N-96-01
II-A-112

United States
Environmental Protection
Agency

Office of Noise Abatement
and Control (ANR-490)
Washington, D.C. 20460

December 1980
EPA 550/9-80-218

Noise

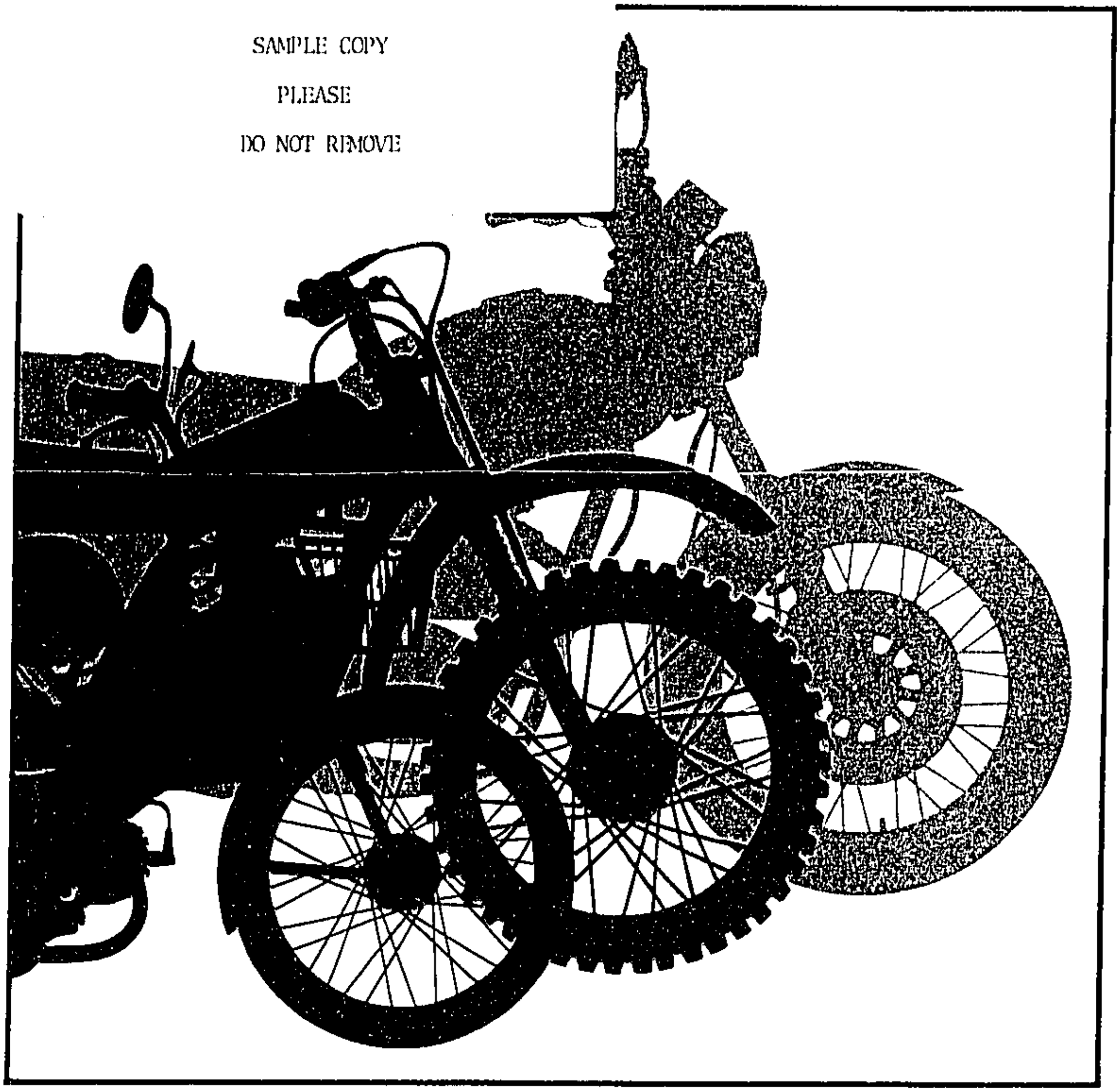
EPA

Regulatory Analysis Appendices for the Noise Emission Regulations for Motorcycles and Motorcycle Exhaust Systems

SAMPLE COPY

PLEASE

DO NOT REMOVE



N-96-01
II-A-112

EPA 550/9-80-218

REGULATORY ANALYSIS APPENDICES FOR THE NOISE EMISSION REGULATIONS FOR MOTORCYCLES AND MOTORCYCLE EXHAUST SYSTEMS

December 1980

U.S. Environmental Protection Agency

Office of Noise Abatement and Control

Washington, D.C. 20460

TABLE OF CONTENTS

Table of Contents (Continued)

Table of Contents (Continued)

APPENDIX A

MOTORCYCLE NOISE EMISSION TEST PROCEDURES

Sound Levels for Motorcycles — SAE J331a

SAE RECOMMENDED PRACTICE

APPROVED MAY 1975

LAND
SEA
AIR
SPACE

SOCIETY OF AUTOMOTIVE ENGINEERS, INC.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

Report of Vehicle Sound Level Committee and Motorcycle Committee
Approved May 1975.

1. SCOPE - This SAE Recommended Practice establishes the test procedure, environment, and instrumentation for determining sound levels typical of normal motorcycle operation.

2. INSTRUMENTATION

2.1 The following instrumentation shall be used, where applicable:

2.1.1 A sound level meter which meets Type 1 or S1A the requirements of American National Standard Specification for Sound Level Meters, S1.4-1971. As an alternative to making direct measurements using a sound level meter, a microphone or sound level meter may be used with a magnetic tape recorder and/or a graphic level recorder or indication instrument provided that the system meets the requirements of SAE Recommended Practice, Qualifying a Sound Data Acquisition System - J184.

2.1.2 An acoustic calibrator with an accuracy of $\pm$ 0.5 dB (see paragraph 7.4.4).

2.1.3 A calibrated engine speed tachometer having the following characteristics:

(a) Steady-state accuracy of better than 1%.

(b) Transient response: Response to a step input will be such that within 10 engine revolutions the indicated rpm will be within 2% of the actual rpm.

2.1.4 A speedometer with steady-state accuracy of at least $\pm$10%.

2.1.5 An anemometer with steady-state accuracy of at least $\pm$10% at 19 km/h (12 mph).

2.1.6 An acceptable wind screen may be used with the microphone. To be acceptable, the screen must mot affect the microphone response more than $\pm$1 dB for frequencies of 20-4000 Hz or $\mp$1-1/2 dB for frequencies of 4000-10,000 Hz.

3. TEST SITE

3.1 The test site shall be a flat open space free of large sound-reflecting surfaces (other than the ground), such as parked vehicles, signboards, buildings or hillsides., located within 30m (100 ft) radius of the microphone location and the following points on the vehicle path:

(a) The microphone point

(b) A point 15m (50 ft) before the micropone point.

(c) A point 15m (50 ft) beyond the microphone point.

3.2 The measurement area within the test site shall meet the following requirements and be laid out as described:

3.2.1 The surface of the ground within at least the triangular area formed by the microphone location and the points 50 ft. (15.2m) prior to and 50 ft (15.2m) beyond the microphone point shall be dry concrete or asphalt, free from snow, soil or other extraneous material.

3.2.2 The vehicle path shall be of relatively smooth, dry concrete or asphalt, free of extroneous materials such as gravel, and of sufficient length for safe acceleration, deceleration and stopping of the vehicle.

3.2.3 The microphone shall be located 15m (50 ft) from the centerline of the vehicle path and 1.2m (4 ft) above the ground plane.

3.2.4 The following points shall be established on the vehicle path:

(a) Microphone point-a point on the centerline of the vehicle path where a normal through the microphone location intersects the vehicle path.

(b) End point-a point on the vehicle path 30m (100 ft) beyond the microphone point.

(c) Acceleration point-a point on the vehicle path.7.5m (25 ft) prior to the microphone point.

3.2.5 The test area layout in Fig. 1 shows a directional approach from left to right with one microphone location, for purposes of clarity. Sound level measurements are to be made on both sides of the vehicle; therefore, it will be necessary to establish either a second microphone point on the opposite side of the vehicle path with a corresponding clear area or end points and acceleration points for approaches from both directions.

4. TEST WEIGHT

4.1 At the start of the test series, the vehicle shall be filled with fuel and lubricant to not less than 75% of capacity.

4.2 The combined weight of the test rider and test equipment used on the vehicle shall be not more than 79 kg (175 lb) nor less than 75 kg (165 lb). Weights shall be placed on the vehicle saddle behind the driver to compensate for any difference between the actual driver/equipment load and the required 75 kg (165 lb) minimum.

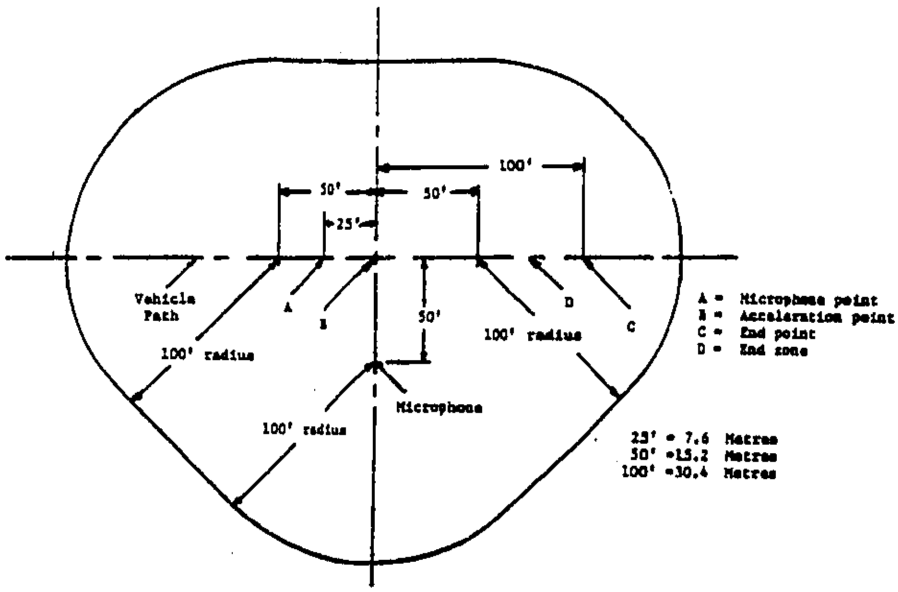


FIG. 1

5. PROCEDURE

5.1 The vehicle shall use second gear unless during the test under acceleration the engine speed at maximum rated net horsepower is reached before the vehicle reaches a point 7.5m (25 ft) beyond the microphone point, in which case the vehicle shall be tested in third gear.

5.2 For the test under acceleration, the vehicle shall proceed along the vehicle path at a constant approach speed which shall correspond to either an engine speed of 60% of the engine speed at maximum rated net horsepower or a vehicle + speed of 48 km/h (30 mph), whichever is slower. When the front of the vehicle reaches the acceleration point, rapidly and fully open the throttle and accelerate until the front of the vehicle is 30 m (100 ft) beyond the microphone point, or until the engine speed at maximum rated house power is reached, at which point the throttle shall be closed. Wheel slip which effects the maximum sound level shall be avoided.

5.3 When excessive or unusual noise is noted during deceleration, the following test shall be performed with sufficient runs to establish maximum sound level under deceleration:

5.3.1 For the test under deceleration, the vehicle shall proceed along the vehicle path at an engine speed at maximum rated net horsepower in the gear selected for the test under acceleration. At the end point, the throttle shall be rapidly and fully closed, and the vehicle allowed to decelerate to an engine speed of one-half of the rpm at maximum rated net horsepower.

5.4 Sufficient preliminary runs to familiarize the driver and to establish the engine operating conditions shall be made before measurements begin. The engine temperature shall be within the normal operating range prior to each run.

6. MEASUREMENTS

6.1 The sound level meter shall be set for fast response and for the A-weighting network.

6.2 The meter shall be observed while the vehicle is accelerating or decelerating. Record the highest sound level obtained for the run, ignoring unrelated peaks due to extraneous ambient noises. All values shall be recorded.

6.3 At least six measurements shall be made for each side of the vehicle. Sufficient measurements shall be made until at least four readings from each side are with 2 dB of each other. The highest and the lowest readings shall be discarded; the sound level for each side shall be the average of the four, which are within 2 dB of each other. The sound level reported shall be for that side of the vehicle having the highest sound level.

6.4 The ambient sound level (including wind effects) at the test site due to sources other than the vehicle being measured shall be at least 10 dB lower than the sound level produced by the vehicle under test.

6.5 Wind speed at the test site during tests shall be less than 19 km/h (12 mph).

7. GENERAL COMMENTS

7.1 Technically competent personnel should select equipment and the tests should be conducted only by trained and experienced persons familiar with the current techniques of sound measurement.

8. REFERENCES

Suggested reference material is as follows:

8.1 ANSI S1.1 - 1960, Acoustical Terminology.

8.2 ANSI S1.2 - 1962, Physical Measurement of Sound.

SAE Technical Board Rules and Regulations
All technical reports, including standards approved and practices recommended, are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no agreement to adhere to any SAE Standard or SAE Recommended Practice, and no commitment to conform to or be guided by an technical report.

7.2 While making sound level measurements, not more than one person other than the rider and the observer reading the meter shall be within 15m (50 ft) of the vehicle or microphone, and that person shall be directly behind the observer reading the meter, on a line through the microphone and the observer.

7.3 The test rider should be fully conversant with and qualified to ride the machine under test and be familiar with the test procedure.

7.4 Proper use of all test instrumentation is essential to obtain valid measurements. Operating manuals or other literature furnished by the instrument manufacturer should be referred to for both recommended operation of the instrument and precautions to be observed. Specific items to be considered are:

7.4.1 The type of microphone, its directional response characteristics, and its orientation relative to the ground plane and source of noise.

7.4.2 The effects of ambient weather conditions on the performance of all instruments (for example, temperature, humidity and barometric pressure).

7.4.3 Proper signal levels, terminating impedances, and cable lengths on multi-instrument measurement systems.

7.4.4 Proper acoustical calibration procedure to include the influence of extension cables, etc. Field calibration shall be made immediately before and after each test sequence. Internal calibration means is acceptable for field use, provided that external calibration is accomplished immediately before or after field use.

8.3 ANSI S1.4 - 1971, Specification for Sound Level Meters.

8.4 ABSU S1.13 - 1971, Method of Measurement of Sound Pressure Levels.

8.5 SAE J47, Maximum, Sound Level Potential for Motorcycles.

In formulating and pproving technical reports, the Technical Board, its Councils and committees will not investigate or Consider patents which may apply to the subject matter, Prospective users of the report are responsible for protecting themselves against liability for infringement of patents.

Printed in U.S.A.

DEPARTMENT OF CALIFORNIA HIGHWAY PATROL

SOUND MEASUREMENT PROCEDURES

THIS PUBLICATION MAY BE PURCHASED FOR $2 EACH,
PLUS CALIFORNIA STATE SALES TAX

MAY 1973

3.5 NEW VEHICLE TEST PROCEDURE

3.5.1 Vehicle Sound Level. The sound levels for new motor vehicles shall be determined by tests performed according to procedures established for each particular class of vehicle.

3.5.2 Definitions. For the purpose of these procedures, the following terms have the meanings indicated:

a. First Gear. "First gear" means the highest numerical gear ratio of the transmission, commonly referred to as low gear.

b. Maximum RPM. "Maximum rpm" means the maximum governed engine speed, or if ungoverned, the rpm at maximum engine horsepower as determined by the engine manufacturer in accordance with the procedures in SAE J245, April 1971.

c. Microphone Point. "Microphone point" means the unmarked location on the center of the lane of travel that is closest to the microphone.

d. Vehicle Reference Point. "Vehicle reference point" means the location on the vehicle used to determine when the vehicle is at any of the points on the vehicle path. The primary vehicle reference point is the front of the vehicle. For vehicles with a gross vehicle rating of 6,000 lbs. or more where the distance from the front of the vehicle to the exhaust outlet exceeds 16 ft., the secondary vehicle reference point is the exhaust outlet.

3.5.3 Operation. New motor vehicles shall be tested both with and without auxiliary equipment that may be in use while the vehicle is in operation on the highway. Auxiliary equipment includes but is not limited to cement mixers, refrigeration units, air conditioners, and garbage compactors. The following general procedures shall apply to all classes of vehicles:

a. Preliminary Runs. Sufficient preliminary runs shall be made to enable the test driver to become familiar with the operation of the vehicle and to stabilize engine operating conditions.

b. Test Runs. At least four test runs shall be made for each side of the vehicle. When the exhaust outlet is more than 16 ft. from the front of the vehicle, at least two runs shall be made for each side of the vehicle using both the primary and secondary reference points. At least two additional runs shall be made from the reference point that gives the highest readings.

c. Reported Noise Level. The reported sound level for each side of the vehicle shall be the average of the two highest readings on that side which are within 2 dB(A) of each other. The sound level reported for the vehicle shall be the sound level of the loudest side.

d. Visual Readings. When sound level instruments have been turned on and calibrated, the graphic level recorder shall be put in operation. Visual readings shall be taken from the sound level meter during preliminary test runs and recorded. The readings from the sound level meter shall be compared with those of the recorder and there shall be no more than ±0.5 dB(A) variation between the readings. When the variation is greater, the equipment shall be checked and recalibrated. If the variation still exists, the test shall be conducted using only direct readings from the sound level meter. This procedure does not apply to the General Radio Type 1523-P1A sound measuring set because the recorder is the meter.

3.5.4 Light Trucks, Truck Tractors, Buses and Passenger Cars. Trucks, truck tractors and buses with a manufacturer's gross vehicle weight rating of less than 6,000 lbs., and passenger cars shall be tested as follows:

a. Vehicle Path. The test area shall include a vehicle path of sufficient length for safe acceleration, deceleration, and stopping of the vehicle.

b. Test Area Layout. The following points and zones shown in Figure 3-2, where only one directional approach is illustrated for purposes of clarity, shall be established on the vehicle path so that measurements can be made on both sides of the vehicle:

(1) Microphone point

(2) Acceleration point - a location 25 ft. before the microphone point

(3) End point - a location 100 ft. beyond the microphone point

(4) End zone - the last 75-ft. distance between the microphone point and the end zone.

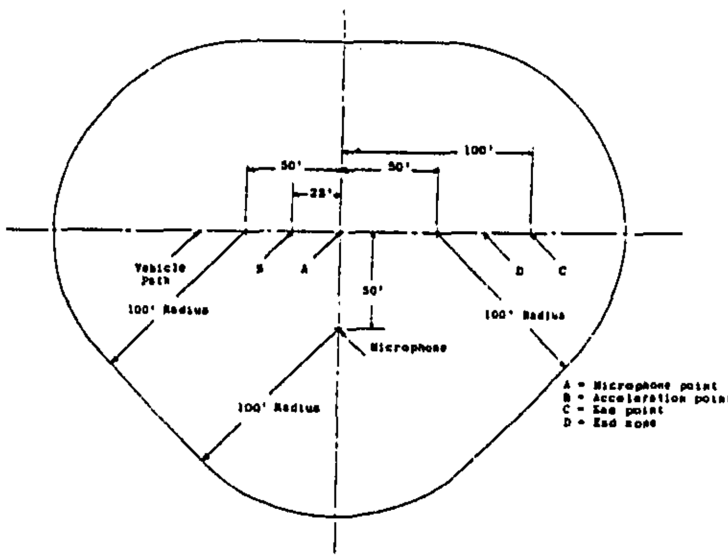


Fig. 3-2. Test Area Layout
for Light Trucks, Buses, and Passenger Cars

c. Test Procedures. Vehicles shall be tested according to the following procedures:

(1) Gear Selection. Motor vehicles equipped with three-speed manual transmissions and with automatic transmissions shall be operated in the first gear. Vehicles

equipped with manual transmissions of four or more speeds shall be operated in first gear and in second gear. Vehicles which reach maximum rpm at less than 30 mph or before reaching the end zone shall be operated in the next higher gear. Auxiliary step-up ratios (overdrive) shall not be engaged on vehicles so equipped.

(2) Acceleration. The vehicle shall proceed along the vehicle path at a constant speed of 30 mph in the selected gear for at least 50 ft. before reaching the acceleration point. When the vehicle reference point reaches the acceleration point, the throttle shall be rapidly and fully opened. The throttle shall be held open until the vehicle reference point reaches the end point or until maximum rpm is reached within the end zone. At maximum rpm, the throttle shall be closed sufficiently to keep the engine just under maximum rpm until the end point, at which time the throttle shall be closed.

(3) Deceleration. Tests during deceleration shall be conducted when deceleration noise appears excessive. The vehicle shall proceed along the vehicle path at maximum rpm in the same gear selected for the tests during acceleration. When the reference point on the vehicle reaches the acceleration point, the throttle shall be rapidly closed and the vehicle allowed to decelerate to less than 1/2 of maximum rpm.

(4) Engine Temperature. The engine temperature shall be within normal operating range throughout each test run. The engine shall be idled in neutral for at least one minute between runs.

3.5.5 Heavy Trucks, Truck Tractors, and Buses. Vehicles with a manufacturer's gross vehicle weight rating of 6,000 lbs. or more shall be tested as follows:

a. Vehicle Path. The test area shall include a vehicle path of sufficient length for safe acceleration, deceleration, and stopping of the vehicle.

b. <u>Test Area Layout</u>. The following points and zones shown in Figure 3-3, where only one directional approach is illustrated for purposes of clarity, shall be established on the vehicle path so that measurements can be made on both sides of the vehicle:

(1) Microphone point

(2) Acceleration point - a location 50 ft. before the microphone point

(3) End point - a location 50 ft. beyond the microphone point

(4) End zone - the last 40-ft. distance between the microphone point and the end point.

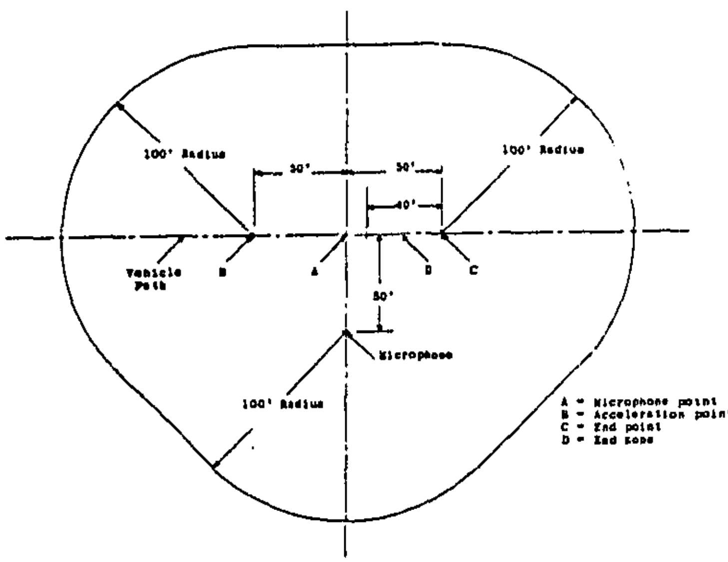


Fig. 3-3. Test Area Layout for Heavy Trucks and Buses

c. Test Procedures. Vehicles shall be tested according to the following procedures:

(1) Gear Selection. A gear shall be selected which will result in the vehicle beginning at an approach rpm of no more than 2/3 maximum rpm at the acceleration point and reaching maximum rpm within the end zone without exceeding 35 mph.

(a) When maximum rpm is attained before reaching the end zone, the next higher gear shall be selected, up to the gear where maximum rpm produces over 35 mph.

(b) When maximum rpm still occurs before reaching the end zone, the approach rpm shall be decreased in 100 rpm increments until maximum rpm is attained within the end zone.

(c) When maximum rpm is not attained until beyond the end zone, the next lower gear shall be selected until maximum rpm is attained within the end zone.

(d) When the lowest gear still results in reaching maximum rpm beyond the end zone, the approach rpm shall be increased in 100 rpm increments above 2/3 maximum rpm until the maximum rpm is reached within the end zone.

(2) Acceleration. The vehicle shall proceed along the vehicle path maintaining the approach engine rpm in the selected gear for at least 50 ft. before reaching the acceleration point. When the reference point on the vehicle reaches the acceleration point, the throttle shall be rapidly and fully opened and held open until maximum rpm is attained within the end zone, at which point the throttle shall be closed.

(3) Deceleration. Tests during deceleration shall be conducted when deceleration noise appears excessive. The vehicle shall proceed along the vehicle path at maximum rpm in the same gear selected for the tests during acceleration. When the reference point on the vehicle reaches the microphone point, the throttle shall be rapidly closed and the vehicle allowed to decelerate to less than 1/2 maximum rpm. Vehicles equipped with exhaust brakes shall also be tested with the brake full on immediately following closing of the throttle.

3.5.6 Motorcycles. Motorcycles shall be tested as follows:

a. Vehicle Path. The test area shall include a vehicle path of sufficient length for safe acceleration, deceleration, and stopping of the vehicle.

b. Test Area Layout. The following points and zones shown in Figure 3-4, where only one directional approach is illustrated for purposes of clarity, shall be established on the vehicle path so that measurements can be made on both sides of the vehicle:

(1) Microphone point

(2) Acceleration point - a location 25 ft. before the microphone point

(3) End point - a location 100 ft. beyond the microphone point

(4) End zone - the last 75-ft. distance between the microphone point and the end point.

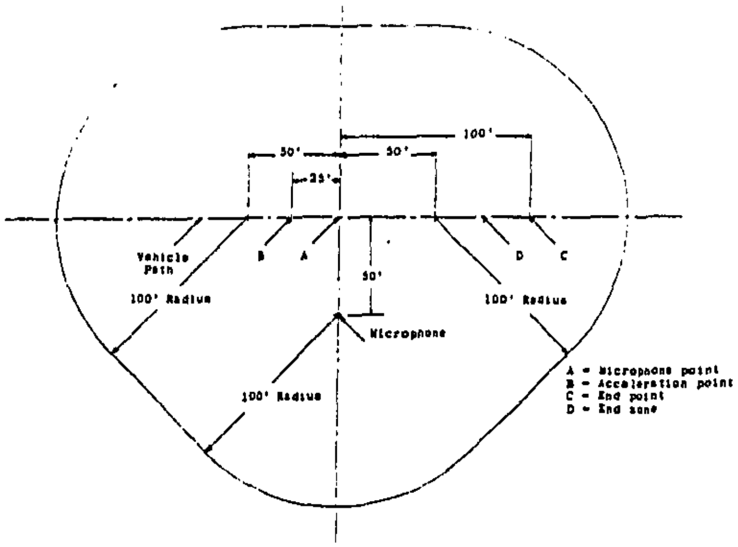


Fig. 3-4. Test Area Layout for Motorcycles

c. Test Procedures. Vehicles shall be tested according to the following procedures:

(1) Gear Selection. Motorcycles shall be operated in second gear. Vehicles which reach maximum rpm at less than 30 mph or before a point 25 ft. beyond the microphone point shall be operated in the next higher gear.

(2) Acceleration. The vehicle shall proceed along the vehicle path at a constant approach apeed which corresponds either to an engine speed of 60 percent of maximum rpm or to 30 mph, whichever is lower. When the reference point on the vehicle

reaches the acceleration point, the throttle shall be rapidly and fully opened and held open until the vehicle reference point reaches the end point, or until the maximum rpm is reached within the end zone, at which point the throttle shall be closed. Wheel slip shall be avoided. When this procedure results in a dangerous operating condition, the next higher gear shall be selected for the test.

(3) Deceleration. Tests during deceleration shall be conducted when deceleration noise appears excessive. The vehicle shall proceed along the vehicle path at maximum rpm in the same gear selected for the tests during acceleration. When the reference point on the vehicle reaches the acceleration point, the throttle shall be rapidly closed and the vehicle shall be allowed to decelerate to less than 1/2 of maximum rpm.

(4) Engine Temperature. The engine temperature shall be within normal operating range before each test run.

(5) Test Weight. The total weight of test driver and test equipment shall be 165 lbs. For small drivers, additional weights shall be used to bring the total to 165 lbs.

3.5.7 Snowmobiles. Snowmobiles shall be tested as follows:

a. Vehicle Path. The test area shall include a vehicle path of sufficient length for safe acceleration, deceleration, and stopping of the vehicle.

b. Test Area Layout. The following points and zones shown in Figure 3-5, where only one directional approach is illustrated for the purposes of clarity, shall be established on the vehicle path so that measurements can be made on both sides of the vehicle:

(1) Microphone point

(2) End point - a location 50 ft. beyond the microphone point

(3) Acceleration point - a location on the vehicle path established as follows: Position the vehicle headed away from the microphone point with the vehicle reference point at 25 ft. from the microphone point. From a standing start with transmission in low gear, rapidly apply wide-open throttle, accelerating until maximum rpm is attained. The location on the vehicle path where maximum rpm was attained is the acceleration point for tests run in the opposite direction

(4) Maximum rpm zone.

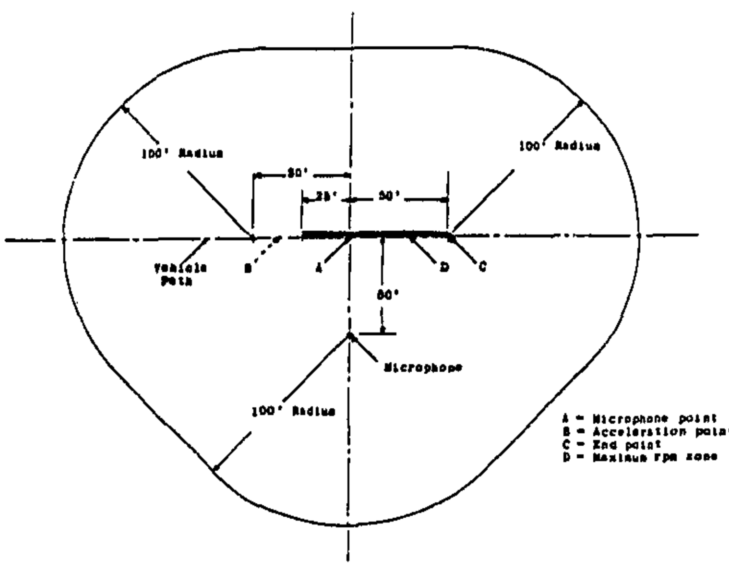


Fig. 3-5. Test Area Layout for Snowmobiles

c. <u>Test Procedures</u>. From a standing start, with transmission in low gear and the vehicle reference point positioned at the acceleration point, the throttle shall be rapidly and fully opened and held through the maximum rpm zone until the reference point on the vehicle reaches the end point after which the throttle shall be closed.

New Vehicle Test Form 061-4

NEW VEHICLE NOISE TEST

ENGINEERING SECTION
DEPARTMENT OF CALIFORNIA HIGHWAY PATROL

DATE

YEAR	VEHICLE MAKE	VEHICLE TYPE	I.D. NO.	MODEL
ENGINE TYPE	HORSEPOWER	ENGINE DISPLACEMENT	LOCATION OF TEST	VEHICLE MILEAGE

EXHAUST OUTLET (check as appropriate) ☐ SINGLE ☐ L. SIDE ☐ REAR ☐ DUAL ☐ R. SIDE ☐ VERTICAL	CHECK DIRECTION AND SIZE OF OUTLET ☐ STRAIGHT ☐ 45° TO REAR ☐ 45° TO SIDE ____ DIA.	RESONATORS ☐ SINGLE ☐ DUAL	MUFFLER NO.	TIRE SIZE ____ x ____	GEAR RATIOS DIFFERENTIAL ____ : ____ SPROCKET (NO. OF TEETH) ____ : ____

RECORDER MODEL AND CHP No.	METER MODEL AND CHP NO.	CALIBRATOR MODEL AND CHP NO.
TEST DRIVER	TEST ENGINEER	VEHICLE SUPPLIED BY

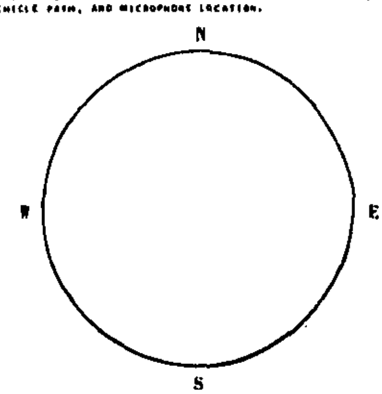
OPERATING CONDITIONS	TIME	dB(A) READINGS[1]		MAXIMUM	
		LEFT SIDE OF VEH.	RIGHT SIDE OF VEH.	R.P.M.	M.P.H.

1. INSTRUMENTATION SET UP AT 50 FT. FROM CENTER LINE OF TRAVEL

TEST CONDITIONS

WEATHER CONDITION (clear, etc.)	TEMPERATURE	REL. HUM. (%)	WIND VELOCITY (m.p.h.)

INDICATE BY PROPER SYMBOLS THE DIRECTION OF THE WIND, VEHICLE PATH, AND MICROPHONE LOCATION.



KEY:

WIND DIRECTION

VEHICLE PATH

MICROPHONE LOCATION

061-4(Rev. 4/69)

SOUND LEVEL FOR PASSENGER CARS

AND LIGHT TRUCKS

SAE STANDARD J986a

Report of Vehicle Noise Committee approved July 1967 and last revised by Vehicle Sound Level Committee July 1968 Editorial change September 1970

1. Scope-This SAE Standard establishes the maximum sound level for passenger cars and light trucks and describes the test procedure, environment, and instrumentation for determining this sound level.

2. Sound Level Limit-The sound level produced by a new passenger car or light truck of 6000 gvw or less shall not exceed an A-weighted sound level of 86 dB at 50 ft when measured in accordance with the procedure described herein (see paragraph 5.2).

3. Instrumentation-The following instrumentation shall be used for the measurement required:

3.1 A sound level meter which meets the requirements of both International Electro-technical Commisssion (IEC) Publication 179, Precision Sound Level Meters, and American National Standard (ANS) S1.4-1961, General Purpose Sound Level Meters.

3.1.1 As an alternative to making direct measurements using a sound level meter, a microphone or sound level meter may be used with a magnetic tape recorder and/or a graphic level recorder or indicating meter, providing the system meets the requirements of SAE J184.

3.2 A sound level calibrator (see paragraph 5.3.4).

3.3 A calibrated engine speed tachometer.

3.4 An anemometer.

4. Procedure

4.1 A suitable test site is a flat open space free of large reflecting surfaces, such as parked vehicles, signboards, buildings, or hillsides, located within 100 ft of either the vehicle or the microphone.

4.1.1 During the measurement, the surface of the ground within the measurement area shall be free from powdery snow, long grass, loose soil, or ashes.

4.1.2 Because bystanders may have an appreciable influence on meter response when they are in the vicinity of the vehicle or the microphone, not more than one person other than the observer reading the meter shall be within 50 ft of the vehicle or microphone, and that person shall be directly behind the observer reading the meter, on a line through the microphone and the observer.

4.1.3 The ambient sound level (including wind effects) due to sources other than the vehicle being measured shall be at least 10 dB lower than the level of the tested vehicle.

4.1.4 The path of vehicle travel shall be relatively smooth, dry concrete or asphalt, free of extraneous materials such as gravel.

4.2 Vehicle Operation

4.2.1 From a approach speed of 30 mph, wide-open throttle shall be established when the front of the vehicle reaches a line 25 ft before a line through the microphone normal to the vehicle path. Use the lowest transmission gear or range such that the front of the vehicle will have reached or passed a line 25 ft beyond the microphone line when maximum rated engine speed[1] is reached. The throttle shall then be closed enough to prevent excessive engine speed and the test continued until the vehicle reaches a line 125 ft beyond the microphone line.

4.2.2 Wheel slip which affect the maximum sound level must be avoided.

4.2.3 The engine temperature shall be within the normal operating range throughout each run. A 1 minute cooling off period with engine at idle in neutral is required between runs.

4.3 Measurements

4.3.1 The microphone shall be located 50 ft from the centerline of the vehicle path at a height of 4 ft above the ground plane.

4.3.2 The meter shall be set for fast response and the A-weighting network.

4.3.3 The meter shall be observed while the vehicle is accelerating. The applicable reading shall be the highest sound level indicated during the run, ignoring unrelated peaks due to extraneous ambient noises. At least four measurement shall be made for each side of the vehicle or for only the side producing the higher sound level if that is obvious from initial runs. All values shall be recorded.

4.3.4 The sound level for each side of the vehicle shall be the average of the two highest readings which are within 2 dB of each other. The sound level reported shall be that of the loudest side of the vehicle.

5. General Comments

5.1 It is strongly recommended that technical trained personnel select the equipment and that the tests be conducted only be qualified persons trained in the current techniques of sound measurement.

5.2 A 2 dB allowance for the sound level limit is necessary to provide for variations in test site, vehicle operation, temperature gradients, wind velocity gradients, test equipment, and inherent differences in nominally identical vehicles.

5.3 Proper usage of all test instrumentation is essential to obtain valid measurements. Operating manuals or other literature furnished by the instrument manufacturer should be referred to for both recommended operation of the instrument and precautions to be observed. Specific items to be considered are:

5.3.1 The type of microphone, its directional response characteristics, and its orientation relative to the ground plane and source of noise.

5.3.2 The effects of ambient weather conditions on the performance of all instruments (for example, temperature, humidity, and barometric pressure).

5.3.3 Proper signal levels, terminating impedances, and cable lengths on multiinstrument measurement systems.

5.3.4 Proper acoustical calibration procedure, to include the influence of extension cables, etc. Field calibration shall be made immediately before and after each test sequence. Internal calibration means is acceptable for field use, provided that external calibration is accomplished immediately before or after field use.

5.4 Measurements shall be made only when wind velocity is below 12 mph.

5.5 Vehicles used for tests must not be operated in a manner such that the break-in procedure specified by the manufacturer is violates.

6. References -- Suggested reference material is as follows:

6.1 ANSI S1.1 - 1960, Acoustical Terminology.

6.2 ANSI S1.4 - 1961, General Purpose Sound Level Meters.

6.3 ANSI S1.2 - 1962, Physical Measurement of Sound.

6.4 International Electrotechnical Commission Publication 179, Precision Sound Level Meters (available from ANSI).

Application for copies of these documents should be addressed to the American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018.

[1]Speed at which maximum horsepower is rated or governed speed.

MAXIMUM SOUND LEVEL POTENTIAL
FOR MOTORCYCLES - SAE J47

SAE RECOMMENDED PRACTICE
APPROVED MAY 1975

Report of Vehicle Sound Level Committee and Motorcycle Committee approved May 1975.

1. SCOPE

This SAE Recommended Practice establishes the test procedure, environment and instrumentation for determining maximum sound level potential for motorcycles.

2. INSTRUMENTATION

2.1 The following instrumentation shall be used, where applicable:

2.1.1 A sound level meter which meets the Type 1 or S1A requirements of American National Standard Specification for Sound Level Meters, S1.4-1971. As an alternative to making direct measurements using a sound level meter, a microphone or sound level meter may be used with a magnetic tape recorder and/or a graphic level recorder or indicating instrument provided that the system meets the requirements of SAE Recommended Practice, Qualifying a Sound Data Acquisition System -J184.

2.1.2 An acoustic calibrator with an accuracy of $\pm$0.5 dB (see paragraph 6.4.4)

2.1.3 A calibrated engine speed tachometer having the following characteristics:

(a) Steady-state accuracy of better than 1%

(b) Transient response: Response to a step input will be such that within 10 engine revolutions the indicated rpm will be within 2% of the actual rpm.

2.1.4 An anemometer with steady-state accuracy within $\pm$10% at (19 km/h) 12 mph.

2.1.5 An acceptable wind screen may be used with the microphone. To be acceptable, the screen must not affect the microphone response more than $\pm$1 dB for frequencies of 20-4000 Hz or $\pm$1-1/2 dB for frequencies of 4000-10,000 Hz.

3. TEST SITE

3.1 The test site shall be a flat open space free of large sound-reflecting surfaces (other than the ground) such as parked vehicles, signboards, buildings or hillsides, located within (30.4m) (100 ft) radius of the microphone location and the following points on the vehicle path:

(a) The microphone point.

(b) A point (15.2m) (50 ft) before the microphone point.

(c) A point (15.2m) (50 ft) beyond the microphone point.

3.2 The measurement area within the test site shall meet the following requirements and be laid out as described:

3.2.1 The surface of the ground with at least the triangular area formed by the microphone location and the points (15.2m) 50 ft prior to and (15.2m) 50 ft beyond the microphone point shall be dry concrete or asphalt, free from snow, soil or other extraneous material.

3.2.2 The vehicle path shall be of relatively smooth, dry concrete or asphalt, free of extraneous materials such as gravel, and of sufficient length for safe acceleration, deceleration, and stopping of the vehicle.

3.2.3 The microphone shall be located (15.2m) (50 ft) from the centerline of the vehicle path and (1.2m) (4 ft) above the ground plane.

3.2.4 The following points shall be established on the vehicle path:

(a) Microphone point-a point on the centerline of the vehicle path where a normal through the microphone location intersects the vehicle path.

(b) End point-a point on the vehicle path (7.6m) (25 ft) beyond the microphone point.

(c) Acceleration point-a point on the vehicle path at least (7.6m) (25 ft) prior to the microphone point established by the method described in paragraph 4.1.

3.2.5 The test area layout in Fig. 1 shows a directional approach from left to right with one microphone location for purposes of clarity. Sound level measurements are to be made on both sides of the vehicle; therefore, it will be necessary to establish either a second microphone location on the opposite side of the vehicle path with a corresponding clear area or end points, and acceleration points for approaches from both direction.

4. PROCEDURE

4.1 To establish the acceleration point, the end point shall be approached in low gear from the reverse direction at a constant road speed obtained from 60% of the engine speed at maximum rated net horsepower. When the front of the vehicle reaches the end point, the throttle shall be rapidly and fully opened to accelerate past the microphone point under wide-open throttle. By trail, the lowest transmission gear shall be selected that will result in the vehicle traveling the shortest distance from the end point to the place where the engine speed at maximum rated net horsepower is reached, but which is not less than (7.6mm) (24 ft) past the microphone point. The location of the front of the vehicle on the vehicle path when the engine speed at maximum rated net horsepower is attained shall be the acceleration point for test runs to be made in the opposite direction.

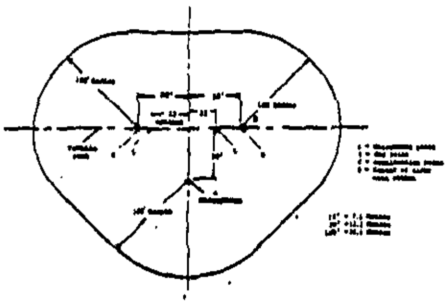


FIG. 1

4.1.1 When the procedure described in paragrah 4.1 results in a dangerous or unusual operating condition such as wheel spin, front wheel lifting, or other unsafe conditions, the next higher gear shall be selected for the test and the procedure rerun to establish the acceleration point. In any event, the procedure shall result in the vehicle being at the end point when the engine speed at maximum rated net horsepower is attained.

4.2 For the test under acceleration, the vehicle shall proceed along the vehicle path at a constant approach speed in the gear selected in paragraph 4.1 and at 60% of the engine speed at maximum rated net horsepower. When the front of the vehicle reaches the acceleration point, the throttle shall be rapidly and fully opened. Full acceleration shall continue until the engine speed at maximum rated net horsepower is reached, which shall be at the end point, at which time the throttle shall be closed. Wheel slip which affects the maximum sound level shall be avoided, and the manufacturer's safe maximum engine speed shall not be exceeded.

4.3 When excessive or unusual noise is noted during deceleration, the following test shall be performed with sufficient runs to establish maximum sound level under deceleration.

4.3.1 For the test under deceleration, the vehicle shall approach the end point from the reverse direction at the engine speed at maximum rated horsepower in the gear selected for the test under acceleration. At the end point, the throttle shall be rapidly and fully closed and the vehicle shall be allowed to decelerate to an engine speed of 1/2 the rpm at maximum rated net horsepower.

4.4 Sufficient preliminary runs to familiarize the driver and to establish the engine operating conditions shall be made before measurements begin. The engine temperature shall be within the normal operating range prior to each run.

5. MEASUREMENTS

5.1 The sound level meter shall be set for fast response and for the A-weighting network.

5.2 The meter shall be observed while the vehicle is accelerating or decelerating. The highest sound level obtained for each run shall be recorded, ignoring unrelated peaks due to extraneous ambient noises.

5.3 At least six measurements shall be made for each side of the vehicle. Sufficient measurements shall be made until at least four readings from each side are within 2 dB of each other. The highest and lowest readings shall be discarded; the sound level for each side shall be the average of the four, which are within 2 dB of each other. The sound level reported shall be for that side of the vehicle having the highest sound level.

