
MOTORCYCLES

Like many law enforcement agencies, the Michigan State Police used motorcycles up until late 1941 and then switched to automobiles. The Michigan State Police rekindled interest in motorcycles for day to day patrol operations in 1993. In 2004, Michigan State Police headquarters asked if we had additional information as a resource for our purchasing decisions regarding motorcycles. During that time, we were given direction to expand vehicle testing to include motorcycle testing. We are pleased to announce the fourth MSP police motorcycle test. We would like to thank Harley-Davidson and BMW for participating and providing their assistance in preparation for this year's successful testing program.

Please keep in mind while reading this evaluation, due to production cycles, BMW entries are model year 2009 motorcycles. BMW begins production on model year 2010 products months after this test was completed. Model year 2011 evaluation results will represent future product offerings from BMW.

When looking at the data, it is very important for the reader to apply your mission requirements to the motorcycle you are considering so you may make an appropriate decision. This report is not an endorsement of products, but a means of learning what's available for your officers so they can do their job more effectively and safely. If anything in this report requires further explanation or clarification, please call or write.



Harley Davidson Road King



TEST VEHICLE DESCRIPTION

MAKE Harley-Davidson	MODEL FLHP	SALES CODE NO.	
ENGINE DISPLACEMENT	CUBIC CENTIMETERS 1690	ENGINE 2 Cyl. CUBIC IN 103	
FUEL SYSTEM	Electronic Sequential Port FI	EXHAUST Two into One into Two Crossover Dual	
BORE & STROKE	3.875 X 4.375	ALTERNATOR 50 Amp 600W	
TORQUE	102 FT.LBS@3500 RPM	BATTERY 12V 28 amp/hour, 270CCA	
COMPRESSION RATIO	9.6:1		
TRANSMISSION	PRIMARY DRIVE 34/46	FINAL DRIVE 32/68	
GEAR RATIO	1st/9.593 2 nd /6.650 3rd/4.938 4th/4.0 5th/3.378 6th/2.875		
LEAN ANGLE	LEFT 31°	RIGHT 33°	
CLUTCH	Wet Multi-Plate		
WHEELS/TIRES	Wheels / Slotted Cast Aluminum front and rear / Front 17 X 3 / Rear 16 X 5 Tires / Front Dunlop D408F 130/80B17 Rear Dunlop D407 180/65B16		
FRONT SUSPENSION	FORK ANGLE 29.25°	RAKE 26°	
REAR SUSPENSION	Swingarm w/ Air Adjustable Shocks		
SUSPENSION TRAVEL	FRONT 4.60 inches	REAR 3.0 inches	
GROUND CLEARANCE, MINIMUM	5.10 inches		
BRAKE SYSTEM	Hydraulic Disc / Independent Front and Rear ABS		
BRAKES, FRONT	TYPE Dual Disc	SWEPT AREA 180 Sq.In.	
BRAKES, REAR	TYPE Single Disc	SWEPT AREA 90 Sq.In.	
FUEL CAPACITY	GALLONS 6.0	LITERS 22.71	
OIL CAPACITY	4.0 Quarts		
GENERAL MEASUREMENTS	WHEELBASE 63.54 in.	LENGTH 95.14 in.	
	TEST WEIGHT 845 lbs	OVERALL HEIGHT 55.10 in.	
	SEAT HEIGHT 27.30 inches / laden		
EPA MILEAGE EST. (MPG)	CITY 35	HIGHWAY 54	COMBINED 44.5

