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TM-03-96
COLLECTION OF EVIDENCE FROM HEAVY COMMERCIAL VEHICLE INCIDENTS

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TECHNICAL MEMORANDUM

Submitted by
Surrey RCMP

December, 1995

NOTE: Further information about this report can be obtained by calling the CPRC information number (613) 998-6343

EXECUTIVE SUMMARY

The incidence of heavy commercial vehicle collisions has risen dramatically. As a result the police traffic investigator is looking to new technology to collect the necessary investigation data. This memorandum compares five instruments - Shot Marker from Max Automotive, MEA Fifth Wheel Assembly, Bowmonk Skidman, the G-Analyst and the Vericom VC 200.

SOMMAIRE

Le nombre de collisions impliquant des véhicules lourds commerciaux a augmenté de façon coinsidérable. Les policiers doivent donc se tourner vers de nouvelles technologies pour recueillir les données necessaires à leurs enquêtes. Cette etude comparative porte sur cinq appareils : le Shot Marker de Max Automotive, le Fifth Wheel Assembly de MEA, le Skidman de Bowmonk, le G-Analyst et le Vericom VC 200.

Collection of Evidence from Heavy Commercial Vehicle Incidents

A Preliminary Investigation of Alternative Data Collection Methods

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95-12-10

Overview

Commercial Vehicle Collisions - The Current Situation

The incidence of heavy commercial vehicle collisions is rising dramatically. Claims for Commercial Vehicle Collisions increased by more than $18 million between 1992 and 1994.

For the amount of distance travelled, heavy commercial vehicles are involved in relatively few collisions. The collisions they do become involved in, however, tend to be very serious. The problem with the lack of frequency means that there is little opportunity to get proficient at collecting the required data from these incidents.

With this in mind, we set out to do some testing to validate some new instrumentation which is becoming commonplace in commercial vehicles, and some new devices which could be used after the fact by Collision Analysts / Reconstructionists.

This seminar was designed to give you adequate knowledge of the available instrumentation, and to provide data which can be used to validate the findings of onboard instrumentation. There is an identifiable need to continue this research, and it is hoped that this information will give you a basis to begin.

Testing took place on two days, the 20th and 2 1st of November 1995, at Boundary Bay. Two large commercial vehicles were instrumented and tested. One was a 1995 Peterbilt tractor from J&R Rentals, and the other was a Kenworth tractor from Canada Safeway. The Peterbilt was equipped with self adjusting brakes and was pulling a trailer which was also rented for the testing. The Canada Safeway tractor was equipped with the Cummins Engine Management system which records data relevant to fleet management. This system also records panic stops.

Instruments Tested

Shot Marker from Blue Max Automotive

Both vehicles were equipped with a shot marker which was attached to the rear cross member of the tractor. This device was wired to the brake light on the tractor.

This shot marker uses a door lock motor (as opposed to a solenoid) and had been tested previously and found to operate with a comparable response time to solenoid equipped bumper gun systems.

This particular design was patterned after a previous model, which had been found to be extremely reliable.

MEA Fifth Wheel Assembly and Computer

MacInnis Engineering Associates donated the use of their Fifth Wheel and computer for acquiring speed and deceleration data from the tests. They also donated their time and experience to interpreting the results.

The fifth wheel assembly was attached to the rear cross member of the tractor and was calibrated at the scene. The data was sampled 32 times per second from approximately one second prior to braking to 15 seconds after the onset of braking.

The data collected was then saved in a spreadsheet application for interpretation.

BOWMONK SkidMan g-force Instrument

Two Bowmonk SkidMan analyzers were used. One was certified accurate from the factor) and the second was displaying the caption, "I Seed Calibration!". The Bowmonk SkidMan demands calibration after a set time limit and this message doesn't necessarily indicate a fault in the system,

The two Bowmonk devices reliably registered similar readings.

The Bowmonk SkidMan is a self contained unit in a hard case which can easily be set up and armed. It could have some practical applications in the realm of enforcement as well.

G-Analyst g-force Instrument

A G-Analyst was also used in the tests on day 2. It consists of two parts, the computer and display unit which contains the data collected, and the sensor unit which is mounted securely on the floor.

Caution should be exercised when using instruments such as the Vericom VC200 and the G-Analyst to determine road friction coefficients at collision sites.

The Vericom results should incorporate the road grade in the direction of the skid because the instrument, when used correctly, is calibrated at the actual test site.

The G-Analyst works differently. Its calibration sequence is designed to determine a true level. Its acceleration results must therefore be compensated for grade.

VERICOM VC 200

The VERICOM was loaned to the testers by the Delta Municipal Police Department. It is designed to measure g-force and to calculate the mu, by tripping automatically at the onset of braking. At times it failed to trip and therefore there was no data collected from this instrument. The VERICOM failed more often than any of the other devices, but this could have been due to a lack of experience with the product.

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The G-Analyst works differently. Its calibration sequence is designed to determine a true level. Its acceleration results must therefore be compensated for grade.

Testing *Methodologies*

Purpose of the Testing

The purpose of the testing was to determine whether the instruments tested gave similar results. This was an essential component of the evaluation process. The most glitzy piece of equipment is of absolutely no value if it doesn't produce accurate, consistent data with a high degree of reliability.

To this end, the trucks were equipped with a fifth wheel recording device which was connected to a computer for the purposes of downloading the wheel travel. The fifth wheel was attached to the rear cross member of the tractor unit. The computer was programmed to collect wheel speed data at a rate of 32 samples per second. The fifth wheel assembly was provided by MacInnis Engineering Associates and was installed and calibrated by engineers from MacInnis. It was operated from the computer in the cab of the truck, and was run by an engineer from MacInnis.