5.4 The ambient sound level (including wind effects) at the test site due to sources other than the vehicle being measured shall be at least 10 dB lower than the sound level produced by the vehicle under test.

5.5 Wind speed at the test site during tests shall be less the 19 km/h (12 mph).

6. GENERAL COMMENTS

6.1 Technically competent personnel should select equipment, and the tests should be conducted only by trained and experienced persons familiar with the current techniques of sound measurement.

6.2 While making sound level measurements, not more than one person other than the rider and the observer reading the meter shall be within 15.2 m (50 ft) of the vehicle or microphone, and that person shall be directly behind the observer reading the meter, on a line through the microphone and the observer.

6.3 The test rider should be fully conversant with and qualified to ride the machine under test and be familiar with the test procedure.

6.4 Proper use of all test instrumentation is essential to obtain valid measurements. Operating manuals or other literature furnished by the instrument manufacturer should be referred to for both recommended operation of the instrument and precautions to be observed. Specific items to be considered are:

6.4.1 The type of microphone, its directional response characteristics, and its orientation relative to the ground plane and source of noise.

6.4.2 The effects of ambient weather conditions on the performance of all instruments (for example, temperature, humidity, and barometric pressure).

6.4.3 Proper signal levels, terminating impedances, and cable lengths on multi-instrument measurement systems.

6.4.4 Proper acoustical calibration procedure, to include the influence of extension cables, etc. Field calibration shall be made immediately before and after each test sequence. Internal calibration is acceptable for field use, provided that external calibration is accomplished immediately before or after field use.

6.5 Vehicles used for tests must not be operated in a manner such that the break-in procedure specified by the manufacturer is violated.

7. REFERENCES

Suggested reference material is as follows:

7.1 ANSI SI.1-1960, Acoustical Terminology.

7.2 ANSI SI.2-1962, Physical Measurement of Sound.

7.3 ANSI SI.4-1971, Specification for Sound Level Meters.

7.4 ANSI SI.13-1971, Method of Measurement of Sound Pressure Levels.

7.5 SAE J184, Qualifying a Sound Data Acquisition System.

7.6 SAE J331, Sound Levels for Motorcycles.

ISO/R362-MEASUREMENT OF NOISE

EMITTED BY VEHICLES

MEASUREMENT OF NOISE EMITTED BY VEHICLES

1. SCOPE

This ISO Recommendation describes methods of determining the noise emitted by motor vehicles, these being intended to meet the requirements of simplicity as far as is consistent with reproducibility of results and realism in the operating conditions of the vehicle.

2. GENERAL REQUIREMENTS

2.1 Test conditions

This ISO Recommendation is based primarily on a test with vehicles in motion, the ISO reference test. It is generally recognized to be of primary importance that the measurements should relate to normal town driving conditions, thus including transmission noise etc. Measurements should also relate to vehicle conditions which give the highest noise level consistent with normal driving and which lead to reproducible noise emission. Therefore, an acceleration test at full throttle from a stated running condition is specified.

Recognizing, however, that different practices already exist, specifications of two other methods used are also given in the Appendix. These relate to:

(a) a test with stationary vehicles (see Appendix A1) and

(b) a test with vehicles in motion, under vehicle conditions which (in the case of certain vehicles) are different from those in the ISO reference test (see Appendix A2).

When either of these tests is used, the relation between the results and those obtained by the ISO reference test should be established for typical examples of the model concerned.

2.2 Test site

The test methods prescribed call for an acoustical environment which can only be obtained in an extensive open space. Such conditions can usually be provided

for type-approval measurements of vehicles,

for measurements at the manufacturing stage, and

for measurements at official testing stations.

It is desirable that spot checking of vehicles on the road should be made in a similar acoustical environment. If measurements have to be carried out on the road in an acoustical environment which does not fulfil the requirements stated in this ISO Recommendation, it should be recognized that the results obtained may deviate appreciably from the results obtained using the specified conditions.

2.3 Interpretation of results

The results obtained by the methods specified give an objective measure of the noise emitted under the prescribed conditions of test. Owing, however, to the fact that the subjective appraisal of the annoyance or noisiness of different classes of motor vehicles is not simply related to the indications of a sound level meter, it is recognized that the correct interpretation of results of the measurements in this ISO Recommendation may require different limits to be set for the corresponding annoyance of different classes of vehicles.

3. MEASUREMENT EQUIPMENT

A high quality sound level meter should be used. The weighting network and meter time constant employed should be curve "A" and "fast response" respectively, as specified in Recommendation No. 123 of the International Electrotechnical Commission for Sound Level Meters. A detailed technical description of the instrument used should be supplied.

NOTES

1. The sound level measured using sound level meters having the microphone close to the instrument case may depend on the orientation of the instrument with respect to the sound source, as well as on the position of the observer making the measurement. The instructions given by the manufacturer concerning the orientation of the sound level meter with respect to the sound source and the observer should therefore be carefully followed.
2. If a wind shield is used for the microphone, it should be remembered that this may have an influence on the sensitivity of the sound level meter.
3. To ensure accurate measurements, it is recommended that before each series of measurements the amplification of the sound level meter be checked, using a standard noise source and adjusting as necessary.
4. It is recommended that the sound level meter and the standard noise source be calibrated periodically at a laboratory equipped with the necessary facilities for free-field calibration.

Any peak which is obviously out of character with the general sound level being read should be ignored.

4. ACOUSTICAL ENVIRONMENT

The test site should be such that hemispherical divergence exists to within $\pm$ 1 dB.

NOTE.—A suitable test site, which could be considered ideal for the purpose of the measurements, would consist of an open space of some 50 m radius, of which the central 20 m, for example, would consist of concrete, asphalt or similar hard material.

In practice, departure from the so-called "ideal" conditions arises from four main causes:

(*a*) sound absorption by the surface of the ground;

(*b*) reflections from objects, such as buildings, and trees, or from persons;

(*c*) ground which is not level or of uniform slope over a sufficient area;

(*d*) wind.

It is impracticable to specify in detail the effect produced by each of these influences. It is considered important, however, that the surface of the ground within the measurement area be free from powdery snow, long grass, loose soil or ashes.

To minimise the effect of reflections, it is further recommended that the sum of the angles subtended at the position of the test vehicle by surrounding buildings within 50 m radius should not exceed 90° and that there be no substantial obstructions within a radius of 25 m from the vehicle.

Acoustical focusing effects and sites between parallel walls should be avoided.

Wherever possible, the level of ambient noise (including wind noise and—for stationary tests—roller stand and tyre noise) should be such that the reading produced on the meter is at least 10 dB below that produced by the test vehicle. In other cases, the prevailing noise level should be stated in terms of the reading of the meter.

NOTE.—Care should be taken that gusts of wind do not distort the results of the measurements.

The presence of bystanders may have an appreciable influence on the meter reading, if such persons are in the vicinity of the vehicle or the microphone. No person other than the observer reading the meter should therefore remain in the neighbourhood of the vehicle or the microphone.

NOTE.—Suitable conditions exist, if bystanders are at a distance from the vehicle which is at least twice the distance from vehicle to microphone.

5. MEASUREMENTS WITH VEHICLES IN MOTION

5.1 Testing ground

The testing ground should be substantially level, and its surface texture such that it does not cause excessive tyre noise.

5.2 Measuring positions

The distance from the measuring positions to the reference line *CC* (Fig. 1) on the road should be 7.5 m. The path of the centre line of the vehicle should follow as closely as possible the line *CC*.

The microphone should be located 1.2 m above the ground level.

5.3 Number of measurements

At least two measurements should be made on each side of the vehicle as it passes the measuring positions.

NOTE.—It is recommended that preliminary measurements be made for the purpose of adjustment. Such preliminary measurements need not be included in the final result.

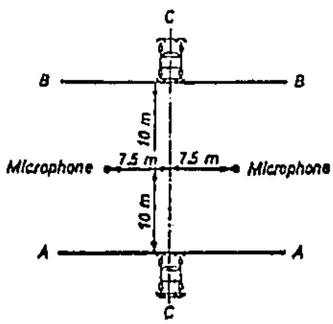


Fig. 1. — Measuring positions for measurement with vehicles in motion

5.4 Test procedure

5.4.1 *General conditions*

The vehicle approaches the line *AA* in the appropriate conditions specified below:

When the front of the vehicle reaches the position, in relation to the microphone, shown as *AA* in Figure 1, the throttle is fully opened as rapidly as practicable and held there until the rear of the vehicle reaches position *BB* in Figure 1, when the throttle is closed as rapidly as possible.

Trailers, including the trailer portion of articulated vehicles, are ignored when considering the crossing of line *BB*.

NOTE.—If the vehicle is specially constructed with equipment (such as concrete mixers, compressors, pumps, etc.), which is used whilst the vehicle is in normal service on the road, this equipment should also be operating during the test.

5.4.2 *Particular conditions*

5.4.2.1 VEHICLE WITH NO GEAR-BOX. The vehicle should approach the line *AA* at a steady speed corresponding

either to an engine speed of three quarters of the speed at which the engine develops its maximum power,

or to three quarters of the maximum engine speed permitted by the governor,

or to 50 km/h,

whichever is the lowest.

5.4.2.2 VEHICLE WITH A MANUALLY OPERATED GEAR-BOX. If the vehicle is fitted with a two-, three-, or four-speed gear box, the second gear should be used. If the vehicle has more than four speeds, the third gear should be used. Auxiliary step-up ratios ("overdrive") should not be engaged. If the vehicle is fitted with an auxiliary reduction gear box, this should be used with the drive allowing the highest vehicle speed.

The vehicle should approach the line *AA* at a steady speed corresponding

either to an engine speed of three quarters of the speed at which the engine develops its maximum power,

or to three quarters of the engine speed permitted by the governor,

or to 50 km/h,

whichever is the lowest.

5.4.2.3 VEHICLE WITH AN AUTOMATIC GEAR-BOX. The vehicle should approach the line *AA* at a steady speed of 50 km/h or at three quarters of its maximum speed, whichever is the lower. Where alternative forward drive positions are available, that position which results in the highest mean acceleration of the vehicle between lines *AA* and *BB* should be selected.

The selector position which is used only for engine braking, parking or similar slow manœuvres of the vehicle should be excluded.

5.4.2.4 AGRICULTURAL TRACTORS, SELF-PROPELLED AGRICULTURAL MACHINES AND MOTOR CULTIVATORS. The vehicle should approach the line *AA* at a steady speed of three quarters of the maximum speed which can be achieved, using the gear-box ratio which gives the highest road speed.

5.5 Statement of results

All readings taken on the sound level meter should be stated in the report.

The basis of horsepower rating, if appropriate, should be stated in the report.

The state of loading of the vehicle should also be specified in the report.

F76 SOUND LEVEL TEST METHOD

FOR MOTORCYCLES

Third Draft, August 1976

F76 - SOUND LEVEL TEST METHOD FOR MOTORCYCLES

1. SCOPE

This test procedure establishes the test procedure, environment, and instrumentation for determining sound levels typical of rapid motorcycle acceleration.

2. INSTRUMENTATION

2.1 The following instrumentation shall be used, where applicable:

2.1.1 A sound level meter which meets the Type 1 or S1A requirements of American National Standard Specification for Sound Level Meters, S1.4-1971, or successor standards. As an alternative to making direct measurements using a sound level meter, a microphone or sound level meter may be used with a magnetic tape recorder and/or a graphic level recorder or indicating instrument provided that the system meets the requirements of SAE Recommended Practice, Qualifying a Sound Data Acquisition System - J184, or successor standards.

2.1.2 An acoustic calibrator with an accuracy of ± 0.5 dB.

2.1.3 An engine speed tachometer having a steady state accuracy of within 3% of actual engine speed at 75% of peak power rpm*. The vehicle tachometer may be used provided steady state accuracy meets the above criterion. It should be noted that the response characteristics of the tachometer will affect the sound level readings; tachometers which lag in response generally lead to higher sound level readings. In lieu of using an engine speed tachometer, speed sensors which provide equivalent accuracy may be used to calculate engine rpm.

---

* "Peak power rpm" shall mean the rpm at which SAE net peak brake power is reached, as defined in SAE Standard J245.

2.1.4 An anemometer with steady-state accuracy of within ± 10% at 20 km/h (12 mph).

2.1.5 An acceptable wind screen may be used with the microphone. To be acceptable, the screen must not affect the microphone response more than ± 0.5 dB for frequencies of 100-8000 Hz, taking into account the orientation of the microphone.

3. TEST SITE

3.1 The test site shall be a flat open space free of large sound-reflecting surfaces (other than the ground), such as parked vehicles, signboards, buildings or hillsides, located within 30 m (98 ft) radius of the microphone location and the following points on the vehicle path (see Fig. 1):

a) The microphone point
b) A point 15 m (49 ft) before the microphone target point
c) A point 15 m (49 ft) beyond the microphone target poing

3.2 The measurement area within the test site shall meet the following requirements and be laid out as described:

3.2.1 The surface of the ground within at least the triangular area formed by the microphone location and the points 15 m (49 ft) prior to and 15 m (49 ft) beyond the microphone target point shall be flat and level (grade not more than 0.5%), dry concrete or asphalt, free from snow, soil or other extraneous material.

3.2.2 The vehicle path shall be of smooth, dry concrete or asphalt, free of extraneous materials such as gravel, and of sufficient length for safe acceleration, deceleration and stopping of the vehicle.

3.2.3 The microphone shall be located 15 m (49 ft) from the microphone target point, measured perpendicular to the centerline of the vehicle path, and 1.2 m (4 ft) above the ground plane.

3.2.4 The following points shall be established on the vehicle path:

a) Microphone target point - a point on the centerline of the vehicle path where a normal through the microphone location intersects the vehicle path.

b) End zone - a zone on the vehicle path 7.5 m ± 1 m (25 ± 3 ft) beyond the microphone target point.

3.2.5 The test area layout in Fig. 1 shows a directional approach from left to right with one microphone location, for purposes of clarity. Sound level measurements are to be made on both sides of the vehicle; therefore it will be necessary to establish either a second microphone location on the opposite side of the vehicle path with a corresponding clear area, or end zones and acceleration points for approaches from both directions.

4. PROCEDURE

4.1 To establish the acceleration point, the end zone shall be approached in second gear from the reverse direction at a constant engine speed of 50% ± 2.5% of peak power rpm. When the front of the vehicle reaches the center of the end zone (approached from the reverse direction), the throttle shall be smoothly and fully opened to accelerate past the microphone target point under wide-open throttle. When the vehicle reaches 75% ± 2.5% of peak power rpm the throttle shall be closed. The location of the front of the vehicle at the time of throttle closure shall be the acceleration point for the test runs to be made in the opposite direction. Sufficient practice runs shall be made to assure test validity, in accordance with paragraph 4.2.

4.1.1 The distance from the acceleration point to the center of the end zone must be at least 7.5 m (25 ft). If it is less than 7.5 m (25 ft) by the procedure of Section 4.1, third gear, if the motorcycle is so equipped, shall be used. If the distance is still less than 7.5 m (25 ft) fourth gear, and so on, shall be used, if the motorcycle is so equipped.

4.1.2 If the road speed at 75% of peak power rpm in second gear exceeds 100 km/h (62 mph), first gear shall be used.

4.1.3 If the motorcycle is equipped with an automatic transmission, the procedure of Section 4.1 shall be followed except that the lowest selectable range shall be employed, and the procedure of 4.1.1 shall be followed using the next selectable higher range if necessary and if the vehicle is so equipped. If 75% of peak power rpm is reached before the vehicle travels 7.5 m (25 ft), the throttle shall be opened less rapidly, but in such a manner that full throttle and 75% rpm are attained in the end zone.

4.1.4 Throttle opening shall be controlled to avoid wheel slip or lift-off. Mandatory requirement is that the acceleration point be chosen such that the vehicle accelerates and reaches an engine speed of 75% ± 2.5% of peak power rpm at full throttle, at the end point.

4.2 For the test under acceleration, the vehicle shall proceed along the vehicle path in the forward direction at a constant engine speed of 50% ± 2.5% of peak power rpm as established in Section 4.1. When the front of the vehicle reaches the acceleration point, also established in Section 4.1, the throttle shall be smoothly and fully opened. Full acceleration shall continue until an engine speed of 75% ± 2.5% of peak power rpm is reached, which shall occur within the end zone, and at which time the throttle shall be closed.

4.3 Sufficient preliminary runs shall be conducted before the testing to familiarize the rider with the test procedure and operating conditions of the motorcycle. The engine temperature shall be within the normal operating range prior to each run.

5. MEASUREMENTS

5.1 The sound level meter shall be set for fast response and for the A-weighting network.

5.2 The meter shall be observed throughout the vehicle accelerating period. The highest sound level obtained for the run shall be recorded.

5.3 At least six measurements shall be made for each side of the vehicle. Sufficient measurements shall be made until at least four readings from each side are within 2 dB of each other. The highest and the lowest readings shall be discarded; the sound level for each side shall be the average of the four, which are within 2 dB of each other. The sound level reported shall be for that side of the vehicle having the highest sound level.

5.4 The ambient sound level (including wind effects) at the test site due to sources other than the vehicle being measured shall be at least 10 dB lower than the sound level produced by the vehicle under test.

6. GENERAL COMMENTS

6.1 Technically competent personnel should select equipment, and the tests should be conducted only by trained and experienced persons familiar with the current techniques of sound measurement.

6.2 While making sound level measurements, not more than one person other than the rider and the observer reading the meter shall be within 15 m (49 ft) of the vehicle or microphone, and that person shall be directly behind the observer reading the meter, on a line through the microphone and the observer.

6.3 The test rider should be fully conversant with and qualified to ride the machine under test and be familiar with the test procedure.

6.4 Proper use of all test instrumentation is essential to obtain valid measurements. The instruction manual provided by the instrument manufacturer should be referred to for both recommended operation of the instrument and precautions to be observed. Specific items to be considered are:

6.4.1 The type of microphone, its directional response characteristics, and its orientation relative to the ground plane and source of noise.

6.4.2 The effects of ambient weather conditions on the performance of all instruments (for example, temperature, humidity and barometric pressure).

6.4.3 Proper signal levels, terminating impedances, and cable lengths on multi-instrument measurement systems.

6.4.4 Proper acoustical calibration procedure to include the influence of extension cables, etc. Field calibration shall be made immediately before and after each test sequence. Internal calibration means are acceptable for field use, provided that external calibration is accomplished immediately before and after field use.

7. <u>REFERENCES</u>

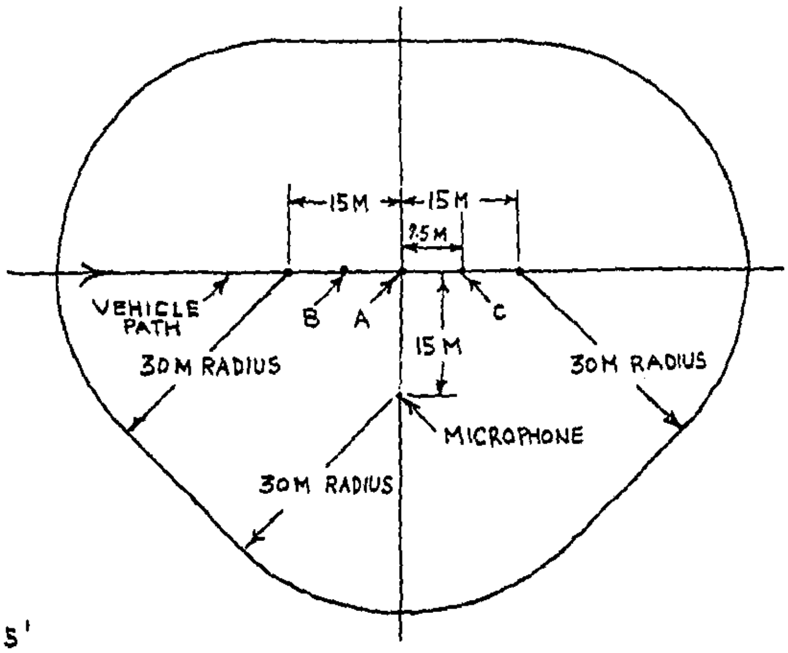
7.1 ANSI S1.1 - 1960, Acoustical Terminology.

7.2 ANSI S1.2 - 1962, Physical Measurement of Sound.

7.3 ANSI S1.4 - 1971, Specification for Sound Level Meters.

7.4 ANSI S1.13 - 1971, Method of Measurement of Sound Pressure Levels.

7.5 SAE J184, Qualifying a Sound Data Acquisition System.



7.5 M = 25'
15 M = 49'
30 M = 98'

A - MICROPHONE TARGET POINT
B - ACCELERATION POINT (VARIABLE)
C - CENTER OF END ZONE

FIG. 1 - TEST MEASUREMENT AREA, PROCEDURE NO. F-76

F76a SOUND LEVEL TEST METHOD

FOR MOTORCYCLES

September 1976

F76a - SOUND LEVEL TEST METHOD FOR MOTORCYCLES

1. SCOPE

This test procedure establishes the test procedure, environment, and instrumentation for determining sound levels typical of rapid motorcycle acceleration.

2. INSTRUMENTATION

2.1 The following instrumentation shall be used, where applicable:

2.1.1 A sound level meter which meets the Type 1 or S1A requirements of American National Standard Specification for Sound Level Meters, S1.4-1971, or successor standards. As an alternative to making direct measurements using a sound level meter, a microphone or sound level meter may be used with a magnetic tape recorder and/or a graphic level recorder or indicating instrument provided that the system meets the requirements of SAE Recommended Practice, Qualifying a Sound Data Acquisition System - J184, or successor standards.

2.1.2 An acoustic calibrator with an accuracy of ± 0.5 dB.

2.1.3 An engine speed tachometer having a steady state accuracy of within 3% of actual engine speeds between 50% and 100% of peak power rpm*. The vehicle tachometer may be used provided steady state accuracy meets the above criterion. It should be noted that the response characteristics of the tachometer will affect the sound level readings; tachometers which lag in response generally lead to higher sound level readings. In lieu of using an engine speed tachometer, speed sensors which provide equivalent accuracy may be used to calculate engine rpm.

2.1.4 An anemometer with steady-state accuracy of within ± 10% at 20 km/h (12 mph).

---

* "Peak power rpm" shall mean the rpm at which SAE net peak brake power is reached, as defined in SAE Standard J245.

2.1.5 An acceptable wind screen may be used with the microphone. To be acceptable, the screen must not affect the microphone response more than ± 0.5 dB for frequencies of 100-8000 Hz, taking into account the orientation of the microphone.

3. TEST SITE

3.1 The test site shall be a flat open space free of large sound-reflecting surfaces (other than the ground), such as parked vehicles, signboards, buildings or hillsides, located within 30 m (98 ft) radius of the microphone location and the following points on the vehicle path (see Fig. 1):

a) The microphone point
b) A point 15 m (49 ft) before the microphone target point
c) A point 15 m (49 ft) beyond the microphone target point

3.2 The measurement area within the test site shall meet the following requirements and be laid out as described:

3.2.1 The surface of the ground within at least the triangular area formed by the microphone location and the points 15 m (49 ft) prior to and 15 m (49 ft) beyond the microphone target point shall be flat and level (grade not more than 0.5%), dry concrete or asphalt, free from snow, soil or other extraneous material.

3.2.2 The vehicle path shall be of smooth, dry concrete or asphalt, free of extraneous materials such as gravel, and of sufficient length for safe acceleration, deceleration and stopping of the vehicle.

3.2.3 The microphone shall be located 15 m (49 ft) from the microphone target point, measured perpendicular to the centerline of the vehicle path, and 1.2 m (4 ft) above the ground plane.

3.2.4 The following points shall be established on the vehicle path:

a) Microphone target point - a point on the centerline of the vehicle path where a normal through the microphone location intersects the vehicle path.

b) End zone - a zone on the vehicle path 7.5 m ± 1 m (25 ± 3 ft) beyond the microphone target point.

3.2.5 The test area layout in Fig. 1 shows a directional approach from left to right with one microphone location, for purposes of clarity. Sound level measurements are to be made on both sides of the vehicle; therefore it will be necessary to establish either a second microphone location on the opposite side of the vehicle path with a corresponding clear area, or end zones and acceleration points for approaches from both directions.

4. PROCEDURE

4.1 The test procedure requires acceleration of the vehicle at full throttle in such a manner that a prescribed engine rpm, herein referred to as the closing rpm, is reached when the motorcycle is within the end zone. The closing rpm is a function of engine size (displacement), being 100% of peak power rpm for 100 cc displacement, and 60% for 600 cc. For displacements between 100 cc and 600 cc, a straight line relationship applies which may be determined from Fig. 2 or computed by

$$\% \text{ rpm} = 108 - 0.08 \text{ (displacement cc)}$$

For displacements below 100 cc the closing rpm is 100% of peak power rpm, and for displacements above 600 cc the closing rpm is 60% of peak power rpm.

4.2 To establish the acceleration point, the end zone shall be approached in second gear from the reverse direction at a constant engine speed of 50% ± 2.5% of peak power rpm. When the front of the vehicle reaches the center of the end zone (approached from the reverse direction), the throttle shall be smoothly and fully opened to accelerate past the microphone target point under wide-open throttle. When the vehicle reaches the specified closing rpm the throttle shall be closed. The location of the front of the vehicle at the time of throttle closure shall be the acceleration point for the test runs to be made in the opposite direction. Sufficient practice runs shall be made to assure test validity, in accordance with paragraph 4.3.

4.2.1 The distance from the acceleration point to the center of the end zone must be at least 7.5 m (25 ft). If it is less than 7.5 m (25 ft) by the procedure of section 4.2, third gear, if the motorcycle is so equipped, shall be used. If the distance is still less than 7.5 m (25 ft) fourth gear, and so on, shall be used, if the motorcycle is so equipped.

4.2.2 If the motorcycle is equipped with an automatic transmission, the procedure of section 4.2 shall be followed except that the lowest selectable range shall be employed, and the procedure of 4.2.1 shall be followed using the next selectable higher range if necessary and if the vehicle is so equipped. If the specified closing rpm is reached before the vehicle travels 7.5 m (25 ft), the throttle shall be opened less rapidly, but in such a manner that full throttle and the specified closing rpm are attained in the end zone.

4.2.3 Throttle opening shall be controlled to avoid wheel slip or lift-off. Mandatory requirement is that the acceleration point be cnosen such that the vehicle accelerates and reaches the specified closing rpm at full throttle, at the end point.

4.3 For the test under acceleration, the vehicle shall proceed along the vehicle path in the forward direction at a constant engine speed of 50% ± 2.5% of peak power rpm as established in section 4.2. When the front of the vehicle reaches the acceleration point, also established in section 4.2, the throttle shall be smoothly and fully opened. Full acceleration shall continue until the specified closing rpm is reached, which shall occur within the end zone, and at which time the throttle shall be closed.

4.4 Sufficient preliminary runs shall be conducted before the testing to familiarize the rider with the test procedure and operating conditions of the motorcycle. The engine temperature shall be within the normal operating range prior to each run.

5. MEASUREMENTS

5.1 The sound level meter shall be set for fast response and for the A-weighting network.

5.2 The meter shall be observed throughout the vehicle accelerating period. The highest sound level obtained for the run shall be recorded.

5.3 At least six measurements shall be made for each side of the vehicle. Sufficient measurements shall be made until at least four readings from each side are within 2 dB of each other. The highest and the lowest readings shall be discarded; the sound level for each side shall be the average of the four, which are within 2 dB of each other. The sound level reported shall be for that side of the vehicle having the highest sound level.

5.4 The ambient sound level (including wind effects) at the test site due to sources other than the vehicle being measured shall be at least 10 dB lower than the sound level produced by the vehicle under test.

6. GENERAL COMMENTS

6.1 Technically competent personnel should select equipment, and the tests should be conducted only by trained and experienced persons familiar with the current techniques of sound measurement.

6.2 While making sound level measurements, not more than one person other than the rider and the observer reading the meter shall be within 15 m (49 ft) of the vehicle or microphone, and that person shall be directly behind the observer reading the meter, on a line through the microphone and the observer.

6.3 The test rider should be fully conversant with and qualified to ride the machine under test and be familiar with the test procedure.

6.4 Proper use of all test instrumentation is essential to obtain valid measurements. The instruction manual provided by the instrument manufacturer should be referred to for both recommended operation of the instrument and precautions to be observed. Specific items to be considered are:

6.4.1 The type of microphone, its directional response characteristics, and its orientation relative to the ground plane and source of noise.

6.4.2 The effects of ambient weather conditions on the performance of all instruments (for example, temperature, humidity and barometric pressure).

6.4.3 Proper signal levels, terminating impedances, and cable lengths of multi-instrument measurement systems.

6.4.4 Proper acoustical calibration procedure to include the influence of extension cables, etc. Field calibration shall be made immediately before and after each test sequence. Internal calibration means are acceptable for field use, provided that external calibration is accomplished immediately before and after field use.

7. REFERENCES

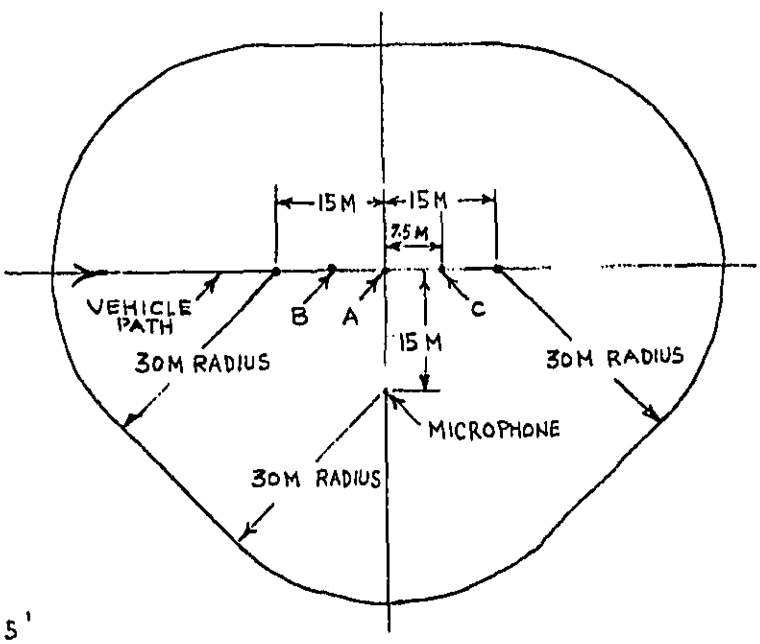
7.1 ANSI S1.1 - 1960, Acoustical Terminology

7.2 ANSI S1.2 - 1962, Physical Measurement of Sound

7.3 ANSI S1.4 - 1971, Specification for Sound Level Meters

7.4 ANSI S1.13 - 1971, Method of Measurement of Sound Pressure Levels

7.5 SAE J184, Qualifying a Sound Data Acquisition System



7.5 M = 25'
15 M = 49'
30 M = 98'

A - MICROPHONE TARGET POINT

B - ACCELERATION POINT (VARIABLE)

C - CENTER OF END ZONE

FIG. 1 - TEST MEASUREMENT AREA, PROCEDURE NO. F-76a

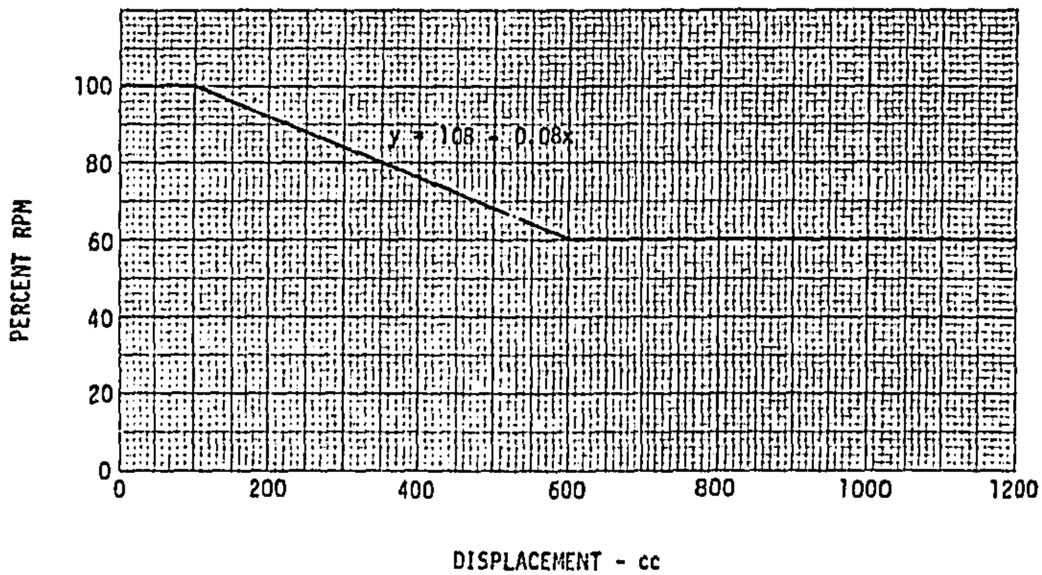


FIGURE 2. CLOSING RPM FOR F76a MOVING VEHICLE ACCELERATION TEST

R_{60} SOUND LEVEL TEST METHOD

FOR MOTORCYCLES

R60 SOUND LEVEL TEST METHOD FOR MOTORCYCLES

1. SCOPE

This test procedure establishes the test procedure, environment, and instrumentation for determining sound levels typical of motorcycle acceleration.

2. INSTRUMENTATION

2.1 The following instrumentation shall be used, where applicable:

2.1.1 A sound level meter which meets the Type 1 or S1A requirements of American National Standard Specification for Sound Level Meters, S1.4-1971. As an alternative to making direct measurements using a sound level meter, a microphone or sound level meter may be used with a magnetic tape recorder and/or a graphic level recorder or indicating instrument provided that the system meets the requirements of SAE Recommended Practice, Qualifying a Sound Data Acquisition System - J184.

2.1.2 An acoustic calibrator with an accuracy of ± 0.5 dB (see paragraph 6.4.4).

2.1.3 An engine speed tachometer having a steady state accuracy of within 3% of actual engine speed at 80% of maximum rated net horsepower rpm. The vehicle tachometer may be used provided steady-state accuracy meets the above criterion. It should be noted that the response characteristics of the tachometer will affect the sound level readings; tachometers which lag in response generally lead to higher sound readings.

In lieu of using an engine speed tachometer, speed sensors with an accuracy of within 2% of the vehicle speed at 50 km/h (31 mph) may be used to calculate engine rpm at the acceleration and end points.

2.1.4 A speedometer with steady-state accuracy of within ± 10%.

2.1.5 An anemometer with steady-state accuracy of within ± 10% at 20 km/h (12 mph).

2.1.6 An acceptable wind screen may be used with the microphone. To be acceptable, the screen must not affect the microphone response more than ± 0.5 dB for frequencies of 100-8000 Hz.

3. TEST SITE

3.1 The test site shall be a flat open space free of large sound-reflecting surfaces (other than the ground), such as parked vehicles, signboards, buildings or hillsides, located within 30 m (98 ft) radius of the microphone location and the following points on the vehicle path (see Fig. 1):

a) The microphone point

b) A point 15 m (49 ft) before the microphone target point

c) A point 15 m (49 ft) beyond the microphone target point

3.2 The measurement area within the test site shall meet the following requirements and be laid out as described:

3.2.1 The surface of the ground within at least the triangular area formed by the microphone location and the points 15 m (49 ft) prior to and 15 m (49 ft) beyond the microphone target point shall be flat and level (grade not more than 0.5%), dry concrete or asphalt, free from snow, soil or other extraneous material.

3.2.2 The vehicle path shall be of relatively smooth, dry concrete or asphalt, free of extraneous materials such as gravel, and or sufficient length for safe acceleration, deceleration and stopping of the vehicle.

3.2.3 The microphone shall be located 15 m (49 ft) from the centerline of the vehicle path and 1.2 m (4 ft) above the ground plane.

3.2.4 The following points shall be established on the vehicle path:

a) Microphone target point - a point on the centerline of the vehicle path where a normal through the microphone location intersects the vehicle path.

b) End point - a point on the vehicle path 7.5 m $\pm$ 1 m (25 $\pm$ 3 ft) beyond the microphone target point.

3.2.5 The test area layout in Fig. 1 shows a directional approach from left to right with one microphone location, for purposes of clarity. Sound level measurements are to be made on both sides of the vehicle; therefore, it will be necessary to establish either a second microphone location on the opposite side of the vehicle path with a corresponding clear area or end points and acceleration points for approaches from both directions.

4. PROCEDURE

4.1 To establish the acceleration point, the end point shall be approached in second gear from the reverse direction at a constant engine speed of 75% of R_{60}, where R_{60} is defined as the engine RPM corresponding to the speed of 60 MPH in the highest transmission gear. When the front of the vehicle reaches the end point, the throttle shall be fully opened to accelerate past the microphone point under wide open throttle. When the vehicle reaches 100% of R_{60}

the throttle shall be closed. The location of the front of the vehicle at the time of throttle closure shall be the acceleration point for the test runs to be made in the opposite direction.

4.1.1 The distance from the acceleration point to the end point must be at least 7.5 m (25 ft). If it is less than 7.5 m by the procedure of section 4.1, third gear, if the motorcycle is so equipped, shall be used. If the distance is still less than 7.5 m, fourth gear, and so on, shall be used, if the motorcycle is so equipped.

4.1.3 If the motorcycle is equipped with an automatic transmission, the procedure of section 4.1 shall be followed except that the lowest selectable range shall be employed, and the procedure 4.1.1 shall be followed using the next selectable higher range if the vehicle is so equipped.

4.1.4 Throttle opening shall be controlled to avoid wheel slip or lift-off. Mandatory requirement is that the acceleration point be chosen such that the vehicle accelerates and reaches an engine speed at 100% of R_{60} at the end point.

4.2 For the test under acceleration, the vehicle shall proceed along the vehicle path in the forward direction at a constant engine speed of 75% of R_{60} as established in section 4.1. When the front of the vehicle reaches the acceleration point, also established in section 4.1, the throttle shall be fully opened. Full acceleration shall continue until an engine speed of 100% of R_{60} is reached.

4.3 Sufficient preliminary runs shall be conducted before the testing to familiarize the rider with the test procedure and operating conditions of the motorcycle. The engine temperature shall be within the normal operating range prior to each run.

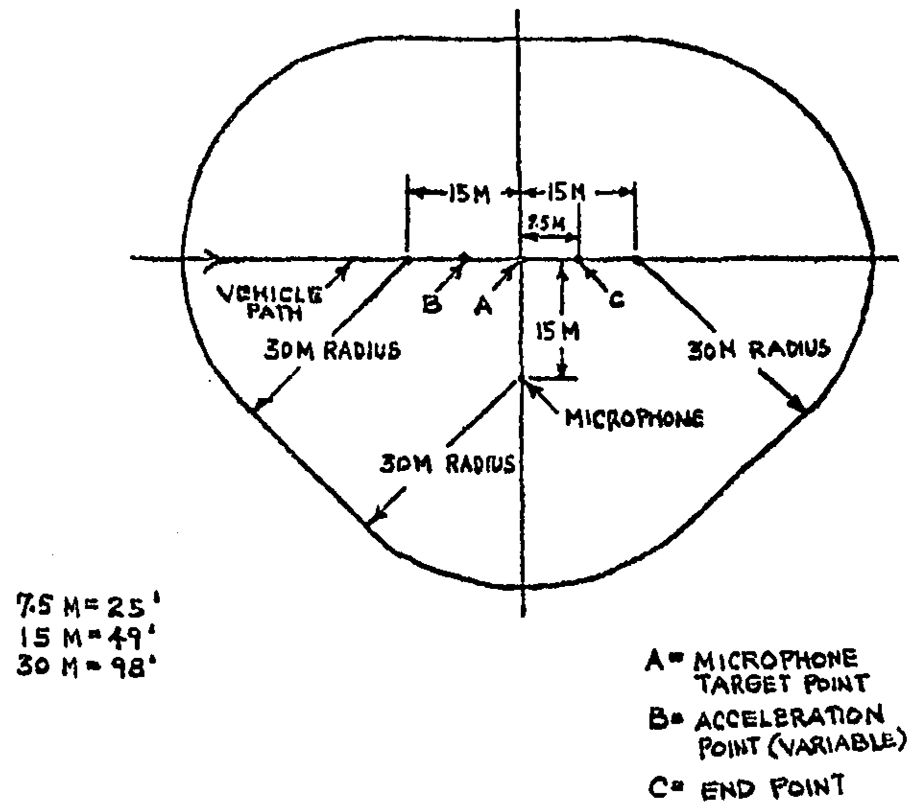


Figure 1

5. MEASUREMENTS

5.1 The sound level meter shall be set for fast response and for the A-weighting network.

5.2 The meter shall be observed throughout the vehicle accelerating period. Record the highest sound level obtained for the run.

5.3 At least six measurements shall be made for each side of the vehicle. Sufficient measurements shall be made until at least four readings from each side are within 2 dB of each other. The highest and the lowest readings shall be discarded; the sound level for each side shall be the average of the four, which are within 2 dB of each other. The sound level reported shall be for that side of the vehicle having the highest sound level.

5.4 The ambient sound level (including wind effects) at the test site due to sources other than the vehicle being measured shall be at least 10 dB lower than the sound level produced by the vehicle under test.

6. GENERAL COMMENTS

6.1 Technically competent personnel should select equipment, and the tests should be conducted only by trained and experienced persons familiar with the current techniques of sound measurement.

6.2 While making sound level measurements, not more than one person other than the rider and the observer reading the meter shall be within 15 m (49 ft) of the vehicle or microphone, and that person shall be directly behind the observer reading the meter, on a line through the micophone and the observer.

6.3 The test rider should be fully conversant with and qualified to ride the machine under test and be familiar with the test procedure.

6.4 Proper use of all test instrumentation is essential to obtain valid measurements. The instruction manual provided by the instrument manufacturer should be referred to for both recommended operation of the instrument and precautions to be observed. Specific items to be considered are:

6.4.1 The type of microphone, its directional response characteristics, and its orientation relative to the ground plane and source of noise.

6.4.2 The effects of ambient weather conditions on the performance of all instruments (for example, temperature, humidity and barometric pressure).

6.4.3 Proper signal levels, terminating impedances, and cable lengths on multi-instrument measurement systems.

6.4.4 Proper acoustical calibration procedure to include the influence of extension cables, etc. Field calibration shall be made immediately before and after each test sequence. Internal calibration means are acceptable for field use, provided that external calibration is accomplished immediately before and after field use.

7. REFERENCES

7.1 ANSI S1.1 - 1960, Acoustical Terminology

7.2 ANSI S1.2 - 1962, Physical Measurement of Sound

7.3 ANSI S1.4 - 1971, Specification for Sound Level Meters

7.4 ANSI S1.13 - 1971, Method of Measurement of Sound Pressure Levels

7.5 SAE J184, Qualifying a Sound Data Acquisition System

F77 - SOUND LEVEL TEST METHOD FOR SMALL MOTORCYCLES

1. SCOPE

This test procedure establishes the test procedure, environment, and instrumentation for determining sound levels of motorcycles which on level terrain do not exceed 100 km/h (62 mph) and the manufacturer's maximum recommended engine speed at wide open throttle in the highest gear.

2. INSTRUMENTATION

2.1 The following instrumentation shall be used:

2.1.1 A sound level meter which meets the Type 1 or S1A requirements of American National Standard Specification for Sound Level Meters, S1.4-1971, or successor standards. As an alternative to making direct measurements using a sound level meter, a microphone or sound level meter may be used with a magnetic tape recorder and/or a graphic level recorder or indicating instrument provided that the system meets the requirements of SAE Recommended Practice, Qualifying a Sound Data Acquisition System - J184, or successor standards.

2.1.2 An acoustic calibrator with an accuracy of ± 0.5 dB.

2.1.3 An anemometer with steady-state accuracy of within ± 10% at 20 km/h (12 mph).

2.1.4 An acceptable wind screen may be used with the microphone. To be acceptable, the screen must not affect the microphone response more than ± 0.5 dB for frequencies of 100-8000 Hz, taking into account the orientation of the microphone.

3. TEST SITE

3.1 The test site shall be a flat open space free of large sound-reflecting surfaces (other than the ground), such as parked vehicles, signboards, buildings or hillsides, located within 30 m (98 ft) radius of the microphone location and the following points on the vehicle path (see Fig. 1):

a) The microphone location.

b) A point 15 m (49 ft) before the microphone target point.

c) A point 15 m (49 ft) beyond the microphone target point.

3.2 The measurement area within the test site shall meet the following requirements and be laid out as described:

3.2.1 The surface of the ground within at least the triangular area formed by the microphone location and the points 15 m(49 ft) prior to and 15 m (49 ft) beyond the microphone target point shall be flat and level (grade not more than 0.5%), dry concrete or asphalt, free from snow, soil or other extraneous material.