Harley Davidson Electra Glide



TEST VEHICLE DESCRIPTION

MAKE Harley-Davidson	MODEL FLHTP	SALES CODE NO. N/A	
ENGINE DISPLACEMENT	CUBIC CENTIMETERS 1690	ENGINE 2 Cyl. CUBIC IN 103	
FUEL SYSTEM	Electronic Sequential Port FI	EXHAUST Crossover Dual	
BORE & STROKE	3.875 x 4.375 in	ALTERNATOR 50 amp 600W	
TORQUE	102 FT.LBS@3500RPM	BATTERY 12v 28 amp hour 270CCA	
COMPRESSION RATIO	9.6:1		
TRANSMISSION	PRIMARY DRIVE 34/46	FINAL DRIVE 32/68	
GEAR RATIO	1 st /9.593 2 nd /6.650 3 rd /4.938 4 th /4.0 5 th /3.378 6 th /2.875		
LEAN ANGLE	LEFT 31°	RIGHT 33°	
CLUTCH	Wet multiple plate		
WHEELS/TIRES	Wheels / Slotted Cast Aluminum front and rear / Front 17 x 3 / Rear 16 x 5 Tires / Front Dunlop D408F 130/80B17 Rear Dunlop D407 180/65B16		
FRONT SUSPENSION	FORK ANGLE 29.25°	RAKE 26°	
REAR SUSPENSION	Swing Arm w/ Air Adjustable Shocks		
SUSPENSION TRAVEL	FRONT 4.6 in.	REAR 3.0 in.	
GROUND CLEARANCE, MINIMUM	5.10 in.		
BRAKE SYSTEM	Hydraulic Disc / Independent Front & Rear ABS		
BRAKES, FRONT	TYPE Dual Disc	SWEPT AREA 180sq in.	
BRAKES, REAR	TYPE Single Disc	SWEPT AREA 90sq in.	
FUEL CAPACITY	GALLONS 6.0	LITERS 22.71	
OIL CAPACITY	4.0 Qts		
GENERAL MEASUREMENTS	WHEELBASE 63.54 in.	LENGTH 95.14 in.	
	TEST WEIGHT 849 lbs.	OVERALL HEIGHT 61 in.	
	SEAT HEIGHT 27.30 in./laden		
EPA MILEAGE EST. (MPG)	CITY 35	HIGHWAY 54	COMBINED 44.5

BMW R1200 RTP



TEST VEHICLE DESCRIPTION

MAKE BMW 2009	MODEL R1200RT-P	SALES CODE NO. 09RB	
ENGINE DISPLACEMENT	CUBIC CENTIMETERS 1170	Engine 2 Cyl. CUBIC IN 72	
FUEL SYSTEM	BMSK-P Injection	EXHAUST Two into One Stainless Steel	
BORE & STROKE	101 mm. x 73 mm.	ALTERNATOR 60 Amp 720 W	
TORQUE	85 ft-lbs @ 6,000 rpm.	BATTERY (2) 12V 19 amp/hour Maintenance-Free	
COMPRESSION RATIO	12.0:1		
TRANSMISSION	PRIMARY DRIVE Gear 1:1.882	FINAL DRIVE Shaft w/ring & pinion gear	
GEAR RATIO	1:2.75 rear drive ratio		
LEAN ANGLE	LEFT 46°	RIGHT 46°	
CLUTCH	Self-adjusting Hydraulic Actuating Single Plate Dry Clutch		
WHEELS/TIRES	Die-cast Aluminum MTH2 Rim / Front Dunlop Roadsmart Size 120/70ZR17 / Rear Dunlop Roadsmart Size 180/55ZR17		
FRONT SUSPENSION	FORK ANGLE 63.4 BMW Telelever	RAKE Castor in normal position 4.3 in.	
REAR SUSPENSION	BMW Evo Paralever		
SUSPENSION TRAVEL	FRONT 4.7 in.	REAR 5.3 in.	
GROUND CLEARANCE, MINIMUM	5.125 in.		
BRAKE SYSTEM	BMW IABS II Partially Integral Brake System		
BRAKES, FRONT	TYPE Dual 12.6 in. Disc	SWEPT AREA 186 sq. in.	
BRAKES, REAR	TYPE Single 10.4 in. Disc	SWEPT AREA 62 sq. in.	
FUEL CAPACITY	GALLONS 7.1	LITERS 27	
OIL CAPACITY	4.0 Qts.		
GENERAL MEASUREMENTS	WHEELBASE 58.4 in.	LENGTH 87.8 in.	
	TEST WEIGHT 679	OVERALL HEIGHT 56.3 in.	
	SEAT HEIGHT 33.2 in. OPTIONAL LOW SEAT 31.2 in.		
EPA MILEAGE EST. (MPG) (Based on DIN standard test)	CITY 43.3*	HIGHWAY 48 @ 75mph 65 @ 55mph	COMBINED N/A

Note: *FTP (Federal Test Procedure) mileage figures indicate 43.3 mpg during exhaust emission test.