The G-Analyst was provided for the second day of testing by Constable Lorne Derkson of the Langley RCMP. It was installed and operated under his supervision. It was configured to collect the data throughout the day and the data was downloaded following all of the tests.

A shot marker was also installed on the truck and was mounted on the rear cross member of the tractor immediately next to the fifth wheel assembly. The shot marker was connected to the brake lamp assembly at the rear of the tractor.

The Vericom VC200 was provided by the Delta Municipal Police Department and was mounted according to the manufacturer's directions on the front windscreen of the truck. It was set to automatically trip and record each stop, but it experienced some failures. The results charts simply show a zero where the Vericom VC200 failed to trip.

The truck from Safeway Canada was equipped with an engine management system called the Road Relay TM. It is an advanced system which records various operating parameters. Of interest to Collision Investigators is it's ability to record panic stops. The Road Relay TM detects

a panic stop and keeps the data from the 45 seconds immediately preceding the panic stop. to a point 14 seconds following the onset of braking. The parameters kept are; speed, RPM, Clutch use and Brake use. These parameters can be printed out for a second by second analysis.

The Bowmonk SkidMan data was printed out and then downloaded after the testing for analysis. The results are presented in table format in the section titled *Findings.*

Process for determining the g results of each instrument

Bowmonk SkidMan

The g values of the results from the Bowmonk Skid-Man devices is calculated by the instrument by default. The Mean Deceleration figure was used for the purposes of comparison, as it is the most straightforward method of collecting the data.

Shot Marker (Bumper Gun)

The normal process for calculating mu was used with the shot marker. The speed was measured by Radar, the distance from the chalk mark to a point beneath the final rest position of the shot marker was measured, and the results were applied to the formula to determine mu from Speed and Distance.

$$\mu = \frac{S^2}{254D} \quad \text{or, in this case} \quad g = \frac{S^2}{254D}$$

MEA Fifth Wheel

The fifth wheel presented a small problem, but a workaround was found. On the day of testing, there was no operable device to provide a signal to the computer the instant the brake pedal was depressed. This meant, that there was no corresponding data stored as to when the brakes were actually applied. Since this is an air brake equipped vehicle, the system lag would not be calculated and therefore, the samples obtained could differ from some of the other instrumentation.

The workaround was relatively simple. Since the fifth wheel samples distance 32 times per second, and calculates the deceleration force with each sample, the standard method of calculating the Mean Deceleration is to average all of the readings taken during braking. The distance the vehicle travelled from the onset of braking to final rest was known from the results of the shot marker test.

Therefore, the distance from the shot marker test was subtracted from the final rest distance of the fifth wheel, and the point where the brakes were applied could be easily located within the data.

Vericom VC200

The Vericom VC200 was set to automatically trip when it sensed deceleration. It then calculated the results automatically and displayed them on a screen. The Vericom VC200 displays two results, both a peak reading and an Average g value. The Average g was used for our purposes.

Caution should be exercised when using instruments such as the Vericom VC200 and the G-Analyst to determine road friction coefficients at collision sites.

The Vericom results should incorporate the road grade in the direction of the skid because the instrument, when used correctly, is calibrated at the actual test site.

G-Analyst

The G-Analyst was also set to trip automatically when it sensed a sudden deceleration. It was-set to collect the data from the tests and was removed from the vehicle. The data was then downloaded to a floppy disk for analysis later.

The G-Analyst data analysis program is an artifact of the days of DOS software. Had the limitations of this software been known prior to downloading the data, it would have been saved in a .pm format to permit analysis via a spreadsheet application. The g force was calculated and registered by the G-Analyst at a rate of ten samples per second. The results of these scans were averaged over the total stopping distance to calculate the average g force. The results of these calculations are shown in the table in Appendix “A”.

Caution should be exercised when using instruments such as the Vericom VC200 and the G-Analyst to determine road friction coefficients at collision sites.

The G-Analyst calibration sequence is designed to determine-a true level. Its acceleration results must therefore be compensated for grade.

Findings

Similarities

The results, taken in their totality, show a remarkable consistency, given the wide range of technologies which calculated the data.

For the purposes of charting the data collected, when an instrument failed, the data is represented as zero. This ensures that there will be no misleading information in the charts.

To fully understand the charts, the details of the tests have been assembled into Table form.

Test Notes

Test	Vehicle	Notes
1	1995 Peterbilt with trailer	Lock-up attempted at ~50 km/h. Data failure with fifth wheel. Concrete surface, dry. Radar @ 48 km/h.
2	1995 Peterbilt with trailer	Lock-up attempted at ~50 km/h. Concrete surface, dry. Radar @ 49 km/h.
3	1995 Peterbilt with trailer	Lock-up attempted at ~50 km/h. Concrete surface, dry. Radar @ 48 km/h.
4	1995 Peterbilt with trailer	Lock-up attempted at ~50 km/h. Concrete surface, dry. Radar @ 49 km/h. Both SkidMan units placed side-by-side in cab of truck.
5	1995 Peterbilt with trailer	Lock-up attempted at -50 km/h. Concrete surface, dry. Radar @ 50 km/h. SkidMan 2 placed on rear of trailer. 16.60 meters rearward of SkidMan 1.
6	1995 Peterbilt with trailer	Lock-up attempted at -90 km/h. Concrete surface, dry. Radar @ 85 km/h. SkidMan 2 placed on rear of trailer. 16.60 meters rearward of SkidMan 1.