3.2.2 The vehicle path shall be smooth, dry concrete or asphalt, free of extraneous materials such as gravel, and of sufficient length for safe acceleration, deceleration and stopping of the vehicle.

3.2.3 The microphone shall be located 15 m (49 ft) from the centerline of tne vehicle path and 1.2 m (4 ft) above the ground plane.

3.2.4 The following points shall be established on the vehicle path:

a) Microphone target point - a point on the centerline of the vehicle path where a normal through the microphone location intersects the vehicle path.

b) End point - a point on the vehicle path 7.5 m ± 1 m (25 ± 3 ft) beyond the microphone target point.

3.2.5 The test area layout in Fig. 1 shows a directional approach from left to right with one microphone location, for purposes of clarity. Sound level measurements are to be made on both sides of the vehicle; therefore, it will be necessary to establish either a second microphone location on the opposite side of the vehicle path with a corresponding clear area or to conduct tests with approaches in both directions.

4. PROCEDURE

4.1 The vehicle shall approach the microphone target point with the throttle fully open and in the highest gear. The vehicle shall start such that maximum speed is reached before the vehicle is within 7.5 m (25 ft) of the microphone target point. The vehicle shall continue along the vehicle path with fully open throttle and maximum speed past the end point, at which time the throttle shall be closed.

4.1.1 If the motorcycle is equipped with an automatic transmission, the procedure of section 4.1 shall be followed except that the highest selectable range shall be employed.

4.2 Sufficient preliminary runs shall be conducted before the testing to familiarize the rider with the test procedure and operating conditions of the motorcycle. The engine temperature shall be within the normal operating range prior to each run.

5. MEASUREMENTS

5.1 The sound level meter shall be set for fast response and for the A-weighting network.

5.2 The meter shall be observed throughout the vehicle pass-by period. The highest sound level obtained for the run shall be recorded.

5.3 At least three measurements shall be made for each side of the vehicle. Sufficient measurements shall be made until three readings from each side are within 2 dB of each other. The sound level for each side of the vehicle shall be the average of the three. The sound level reported shall be for that side of the vehicle having the highest sound level.

5.4 The ambient sound level (including wind effects) at the test site due to sources other than the vehicle being measured shall be at least 10 dB lower than the sound level produced by the vehicle under test.

6. GENERAL COMMENTS

6.1 Technically competent personnel should select equipment, and the tests should be conducted only by trained and experienced persons familiar with the current techniques of sound measurement.

6.2 While making sound level measurements, not more than one person other than the rider and the observer reading the meter shall be within 15 m (49 ft) of the vehicle or microphone, and that person shall be directly behind the observer reading the meter, on a line through the microphone and the observer.

6.3 The test rider should be fully conversant with and qualified to ride the machine under test and be familiar with the test procedure.

6.4 Proper use of all test instrumentation is essential to obtain valid measurements. The instruction manual provided by the instrument manufacturer should be referred to for both recommended operation of the instrument and precautions to be observed. Specific items to be considered are:

6.4.1 The type of microphone, its directonal response characteristics, and its orientation relative to the ground plane and source of noise.

6.4.2 The effects of ambient weather conditions on the performance of all instruments (for example, temperature, humidity and barometric pressure).

6.4.3 Proper signal levels, terminating impedances, and cable lengths on multi-instrument measurement systems.

6.4.4 Proper acoustical calibration procedure to include the influence of extension cables, etc. Field calibration shall be made immediately before and after each test sequence. Internal calibration means are acceptable for field use, provided that external calibration is accomplished immediately before and after field use.

7. REFERENCES

7.1 ANSI S1.1 - 1960, Acoustical Terminology.

7.2 ANSI S1.2 - 1962, Physical Measurement of Sound.

7.3 ANSI S1.4 - 1971, Specification for Sound Level Meters.

7.4 ANSI S1.13 - 1971, Method of Measurement of Sound Pressure Levels.

7.5 SAE J184, Qualifying a Sound Data Acquisition System.

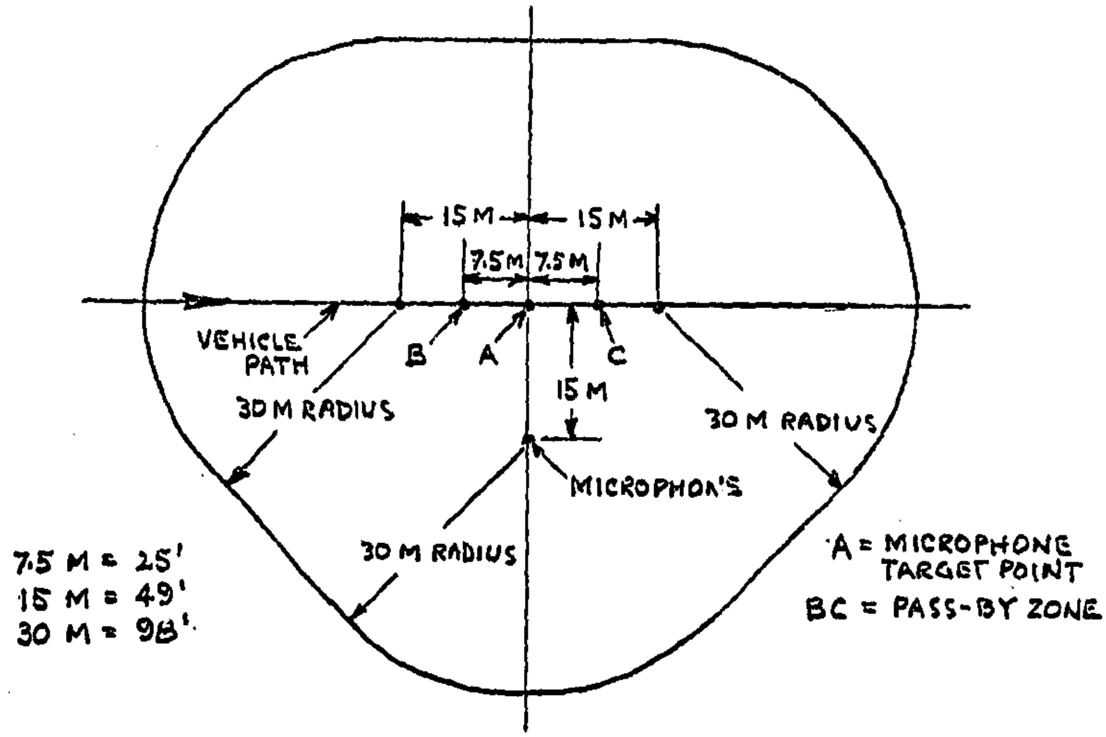


FIG. 1 – TEST MEASUREMENT AREA, PROCEDURE NO. F-77

F50 - STATIONARY VEHICLE NOISE TEST

PROCEDURE FOR MOTORCYCLES

Second Draft, July 1976

F50 - STATIONARY VEHICLE NOISE TEST PROCEDURE FOR MOTORCYCLES

1. SCOPE

This document establishes the test procedure, environment and instrumentation for determining sound levels of stationary motorcycles. This test method is complementary to, but independent from, other standardized test procedures such as acceleration sound level tests. The test is intended to check exhaust systems and exhaust noise from motorcycles in use, and for certification of aftermarket products which affect exhaust system noise.

2. INSTRUMENTATION

2.1 A sound level meter which meets the Type 1 or S1A requirements of American National Standard Specification for Sound Level Meters, S1.4-1971, or successor standards. As an alternative to making direct measurements using a sound level meter, a microphone or sound level meter may be used with a magnetic tape recorder and/or a graphic level recorder or indicating instrument provided that the system meets the requirements of SAE Recommended Practice, Qualifying a Sound Data Acquisition System - J184, or successor standards. Type 2 and Type S2A sound level meters are acceptable if allowance is made for the wider tolerance limits of these meters.

2.2 An acoustic calibrator with an accuracy of ± 0.5 dB.

2.3 An engine speed tachometer having steady-state accuracy of within 3% of actual engine speed at 50% of maximum net horsepower rpm*. The vehicle tachometer may be used provided that the above criterion is met.

2.4 An anemometer with steady-state accuracy of within ± 10% at 20 km/h (12 mph). An acceptable wind screen may be used with the microphone. To be acceptable, the screen must not affect the microphone response more than ± 0.5 dB for frequencies of 100-8000 Hz, taking into account the orientation of the microphone.

* "Maximum net horsepower rpm" shall mean the rpm at which SAE net peak brake power is reached, as defined in SAE Standard J245.

3. TEST SITE

3.1 The test site shall be a flat open surface free of large sound-reflecting surfaces (other than the ground) such as parked vehicles, signboards, buildings, or hillsides, located within 5 m (16 ft) radius of the motorcycle being tested and the location of the microphone.

3.2 The surface of the ground, within a one meter radius of the exhaust outlet shall be concrete or asphalt and flat and level.

3.3 The ambient sound level (including wind effects) at the test site due to sources other than the motorcycle being measured shall be at least 10 dB(A) lower than the sound level produced by the motorcycle under test.

3.4 Wind speed at the test site during test shall be not greater than 32 km/h (20 mph).

3.5 While making sound level measurements, not more than one person other than the rider and the measurer shall be within 3 m (10 ft) of the motorcycle under test or the microphone, and that person shall be directly behind the measurer on a line through the microphone and the measurer.

4. MEASUREMENTS

4.1 The sound level meter shall be set for the A-weighting network and shall be set for "slow" response.

4.2 The microphone shall be located 0.5 m from the rearmost exhaust outlet, at the same height above the ground as the exhaust outlet, and on a line 45° ± 10° (measured in the horizontal plane) from the direction of the exhaust discharge, on the side of the discharge away from the centerline of the vehicle. The microphone shall be oriented in relation to the exhaust outlet, for maximum sensitivity, in the manner prescribed by the manufacturer of the instrument.

4.3 The rider shall sit astride the motorcycle in normal riding position with both feet on the ground and run the engine with the gearbox in neutral at a speed equal to 50% maximum net horsepower rpm. If no neutral is provided the motorcycle shall be operated either with the rear wheel 5-10 cm (2-4 in.) clear of the ground, or with the drive chain or belt removed.

4.4 The sound level recorded shall be that measured during steady-state operation at the above-mentioned engine speed, measured on the loudest side of the motorcycle. Measurements must be taken with the engine at normal operating temperature.

5. STATEMENT OF RESULTS

The test report shall include all relevant details about the measurements, including the following:

- the vehicle type tested, with description of abnormal conditions
- the test site, ground conditions and weather conditions
- the measurement instrumentation
- the location and orientation of the microphone
- engine operating speed used for the test
- the sound level determined by the test
- background sound level at each measuring point

6. GENERAL COMMENTS

6.1 Proper use of all test instrumentation is essential to obtaining valid measurements. Operating manuals or other literature furnished by the instrument manufacturer should be referred to for both recommended operation of the instrument and precautions to be observed.

6.2 Specific items for consideration:

6.2.1 The type of microphone, its directional response characteristics, and its orientation relative to the ground plane and the sources of sound.

6.2.2 The effects of ambient weather conditions on the performance of all instruments (e.g., temperature, humidity and barometric pressure).

6.2.3 Proper acoustical calibration procedure to include the influence of extension cables, etc. Field calibration should be made immediately before the first test of each test day, and thereafter at intervals of no less than 1 hour. Internal calibration is acceptable for field use, provided that external (acoustical) calibration is accomplished immediately before and after each test day.

6.2.4 A measuring probe (to establish the 0.5 m distance) attached to the microphone or sound level meter should not be employed without verifying that the technique does not affect measured sound level readings.

PROPOSED FIELD TEST PROCEDURE

FOR SOUND LEVELS OF COMPETITION MOTORCYCLES

(Stationary Vehicle Test)

MOTORCYCLE INDUSTRY COUNCIL, INC.

PROPOSED FIELD TEST PROCEDURE

FOR SOUND LEVELS OF COMPETITION MOTORCYCLES

1. Scope. This document establishes the test procedure, environment, and instrumentation for determining sound levels of competition motorcycles under field conditions. This procedure is designed to be incorporated as part of a mandatory technical inspection.

2. Instrumentation.

2.1. The following instrumentation shall be used:

2.1.1. For professional competition, a sound level meter meeting all requirements for type 1, type 2, type S1A or type S2A of American National Standards Institute S1.4-1971 (ANSI S1.4-1971).

2.1.2. For amateur competition, a sound level meter meeting the requirements of Section 2.1.1., above, or of ANSI S1.4-1971 type 3 or type S3A.

2.2. A windscreen which does not affect microphone response more than $\pm$ 1 dB(A) for frequencies of 63-4000 Hz and $\pm 1\frac{1}{2}$ dB(A) for frequencies of 4000-10,000 Hz, taking into account the orientation angle of the microphone.

2.3. If the motorcycle under test is not provided with a tachometer, then an engine speed tachometer with a steady state accuracy of $\pm$ 5% shall be used. The tachometer may be a pointer type or a vibrating reed type as long as the accuracy specification is met.

4100 Birch St. Suite 101 • Newport Beach, Calif. 92660 • (714) 752-7833

3. Test Site.

3.1 The test site shall be a flat open surface free of large sound-reflecting surfaces (other than the ground) such as parked vehicles, signboards, buildings, or hillsides, located within 5m (16 ft) radius of the motorcycle being tested and the location of the microphone.

3.2. The surface of the ground, within the area described in Section 3.1., should be as level as possible and shall be free of loose or powdered snow, plowed soil, grass of a height greater than 15 cm (6 in), brush, trees, or other extraneous material.

3.3. The microphone shall be located behind, 0.5m (20 in) ($\pm$ .01m($\frac{1}{2}$ in) from, and at the same height as, the rearmost exhaust outlet and at a 45-degree angle ($\pm$ 10 degree) to the normal line of travel of the motorcycle. The longitudinal axis of the microphone shall be in a plane parallel to the ground plane.

3.4. No wire or other means of distance measurement shall be attached to the microphone. (This may lead to erroneous reading)

4. Procedure. The rider shall sit astride the motorcycle in normal riding position with both feet on the ground and run the engine with the gearbox in neutral at a speed equal to $\frac{1}{2}$ of the manufacturer's recommended maximum engine speed (red line). If no neutral is provided the motorcycle shall be operated either with the rear wheel 5-10 cm (2-4 in) clear of the ground, or with the drive chain or belt removed. If no red line is published for the particular motorcycle then an engine speed equal to 60 percent of the engine speed at which maximum horsepower is developed shall be used. If neither red line nor maximum horsepower engine speed is published, then the test speed N shall be calculated

from the following formulae:

$N = 306{,}000 \div \text{stroke, mm}$ <u>or</u> $N = 12{,}000 \div \text{stroke, inches}$

5. <u>Measurements</u>:

5.1. The sound level meter shall be set for the A-weighting network and should be set for "slow" response. ("Fast" may be used.)

5.2. The sound level recorded shall be that measured during steady state operation at the above-mentioned engine speed, measured on the loudest side of the motorcycle. If tests are to be made on one side of the motorcycle only then they shall be made on the exhaust outlet side. The test RPM shall also be recorded.

5.3. The ambient sound level (including wind effects) at the test site due to sources other than the motorcycle being measured shall be at least 7 dB(A) lower than the sound level produced by the motorcycle under test.

5.4. Wind speed at the test site during test should be less than 32 Km/hr (20 mph). If this is not possible, then the motorcycle and measuring microphone shall be positioned so that the prevailing wind direction is parallel to the normal direction of travel of the motorcycle.

6. <u>General Comments.</u>

6.1. Both rider and tester are strongly urged to use suitable personal hearing protection, such as expandable foam ear plugs or a muff. Motorcycle helmets, plain cotton, and certain "ear valves" are not suitable as hearing protectors.

6.2. While making sound level measurements, not more than one person other than the rider and the measurer shall be within 3m (10 ft) of the motorcycle under test or the microphone, and that person shall be directly behind the measurer on a line through the microphone and the measurer.

6.3. Proper use of all test instrumentation is essential to obtaining valid measurements. Operating manuals or other literature furnished by the instrument manufacturer should be referred to for both recommended operation of the instrument and precautions to be observed.

Specific items to be considered are:

6.3.1. The type of microphone, its directional response characteristics, and its orientation relative to the ground plane and the sources of sound.

6.3.2. The effects of ambient weather conditions on the performance of all instruments (e.g., temperature, humidity and barometric pressure).

6.3.3. Proper accoustical calibration procedure to include the influence of extension cables, etc. Field calibration should be made immediately before the first test of each test day, and thereafter at intervals of no less than 1 hour. Internal calibration is acceptable for field use, provided that external (accoustical) calibration is accomplished immediately before and after each test day.

6.4. The procedure is intended for use as a pass-fail test, therefore, when limits are specified to be measured by this procedure, they should be set at maxima, with no additional tolerance permitted.

6.5. The use of the word "shall" in the procedure is to be understood as obligatory. The use of the word "should" is to be understood as advisory.

ISO PROPOSED STATIONARY

VEHICLE TEST METHOD

ISO/TC 43/SC1 (SECRETARIAT-192) 202E
May 1975

Second Draft Proposal

For

Acoustics -
Survey Method for the Measurement of Noise
Emitted by Stationary Motor Vehicles
(Revision of doc 43/1 N 214)

1. INTRODUCTION

This document describes a test method for the control of vehicles in use, which is complementary, but independent from measuring methods described in other international standards and intended for type approval of vehicles.

2. SCOPE

This document specifies the conditions for measuring the noise produced by a stationary vehicle at a readily obtainable site having usual characteristics. The method is intended to check vehicles in service, and also to determine variations of the noise emitted by different parts of the vehicle under test which can result from:

- the wear or abnormal working of certain components, when the defect does not appear by visual inspection.
- the partial or complete removal of devices reducing the emission of certain noises.

These variations shall be determined by comparing the roadside or control measurements with reference measurements made under similar conditions during the type approval of the vehicle.

3. MEASURING DEVICES

3.1 Instrumentation for acoustical measurements

The microphone must be of the omnidirectional type.

The noise measurement device must be of the "precision sound level meter" type in accordance with Publication IEC 179.

The measurements shall be made using weighting network 'A', and meter time constant "fast response".

A suitable wind screen may be used to reduce the influence of wind on the readings.

3.2 Measurement of engine speed

Measurement of the engine speed shall be carried out by means of a revolution counter external to the vehicle, which allows measurements to be made within an accuracy of 3%.

4. TEST SITE - LOCAL CONDITIONS

Measurements shall be made on a stationary vehicle in an area which does not present a great deal of disturbance to the sound field. Every open space will be considered as a suitable test site if it consists of a flat area made of concrete, asphalt or hard materials having a high acoustical reflectivity, excluding compressed or other earth surfaces, in which one can trace a rectangle whose sides are at least three meters from the extremities of the vehicle, inside which there is no noticeable obstacle; in particular the vehicle shall be at a distance not less than 1 m from a pavement edge when the exhaust noise is measured.

Nobody shall stand in the measurement area, except the observer and the driver, whose presence must have no influence on the meter reading.

5. AMBIENT NOISE AND WIND INTERFERENCE

The ambient noise levels at each measuring point shall be at least 10 dB(A) below the levels measured during the tests at the same points.

6. MEASURING METHOD

6.1 Number of measurements

At least three measurements shall be carried out at each measuring point. The measurements shall be considered valid if the range of three measurements made immediately one after the other is not greater than 2 dB (A). The highest value given by these three measurements will constitute the result.

6.2 Positioning and preparation of the vehicle

The vehicle shall be located in the centre of the test area, with the gear box in neutral and the clutch engaged.

Before each series of measurements the engine must be brought to its normal operating temperature.

Note: For the reference test, it shall be verified that the cooling fan and other accessories necessary for engine functioning are working.

6.3 Measuring of noise in proximity to the exhaust (fig. 1)

6.3.1 Positions of the microphone

The height of the microphone above the ground shall be equal to that of the outlet pipe of the exhaust gases, but in any event shall be limited to a minimum value of 0.2 m.

The microphone must be pointed towards the orifice of the gas flow and located at a distance of 0.5 m from the latter.

Its axis of maximum sensitivity must be parallel to the ground and must make an angle of 45° ± 10° with the vertical plane containing the direction of the gas flow.

In relation to this plane, the microphone must be placed to the external side of the vehicle (the side which gives a maximum distance between the microphone and the driving position).

In the case of a vehicle provided with two or more exhaust outlets spaced less than 0.3 m apart and connected to a single silencer, only one measurement is made; the microphone position is related to the outlet nearest to the external side of the vehicle or, when such outlet does not exist, to the outlet which is the highest above the ground.

For vehicles with a vertical exhaust (e.g. commercial vehicles) the microphone shall be placed at a height of 1.2 m. Its axis shall be vertical and oriented upwards. It shall be placed at a distance of 0.5 m from the side of the vehicle nearest to the exhaust.

For vehicles provided with exhaust outlets spaced more than 0.3 m apart, one measurement is made for each outlet as if it were the only one, and the highest level is noted.

6.3.2 <u>Operating conditions of the engine</u>

The engine speed is stabilized at one of the following values:

- For vehicles with controlled ignition engine, 3/4 S
- For vehicles with diesel engine, the governed no load speed
- For motorcycles, S/2 if S > 5000 RPM, 3/4 S if S < 5000 RPM

S is the engine speed at which the engine produces its maximum power.

Note: It is recommended to ascertain that the governed speed of the diesel engine corresponds with its nominal governed speed.

The throttle is then suddenly closed, and the noise levels are measured during the whole deceleration period. The highest level only should be noted.

6.4 Measurement of noise near the engine (fig 2)

6.4.1 Position of the microphone:

The height of the microphone should be equal to 0.5 m. Its axis of maximum sensitivity shall be parallel with the ground and situated in a vertical plane whose position depends on the type of vehicle:

engine in front: vertical plane through the front axle

engine at the rear: vertical plane through the rear axle

engine at the center and motorcycles: vertical plane through the mid-point of the wheel base.

The microphone shall be pointed towards the vehicle and placed at a distance of 0.5 m measured horizontally from the lower edge of the nearest wheel rim or from the line joining the lower edge of the wheel rims of the front and rear axles.

The measurement is made only on the side furthest from the driving position.

For motorcycles, the distance of the microphone shall be measured from the external side of the motor case or from the cylinder head, whichever projects farther.

The measurement is made on the side of air intake or, if the latter is in the symmetrical plane, on the right-hand side of the vehicle.

6.4.2 Operating conditions of the engine

The engine is stabilized at idling speed and then the throttle is opened as rapidly as possible, and kept open in such a way as to obtain one of the maximum engine speeds defined below:

- For engines with controlled ignition, engine speed equal to S/2.
  A suitable device should be used to prevent overspeed of the engine

and to disconnect the sound level meter when the rotational speed S/2 is reached.

- For diesel engines, the governed speed.

Note: It is recommended to ascertain that the governed speed of the diesel engine corresponds with is nominal governed speed.

The noise levels shall be measured during the whole acceleration period. The highest level only should be noted.

7. STATEMENT OF RESULTS

The test report shall include all relevant details about the measurements, including the following:

- the vehicle type tested, with description of abnormal conditions
- the test site, ground conditions and weather conditions
- the measurement instrumentation
- the location and orientation of the microphone
- engine operating speeds used for the tests
- the sound levels determined by the tests
- the background sound levels at each measuring point

8. INTERPRETATION OF RESULTS

At the type approval of a vehicle type, the results of measurements obtained in the application of this method shall be entered into the type approval sheet of the vehicle, along with the engine speeds during the tests. They shall be completed with sketches showing the microphone positions during the measurements.

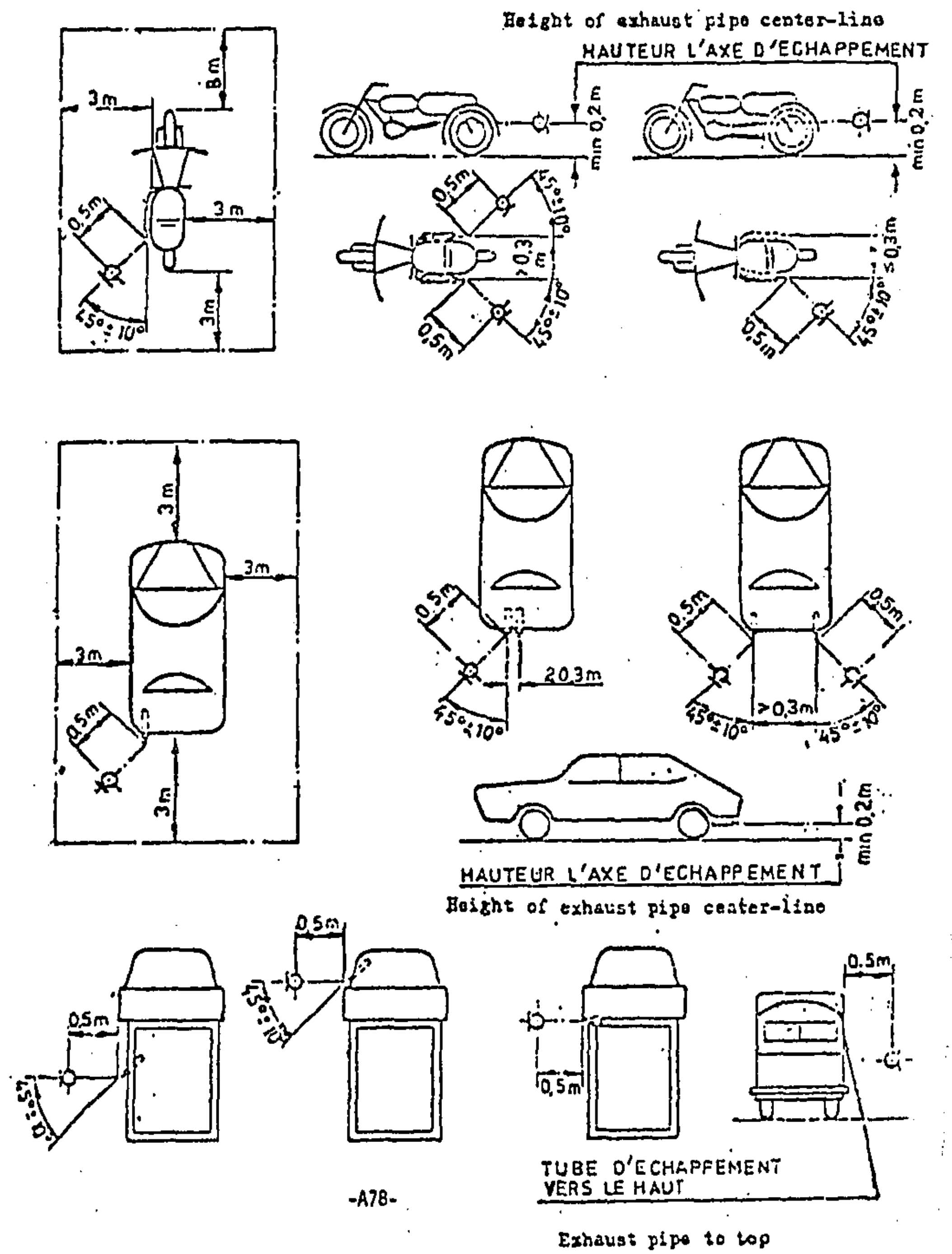
If checks are carried out on vehicles of the same type in use and if the corresponding measurement results exceed the values obtained during type approval by a quantity stated by regulations, the vehicles wil be considered to be too noisy.

Note: On account of the degree of accuracy of the measurements and of the differences between results corresponding to different vehicles of the same type, etc., a difference less than 5 dB with the corresponding result of the approval test should not be considered as significant.

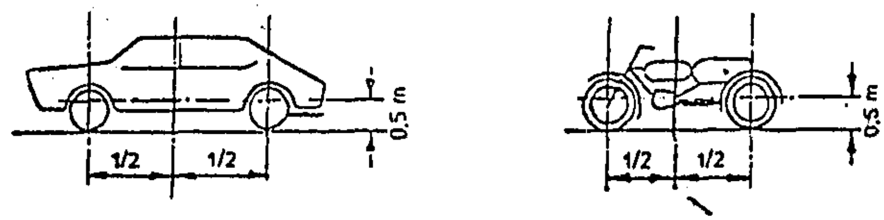
The values obtained by this method are not representative of the total noise emitted by the vehicles in motion, as measured in other ISO standards. They should not be used to make comparisons between the levels emitted by different vehicles.

6.3 CONTROLE DE BRUIT D'ECHAPPEMENT

Exhaust noise control

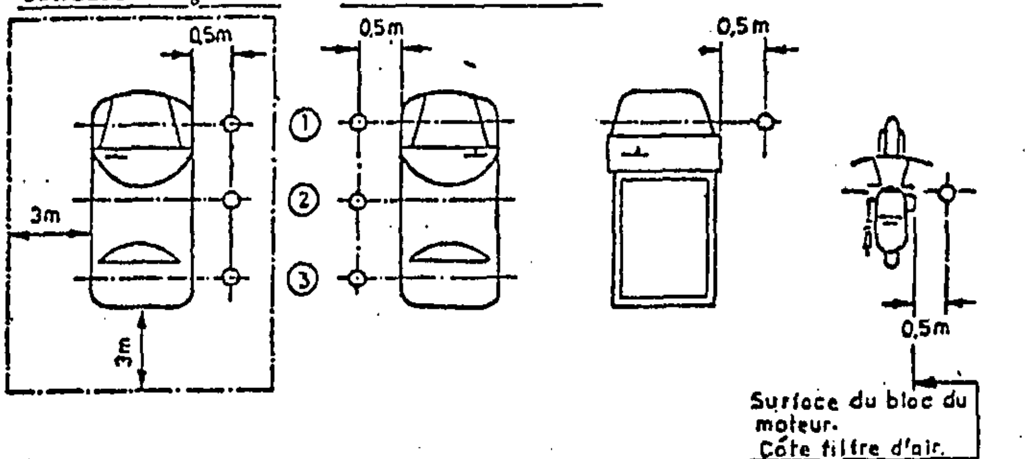


6.4 Contrôle du bruit de moteur
Engine noise control



LHD
Conduite à gauche

RHD
Conduite à droite

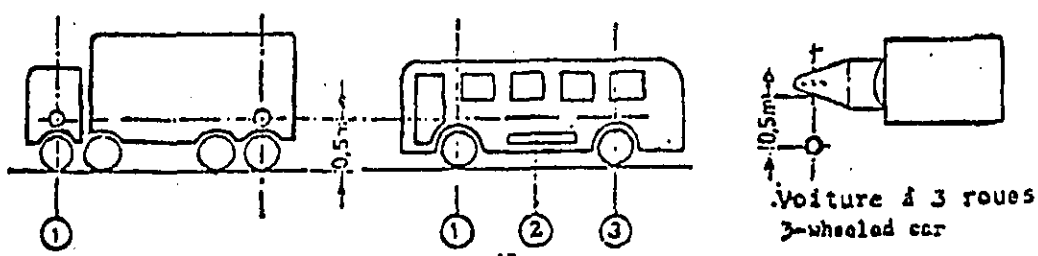


Surface of engine block
Air cleaner side

① Moteur à l'avant / front engine

② Moteur à la moyenne / middle engine

③ Moteur à l'arrière / rear engine



Voiture à 3 roues
3-wheeled car

APPENDIX B

TEST SITES AND INSTRUMENTATION

APPENDIX B

TEST SITES AND INSTRUMENTATION

The various test sites used to acquire data are described in this Appendix. Site anomalies and deviations from the requirements of SAE J331a Recommended Practice are noted. Photographs of the test sites follow the site descriptions.

Site A. Argosy Avenue, Huntington Beach, California

The site was chosen for its accessibility and its long run (one-half mile) of unobstructed pavement necessitated by the 55 mph constant speed test. Argosy Avenue is a new street, running in an E-W direction, asphalt paved, 74 feet wide, in a proposed industrial park, with no buildings or trees within one-quarter mile of the street center line. The pavement is bordered by an 8" curb, then 20 ft. hard clay, beyond which is open, plowed ground. Except for the presence of the curb and the strip of hard, flat clay (instead of asphalt) the site conforms to SAE J331a requirements.

Site B. Orange County Fairgrounds, California

This test site was located on the parking lot of the Orange County Fairgrounds complex. The surface of the site is asphalt. There are no buildings or trees within 300 feet of the test track. There are no site deviations from the requirements of SAE J331a.

Site C. Daytona Beach Florida

The Daytona Beach test site was located in the parking lot of the City Island Ball Park. The surface of the site is asphalt with many surface cracks, visible in the photographs. The width of the asphalt surface is 80 feet. One microphone was situated on a sidewalk with an 8 inch curb, the other microphone located 20 feet off the asphalt surface on hard packed, flat sand. Except for these deviations the site conforms to the SAE J331a requirements.

Site D. Los Alamitos Naval Air Station, California

This test site was located on the unused North/South runway at Los Alamitos Naval Air Station. The test track is 3000 feet long and 150 feetwide, the surface in the measurement area is asphalt. There are no buildings or trees within one-quarter mile of the test site. There are no deviation in site configuration from the SAE J331a requirements.

Site E. Los Angeles County Fair Grounds, Pomona, California

This test site was located on the main parking lot at the Los Angeles County Fair Grounds. The surface of the test site is smooth asphalt. No buildings or trees are within 300 feet of the test area. The site conforms to the requirements of SAE J331a.

Site F. Houston, Texas

The test site was on a private road paralleled by a public road which was lightly travelled during the testing period. The center line of the test track was 50 feet from the edge of this roadway. One microphone, adjacent to the roadway, was set up on a 20 ft. wide strip of grass which bordered the roadway. The other microphone was located with 45 feet of hard packed clay between it and the test track. Trees were located 20 feet behind one microphone. The test track surface was aspalt. Because of these deviations the track is not in conformance with the requirements of SAE J331a.

Site G. St. Petersburg, Florida

The test site was a secondary road adjacent to the dealer's source of motorcycles. The surface of the road was smooth asphalt and was 20 feet wide. It was not possible to place microphones on both sides of the test track because of reflecting surfaces on one side of the track. The microphone position used was located 50 feet from the track centerline, 40 feet of which was grass and hard packed sand. Trees and bushes were located 100 feet behind the microphone. This site did not conform to the requirements of SAE J331a.

Site H. Albany, Georgia

This test site was located on an aircraft taxiway at the Albany Naval Air Station. The taxiway surface was smooth concrete and is 300 feet wide. No buildings, trees or reflective surfaces are within 500 feet. The site conformed to the requirements of SAE J331a with no deviations.

Site I. Chappel Hill, North Carolina

This test site was on a secondary road adjacent to the motorcycle dealership. The road paralleled a main dual highway and was separate from the highway by a grass strip and drainage ditch approximately 75 feet wide. The test track surface was asphalt. Only one microphone was used to measure noise levels and this was located 50 feet from the track center line in the dealer's driveway which was concrete with a 10 ft. wide strip of gravel between the end of the drive and the edge of the test track. Reflecting surfaces, shown in the photograph, included a utility pole, utility box and sign pole, which were all within 15 feet of the microphone. Because of these deviations the site did not conform to the requirements of SAE J331a.

Site J. Suffolk, Virginia

This test site was on one runway at Suffolk Airport. The test track is also used as a drag strip and is in excess of one-half mile long. The track is 120 feet wide and the surface is concrete. Buildings are located 100 feet behind the microphones. The site complies with the SAE J331a requirements.

Site K. Fort Belvoir, Virginia

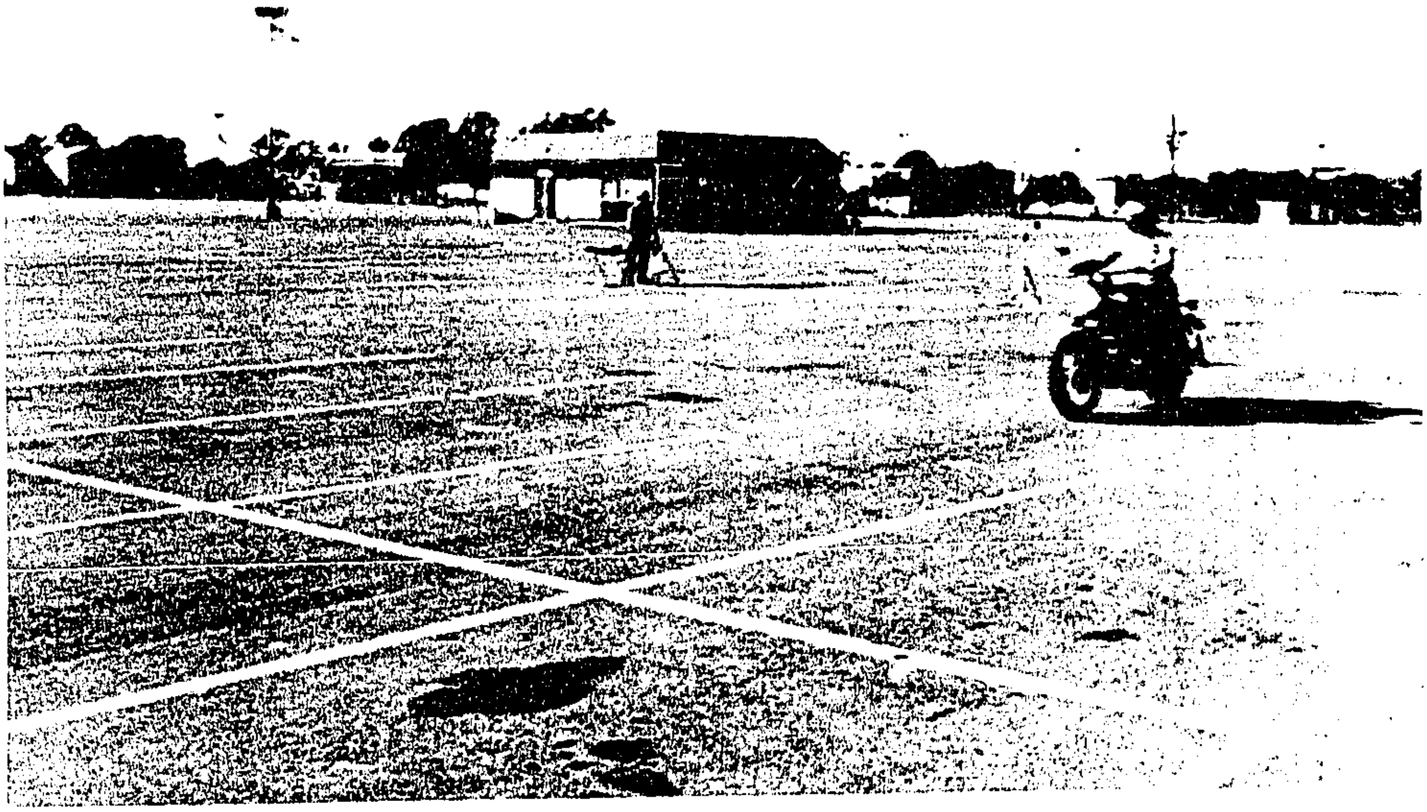
This test site was located at the Army Vehicle Proving Ground at Fort Belvoir, Virgina. The site deviated from J331a specifications in the following manner: a) Approximately 40 feet of hard packed earth was between the microphone and the concrete track, and b) A ditch, earth beam and small pine trees were on the side opposite the microphone in the area specified in the SAE J331a Recommended Practice to be clear of all obstructions.

Instrumentation

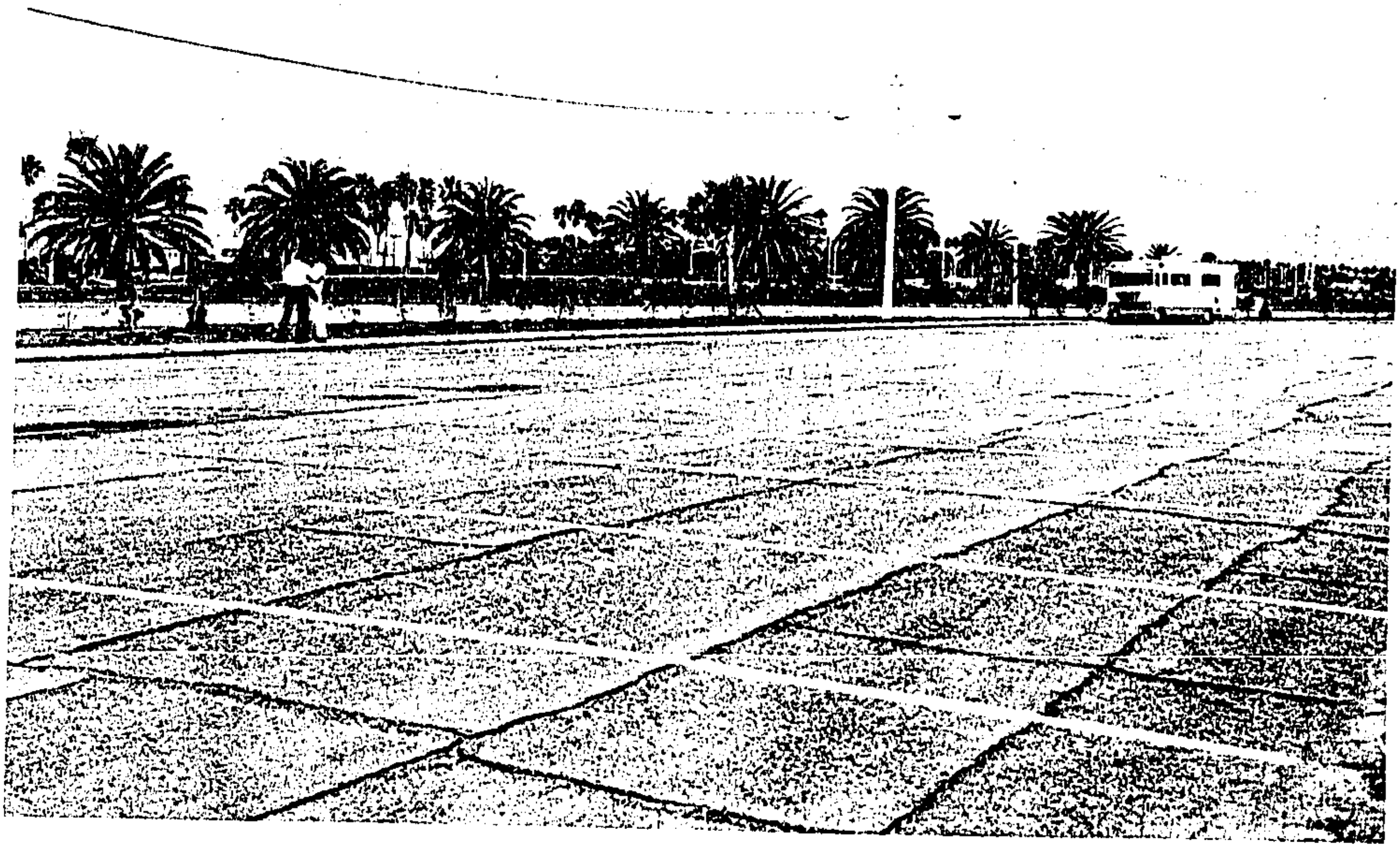
Two Bruel & Kjaer (B&K) model 2204 sound level meters, fitted with B&K model 4145 microphones, were used to obtain the reported noise level measurements. B&K UA0207 windscreens were used in all cases. A-weighted sound pressure levels (fast response) were read directly from the meters as the vehicle made succesive passes. Magnetic tape recordings using Nagra IV B tape recorders, and strip chart recordings using B&K model 2306 level recorders, were also obtained from the output of the sound level meters. Calibration of the acoustical equipment was verified twice daily using a B&K model 4220 pistonphone. All instrumentation was certified, with traceability to the National Bureau of Standards.

The vehicle tachometer was employed with vehicles so equipped. For vehicles without tachometers, a Sanwa model MT-03, a Rite Autotronics model 4036, and/or a Dynal model TAC-20 were used. A calibrated signal generator, oscilloscope, and inductive pickup from the motorcycle spark plug lead, were used to verify tachometer accuracy.

Wet and dry bulb temperatures were measured using a Bendix Psychrometer model 566-2. Barometric pressure was read from a B&K model UZ0001 Barometer, and wind velocity from a Dwyer wind gauge.