Buell Ulysses



Test Vehicle Sheet

MAKE Buell	MODEL XB12XP	SALES CODE NO.	
ENGINE DISPLACEMENT	CUBIC CENTIMETERS 1203	ENGINE 2 Cyl. CUBIC IN 73	
FUEL SYSTEM	49mm downdraft DDFI III FI	EXHAUST Two into One Underslung	
BORE & STROKE	3.50 X 3.812	ALTERNATOR 30 Amp 360W	
TORQUE	84 ft-lbs. @ 6000 rpm	BATTERY 12V 12 amp/hour, 200CCA	
COMPRESSION RATIO	10.0:1		
TRANSMISSION	PRIMARY DRIVE 57/38	FINAL DRIVE 65/27	
GEAR RATIO	1st/2.648 2 nd /1.892 3rd/1.407 4th/1.166 5th/1.000		
LEAN ANGLE	LEFT 39°	RIGHT 39°	
CLUTCH	Wet multiple plate		
WHEELS/TIRES	Wheels / Reinforced Six Spoke Cast Aluminum front and rear Front 17 X 3.5 / Rear 17 X 5.5 Tires / Front Pirelli Scorpion Sync 120/70 ZR17 Rear Pirelli Scorpion Sync 180/55 ZR17		
FRONT SUSPENSION	FORK ANGLE 22°	RAKE 23.5°	
REAR SUSPENSION	Showa Coil Over Monoshock with remote reservoir and remote spring preload adjust (fully adjustable / compression, damping, rebound damping and spring preload)		
SUSPENSION TRAVEL	FRONT 6.51 in.	REAR 6.38 in.	
GROUND CLEARANCE, MINIMUM	6.97 in.		
BRAKE SYSTEM	Hydraulic / Disc front and rear (ABS not available)		
BRAKES, FRONT	TYPE Single Disc	SWEPT AREA 50.1 sq in.	
BRAKES, REAR	TYPE Single Disc	SWEPT AREA 34.4 sq in.	
FUEL CAPACITY	GALLONS 4.4	LITERS 16.66	
OIL CAPACITY	2.5 Qts.		
GENERAL MEASUREMENTS	WHEELBASE 54.4 in.	LENGTH 86.10 in.	
	TEST WEIGHT 571	OVERALL HEIGHT n/a	
	SEAT HEIGHT 31.80 in. / laden		
EPA MILEAGE EST. (MPG)	CITY 51	HIGHWAY 64	COMBINED 57.5

BMW G650 GS-P



Test Vehicle Description

MAKE BMW	MODEL G 650 GS-P	SALES CODE NO. 09FB	
ENGINE DISPLACEMENT	CUBIC CENTIMETERS 652 cc	ENGINE 1-Cyl. CUBIC IN 40	
FUEL SYSTEM	BMS-C II Engine Management with Fuel Injection	EXHAUST Stainless Steel with Catalytic Converter	
BORE & STROKE	100 mm x 83 mm	ALTERNATOR 33 Amp 400 W	
TORQUE	44 ft-lbs 53 hp @ 7,000 rpm	BATTERY 12V 12 amp/hour	
COMPRESSION RATIO	11.5:1		
TRANSMISSION	PRIMARY DRIVE 1.946 Primary Gear Ratio	FINAL DRIVE 520 O'ring Chain 2.937:1	
GEAR RATIO	2.750 1 st , 1.750 2 nd , 1.31 3 rd , 1.05 4 th , 0.84 5 th .		
LEAN ANGLE	LEFT 45°	RIGHT 45°	
CLUTCH	Seven-disc oil-bath wet clutch		
WHEELS/TIRES	Wheels / Spoke Front and Rear / Front 2.50 x 19 / Rear 3.0 x 17 Tires / Front Metzler Tourance Size 100/90x19 / Rear Metzler Tourance Size 130/80x17		
FRONT SUSPENSION	FORK ANGLE	RAKE	
REAR SUSPENSION	Central spring strut actuated by lever linkage		
SUSPENSION TRAVEL	FRONT 6.7 in.	REAR 6.5 in.	
GROUND CLEARANCE, MINIMUM	5.1 in.		
BRAKE SYSTEM	Hydraulic 2-channel ABS brake system. ABS disengageable		
BRAKES, FRONT	TYPE Single disc self-cleaning Wave design ABS	SWEPT AREA n/a	
BRAKES, REAR	TYPE Single disc self-cleaning wave design ABS	SWEPT AREA n/a	
FUEL CAPACITY	GALLONS 4.0	LITERS 15	
OIL CAPACITY	2.4 Qts.		
GENERAL MEASUREMENTS Note: GVWR 739 lbs.	WHEELBASE 59.3 in.	LENGTH 86.8 in.	
	TEST WEIGHT 506	OVERALL HEIGHT 50" without mirrors	
	SEAT HEIGHT 30.7 in. OPTIONAL LOW SEAT 29.7 in.		
EPA MILEAGE EST. (MPG)	CITY 59.6	HIGHWAY 69.2	COMBINED