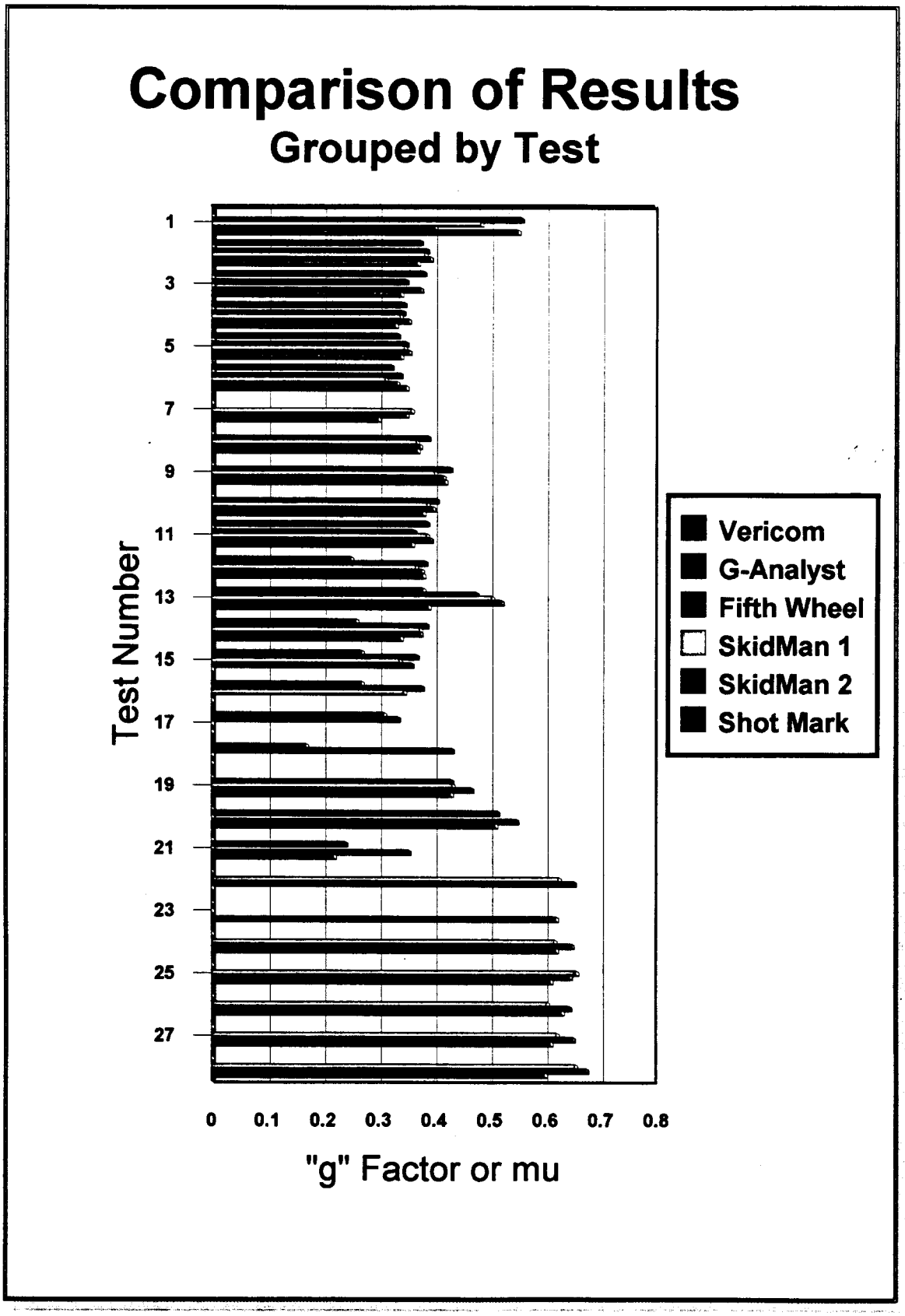
7	1995 Peterbih with trailer	Lock-up attempted at -80 km/h. Concrete surface, dry. Radar @ 84 km/h. Computer for fifth wheel failed. SkidMan 2 was placed on roof of tractor.
8	1995 Peterbilt with trailer	Lock-up attempted at -80 km/h. Concrete surface, dry. Radar @ 81 km/h. SkidMan 2 was placed on roof of tractor.
9	1995 Peterbilt with trailer	Lock-up attempted at ~100 km/h. Concrete surface, dry. Radar @ 98 km/h. SkidMan 1 was tilted at -7% to the front, SkidMan 2 was tilted -140 from the front.
10	1995 Peterbilt with trailer	Lock-up attempted at ~100 km/h. Concrete surface, dry. Radar @ 106 km/h. SkidMan 1 was triggered by the pedal force transducer, SkidMan 2 was internally triggered.
11	1995 Peterbilt with trailer	Lock-up attempted at -50 km/h. Concrete surface, dry. Radar @ 49 km/h.
12	1995 Peterbilt with trailer	Lock-up attempted at -50 km/h. Asphalt surface, dry. Radar @ 60 km/h. Brakes were backed off manually to the legal limit (2 inches)
13	1995 Peterbilt with trailer	Lock-up attempted at -50 km/h. Asphalt surface, dry. Radar @ 57 km/h. Brakes were backed off manually to the legal limit (2 inches)
14	1995 Peterbilt with trailer	Lock-up attempted at -60 km/h. Asphalt surface, dry. Radar @ 56 km/h. Brakes were backed off manually to the legal limit (2 inches) NO STEERING AXLE BRAKES.
15	1995 Peterbilt with trailer	Lock-up attempted at -60 km/h. Asphalt surface, dry. No Radar reading as Shot Marker failed. Brakes were backed off manually to the legal limit (2 inches) NO STEERING AXLE BRAKES.
16	Canada Safeway Kenworth	No Trailer. Tests to validate the Road Relay system. Panic stop from 60 km/h. No radar reading as the Shot Marker failed. Results from Road Relay matched those from fifth wheel.
17	Canada Safeway Kenworth	No Trailer. Tests to validate the Road Relay system. Panic stop from 60 km/h. No radar reading as the Shot Marker failed. Results from Road Relay matched those from fifth wheel.
18	Canada Safeway Kenworth	No Trailer. Panic stop from 32 km/h. No radar reading as the Shot Marker failed.
19	1995 Peterbilt with trailer	Lock-up attempted at -60 km/h. Asphalt surface, wet. Radar @ 58 km/h. Brakes were backed off manually to the legal limit (2 inches) Brakes were run until HOT.