TEST SITE B, ORANGE COUNTY FAIRGROUNDS, CALIFORNIA



TEST SITE C, DAYTONA BEACH, FLORIDA

TEST SITE D, LOS ALAMITOS NAVAL AIR STATION, CALIFORNIA

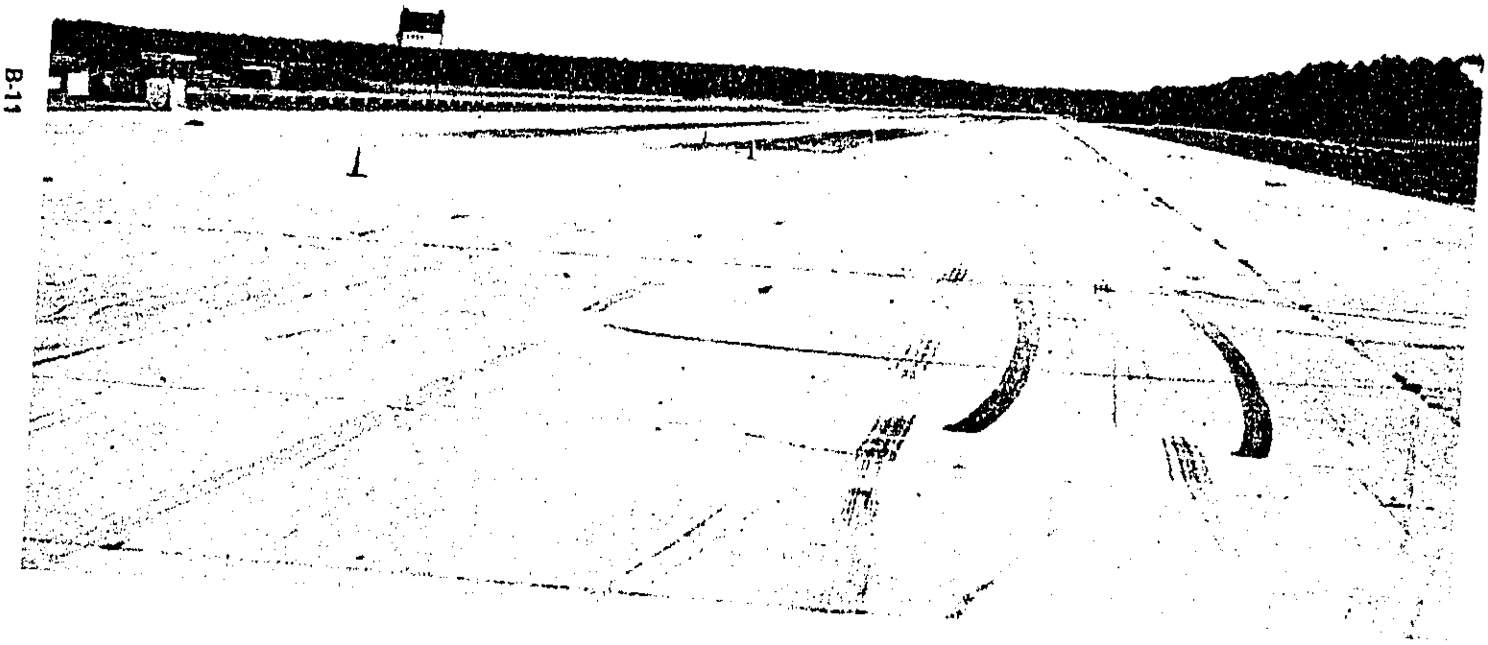
TEST SITE F, HOUSTON, TEXAS

TEST SITE G, ST. PETERSBURG, FLORIDA

TEST SITE H, ALBANY, GEORGIA

TEST SITE I, CHAPEL HILLS, NORTH CAROLINA

BLACK COPY



TEST SITE J, SUFFOLK, VIRGINIA

TEST SITE K. WASHINGTON, D.C.

APPENDIX C

PRODUCT IDENTIFICATION AND NOISE LEVELS

TABLE C-1 LISTING OF NEW MOTORCYCLES TESTED -- YEAR OF MANUFACTURE 1975 AND 1976

BIKE NO.	MO./YR. OF MFG.	MAKE	MODEL	DISPLACEMENT (cc)	DESIGN USAGE	USE* CATEGORY
2	2-75	Honda	GL-1000	999	Street	S
3	75	Bultaco	Series 143 Frontera	363	Trail Riding Enduro	X
4	75	Bultaco	Series 143 Frontera	363	Trail Riding Enduro	X
7	75	Honda	CB 750F	736	Street	S
8	10-75	Honda	CB 550	544	Street	S
20	75	Harley-Davidson	FLH-1200	1207	Street	S
22	3-75	Honda	CB 550F	544	Street	S
23	75	BMW	R90/6	898	Street	S
26	3-75	Honda	GL 1000	999	Street	S
27	75	BMW	R90/6	898	Street	S
31	75	Honda	GL-1000	999	Street	S
35	2-76	Yamaha	Chappy	72	Street/Trail	SX
36	4-75	Yamaha	Chappy	72	Street/Trail	SX
42	1-75	Kawasaki	KZ 900	903	Street	S
44	75	BMW	R90S	898	Street	S
45	75	Honda	GL-1000	999	Street	S
51	75	Honda	CB 550F	544	Street	S
52	75	Honda	CB 550F	544	Street	S
58	75	BMW	R90/6	898	Street	S
59	2-75	Honda	CB 750F	736	Street	S
60	5-75	Harley-Davidson	SS-175	174	Street	S
101	11-75	Honda	CJ 360T	356	Street	S
102	6-75	Honda	XL 70	72	Street/Trail	SX
103	8-75	Honda	MT 125	123	Street/Trail	SX
104	8-75	Honda	GL-1000	999	Street	S
105	9-75	Honda	CB 750	736	Street	S
106	6-75	Honda	CB 550F	544	Street	S
107	4-75	Honda	CB 200T	198	Street	S
108	6-75	Honda	CB 125S	124	Street	S
109	6-75	Honda	TL 250	248	Trials	X
110	5-75	Honda	XL 125	124	Street/Trail	SX

* Category Code: S = Street, X = Off-Road, SX = Combination Street/Off-Road

Cont'd.

TABLE C-1 (CONT'D.)

BIKE NO.	MO./YR. OF MFG.	MAKE	MODEL	DISPLACEMENT (cc)	DESIGN USAGE	USE * CATEGORY
111	7-75	Honda	MR 175	171	Trail Riding Enduro	X
112	6-75	Honda	XL 100	99	Street/Trail	
113	7-75	Honda	XL 250	248	Street/Trail	SX
114	9-75	Kawasaki	KM 100A	99	Street/Trail	SX
115	3-75	Kawasaki	KH 100	99	Street	S
117	3-75	Kawasaki	KV 100	99	Street/Trail	SX
118	8-75	Kawasaki	KE 175	174	Street/Trail	SX
119	3-75	Kawasaki	KH 400	400	Street	S
120	75	Kawasaki	KZ 750	746	Street	S
122	75	Kawasaki	KV 75	73	Trail	SX
123	3-75	Kawasaki	KH 250	249	Street	S
124	75	Kawasaki	KT 250	246	Trials	X
125	5-75	Suzuki	TS 400A	396	Street/Trail	SX
126	6-75	Suzuki	GT 185	184	Street	S
127	4-75	Suzuki	GT 750	738	Street	S
128	10-75	Suzuki	GT 500T	492	Street	S
130	3-75	Suzuki	TS 100	98	Street/Trail	SX
131	10-75	Suzuki	GT 380	371	Street	S
132	9-75	Suzuki	GT 550	543	Street	S
134	3-75	Yamaha	DT 250C	246	Street/Trail	SX
135	6-75	Yamaha	DT 175C	171	Street/Trail	SX
137	75	Bultaco	250 Alpina	244	Trail Riding/Trials	X
138	75	Bultaco	350 Sperpa T	326	Trials	X
139	9-75	BMW	R90/6	898	Street	S
141	75	NVT	ERB	49	Street	Moped
144	8-75	Moto Morini	3 1/2	344	Street	S
145	1-75	Laverda	1000 THREE	981	Street	S
151	9-75	Moto Guzzi	1000 Converter	949	Street	S
152	75	Rokon	RT-340 II	336	Trail Riding Enduros	X
153	75	Montessa	250 Enduro	248	Trail Riding Enduros	X
154	75	Montessa	Cota 123	123	Trials	X
156	75	Yamaha	TY 80	72	Off-Road	X
160	1-76	Honda	CB 750A	736	Street	S
161	2-75	Can-Am Bombardier	250 TNT Enduro	247	Street/Trail	SX

* Category Code: S = Street, X = Off-Road, SX = Combination Street/Off-Road

Cont'd.

TABLE C-1 (CONT'D.)

BIKE NO.	MO./YR. OF MFG.	MAKE	MODEL	DISPLACEMENT (cc)	DESIGN USAGE	USE * CATEGORY
162	5-75	Kawasaki	KE 125	124	Street/Trail	SX
163	12-75	Kawasaki	KZ 900 LTD	903	Street	S
164	12-75	Kawasaki	KD 80	79	Competition	X
165	5-75	Yamaha	RD 200C	195	Street	S
166	6-75	Yamaha	Chappy	72	Street/Trail	SX
167	6-75	Yamaha	DT 100C	97	Street/Trail	SX
168	1-76	Honda	NC-50	49	Street	S
169	4-75	Honda	CT-90	89	Street/Trail	SX
170	4-75	Vespa	Ciao	49	Street	Moped
171	7-75	Honda	CT-70	72	Street/Trail	SX
172	5-75	Honda	XR-75	72	Competition	X
173	4-75	Yamaha	DT 400C	397	Street/Trail	SX
174	10-75	Yamaha	XS 650C	653	Street	S
175	1-76	Benelli	750 SEI	748	Street	S
176	4-75	Suzuki	GT 750	738	Street	S
177	10-75	Motobecane	Mobylette	49	Street	Moped
178	4-75	Sinfac Velosolex	4600	49	Street	Moped
179	6-75	Kawasaki	KZ 900	903	Street	S
180	5-75	Suzuki	RE 5 Rotary	497	Street	S
181	12-75	Suzuki	TS-185	183	Street/Trail	SX
182	12-75	Suzuki	TM-75	72	Competition	X
183	75	Husqvarna	360 WR X-Country	354	Racing: MX & Off-Road	X
184	75	Husqvarna	360 Automatic	354	Racing: MX & Off-Road	X
187	2-76	Harley-Davidson	FLH-1200	1207	Street	S
188	5-75	Harley-Davidson	SX-175	174	Street/Trail	SX
189	5-75	Harley-Davidson	SS-175	174	Street	S
190	5-75	Harley-Davidson	SS-250	242	Street	S
192	6-75	Harley-Davidson	SS-125	123	Street	S
193	6-75	Harley-Davidson	SX-125	123	Street/Trail	SX
194	2-76	Harley-Davidson	FXE-1200	1207	Street	S
195	1-75	Harley-Davidson	XLH-1000	995	Street	S
196	10-75	Harley-Davidson	XLH-1000	995	Street	S
198	10-75	Ossa	250 Pioneer	246	Trail Riding Enduros	X

* Category Code: S = Street, X = Off-Road, SX = Combination Street/Off-Road

Cont'd.

TABLE C-1 (CONT'D)

BIKE NO	MO./YR. OF MFG.	MAKE	MODEL	DISPLACEMENT (cc)	DESIGN USAGE	USE* CATEGORY
199	75	Peugeot	103 LVS V3	49	Street	Moped
200	9-75	Ossa	350 Plonker	310	Trials	X
203	7-75	Harley-Davidson	XLH-1000	995	Street	S
204A	7-75	Honda	GL-1000	999	Street	S
205A	9-75	Honda	CB 550	544	Street	S
207A	12-75	Suzuki	TS-185	183	Street/Trail	SX
208A	6-75	Honda	CB 360T	356	Street	S
209A	75	Hodaka	250	24[illegible]	Racing: MX & Off-Road	X
211	75	Montessa	250 Enduro	248	Trail Riding & Enduros	X
213	11-75	Kawasaki	KZ 400	398	Street	S
214	7-75	Kawasaki	KZ 900	903	Street	S
215	9-75	Honda	CB 750	736	Street	S
218	6-75	Yamaha	DT 175C	171	Street/Trail	SX
219	11-75	Honda	CB 750	736	Street	S
502	1-76	Yamaha	RD 400C	398	Street	S
508	1-75	Honda	CB 750F	736	Street	S
510	11-75	Moto Guzzi	1000 Converter	949	Street	S
514	3-75	Yamaha	DT 250C	246	Street & Trail	SX
516	4-75	Yamaha	DT 175C	171	Street & Trail	SX
532	75	Honda	MR 50	49	Trail	X
541	5-75	Suzuki	RM 125	123	Racing: MX & Off-Road	X
546	75	Honda	MR 50	49	Trail	X
551	10-75	Honda	CB 550	544	Street	S
552	5-75	Honda	GL 1000	999	Street	S
555	10-75	Yamaha	XT 500	499	Street/Trail	SX
557	8-75	BMW	R90/6	898	Street	S
559	11-75	Honda	CB 550	544	Street	S
561	7-75	Honda	GL 1000	999	Street	
563	4-75	Honda	XL 125	124	Street/Trail	SX
565	1-76	Yamaha	XS 650C	653	Street	S
566	7-75	Garelli	Moped	49	Street	Moped
567	4-75	Yamaha	DT 400C	397	Street/Trail	SX
571	10-75	Honda	CB 750	544	Street	S

* Category Code: S = Street, X = Off-Road, SX = Combination Street/Off-Road

TABLE C-1 (CONT'D)

BIKE NO.	MO./YR. OF MFG.	MAKE	MODEL	DISPLACEMENT (cc)	DESIGN USAGE	USE * CATEGORY
573	75	Can-Am	125 TNT Enduro	124	Street/Trail	SX
575	4-75	Honda	CB 500T	498	Street	S
587	12-75	Yamaha	YZ 125C	123	Motocross	X
590	2-76	Yamaha	RD 400C	398	Street	S
593	10-75	Yamaha	XT 500C	499	Street/Trail	SX
594	3-76	Yamaha	XS 360C	358	Street	S
598	7-75	Honda	GL 1000	999	Street	S
602	12-75	Honda	CJ 360T	356	Street	S
604	10-75	Honda	CB 750	736	Street	S
605	5-75	Honda	CB 750F	736	Street	S
606	3-75	Honda	CB 550F	544	Street	S
607	11-75	Honda	CB 550	544	Street	S
609	6-75	Honda	XL 250	248	Street/Trail	SX
610	6-75	Honda	CB 125S	124	Street	S
611	5-75	Honda	XL 125	124	Street/Trail	SX
612	6-75	Honda	XL 100	99	Street/Trail	SX
613	9-75	Honda	XL 70K2	72	Street/Trail	SX
628	4-75	Honda	CB 500T	498	Street	S
629	75	Bultaco	250 Frontera	244	Trail Riding Enduros	X
630	75	Bultaco	250 Pursang	247	Racing: MX & Off-Road	X
631	1-76	Bultaco	350 Matador MK9	348	Street/Trail	SX
632	75	Montessa	250 Enduro	248	Trail Riding & Enduros	X
633	75	Montessa	Cota 247	247	Trials	X
634	75	Montessa	Cota 348	310	Trials	X
635	75	Carabela	125 Marquesa MX	119	Racing: MX & Off-Road	X
636	75	Carabela	250 Centauro Enduro	246	Trail Riding Enduros	SX
637	10-75	Yamaha	XT 500C	499	Street/Trail	SX
638	12-75	Indian	MT 175	171	Trail	X
909	75	Honda	All Terrain Cycle	89	All Terrain	X

* Category Code: S = Street, X = Off-Road, SX = Combination Street/Off-Road

TABLE C-2 LISTING OF 1974 MANUFACTURED MOTORCYCLES TESTED (STOCK CONFIGURATION

BIKE NO.	MO./YR. OF MFG.	MAKE	MODEL	DISPLACEMENT (cc)	DESIGN USAGE	USE* CATEGORY
6	74	Yamaha	XS 650B	653	Street	S
12	8-74	Kawasaki	900 Z-1	903	Street	S
16	12-74	Harley-Davidson	FXE-1200	1207	Street	S
25	74	BMW	R90/6	898	Street	S
28	4-74	Yamaha	RD-250	247	Street	S
33	74	Kawasaki	900 Z-1	903	Street	S
37	74	Suzuki	GT 550	543	Street	S
41	2-74	Suzuki	TS-185	183	Street and Trail	SX
43a	74	BMW	R90S	898	Street	S
63	74	Ducati	DM 750S	749	Street	S
64	7-74	Can-Am	250 TNT	247	Street and Trail	SX
68	10-74	Kawasaki	900 Z-1	903	Street	S
73	2-74	Kawasaki	KZ 400D	398	Street	S
74	74	BMW	R60/6	599	Street	S
121	6-74	Kawasaki	900 Z-1	903	Street	S
140	11-74	Norton	850 Commando	828	Street	S
142	8-74	Laverda	750 SF	744	Street	S
146	8-74	Can-Am	250 MX-1	246	Racing: MX & Off-Road	C
147	4-74	Moto Guzzi	850-T Intercepter	844	Street	S
155	11-74	Hodaka	Road Toad	98	Street and Trail	SX
157	74	Kreidler	MP3	49	Street	Moped
158	11-74	BMW	R90S	898	Street	S
191	9-74	Harley-Davidson	SX 250	242	Street and Trail	SX
197	11-74	Harley-Davidson	SX 250	242	Street and Trail	SX
201	10-74	Ossa	Desert Phantom 250	246	Trail Riding Enduros	X
212	5-74	Yamaha	RD-350	347	Street	S
501	12-74	Yamaha	XS 650B	653	Street	S
503	10-74	Yamaha	RD-350	347	Street	S
504	7-74	Yamaha	RD-250	247	Street	S
505	5-74	Yamaha	RD-200B	195	Street	S
506	10-74	Yamaha	RD-125B	124	Street	S
507	12-74	Kawasaki	KZ 400S	398	Street	S
519	4-74	Kawasaki	KZ 400D	398	Street	S

* Category Code: S = Street, X = Off-Road, SX = Combination Street/Off-Road

TABLE C-2 (CONT'D)

BIKE NO.	MO./YR. OF MFG.	MAKE	MODEL	DISPLACEMENT (cc)	DESIGN USAGE	USE * CATEGORY
521	6-74	Honda	CB 450	444	Street	S
528	4-74	Honda	CL 450	444	Street and Trail	SX
530	6-74	Honda	XL 125	122	Street and Trail	SX
533	74	Honda	Z 50A	49	Trail (mini)	X
534	74	Honda	Z 50A	49	Trail (mini)	X
535	74	Honda	Z 50A	49	Trail (mini)	X
536	74	Honda	Z 50A	49	Trail (mini)	X
537	6-74	Honda	CB 360T	356	Street	S
545	8-74	Honda	CB 125S	122	Street	S
547	10-74	Suzuki	RV 90	88	All-terrain	SX
548	7-74	Honda	XL 175	173	Street and Trail	SX
550	9-74	Suzuki	TS 400S	396	Street and Trail	SX
558	8-74	Yamaha	RS-100B	97	Street	S
560	7-74	Honda	CB 360T	356	Street	S
562	10-74	Honda	CB 200T	198	Street	S
568	6-74	Yamaha	DT-250	245	Street and Trail	SX
570	4-74	Honda	CB 125S	122	Street	S
577	74	Yamaha	DT-175B	171	Street and Trail	SX
583	74	Yamaha	MX 125	123	Racing: MX and Off-Road	X
589	7-74	Yamaha	TX 750	743	Street	S
599	8-74	Honda	CB 500T	498	Street	S
601	9-74	Honda	CB 400F	408	Street	S
603	7-74	Honda	CB 360T	356	Street	S
608	7-74	Honda	XL 350	348	Street and Trail	SX
614	8-74	Honda	CL 360	356	Street and Trail	SX
623	6-74	Honda	CB 350F	347	Street	S
626	12-74	Honda	CB 400F	408	Street	S

* Category Code: S = Street, X = Off-Road, SX = Combination Street/Off-Road

TABLE C-3 MOTORCYCLES MANUFACTURERS IDENTIFICATION CODE

LETTER CODE	MANUFACTURERS NAME
A	HUSQVARNA
B	NVT
C	CAN-AM
D	KTM PENTON
E	ROKON
F	HARLEY-DAVIDSON
G	MOTO-GUZZI
H	BENELLI
I	INDIAN
J	OSSA
K	CARABELA
L	LAVERDA
M	SINFAC VELOSOLEX
N	HODAKA
O	MOTO MORINI
P	BMW
Q	KAWASAKI
R	PEUGEOT
S	DUCATI
T	MONTESSA
U	SUZUKI
V	HONDA
W	NORTON
X	BULTACO
Y	KREIDLER
Z	PIAGGIO VESPA
AA	GARELLI
BB	MOTOBECANE
AC	YAMAHA
AD	TRIUMPH

TABLE C-4 NOISE LEVELS, NEW MOTORCYCLES, YEAR OF MANUFACTURE 1975 AND 1976

USE* CATEGORY	DISPL. CC	ENG. TYPE	NOISE LEVEL - dB						TEST SITE	MFG'R	BIKE NO.
			J331a	F76	R_{60}	F50	35 MPH	55 MPH			
S	1207	4 S	82	86	80	94	73	76	D	F	194
S	1207	4 S	84	84		90		77	D	F	187
S	1207	4 S	85						C	F	20
S	999	4 S	76	81		87	68	71	D	V	204A
S	999	4 S	82			88			C	V	2
S	999	4 S	76	79		88			F	V	598
S	999	4 S	77	85		88			J	V	561
S	999	4 S	76	83		88			I	V	552
S	999	4 S	76	84		88	70	74	B	V	104
S	999	4 S	80			83			C	V	45
S	999	4 S	76			89			C	V	31
S	999	4 S	77			88			C	V	26
S	995	4 S	87	88		99			D	F	203
S	995	4 S	84	88	83	99	74	77	D	F	196
S	995	4 S	84	87				77	D	F	195
S	981	4 S	92	94		95			D	L	145
S	949	4 S	80	83		89			G	G	510
S	949	4 S	84	88		86		72	D	G	151
S	903	4 S	82	87		95	72	76	D	Q	214
S	903	4 S	80	87		96		74	D	Q	179
S	903	4 S	81	89	82	97		74	D	Q	163
S	903	4 S	88			96			C	Q	42
S	898	4 S	83	84		90			J	P	557
S	898	4 S	82	82		89	67	73	D	P	139
S	898	4 S	81			87			C	P	58
S	898	4 S	82			88			C	P	44
S	898	4 S	81			82			C	P	27
S	898	4 S	81			87			C	P	23
S	748	4 S	82	86		92		72	D	H	175
S	746	4 S	81	83		90			B	Q	120
S	736	4 S	81	83		91			D	V	219
S	736	4 S	77			88			C	V	59
S	738	2 S	83	84	82	94		74	D	U	176
S	738	2 S		84		92			D	U	127
S	736	4 S	76	78		87			F	V	605
S	736	4 S	79	82		95			F	V	604
S	736	4 S	76	77		85			G	V	508
S	736	4 S	81	84		93	68	74	D	V	215
S	736	4 S	77	79		89		73	D	V	160
S	736	4 S	82	85		94			B	V	105
S	736	4 S	77			86			C	V	7
S	653	4 S	83	87		92			J	AC	565
S	653	4 S	82	86	81	89		74	D	AC	174

*CATEGORY CODE: S = STREET, X = OFF-ROAD, SX = COMBINATION STREET/OFF-ROAD

(Cont'd.)

TABLE C-4 CONT'D.)

USE* CATEGORY	DISPL. CC	ENG. TYPE	NOISE LEVEL - dB J331a	F76	R_{60}	F50	35 MPH	55 MPH	TEST SITE	MFG'R	BIKE NO.
S	544	4 S	82	83		84			B	V	106
S	544	4 S	82	82		91			K	V	571
S	544	4 S	83	84		90			D	V	205A
S	544	4 S	82	83		92			F	V	607
S	544	4 S	78	79		84			F	V	606
S	544	4 S	83	85		89			J	V	559
S	544	4 S	80			83			C	V	52
S	544	4 S	83			84			C	V	51
S	544	4 S	80			84			C	V	22
S	544	4 S	84			93			C	V	8
S	544	4 S	85	83		91			I	V	551
S	543	2 S	83	83		93			D	U	132
SX	499	4 S	82	78		89			E	AC	637
SX	499	4 S	81	81		90			F	AC	593
SX	499	4 S	85	83		89			J	AC	555
S	498	4 S	73	79		86			K	V	575
S	498	4 S	74	78		85			F	V	628
S	497	Rotary	82	83	81	96		78	D	U	180
S	492	2 S	82	84		95			D	U	128
S	400	2 S	84	85		89			B	Q	119
S	398	4 S	79	79			70	75	D	Q	213
S	398	2 S	81	80		93			F	AC	590
S	398	2 S	83	83		90			G	AC	502
SX	397	2 S	82	78		91			J	AC	567
SX	397	2 S	83	80		93		79	D	AC	173
SX	396	2 S	81	81		91			D	U	125
S	371	2 S	84	84		90			D	U	131
S	358	4 S	79	80		90			F	AC	594
S	356	4 S	76	80		89	71	76	B	V	101
S	356	4 S	76	79		89			F	V	602
S	356	4 S	77	81		85			D	V	208A
SX	348	2 S	89	89		87			E	X	631
S	344	4 S	84	86		92			D	O	144
S	249	2 S	82	82		91			B	Q	123
SX	248	4 S	79	79		83			D	V	113
SX	248	4 S	79	78		83			F	V	609
SX	247	2 S	91	91		103			D	C	161
SX	246	2 S	97	95		102			E	K	636
SX	246	2 S	81	77		80			G	AC	514
SX	246	2 S	82	80		89			D	AC	134
X	244	2 S	89	89		95			E	X	629
S	242	2 S	81	79	81	88		77	D	F	190
S	198	4 S	77	78		85			B	V	107

* Category Code: S = Street, X = Off-Road, SX = Combination Street/Off-Road

(Cont'd)

TABLE C-4 CONT'D.)

USE* CATEGORY	DISPL. CC	ENG. TYPE	NOISE LEVEL - dB J331a	F76	F77	F50	35 MPH	55 MPH	TEST SITE	MFG'R	BIKE NO.
S	195	2 S	81	83		91		79	D	AC	165
S	184	2 S	79	76		85			D	U	126
SX	183	2 S	81	81		91			D	U	207A
SX	183	2 S	82	79		92		79	D	U	181
S	174	2 S	83	81		86	68	75	D	F	189
SX	174	2 S	84	80		89		77	D	F	188
SX	174	2 S	83	79		85			B	Q	118
S	174	2 S	81			86			C	F	60
SX	171	2 S	83	81		92			D	AC	218
SX	171	2 S	82	80		92			D	AC	135
SX	171	2 S	82	80		92			G	AC	516
SX	124	4 S	78	76		94			J	V	563
SX	124	4 S	83	80		94			B	V	110
SX	124	4 S	81	81		90			F	V	611
SX	124	2 S	88	85					K	C	573
SX	124	2 S	78	77		90		75	D	Q	162
S	124	4 S	81	81		85			B	V	108
S	124	4 S	80	80		89			F	V	610
S	123	2 S	80	78		83	68	79	D	F	192
SX	123	2 S	83	77		89	73	81	D	F	193
SX	123	2 S	83	80	83	90	79	84	B	V	103
S	99	2 S	82	82		91			B	Q	115
SX	99	4 S	84	79		95			B	V	112
SX	99	4 S	85			93			F	V	612
SX	99	2 S	78	77		91			B	Q	114
SX	99	2 S	81	81		90			B	Q	117
SX	98	2 S	76	75		83			D	U	130
SX	97	2 S	77	77	80	85			D	AC	167
SX	89	4 S	76	73	77	82			D	V	169
SX	73	2 S	78		79	93			B	Q	122
SX	72	4 S	76	73	78	79			D	V	171
SX	72	4 S	82	77		84			B	V	102
SX	72	4 S	80	80		92			F	V	613
SX	72	2 S	72	70	72	79			D	AC	166
SX	72	2 S	69						C	AC	36
SX	72	2 S	74						C	AC	35
S	49	2 S			71				D	V	168
X	363	2 S	94						C	X	4
X	363	2 S	95						C	X	3
X	354	2 S				92			D	A	184
X	354	2 S	88	83		91			D	A	183
X	336	2 S	90	89		99		88	D	E	152
X	326	2 S	79	80		84			D	X	138

* Category Code: S = Street, X = Off-Road, SX = Combination Street/Off-Road

cont'd.

TABLE C-4 CONT'D.)

USE* CATEGORY	DISPL. CC	ENG. TYPE	NOISE LEVEL - dB J331a	F76	F77	F50	35 MPH	55 MPH	TEST SITE	MFG'R	BIKE NO.
X	310	2 S	86	84		88			E	T	634
X	310	2 S	91	89		98	80		D	J	200
X	248	4 S	84	78		88			B	V	109
X	248	2 S	91	90		104			E	T	632
X	248	2 S	84	84		93			D	T	211
X	248	2 S	90	89		89			D	T	153
X	247	2 S	84	82		91			E	T	633
X	247	2 S	101	101		116			E	X	630
X	246	2 S	92	89		98			D	N	209 A
X	246	2 S	93	91		89	82	85	D	J	198
X	246	2 S	89	88		89			B	Q	124
X	244	2 S	90	86		90			D	X	137
X	171	2 S	90	86		91			E	I	638
X	171	2 S	87	83		94			B	V	111
X	123	2 S	95	92		95			F	AC	587
X	123	2 S	100	97		104			I	U	541
X	123	2 S	77	77		85			D	T	154
X	119	2 S	95						E	K	635
X	89	2 S			73				D	V	909
X	79	2 S	79	78	81	86			D	O	164
X	72	4 S	81	78	82	84			D	V	172
X	72	2 S	75	74	78	94			D	U	182
X	72	2 S	76	75	77	85			D	AC	156
X	49	2 S			69				I	V	546
X	49	2 S			74				H	V	532
MOPED	49	2 S			66				J	AA	566
MOPED	49	2 S			60				D	N	178
MOPED	49	2 S			67				D	AB	177
MOPED	49	2 S			69				D	Z	170
MOPED	49	2 S			74**				D	B	141
MOPED	49	2 S			69				D	R	199

* Category Code: S = Street, X = Off-Road, SX = Combination Street/Off-Road

** Limited edition vehicle - no longer in production

Table C-5

NOISE LEVEL - NEW MOTORCYCLES,
YEAR OF MANUFACTURE 1975 AND 1976 (BY MANUFACTURER)

For off-road motorcycles (mx) means motorcross
and (t) means trials motorcycles

HONDA

Model	J-331a	F-76	F-50	35mph	55mph	Site
Street						
GL-1000	76	81	87	68	71	D
GL-1000	82		88			C
GL-1000	76	79	88			F
GL-1000	77	85	88			J
GL-1000	76	83	88			I
GL-1000	76	84	88	70	74	B
GL-1000	80		88			C
GL-1000	76		89			C
GL-1000	77		88			C
CB-750F	77		88			C
CB-750F	76	78	87			F
CB-750F	77		86			C
CB-750F	76	77	85			G
CB-750	81	84	93			D
CB-750	79	82	95			F
CB-750	82	85	94			B
*CB-750A	77	79	89			D
CB-550	84		93			C
CB-550	82	82	91			K
CB-550	83	84	90			D
CB-550	82	83	92			F
CB-550	83	85	89			J
CB-550	85	83	91			I
CB-550F	82	83	84			B
CB-550F	80		83			C
CB-550F	83		84			C
CB-550F	80		84			C
CB-550F	78	79	84			E
CB-500T	73	79	86			K
CB-500T	74	78	85			F
CJ-360T	76	80	89			B
CJ-360T	76	79	89			F
CB-360T	77	81	85			D
CB-200T	77	78	85			B
CB-125	81	81	85			B
CB-125	80	80	89			F
Combination						
XL-250	79	79	83			B
XL-250	79	78	83			F
XL-125	78	76	94			J
XL-125	83	80	84			B
*CB-750	81	83	91			D

Table C-5 (CONT'D.)

Model	J-33a	F-76	F-50	35mph	55mph	Site
HONDA						
XL-125	81	81	90			F
MT-125	83	80	90	79	84	B
XL-100	84	79	85			B
XL-100	85		93			F
CT-90	76	73	82			D
CT-70	76	73	79			D
XL-70	82	77	84			B
XL-70	80	80	92			F
Off-Road						
TL-250 (t)	84	78	88			B
MR-175	87	83	94			B
XR-75	81	78	84			D
YAMAHA						
Street						
XS-650 C	83	87	92			J
XS-650 C	82	86	89		74	D
RD-400 C	81	80	93			F
RD-400 C	83	83	90			G
XS-360 C	79	80	90			F
RD-200 C	81	83	91		79	D
Combination						
XT-500 C	82	78	89			E
XT-500 C	81	81	90			F
XT-500 C	85	83	89			J
DT-400 C	82	78	91			J
DT-400 C	83	80	93		79	D
DT-250 C	81	77	80			G
DT-250 C	82	80	89			D
DT-175 C	83	81	92			D
DT-175 C	82	80	92			D
DT-175 C	82	80	92			G
DT-100 C	77	77	85			D
Chappy	72	70	79			C
Chappy	69					C
Chappy	74					
Off-Road						
YZ-125 C (mx)	95	92	95			F
TY-80 (t)	76	75	85			D

Table C-5 (CONT'D.)

SUZUKI

Model	J-331a	F-76	F-50	35mph	55mph	Site
Street						
GT-750	83	84	94		74	D
GT-750		84	92			D
GT-550	83	83	93			D
RE-5	82	83	96		78	D
GT-500	82	84	95			D
GT-380	84	84	90			D
GT-185	79	76	85			D
Combination						
TS-400	81	81	91			D
TS-185	81	81	91			D
TS-185	82	79	92		79	D
TS-100	76	75	83			D
Off-Road						
RM-125 (MX)	100	97	104			I
TM-75	75	74	94			D

KAWASAKI

Model	J-331a	F-76	F-50	35mph	55mph	Site
Street						
KZ-900	82	87		72	76	D
KZ-900	80	87	96		74	D
KZ-900 LTD	81	89	97			D
KZ-750	81	83	90			B
KH-400	84	85	89			B
KZ-400	79	79		70	75	D
KH-250	82	82	91			B
KH-100	82	82	91			B
Combination						
KE-175	83	79	85			B
KE-125	78	77	90			D
KM-100A	78	77	91			B
KV-75	78		93			B
KV-100	81	81	90			B
Off-Road						
KT-250 (t)	89	88	89			B
KD-80	79	78	86			D

Table C-5 (CONT'D.)

HARLEY-DAVIDSON

Model	J-331a	F-76	F-50	35mph	55mph	Site
Street						
FXE (Calif)	82	86	94	73	76	D
FLH (Calif)	84	84	90		77	D
FLH	85					C
XLCH (Calif)	87	88	99			D
XLCH (Calif)	84	88	99	74	77	D
XLCH (Calif)	84	87			77	D
SS-250	81	79	88		77	D
SS-175	83	81	86	68	75	D
SS-125	80	78	83	68	79	D
SS-175	81		86			C
Combination						
SX-175	84	80	89		77	F
SXT-125	83	77	89	73	81	D

OTHER MANUFACTURERS

Model	J-331a	F-76	F-50	35mph	55mph	Site
Street						
Laverda 1000 Three	92	94	95			D
MotoGuzzi						
1000 Converter	80	83	89			G
1000 Converter	84	88	86		72	D
BMW R90/6	83	84	90			J
BMW R90/6	82	82	89	67	73	D
BMW R90/6	81		87			C
BMW R90/S	82		88			C
BMW R90/6	81		82			C
BMW R90/6	81		87			C
Benelli 750 Sei	82	86	92		72	D
MotoMorini 3 1/2	84	86	92			D
Combination						
Bultaco 350 Matador	89	89	87			E
Can-Am 250 TNT	91	91	103			D
Carabella 250 Centauro Enduro	97	95	102			E
Can-Am 125 TNT Enduro	88	85				C

Table C-5 (CONT'D.)

OTHER MANUFACTURERS

Company	Model	J-331a	F-76	F-50	35mph	55mph	Site
Off-Road							
Montesa	Cota 348 (t)	86	84	88			E
	250 Enduro	91	90	140			E
	250 Enduro	84	84	93			D
	250 Enduro	90	89	89			D
	Cota 247 (t)	84	82	91			E
	Cota 123 (t)	77	77	85			D
Bultaco	370 Frontera	94					C
	370 Frontera	95					C
	350 Sherpa T(t)	79	80	84			D
	250 Pursang (mx)	101	101	116			E
	250 Alpina	90	86	90			D
	250 Frontera	89	89	95			E
Husqvarna	360 Automatic			92			D
	360 WR Cross Country	88	83	91			D
OSSA	350 Plonker (t)	91	89	98	80		D
	250 Pioneer	93	91	89	82	85	D
Rokon	RT-340 II	90	89	99		88	D
Hodaka	250	92	89	98			D
Indian	MT-175	90	86	91			E
Carabela	125 Marquesa MX	95					E

Mopeds

Model		F-77	Site
NVT*		74	D
Garelli		66	J
Velosolex	4600	60	D
MotoBecane	Mobylette	67	D
Vespa	Ciao	69	D
Peugeot	103 LVS v3	69	D
Other small motorcycles			
Honda	MR-50	74	H
Honda	NC-50	71	D
Honda	MR-50	69	I
Honda All Terrain Cycle		73	D

* Limited edition vehicle - no longer in production.

TABLE C-6 NOISE LEVELS,
1969-1974 (YEAR OF MANUFACTURE)
IN-SERVICE MOTORCYCLES IN STOCK CONFIGURATION

USE* CATEGORY	DISPL. CC	ENG. TYPE	NOISE LEVEL - dB						TEST SITE	MFG'R	BIKE NO.
			J331a	F76	F77	F50	35 MPH	55 MPH			
S	1207	4 s	83			105	72		A		A78
S	1207	4 S	84			103	72	79	A		A86
S	1207	4 S	85			104	72	79	A		A98
S	1207	4 S	91			105	77	82	A		A99
S	1207	4 S	89			105	79	84	A		A100
S	1207	4 S	85			98	72	76	A		A59
S	1207	4 S	87				74	79	A		A74
S	1207	4 S	89				75	79	A		A75
S	1207	4 S	87			103	72		A		A77
S	1207	4 S	86			100	72	77	A		A20
S	1207	4 S	102						C		16
S	1207	4 S	87			104			C		30
S	1207	4 S	92						C		55
S	995	4 S	84			98	71	76	A		A76
S	995	4 S	84			98	73	78	A		A124
S	995	4 S	84			99	74	77	A		A111
S	999	4 S	74			88	61	66	A		A182
S	903	4 S	82			96	72	75	A		A1
S	903	4 S	83			97	70	73	A		A24
S	903	4 S	84			97	72	76	A		A69
S	903	4 S	84			95	71	75	A		A153
S	903	4 S	85			94			C		68
S	903	4 S	86			95			C		33
S	903	4 S	83			95			C		12
S	903	4 S		89		97			B		121
S	898	4 S	88			94			C		43a
S	898	4 S	80			90			C		25
S	898	4 S	82	85		86		69	D		158
S	844	4 S	81			96	68	73	A		A131
S	844	4 S	83	88		90			D		147
S	828	4 S	79			89	73	75	A		A50
S	828	4 S	82			92	67	75	A		A9
S	828	4 S	81	84		91			D		140
S	748	4 S	80			97	78	78	A		A43
S	736	4 S	90	93		102		80	D		159
S	749	4 S	82			94	72	77	A		A192
S	749	4 S	91	100					C		63
S	748	4 S	80			91	68	72	A		A138
S	748	4 S	80			89	68	71	A		A106
S	748	4 S	73			87	62	69	A		A107

*CATEGORY CODE: S = STREET, X = OFF-ROAD, SX = COMBINATION STREET/OFF-ROAD

Cont'd.

TABLE C-6 (CONT'D.)

USE CATEGORY*	DISPL. CC	ENG. TYPE	NOISE LEVEL - dB J331a	F76	F77	F50	35 MPH	55 MPH	TEST SITE	MFG'R	BIKE NO.
S	748	4 S	85			91	72	77	A		A2
S	748	2 S	83			93	73	76	A		A118
S	745	4 S	87			98	74	79	A		A3
S	745	4 S	76			88	63	69	A		A97
S	745	4 S	74			88	61	66	A		A91
S	745	4 S	75			87	62	69	A		A103
S	745	4 S	76			87	64	72	A		A162
S	745	4 S	77			87	64	70	A		A163
S	745	4 S	76	79		89			G		515
S	745	4 S	83			96			C		10
S	745	4 S	77			90			C		71
S	744	4 S	89	94		96			D		142
S	743	4 S	84			94	72	76	A		A81
S	743	4 S	82	84		94			F		589
S	738	2 S	83			94	68	74	A		A119
S	738	2 S	85			92	72	75	A		A115
S	738	2 S	82			94	72	74	A		A32
S	736	4 S	86	89		98			F		625
S	736	4 S	86	90		99			I		549
S	736	4 S	91			101			C		11
S	736	4 S	96			105			C		62
S	736	4 S	79			93	65	70	A		A17
S	736	4 S	78			92	67	73	A		A39
S	736	4 S	77			94	68	71	A		A49
S	736	4 S	81			93	69	73	A		A133
S	736	4 S	79			94	66	71	A		A128
S	654	4 S	85			100	72	80	A		A171
S	654	4 S	85			100	74	79	A		A177
S	653	4 S	87			95			C		6
S	653	4 S	87			99	74	77	A		A165
S	653	4 S	92			97	73	74	A		A68
S	653	4 S	85				73	75	A		A26
S	653	4 S	84	87		93			G		501
S	649	4 S	86			95	71	72	A		A172
S	749	4 S	86			97	70	78	A		A104
S	649	4 S	84			100	67	72	A		A11
S	599	4 S	81			87			C		74
S	544	2 S	81			89	67	71	A		A33
S	544	4 S	80			93	64	71	A		A30
S	544	4 S	80			91	69	73	A		A96
S	544	4 S	81			92	67	75	A		A105
S	544	4 S	80			93	69	74	A		A157
S	544	4 S	82	81		89			I		543

* Category Code: S = Street, X = Off-Road, SX = Combination Street/Off-Road

cont'd.

TABLE C-6 (CONT'D.)

USE CATEGORY *	DISPL. CC	ENG. TYPE	NOISE LEVEL - dB J331a	F76	F77	F50	35 MPH	55 MPH	TEST SITE	MFG'R	BIKE NO.
S	544	4 S	83	85		90			G		509
S	544	2 S	81			89	67	71	A		A33
S	543	2 S	92			98			C		37
S	543	2 S	87	88		101			F		591
S	498	2 S	87			96	74	79	A		A82
S	498	4 S	78			89	68	72	A		A44
S	498	4 S	78	79		86			F		599
S	498	4 S	84			92	71	77	A		A73
S	498	4 S	83			96	71	76	A		A101
S	498	4 S	80			93	67	73	A		A132
S	498	4 S	80			94	65	70	A		A146
S	498	4 S	79			90			A		A144
S	498	4 S	79			91	67	71	A		A141
S	498	4 S	80			93	66	70	A		A140
S	498	4 S	84	84		90			I		554
S	498	4 S	82	82		89			J		556
S	498	4 S	80	81		89			G		513
S	498	4 S	83	85		96			F		580
S	498	4 S	78	80		91			F		582
S	498	4 S	80	82		90			F		595
S	498	2 S	88			96	72	76	A		A31
S	498	2 S	86			100	71	81	A		A108
S	498	2 S	84			94	76	78	A		A191
S	498	2 S	90			98	76	87	A		A195
S	498	2 S	84			93	72	77	A		A196
S	492	2 S	78			96	74	74	A		A34
S	492	2 S	88			95			C		49
S	489	2 S	83			98	70	73	A		A19
S	444	4 S	86			98	74	76	A		A190
S	444	4 S	83	82		90			G		517
S	444	4 S	91	89		90			H		521
S	444	4 S	85	88		100			F		618
S	444	4 S	84	83		88			H		528
S	444	4 S	83	84		92			F		621
SX	444	4 S	84			92	71	76	A		A158
S	444	4 S	80			89	67	71	A		A122
S	444	4 S	81			90	69	73	A		A94
S	444	4 S	81			89	69	73	A		A61
S	408	4 S	74	75		85			F		626
S	408	4 S	76	76		85			F		601
S	398	2 S	84	86		92			G		519

* Category Code: S = Street, X = Off-Road, SX = Combination Street/Off-Road

TABLE C-6 (CONT'D.)