TEST VEHICLE DESCRIPTION SUMMARY

	Harley-Davidson FLHP	Harley-Davidson FLHTP	BMW R1200 RT-P
CUBIC CENTIMETERS	1690	1690	1170
ENGINE DISPLACEMENT – CU. IN.	103	103	72
ENGINE FUEL SYSTEM	EFI	EFI	Injection
EXHAUST	Crossover Dual	Crossover Dual	Two into One SS
BORE & STROKE	3.875x4.375 (inches)	3.875x4.375 (inches)	101x73 (mm)
ALTERNATOR	600 watts	600 watts	720 watts
TORQUE - FT. LBS.	102	102	85
BATTERY	12V 28 amp/hour	12V 28 amp/hour	(2) 12V 19 amp/hour
COMPRESSION RATIO	9.6:1	9.6:1	12.0:1
TRANSMISSION	6-Speed	6-Speed	6-Speed
PRIMARY DRIVE	34/46	34/46	1:1.882
FINAL DRIVE	32/68	32/68	Shaft w/ring & pinion
GEAR RATIO	2.875	2.875	1:2.75
LEAN ANGLE - LEFT	31°	31°	46°
LEAN ANGLE – RIGHT	33°	33°	46°
CLUTCH	Wet multi plate	Wet multi plate	Dry single plate
WHEELS/TIRES	3x16 MT/90-16 72H	3x16 MT/90-16 72H	Alum. MTH2
FORK ANGLE	29.25°	29.25°	63.4°
RAKE	26°	26°	4.3 in.
REAR SUSPENSION	Swing Arm	Swing Arm	EVO Paralever
SUSPENSION TRAVEL – FRONT	4.6 in.	4.6 in.	4.7 in.
SUSPENSION TRAVEL – BACK	3.0 in.	3.0 in.	5.3 in.
GROUND CLEARANCE-MINIMUM	5.1 in.	5.1 in.	5.125 in.
BRAKE SYSTEM	Disc/ABS	Disc/ABS	Disc/ABS
FRONT SWEPT AREA (sq. in.)	180	180	186
REAR SWEPT AREA (sq. in.)	90	90	62
FUEL CAPACITY – GALLONS	6	6	7.1
FUEL CAPACITY – LITERS	22.71	22.71	27
OIL CAPACITY – QUARTS	4	4	4
WHEELBASE	63.54	63.54	58.4
LENGTH	95.14	95.14	87.8
WEIGHT	845	849	679
OVERALL HEIGHT	55.1	61	56.3
SEAT HEIGHT	27.3	27.3	32.2
EPA MILEAGE – CITY	35	35	43.3
EPA MILEAGE - HIGHWAY	54	54	48 @ 75mph 65 @ 55mph

	Buell Ulysses	BMX G650 GS-P
CUBIC CENTIMETERS	1203	652
ENGINE DISPLACEMENT – CU. IN.	73	40
ENGINE FUEL SYSTEM	49mm DDFI	BMS-C II FI
EXHAUST	Two into One Underslung	Stainless Steel Single
BORE & STROKE	3.5 x 3.812	100mm x 83 mm
ALTERNATOR	360 watts	400 watts
TORQUE - FT. LBS.	84	44
BATTERY	12V 12 amp/hour	12V 12 amp/hour
COMPRESSION RATIO	10.0:1	11.5:1
TRANSMISSION	5-Speed	5-Speed
PRIMARY DRIVE	57/38	1.946
FINAL DRIVE	65/27	2.937:1
GEAR RATIO	1 st /2.648 2 nd /1.892 3rd/1.407 4 th /1.166 5 th /1.000	2.750 1 st , 1.750 2 nd , 1.131 3 rd , 1.05 4 th , .84 5 th
LEAN ANGLE - LEFT	39°	45°
LEAN ANGLE – RIGHT	39°	45°
CLUTCH	Wet Multi-Plate	7-Disk oil-bath wet clutch
WHEELS/TIRES	Alum Spoke F17 x 3.5 R17 x 5.5	Spoke 2.50"x19 100/90 x 19 / 3.00x17 130/80x17
FORK ANGLE	22°	60.8°
RAKE	23.5°	4.5 in.
	Coil over shock/Adjustable Monoshock	Central spring strut actuated by lever linkage
SUSPENSION TRAVEL – FRONT	6.51	6.7
SUSPENSION TRAVEL – BACK	6.38	6.5
GROUND CLEARANCE-MINIMUM	6.97	5.1
BRAKE SYSTEM	Disk/Non-ABS	Disk/ABS
FRONT SWEPT AREA (sq. in.)	50.1	n/a
REAR SWEPT AREA (sq. in.)	34.4	n/a
FUEL CAPACITY – GALLONS	4.4	4.0
FUEL CAPACITY – LITERS	16.66	15
OIL CAPACITY – QUARTS	2.5	2.4
WHEELBASE	54.4	59.3
LENGTH	86.10	86.8
WEIGHT	571	506
OVERALL HEIGHT	n/a	n/a
SEAT HEIGHT	31.8	30.7
EPA MILEAGE – CITY	51	59.6
EPA MILEAGE - HIGHWAY	64	69.2