20	1995 Peterbilt no trailer	Lock-up attempted at -50 km/h. Asphalt surface. wet Radar @ 50 km/h. Brakes were backed off manually to the legal limit (2 inches) Brakes were run until HOT.
21	1995 Peterbilt no trailer	Lock-up attempted at -50 km/h. Asphalt surface, wet. Radar @ 48 km/h. Brakes were backed off manually to the legal limit (2 inches) Front brakes were completely backed off. Brakes were run until HOT.
22	Plymouth Voyager	Bumper Gun Failed
23	Plymouth Voyager	Skid-Man 1 was mounted on the floor between the front seats. Skidman 2 was placed in a cupboard at the rear of the vehicle, 1.45 meters to the rear and 0.72 meters higher. Speed from Radar was 55 km/h and the slide distance was 19.00 meters.
24	Plymouth Voyager	SkidMan 1 was mounted on the floor between the front seats. SkidMan 2 was placed in a cupboard at the rear of the vehicle, 1.45 meters to the rear and 0.72 meters higher. Speed from Radar was 64 km/h and the slide distance was 25.75 meters.
25	Plymouth Voyager	SkidMan 1 was mounted on the floor between the front seats. SkidMan 2 was placed on the floor at the rear of the vehicle, 1.45 meters to the rear. Speed from Radar was 61 km/h and the slide distance was 23.90 meters.
26	Plymouth Voyager	SkidMan 1 was mounted on the floor between the front seats. SkidMan 2 was placed on the floor at the rear of the vehicle, 1.45 meters to the rear. Speed from Radar was 62 km/h and the slide distance was 23.90 meters.
27	Plymouth Voyager	Both SkidMan devices mounted on floor side by side. Speed from Radar was 62 km/h and the slide distance was 24.65 meters.
28	Plymouth Voyager	Both SkidMan devices mounted on floor side by side. Speed from Radar was 62 km/h and the slide distance was 24.65 meters.

The information in the table above, should be used when reading the following table and chart. Most often, discrepancies between instrumentation can be explained from the information in the table.