USE CATEGORY*	DISPL. CC	ENG. TYPE	NOISE LEVEL - dB J331a	F76	F77	F50	35 MPH	55 MPH	TEST SITE	MFG'R	BIKE NO.
S	398	4 S	86	84		90			G		507
S	398	4 S	87			90			C		73
S	398	4 S	87			88	71	78	A		A51
S	398	4 S	87			89	70	75	A		A53
S	398	4 S	82			92	70	76	A		A154
S	397	2 S	83			98	76	79	A		A14
S	371	2 S	90			89	71	73	A		A148
S	371	2 S	87			87	66	71	A		A92
S	371	2 S	80			89	67	72	A		A58
S	371	2 S	82			92	68	71	A		A63
S	356	4 S	92	92		101			H		526
S	356	4 S	82	81		88			I		537
S	356	4 S	82	83		89			I		553
S	356	4 S	83	83		89			J		560
S	356	4 S	80	80		90			F		603
SX	356	4 S	79	81		91			F		614
S	356	4 S	80	80		89			F		627
S	356	4 S	76			88	71	71	A		A67
S	356	4 S	80			92	67	72	A		A152
S	356	4 S	81			91	67	70	A		A187
S	356	4 S	79			89	69	70	A		A184
S	351	2 S	84			97	80	87	A		A27
S	347	2 S	87	85					D		212
S	347	4 S	77	78		91			F		623
S	347	4 S	79			91			C		75
S	347	4 S	76			87	65	70	A		A168
S	347	2 S	82	80		92			G		503
S	347	2 S	85			87	73	76	A		A22
S	347	2 S	85			94	74	74	A		A48
S	347	2 S	86			86	72	75	A		A71
S	347	2 S	84			88	74	76	A		A62
S	347	2 S	83			95	75	78	A		A127
S	347	2 S	88			98	73	79	A		A179
S	346	2 S	87			94	78	81	A		A169
S	346	2 S	82			87	73	76	A		A110
S	346	2 S	83			88	73	77	A		A52
S	326	4 S	85			96	72	78	A		A129
S	325	4 S	82	83		89			H		525
S	325	4 S	85	85		94			I		539
S	325	4 S	86	87		92			K		576
S	325	4 S	81	82		91			F		624
S	325	4 S	76			91	68	72	A		A16

* Category Code: S = Street, X = Off-Road, SX = Combination Street/Off-Road

TABLE C-6 (CONT'D.)

USE CATEGORY *	DISPL. CC	ENG. TYPE	NOISE LEVEL - dB						TEST SITE	MFG'R	BIKE NO.
			J331a	F76	F77	F50	35 MPH	55 MPH			
S	325	4 S	80			93	68	72	A		A23
S	325	4 S	83			94	71	75	A		A95
S	325	4 S	80			92	69	73	A		A93
S	325	4 S	80			92	69	73	A		A93
S	325	4 S	87			96	74	79	A		A89
S	325	4 S	79			91	68	75	A		A109
S	325	4 S	85			94	71	75	A		A159
S	325	4 S	77			89	67	70	A		A147
S	325	4 S	82			93	67	72	A		A145
S	325	4 S	81			92	69	74	A		A139
S	325	4 S	81			95	72	75	A		A166
S	305	4 S	86			100	76	78	A		A161
S	249	2 S	82			92	70	76	A		A4
S	247	2 S	84	78		91			G		504
S	247	2 S	84			92			C		28
S	247	2 S	81			94	75	77	A		A46
S	247	2 S	81			90	76	76	A		A160
S	247	2 S	82			86	72	75	A		A25
S	247	2 S	83			90	75	78	A		A54
S	246	2 S	84			88	70	75	A		A40
S	198	4 S	80			90	71	76	A		A21
S	198	4 S	78	79		88			F		600
S	198	4 S	77	78		84			J		562
S	198	4 S	76	76		85			G		511
S	198	4 S	80			92	70	75	A		A136
S	195	2 S	80			89	71	73	A		A28
S	195	2 S	79	80		87			G		505
S	192	4 S	70						C		57
S	190	4 S	82	84		84			J		569
S	184	2 S	83			89	70	76	A		A114
S	184	2 S	77			86	68	73	A		A38
S	180	2 S	81			92	74	77	A		A194
S	174	4 S	76			86	67	73	A		A143
S	174	4 S	76			87	66	73	A		A130
S	174	4 S	76			86	68	72	A		A134
S	174	4 S	83			86	72	78	A		A112
S	174	4 S	83			86	71	79	A		A87
S	174	2 S	95			98			C		24
S	174	2 S	82			87	80	80	A		A120
S	174	2 S	83			91	80	83	A		A121
S	174	2 S	85			88	79		A		A137
S	174	2 S	86			97	76	81	A		A113
S	174	2 S	85			89	74	78	A		A80
S	174	2 S	83			89	79	82	A		A66

* Category Code: S = Street, X = Off-Road, SX = Combination Street/Off-Road

cont'd.

TABLE C-6 (CONT'D.)

USE CATEGORY*	DISPL. CC	ENG. TYPE	NOISE LEVEL - dB J331a	F76	F77	F50	35 MPH	55 MPH	TEST SITE	MFG'R	BIKE NO.
S	174	2 S	84			89	75	78	A		A18
S	171	2 S	80			88	77	79	A		A47
S	124	2 S	77	76		83			G		506
S	124	2 S	80			89	74	78	A		A8
S	123	2 S	81			85	77	76	A		A13
S	122	4 S	76			89	70	77	A		A142
S	122	4 S	81			87	72	79	A		A180
S	122	4 S	83	78		90			J		570
S	122	4 S	80	78		88			I		545
S	122	4 S	81	77		88			I		544
S	122	4 S	79	77		88			H		529
S	122	4 S	84						H		522
S	99	4 S	82			95			A		A84
S	99	4 S	82			91	71	81	A		A150
S	99	4 S	79			94	76	79	A		A185
S	99	4 S	83			89	76	81	A		A183
S	99	2 S	80			88			A		A15
S	99	2 S	77				71	78	A		A6
S	97	2 S				74	74	87	J		558
S	90	4 S	76			84	74	79	A		A10
S	89	2 S	78				73	75	A		A7
S	73	2 S	82	81		95			G		512
S	73	2 S	71	68		82			F		585
S	72	4 S	73			93	69		A		A135
S	49	2 S			67				D		157
SX	396	2 S	84	83		100			I		550
SX	396	2 S	80			93	71	74	A		A42
SX	396	2 S	80			95	72	75	A		A35
SX	359	2 S	99	95		105			I		542
SX	351	2 S	85			100	79	81	A		A178
SX	351	2 S	82			93	76	80	A		A36
SX	351	2 S	83	83		96			F		592
SX	348	4 S	81			91	73	75	A		A155
SX	348	4 S	79			90	73	74	A		A123
SX	348	4 S	82	80		89			F		608
SX	325	4 S	92	90		92			I		538
SX	325	4 S	85	84		91			F		616
SX	325	4 S	82			94	72	75	A		A70
SX	248	4 S	80			88	74	76	A		A193
SX	248	4 S	79			80	71	78	A		A5
SX	248	4 S	81			89	69	74	A		A60
SX	248	4 S	80			88	73	75	A		A88

* Category Code: S = Street, X = Off-Road, SX = Combination Street/Off-Road

TABLE C-6 (CONT'D.)

USE CATEGORY *	DISPL. CC	ENG. TYPE	NOISE LEVEL - dB						TEST SITE	MFG'R	BIKE NO.
			J331a	F76	F77	F50	35 MPH	55 MPH			
SX	248	4 S	80			89	71	75	A		A102
SX	248	4 S	81			90	73	76	A		A156
SX	248	4 S	90	84		92			G		520
SX	248	2 S	82	82		90			G		518
SX	248	2 S	85	85		92			I		540
SX	247	2 S	90						C		64
SX	246	2 S	83			95	70	75	A		A151
SX	246	2 S	82	82		97			F		581
SX	246	2 S	86			99			A		A126
SX	246	2 S	79			90	74	74	A		A57
SX	246	2 S	79			88	70	76	A		A37
SX	245	2 S	85	83		94			J		568
SX	242	2 S	87	82		96		81	D		197
SX	242	2 S	91	90		95		83	D		191
SX	183	2 S	92			118			C		48
SX	183	2 S	80			93	73	76	A		A41
SX	183	2 S	84			94	71	79	A		A55
SX	183	2 S	83			94	74	81	A		A64
SX	183	2 S	86			95	77	83	A		A72
SX	183	2 S	84						A		A149
SX	183	2 S	85			92	75	80	A		A173
SX	174	4 S	82			95			A		A83
SX	174	4 S	86			91	74	80	A		A79
SX	173	4 S	83			89	75	79	A		A117
SX	171	2 S	86			91	81	84	A		A125
SX	171	2 S	84	81		91			F		577
SX	123	2 S	83			91	79	87	A		A45
SX	123	2 S	81			86	70	78	A		A56
SX	123	2 S	84			91	80	84	A		A167
SX	123	2 S	88			90	88	87	A		A175
SX	123	2 S	87			97	78	90	A		A189
SX	123	2 S	82			92	78	82	A		A197
SX	123	2 S	88			96	81	87	A		A198
SX	123	2 S	83	80		95			F		579
SX	122	4 S	86	83		88			H		530
SX	122	4 S	100			98			C		15
SX	122	4 S	79			88	73	79	A		A188
SX	99	4 S	79			88	72	79	A		A85
SX	99	4 S	81			87	77	79	A		A116

* Category Code: S = Street, X = Off-Road, SX = Combination Street/Off-Road

cont'd.

TABLE C-6 (CONT'D)

USE CATEGORY *	DISPL. CC	ENG. TYPE	NOISE LEVEL - dB J331a	F76	F77	F50	35 MPH	55 MPH	TEST SITE	MFG'R	BIKE NO.
SX	99	4 S	83			88	74	80	A		A181
SX	98	2 S	82	81	81	98			D		155
SX	97	2 S	81	81		85			F		584
SX	97	2 S	82	82		102			F		586
SX	97	2 S	79			91	74	80	A		A199
SX	97	2 S	78			92	76	82	A		A176
SX	97	2 S	81			92	74	77	A		A194
SX	97	2 S	75			80	73	75	A		A65
SX	97	2 S	76			92	74		A		A29
SX	97	2 S	79			92	79	82	A		A200
SX	90	4 S	71			87	61	70	A		A90
SX	88	2 S	71			79			I		547
SX	72	4 S	74			82	74		A		A170
SX	72	4 S	77						C		18
X	246	2 S	92	91		92			D		143
C	246	2 S	91	91		101			D		146
X	246	2 S	94	92		96	85	88	D		201
SX	183	2 S	85			91			C		41
SX	173	4 S	85	85		95			I		548
X	123	2 S	80			90			C		25
X	123	2 S	88	87		97			F		583
X	72	4 S	80	78	82	84			H		523
X	49	4 S			76				H		536
X	49	4 S			75				H		535
X	49	4 S			76				H		534
X	49	4 S			75				H		533

* CATEGORY CODE: S= STREET, X= OFF-ROAD, SX= COMBINATION STREET/OFF-ROAD, C= COMPETITION ONLY (Labeled)

TABLE C-7 NOISE LEVELS, 1969 - 1976 MODEL YEAR IN-SERVICE MODIFIED MOTORCYCLES

USE CATEGORY*	DISPL. CC	ENG. TYPE	NOISE LEVEL - dB J331a	F76	F77	F50	35 MPH	55 MPH	TEST SITE	MFG'R	BIKE NO.
S	1207	4 S	92	96		99			D	F	185
S	1207	4 S	95						C	F	19
S	1207	4 S	89						C	F	66
S	1207	4 S	94						C	F	46
S	1207	4 S	91						C	F	32
S	1207	4 S	98						C	F	29
S	1207	4 S	87						C	F	21
S	1000	4 S	94						C	F	61
S	999	4 S	92						C	V	34
S	995	4 S	91	93		101			D	F	186
S	903	4 S	102						C	Q	72
S	903	4 S	91						C	O	50
S	745	4 S	84						C	P	17
S	739	4 S	100						C	V	39
S	738	4 S	98						C	V	43
S	736	4 S	90	92		104			F	V	617
S	736	4 S	91	93		103			F	V	596
S	736	4 S	97	99		101			K	V	574
S	736	4 S	91	96		97			H	V	531
S	736	4 S	89						C	V	67
S	736	4 S	86						C	V	56
S	736	4 S	92						C	V	38
S	544	4 S	86						C	V	9
S	498	4 S	78	79		86			F	V	599
S	498	4 S	83	85		96			F	V	597
S	498	4 S	97						C	O	69
S	490	4 S	97						C	AD	54
S	444	4 S	82	85		97			F	V	620
S	444	4 S	100	101		112			F	V	619
S	388	2 S	97						C	O	53
S	350	4 S	97						C	V	5
S	348	4 S	100	98		106			J	AC	564
S	348	2 S	98	96		102			F	V	622
S	347	2 S	87	85		97			F	AC	588
S	347	2 S	88						C	AC	65
S	325	4 S	99						C	V	70
S	325	4 S	89						C	V	13
S	325	2 S	93	94		103			F	V	615
SX	122	4 S	95						C	V	14
X	750	4 S	101						C	V	1
X	174	2 S	100						C	C	47
X	123	2 S	102	98		103			K	V	572
X	72	4 S	83	77	79	93			H	V	524

* Category Code: S = Street, X = Off-Road, SX = Combination Street/Off-Road

TABLE C-8 MOTORCYCLES USED IN AFTERMARKET PRODUCTS STUDY

BIKE NO.	MAKE/MODEL		MFG. DATE
174	Yamaha	XS 650C	10/75
203	Harley-Davidson	XLH-1000	7/75
204	Honda	GL 1000	7/75
205	Honda	CB 550	9/75
206	Kawasaki	KZ 900	6/75
207	Suzuki	TS 185	12/75
208	Honda	CB 360T	6/75
210	Honda	GL 1000	8/75
212	Yamaka	RD 350	5/74
213	Kawasaki	KZ 400	11/75
214	Kawasaki	KZ 900	7/75
215	Honda	CB 750	9/75
216	Honda	CB 500	5/74
217	Suzuki	GT 750	8/74
218	Yamaha	DT 175C	6/75
219	Honda	CB 750	11/75

TABLE C-9 AFTERMARKET EXHAUST SYSTEMS

Alphabets

Model	Manufacturer Part No.
Yamaha XS-650C	10-1401 2:1
H-D XLCH	10-1056
Honda GL-1000	10-1281
Honda GL-1000	10-1280 4:2
Honda CB 550	10-1252 4:1
Honda CB 550	10-1254 4:2
Kaw KZ-900	10-1501 4:1
'aw KZ-900	10-1502 4:2
.aw KZ-900	10-1503 4:2
Honda CB 360 T	10-1230 2:1
Kaw KZ 400	10-1510 2:1
Honda CB 750	10-1274 4:2
Honda CB 750	CB 750

Jardine

Model	Manufacturer Part No.
H-D XLCH	6100 2:1
Honda CB-550	1500
Honda CB-550	9500 4:1
Honda GL-1000	10200
Honda GL-1000	1000
Kaw KZ-400	5400 2:1
Kaw KZ-900	5900 4:1
Kaw KZ-900	1900 KZ 900
Honda CB 750	CB 750

Hooker

Model	Manufacturer Part No.
H-D XLCH	27183
Honda CB 500	27181 4:1
Honda GL 1000	27322
Honda CB 750	27324 4:4
Honda CB 750	27324 4:4 *
Honda CB 750	CB 750 4:1

* Baffle removed

Table C-9 (Continued)

Bassani

Model	Manufacturer Part No.
Honda CB 550	Honda CB 550 4:2
Kaw KZ-900	KZ 900 4:2 Perf. core
Kaw KZ-900	KZ 900 4:2 Punched core
Suzuki TS-185	Suzuki TS-185
Yamaha RD 350	RD 350
Kaw Kz 400	KZ 400 Sawcut Baffle
Kaw KZ 400	KZ 400 Glass Pak Baffle
Kaw KZ-400	KZ 400 Baffle Removed
Suzuki GT-750	GT-750 3:1
Suzuki GT-750	GT-750 3:1 Baffle Removed
Yamaha DT-175 C	Yamaha 175
Honda CB 750	CB 750-Large 4:1
Honda CB 750	CB 750-Small 4:1

J & R

Honda CB 550	H 7500 Street
Honda CB 550	H 7500 Competition
Honda CB 550	H 7500 Baffle Removed
Yamaha RD 350	RD 350
Kaw KZ 400	KZ 400 Street
Kaw KZ 400	KZ 400 Competition
Honda CB 750	CB 750 Street
Honda CB 750	CB 750 Competition
Suzuki GT 750	GT 750
Yamaha DT 175-C	DT 100-175
Honda CB 750	CB 750 Street
Honda CB 750	CB 750 Competition

TABLE C-9 (Continued)

MCM

Model	Manufacturer Part No.
Honda CB 550	HO 550 4:2 QTS
Honda CB 550	Honda CB 550 2:1
Honda CB 550	HO 550 4:2 QTCM
Kaw KZ 900	KZ 900
Honda CB 360 T	HO 360 2:1 QTS
Honda GL-1000	HO 1000 QTM
Kaw KZ 400	KA 40 RE
Kaw KZ 900	KAZI QTM 4:2
Kaw KZ 900	ZI-412 CM

S & S

Honda CB 550	H500 4:1
Honda CB 550	HS 500 4:2
Honda CB 550	H 500 F 4:2
Honda CB 550	H 500 TO
Kaw KZ 900	KZ 900 header 4:2
Kaw KZ 900	KZ 900 4:1
Kaw KZ 400	KZ 400 2:1

KERKER

Honda CB-550 4:1	
Honda CB-550 Baffle Removed	
Kawasaki KZ-900 4:1	
Kawasaki KZ-900 Baffle Removed	
Honda CB-750 Small Core	

TABLE C-9 (Continued)

Winning

Model	Manufacturer Part No.
Honda CB 750	CB 750

Torque Engineering

Model	Manufacturer Part No.
Honda CB 550	5230 4:2
Honda CB 550	5230 4:2 Insert Removed
Honda CB 550	5230 4:2 Glass Removed with inserts in
Honda CB 360 T	5216 2:1
Honda CB 360 T	5216 2:1 Baffle Removed
Kaw KZ 400	5303
Honda CB 750	5240 4:2
Honda CB 750	5240 4:2 Baffle Removed
Honda CB 500	Silver Smith 4:1 Special Baffle
Honda CB 500	Silver Smith 4:1 Stock Core
Honda CB 500	Silver Smith 4:1 Baffle Removed
Honda CB 750	CB 750 4:1

Yoshimura

Model	Manufacturer Part No.
Honda CB 550	92100
Honda CB 550	92100 Insert Removed

TABLE C-9 (Continued)

Santee

Model	Manufacturer Part No.
Yamaha XS-650 C	CYM-650 A
H-D XLCH	108-22 A
Honda CB-360 T	360-21 E 2:1
Honda CB-360 T	360-21 E 2:1 muffler removed

Dick's Cycle West

Kawasaki KZ-400	KZ-400 2:1
Kawasaki KZ-900	KZ-900
Honda CB 750	CB-750
Yamaha RD 350	350 Racer 1

RJS

Honda CB-750	CB-750 with Quiet Tone
Honda CB-750	CB 750 without Core Insert

Trebaca

Honda CB-750	CB-750 2:1

RC Engineering

Honda CB-750	CB-750 Small Cone

TABLE C-10

COMPARISON OF NOISE LEVELS FROM

OEM AND AFTERMARKET EXHAUST SYSTEMS

		J331a	F-76	F-50
Yamaha XS-650C	(OEM)	82	86	89
exhaust system	a	95	98	100
exhaust system	b	90	95	89
Harley-Davidson XLH-1000	(OEM)	87	88	99
exhaust system	a	90	91	98
	b	90	92	98
	c	93	96	102
	d	102	101	107
Honda GL-1000	(OEM)	76	81	87
	a	74	82	89
	b	75	83	89
Honda GL-1000	(OEM)	76	83	88
	a	77	84	96
	b	81	85	97
	c	78	85	94
	d	74	82	95

TABLE C-10 (CONT'D.)

		J331a	F-76	F-50
Honda CB-550	(OEM)	83	84	90
	a	85	86	94
	b	82	84	93
	c	83	82	86
	d	90	90	97
	e	84	84	92
	f	83	83	92
	g	95	98	108
	h	82	83	92
	i	99	90	99
	j	88	91	99
	k	83	95	90
	l	84	86	92
	m	85	89	98
	n	83	86	96
	o	86	87	96
	p	92	95	100
	q	92	93	104
	r	84	85	90
	s	85	86	92
	t	92	94	99

TABLE C-10 (CONT'D.)

		J331a	F-76	F-50
Kawasaki KZ-900	(OEM)	80	87	96
	a	86	91	99
	b	90	96	107
	c	79	86	94
	d	84	90	96
	e	78	86	98
	f	79	87	97
	g	80	86	95
	h	87	91	101
	i	90	97	103
	j	87	91	102
	k	82	87	97
Kawasaki KZ-900	(OEM)	82	86	95
	a	82	86	98
	b	83	87	95
	c	90	97	107
Yamaha DT-175C	(OEM)	83	81	92
	a	89	86	101
	b	88	86	100

TABLE C-10 (CONT'D.)

		J331a	F-76	F-50
Kawasaki KZ-400	(OEM)	79	79	91
	a	86	86	97
	b	83	83	89
	c	102	97	105
	d	84	82	95
	e	89	88	91
	f	83	84	91
	g	91	91	97
	h	89	88	95
	i	87	87	95
	j	94	95	101
Yamaha RD-350	(OEM)	87	85	
	a	101	97	
	b	89	86	
	c	88	85	
Suzuki TS-185	(OEM)	81	81	91
	a	87	86	100
Honda CB-360T	(OEM)	78	81	85
	a	94	94	99
	b	81	83	91
	c	85	86	96
	d	88	86	101

TABLE C-10 (CONT'D.)

		J331a	F-76	F-50
Honda CB-750	(OEM)	81	83	93
	a	79	84	89
	b	86	87	97
Honda CB-750	(OEM)	81	83	91
	a	85	87	96
	b	88	94	100
	c	89	90	99
	d	82	82	94
	e	84	86	96
	f	83	81	98
	g	82		92
	h	82	84	93
	i	89	95	102
	j	87	89	99
	k	90	91	101
	l	87	94	98
	m	81	83	96
	n	82	87	92
	o	90	98	100
	p	84	87	94
	q	91	95	104
Suzuki GT-750	(OEM)	83	84	94
	a	84	85	93
	b	87	89	98

TABLE C-10 (CONT'D.)

Inserts and Baffles Removed

	dB over insert or baffle in place		
	J331a	F-76	F-50
a	21	21	15
b	16	15	13
c	17	17	13
d	13	11	17
e	13	10	13
f	11	11	14
g	18	16	14
h	19	17	14
i	13	15	15
j	6	4	3
k	16	17	
l	5	5	8
m	18	22	17

Muffler Removed

	dB over muffler in place		
	J331a	F-76	F-50
Yamaha XS-650C	22	18	23
Harley-Davidson XLCH	19	16	11
Honda CB-550	16	15	20
Honda GL-1000	20	17	24
Kawasaki KZ-900	19		
Honda CB-750	20	20	19

TABLE C-11

CLOSING CONDITIONS IN J331a TESTS

BIKE No.	DISPL.	J331a CLOSING CONDITIONS % RPM	Ft. Past Mic .	MPH
101	356		100	
102	72	100	45	18
103	123	100	64	27
104	999		100	
105	736		100	
106	544	71	100	45
107	198	93	100	38
108	124	94	100	32
109	248	100	25	
110	124	100	45	30
111	171	100	100	35
112	99	100	30	25
113	248	100	100	35
114	99	100	30	25
115	99	100	78	31
117	99	100	100	27
118	174	100	27	29
119	400	100	100	41
120	746	93	100	
122	73	100	25	
123	249	100	100	38
124	246	100	72	
125	396	100	100	44
126	184	100	56	30
128	492	88	100	46
130	98	100	25	26
131	371	93	100	45
132	543	100	100	44
134	246	100	30	23
135	171	100	25	20
137	244	100	25	
138	326	100	25	
139	898	100	95	48
140	828	80	100	49
142	744	74	100	50
143	246	100	50	40
144	344	94	100	48
145	981	88	100	52
146	246	100	100	
147	844	69	100	52
151	949	77	100	45
152	336	92	100	35
153	248	100	30	
154	123	100	100	32
155	98	100	75	
156	72	100	35	
158	898	83	100	60

TABLE C-11 (CONT'D.)
CLOSING CONDITIONS IN J331a TESTS

		J331a CLOSING CONDITIONS		
BIKE NO.	DISPL.	% RPM	Ft. PAST Mic.	MPH
156	72	100	35	
158	898	83	100	50
159	750	70	100	45
160	736	69	100	
162	124	100	25	25
163	903	68	40	52
			100	
164	79	100	25	
165	195	93	100	36
166	72	100	35	19
167	97	100	75	30
169	89	100	55	22
171	72	100	50	20
172	72	100	55	
173	397	100	25	24
174	653	64	100	46
175	748	76	100	57
176	738	83	100	53
179	903	67	100	49
180	497	88	100	48
181	183	100	25	28
182	72	100	40	
183	354	100	50	
185	1200	77	100	45
186	995	80	100	50
187	1200	90	100	45
188	174	100	35	45
189	174	100	50	32
190	242	100	25	35
191	242	100	25	37
192	123	100	60	35
193	123	100	40	32
194	1200	77	100	42
.195	995	75	100	48
196	995	75	100	48
197	242	100	25	32
198	246	100	35	32
200	310	100	65	32
201	246	100	40	32
203	995	85	100	47
204A	999	67	100	50
205A	544	82	100	48
207A	183	100	100	40
208A	356	92	100	45
209A	246	100		33
210A	999	67	100	48
211	248	100	90	
212	347	100	100	40
213	398	96	100	42
214	903	71	100	48
215	736	69	100	50
218	171	100	25	22
219	736	75	100	50

TABLE C-12 MEASURED NOISE LEVELS RELATED TO CLOSING RPM

The sound level data presented in this table were obtained using the F76, J47, R60 or variations of these procedures. Commonality is closing rpm being obtained at full throttle at a point 25 feet past the microphone target point. Motorcycles are 1975 or 1976 year of manufacture except as noted.

BIKE NO.	USE**	MAKE/MODEL	dB @ % rpm 75%	100%	NOTED	REMARKS
101	S	Honda CJ 360T	79.5	83.3		
103	SX	Honda MT 125	80.1	82.4		
104	S	Honda GL 1000	83.5	87.4*		
105	S	Honda CB 750	85.0	89.1*		
106	S	Honda CB 550F	82.8	85.2		
107	S	Honda CB 200T	78.1	82.4		
108	S	Honda CB 125S	81.1	83.7		
109	X	Honda TL 250	78.0	83.9		
110	SX	Honda XL 125	79.6	85.1*		
111	X	Honda MR 175	82.2	88.8		
112	SX	Honda XL 100	78.6	84.4*		
113	SX	Honda XL 250	78.6	82.7		
114	SX	Kawasaki KM100A	77.0	78.0*		
115	S	Kawasaki KH 100	81.8	84.3		
117	SX	Kawasaki KV 100	81.2	83.8		
118	SX	Kawasaki KE 175	79.3	82.6*	80.9 @ 86%	
119	S	Kawasaki KH 400	84.6	87.5	85.6 @ 91%	
120	S	Kawasaki KZ 750	83.0	88.5*		
121	S	Kawasaki Z1F 900	89.4	91.8	91.4 @ 84%	'74 yr. of mfg.
123	SX	Kawasaki KH 250	81.6	88.3		
124	X	Kawasaki KT 250	87.8	92.9*		
125	SX	Suzuki TS 400A	80.6	84.4		
126	S	Suzuki GT 185	76.7	79.8		
128	S	Suzuki GT 500A	83.9	85.7		
130	SX	Suzuki TS 100	74.8	75.6		
131	S	Suzuki GT 380	83.5	85.3		
132	S	Suzuki GT 550	82.9	85.2		
134	SX	Yamaha DT 250C	80.2	81.5		
135	SX	Yamaha DT 175C	80.5	82.4		
163	S	Kawasaki KZ 900 LTD	88.7		81.8 @ 46%	
174	S	Yamaha XS 650C	86.2		81.4 @ 49%	
176	S	Suzuki GT 750	84.0	88.0	82.1 @ 50%	
180	S	Suzuki RES (500)	83.1		81.0 @ 58%	
185	S	Harley FXE 1200	95.6		89.4 @ 58%	modified ex.
186	S	Harley XLH 1000	93.1		86.5 @ 53%	modified ex.
188	SX	Harley SX 175	79.6		81.7 @ 88%	

* Lower gear used
** Category Code: S = Street, X = Off-Road, SX = cmbination Street/Off-Road

TABLE C-12 (contined)

BIKE No.	USE*	MAKE/MODEL	dB @ 5 rpm 75%	100%	NOTED	REMARKS
189	S	Harley SS 175	81.3		81.1 @ 89%	
190	S	Harley SS 250	79.1		80.8 @ 76%	
191	SX	Harley SX 250	89.9	90.9		'74 yr. of mfg.
192	S	Harley SS 125	78.3		79.6 @ 86%	
193	SX	Harley SX 125	77.4		82.7 @ 99%	
194	S	Harley FXE 1200	85.8		80.4 @ 58%	
196	S	Harley XLH 1000	87.7		83.0 @ 50%	

* Category Code: S= Street, X - Off-Road, SX = Combination Street/Off-Road

TABLE C-13 CALCULATED F-76a NOISE LEVELS

The F-76a noise level presented in this table have been obtained by linear 'nterpolation of the measured levels presented in Table C-12.

100-125c.c.

Bike No.	J331a dBA	F76 dBA	F76a dBA
103	83.4	80.1	81.3
108	80.6	81.1	82.5
110	82.5	79.6	82.6
112	84.1	78.6	82.1
114	78.0	77.0	77.6
115	81.8	77.0	83.3
117	80.5	86.2	82.7
130	75.6	74.8	75.3
192	79.6	78.3	79.9
193	82.8	77.4	80.4
x=	80.9	78.5	80.8
σ=	2.62	2.03	2.57
N= 10			

175-250c.c

Bike No.	J331a dBA	F76 dBA	F76a dBA
107	76.8	78.1	79.8
113	79.2	78.6	79.8
118	82.6	79.3	80.5
123	82.2	81.6	83.6
126	78.7	76.7	78.0
134	81.5	80.2	80.6
135	82.4	80.5	81.2
188	83.5	79.6	82.5
x=	80.9	79.3	80.8
σ=	2.34	1.53	1.73
N= 8			

300-500c.c

Bike No.	J331a dBA	F76 dBA	F76a dBA
101	76.2	79.5	79.8
119	83.9	84.6	84.6
125	80.7	80.6	80.6
128	82.4	83.9	83.5
131	83.5	83.5	83.5
180	82.4	83.1	82.5
x=	81.5	82.5	82.5
σ=	2.83	2.02	1.77
N= 6			

550-750c.c.

Bike No.	J331a dBA	F76 dBA	F76a dBA
105	81.5	85.0	82.5
106	81.5	82.8	82.1
120	81.2	83.0	79.7
132	82.5	82.9	82.2
174	82.1	86.2	83.9
176	82.8	84.0	82.9
x=	81.9	84.0	82.3
σ=	0.63	1.38	1.38
N= 6			

900-1200c.c.

Bike No.	J331a dBA	F76 dBA	F76a dBA
104	75.5	83.5	81.2
121	81.4	89.4	85.1
196	83.9	87.7	83.0
194	81.5	85.8	81.0
x=	80.6	86.6	82.6
σ=	3.58	2.54	1.91
N=			

The above tabulation includes only unmodified 1975 - 1976 year of manufacture street and combination street/off-road motorcycles

TABLE C-14 VARIABILITY IN NOISE LEVEL DATA

A. DIFFERENT VEHICLES OF SAME MODEL TESTED AT DIFFERENT SITES:

BIKE NO.	TEST SITE	NORMALIZED* NOISE LEVEL - dB J331a	F76	F50	F77
22	C	2		0	
106	B	4	4	0	
606	F	0	0	0	
59	C	1		3	
508	G	0	0	0	
605	F	0	1	2	
26	C	1		1	
104	B	0	5	1	
204A	D	0	2	0	
552	I	0	4	1	
561	J	1	6	1	
598	F	0	0	1	
555	J		5	0	
593	F	0	3	1	
637	E	1	0	0	
218	D	1	1	0	
516	G	0	0	0	
553	I	2	3	0	
627	F	0	0	0	
560	J	3	3	0	
603	F	0	0	1	
101	B	0	1	0	
602	F	0	0	0	
8	C	2		4	
205A	D	1	2	1	
551	I	3	1	2	
559	J	1	3	0	
571	K	0	0	2	
607	F	0	1	3	
105	B	3	3	3	
219	D	2	1	0	
604	F	0	0	4	

* For each vehicle model in each test method, measured noise level normalized to lowest value.

TABLE C-14 (Continued)

BIKE No.	TEST SITE	J331a	F76	F50	F77
(112	B	0		2	
(612	F	1		0	
(529	H	0	0	0	
(544	I	2	0	0	
(522	H	4			
(545	I	0	0	0	
(570	J	3	0	2	
(110	B	5	4	4	
(563	J	0	0	4	
(611	F	3	5	0	
(113	B	0	1	0	
(609	F	0	0	0	
(58	C	0		0	
(139	D	1	0	2	
(557	J	2	2	3	
(153	D	0	0	0	
(632	E	1	0	5	
(575	K	0	1	1	
(628	F	1	0	0	
(102	B	2	0	0	
(613	F	0	3	8	
(108	B	1	1	0	
(610	F	0	0	4	
(174	D	0	0	0	
(565	J	1	1	3	
(36	C	0			
(166	D	1			
(134	D	1	3	9	
(514	G	0	0	0	
(173	D	1	2	2	
(567	J	0	0	0	
(502	G	2	3	0	
(590	F	0	0	3	

Continued

TABLE C-14 (Continued)

B. DIFFERENT VEHICLES OF SAME MODEL TESTED AT THE SAME SITE:

BIKE NO.	TEST SITE	J331a	F76	F50	F77
(533	H				0
(534	H				1
(535	H				0
(536	H				1
(601	F	2	1	0	
(626	F	0	0	0	
(215	D	0	1	2	
(219	D	0	0	0	
(179	D	0	0	1	
(214	D	2	0	0	
(23	C	0		5	
(27	C	0		0	
(58	C	0		5	
(2	C	6		0	
(26	C	1*		0	
(31	C	0**		1	
(45	C	4		0	
(7	C	0		0	
(59	C	0		2	
(3	C	1			
(4	C	0			
C. SAME VEHICLE TESTED AT DIFFERENT SITES:***					
(105	B	1	1	1	
(215	D	0	0	0	
D. SAME VEHICLE TESTED AT SAME SITE:***					
(135	D	0	0	0	
(218	D	1	1	0	
(127	D		0	0	
(176	D		0	2	
(181	D	1	0	1	
(207A	D	0	2	0	

* 250 lb. added accessories
** Equipped with Windjammer III fairing
*** "SAME" vehicles were received in different phases of the test program and given different identification numbers.

TABLE C-15. EFFECT OF 6 INCH TURF ON MEASURED NOISE LEVELS

a) Bike No. 214C traveling in center of 150' wide asphalt runway:

J331a	:	90.7 dBA
F76	:	97.8 dBA

b) Bike No. 214C traveling on edge of 150' wide asphalt runway; area beyound runway 6" turf:

J331a	:	92.7 dBA measured over ashalt
		85.3 dBA measured over turf
F76	:	98.3 dBA measured over asphalt
		91.1 dBA measured over turf.

<u>Note:</u> The above data were obtained at Test Site D (described in Appendix B) using one motorcycle only. The effect should not be assumed to be representative of all motorcycles. As discussed in section 3.2.1 of the report, theory suggests that the sound level measured over turf could be either higher or lower than the level measured over asphalt, the effect being dependent on the spectral content of the noise.

The data suggests, however, that surface texture may be important. For example, sealed asphalt might yield different results then unsealed asphalt having a porous texture.

APPENDIX D

STATE AND LOCAL NOISE REGULATIONS

APPENDIX D

STATE AND LOCAL NOISE REGULATIONS

EPA has established motorcycle noise emission standards that will preempt the standards for newly manufactured motorcycles and motorcycle exhaust systems adopted by several states, and to provide national uniformity of treatment for controlling motorcycle noise. However, State and local governments are not preempted by Federal regulations from establishing and enforcing controls on environmental noise through the licensing, regulation, or restriction of the use, operation, or movement of any product or combination of products. Prior to promulgation, EPA conducted a thorough review of current state and local motorcycle noise regulations to insure that the final Federal regulation will provide the necessary tools to state and local governments for effectively reducing motorcycle noise impact. This Appendix summarizes the results of that review.

STATE LAWS REGULATING MOTORCYCLE NOISE

Nineteen states, including the District of Columbia have laws regulating motorcycle noise. The laws as analyzed are primarily applicable to the regulation of noise from motorcycles operated on highways. However, regulations of off-road motorcycles are analyzed in the latter part of this Appendix.

Notes for Table of State Laws
(Beginning on page D-4)

1. California also specifies operational noise limits for speed zones of 35 mph or less. For motorcycles, 77 dB; for motor driven cycles, 74 dB.

2. Connecticut also specifies operational noise limits for soft test site measurements. For motorcycles, 78 dB at $\leq$ 35 mph; 82 dB at > 35 mph. A stationary sound level standard is also provided. For motorcycles manufactured after January 1, 1979: 78 dB (soft site); 80 dB (hard site).

3. The District of Columbia provides correctional factors for distances other than 50 feet and for soft and hard sites.

4. Although Hawaii has a noise pollution statute authorizing the Director of the Department of Health to "establish by rule or regulation limitations on vehicular noise, "only the island of Oahu has enacted specific vehicle noise control regulations.

5. Noise level limits vary with both posted speed and measurement distance from the vehicle. To calculate noise levels at posted speed limits there is a 2 dB difference per 5 mph. Oahu differentiates between vehicles first landed on the island before and after January 1, 1977.

6. Idaho's muffler statute prohibits the operation of a motor vehicle which produces unusual or excessive noise, defined as any sound which exceed 92 dB under any condition, when measured from a distance of 20 feet. Idaho Code Section 43-835 authorizes the Board of Health and Welfare to prescribe more stringent levels, however the Board has not exercised this authority.

7. Illinois provides rules and regulations governing noise reduction requirements for mufflers installed on racing vehicles.

8. Illinois also specifies that when speed limits are less than 35 mph and operation is on a grade exceeding 3 percent, the noise limit is 82 dB.

9. Michigan provides for a stationary run-up test for motorcycles of 95 dB at 75 inches.

10. Minnesota provides a chart for continuous measurement distances. The indicated value is for a distance of 50 feet, for motorcycles manufactured after January 1, 1975. A third standard is provided for motorcycles manufactured before January 1, 1975 of 86 dB at 50 feet.

11. New Jersey's only state vehicle noise emission regulations have been promulgated by the New Jersey Turnpike Authority and apply only to vehicle operations on the New Jersey Turnpike.

12. Oregon has a moving test at 50 feet or greater and indicated speed. Oregon also provides for a stationary test at 20 inches for in-use motorcycles. The current stationary standard is 102 dB for vehicles manufactured before 1976 and 99 db for motorcycles beginning in 1976.

CODE FOR STATE NOISE LAW EQUIPMENT STANDARDS

A. Motor vehicles are required to have an adequate muffler in good working order and in constant operation.

B. No muffler may have a cutout, bypass or similar device.

C. Equipment modifications are not allowed to increase noise emissions above those of the original equipment.

D. Manufacturers must certify that equipment sold or offered for sale meet established requirements.

E. No dealer may sell, offer for sale or install equipment that does not meet established requirements.

F. No person may sell or offer for sale equipment that would cause vehicles to emit excessive noise.

G. There are restrictions on the type of repairs allowed.

TABLE OF STATE LAWS 1/

State	CALIFORNIA			COLORADO		
Definitions	Motorcycle (MC) Any motor vehicle with seat or saddle for driver & $\leq$ 3 wheels & $\leq$ 1500 pounds.	Motor-Driven Cycle (MDC) Any motorcycle or motor scooter w/ < 15 gross brake horsepower, or bicycle with motor; excludes motorized bike < 2 horse power or maximum speed $\leq$ 30 mph.		Motorcycle (MC) Any motor vehicle $\leq$ 3 wheels, except tractors.	Motor-Driven Cycle (MDC) Any motorcycle or motor scooter with $\leq$ 6 brake horsepower; or bicycle w/ motor.	
Enforcement Authority	Dept. Transportation/Dept. Motor Vehicles/Calif. Highway Patrol			Dept. Revenue/Local Governments		
New Vehicle Sales Standards (dBA)	Motorcycle 83 80 75 70	Motor-Driven Cycle 80	Beginning 1975 1981 1986 1990	Motorcycle 86	Motor-Driven Cycle 84	Beginning 1973
Test Procedure	Based on SAE J 331a			Based on SAE procedures, measured at 50 feet.		
Operational Noise Limits (dBA)	(1) Motorcycle Motor-Driven Cycle	$\leq$ 45 82 76	mph > 45 86 82	 Motorcycle	$\leq$ 35 86	mph > 35 90
Measurement Distance	50 feet from center of lane of travel			50 feet from center of lane of travel		
Equip. Modif. Prohibited	A,B,C,D,E			A,B,C		
Equip. Replacement Standards	Yes					
Penalty for Violation	Yes			Yes		

1/ Data are unavailable if section of this table are blank; Noise levels are A-weighted; Footnotes precede this table.

TABLE OF STATE LAWS (cont'd.)1/

State	CONNECTICUT		DISTRICT OF COLUMBIA	
Definitions	Motorcycle (MC) Any motor vehicle w/ seat or saddle for driver or platform on which he stands & ≤ 3 wheels; includes bicycles w/ motor, except helper motors.		Motorcycle (MC) Any motor vehicle ≤ 3 wheels & seat or saddle for operator, excludes motorized bicycle.	Motorized Bicycle (MB) Motor vehicle w/ ≤ 3 wheels w/ tire ≥ 16 in. diameter & ≤ 120 pounds & automatic transmission & ≤ 1.5 horsepower & ≤ 50 cc, speed ≤ 25mph.
Enforcement Authority	Commissioner of Motor Vehicles/Environmental Protection Agency		Mayor	
New Vehicle Sales Standards (dBA)			MC / MB / Beginning 83 / / 1977 / 80 / 1978	
Test Procedure			Based on SAE J 331	
Operational Noise Limits (dBA)	(2) ≤ 35 mph / > 35 Motorcycle (Manufactured prior to 1-1-79) 82 / 86 After 1-1-79 80 / 84		(3) ≤ 35 mph / > 35 Motorcycle 82 / 86 Motorized Bicycle 76 / 82	
Measurement Distance	50 feet from centerline of travel, any grade, load, acceleration or deceleration		50 feet from centerline of travel, any grade, load, acceleration or deceleration	
Equip. Modif. Prohibited	A,B,C,E,G		C,D	
Equip. Replacement Standards	Yes			
Penalty for Violation	Yes		Yes	

1/ Data are unavailable if section of this table are blank; Noise levels are A-weighted; Footnotes precede this table.

TABLE OF STATE LAWS (cont'd.)[1/]

State	FLORIDA		HAWAII (4)	
Definitions	**Motorcycle (MC)** Any motor vehicle w/ seat or saddle for rider & ≤ 3 wheels; excludes tractors.	**Motor-Driven Cycle (MDC)** Any motorcycle or motor scooter w/ ≤ 5 brake horsepower, includes bicycle w/ motor.	**Motorcycle (MC)** Any motor vehicle w/ seat or saddle for rider & ≤ 3 wheels; excludes tractors.	**Motor-Driven Cycle (MDC)** Any motorcycle with ≤ 5 brake horsepower.
Enforcement Authority	Dept. Highway Safety & Motor Vehicles		Dept. of Health	
New Vehicle Sales Standards (dBA)	Motorcycle / Motor-Driven Cycle / Beginning 83 / 80 / 1975 80 / / 1981 78 / / 1983 75 / 75 / 1985			
Test Procedure	Based on SAE J 331a			
Operational Noise Limits (dBA)	≤ 35 mph / > 35 Motorcycle: 78 / 82 Motor-Driven Cycle: 72 / 79		(5) Landed: 20ft. / 25ft. / 50ft. Before 1-1-77: 81 / 79 / 73 After 1-1-77: 73 / 71 / 65	
Measurement Distance	50 feet from center lane, any grade, load, acceleration or deceleration		Measurements are allowed at 20, 25 or 50 feet.	
Equip. Modif. Prohibited	A,B,C,D,F		A,B,C,E	
Equip. Replacement Standards	Yes			
Penalty for Violation			Yes	

1/ Data are unavailable if section of this table are blank; Noise levels are A-weighted; Footnotes precede this table.

