Crush Profile Measurements: 6 Crush Profile Measurements: 6 Vinequal Zone Spacing Zone Area Depth(x) Depth(x) Depth(x) Depth(x) (inches) 10.00 (inches) 50.37 C1 (inches) 10.00 12.30 4.60 50.37 5.50 271.17 6.99 3352.31 3351 C3 (inches) 10.00 12.20 82.35 3.51 289.16 44.00 7.10 7.10 15.62 1.47 22.91 30.07 480.58 C6 (inches) 0.00 7.10 15.62 1.47 22.91 30.77 480.58 C6 (inches) 0.00 0.00 0 <	Angle Coll Force to Normal (degrees): 30.0 No Damage Speed (mph): 2.0 Energy Crush Depth (inches): 9.61 Damage Length (inches): 155.9 Crush Profile Measurements: 10 Unequal Zone Area Spacing Zone Area Depth(x) Depth(y) (inches) 0.00 29.30 68.86 1.57 107.87 C1 (inches) 0.00 29.30 68.86 1.57 107.87 19.53 1344.97 C2 (inches) 4.70 18.30 130.85 3.71 486.08 28.50 3728.44 C3 (inches) 9.60 1.30 11.96 4.60 55.05 3.24 38.76 C4 (inches) 8.80 1.30 11.96 4.60 55.05 3.24 38.76 C4 (inches) 19.00 8.60 172.43 10.03 1730.19 38.78 6685.98 C6 (inches) 21.10 18.10 377.39 10.43 3934.43 99.51 3755.53 C7 (inches) 20.60 10.80 196.02 9.13
Average Crush (inches): 6.65	Average Crush (inches): 9.61
Average KE Closing Force Damage Speed Delta V Speed A B (poundsf) Energy (ft*lbs) (mph) (MPH)	Average KE Results Force Damage Speed Delta V A B (poundsf) Energy (ft*lbs) (mph) (mph) bsub1
Minimum 207.6 40.4 12454.10 13318.06 10.3 11.0 23.9 Avg - 2 Std. Deviations 173.6 23.8 8678.34 10722.52 9.2 9.5 20.7 Avg - 1 Std. Deviations 215.2 41.7 12878.90 13793.92 10.5 11.2 24.3 Average 256.8 59.6 17079.46 17195.65 11.7 12.7 27.5 Avg + 1 Std. Deviations 298.4 77.5 21280.02 20698.82 12.8 14.0 30.4 Avg + 2 Std. Deviations 340.0 95.4 25480.58 24246.34 13.9 15.2 33.0 Maximum 340.6 96.4 25670.17 24368.75 13.9 15.3 33.1 Damage Centroid Depth (x) (inches) 42.5 k² 3290.26 3290.26 340.0 340.0 347.79 Area of Damage (inches²): 347.79 347.79 340.62 1.00 340.02 347.79 ANGXPRT StiftCalcs® licensed by 4N6XPRT Systems (www.4N6XPRT.com) to: Serial Number: 15R-0302015C02301	Minimum 30.4 11.2 12454.10 19666.11 12.2 10.4 13.0 Avg - 2 Std. Deviations 24.8 7.5 8678.34 14054.87 10.3 9.0 10.6 Avg - 1 Std. Deviations 31.0 11.7 12878.90 20295.29 12.4 10.5 13.3 Average 36.2 16.0 17079.46 26500.18 14.1 11.9 15.5 Avg + 1 Std. Deviations 40.9 20.3 21280.02 32682.01 15.7 13.2 17.5 Avg + 2 Std. Deviations 45.1 24.8 25480.58 38847.32 17.1 14.3 19.3 Maximum 45.3 25.0 25670.17 39125.26 17.1 14.4 19.4 Damage Centroid Depth (x) (inches) 7.43 k² 3374.76 Damage Centroid Depth (y) (inches) 109.73 Eff. Mass Ratio (gamma) 0.81 Area of Damage (inches²): 1498.18 4N6XPRT Stystems (www.4N6XPRT.com) to: Serial Number: 15R-0302015C02301 Serial Number: 4N6XPRT StySTEMS