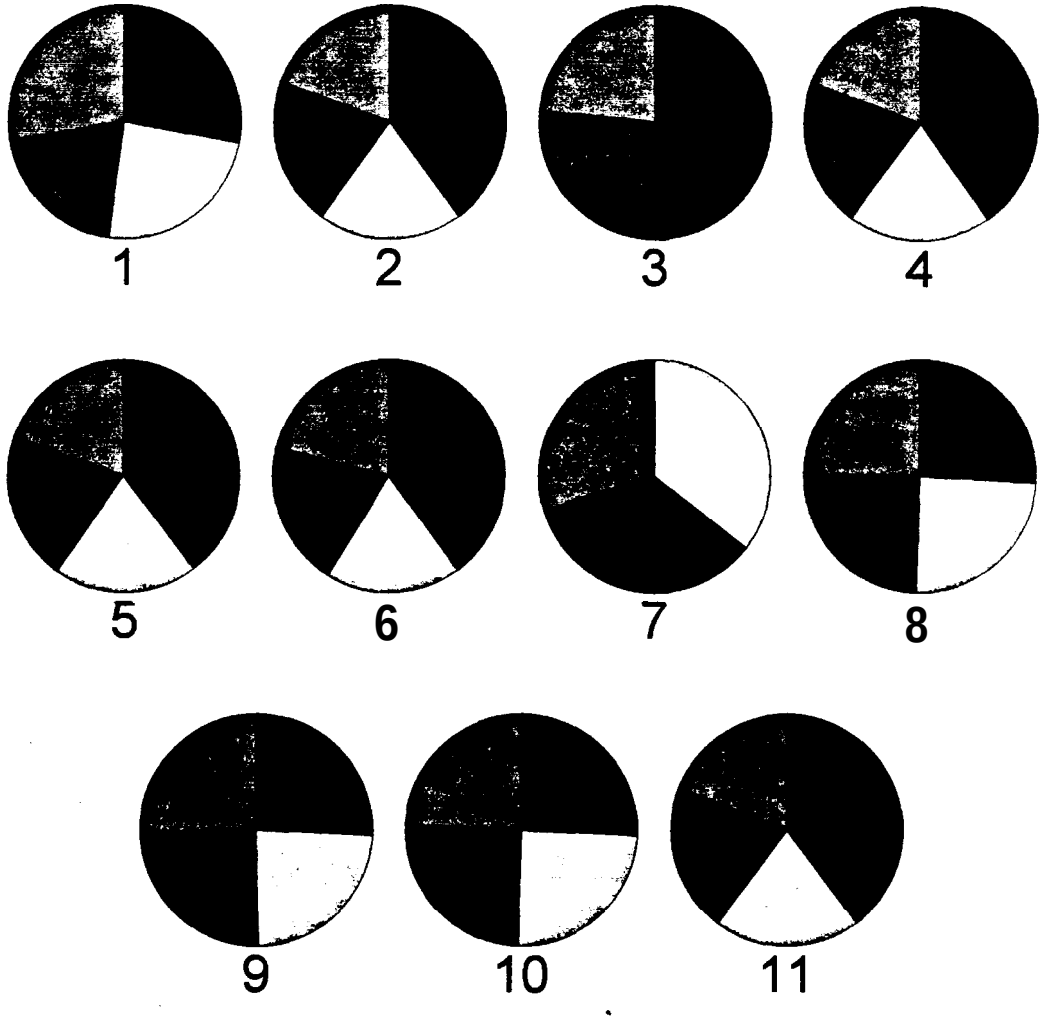
Summation of Mu Values from Testing						
Test	Instrument					
	Vericom	G-Analyst	Fifth Wheel	SkidMan 1	SkidMan 2	Shot Mark
1	0.000	0.000	0.556	0.483	0.401	0.550
2	0.375	0.000	0.386	0.383	0.393	0.370
3	0.381	0.000	0.350	0.000	0.376	0.340
4	0.346	0.000	0.344	0.339	0.354	0.330
5	0.335	0.000	0.350	0.347	0.355	0.340
6	0.323	0.000	0.339	0.312	0.333	0.350
7	0.000	0.000	0.000	0.359	0.350	0.300
8	0.000	0.000	0.389	0.368	0.374	0.370
9	0.000	0.000	0.429	0.401	0.417	0.420
10	0.000	0.000	0.404	0.388	0.398	0.380
11	0.387	0.000	0.364	0.387	0.394	0.360
12	0.000	0.250	0.384	0.367	0.378	0.380
13	0.214	0.380	0.476	0.504	0.521	0.390
14	0.000	0.260	0.368	0.374	0.376	0.340
15	0.000	0.270	0.368	0.338	0.359	0.000
16	0.000	0.270	0.378	0.346	0.000	0.000
17	0.000	0.310	0.335	0.000	0.000	0.000
18	0.000	0.170	0.432	0.430	0.000	0.000
19	0.000	0.000	0.431	0.433	0.467	0.430
20	0.000	0.000	0.514	0.000	0.548	0.510
21	0.000	0.000	0.240	0.000	0.354	0.220
22	0.000	0.000	0.000	0.624	0.652	0.000
23	0.000	0.000	0.000	0.000	0.000	0.620
24	0.000	0.000	0.000	0.617	0.648	0.620
25	0.000	0.000	0.000	0.656	0.645	0.610
26	0.000	0.000	0.000	0.603	0.644	0.630
27	0.000	0.000	0.000	0.621	0.650	0.610
28	0.000	0.000	0.000	0.654	0.674	0.600

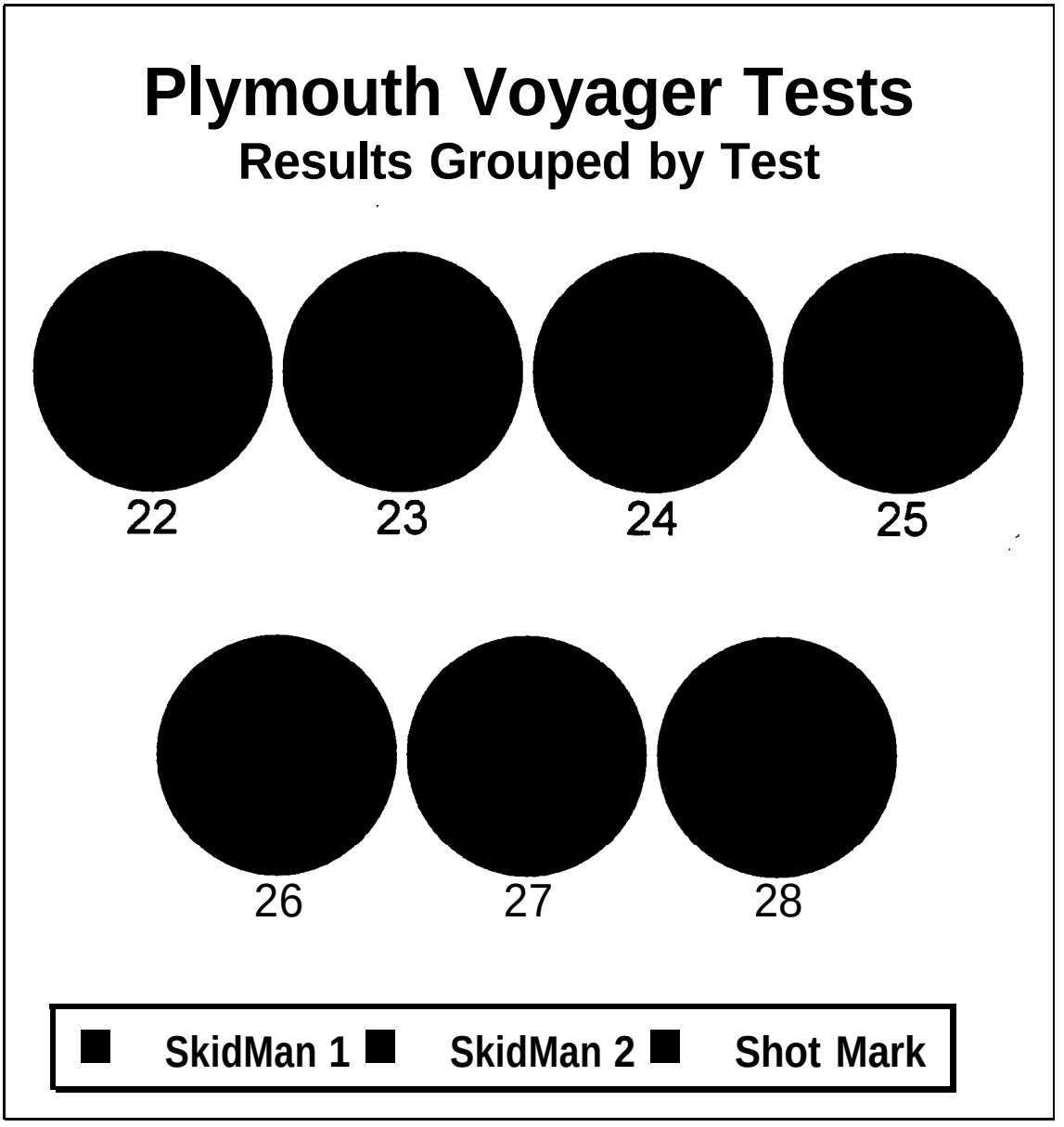
NOTE: Where the chart shows a result of "0.000", this means that the system either failed to provide a reading, or was not used for that test.