MOTORCYCLE DYNAMICS TESTING

MOTORCYCLE DYNAMICS TEST OBJECTIVE

Determine each motorcycle's high speed handling characteristics and performance in comparison to other motorcycles. The course used contains 9 turns and curves (including a 90 degree left turn, a switch back, a sweeping turn, a high speed turn and a decreasing radius, with different braking requirements) and is 1 mile in length. The course simulates actual conditions encountered in pursuit or emergency driving situations in the field, with the exception of other traffic. The evaluation is a true test of the vehicle manufacturers in offering balanced packages of acceleration capabilities, suspension components, and braking characteristics.

MOTORCYCLE DYNAMICS TEST METHODOLOGY

Each motorcycle is driven using 4 separate riders for a 6-lap series. The best 5 out of 6 laps for each rider will be totaled for a cumulative time. The cumulative time is the score for each driver. The final score of each motorcycle is the combined average from the four riders' cumulative times.

TEST DAY WEATHER

The weather during Motorcycle Dynamics Testing is shown in the table below:

DATE	TIME	TEMP F	HUMIDITY	WIND SPEED	WIND DIRECTION
9/20/2009	1:00 PM	70.8	50	5	E
9/20/2009	1:30 PM	72.6	50	5	E
9/20/2009	2:00 PM	73.1	50	6	E
9/20/2009	2:30 PM	73.9	50	6	E
9/20/2009	3:00 PM	74.4	50	5	E
9/20/2009	3:30 PM	76.5	50	3	SSW
9/20/2009	4:00 PM	70.6	50	0	---
9/20/2009	4:30 PM	71.6	50	0	---
9/20/2009	5:00 PM	80.6	50	0	---

MOTORCYCLE DYNAMICS

VEHICLES	DRIVERS	COMBINED CUMMULATIVE*
Harley-Davidson	GROMAK	06:03.70
FLHTTP	JOHNSON	06:08.50
Electra Glide	TRAMMEL	06:11.50
	FLEGEL	06:00.90
Overall Average		06:06.15
Harley-Davidson	GROMAK	06:05.30
FLHP	JOHNSON	06:07.10
Road King	TRAMMEL	06:12.30
	FLEGEL	06:03.10
Overall Average		06:06.95
BMW	GROMAK	05:30.40
R1200 RTP	JOHNSON	05:41.40
	TRAMMEL	05:42.80
	FLEGEL	05:38.10
Overall Average		05:38.18
Buell Ulysses	GROMAK	05:20.50
	JOHNSON	05:32.20
	TRAMMEL	05:42.80
	FLEGEL	05:19.40
Overall Average		05:28.72
BMW G650 GS-P	GROMAK	05:30.10
Challenge	JOHNSON	05:43.00
	TRAMMEL	05:49.60
	FLEGEL	05:30.80
Overall Average		05:38.38

MOTORCYCLE ACCELERATION AND TOP SPEED TESTING

ACCELERATION TEST OBJECTIVE

Determine the ability of each test motorcycle to accelerate from a standing start to 60 mph, 80 mph, and 100 mph.

ACCELERATION TEST METHODOLOGY

Using a Correvit L-350 1 Axis Optical Sensor, each motorcycle is driven through four acceleration sequences, two northbound and two southbound, to allow for wind direction. The four resulting times for each target speed are averaged and the average times used to derive scores on the competitive test for acceleration.

TOP SPEED TEST OBJECTIVE

Determine the actual top speed attainable by each test motorcycle within a distance of 10 miles from a standing start.

TOP SPEED TEST METHODOLOGY

Following the fourth acceleration run, each test motorcycle will continue to accelerate to the top speed attainable within 10 miles from the start of the run. The highest speed attained within the 10-mile distance will be the vehicle's score on the competitive test for top speed.