TABLE OF STATE LAWS (cont'd.)1/

State	IDAHO		ILLINOIS (7)	
Definitions	Motorcycle (MC)	Motor-Driven Cycle (MDC)	Motorcycle (MC)	Motor-Driven Cycle (MDC)
	Any motor vehicle with seat or saddle for rider & ≤ 3 wheels; excludes tractors.	Any motorcycle or motor scooter with ≤ 5 brake horsepower, includes bicycle w/ motor attached.	Any motor vehicle with seat or saddle for rider & ≤ 3 wheels; excludes tractors.	Every motorcycle, motor scooter or bicycle w/ motor attached w/ < 150 cc.
Enforcement Authority	Board of Health and Welfare		Pollution Control Board	
New Vehicle Sales Standards (dBA)				
Test Procedure				
Operational Noise Limits (dBA)	Any motor vehicle 92 (6)		Motorcycle & Motor-Driven Cycle: ≤ 35 mph 80; > 35 mph 86 (8)	
Measurement Distance	Not < 20 feet under any grade, speed or acceleration.		50 feet from center lane, any grade, load, acceleration or deceleration.	
Equip. Modif. Prohibited	A,B,C,E,F,G		A,B,C	
Equip. Replacement Standards	Yes			
Penalty for Violation				

1/ Data are unavailable if section of this table are blank; Noise levels are A-weighted; Footnotes precede this table.

TABLE OF STATE LAWS (cont'd.)[1/]

State	INDIANA		MARYLAND	
Definitions	Motorcycle (MC) Any motor vehicle w/ saddle for use of rider & ≤ 3 wheels, excludes farm tractors & motorized bicycles.	Motor-Driven Cycle (MDC) Every motorcycle w/ ≤ 1.5 horsepower, & ≤ 50 cc, with automatic transmission & maximum speed ≤ 25 mph.	Motorcycle (MC) Any motor vehicle w/ seat straddled by driver & ≤ 3 wheels & > 1.5 horsepower & > 74 cc; no enclosure other than wind-screen; singluar front steering.	Motor-Driven Cycle (MDC)
Enforcement Authority	Bureau of Motor Vehicles		Motor Vehicle Admin./Dept. Transportation/State Police	
New Vehicle Sales Standards (dBA)			Motorcycles: 83 / 78 / Reserved	Beginning: 1975 / 1982 / 1985
Test Procedure			SAE J 331a	
Operational Noise Limits (dBA)	≤ 35 mph / > 35 Motorcycle 82 / 86		Motorcycles ≤ 45 mph / > 45 1979 78 / 82 1990 75 / 79	
Measurement Distance	At least 50 feet from center lane under any grade, load, acceleration or deceleration.		50 feet under any speed, grade, load, acceleration or deceleration.	
Equip. Modit. Prohibited	A,B		A,B,C,D,F	
Equip. Replacement Standards			Yes	
Penalty for Violation			Yes	

1/ Data are unavailable if section of this table are blank; Noise levels are A-weighted; Footnotes precede this table.

TABLE OF STATE LAWS (cont'd.)[1/]

State	MICHIGAN		MINNESOTA	
Definitions	Motorcycle (MC) Every motor vehicle with saddle or seat for rider & $\leq$ 3 wheels; excludes tractors.	Moped Vehicle $\leq$ 3 wheels w/ operable pedals & motor, $\leq$ 50 cc piston displacement & $\leq$ 1.5 horsepower & max. speed $\leq$ 25 mph on level surface.	Motorcycle (MC) Any motor vehicle w/ seat or saddle for rider & $\leq$ 3 wheels, includes motor scooter & bicycle w/ motor, excludes tractors.	Motorized Bicycle Bicycle with motor & < 50 cc piston displacement & $\leq$ 2 horsepower & max. speed $\leq$ 30 mph on 1% grade.
Enforcement Authority	Dept. State Highways & Transportation		Pollution Control Agency	
New Vehicle Sales Standards (dBA)	Motorcycle or moped 83			
Test Procedure	Based on SAE test procedures.			
Operational Noise Limits (dBA)	$\leq$ 35 mph / > 35 (9) Motorcycle or moped: 82 / 86		$\leq$ 35 mph / > 35 (10) Motorcycles: 80 / 83	
Measurement Distance	Measured at 50 feet.		Measured at $\geq$ 20 feet under any grade, load, acceleration or deceleration.	
Equip. Modif. Prohibited	A,B,C,E,F		A,B,C,E,F	
Equip. Replacement Standards			Yes	
Penalty for Violation	Yes		Yes	

1/ Data are unavailable if section of this table are blank; Noise levels are A-weighted; Footnotes precede this table.

TABLE OF STATE LAWS (cont'd.)[1/]

State	MONTANA	NEVADA
Definitions	**Motorcycle (MC)** Any motor vehicle with saddle for rider or platform on which he stands & ≤ 3 wheels, includes bicycles w/ motors.	**Motorcycle (MC)** Any motor vehicle w/ seat or saddle for driver & ≤ 3 wheels, includes power cycle, excludes tractors.
Enforcement Authority	Highway Patrol	Dept. Motor Vehicles
New Vehicle Sales Standards (dBA)		**Motorcycles** — **Beginning** 86 — 1973
Test Procedure	50 feet from closest point to motorcycle	Based on SAE J331a
Operational Noise Limits (dBA)	**Motorcycles** — **Beginning** 75 — 1970 70 — 1988	≤ 35 mph / > 35 mph Motorcycles: 82 / 86
Measurement Distance		50 feet from center lane, any grade, load, acceleration or deceleration.
Equip. Modif. Prohibited	A	A,B
Equip. Replacement Standards		
Penalty for Violation	Yes	Yes

1/ Data are unavailable if section of this table are blank; Noise levels are A-weighted; Footnotes precede this table.

TABLE OF STATE LAWS (cont'd.)1/

State	NEW JERSEY (11)		OREGON	
Definitions	Motorcycle (MC) Any motor vehicle with seat or saddle for driver or platform; includes bicycles with motors attached; excludes motorized bicycles.	Motorized Bicycle Pedal bicycle w/ helper motor & is either < 50 cc or 1.5 brake horsepower; max speed ≤ 25 mph on flat surface.	Motorcycle (MC) Any motor vehicle with seat or saddle for rider & ≤ 3 wheels, excludes tractors.	
Enforcement Authority	Dept. Environmental Protection/Noise Control Council/DMV		Environmental Quality Commission	
New Vehicle Sales Standards (dBA)			Motorcycles 81 78 75	Beginning 1977 1983 1988
Test Procedure			Based on SAE J331a, moving test at 50 feet.	
Operational Noise Limits (dBA)	Motorcycles 1978 1990	≤ 35 mph > 35 78 82 75 78	Motorcycles 1977 1983 1988	≤ 35 mph > 35 (12) 79 83 76 80 73 77
Measurement Distance	50 feet from center lane, any grade, load, acceleration or deceleration.		Measured at 50 feet.	
Equip. Modif. Prohibited	A,B		A,B,C,F	
Equip. Replacement Standards				
Penalty for Violation	Yes		Yes	

1/ Data are unavailable if section of this table are blank; Noise levels are A-weighted; Footnotes precede this table.

TABLE OF STATE LAWS (cont'd.)[1/]

State	PENNSYLVANIA		RHODE ISLAND	
Definitions	Motorcycle (MC)	Motor-Driven Cycle (MDC)	Motorcycle (MC)	Motor-Driven Cycle (MDC)
	Any motor vehicle with saddle for rider & ≤ 3 wheels.	A motorcycle, including motor scooter, ≤ 5 horsepower; includes pedalcycle with motor attached.	Any motor vehicle with saddle for rider & ≤ 3 wheels; excludes bicycles with helper motors.	Any motorcycle including motor scooter with ≤ 5 brake horsepower; excludes bicycles with helper motors.
Enforcement Authority	Sec. of Transportation		Dept. of Transportation	
New Vehicle Sales Standards (dBA)				
Test Procedure				
Operational Noise Limits (dBA)	≤ 35 mph > 35 MC (soft) 82 86 MDC (soft) 76 82 MC (Hard) 84 88 MDC (Hard) 78 84		≤ 35 mph > 35 Motor Vehicles 86 90	
Measurement Distance	50 feet from center lane under any grade, load, acceleration or deceleration.		50 feet from center lane under any grade, load, acceleration or deceleration.	
Equip. Modif. Prohibited	A,B,C,G			
Equip. Replacement Standards	Yes			
Penalty for Violation	Yes		Yes	

1/ Data are unavailable if section of this table are blank; Noise levels are A-weighted; Footnotes precede this table.

TABLE OF STATE LAWS (cont'd.)[1/]

State	WASHINGTON			
Definitions	Motorcycle (MC)	Motor-Driven Cycle (MDC)	Motorcycle (MC)	Motor-Driven Cycle (MDC)
	Any motor vehicle with saddle for rider & ≤ 3 wheels; excludes tractors & vehicles < 5 horsepower.	Any motorcycle or motor scooter with ≤ 5 brake horsepower; includes bicycle with motor.		
Enforcement Authority	Dept. of Ecology			
New Vehicle Sales Standards (dBA)	Motorcycle 83 Motor-Driven Cycle 80			
Test Procedure	Based on SAE J331a			
Operational Noise Limits (dBA)	≤ 35 mph > 35 Motor Vehicles 80 84 Motor-Driven Cycle 76 80			
Measurement Distance				
Equip. Modif. Prohibited	A,B,C			
Equip. Replacement Standards				
Penalty for Violation	Yes			

1/ Data are unavailable if section of this table are blank; Noise levels are A-weighted; Footnotes precede this table.

SELECTED MUNICIPAL AND COUNTY LAWS

Local motorcycle noise laws unlike state laws are not reported nationally in the standard legal references. Thus, the laws summarized below were compiled by contacting over 80 jurisdictions, from which 66 responses were received. On page D-16 is a table of ordinances that were analyzed. Where applicable, standards for highway use and off-road use are distinguished. Off-road vehicles are abbreviated as ORV.

Code for Municipal Noise Ordinances Equipment Standards

A. Motor vehicles are required to have an adequate muffler in good working order and in constant operation.

B. No motor vehicle muffler may have a cutout, bypass or similar device.

C. Equipment modifications are not allowed to increase noise emissions above those of the original equipment.

E. No person may sell or install equipment which cause a vehicle to fail a noise emission test.

H. Equipment modifications must not cause vehicles to fail noise emission tests.

I. All engines are required to have mufflers.

NOISE ORDINANCES OF
SELECTED MUNICIPALITIES AND COUNTIES 1/

Jurisdiction	Motor Vehicle Noise Standards (dBA)	Measurement Distance	Equipment Standards	Penalties for Violation	Community Noise Standards	Conformity W/ Fed. Reg.
ALASKA Anchorage	≤35 mph ≥35 Motorcycles 76 80 ORV's 76 76	50ft.	A,H,I	Yes, but not specified	Yes	Yes
ARIZONA Tempe		50ft.		≤$300 and/or 6 months in jail	Yes	
CALIFORNIA Alhambra					Yes	
Beverly Hills	Nuisance Standard			Restraining Order or Injunction	Yes	
Burbank	Adopts State Standard		I		Yes	
Inglewood	Adopts State Standard				Yes	
Modesto					Yes	
Palo Alto			A		Yes	
Pasadena	Community Noise Standards Exempt Motor Vehicles on Public Roads				Yes	
Pleasant Hill	Adopts State Standard				Yes	
San Diego	Adopts State Standard				Yes	
Santa Rosa	Adopts State Standard				Yes	
Stockton	Adopts State Standard		A,C		Yes	
Torrance	Adopts State Standard					
COLORADO Colorado Springs	All Light Vehicles 80	25ft.	A,B,C,E,I		Yes	
Denver	All Light Vehicles 80	25ft.	B,C,H,I		Yes	
Lakewood	All Light Vehicles 80	25ft.	B,C,I		Yes	
FLORIDA Broward County	Community Noise Standard Exempts Motor Vehicles on Public Right-of-Way				Yes	Yes
West Palm Beach	≤35 mph >35 Motorcycles 78 82 Motor Driven Cycles 70 79	50ft.	C,I	Yes, but not specified	Yes	

1/ Data are unavailable if section of this table are blank; Noise levels are A-weighted; Footnotes precede this table.

NOISE ORDINANCES OF

SELECTED MUNICIPALITIES AND COUNTIES 1/

(Continued)

Jurisdiction	Motor Vehicle Noise Standards (dBA)	Measurement Distance	Equipment Standards	Penalties for Violation	Community Noise Standards	Conformity W/Fed. Reg.
ILLINOIS						
Barrington	Adopts State Standard					
Chicago	≤35 mph >35 New Motorcycle 78 82 75(1980) Motor-driven Cycle 70 79 75(1980) ORV 82 82 73(1975)	50ft.	C	≥$15 but ≤$300 subsequent offenses more stringent fines	Yes	
Des Plaines	≤35 mph >35 New Motorcycles 78 82 84 Motorbike 70 79 75 ORV's 82 82 73	50ft.	C	Not <$15 or >$300 subsequent offenses subject to more stringent fines	Yes	Yes
Park Ridge	All Noise Sources 87	75ft.	A,B	≥$10 but ≤$200 each day separate offense		
Rockford	≤35 mph >35 Motorcycle 82 86 Motorbike 76 82 ORV 76 76	50ft.	E,H	≥$15 but ≤$300 and/or 6 months jail, more stringent for second offense		
Urbana	≤35 mph >35 New Motorcycles 78 82 74(1980) Motorbike 70 79 80(1975) ORV 70(1975)	50ft.	C	≤$200	Yes	
INDIANA						
Evansville	All Vehicles 85 Accelerating from full stop 90	50ft.	B		Yes	
Hammond	≤35 mph >35 Motorcycles 86 90 ORV 82 82	25ft.	C,I	≥$50 but ≤$300 and/or 180 days in jail	Yes	Yes
IDAHO						
Boise	Adopts Federal Standards	50ft.	A,B,C		Yes	Yes

1/ Data are unavailable if section of this table are blank; Noise levels are A-weighted; Footnotes precede this table.

NOISE ORDINANCES OF

SELECTED MUNICIPALITIES AND COUNTIES 1/

(Continued)

Jurisdiction	Motor Vehicle Noise Standards (dBA)	Measurement Distance	Equipment Standards	Penalties for Violation	Community Noise Standards	Conformity W/Fed. Reg.
IOWA Cedar Falls	≤35 mph >35 Motorcycle 86 90 Motorbike 78 84	30ft.	A,B,I	Yes, but not specified	Yes	
Dubuque	≤35 mph >35 Motorcycle 86 90 Motorbike 78 84	30ft.	I	Yes, but not specified	Yes	
Storm Lake	≤35 mph >35 Motorcycle 86 90 Motorbike 78 84	30ft.	I	Yes, but not specified	Yes	
KANSAS Praire Village	≤35 mph >35 New Motorcycle 78 82 75(1980) Motor-driven Cycle 70 79 75(1980) ORV 82 82 73(1975)	50ft.	C	≤$300 and/or 6 months in jail	Yes	Yes
MARYLAND Baltimore				Not >$500 per offense-each day separate offense	Yes	
Montgomery County	≤35 mph >35 Motorcycle 82 86 Motorbike 76 82	50ft.	A,B	≤$1,000-each day separate offense	Yes	Yes
MASSACHUSETTS Boston	New Motorcycle 84(1975 75(1982) Motor-driven Cycle 80(1975)	50ft.			Yes	Yes
MICHIGAN Ann Arbor	All Motor Vehicles 90	25ft.	A,E,H,I	Yes, subject to criminal prosecution		

1/ Data are unavailable if section of this table are blank; Noise levels are A-weighted; Footnotes precede this table.

NOISE ORDINANCES OF

SELECTED MUNICIPALITIES AND COUNTIES 1/

(Continued)

Jurisdiction	Motor Vehicle Noise Standards (dBA)	Measurement Distance	Equipment Standards	Penalties for Violation	Community Noise Standards	Conformity W/ Fed. Reg.
MICHIGAN Birmingham	≤35 mph >35 Motorcycle 78 82 Motor-driven 70 79 Cycle	50ft.	I			
Detroit	Nuisance Provision		A,B,H			
Kalamazoo	≤35 mph >35 Motorcycle 82 86 Motorbike 74 78	50ft.	C,I	Yes, but not specified	Yes	
MINNESOTA Cannon Falls	Varies With Speed and Distance i.e. 35 mph - 65 dBA at 50 ft. 60 mph - 75 dBA at 50 ft.	20,25 or 50ft.	C	Up to 90 days in jail and/or $300		
Minneapolis	Varies With Speed and Distance i.e. 35 mph - 65 dBA at 50 ft. 60 mph - 75 dBA at 50 ft.	20,25 or 50ft.	C	≤ $500 and/or 90 days in jail	Yes	
MONTANA Billings	50ft. 25ft. Motorcycles & 74 90 Minibikes	25 or 50ft.	C,I	Yes, but no specific fine set	Yes	
Great Falls	50ft. 25ft. Motorcycles & 74 80 Minibikes	25 or 50ft.	A,B,I	≤ $300 and/or 90 days in jail - each day separate offense	Yes	
Helena	Motorcycles & 80 Minibike	25ft.	C,I	≤ $300 and/or 90 days	Yes	
Missoula	Motorcycle & 80 Motor-driven cycle & ORV	25ft.	A	≤ $300	Yes	

1/ Data are unavailable if section of this table are blank; Noise levels are A-weighted; Footnotes precede this table.

NOISE ORDINANCES OF

SELECTED MUNICIPALITIES AND COUNTIES 1/

(Continued)

Jurisdiction	Motor Vehicle Noise Standards (dBA)	Measurement Distance	Equipment Standards	Penalties for Violation	Community Noise Standards	Conformity W/ Fed. Reg.
NEW MEXICO Albuquerque	≤35 mph >35 Motorcycle 82 86 ORV 80 80	50ft.		Same as general penal violations	Yes	
NEW YORK New York	50ft. ≤35 mph >35 Motorcycle 78 82 Motor-drive 70 79 cycle	25 or 50ft.	I	≤ $500	Yes	
OHIO Cincinnati	All Motor Vehicles 95	5ft.				
Cleveland	All Motor Vehicles 95	5ft.	A,B,C,I			
Shaker Heights	All Motor Vehicles 80	50ft.		Yes, but not specified	Yes	
Toledo	≤35 mph >35 Motorcycle 82 86 Minibikes & 82 82 ORV	50ft.		≤ $100/day-each day separate offense	Yes	
OREGON Euguene				≤ $50	Yes	
PENNSYLVANNIA Allentown	Adopts State Standard			≤ $300 and/or 90 days jail	Yes	
UTAH Ogden City	Motorcycle Residential Zones 86 Other Zones 90	50ft.	A,B,C,I	≤ $300 and/or 30 days jail	Yes	
Salt Lake City	≤35 mph ≥35 50ft. Motorcycles 80 84 ORV 82	25ft.	B,C,I	≤ $300 and/or 6 months in jail	Yes	

1/ Data are unavailable if section of this table are blank; Noise levels are A-weighted; Footnotes precede this table.

NOISE ORDINACES FOR

SELECTED MUNICIPALITIES AND COUNTIES
(Continued)

Jurisdiction	Motor Vehicle Noise Standards (dBA)	Measurement Distance	Equipment Standards	Penalties for Violation	Community Noise Standards	Conformity W/ Fed. Reg.
VIRGINIA Alexandria	Reserved for Future Enactment		A,I	≤ $500 - each day separate offense	Yes	
Arlington	<35 mph >35 Motorcycle 80 84 Other 70 79	50ft.	H	≥ $25 but ≤ $1,000; and/or 30 days - each day separate offense	Yes	Yes
WASHINGTON College Place	All Motor Vehicles 95	20ft.	A,B,I	≤ $100 and/or 30 days jail		
Medina	Adopts State Standard		A,I			
Pullman	Motorcycle 88 Motorbike 82	25ft.		≤ $500 and/or 30 days jail		
Snohomish	50ft. 25ft. Motorcycles 87 93	25ft. or 50 ft.		≤ $300 and/or 30 days jail	Yes	
Walla Walla	All Motor Vehicles	20ft.	A,B			
WISCONSIN Milwaukee	<35 mph >35 Motorcycle 80 84	50ft.	A,C,H		Yes	Yes
WYOMING Lander	All Motor Vehicles 80	25ft.				Yes
	All Motor Vechicles 80	35ft.		Yes, but not specified	Yes	

1/ Data are unavailable if section of this table are blank; Noise levels are A-weighted; Footnotes precede this table.

SPECIFIC REGULATION OF OFF-ROAD MOTORCYCLES

STATE LAWS

The following states have specific statutes which provide noise standards for off-road motorcycles:

California
- Scope: New off-highway motor vehicles
- Noise Limit: Vehicles manufactured after January 1, 1975 must meet 86 dB level at 50 feet.

Colorado
- Scope: New off-highway vehicles required to be registered
- Noise Limit: Vehicles manufactured after January 1, 1973 must meet 84 dB level at 50 feet.

Delaware
- Scope: Operating or selling off-highway vehicles
- Noise Limit: Vehicles manufactured after January 1, 1978 may not exceed 88 dB at 50 feet.

Illinois
- Scope: Off-road motorcycles
- Noise Limit: Off-road vehicles are subject to the limitations for property-line noise sources.

Maryland
- Scope: Off-road motorcycles
- Noise Limit: All off-road vehicles must meet the 84 dB level at 50 feet.

Michigan
- Scope: Operating or selling off-road vehicles
- Noise Limit: Vehicles manufactured after January 1, 1975 may not exceed 86 dB at full throttle from 50 feet.

New Hampshire
- Scope: Operating off-highway recreational vehicles
- Noise Limit: Vehicles may not exceed 86 dB; 78 dB after January 1, 1983.

Oregon
- Scope: Operating off-road recreational vehicles
- Noise Limit: Vehicles manufactured 1975 or before may not exceed 102 dB at 20 inches in stationary test; 99 dB if manufactured after 1975.

Washington
- Scope: Any non-highway vehicle
- Noise Limit: Vehicles may not exceed 86 dB at 50 feet or 105 dB at a distace of 20 inches using the stationary test.

The following states make their general motorcycle noise statutes specifically applicable to off-road vehicles:

- Colorado
- Idaho
- Minnesota
- Oregon

The following states have implied that their street motorcycle noise statutes are applicable to off-road vehicles:

- Connecticut
- Florida
- Montana
- Nevada
- New York
- Pennsylvania
- Rhode Island

Regulation of Off-Road Motorcycles Within Municipalities

Increasingly, municipalities are regulating off-road motorcycles to meet local needs. The local noise tables summarize the levels for off-road vehicles. There is a trend toward establishing land-use regulations for operating on property such as alleys and vacant lots.

APPENDIX E

FOREIGN MOTORCYCLE NOISE LAWS

APPENDIX E

Foreign Motorcycle Noise Laws

Council of European Communities (EEC)

On November 23, 1978, the Council of European Communities issued a directive on motorcycles noise which requires that member states of the European Economic Community (EEC) adopt and put into force regulations for motorcycles with the noise emission limits and other provisions specified by the directive. Because the EEC test procedure and enforcement and compliance programs are different from that set by the U.S. for motorcycles, care must be taken in comparing the relative stringency of the EEC and U.S. motorcycle noise standards. The following discussion and tables attempt to compare the EEC noise emission standards with those of the U.S.

From product manufacturers, and from its own observations, EPA has determined that differences in compliance and enforcement requirements between nations can and do make substantial differences in the meaning of the levels to the manufacturers. For example, it has not often seemed well understood that U.S. federal noise limits on products are absolute maximum not-to-exceed levels. No tolerances are allowed. Further, under U.S. law the government can and does order manufacturers to recall defective products after the products have been sold for engineering correction, and imposes large civil, financial, and even possibly criminal penalties on manufacturers for selling non-complying products. Accordingly, EPA's experience is that manufacturers having to comply with U.S. federal noise limits virtually always design and build their products to make less noise (2-3 decibels) than the limit set by U.S. regulations. Manufacturers have likewise indicated to the Agency that in complying with non-U.S. federal government noise limits, they may add one to two decibels for tolerance. Under such a circumstance one can see that the practical difference between two apparently similar regulatory requirements for the same product could be from 2 to 5 decibels.

In the accompanying tables E-1 and E-2 the Agency has endeavored to make a comparison between the current EEC regulations and the proposed U.S. federal regulation, as well as OECD proposed future EEC and the proposed U.S. regulation.

The first column of each table shows the current or the OECD proposed future EEC regulatory noise limits. The second column of the tables shows the expected range of the EEC noise levels when corrected to the U.S. equivalent value. The range of values is due primarily to the variability in the location of the vehicles within the testing areas when the noise level is recorded. For motorcycles the range is -2 to 7dB. EPA has a mean value of 3 dB for motorcycles. The third column in the tables presents the mean value of the EEC levels with the above adjustments to U.S. equivalents.

Columns five and six compare the equivalent EEC levels and the U.S. levels, when the associated enforcement programs are considered. U.S. production verification data shows that manufacturers design their products to be 2-3 dB below the regulatory level in order to ensure compliance with the U.S. regulation. Accordingly, this value has been subtracted from the

U.S. level to depict the impact of U.S. enforcement programs. The European enforcement programs appear relatively less stringent, with no perceived or apparent impact on manufacturers in, for example, recalls or civil penalities. Therefore, the EEC levels have not been adjusted to show the impact of an enforcement program similar to that encountered in the U.S. EEC rules do permit manufacturers to add one dB for tolerance, however, when testing for compliance with EEC directives. The last columns on the table show the relative stringency of the EEC and U.S. regulations when enforcement and compliance programs are considered.

The comparison shows the U.S. requirements to be more stringent by 1 to 10 dB, than those of the current EEC regulations. In addition the U.S. requirements are 3 to 4 dB more stringent than the OECD proposed future levels. Unlike the EPA test procedure, the EEC test procedure is highly sensitive to a change in gear or sprocket ratios. Changing sprockets does not necessarily affect the noise generated in actual use, but does have a major effect on the measured level in the EEC test. Thus, to reduce the measured noise level, manufacturers can select a sprocket ratio which gives the most favorable results under the EEC test procedure, even though that sprocket change would not lower the noise generated by the motorcycle in actual use. It is reasonable, therefore, to expect manufacturers testing under the EEC test procedures to obtain a 2 dB reduction by such means (corresponding to about a 10% decrease in maximum engine speed reached during the test), The EPA test procedure is insensitive to a change in gearing or sprocket ratios. This is because the EPA test prodedure calls for the attainment of a specific condition of power and rpm at a specified location in relation to the microphone which is not the case for the EEC test procedure.

United Nations Economic Commission For Europe (ECE)

ECE Regulation No. 9, entitled "Uniform Provisions Concerning the Approval of Vehicles with Regard to Noise," dated March 20, 1958, and revised March 26, 1974, specifies motorcycle noise limits. Vehicles are tested under full acceleration in second gear with the microphone placed 7.5 m from the center lane of travel.

The following Noise limits are currently in effect:

Engine Displacement	A-weighted Noise Level
50 cc - 125 cc	82 dB
125 - 500 cc	84 dB
Over 500 cc	86 dB

However, on June 2, 1978, the ECE proposed motorcycle noise emission standards identical to those of the Council of European Communities (EEC). As of October 22, 1979, the proposed had been transmitted to the U.N. Secretary General for approval.

TABLE E-1

VEHICLE TYPE	I CURRENT FUTURE EEC LEVELS	II EEC LEVELS CONVERTED TO U.S. EQUIV (RANGE) (1)	III EEC LEVELS CONVERTED TO U.S. EQUIV (MEAN) (2)	IV U.S. REGULATORY LEVELS (4)	V IMPACT OF ENFORCEMENT AND COMPLIANCE PROGRAMS ON REGULATORY LEVELS EEC (4)	VI U.S. (5)	VII RELATIVE STRINGENCY OF REGULATIONS (EEC - U.S.)
							U.S. more stringent by:
Motorcycle							
A. ≤ 80	78	80 - 71	75	78	77	76 - 75	1 - 2 dB
B. ≤ 125	80	82 - 73	77	78	79	76 - 75	3 - 4 dB
C. ≤ 350	83	85 - 76	80	78	82	76 - 75	6 - 7 dB
D. ≤ 500	85	87 - 78	82	78	84	76 - 75	8 - 9 dB
E. ≥ 500	86	88 - 79	83	78	85	76 - 75	9 - 10 dB

* Comparisons should be made in sequence (i.e. I-VII).

(1) Due to differences in test procedure and measurement distances associated with the ISO R362 test procedure and the U.S. test procedure, differences of -2 to +7 dB can be realized in the measurements.

(2) Mean value of the -2 to +7 dB range in test procedure differences is 3 dB.

(3) This scenario assumes a 78 dB level of stringency.

(4) It is reasonable to expect manufacturers testing under the EEC test procedures to obtain at least a 2 dB reduction by changing gear or sprocket ratio (corresponding to a 10% decrease in maximum engine speed reached during the test). Two dB is added to the EEC levels to account for this effect.

(5) Incorporates enforcement and production tolerances (generally 2 to 3 dB less for production verification).

TABLE E-2*

VEHICLE TYPE	I OECD PROPOSED FUTURE EEC LEVELS	II OECD PROPOSED FUTURE EEC LEVELS CONVERTED TO U.S. EQUIV. (RANGE) (1)	III OECD PROPOSED FUTURE EEC LEVELS CONVERTED TO U.S. EQUIV. (MEAN) (2)	IV U.S. REGULATORY LEVELS (3)	V IMPACT OF ENFORCEMENT AND COMPLIANCE PROGRAMS ON REGULATORY LEVELS EEC (4)	VI U.S. (5)	VII RELATIVE STRINGENCY OF REGULATIONS (EEC - U.S.)
							U.S. more stringent by:
Motorcycle	80	82 - 73	77	78	79	76 - 75	by 3 to 4 dB

---

* Comparisons should be made in sequence (i.e. I-VII).

(1) Due to differences in test procedure and measurement distances associated with the ISO R362 test procedure and the U.S. test procedure, differences of -2 to +7 dB can be realized in the measurements.

(2) Mean value of the -2 to +7 dB range in test procedure differences is 3 dB.

(3) This scenario assumes a 78 dB level of strigency.

(4) It is reasonable to expect manufacturers testing under the EEC test procedures to obtain at least a 2 dB reduction by changing gear or sprocket ratio (corresponding to about a 10% decrease in maximum engine speed. reached during the test). Two dB is added to the EEC levels to account for this effect.

(5) Incorporates enforcement and production tolerances (generally 2 to 3 dB less for production verification).

Canada

The Motor Vehicle Safety Act controls noise emissions for motor vehicles. In 1976, the Canadian Transport Ministry advised that the current standard for motorcycles was 88 dB, measured by testing method J 986a.

· On June 29, 1976, the Department of Transport proposed new regulations, which would take effect September 1, 1977, lowering the motorcycle noise limit to 85 dB and adopting SAE J47 as the official test procedure.

Japan

The Japanese Noise Regulation Law directs the Director-General of the Environmental Agency to set maximum permissible noise levels for motor vehicles. Environment Agency Bulletin No. 53, September 4, 1975, set forth maximum permissible noise limits for automobiles and other motor vehicles.

Measurement procedures have been established for normal operating noise, exhaust noise, and acceleration noise. Normal operating noise is measured from a distance of 7.0 meters while the vehicle is traveling past the test point at a constant speed of 35 km/h (25 km/h for bicycles with motors). Exhaust noise is measured at a distance of 20 meters from the rear of an open exhaust pipe when the vehicle is operating at 60% of maximum output. Acceleration measurements are made on vehicles operating at full throttle past a microphone 7.5 m from the center lane of travel.

The following motorcycle noise emission standards are currently in effect:

Engine Displacement	A-weighted Noise Level
$>$ 250 cc	78 dB
$\leq$ 250 cc	78 dB
$>$ 125 cc	78 dB
$\geq$ 125 cc	75 dB
$>$ 50 cc	75 dB
$\leq$ 50 cc	75 dB

APPENDIX F

MOTORCYCLE DEMAND FORECASTING MODEL

AND

ESTIMATION OF REPLACEMENT EXHAUST SYSTEM SALES

MOTORCYCLE DEMAND FORECASTING MODEL*

Approach and Methodology

The analysis of the market environment for motorcycles and the price of motorcycles (and other prices) over the period 1973 to 1975 indicated the approach to model statistically the determinants of demand for unit motorcycle sales. Statistically equations were estimated econometrically by relating unit motorcycle sales (by type and function) to demographic, income, price, and motorcycle characteristics over the period 1973 to 1975. Given these estimated equations, and the forecasts of the explanatory variables from Data Resources, forecasts of unit sales and revenues (given prices) for each class of motorcycle were generated.

1. Estimation Methodology

Each equation for motorcycle sales was estimated in real terms; i.e., units, rather than total retail value. Total retail value is the product of total unit sales and unit price; estimating the retail value of motorcycles would not indicate the real influence of price effects on unit sales.

All sales series were seasonally adjusted to derive the true growth pattern of sales without the influence of trend, cyclical or irregular factors. Furthermore, the explanatory variables, prices and incomes are seasonally adjusted. The seasonal adjustment process was conducted using the Bureau of the Census XII Seasonally Adjustment Program.

PRICE

The Consumer Price Index (CPI) is reported by the Bureau of Labor Statistics (BLS) each month on a seasonally adjusted and unadjusted basis.

POPULATION

The mean income of males (with income by age cohort is reported annually by the Bureau of the Census.

2. The Dynamics of Motorcycle Demand .

For estimation purposes, it was hypothesized that consumers of motorcycles have a desired level of motorcycle purchases, and that, in any given period, a portion of that desire will be met. In equation form:

$$S_t - S_{t-1} = \propto (\overset{*}{S}_t - S_t\text{-}1) \qquad (1)$$

* A more detailed explanation of the development and estimation of this model is in the "Background Report for Motorcycle Noise Emission Regulations, Phase II: Cost and Economic Impact Analysis, Volumes I and II," prepared by EPA's contractor McDonnell Douglas, October, 1976.

Where: S_t = actual sales (purchases) in period t

S_{t-1} = actual sales (purchases in period) t-1

$\overset{*}{S}_t$ = desired sales (purchases in period t

The coefficient, α, measures the extent to which actual sales meet desired sales in any given period, i.e., if $\alpha = 1$, the actual sales equal desired sales; if $\alpha < 1$, then some desired sales in any given period are unmet.

Solving (1),

$$S_t = (1-\alpha) S_{t-1} + \alpha \overset{*}{S}_t \qquad (2)$$

For estimation purposes, S_t and S_{t-1} are known; $\overset{*}{S}_t$, desired sales, is not. It is reasonable to assume that desired sales (S_t) are a function of the demographic and income characteristics of motorcycle demanders, and characteristics of motorcycles; i.e., purchase price and operating costs and the price(s) of all other competing commodities.

Thus, for each type of motorcycle considered, the basic hypothesis tested was that unit motorcycle sales in any given period was functionally related to:

(a) Unit motorcycle sales in the previous period.

(b) The demographic patterns in the age group consuming motorcycles.

(c) The income characteristics of these age groups.

(d) The price of each class of motorcycle.

(e) The price of competing commodities, including those of different types of motorcycles.

(f) The user operating costs of each type of motorcycle.

EXPLANATORY VARIABLES POPULATION

Evidence indicates that the relevant consuming groups for motorcycles were males in the age cohorts 20 to 24, and 25 to 34 years. A variant on these data was selected to reflect the true effective demographic factors; i.e., males with income in these age groups. These data are reported annually by the Bureau of Labor Statistics and are forecast regularly by an EPA contractor's publication "Age Income Matrix Model." These annual data were distributed linearly to generate monthly time series data.

INCOME

The income variable selected to reflex the real purchasing power of motorcycle consumers was the Mean Income in 1974 dollars, of males (with income) in the age cohorts 20 to 24, and 25 to 34 years. Mean incomes of other age groups were tested for statistical significance in the equations but did not fare as well as the above. Mean income, in 1974 dollars, of these groups enters all equations. These series are reported annually by the Bureau of the Census. To generate a monthly time path for these series, the monthly distribution of Personal Income for the economy as a whole, in 1974 dollars, was imposed upon the annual series. Personal income is reported monthly, seasonally adjusted, by the Department of Commerce. This series was deflated by the Consumer Price Index (CPI), reindexed from a 1967 to a 1974 base.

PRICE

The retail price of each type of motorcycle was generated by dividing total retail value (for each type of motorcycle) by the corresponding unit retail sales.

COMPETING PRICES

Sales of motorcycles compete for the consumer budget with all other goods sold in the economy. Several alternative competing price variables were considered and tested in the estimation process: the implicit price deflator for consumption expenditures on durable commodities,and the consumer price index for durable commodites, and the consumer price index for all commmodities. On statistical grounds, the price variable selected to represent the price of competing commodities was the consumer price index for all commodities (CPI).

Cross price substitution effects were considered in the estimation of the specific classes of motorcycles; i.e., sales by displacement class and by two-stroke and four-stroke class. The demand for a motorcycle of a particular class will be affected by aggregate demand variables; i.e., age-income factors, own price, competing price (i.e., CPI) but also by the price of the impact of competing motorcycle price variables. However, in all cases, these variables were rejected on statistical grounds.

USER OPERATING COSTS

User operating costs (gas, insurance, maintenance, depreciation, etc.) have been found to be significant in influencing new automobile sales. A priori, it was expected that such factors should influence motorcycle sales to some extent. Various proxies for user operating costs of motorcycles (i.e., the consumer price index for gas and oils, the implicit price deflator for consumption expenditures on gasoline, etc. relative to general price variables were tested for statistical significance in the equation estimation. None of these variables, however, were found statistically significant and all were dropped from the equations.

The basic hypothesis tested for unit motorcycle sales was:

$$UNITSSA_i = f\ (N20@34,\ MEAN20@34,\ P_1,\ CPI)$$

Where:

$UNITSSA_i$ = Unit sales, seasonally adjusted, for the ith class of motorcycle.

N20@34 = Population of males, with income, in the age groups of 20 to 34 years.

MEAN20@34 = Mean income, in 1974 dollars, of males in the age groups 20 to 34 years.

P_1 = The price of the ith class of motorcycle.

CPI = Consumer Price Index for all commodities (CPI).

All equations were estimated, monthly from 1973:2 through 1975:12 using the Ordinary Least Squares Regression technique.

DATA

Monthly data, from 1973:1 through 1975:12 on total motorcycle unit sales, retail and wholesale values, were made available by the Motorcycle Industry Council (MIC). Annual data, from 1973 through 1975, were made available by MIC for unit motorcycle sales, retail and wholesale values for street, off-road and dual purpose motorcycles by engine displacement size (in cubic centimeters) and by two-stroke and four-stroke engine categories.

Unit retail price for each type of motorcycle was generated by dividing retail dollar value by unit sales.

Since only three years of data were available for estimation purposes, the equations were all estimated on a monthly basis. Monthly price and unit sales data for all annual series (street, off-road and dual purpose, by displacement class and by two-stroke and four-stroke breakout) were generated by applying the monthly distribution of total motorcycle unit sales and unit price to these annual series. The explanatory variables used in the equation estimations, income, populations and price, were derived from public sources and are documented and stored in the DRI computer data banks.

3. Forecast Methodology

Forecasts of Male Population (with income) between the age groups 20 and 34 years, and Mean Income, in 1974 dollars, of this age group, were generated from the 12/75 forecast of an EPA contractor's Age Income Matrix. The forecast of the Consumer Price Index was generated by a contractor's Cycle Long 12/75 Long Term Forecast of the U.S. economy.

For the unit price of motorcycles, it was assumed, as a baseline case, that prices would increase at the rate of 7 percent per year from 1976 through 1990.

Given the estimated equations and the forecasts of the explanatory variables, forecasts of (seasonally adjusted) total monthly unit motorcycle sales, total street, off-road and dual purpose unit sales; street, off-road and dual purpose unit sales by two-stroke/four-stroke breakouts, and street, off-road and dual purpose unit sales by displacement classes, were generated using a contractor's MODSIM software. (Stored on-line on a contractor's computers, alternative forecasts can be readily generated based upon different assumptions regarding demographic/income developments, inflationary developments or differing assumptions regarding the retail unit price of motorcycles.) The monthly, seasonally adjusted sales forecasts are summed to generate annual unit sales forecasts.

4. Estimated Equations

The basic functional form of the estimated equations for unit motorcycle sales was:

- Unit Sales (seasonally adjusted), per consuming population group (i.e., males from 20 to 34 years) was functionally related to:

(a) the lagged (one-month) value of this variable

(b) the relative price of motorcycles vis-a-vis the Consumer Price Index (CPI)

(c) the Real Mean Income of the consuming age group, and

(d) dummy variables.

The formulation reflected (a) the adaptive purchasing behavior outlined above, (b) the influence of aggregrate demographic and income characteristics of motorcycle purchasers, and (c) relative price effects. Dummy variables for December 1973 and January 1974 were introduced into most equations to take account of the distorting influence of the energy crisis on motorcycle sales. The dependent variable in the equations was expressed in per capita terms given the crucial importance of demographics in determining motorcycle demand.

The estimation procedure was conducted in two steps. First, unit sales, seasonally adjusted, per consuming population group was estimated econometrically. To determine how well these formulations implicitly explained actual unit sales, (not seasonally adjusted), the estimate from this equation was multiplied by the number of males, aged 20 to 34 years and by the seasonal factors of unit sales to derive an estimate of actual unit sales. Actual unit sales were then regressed against this estimate. If the first equation was specified correctly, the coefficient on this estimate should be approximately equal to one. This was found to be true for all equations.

TOTAL UNIT SALES

Total unit motorcycle sales, seasonally adjusted, and divided by the relevant consuming population group (males, aged 20 through 34 years) was regressed on

(a) its own lagged value (one month)

(b) the average unit price of motorcycles relative to the CPI

(c) the Mean Income in 1974 dollars, of males aged 20 through 34 years

(d) two dummy variables, for 1973:12 and 1974:1.

Each variable in the equation is statistically significant and has the right sign:

- the relative price variable enters the equation with a negative sign, as expected, indicating that as the relative price of motorcycles increases relative to the price of all other goods, then total unit sales will decline, holding everything else constant.
- mean income, in 1974 dollars, of males aged 20 through 34 years, has a positive sign, indicating that as real income increases, so also will unit motorcycle sales, other things being equal.

The elasticities of the relative price variable and the income variable are -. 738 and 1.39 respectively. These indicate, that (a) for every 1 percent increase in the relative price of motorcycles vis-a-vis the CPI, total unit motorcycle sales will decline by .738 percent, holding everything else constant, (b) for every 1 percent increase in the real income of the 20 to 34 male population age groups, total unit motorcycle sales will increase by approximately 1.4 percent, other things being equal.

This formulation explains almost 83 percent ($\bar{R}^2$ = .8255) of the (month-to-month) variation in total unit motorcycle sales, seasonally adjusted, per consuming population age group. On a transformed basis (see below) this formulation explains over 84 percent (transformed $\bar{R}^2$ = .8416) of the variation in total actual unit sales.

ESTIMATED EQUATION: TOTAL UNIT SALES

UNITSTSACAP = .274224 * UNITSTSACAPLAGI
(2.67635)
-4244.29 * RELPT
(3.17453)
+.613208 * MEAN20@34
(4.80927)
(+5573.28 * DUM7312
(6.65)
+4638.40 * DUM741

R^{-2} = .8255 FIT: MONTHLY 73:2 to 75:12

Transformed R^{-2} = .8416 t-STATISTICS in parenthesis

Durbin Watson = 1.6054

ELASTICITIES	RELATIVE PRICE	REAL INCOME
	-.7385	+1.39

WHERE:

UNITSTSACAP = TOTAL UNIT SALES, SEASONALLY ADJUSTED, DIVIDED BY N20@34

N20@34 = MALE POPULATION, AGED 20 THROUGH 34

UNITSTSA = TOTAL UNIT SALES

UNITSTSACAPLAGI = UNITSTSACAP(-1)

RELPT = AVERAGE UNIT PRICE OF MOTORCYCLES, DIVIDED BY THE CPI

MEAN20@34 = REAL (1974 DOLLARS) MEAN INCOME OF THE MALE POPULATION AGED 20 THROUGH 34 YEARS.

The same basic specification and functional form of the equations was followed for each type of motorcycle (i.e., street, off-road, dual purpose,. by two-stroke and four-stroke breakout and by displacement classification). In all cases the relative price variable had a negative sign and the real income variable a positive sign on its coefficient. In the case of motorcycle sales by two-stroke and four-stroke breakout and by displacement classification, the price of competing types of motorcycles was introduced into the equations in order to generate estimates of price cross-elasticities between different types of motorcycles. However, on statistical grounds, this attempt did not prove feasible. Summary statistics of the estimated equations are provided in Tables F-1 - F-5.