Comparison of Results
Grouped by Test
Test Number
1
3
5
7
9
11
13
15
17
19
21
23
25
27
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
"g" Factor or mu
Vericom
G-Analyst
Fifth Wheel
SkidMan 1
SkidMan 2
Shot Mark

Comparison of Results

Instruments Compared by Test

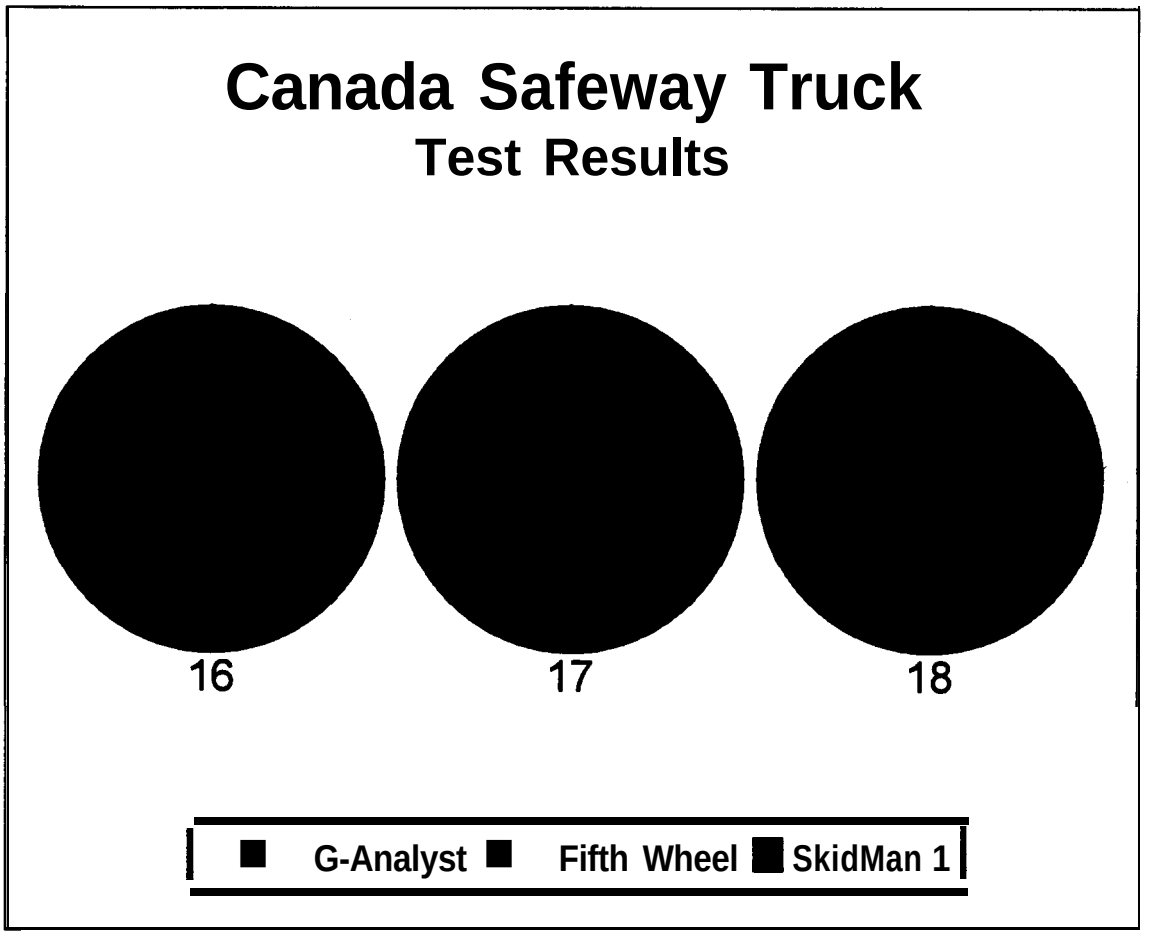




This chart shows the representative value of each instrument at each test. As it ignores zero values, which indicate that an instrument failed, it shows the relationship between each instrument. If all of the instruments returned an identical value, they would all share equal space on the pie chart.