SUMMARY OF ACCELERATION & TOP SPEED

ACCELERATION*	Harley-Davidson Electra Glide	BMW R1200 RTP	Harley-Davidson Road King	Buell Ulysses	BMW G650 GS-P
0 – 20 mph (sec.)	1.25	1.34	1.26	1.47	1.21
0 – 30 mph (sec.)	2.04	1.97	2.05	2.26	1.96
0 – 40 mph (sec.)	2.91	2.64	2.93	3.03	2.99
0 – 50 mph (sec.)	4.10	3.57	4.15	3.81	4.08
0 – 60 mph (sec.)	5.57	4.45	5.68	4.92	5.67
0 – 70 mph (sec.)	7.37	5.80	7.47	5.98	7.80
0 – 80 mph (sec.)	9.95	7.10	10.06	7.62	10.65
0 – 90 mph (sec.)	13.96	9.07	13.63	9.44	15.61
0 – 100 mph (sec.)	25.43	11.62	21.42	12.35	27.02
TOP SPEED (mph)	106	127	108	108	104
QUARTER MILE					
Time (sec.)	14.50	13.06	14.52	13.52	14.67
Speed (mph)	90.90	104.73	91.89	103.36	88.60



BRAKE TESTING

BRAKE TEST OBJECTIVE

Determine the deceleration rate attained by each test motorcycle on twelve 60 – 0 mph impending skid (threshold) stops, with ABS in operation if the motorcycle is so equipped. Each bike will be scored on the average deceleration rate it attains.

BRAKE TEST METHODOLOGY

Each motorcycle makes two decelerations at specific predetermined points on the test road from 90 – 0 mph at 22 ft/s², with the rider using a decelerometer to maintain the deceleration rate. Immediately after these “heat-up” stops are completed, the motorcycle turns around and makes six measured 60 – 0 mph impending skid (threshold) stops with ABS in operation, if so equipped, at specific predetermined points. The entire sequence is repeated. The exact initial velocity at the beginning of each of the 60 – 0 mph decelerations, and the exact distance required to make each stop, is recorded by means of a non contact optical sensor in conjunction with electronic speed and distance meters. The data resulting from the twelve total stops is used to calculate the average deceleration rate which is the motorcycle’s score for this test.

DECELERATION RATE FORMULA

$$\text{Deceleration Rate (DR)} = \frac{\text{Initial Velocity}^*(IV) \text{ squared}}{2 \text{ times Stopping Distance (SD)}} = \frac{(IV)^2}{2 (SD)}$$

EXAMPLE:

$$\begin{aligned} \text{Initial Velocity} &= 89.175 \text{ ft/s (60.8 mph x 1.4667*)} \\ \text{Stopping Distance} &= 171.4 \text{ ft.} \end{aligned}$$

$$\text{DR} = \frac{(IV)^2}{2(SD)} = \frac{(89.175)^2}{2(171.4)} = \frac{7952.24}{342.8} = 23.198 \text{ ft/s}^2$$

Once a motorcycle’s average deceleration rate has been determined, it is possible to calculate the stopping distance from any given speed by utilizing the following formula:

Select a speed; translate that speed into feet per second; square the feet per second figure by multiplying it by itself; divide the resultant figure by 2; divide the remaining figure by the average deceleration rate of the motorcycle in question.

EXAMPLE:

$$60 \text{ mph} = 88.002 \text{ ft/s} \times 88.002 = 7744.352 / 2 = 3872.176 / 23.198 \text{ ft/s}^2 = 166.9 \text{ ft.}$$

BRAKE TESTING

TEST LOCATION: Chrysler Proving Grounds

DATE: September 19, 2009

BEGINNING Time: 8:15 a.m.

TEMPERATURE: 41.8°F

MAKE & MODEL: Harley-Davidson Electra Glide FLHTP

BRAKE SYSTEM: Anti-lock

Phase I

BRAKE HEAT-UP: (Two 90 –0 mph decelerations @ 22 ft.sec.²)

TEST: (Six 60 – mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	60.55 mph	149.22 feet	26.43 ft/s ²
Stop #2	60.37 mph	154.29 feet	25.41 ft/s ²
Stop #3	60.48 mph	148.22 feet	26.54 ft/s ²
Stop #4	60.31 mph	151.32 feet	25.85 ft/s ²
Stop #5	60.42 mph	148.27 feet	26.48 ft/s ²
Stop #6	59.67 mph	149.49 feet	25.62 ft/s ²

AVERAGE DECELERATION RATE

26.06 ft/s²

Phase II

BRAKE HEAT-UP: (Two 90 –0 mph decelerations @ 22 ft.sec.²)

TEST: (Six 60 – mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	60.04 mph	148.68 feet	26.08 ft/s ²
Stop #2	59.99 mph	152.25 feet	25.42 ft/s ²
Stop #3	60.97 mph	153.34 feet	26.08 ft/s ²
Stop #4	60.50 mph	151.46 feet	25.99 ft/s ²
Stop #5	60.44 mph	151.13 feet	26.00 ft/s ²
Stop #6	60.51 mph	152.76 feet	25.78 ft/s ²

AVERAGE DECELERATION RATE

25.89 ft/s²

Phase III

Evidence of severe fading?