TABLE F-1

STREET MOTORCYCLE STATISTICS

	LAGGED UNIT SALES	RELATIVE PRICE		MEAN INCOME		TRANSFORMED	DURBIN WATSON
	COEFFICIENT (T-STATISTIC)	COEFFICIENT (T-STATISTIC)	ELASTICITY	COEFFICIENT	ELASTICITY	$\bar{R}^2$	
Less Than 99 c.c.							
100-169 c.c.	.738673 (6.25191)	-267.005 (1.88866)	-.9275	.0138 (2.03)	1.162	.8510	1.859
170-349 c.c.	.657243 (7.87124	-266.771 (2.27)	-.9346	.022181 (2.694)	1.22	.8245	2.04
350-449 c.c.	.372936 (3.72138	-699.473 (2.807)	-.967	.08718 (3.9261	1.52	.8174	1.588
450-749 c.c.	.299783 (2.802)	-362.33 (2.33)	-.863	.0697069 (3.61965)	1.49	.8116	1.5548
750-899 c.c.	.263063 (2.09)	-120.92 (3.027)	-.768	.048142 (4.373)	1.44	.8206	1.56
900 c.c. plus							

TABLE F-2

OFF-ROAD MOTORCYCLE STATISTICS

	LAGGED UNIT SALES COEFFICIENT (T-STATISTIC)	RELATIVE PRICE COEFFICIENT (T-STATISTIC)	RELATIVE PRICE ELASTICITY	MEAN INCOME COEFFICIENT	MEAN INCOME ELASTICITY	TRANSFORMED $\bar{R}^2$	DURBIN WATSON
Less Than 99 c.c.	.346644 (2.780181	-1638.00 (-3.07013)	-.953169	.0837784 (4.06085)	1.54892	.8158	1.6145
100-169 c.c.	.252134 (2.94974)	*	*	.01462 (7.74991)	.674485	.8493	1.8368
170-349 c.c.	.451802 (4.05766)	-180.905 (-2.53415)	-1.14813	.0221605 (3.27084)	1.67024	.7282	1.8253
350-449 c.c.	.43004 (3.49149)	*	*	.00267284) (4.29743)	.527595	.7296	1.7539
450-749 c.c.	.316025 (3.86852	*	*	.00110338 (7.14955)	.6055594	.8431	1.7968

* Price variable not statistically significant, and therefore omitted from specification.

TABLE F-3

DUAL PURPOSE MOTORCYCLE STATISTICS

	LAGGED UNIT SALES	RELATIVE PRICE		MEAN INCOME		TRANSFORMED	DURBIN WATSON
	COEFFICIENT (T-STATISTIC)	COEFFICIENT (T-STATISTIC)	ELASTICITY	COEFFICIENT	ELASTICITY	$\bar{R}^2$	
Less Than 99 c.c.	.579097 (6.00582)	-711.931 (2.034)	-.867	.03331 (2.668)	1.2137	.7928	1.6848
100-169 c.c.	.469664 (5.39922)	-1159.7 (2.48487)	-.9969	.0771913 (3.33068)	1.438	.8101	1.567
170-349 c.c.	.456098 (5.845)	-616.782 (1.90078)	-.74	.06576 (2.9283)	1.19	.8242	1.5033
350-449 c.c.	.400972 (4.29955)	-179.967 (2.295)	-.912	.0233366 (3.334)	1.43	.8089	1.5199
450-749 c.c.	.675174 (6.96569	-3.02146 (1.5058)	-.45	.000496 (2.31)	.7411	.787	1.4887

TABLE F-4

UNIT SALES - SUMMARY

	LAGGED UNIT SALES COEFFICIENT (T-STATISTIC)	RELATIVE PRICE		MEAN INCOME		TRANSFORMED $\bar{R}^2$	DURBIN WATSON
		COEFFICIENT (T-STATISTIC)	ELASTICITY	COEFFICIENT	ELASTICITY		
TOTAL UNIT SALES	.274224 (2.67635)	-4244.29 (3.17453)	-.738	.613208	1.39	.8416	1.6054
TOTAL STREET UNIT SALES	.281494 (2.37492)	-1067.83 (2.79)	-.5948	.239737 (4.45)	1.25	.824	1.61
TOTAL OFF-ROAD UNIT SALES	.255683 (2.169)	-1281.96 (2.3839)	-.6508	.128049 (4.13)	1.33	.8210	1.6266
TOTAL DUAL PURPOSE UNIT SALES	.469622 (5.48137)	-2417.31 (2.35)	-.87	.20186 (3.3)	1.31	.815	1.5541

TABLE F-5

TWO-STROKE/FOUR-STROKE MOTORCYCLE SALES

	LAGGED UNIT SALES COEFFICIENT (T-STATISTIC)	RELATIVE PRICE		MEAN INCOME		TRANSFORMED	DURBIN WATSON
		COEFFICIENT (T-STATISTIC)	ELASTICITY	COEFFICIENT	ELASTICITY	$\bar{R}^2$	
TWO-STROKE Street	.3459 (3.36869)	-456.644 (3.17)	-.8437	.0648 (4.59)	1.428	.8306	1.664
Off-Road	.230848 (2.26788)	-415.923 (1.17)	-.422	.06466 (2.93)	1.12	.8314	1.68
Dual Purpose	.4898 (5.88)	-1612.38 (2.17)	-.7999	.138436 (3.1487)	1.225	.8247	1.5949
FOUR-STROKE Street	---	-889.507 (3.486)	-.689	.2369 (8.02)	1.6	.8093	1.0317
Off-Road	.473304 (4.53)	-919.249 (2.748)	-.8255	.05056 (3.63)	1.315	.8073	1.5107
Dual Purpose	.619465 (6.368)	-419.938 (1.37)	-.545	.03336 (2.088)	.85	.7761	1.7129

ESTIMATION OF REPLACEMENT EXHAUST SYSTEM SALES

Aftermarket exhaust system sales are simply a fixed proportion of the stock of motorcycles each year. That proportion, .1214, was derived from 1974 data by dividing exhaust system sales (Table 8-18) by the stock of motorcycles (Table 8-16).

EPA developed a computer program to calculate the stock of motorcycles each year. Annual motorcycle sales were taken from the 1979 Motorcycle Statistical Annual (published by MIC and included in Table 8-1) from 1969-78, from the Motorcycle Demand Forecasting Model for 1979-1990, and were estimated for the 1965-68 period. Data on sales were derived from the 5 largest firms in the industry in 1978 and since these firms represented 96.4% of total sales from 1973-1978, the MIC figures were divided by .964 to augment the forecasts to the total industry level. From 1991-2000 sales are expected to grow 2% per year. After the year 2000 the sales growth rate is flat and sales are equal to their 2000 level.

S_i, the scrappage rate (1 minus the survival rate), was derived from the 1979 Motorcycle Statistical Annual and was reproduced as Table 8-20 in Chapter 8. After 13 years, all motorcycles of a given vintage will have been scrapped and, therefore, could not contribute to the stock of motorcycles.

By using the above data, EPA estimated motorcycle stocks for the years from 1976-2010. Since the period of interest began in 1979, an assumption was made that no pre-1967 motorcycles existed. The 1967 sales data were run through the scrappage subroutine and the number of motorcycles remaining in 1979 were calculated. Similarly, the sales for succeeding years were "scrapped" and the 1979 remainder was calculated. When this procedure was completed for the years 1967-1979 the remainder was totaled and the 1979 stock was derived. The calculations are summarized in the following equation:

$$K_t = \sum_{i=t}^{t-13} (1-S_i)\, M_i$$

where

K_t = stock of motorcycles in year t

M_i = motorcycle sales in year i

S_i = scrappage rate for motorcycles of age i

To derive the 1980 stock the 1979 estimate was eliminated and the entire sequence of calculations was performed. The calculations were started with 1968 data because all 1967 motorcycles had been scrapped (they were 13 years old).

Hence, for each year the stock of motorcycles was completely recalculated from a clean slate. The time series of the motorcycle stock was completed by carrying out the calculations for all years. The forecasted stock of motorcycles from 1979-2010 and the estimates of exhaust system unit sales are presented in Table 8-19.

APPENDIX G

RELATION BETWEEN STANDARD TEST METHODOLOGIES AND REPRESENTATIVE ACCELERATION CONDITIONS

Introduction

The health and welfare analysis of motorcycle noise impact (and possible reductions of that impact) requires noise level information on motorcycles under actual operating conditions. The analysis(Section 5) requires motorcycle noise levels as measured by a standardized acceleration test to be translated into motorcycle noise levels that would be measured under representative actual acceleration conditions. This Appendix presents supporting information for the assumption that noise levels measured under J-331a or F-76a less 3 dB are representative of unconstrained traffic accelerations for purposes of the health and welfare analysis.

The operating conditions that describe motorcycle accelerations consist of several parameters: (a) acceleration rates, (b) engine speeds at gear shift points, and (c) throttle settings. These operating conditions, of course, differ from motorcycle to motorcycle and from motorcyclist to motorcyclist. Situational factors, too, will cause an individual motorcyclist to accelerate differently under varying conditions. Describing motorcycle accelerations, then, either with distributional statistics or "average" cases is seen to be a very difficult task. Studies on automobile operation[1] have shown great variances in automobile acceleration conditions. Motorcycles could be expected to display even greater variances due to the broad range of vehicle capacities (horsepower to weight ratios) and wide engine speed ranges coupled with near universal use of manual transmission. To EPA's knowledge, no study exists which specifically focuses on motorcycle acceleration conditions in the U.S. A detailed study has been conducted on motorcycle operation in Japan[2] but is not felt to be directly applicable to U.S. operations.

Current Standardized Tests

Current SAE procedures and ISO procedures measure motorcycle noise under full throttle acceleration conditions (see Appendix A). Typically second gear is required, although third and higher gears are specified in some cases. Motorcycles are accelerated up to various engine speeds including 100% of maximum rated RPM for some motorcycles under some tests. Further, maximum noise under test (presumed for most motorcycles to occur at the highest engine speed achieved during the test) occurs at various distances relative to a microphone location. The procedure most commonly used in the U.S. currently is the SAE J-331a or variants thereof. The J-331a procedure includes a feature whereby motorcycles reach their maximum tested engine speed at different distances from a microphone depending on motorcycle performance characteristics. The procedure which EPA investigated for use in Federal regulations (F-76a) measures motorcycle noise at differing fractions of maximum rated engine speed (depending on engine displacement) at a standardized position relative to a microphone location. As discussed in Section 3, noise levels measured under these two procedures are felt to be statistically comparable although individual models may vary by several decibels.

The J-331a procedure is representative of very rapid acceleration conditions. Most motorcycles are accelerated at full throttle to very high engine speeds under this test. The F-76a procedure, also a full-throttle procedure, features somewhat lower engine speeds. Acceleration rates, however, would be expected to be comparable under the two tests. Entering and closing road speed and distance traveled under the J-331a test can be used to calculate average acceleration rates during the test. Calculations based on data in Appendix C reveal that very small motorcycles accelerate at about 0.15 - 0.20 "g", and that very powerful motorcycles can have average acceleration rates in excess of 0.50 "g" during that test. Although some motorcyclists undoubtedly accelerate at these very fast rates, the average acceleration rates achieved in J-331a are not felt to be representative of the distribution of accelerations in unconstrained traffic conditions.

Adjustment to Noise Level Measured Under Standardized Tests

Since J-331a and other tests are not directly applicable for noise impact analysis, certain adjustments must be made to measured values. Several studies have been conducted which measured motorcycle noise during actual operational conditions.[3,4,5,6,7] Some of these studies included a broad range of motorcycle operating conditions with qualitative descriptors of acceleration or cruise conditions. The study conducted by the Illinois Task Force on Noise, however, tested motorcycles at controlled acceleration rates. It is not apparent that standardized tests were conducted on measured motorcycles in any of these studies so comparison with existing data on motorcycle noise levels cannot be made. It is apparent from every one of these studies, however, that motorcycles under cruise are considerably quieter than under acceleration, and that acceleration rate is a very important determinant of noise levels.

Since direct relationships between operational noise levels and standardized test noise levels are not available, the health and welfare analysis requires several assumptions to be made. EPA attempted to develop a relationship between noise levels and fractional acceleration rates based on the Illinois Task Force on Noise study. This effort, however, was not successful in obtaining useable results. Instead, motorcycle noise levels as a function of engine speed at the shift points between first and second gear, and between second and third gear were examined. It was apparent that for most motorcycles these two shift points occur at about the same engine speed. Accordingly, the shift point between second and third gear was used exclusively in this analysis.

Representative motorcycle accelerations are described in this analysis by a single set of acceleration conditions. These "representative" conditions feature partial-throttle acceleration to a moderately high engine speed before shifting. The engine speed achieved before shifting is assessed to be a speed somewhat lower than is specified in the F-76a procedure. Similarly, throttle setting is considered to be somewhat less than the full throttle condition specified in J-331a/F-76a testing.

It is generally agreed that smaller motorcycles accelerate to higher relative engine speeds before shifting than do larger motorcycles. This phenomenon is accounted for in the F-76a test. It is considered to be a reasonable assumption that accelerations can be represented by maximum engine speeds some ten percentage points of maximum rated RPM less than

TABLE G-1

MOTORCYCLE ENGINE SPEEDS AT 28 MPH

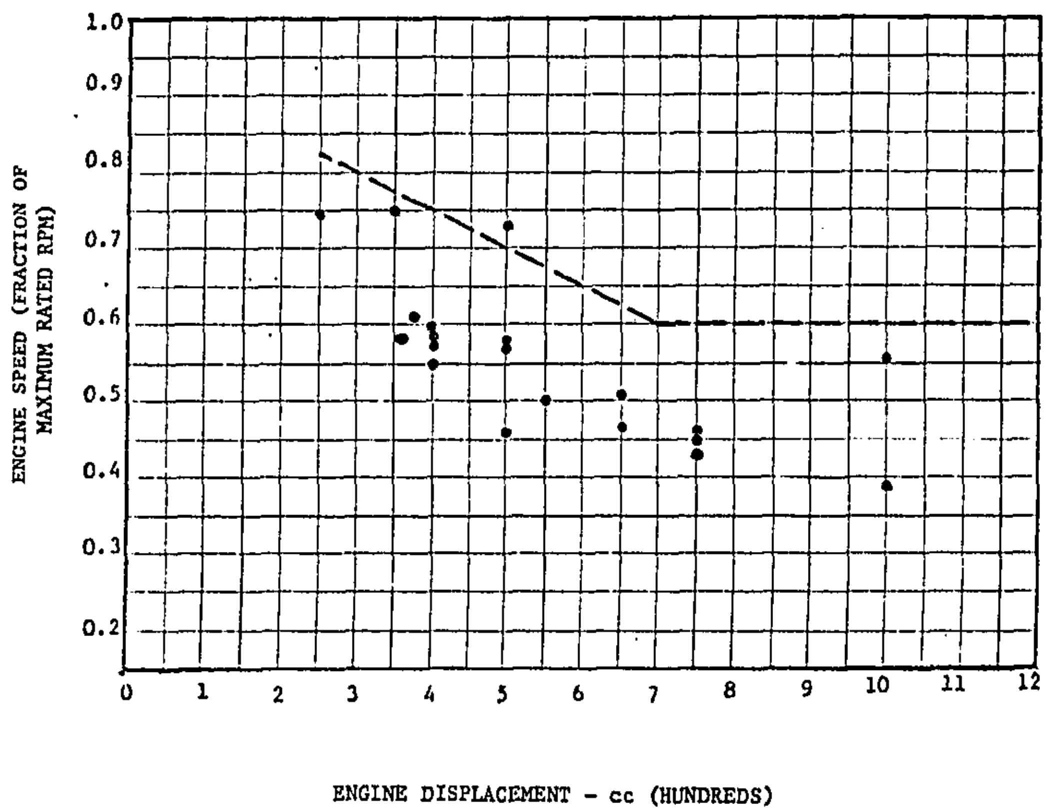
MODEL	ENGINE SPEED AT 28 MPH - 2ND GEAR (RPM)	RATED ENGINE SPEED (RPM)	FRACTION OF MAXIMUM RATED RPM AT 28 MPH
Honda			
CB-550K	4000	8000	0.50
CB-500T	3900	8500	0.46
CB-400F	5200	6000	0.58
XL-350	5500	7500	0.75
Yamaha			
XS-750D	3200	7000	0.47
XS-650D	3200	7000	0.47
XS-500C	4600	8000	0.58
RD-400C	4100	7000	0.59
XS-360 2D	4600	8000	0.59
Kawasaki			
KZ-1000	3200	8500	0.39
KZ-750	3400	7500	0.46
KZ-650	4100	8000	0.51
KH-400	4100	7500	0.55
KX-400	5100	7000	0.73
Suzuki			
GS-750	3700	8500	0.44
GT-500	3500	6000	0.57
GS-400B	5100	8500	0.60
GT-380M	4900	8500	0.61
GT-250A	5600	7500	0.75
H-D			
XL-1000	2800	5000	0.56

Source: Motorcycle reviews in Cycle and Cycle Guide magazines

FIGURE G-1

MOTORCYCLE ENGINE SPEED AT 28MPH - 2ND GEAR

SELECTED MODELS 250cc AND GREATER



Source: Table G-1

TABLE G-2

MOTORCYCLE NOISE LEVELS AT TEN PERCENTAGE POINTS LESS THAN F-76a CLOSING ENGINE SPEED

Motorcycle Number	Motorcycle Model		F76a Sound Level Less F-76a - 10% Sound Level (dB)
104	Honda	GL-1000	1.5
121	Kawasaki	KZ-900	2.4
176	Suzuki	GT-750	1.6
94	H-D	FXE-1200	3.2
186	H-D	XL-1000	1.9
105	Honda	CB-750	1.6
101	Honda	CJ-360	1.5
106	Honda	CB-550	1.0
108	Honda	CB-125	1.1
119	Kawasaki	KH-400	1.1
120	Kawasaki	KZ-750	2.2
128	Suzuki	GT-500	0.7
107	Honda	CB-200	1.3
132	Suzuki	GT-500	0.9
110	Honda	XL-125	2.2
131	Suzuki	GT-380	0.7
126	Suzuki	GT-185	1.2
125	Suzuki	TS-400	1.5
130	Suzuki	TS-100	0.3
188	H-D	SX-175	0.5
92	H-D	SS-125	0.4
93	H-D	SX-125	2.2
123	Kawasaki	KH-250	2.6
115	Kawasaki	KH-100	1.0
118	Kawasaki	KE-100	1.3
112	Honda	XL-100	2.5
113	Honda	XL-250	1.6
134	Yamaha	D7-250	0.3
135	Yamaha	D7-175	0.7
174	Yamaha	XS-650	1.5

$n = 30$ $\bar{x} = 1.42$ dB $s = 0.72$ dB

Source: Table C-12

the speed specified by F-76a. According to this assumption small motorcycles would be considered to accelerate to 80% of maximum rated RPM and very large motorcycles to 50%, with a sliding scale in between. The extreme points of 80% and 50% of maximum rated RPM do not appear to be unreasonable although the 80% figure may be somewhat low for very small motorcycles.

The reasonableness of the assumption that representative accelerations might be some constant decrement below F-76a (rather than different decrements for large and small motorcycles), can be checked by investigating motorcycle engine speeds as a function of road speed. EPA air emission regulations specify that, unless otherwise stipulated by the manufacturer, gear changes between second and third gear during the standard air emission test are to occur at 28 mph for motorcycles over 250 cc. Table G-1 presents the engine speed (as a fraction of maximum rated RPM) of several motorcycle models at 28 mph in second gear. The results in Figure G-1 indicate that, if motorcycles of 250 cc and greater generally are shifted at about the same road speed, the graduation of engine speeds in F-76a is not unreasonable for representative accelerations.

Motorcycle noise levels at ten percentage points less than F-76a closing RPM were obtained from the data in Appendix C. Table C-12 contains noise level measurements for several motorcycles that were tested at more than one closing engine speed under F-76/J-47-type testing. From these data it is possible to interpolate motorcycle noise levels at F-76a closing engine speed and F-76a less ten percentage point closing speed. These data are included in Table G-2. This Table indicates that, for this sample, motorcycle noise levels at ten percentage points below F-76a closing speed (full throttle) would be between one and two dB below their F-76a value.

To account for the fact that representative accelerations are likely to be conducted at less than full-throttle, an additional adjustment is necessary. EPA is not aware of available data which specifically focuses on engine load as a variable distinct from other parameters such as engine speed. The JAMA[2] study did develop a relationship which empirically modelled noise level as a function of acceleration rate, but that is not directly applicable. The formula developed, however, would indicate that the impact of average acceleration rate is not particularly large (the difference between a 0.2 "g" acceleration and a 0.4 "g" acceleration would be 3 dB). Wanting directly applicable information, it is assumed that the effect of less-than-full throttle acceleration amounts to one-to-two dB for most motorcycles. Additional measurements to quantify this phenomenon are desirable.

The combination of the two assumed adjustments to J-331a or F-76a noise levels for representative accelerations amounts to a two to four dB decrement across all model lines. Accordingly, the health and welfare analysis uses the assumption that F-76a or J-331a noise levels less 3 dB are representative of accelerations in unconstrained traffic conditions.

Comparison With Other Studies

It is useful to compare this assumption with the results of abovementioned studies. As discussed below no serious incompatibilities between this assumption and measured data have been found.

TABLE G-3

SPEED LIMIT 35 MPH OR LESS

dB(A) Variation from Present Limit	dB(A)	Level Roadway Motorcycles				Acceleration Motorcycles				Grade Motorcycles			
		Stock		Modified		Stock		Modified		Stock		Modified	
		No. of Veh. Over	% of Veh. Over	No. of Veh. Over	% of Veh. Over	No. of Veh. Over	% of Veh. Over	No. of Veh. Over	% of Veh. Over	No. of Veh. Over	% of Veh. Over	No. of Veh. Over	% of Veh. Over
0	82	1	1.5	4	13	4	5	30	46	9	17	17	57
-1	81	1	1.5	4	13	9	12	33	51	15	29	18	60
-2	80	1	1.5	10	34	10	13	39	60	17	32	22	73
-3	79	2	3.0	12	38	15	20	45	69	21	40	23	77
-4	78	3	4.6	13	41	19	25	49	76	25	48	23	77
-5	77	3	4.6	15	47	28	37	54	83	31	59	27	90
-6	76	5	7.7	18	56	33	44	56	86	33	63	27	90
-7	75	11	16.8	22	69	44	58	58	88	38	72	28	93
-8	74	16	24.6	27	85	52	69	59	91	42	79	28	93
-9	73	25	38	30	94	65	86	69	91	45	85	28	93
-10	72	35	54	31	97	70	92	60	93	47	89	28	93
TOTAL VEHICLES MEASURED		65		32		76		65		53		30	

Source: Reference 5

(a) Motorcycle Industry Council Studies. Studies conducted by the Motorcycle Industry Council have been summarized in Reference 4. The summarized studies include motorcycles measured both under acceleration and cruise conditions. It was found that low speed noise levels of motorcycles have fallen from the high to low 70's (dB) over the past six years. Further, it was found that acceleration noise levels of motorcycles (with modified motorcycles included) range from mid-70's to high 80's. Differences between acceleration and cruise noise levels were found to vary between 3.5 and 12 dB. These differences between acceleration and cruise noise levels provide a very limited basis for comparison of the assumption and these measured data, as discuss further below.

(b) California Highway Patrol and Chicago Urban Studies. A survey of vehicles operating on California highways[5] included measurements of motorcycle noise under the following conditions: level roadway, acceleration, and grade. Since these measurements included modified and unmodified motorcycles of unspecified manufacture date, and since no standardized test was conducted on measured motorcycles, no direct conclusions can be drawn from these data on the relationship between operational and standardized test noise levels. However, the noise level differences between acceleration and level roadway operation can be determined if it is assumed that a ranking of a motorcycle population according to increasing noise level would remain the same under both of these operating conditions. Examining Table G-3, it can be seen that the noise level representative of the upper tenth percentile of motorcycles shifts from 6.5 dB below "present limit" under cruise conditions to 1 dB below "present limit" under acceleration conditions, a change of 5.5 dB. This transformation can be conducted for all percentiles to determine a trend. Again assuming that relative motorcycle noise rankings do not change, this survey would indicate that acceleration operations are 4-6 dB louder than cruise operations and that grade operation is about 7 dB louder than cruise.

The Chicago Urban study[6] also measured noise levels under acceleration and cruise conditions. Again, no standardized tests were made on measured motorcycles. The difference between acceleration and cruise operations can be determined in a manner similar to that described for the California study. Figure G-2 shows of that study acceleration noise levels of 80.1 dB ($s = 5.6$) and cruise levels of 73.3 dB ($s = 4.4$), a difference of 7 dB.

These studies imply a certain relationship between motorcycle acceleration and cruise noise. If a relation between motorcycle cruise and standardized test conditions can be developed, the assumed relation between acceleration and standardized test can be checked. The difference in motorcycle noise level between cruise conditions and a standardized test was analyzed using the data in the 1975 MIC study.[8] This study included 200 motorcycles, many of which were measured both under J-331a and 35 mph cruise. Differences for 70 models were averaged with a resulting difference in noise level of 10.3 dB ($s = 3.2$).

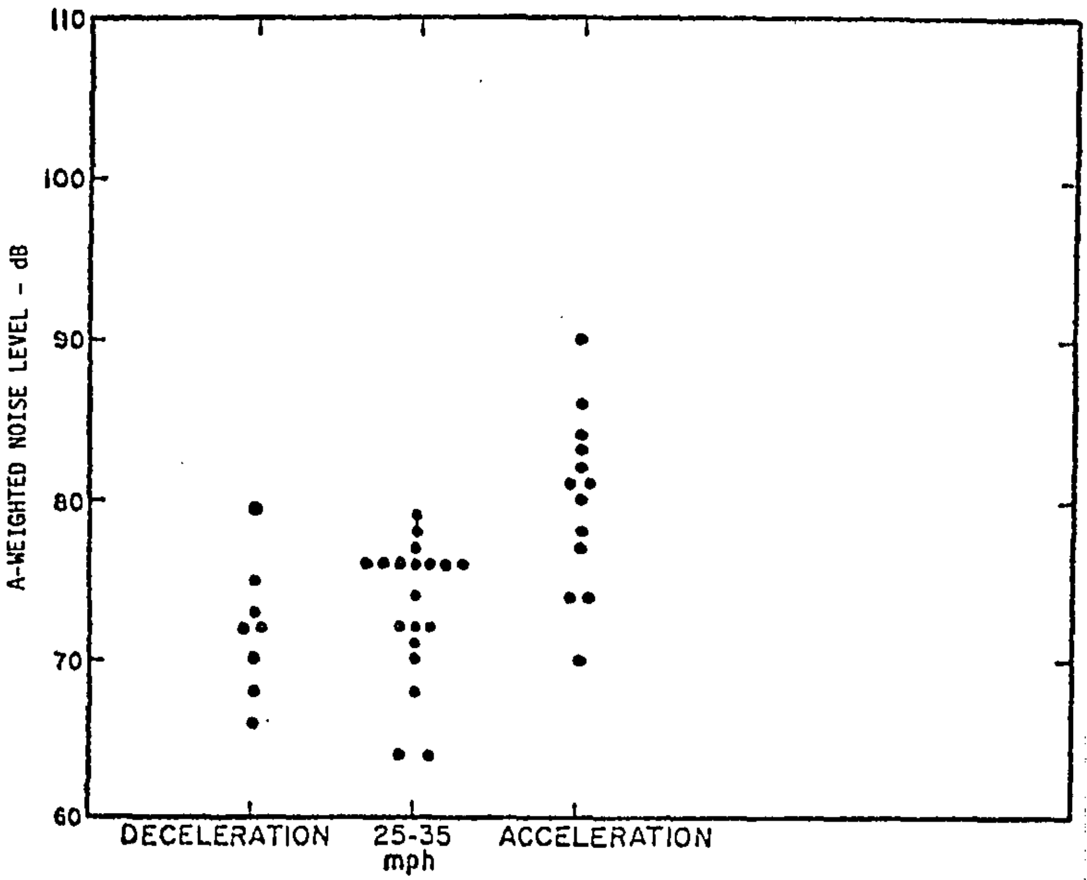


FIGURE G-2 NOISE OF MOTORCYCLES WITH STOCK MUFFLERS
DATA NORMALIZED TO 50 ft - 40 Samples

Source: Illinois Task Force on Noise Motorcycle Noise Levels A Report on Field Tests (Ref. 7)

If 7 dB is used as the difference between motorcycle sound levels under acceleration and cruise conditions, and if 10 dB is used as the difference between J-331a or F-76a levels and cruise conditions, it is seen that the assumption that J-331a/F-76a noise levels less 3 dB are representative of accelerations in unconstrained traffic situations may not be inconsistent with data measured in the MIC, California and Chicago studies. This artificially constructed difference between highly varying figures, however, is not in any sense intended to be a showing that a 3 dB decrement is accurate. Rather it is intended to show a lack of conflict with measured data.

(c) Illinois Task Force on Noise. In a study conducted at the University of Illinois, twenty motorcycles were tested under controlled acceleration conditions.[7] Motorcycles were tested under different acceleration rates until a motorcycle accelerated from a dead stop for 100 feet in 4.8 seconds (terminal speed 28 mph, average acceleration rate 0.27 "g"). This time interval was used because a previous study had determined that it represented the 75th percentile of acceleration rates of automobile drivers in Illinois. The study showed that the noise levels of unmodified motorcycles tended to be in the mid-to-low 70's (dB) at these acceleration rates. Of the relatively new bikes tested with no apparent defects, J-331a data were available in the MIC report on seven. These motorcycles, shown in Tables G-4 and G-5, displayed acceleration noise levels some 5-12 dB below J-331a values. The acceleration rate tested, however, is considered to be lower than the representative acceleration desired for the health and welfare analysis. As discussed above, adjustments to account for different acceleration rates were pursued but did not provide meaningful results. The data in the Illinois study, however, are not felt to be seriously inconsistent with the representative acceleration assumptions made.

TABLE G-4

REPORTED RESULTS ON MOTORCYCLE ACCELERATION TESTING

(TABLE 1. MOTORCYCLE SUMMARY)

	Year	Make	Size (cc)	dB Tendency	Maximum dB Recorded	Overall Maximum dB	Group
1.	1971	Kawasaki	90	76	76	76	II
2.	1973	Suzuki	125 (TS 125)	--	--	--	Not usable
3.	1973	Honda	325 (350 CB)	70	71	71	I
4.	1973	Kawasaki	100 (65)	71	73	73	I
5.	1974	Honda	360 (360 CB)	71	70.5	71	I
6.	1966	Suzuki	149	84.5	77 ?	84.5	III
7.	1966	Honda	160 (CB)	76	78	78	III
8.	1974	Honda	550	72	70.5	72	I
9.	1975	Honda	750 (KS)	73	74	74	I
10.	1972	Honda	250	73	73	73	II
11.	1970	Suzuki	492 (T500)	75	75	75	II
12.	1973	Suzuki	250 (TS)	83	83	83	IV
13.	1971	Honda	325 (CB)	78	80	80	IV
14.	1971	Honda	100 (CB)	--	--	--	Not usable
15.	1971	Honda	350 (SL)	78	78	78	II
16.	1974	Suzuki	738 (750 GT)	72.5	73	73	I
17.	1972	Yamaha	650 (XS)	78	79	79	II
18.	1973	Honda	444 (450 CB)	73	73	73	I
19.	1974	Kawasaki	175	--	--	--	Not usable
20.	1972	Honda	350 (CL)	72	72	72	II

<u>Source</u>: MOTORCYCLE NOISE LEVELS - A REPORT ON FIELD TESTS (Ref. 7)

TABLE G-5

J-331a NOISE LEVELS COMPARED WITH
MOTORCYCLE NOISE LEVELS UNDER ACCELERATION

Motorcycle Model	J-331a Sound Level (dB)	Acceleration Sound Level (dB)	Difference (dB)
1973 Honda CB 350	80	70	10
1974 Honda 360	76	71	5
1974 Honda CB 550	79.5	72	7.5
1975 Honda CB 750K	79	73	6
1974 Suzuki G7-750	84.5	72.5	12.5
1973 Honda CB-450	81	73	8
1972 Yamaha XS-650	84.5	78	6.5

Source: Refs. 7 and 8

References

1. Gary, Richard F., A Survey of Light Vehicle Operations, Noise and Vibration Laboratory, General Motors Proving Ground, Milford, MI, Engineering Publication 6313, July 1975.

2. Japan Automobile Manufacturers Assn, Inc., Motorcycle Noise Control Committee, Motorcycle Noise Studies, July 1975.

3. Motorcycle Industry Council, Sound Level Monitoring - Portland, Oregon, 1976.

4. Walsh, J., Hagie, R., and Harrison, T., Motorcycle Noise in the Community - A Review, June 1977.

5. California Highway Patrol, Noise Survey of Vehicles Operating on California Highways, 1971.

6. Bolt, Beranek and Newman, Inc., Chicago Urban Noise Study, Report 1411, 1970.

7. Illinois Task Force on Noise, Motorcycle Noise Levels - A Report on Field Tests, June 1975.

8. Motorcycle Industry Council/McDonnell Douglas Astronautics Company - West, Evaluation of Stationary and Moving Motorcycle Noise Test Methods for Use in Proposed Regulations, December, 1975.

APPENDIX H

ADDITIONAL MOTORCYCLE NOISE LEVEL DATA

This appendix discusses the 76a test procedure methods of eliminating tachometer variables, and stationary vehicle test methods which may be correlateable to the moving test method. Noise levels prevailing at the rider's ear during various operational modes of the motorcycle were also measured.

Noise Emission Data Base, F76a Procedure

F76a noise emission data, obtained for representative motorcycles, are presented in Table H-1. Included in the table are data obtained at other closing rpm's and comparison J331 data.

The annotation "by tach" means that the vehicle tachometer (if so equipped) was employed to establish entering and closing rpm; if the vehicle was not equipped with a tachometer, a portable tachometer was employed. In all cases, the steady-state calibration of the tachometer was verified (and a correction applied if necessary) by matching a signal from the ignition secondary of the motorcycle with a signal of known frequency (accuracy ± 0.5%) from an oscillator (Figure H-1).

The annotation "by gate" means that the closing rpm was established by the tape-switch gate. The pair of tape switches, spaced one-meter apart, located at the acceleration end-point measure the time (accuracy ± 0.05 milliseconds; typically ± 0.1%) of traverse of the one-meter distance. The method of employing the gate consisted of establishing the proper traverse time by making constant speed passes thru the gate at the desired F76a closing rpm (using the calibrated vehicle tachometer). For the F76a test, the acceleration distance was adjusted such that the same traverse time was attained, (closing the throttle at the gate, rather than reference to the tachometer) thus eliminating the effect of tachometer lag. During successive passes in an F76a test, traverse time consistency was typically ± 1 ms (for street bikes), implying a closing rpm consistence of about 2%. This variability is primarily related to the degree of repeatability achievable by the rider; its effect is minimized by averaging repeated runs. In the case of off-road motorcycles considerably greater indicated variability in traverse time occurs among successive passes; this is due to the variability of contact of the knobby tire with the tape switch. A further variable is introduced by the fact that average speed of traverse thru the gate is not necessarily the same as the maximum speed occuring in the one-meter distance. For a large street motorcycle, assuming uniform acceleration, the effect of this source of error is conservatively estimated at 0.7%.

Considering the foregoing, it is estimated that the F76a data "by gate" presented in Table H-1 were obtained with closing rpm probable accuracy within 2%.

Photographs H-1 thru H-14 (at the end of this appendix) show the EPA's contractor test track and instrumentation employed.

Effect of Tachometer Lag

In Table H-2, the F76a noise emission data have been formatted to show more clearly the amount of tachometer lag typically experienced in the F76a test, and the effect of this error on measured noise levels. Although noise

TABLE H-1 1977 MOTORCYCLE NOISE LEVELS

		J331a	F76	F76a			F76a Variation		
Make/Model	Bike I.D.	by tach	by tach	by tach	by gate	%rpm	by tach	% rpm	F50
Honda GL1000	702	76	83	79	77	50-60	74 74	40-50 45-55	88
Honda 750K	701	78	83	80	79	50-60	76 78	40-50 45-55	90
Honda XL350	703	81		78	75	50-77.5			83
Honda MR250	Δ704*	85(2nd) 83(3rd)	83	84	81	50-82.5	84	50-90	84
Honda TL125	Δ712*	76	75	76	77	50-88.8	78	50-95	95
Honda XR75	Δ724*	85	81	83	82	50-90	86	50-100	88
Kawasaki KZ1000	705	77	83	80	78	50-60	77	40-50	90
Kawasaki KZ650B	706	78	82	79	77	50-62.5	77	45-55	88
Kawasaki KZ400	709*	79	81	81	80	50-75	76	50-60	
Kawasaki KE250	707	81	78	80	77	50-82.5	81	50-90	83
Kawasaki KX125	Δ711*	87	86	86	86	50-88.8	87	50-95	94
Harley FLH-1200	719*	82	86	84	83	50-60	80 81	40-50 45-55	90
Harley FXE-1200	713	84	88	83	83	50-60	81	40-50	96
Harley XL-1000	714	82	86	82	82	50-60	79	40-50	94

*Bikes not equipped with tachometer

Δ Off-Road (only) Motorcycles

TABLE H-1 1977 MOTORCYCLE NOISE LEVELS (Cont'd)

Make/Model	Bike I.D.	J331a by tach	F76 by tach	F76a by tach	F76a by gate	F76a % rpm	F76a Variation by tach	F76a Variation % rpm	F50
Harley SS-175	720	81	78	80	79	50-86.3	81	50-90	87
Harley SX-175	721	84	81	81	82	50-86.3	84	50-95	90
Suzuki GS550 @531 mi.	716	79	81	81	79	50-67.5	78	50-60	93
@1104 mi.	716A	78		81	80				92
Suzuki GS400X	718	79	80	80	79	50-75	77	50-60	90
Suzuki TS400 **	722	85	84	84	83	50-75	82 86	50-60 50-85	97
Suzuki GT380	717	85		85	85	50-76	82	50-60	89
BMW R100/7	710	82	83	81	80	50-60	77	40-50	89
	710A ***	84	85	82	82	50-60	78	40-50	88
Bultaco Frontera 250	Δ715*	89(2nd) 90(3rd)	90	90	90	50-82.5			94
Bultaco Alpina 350	Δ723*	88		89	89	50-77.5	90 89	50-85 50-65	84
Husqvarna 360WR	Δ708*	87		85	85	50-77			
Yamaha DT250D	725	84	83	83	82	50-82.5	84	50-95	91
Yamaha XT500D	726	80	79	79	77	50-70	81	50-85	84
Yamaha XS650D	727	83	87	85	84	50-62.5	82	40-50	92
Yamaha IT400D	728*	93	92	92	91	50-75	93	50-90	101
Yamaha IT175D	729*	93	91	92	91	50-86.3	94	50-95	96

*Bikes not equipped with tachometer **Not in 1977 model configuration Δ Off-Road (only) Motorcycles
***Same bike as 710 one month later; unknown use and servicing.

TABLE H-1 1977 MOTORCYCLE NOISE LEVELS (Cont'd)

Make/Model	Bike I.D.	J331a by tach	F76 by tach	F76a by tach	F76a by gate	F76a % rpm	F76a Variation by tach	F76a Variation % rpm	F50
Yamaha DT100D	730*	79	76	79	79	50-90	80	50-100	91
Can-Am Qualifier 250	Δ732*	83	81	83(2nd) 82(3rd)	83 82	50-82.5	83	50-90	
Can-Am Qualifier 125	Δ733*	84	83	85	84	50-88.8	87	50-90	87
Can-Am Qualifier 175	734*	85		84(2nd) 85(3rd)	84	50-86.3			

*Bikes not equipped with tachometer

Δ Off-Road (only) Motorcycles

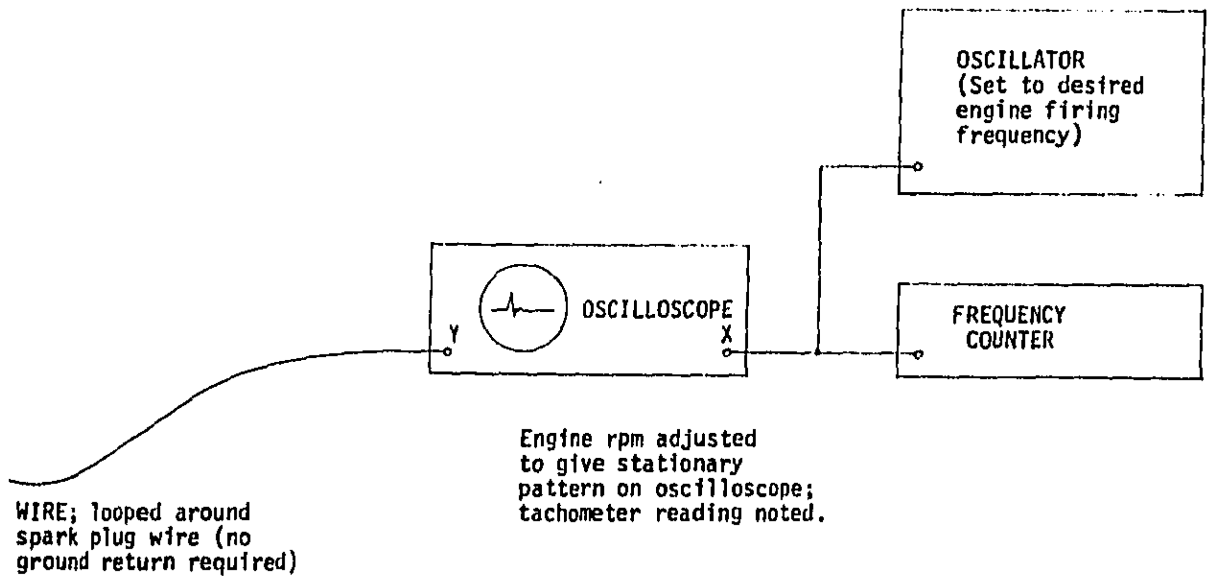


FIGURE H-1   INSTRUMENTATION FOR CALIBRATING VEHICLE TACHOMETER levels and noise level increments are shown to tenths, the incremental data must not be considered accurate or reproducible to better than 0.5 dB, nor the noise level data to better than 1 dB.

Analysis of those cases where a noise level difference of 0.5 dB or more is experienced between the gate and tach methods, the approximate relationship between noise level error and tachometer error is shown:

$$\Delta \text{ dB}/\% \quad \Delta \text{ rpm} = 0.2 \pm 0.1$$

A 1% error in rpm can be expected to result in a 0.2 dB error in noise level. For measurement accuracy within 0.5 dB, closing rpm should be controlled within 2%. Typical variations in noise level vs. engine rpm are shown graphically in Figure H-2.

Gear Selection and Acceleration Distance

The 76a procedure as currently drafted stipulates use of 2nd gear, unless the acceleration distance is less than 25 ft., in which case higher gears are used as required to achieve the minimum 25 ft. distance. Further consideration was given to:

(a) Difference in measured level resulting from use of a different gear, and

b) Desirability of stipulating a longer acceleration distance.

Table H-3 shows the effect of gear selection on noise level. Although noise levels can differ as much as 1 dB between gears, these differences are much less than those resulting in the J331a test. While the 1 dB difference is more than would be desired, measured levels in the F76a test will not be materially affected by sprocket ratio changes.

Regarding the acceleration distance, in the original draft of the F76a procedure a 50 ft. minimum acceleration distance was stipulated; this was changed to 25 ft. because of the following difficulties encountered with the 50 ft. requirement:

- some motorcycles cannot attain the 50 ft. distance before reaching the specified rpm even in highest gear;
- some motorcycles do not pull properly from 50% rpm in the gear required to attain the 50 ft. distance.

A third factor to be considered is that a 50 ft minimum acceleration distance would result in use of 3rd gear for some high performance street bikes (such as the KZ-1000) with attendant high operating speeds and long acceleration distances.