The purpose of the tests with the Plymouth Voyager was to attempt to confuse the Bowmonk SkidMan instruments. As the chart indicates, all attempts to confuse this instrument failed.

The chart on the next page is identical in nature, but only shows the tests involving the truck from Canada Safeway. Since there were various equipment failures when testing the Canada Safeway truck, the data appears incomplete, however, it acts as an accurate representation of the relationships between the instruments which did function.



Of special interest here is the result from the G-Analyst in Test #18. More research will be necessary to understand this failure.

G-Analyst Data from Testing on the 21st of November 1995 at Boundary Bay							
	Mu value (g) for each time increment						
	Test 12	Test 13	Test 14	Test 15	Test 16	Test 17	Test 18
Time (Seconds)							
0.1	0.01	0.13	0.02	0.18	0.04	0.10	0.18
0.2	0.03	-0.01	0.19	0.47	0.32	0.49	0.19
0.3	0.04	0.40	0.47	0.43	0.21	0.58	0.00
0.4	0.30	0.49	-0.01	0.38	0.49	-0.01	0.20
0.5	0.03	0.51	0.43	0.32	-0.01	0.59	0.20
0.6	0.51	0.57	0.38	-0.01	0.49	0.59	0.21
0.7	0.41	0.58	0.38	0.35	0.49	0.59	0.21
0.8	0.40	-0.01	0.38	0.39	0.50	0.51	0.23
0.9	0.35	0.59	0.38	0.33	0.50	-0.02	0.00
1	0.40	0.57	-0.01	0.31	0.48	-0.01	0.23
1.1	0.03	0.38	0.36	0.29	-0.01	0.01	0.24
1.2	0.38		0.34	-0.01	0.08		0.25
1.3	0.35		0.33	0.28	-0.02		0.26
1.4	0.35		0.32	0.08			0.28
1.5	0.34		-0.03				0.00
1.6	0.29						0.26
1.7	0.03						0.17
1.8							0.02
1.9							
2							
Average g	0.25	0.38	0.26	0.27	0.27	0.31	0.17

Appendix B

Road Relay Tests

The truck from Canada Safeway was instrumented with a fifth wheel to determine the accuracy of the Road Relay system.

The Road Relay results of the first panic stop showed a speed of 39 miles per hour immediately preceding braking action. The figure for the second panic stop was 37 miles per hour. It was not possible to match the results during braking, only the figure immediately preceding braking action was accurate. This is likely due either to the fact that the truck's wheels are experiencing braking where the fifth wheel is free wheeling, or that the speed change is too rapid for the sampling system of the Road Relay.

The next two pages show the results from the fifth wheel as they pertain to the panic stop tests. The speeds match exactly to the speed obtained from the Road Relay.

File Name : TR_BR16.CSV										
Description: Truck braking tests										
Test Time and Date : 12:09:57 11/21/95										
Sampling Sequence Completed Normally										
Sampling Rate : 32.00 Hz										
Sample Time before Trigger : 1.0 seconds										
Sample Time after Trigger : 12.0 seconds										
Encoder Ports Sampled:										
	Port A MEA 5th Wheel - Diameter : -0.658 meters (20000 PPR)									
Acceleration Averaged Across 16 Time Slices										
Time	Wheel A	Distance	Velocity	Acceleration		Average Acceleration during braking				
(sec)	(pulses)	(m)	(m/s)	(g)		(g)				
-1	8379163	-17.627	17.7545			-0.3789				
-0.9688	8373812	-17.0737	17.7578				Km/h	MPH		
-0.9375	8368429	-16.5172	17.7495				63.84712	39.58522		
-0.9063	8363083	-15.9644	17.7231				63.75216	39.52634		
-0.875	8357716	-15.4095	17.7446				63.8295	39.57429		
-0.8438	8352357	-14.8554	17.6966				63.65683	39.46724		
-0.8125	8347019	-14.3034	17.6552				63.50791	39.37491		
-0.7813	8341685	-13.7519	17.7297				63.7759	39.54106		
-0.75	8336302	-13.1953	17.7131	-0.019			63.71619	39.50404		
-0.7188	8330978	-12.6448	17.6685	-0.01			63.55576	39.40457		
-0.6875	8325622	-12.091	17.6983	-0.009			63.66295	39.47103		
-0.6563	8320280	-11.5387	17.685	0			63.61511	39.44137		
-0.625	8314932	-10.9857	17.7016	0			63.67482	39.47839		
-0.5938	8309580	-10.4323	17.6817	0.012			63.60324	39.43401		
-0.5625	8304244	-9.88062	17.647	0.016			63.47842	39.35662		
-0.5313	8298913	-9.32941	17.6883	-0.002			63.62698	39.44873		
-0.5	8293552	-8.7751	17.7131	0.002			63.71619	39.50404		
-0.4688	8288206	-8.22234	17.6701	-0.007			63.56151	39.40814		
-0.4375	8282871	-7.67071	17.7512	-0.013			63.85324	39.58901		
-0.4063	8277476	-7.11289	17.7429	-0.046			63.82338	39.5705		
-0.375	8272146	-6.56178	17.7793	-0.064			63.95432	39.65168		
-0.3438	8266729	-6.00168	17.8223	-0.104			64.10899	39.74758		
-0.3125	8261373	-5.44788	17.4931	-0.11			62.92482	39.01339		
-0.2813	8256155	-4.90836	17.5097	-0.086			62.98453	39.05041		
-0.25	8250789	-4.35353	17.6635	-0.111			63.53777	39.39342		
-0.2188	8245478	-3.80439	17.5212	-0.112			63.0259	39.07606		
-0.1875	8240198	-3.25845	17.4269	-0.103			62.68669	38.86575		
-0.1563	8234944	-2.71521	17.2996	-0.075			62.22878	38.58184		
-0.125	8229741	-2.17723	17.288	-0.05			62.18705	38.55597		
-0.0938	8224494	-1.63471	17.5146	-0.028			63.00216	39.06134		
-0.0625	8219154	-1.08257	17.5179	-0.042			63.01403	39.0687		
-0.0313	8213905	-0.53984	17.3211	-0.046			62.30612	38.62979		
0	8208684	0	17.3591	-0.027			62.44281	38.71454		
0.0313	8203412	0.54511	17.4501	-0.043			62.77014	38.91749		
0.0625	8198136	1.09063	17.4617	-0.063			62.81187	38.94336		
0.0938	8192857	1.63646	17.3757	-0.086			62.50252	38.75156		
0.125	0187633	2.17661	17.2549	0.113			62.06799	38.48215		