Yes/No

No

Vehicle equipped with ABS?

Yes

OVERALL AVERAGE DECEL. RATE:

25.97 ft/s²

Projected Stopping Distance from 60.0 mph 149.1 feet

BRAKE TESTING

TEST LOCATION: Chrysler Proving Grounds

DATE: September 19, 2009

BEGINNING Time: 7:35 p.m.

TEMPERATURE: 61.8°F

MAKE & MODEL: BMW R1200RTP

BRAKE SYSTEM: Anti-lock

Phase I

BRAKE HEAT-UP: (Two 90 → 0 mph decelerations @ 22 ft.sec.²)

TEST: (Six 60 – mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	60.54 mph	148.77 feet	26.50 ft/s ²
Stop #2	60.57 mph	156.52 feet	25.21 ft/s ²
Stop #3	60.24 mph	141.54 feet	27.58 ft/s ²
Stop #4	60.59 mph	151.02 feet	26.15 ft/s ²
Stop #5	60.20 mph	152.85 feet	25.50 ft/s ²
Stop #6	60.24 mph	146.37 feet	26.67 ft/s ²

AVERAGE DECELERATION RATE **26.27 ft/s²**

Phase II

BRAKE HEAT-UP: (Two 90 → 0 mph decelerations @ 22 ft.sec.²)

TEST: (Six 60 – mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	59.84 mph	139.67 feet	27.58 ft/s ²
Stop #2	60.59 mph	157.20 feet	25.12 ft/s ²
Stop #3	60.13 mph	152.83 feet	25.45 ft/s ²
Stop #4	60.76 mph	154.84 feet	25.65 ft/s ²
Stop #5	60.21 mph	152.51 feet	25.57 ft/s ²
Stop #6	60.99 mph	140.82 feet	28.41 ft/s ²

AVERAGE DECELERATION RATE **26.29 ft/s²**

Phase III

Evidence of severe fading?

Yes/No

No

Vehicle equipped with ABS?

Yes

OVERALL AVERAGE DECEL. RATE: **26.28 ft/s²**

Projected Stopping Distance from 60.0 mph 147.3 feet

BRAKE TESTING

TEST LOCATION: Chrysler Proving Grounds

DATE: September 19, 2009

BEGINNING Time: 11:23 a.m.

TEMPERATURE: 61.2°F

MAKE & MODEL: Harley-Davidson Road King FLHP

BRAKE SYSTEM: Anti-lock

Phase I

BRAKE HEAT-UP: (Two 90 → 0 mph decelerations @ 22 ft.sec.²)

TEST: (Six 60 → mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	60.54 mph	157.36 feet	25.05 ft/s ²
Stop #2	59.53 mph	157.77 feet	24.16 ft/s ²
Stop #3	60.59 mph	156.54 feet	25.22 ft/s ²
Stop #4	60.04 mph	154.12 feet	25.16 ft/s ²
Stop #5	60.40 mph	159.52 feet	24.60 ft/s ²
Stop #6	59.75 mph	150.96 feet	25.44 ft/s ²

AVERAGE DECELERATION RATE

24.94 ft/s²

Phase II

BRAKE HEAT-UP: (Two 90 → 0 mph decelerations @ 22 ft.sec.²)

TEST: (Six 60 → mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	59.92 mph	161.87 feet	23.86 ft/s ²
Stop #2	60.26 mph	156.16 feet	25.01 ft/s ²
Stop #3	60.07 mph	153.95 feet	25.21 ft/s ²
Stop #4	60.57 mph	155.91 feet	25.31 ft/s ²
Stop #5	59.95 mph	154.64 feet	25.00 ft/s ²
Stop #6	60.81 mph	162.05 feet	24.54 ft/s ²

AVERAGE DECELERATION RATE

24.82 ft/s²

Phase III

Evidence of severe fading?

Yes/No

No

Vehicle equipped with ABS?

Yes

OVERALL AVERAGE DECEL. RATE:

24.88 ft/s²

Projected Stopping Distance from 60.0 mph 155.6 feet

BRAKE TESTING

TEST LOCATION: Chrysler Proving Grounds

DATE: September 19, 2009

BEGINNING Time: 5:43 p.m.