The results for the first test of the Road Relay. The full second prior to braking is shown, as well as the braking point. The Speed registered prior to braking by the Road Relay was 39 mph.

File Name : TR_BR17.CSV
Description Truck braking tests
Test Time and Data : 12:30:12 11/21/95
Sampling Sequence Completed Normally
Sampling Rate : 32.00 Hz
Sample Time **before** Trigger : **1.0** seconds
Sample hme after Trigger : **12.0 seconds**
Encoder Ports Sampled:
Port A MEA 5th Wheel - Diameter : -0.658 meters (20000 PPR)
Acceleration Average Across 16 Time Slices

lime (sec)	Wheel **A** / (pulses)	Distance l (m)	Velocity (m/s)	Acceleration (g)	/Average Acceleration during braking (g)	Km/H	MPH
-1	7469850	-16.7225	16.8347		-0.33514		
-0.9688	74647561	-16.1958	16.76851				
-0.9375	74597141	-15.6745	16.6494				
-0.9063	7454692	-15.1552	16.7156				
-0.875	74496101	-14.6297	16.7664				
-0.8438	7444544	-14.1059	16.7139				
-0.8125	7439507	-13.5851	16.6411				
-0.7813	7434485	-13.0659	16.5832			59 .6518	36.98412
-0.75	7429483	-12.5487	16.5601	0.0		59.5 6871	36.9326
-0.7188	7424475	-12.0309	16.6345	0.049		59.8 .13633	37.09853
-0.6875	7419428	-11.509	16.6295	0.04		59.81835	37.08737
-0.6563	7414423	-10.9915	16.704	0.058		60.08633	37.25353
-0.625	7409331	-10.465	17.0183	0.045		61.21691	37.95448
-0.5938	7404136	-9.92787	16.9753	0.004		61.06223	37.85858
-0.5625	7399070	-9.40406	16.8347	-0.001		60.55647	37.54501
-0.5313	7393960	-8.8757	16.6659	-0.026		59.94928	37.16855
-0.5	7388996	-8.36244	16.6329	-0.01 1		59.8 3058	37.09496
-0.4688	7383906	-7.83615	16.699	-0.031		6O.0 6835	37.24237
-0.4375	7378902	-7.31875	16.7007	-0.009		60.0 7446	37.24617
-0.4063	7373811	-6.79236	16.7321	-0.034		60.1 8741	37.31619
-0.375	7368788	-6.27299	16.7205	-0.019		60.14568	37.29032
-0.3438	7363704	-5.74732	16.79	-0.004		60.39568	37.44532
-0.3125	7358639	-5.22362	16.7354	-0.006		60.19928	37.32355
-0.2813	7353588	-4.70136	16.6527	0.011		59.9018	37.13912
-0.25	7348573	-4.18282	16.6527	0.005		59.9018	37.13912
-0.2188	7343522	-3.66056	16.7784	0.012		60.35396	37.41945
-0.1875	7338431	-3.13417	16.747	-0.003		60.24101	37.34942
-0.1563	7333399	-2.61388	16.6676	0.015		59.9554	37.17235
-0.125	7328356	-2.09245	16.7123	0.01		60.11619	37.27204
-0.0938	7323297	-1.56936	16.7321	0.018		60.18741	37.31619
-0.0625	7318242	-1.04669	16.7834	0.03		60.37194	37.4306
-0.0313	7313152	-0.5204	16.747	0.02		60.24101	37.34942
0	7308119	0	16.6891	0.036		60.03273	37.22029
0.0313	7303064	0.52267	16.7784	0.032		60.35396	37.41945
0.0625	7297977	1.04865	16.8215	0.014		60.50899	37.51558
0.0938	7292896	1.57401	16.7321	0.005		60.18741	37.31619
0.125	7287863	2.09441	16.7272	0.018		60.16978	37.30527

The results for the second test of the Road Relay. The full second prior to braking is shown, as well as the braking point. The Speed registered prior to braking by the Road Relay was 37 mph.