TEMPERATURE: 68.9°F

MAKE & MODEL: Buell Ulysses

BRAKE SYSTEM: Hydraulic

Phase I

BRAKE HEAT-UP: (Two 90 → 0 mph decelerations @ 22 ft.sec.²)

TEST: (Six 60 → mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	59.78 mph	171.07 feet	22.47 ft/s ²
Stop #2	59.92 mph	167.13 feet	23.11 ft/s ²
Stop #3	60.59 mph	169.82 feet	23.25 ft/s ²
Stop #4	60.55 mph	159.52 feet	24.72 ft/s ²
Stop #5	60.37 mph	158.81 feet	24.68 ft/s ²
Stop #6	60.23 mph	153.12 feet	25.48 ft/s ²

AVERAGE DECELERATION RATE

23.95 ft/s²

Phase II

BRAKE HEAT-UP: (Two 90 → 0 mph decelerations @ 22 ft.sec.²)

TEST: (Six 60 → mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	60.26 mph	154.88 feet	25.22 ft/s ²
Stop #2	60.01 mph	155.34 feet	24.94 ft/s ²
Stop #3	60.61 mph	155.20 feet	25.46 ft/s ²
Stop #4	60.29 mph	162.21 feet	24.10 ft/s ²
Stop #5	59.96 mph	150.80 feet	25.64 ft/s ²
Stop #6	60.27 mph	157.82 feet	24.76 ft/s ²

AVERAGE DECELERATION RATE

25.02 ft/s²

Phase III

Evidence of severe fading?

Yes/No

No

Vehicle stopped in straight line?

Yes

Vehicle stopped within correct lane?

Yes

OVERALL AVERAGE DECEL. RATE:

24.49 ft/s²

Projected Stopping Distance from 60.0 mph 158.1 feet

BRAKE TESTING

TEST LOCATION: Chrysler Proving Grounds

DATE: September 19, 2009

BEGINNING Time: 3:25 p.m.

TEMPERATURE: 69°F

MAKE & MODEL: BMW G650 GS-P

BRAKE SYSTEM: Anti-lock

Phase I

BRAKE HEAT-UP: (Two 90 –0 mph decelerations @ 22 ft.sec.²)

TEST: (Six 60 – mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	60.65 mph	163.59 feet	24.19 ft/s ²
Stop #2	60.56 mph	160.39 feet	24.60 ft/s ²
Stop #3	59.81 mph	149.96 feet	25.66 ft/s ²
Stop #4	60.49 mph	163.03 feet	24.14 ft/s ²
Stop #5	60.36 mph	166.41 feet	23.55 ft/s ²
Stop #6	60.20 mph	163.34 feet	23.86 ft/s ²

AVERAGE DECELERATION RATE

24.33 ft/s²

Phase II

BRAKE HEAT-UP: (Two 90 –0 mph decelerations @ 22 ft.sec.²)

TEST: (Six 60 – mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	60.56 mph	156.27 feet	25.24 ft/s ²
Stop #2	60.77 mph	160.73 feet	24.71 ft/s ²
Stop #3	60.91 mph	159.71 feet	24.99 ft/s ²
Stop #4	60.31 mph	165.44 feet	23.65 ft/s ²
Stop #5	60.55 mph	156.49 feet	25.20 ft/s ²
Stop #6	60.35 mph	160.68 feet	24.38 ft/s ²

AVERAGE DECELERATION RATE

24.70 ft/s²

Phase III

Evidence of severe fading?
Vehicle equipped with ABS?

Yes/No

No

Yes

OVERALL AVERAGE DECEL. RATE:

24.51 ft/s²

Projected Stopping Distance from 60.0 mph 158.0 feet

COMMUNICATIONS

TEST OBJECTIVE

Rate each test motorcycle's ability to:

Accommodate the required communications and emergency warning equipment and assess the relative difficulty of such installations.

TEST METHODOLOGY

The installation and communications portion of the evaluation will be conducted by personnel from DIT Communications based upon the relative difficulty of the necessary installations. Each factor will be graded on a 1 to 10 scale, with 1 representing "totally unacceptable," 5 representing "average," and 10 representing "superior." The scores will be averaged to minimize personal prejudice for or against any given motorcycle.

	BMW R1200RTP	FLHP ROAD KING	FLHTP ELECTRA GLIDE	Buell Ulysses XB12XP	BMW G650 XP
Dash Access					
Ignition Fuse terminal block	4.00	4.33	4.33	3.00	4.00
Radio-Ease of Installation	5.67	5.67	5.33	4.67	4.33
Radio Interference	10.00	10.00	10.00	10.00	10.00
Radio Box					
Antenna Installation	7.33	7.00	7.00	4.33	5.67
Emergency Lights Installation	5.33	7.00	6.67	5.33	5.00
Engine Access					
Radio Power Conn.	5.33	5.67	5.67	4.67	5.67
Power/Cont.Cable	5.67	5.33	5.33	4.67	5.67
TOTAL	56.22	58.67	57.72	47.39	51.78