TABLE H-2 EFFECT OF TACHOMETER LAG, F76a TEST

Bike	Make/Model	Max. HP rpm	F76a Level dB by gate	F76a Level dB by tach	Closing rpm rpm by gate	Closing rpm rpm by tach	Tachometer*
701	Honda 750K	8500	78.5	1.9	5100	490	
702	Honda GL1000	7500	77.1	1.7	4500	390	
703	Honda XL350	7000	75.1	2.5	5400	420	
704	Honda MR250	7000	80.6	3.3	5775	970	Sanwa/ECI
705	Kawasaki KZ1000	8000	78.4	1.3	4800	850	
706	Kawasaki KZ650	8500	77.1	1.9	5310	710	
707	Kawasaki KE250	6000	77.0	2.6	4950	330	
708	Husqvarna 360WR	6500	84.6	0.2	5000	170	Dynall
709	Kawasaki KZ400	8500	80.2	0.3	6375	100	Dynall
710	BMW R100/7	7250	80.4	0.4	4350	-30	
710A	BMW R100/7	7250	81.8	0.5	4350	150	
711	Kawasaki KX125	9750	86.0	0.3	8650	460	Sanwa
712	Honda TL125	8000	76.5	-0.3	7100	840	Rite
713	Harley FXE-1200	5200	83.2	-0.1	3120	-120	
714	Harley XL-1000	6000	81.7	-0.1	3600	-80	
715	Bultaco Fr. 250	7500	89.8	0.4	6190	50	Sanwa
716	Suzuki GS550	9000	79.4	1.4	6075	360	
717	Suzuki GT380	7500	84.7	-0-	5700	410	
718	Suzuki GS400X	8500	78.6	1.7	6375	370	
719	Harley FLH-1200	5200	83.2	0.4	3120	-10	Dynall
720	Harley SS-175	6750	78.8	1.5	5820	310	
721	Harley SX-175	6800	82.1	-1.0	5865	-200	
722	Suzuki TS400B	6000	82.5	1.1	4500	310	
723	Bultaco Alp. 350	5500	89.0	0.1	4260	1500	Sanwa/ECI
724	Honda XR75	10500	81.7	1.0	9450	970	Rite
725	Yamaha DT250D	6000	82.4	0.9	4950	890	
726	Yamaha XT500D	6000	76.6	1.9	4200	580	
727	Yamaha XS650D	7500	84.0	0.7	4690	320	
728	Yamaha IT400D	7000	90.9	1.5	5250	500	Sanwa
729	Yamaha IT175D	9500	90.9	0.6	8200	350	Dynall
730	Yamaha DT100D	7000	78.6	0.5	6300	70	Dynall
732	CanAm Qualifier 250	7500	82.7	0.3	6190	80	Dynall
733	CanAm Qualifier 125	9000	83.8	0.9	7990	-60	Dynall

*Motorcycles tach employed where so equipped; portable tach employed as listed.

MOTORCYCLE NO. 702 HONDA GL1000
705 KAWASAKI KZ1000
711 KAWASAKI KX125
719 HARLEY FLH-1200
724 HONDA XR75
733 CAN-AM 125

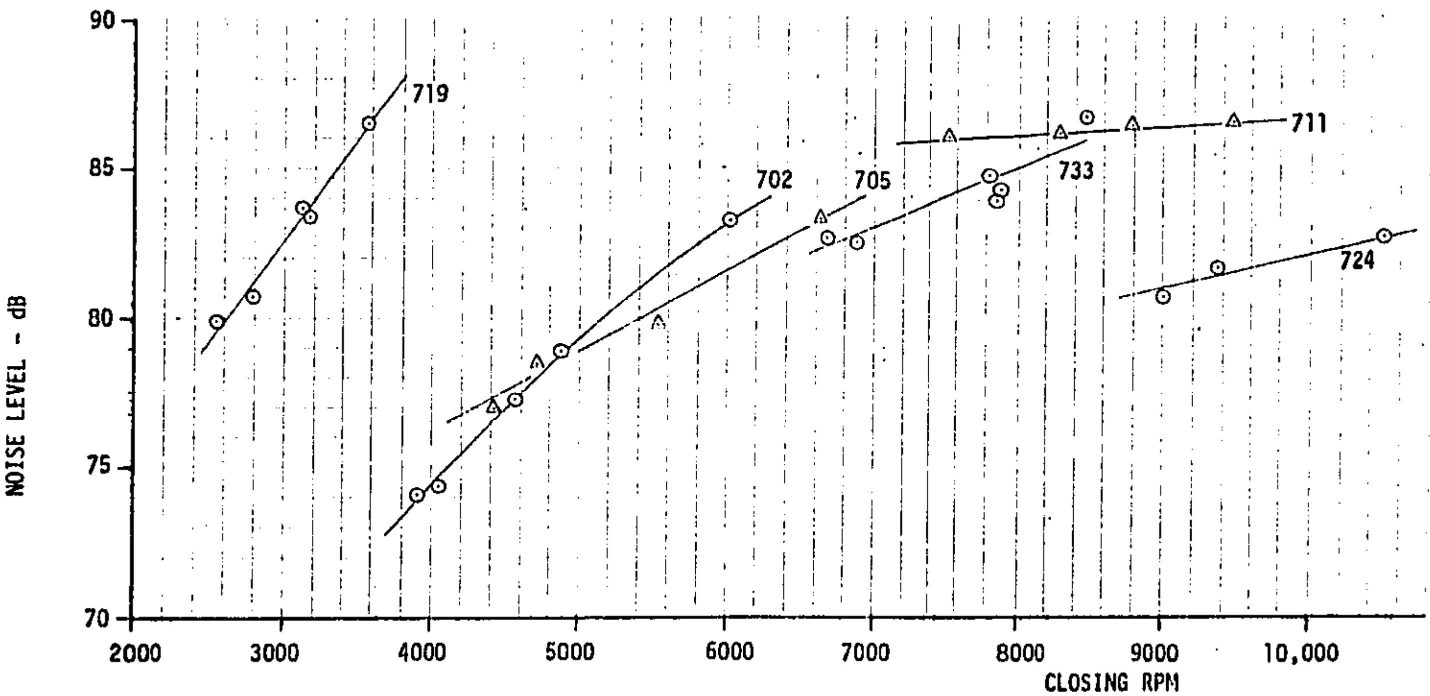


FIGURE H-2 MEASURED NOISE LEVEL AS FUNCTION OF CLOSING RPM

Review of available data suggests that the 25 ft. minimum could be increased to 33 ft. (10 m); before adopting such a change, however, suitability should be verified on selected vehicles.

TABLE H-3 EFFECT OF GEAR SELECTION, F76a TEST

Bike No.	Make/Model	Tachometer	Gear	F76a (dB)	Accel. Dist.
703C	Honda XL350	Rev. Control	2nd	76.2	39
			3rd	76.5	79
732	Can Am Qualifier 250	Dynall	2nd	83.0	25
			3rd	82.0	56
		Gate	2nd	82.7	25
			3rd	81.5	50
734	Can Am Qualifier 175	Rev. Control	2nd	84.1	28
			3rd	85.0	72

Vehicle Speed Measurement Techniques

One method to either establish, or to verify, closing rpm is to measure vehicle speed. The engine rpm could be calculated, knowing the gear ratio and effective radius of the rear wheel, or alternatively the speed measurement can be used as a transfer device as used in this study (described earlier).

Tape Switch Speed Gate

A pair of commercially available tape switches (McMaster-Carr, Cat. No. 7379K1) was used for speed/rpm reference throughout the test program. The tape switches activated an interval counter (such as Systron-Donner 1033 series) with read-out to tenths of milliseconds. The tape switches are convenient to use and are adequate for street bikes. Off-road bikes present a problem, where the knobby tires may not actuate the switch. For this situation one-inch wide metal strips were placed over the tape switches; this is not a recommended procedure since accuracy and reproducibility are degraded.

The estimated accuracy of the average speed measurement across the gate is within 1%; however, there can be an additional error approaching 1% due to the difference between the average gate speed and the peak gate speed.

Photograph H-6 shows the tape switches, together with optical speed measuring instrumentation.

Optical Speed Gate

The problems inherent with the tape switch speed gate can be avoided by use of optical sensors activating the time interval counter, in lieu of tape switches. This concept was evaluated using laser equipment shown in Photographs H-4 thru H-7 (Hughes Aircraft Co., Industrial Products Division, Carlsbad, California; Laser Model 3176H, Power Supply Model 3599H). This equipment was employed because of its ready availability; collimated incoherent light could serve equally well. A double pass of the light beam was employed, with the return pass displayed vertically one-inch above the inital pass. A high probability existed that the light beam would be interrupted by the forward edge of a knobby tire. Also, the higher accuracy inherent in this technique permitted a gate traverse spacing substantially less than one-meter, thereby reducing the difference between peak and average gate traverse time.

The set-up employed, shown in the photographs, was not sufficiently rigid for maintaining alignment after repeated vehicle passes. Accordingly, for expediency in the testing, we reverted to the tape switches since they were adequate.

Radar Gun

Radar guns by two manufacturers were evaluated: CMI Incorporated, Minturn, Colorado; and Kustom Signals, Chanute, Kansas. The units employed were configured for police applications, and different features (which both manufacturers state could be supplied) were needed for the application considered here. The required features (not present in the units employed, but which are available) are:

- display to tenths of mph

- max-hold
- sampling rate of 20 per second or better

The sampling rate of 20 per second was derived from the fact that the rate of change of rpm in the F76a test was typically in the range 1000-2000 rpm/second. If resolution to 100 rmp was desired, sampling interval must be not greater than 0.05 seconds.

The radar gun could be either stationary, or mounted on the vehicle, reading a stationary target. The technique had the advantage that maximum speed determination was not tied to vehicle position; a position variation of ± 5 ft had no effect on noise measurements, providing the correct closing rpm was attained. This permitted greater latitude in vehicle operation than the optical or tape switch techniques.

A further potential feature of the radar gun technique was that if the gun was mounted on the vehicle, the max-hold signal could be used to effect ignition disable (discussed later), thus precisely controlling closing rpm.

Evaluation of the radar gun technique was limited to (a) demonstration of feasibility of the concept, and (b) identification of sources of commercially available units having the required features.

Engine RPM Measurement Techniques

The vehicle speed measurement techniques offered uniform application to a broad range of vehicles, but required correlation of vehicle speed with engine rpm; application to vehicles with automatic transmission was excluded. Direct measurement of engine rpm had fundamental advantages, but such techniques addressed a wide variety of ignition types and pulses per revolution, not identifiable simply by engine type and number of cylinders.

Various types of tachometers (Photograph H-2) were evaluated in relation to their suitability for engine speed measurement in the F76a test:

Vehicle Tachometers

The tachometers supplied on the Japanese motorcycles (as opposed to the European and American motorcycles) were heavily damped, resulting in tachometer lag under vehicle acceleration. This damping was intentional, giving a very steady and smooth rpm indication. The associated lag, however, resulted in F76a closing rpm higher than specified; due to this, measured values of noise emission in the order of 2 dB higher than appropriate were not uncommon (Table H-2). This difficulty was not experienced in the BMW or the large Harley-Davidson street motorcycles.

Optimized Tachometer Damping

A tachometer manufactured by the German firm VDO Automotive Instruments was procured from a local speedometer shop (North Hollywood Speedometer & Clock Co.), and fitted to a Honda GL1000. This tachometer was selected because it was directly interchangeable with the vehicle tachometer, and because its internal configuration was such that its damping (by silicone fluid) could be readily changed for test purposes. The VDO tachometer was tested in three damping configurations on the GL1000 (Table H-4). Configuration 1 was essentially the same as the vehicle tachometer; configuration 2 was underdamped and exhibited undesirable pointer "jiggle"; configuration 3 was intermediately damped and functioned in an entirely acceptable manner. This showed that the vehicle manufacturer's options included (in addition to the various other techniques) fitting production vehicles with optimumly damped tachometers, or alternatively, fitting a special optimumly damped tachometer for F76a test purposes only.

Another tachometer found to have near optimum damping (Table H-4) was the Auto Meter (Auto Meter Products, Inc., Elgin, Illinois) Model 439. It was a fast response electronic tachometer, connecting to the ignition primary, but requiring interface electronics for connection to vehicles with CDI ignition. The tachometer had provisions for ignition disable (discussed later). The unit was ordered for a specific number of pulses per revolution; interestingly, one pulse per revolution was appropriate for all vehicles shown in Table H-4.

Digital Tachometers

The digital tachometer type offered potential for high accuracy, and its circuitry lended itself to additional features such as max-hold read-out and pre-set ignition disable. The digital display, however, was not well suited for rider control of closing rpm in the acceleration test; for rider control, an analog display was considerably easier to use.

Radio Tachometers

On two motorcycles (a 4-cyl. 4-stroke, and a 1-cyl. 2-stroke) a Hartman Wireless Tachometer (mfgr. no longer in business; provided by Kawasaki Motors corp., U.S.A.) was evaluated (Table H-4). The tachometer functioned well, required no connection to the motorcycle, and could be mounted either on the motorcycle* or located remotely.

It was also demonstrated that Harmon Tach II, with max-hold, could be activated by a radio link. For this demonstration, a Vega Electronics (Division of Computer Equipment Corp., Santa Ana, California) radio microphone was employed for the radio link. The microphone circuit (with microphone removed) picked up RF energy from proximity to a spark plug lead. By this technique an operator recording noise levels could simultaneously verify that correct closing rpm had been attained on each pass.

Portable Tachometers

Motorcycles not equipped with tachometers necessarily require fitting a portable tachometer for the F76a test. Portable tachometers employed in the study included the Sanwa Model MT-03, the Rite Autotronics Model 4036, and the Dynall Model TAC-20. The Sanwa and Rite exhibited substantial lag (H-2); the Dynall was good in this respect but would not function on all motorcycles. The above three tachometers are able to be connected to the ignition secondary, which was an operational convenience.

*The tachometer face had to be vertical, otherwise the needle would respond to inertial forces during vehicle acceleration.

The Auto Meter 439 (or 430 series) which altnough not designed for portable use, and required connection to the ignition primary (e.g. to the kill button wire) was a suitable candidate for use in the F76a test. The additional option of ignition disable offered major additional advantages, discussed later.

Other candidate portable tachometers included the Harman Radio Tachometer, and the Dixom Model 1081 Inductive Tachometer (Dixon, Inc., Grand Junction, Colorado). The latter was a close range RF tachometer, subjected to the specification review only, not evaluated in this study.

Ignition Disable Techniques

Because of the dependence of measured noise level on closing rpm in the F76a test, means of shutting off the engine by means of a pre-set ignition disable were evaluated. (Preciseness in closing rpm can be important in the J331a test also, particularly where closing conditions are reached with the vehicle close to the microphone). Available as a companion item to the Auto Meter 439 Tachometer, was the Auto Meter 451 Rev-Control. This combination of a low-lag tachometer with automatic ignition disable enhanced the rapidity, reproducibility, and accuracy in the conduct of the F76a test.

In the test program, for motorcycles having a single ignition system with breaker points, the Rev-Control unit was connected across the points. For vehicles having two ignition systems (2 pair of breaker points), such as the GL-1000, the Rev-Control was connected to each system thru a diode, thus maintaining electrical isolation of the two systems (Figure H-3). (Auto Meter has since made available a Model 451-1 Rev-Control, which incorporates the isolation diodes).

For motorcycles having CDI magneto ignition systems, the Auto Meter tachometer will function (but not read correctly) if connected to the "trigger" terminal, but can be made to read correctly if connected to the engine "kill" circuit thru a capacitor of proper value. For the motorcycles tested (Table H-4), the proper values were in the range 0.002 to 0.0072 mfd. A decade capacitor box having 0.0001 mfd steps was employed as an expediency measure; it was presumed that interface electronics could be selected to obviate need for such adjustment.

While conducting the F76a test using the Rev-Control, a single pass was sufficient to establish the acceleration start point. During the prescribed runs, when ignition disable occurred, the throttle was closed promptly, thus avoiding backfire when ignition was re-established by pressing the "re-set" button.

Referring to Table H-4, the designation "Auto Meter" refers to the Model 439 Tachometer without ignition disable; the designation "Rev-Control" refers to the Model 439 Tachometer and Model 451 Rev-Control combination. For each entry in the table, performance of the tachometer configuration was compared to noise and rpm measurements obtained with the tape switch gate technique (which was used as the reference, and subject to some uncertainty in the case of the off-road motorcycles having knobby tires, as explained earlier.

TABLE H-4 TACHOMETER AND REV. CONTROL COMPARISONS, F76a TEST

Motorcycle No.	Make/Model	F76a rpm	Tachometer	dB re Gate	Tach. Lag
702	Honda GL1000	4500	Honda	1.7	390
702A	Honda GL1000	4500	Rev. Control	0.2	10
731	Honda GL1000	4500	Honda	1.3	370
			Auto-Meter	0.4	90
			VDO Config. 1	2.0	300
			VDO Config. 2	0.1	80
			VDO Config. 3	0.1	110
			Hartman	0.3	70
703	Honda SL350	5400	Honda	2.5	420
703A			Auto-Meter	0	40
703B			Rev. Control	-0.3	-50
703C			Rev. Control	-0.4	-170
716A	Suzuki GS550	6075	Suzuki	0.9	470
			Auto-Meter	-0-	-220
			Rev. Control	0.5	60
720	Harley SS175	5820	Harley	1.5	310
			Rev. Control	-0.2	-0-
725	Yamaha DT250D	4950	Yamaha	0.9	890
			Dynall	0.6	320
			Rev. Control	-0.4	--
730	Yamaha DT100D	6300	Dynall	0.5	70
			Rev. Control	-0.9	--
733	CanAm Qualifier 125	7990	Dynall	0.9	-60
			Hartman	0.4	30
			Rev. Control	0.6	--
734	CanAm Qualifier 175	7330	Rev. Control	-0-	-120

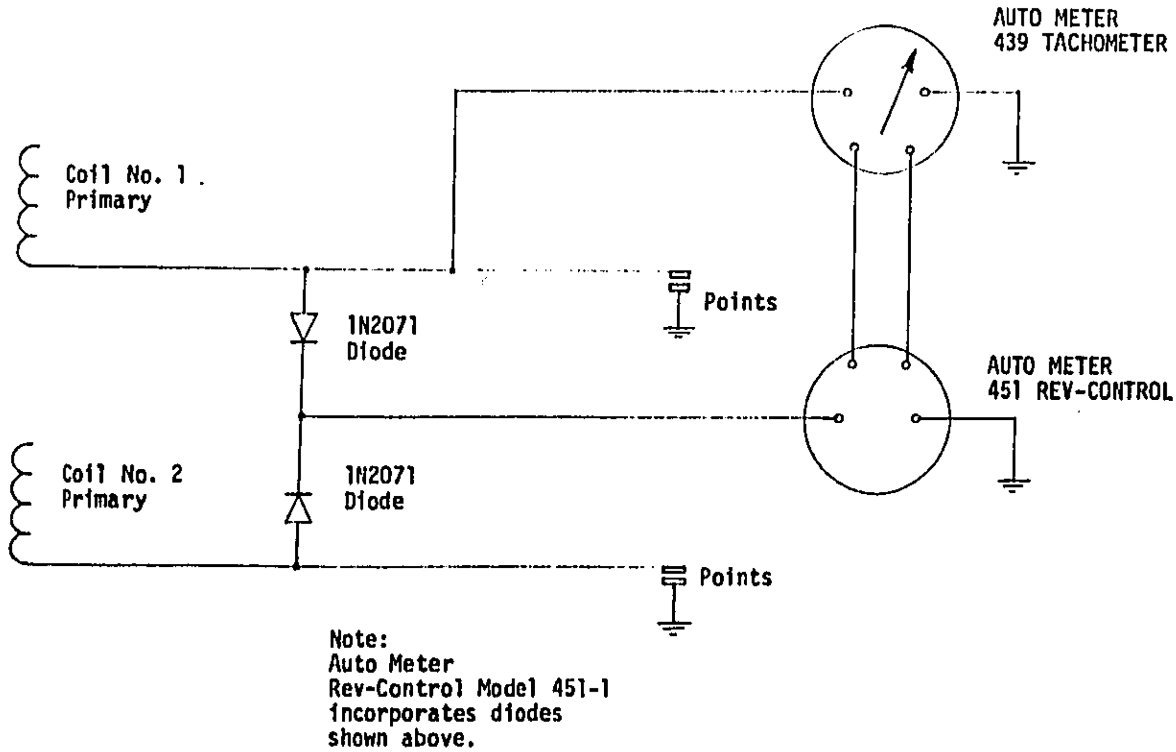


FIGURE H-3 METHOD OF CONNECTING REV-CONTROL TO MOTORCYCLE HAVING DUAL IGNITION SYSTEM

IMI Test Procedures

In the IMI procedures the measured level is dependent on how rapidly the throttle is opened, on the reaction time of the operator in closing the throttle at the "correct" point, and the tachometer lag. The duration of the operation from throttle opening to initiation of throttle closing was on the order of 0.35 seconds. Considering that the human reaction time (seeing the tachometer needle at closing rpm value, to initiating hand motion to close throttle) was on the order of 0.2 seconds, it appeared that mental anticipation was probably involved in performing the test. Also, considering that rates of change of rpm will be in excess of 8000 rpm/sec., the actual rpm overshoot could be much greater than the rpm overshoot indicated by the tachometer. On motorcycle No. 729, where the Dynall tach was used, indicated overshoot was 12,000 rpm (associated with an F76a rpm of 8200).

Noise level measurements taken on the various motorcycles by IMI-C and IMI-E procedures are presented in Table H-5. Considering the foregoing, the degree of repeatability and consistency among operators was better than might be expected - usually within a 3 dB range, although differences of 6 dB were encountered.

In view of the success of the Rev-Control in the F76a test, its application was briefly evaluated in the IMI-C test, with results presented in Table H-6. The substantial improvement in consistency was apparent. Also, comparing the IMI-C levels for motorcycle No. 703 in Table H-6 with that for the same motorcycle in Table H-5, considerably lower noise levels resulted with use of the Rev-Control. Table H-8 provides further data on consistency among operators when the Rev-Control technique was employed in the IMI test.

In the IMI-C50 test, the same distance relationship between the vehicle and microphone prevailed as in the F76a test at closing conditions. A comparison of noise emission measurements by the two methods is shown in Table H-7 which is sufficiently good to warrant further consideration of the IMI-C50 as a substitute for the F76a method.

Also of potential value would be the investigation of correlation between IMI-(noise level measurement at 10 ft.) and F76a, both by Rev-Control. Such data was obtained for two motorcycles only: No. 703B where the difference was 14.8 dB, and No. 716A where the difference was 15.5 dB. The theoretical difference, by the inverse square law, was 15.0 dB. The closer distance offered obvious advantages in space requirements, environmental noise constraints, and perturbations by atmospheric factors.

Effect of Torque (Dynamometer Tests)

The objective here was to provide information on the effect of torque (at constant rpm) on noise levels. The portable dynamometer employed (Pabatco) was not well suited to this task, and only limited data were obtained (Table H-9). Even though precautions were taken to quiet the dyno by use of lead vinyl blankets, it was apparent to the "rider" that dyno noise (from the hydraulic pump) was contributing significantly to the total noise. Difficulty was also experienced in establishing stable operation at desired rpm/torque conditions. For these reasons this effort was discontinued.

TABLE H-5 IMI NOISE LEVELS (Procedures C and E)

Coding: L = Left side of bike, dBA @10'
R = Right side of bike, dBA @10'
T = Max. tachometer reading, RPM/100

Motorcycle No.	MAKE/MODEL		IMI "C"					IMI "E"			OPERATOR
701	Honda 750K	L	100	101	101			97	98	98	VP
		R	99	99	100			98	98	99	
		T	68	72	74			64	64	68	
		L	101	101	101						JW
		R	100	99	100						
		T	76	76	76						
		L	99	101	100			97	97	98	IW
		R	99	100	100			99	98	99	
		T	68	76	70			64	64	68	
		L	101	100	--	102					SE
		R	101	99	100	102					
		T	78	74	76	81					
		L	99	98	98	99	97	94	95	94	DF
		R	99	98	99	100	99	93	93	94	
		T	68	63	66	72	64	56	56	54	
702	Honda GL1000	L	95	95	94			95	96	96	VP
		R	92	92	92			90	93	92	
		T	64	59	61			54	61	59	
		L	95	95	95	92	94				RL
		R	93	92	93	90	92				
		T	--	60	65	55	60				
		L	90	90	90						DF
		R	88	88	88						
		T	52	54	54						

TABLE H-5 IMI NOISE LEVELS (cont'd) (Procedures C and E)

Motorcycle No.	MAKE/MODEL		IMI "C"				IMI "E"				OPERATOR
703	Honda XL350	L	96	98	97		96	96	96		VP
		R	93	95	94		94	94	94		
		T	--	70	72		67	68	68		
		L	96	95	96						RL
		R	94	93	94						
		T	70	70	70						
		L	94	97	96	97					SE
		R	92	95	94	95					
		T	68	75	70	75					
		L	95	96	95						DF
		R	93	92	93						
		T	70	70	70						
		L	97	97	96						IW
		R	94	95	94						
		T	70	72	70						
		L	91	94	95	93	94	93	93		TB
		R	93	95	96	96	97	95	95		
		T	65	67	70	68	68	65	65		
		L	91	96	95	96	94	95	93		MM
		R	93	98	97	97	95	96	96		
		T	62	72	72	73	66	70	66		
		L	96	98	96		96	94	95		IW
		R	98	98	97		97	97	96		
		T	74	76	74		70	67	68		
		L	99	99	100		93	93	94		JA*
		R	98	99	100		93	93	95		
		T	78	80	80		70	70	74		
		L	98	94	96	96	94	96	92	94	IW
		R	98	94	96	96	94	96	94	94	
		T	78	78	80	80	78	78	70	78	
		L	94	93	94		91	92	93	92	GL
		R	95	94	95		92	93	95	92	
		T	76	76	76		68	72	74	68	

*First try, no demonstration, no motorcycle experience.

TABLE H-5 IMI NOISE LEVELS (cont'd) (Procedures C and E)

Motorcycle No.	MAKE/MODEL		IMI "C"				IMI "E"					OPERATOR
704	Honda MR250	L	104	103	103		102	102	102			TB
	(Rite Tach.)	R	103	103	103		102	102	101			
		T	100	95	94		94	90	89			
		L	103	103	104		105	102	103	103		IW
		R	103	103	103		102	102	102	101		
		T	92	93	93		85	86	88	86		
		L	103	103	105	104						OH
		R	102	102	103	103						
		T	93	90	93	92						
							103	102	103			MM
							103	102	103			
							91	90	93			
705	Kawasaki KZ1000	L	99	100	99		99	--	98	99		
		R	98	99	98		98	99	98	98		
		T	65	65	62		58	62	59	60		
		L	99	101	98	100	101	102	101			RH
		R	99	100	99	100	102	102	101			
		T	65	70	63	67	65	70	66			
		L	96	99	99	100	97	94	100	97	97	TB
		R	95	99	98	99	97	95	99	97	98	
		T	58	65	61	65	55	51	61	53	54	
		L	103	102	105	102	102	101	102			IW
		R	101	101	104	102	102	101	102			
		T	78	70	81	72	69	65	67			
706	Kawasaki KZ650	L	100	100	99		99	100	101			
		R	98	98	97		97	98	98			
		T	65	65	65		58	60	61			
707	Kawasaki KE250	L	97	97	96		97	96	96			
		R	97	96	96		96	96	96			
		T	75	72	72		70	70	70			

TABLE H-5 IMI NOISE LEVELS (cont'd) (Procedures C and E)

Motorcycle No.	MAKE/MODEL		IMI "C"					IMI "E"				OPERATOR
708	Husqvarna 360WR (Dynall Tach)	L	103	104	105			104	104	104		
		R	105	105	105			104	104	104		
		T	50	52	50							
709	Kawasaki KZ400	L	99	99	100			98	95	96	97	
		R	101	101	101			100	98	98	100	
		T	82	82	82			82	75	78	80	
710	BMW R100/7	L	91	93	92			90	90	91		VP
		R	93	95	94			91	92	92		
		T	70	70	70			55	55	55		
711	Kawasaki KX125	L	103	103				103	102	102		
		R	107	107				107	106	106		
		T	110	110				100	98	98		
712	Honda TL125 (Harmon Tach)	L										
		R	97	97	97							
		T	82	90	80							
		L										
		R	92	93	94							
		T	84	78	.94							
713	Harley FX-1200	L	99	97	97			94	93	94		HH
		R	101	100	100			97	95	96		
		T	48	45	47			40	38	38		
714	Harley XL1000	L	96	97	100	94	95					IW
		R	98	98	101	94	97					
		T	48	48	55	45	47					

TABLE H-5 IMI NOISE LEVELS (cont'd) (Procedures C and E)

Motorcycle No.	MAKE/MODEL		IMI "C"				IMI "E"				OPERATOR
710A*	BMW R100/7	L	97	98	97		91	89	92	92	TB
		R	96	97	96		91	88	91	91	
		T	75	77	74		56	52	54	54	
		L	99	99	98	98	92	93	95	93	GL
		R	99	98	97	98	93	92	95	92	
		T	77	76	73	77	53	55	63	54	
		L	98	99	97		93	92	93		IW
		R	97	98	96		94	92	93		
		T	72	76	73		52	53	57		

*710A is same bike as 710, received back a month later.

TABLE H-5 IMI NOISE LEVELS (cont'd) (Procedures C and E)

Motorcycle No.	MAKE/MODEL		IMI "C"					IMI "E"							OPERATOR
715	Bultaco Frontera 250	L	108	108	109			108	109	109					IW
	(Sanwa Tach)	R	109	108	109			107	107	108					
		T	90	88	88			82	83	84					
		L	107	108	109										TB
		R	106	107	108										
		T	97	90	89										
717	Suzuki GT380	L	102	100	103	102		101	100	101					IW
		R	103	100	102	101		101	100	102					
		T	90	80	90	85		80	75	80					
		L	102	99	102	100									TB
		R	100	97	100	99									
		T	82	64	82	78									
718	Suzuki GS400X	L	99	100	100			94	95	93	100	97	98	95	IW
		R	99	101	100			94	95	93	100	97	97	95	
		T	80	80	77			64	64	58	71	68	68	64	
		L						96	96	96					TB
		R						95	97	96					
		T						65	69	65					
719	Harley FLH-1200	L	102	102	102			97	98	101	97				TB
	(Dynall Tach)	R	102	102	101			97	99	101	98				
		T	55	57	55			49	51	64	49				
		L	104	102	102	104	102	97	97	98					GL
		R	103	101	102	103	102	99	97	99					
		T	57	53	53	57	54	48	47	50					
		L	103	102	103			97	97	97					IW
		R	102	103	102			98	98	97					
		T	58	58	58			46	50	48					

TABLE H-5 IMI NOISE LEVELS (cont'd) (Procedures C and E)

Motorcycle No.	MAKE/MODEL		IMI "C"			IMI "E"	OPERATOR
716	Suzuki GS550	L	100	100	100		IW
		R	100	100	101		
		T	88	86	90		
		L	98	97	98		JW
		R	98	98	98		
		T	78	75	75		
		L	97	97	99		SE
		R	98	98	99		
		T	74	76	81		
		L	99	99	98		VP
		R	99	98	98		
		T	80	80	78		

TABLE H-5 IMI NOISE LEVELS (cont'd) (Procedures C and E)

Motorcycle No.	MAKE/MODEL		IMI "C"				IMI "E"				OPERATOR
720	Harley SS-175	L	98	99	98		97	95	96		IW/GL
		R	97	97	96		97	95	95		
		T	85	85	81		81	77	78		
		L	97	99	98		96	94	95		TB
		R	96	96	95		96	94	94		
		T	80	82	80		80	77	78		
		L	96	95	95		97	96	96		MM
		R	95	93	94		97	96	96		
		T	78	79	78		83	80	80		
721	Harley SX-175	L	97	97	97		96	96	95		TB
		R	95	95	96		95	94	95		
		T	90	90	95		100	98	98		
		L	97	97	97		95	94	94		IW
		R	96	96	96		95	93	93		
		T	95	93	94		95	82	85		
		L	97	96	97	97	94	96	94	96	MM
		R	96	93	95	95	93	95	92	95	
		T	93	85	92	93	86	100	83	92	
722	Suzuki TS400B	L	100	102	100		102	100	102		
		R	101	101	101		101	101	103		
		T	56	56	56		56	56	58		

TABLE H-5 IMI NOISE LEVELS (cont'd) (Procedures C and E)

Motorcycle No.	MAKE/MODEL		IMI "C"			IMI "E"			OPERATOR
723	Bultaco Alpina 350	L	104	104	104	104	104	105	IW
	(Sanwa Tach)	R	101	102	102	100	100	102	
		T	65	65	66	57	59	63	
		L	104	104	104	103	104	104	TB
		R	102	102	102	101	102	102	
		T	65	65	65	63	64	64	
		L	108	105	104	105	105	104	MM
		R	104	103	102	102	103	102	
		T	70	67	65	65	65	65	
724	Honda XR75	L	101	100	102	101	100	102	TB
	(Rite Tach)	R	102	102	102	102	100	102	
		T	31	29	31	30	29	30	
		L	98	97	98	97	99	98	EO
		R	98	97	97	98	100	98	
		T	28	26	27	26	28	26	
		L	101	101	101	99	101	99	MM
		R	101	101	102	99	101	99	
		T	30	30	31	28	29	27	
725	Yamaha DT250D	L	101	101	101	98	99	100	IW
		R	101	102	102	99	99	98	
		T	68	69	70	57	61	61	
		L	100	100	100	99	98	98	TB
		R	101	101	101	99	99	99	
		T	68	67	67	65	64	64	
		L	101	101	99				MH
		R	102	102	101				
		T	69	69	67				
		L				97	99	98	GL
		R				98	100	100	
		T				54	63	57	

TABLE H-5 IMI NOISE LEVELS (cont'd) (Procedures C and E)

Motorcycle No.	MAKE/MODEL		IMI "C"					IMI "E"				OPERATOR
726	Yamaha XT500D	L	100	97	98	99		101	97	100	102	TB
		R	98	97	98	99		99	98	99	99	
		T	62	57	58	59		60	58	60	61	
		L	102	104	101	100	100	99	99	100		MM
		R	102	102	100	98	99	98	99	98		
		T	64	69	62	62	62	59	59	60		
		L	101	102	102			102	101	103		IW
		R	100	101	101			101	101	102		
		T	62	65	65			63	62	65		
727	Yamaha SX650D	L	102	103	105	103		102	102	100		IW
		R	102	103	105	103		102	102	101		
		T	68	72	75	72		64	65	60		
		L	101	102	99	99		99	101	99	100	TB
		R	101	101	100	100		99	101	99	100	
		T	65	66	64	64		55	60	65	58	
		L	99	98	99			100	101	100		MM
		R	99	97	99			101	101	101		
		T	62	57	62			62	62	60		
728	Yamaha IT400D (Sanwa Tach)	L	104	104	104			102	103	102		TB
		R	104	104	104			102	103	103		
		T	70	72	70			64	65	65		
		L	104	105	106	105		104	104	105		MM
		R	104	107	108	106		106	106	106		
		T	74	76	82	76		74	76	76		
		L	107	108	108			105	105	106		IW
		R	108	109	110			105	106	107		
		T	82	84	85			78	76	78		

TABLE H-5 IMI NOISE LEVELS (cont'd) (Procedures C and E)

Motorcycle No.	MAKE/MODEL		IMI "E"				IMI "E"			OPERATOR
729	Yamaha IT175D	L	107	108	108		107	105	106	IW
	(Dynall Tach)	R	105	106	105		106	106	106	
		T	120	118	118		121	118	121	
		L	109	108	108		106	106	107	GL
		R	106	106	106		104	105	105	
		T	117	118	120		121	121	118	
		L	106	107	105		106	106	106	MM
		R	105	105	105		105	106	105	
		T	120	118	120		120	117	120	
730	Yamaha DT100D	L	94	95	94		93	94	94	TB
	(Dynall Tach)	R	97	97	97		96	96	97	
		T	115	115	114		112	112	112	
		L	94	94	95		93	93	93	GL
		R	96	96	97		95	96	96	
		T	112	112	113		112	112	111	
		L	94	94	94		93	93	94	MM
		R	95	95	96		94	94	95	
		T	111	112	112		112	112	112	
731	Honda GL1000 #2	L	97	95	95		97	97	97	JA
		R	97	94	95		97	97	97	
		T	70	64	64		54	72	72	
		L	95	97	98	96	97	98	98	GL
		R	95	97	97	96	97	98	98	
		T	63	73	73	68	71	73	74	
		L	95	94	95		95	95	96	TB
		R	95	94	95		96	94	96	
		T	65	63	65		64	59	65	

It should be noted, however, that there are commercially available dynamometers which offer potential for noise testing; one such unit is the AESi motorcycle dynamometer, which can be programmed to maintain a pre-set rpm, which is maintained stable regardless of throttle setting or developed torque.

Operator Exposure to Motorcycle Noise

Noise levels at the operator's ear were obtained by analysis of magnetic tape cassettes recorded on a modified Sony TC-55 "Cassette-Corder", identified as Model IRI Mk3 "Ear Bug" Personal Noise Exposure Recorder, developed by the Industrial Research Institute of the University of Windsor. The modifications permitted the use of a miniature piezoelectric ceramic microphone, two precision input attenuators, and an input filter network resulting in an aweighted spectrum recording.

Signal drop-outs and level changes encountered during field usage were traced to the microphone holder and ear clip combination; soldering leads directly to microphone, and inserting the microphone in a foam holder taped to the ear, solved the problem. The recorder, calibrator, microphone and microphone holder are shown in Photograph H-14.

Tests were performed to determine the validity of the A-weighted noise levels (SL) derived from the "Ear Bug" system; simultaneous recordings were made with a laboratory precision system consisting of a NAGRA IV-B tape recorder, a Bruel and Kjaer 1/2 inch condenser microphone (with a wind-tip) and associated electronics. Simultaneous ear-level measurements (within a helmet) are shown in Table H-10 together with the 50 foot Sound Level Meter (SLM) responses during the same events. In an additional test, the ear level miniature microphone was taped to a SLM microphone, and 3 motorcycle passby noises in real time noted and compared to the recorded SL for the same events, as shown in the bottom of Table H-10.

The average SL (rounded to the nearest dB) at the ear of the operator during various moving motorcycle tests is shown in table H-11; each of these SL is typically the average of from 6 to 12 passes. Ear level SL during IMI stationary tests are sown in Table H-12 and those obtained during stationary dynamometer tests are shown in Table H-13.

The difference between the formal 50 foot Noise level during passby test and the average noise level at the operator's ear during the same passby is shown in Table H-14. The mean noise level difference for the whole set (n-31) is 19.6 dB, with a standard deviation of 2.4. Note that it is about the same as the noise level difference obtained in dynamometer tests (Table H-13).

Recordings of ear level motorcycle noise in presence of wind have clearly audible wind noise; this effect is shown in Table H-15.

Typical Noise levels at the operator's ear during the operator's verbalization are also shown in Table H-15 note that the highest recorded noise level at the operator's ear is an operator's shout (118 dB).

TABLE H-6 IMI NOISE LEVELS (BY REV-CONTROL)

Motorcycle No.	Make/Model		Noise Level - dB				Operator
703B	Honda XL350 (IMI-C, 3500-5400 rpm)	L	89.0	90.2	90.2	90.2	TB
		R	91.0	91.2	91.3	91.0	
		L	90.2	90.2	90.6	90.8	JA
		R	90.2	90.3	90.1	90.1	
		L	90.1	90.4	90.6	90.2	IW
		R	91.0	91.0	90.3	90.5	
703C	Honda XL350 (IMI-C Variation 4500-6100 rpm)	L	92.0	91.5	91.5		IW
		R	93.0	92.5	92.5		
		L	92.1	92.2	92.5		VP
		R	93.0	93.0	92.8		
		L	92.5	92.0	92.2		JA
		R	93.0	93.0	92.5		
		L	92.5	92.3	92.3		SE
		R	93.6	93.2	93.4		

TABLE H-7. F76a vs 76a STATIONARY SIMULATION

	F76a Stationary Simulation (50 feet)	F76a Rev. Control
Motorcycle No. 730C, Honda XL350	77.	76.2
Motorcycle No. 720, Harley SS175	79.5	78.6
Motorcycle No. 725, Yamaha DT250D	81.8	81.7
Motorcycle No. 730, Yamaha DT100D	77.8	77.7
Motorcycle No. 733, CanAm Qualifier 125	84.7	84.4
Motorcycle No. 702A, Honda GL-1000	76.8	78.3
Motorcycle No. 734, CanAm Qualifier 175	87.6	84.2

TABLE H-8 TACHOMETER AND REV. CONTROL COMPARISONS, IMI-C TEST

Motorcycle No.		Bike Tach			Auto-Meter Tach			Rev. Control			Operator
716A, Suzuki GS550	L	98.6	98.4	98.0	97.0	96.8	96.8	95.0	95.0	95.5	VP
	R	98.5	98.6	98.0	97.0	97.2	96.5	95.8	96.4	95.5	
	T	80	80	78	95	95	95	61	61	61	
	L	96.8	97.4	98.8	93.5	91.5	93.1	94.8	96.1	96.0	SE
	R	97.6	97.7	99.0	93.7	92.0	92.8	95.2	96.7	96.0	
	T	74	76	81		78	84	61	61	61	
	L	97.5	97.3	97.6	93.0	93.0	95.1				JW
	R	98.3	97.7	98.0	93.6	93.8	95.0				
	T	78	75	75	85	84	87				
	L	99.8	99.5	100	98.4	97.2	96.2	95.3	95.5	95.7	IW
	R	99.6	99.6	101	97.4	97.4	96.8	95.3	95.7	95.5	
	T	88	86	90	95	95	95	61	61	61	

TABLE H-9 EFFECT OF TORQUE (DYNAMOMETER TESTS)

Motorcycle No. 703, Honda XL350

2nd Gear

RPM	Normalized Torque	dBA @50 Ft.	dBA @Ear*
5400**	1.00	78.5	99.5
5400	0.63	77.0	96.0
5400	0.41	76.5	95.0
5400	-0-	74.5	
4200***	0.89	76.0	97.5
4200	0.74	73.5	93.0
4200	0.48	72.0	90.5

*With Helmet "B"
**F76a rpm, full throttle
***Full Throttle

Table H-10
COMPARISON OF LABORATORY STANDARD
SYSTEM (NAGRA) AND FIELD SYSTEM (SONY)
NOISE LEVELS (dB)

	NAGRA	SONY	EAST SLM	WEST SLM
	103.2	104.4		
	103.8	104.9		
	104.2	104.4		
J331a,	104.0	104.4	81.5	83.0
wrong rpm	104.0	104.4	82.0	82.5
	104.4	104.4	81.7	83.6
	104.2	104.8	82.5	82.0
	104.0	104.4	82.0	83.9
	104.2	104.8	83.1	82.0
$\bar{x}$	104.0	104.5	$\overline{\text{HIGH}}$:83.0	$\overline{\text{LOW}}$:82.0
σ	.3	.2	FORMAL:83.1	
	103.8	104.2		
	103.8	104.0		
	104.2	104.6	83.0	83.0
J331a	104.0	104.4	82.0	84.0
	104.0	104.2	82.8	82.9
	103.8	104.4	82.5	84.6
	105.2	105.0	82.5	82.6
	103.8	103.8	83.0	84.2
$\bar{x}$	104.1	104.3	$\overline{\text{HIGH}}$:83.5	$\overline{\text{LOW}}$:82.7
σ	.5	.4	FORMAL:83.5	
	103.4	104.0	83.0	82.0
	104.0	104.2	81.7	82.5
F76	103.8	104.4	82.4	81.0
	104.0	104.2	81.8	83.1
	104.8	104.8	82.8	82.5
	104.8	104.8	82.0	84.1
$\bar{x}$	104.1	104.4	$\overline{\text{HIGH}}$:83.0	$\overline{\text{LOW}}$:81.8
σ	.6	.3	FORMAL:82.9	

	REAL TIME SLM	RECORDED SONY
Pass By,	89.6	89.6
Common Microphone	84.3	85.0
Position	88.0	87.2

TABLE H-11

EAR LEVEL MOTORCYCLE NOISE - NOISE LEVELS ROUNDED TO NEAREST dB

Motorcycle Number	J331a	F-76	*	2nd Max	35mph	55mph	55 Coast	Helmet	Notes
704				99	94	102	104	B	
705	102	106						R	See Table 6
		99	t					R	
		97	g					R	
710		102		107				R	
710A	107							R	
712	96	93						B	97 @ 7100 rpm
		96	t					B	idle or 2nd gear
		95	g					B	cruise
718		97	a					R	
		95	v					R	
		94				102	95	0	
719				102	95	92	90	B	
720				97	94	99	100	B	
721				100	94	100	102	B	
722		97	g	98	93	97		B	
723	109	108	t			110	96	B	97 @ 5500rpm B or 0
725	104	104				105	101	B	
		102	t					B	
						107	108	R	
725R		102	t					R	See table 6
		100	g			107	101	R	
730	102	96				105	97	R	See table 6
		99	t						
		100	v						
731	97	96	t					R	See table 6

B = blue helmet, R = red helmet, 0 = bare head
*t = F76a, tach; g = F76a, gate; v = F76a variation

TABLE H-12

EAR LEVEL MOTORCYCLE NOISE DURING IMI TESTS

	Left La_{10},	$\bar{\Delta}$	Ear La	$\bar{\Delta}$	Right La_{10},	Type
Motorcycle Number 730, No Helmet	94		102.6		96.5	IMI C
	94.6		102.8		97	IMI C
	94.3		102.8		96.5	IMI C
		8 1/2		6		
	93		102.6		95.5	IMI E
	93.5		102.6		95.5	IMI E
	94		102.8		97	IMI E
		9		6 1/2		
Motorcycle Number 710A, No Helmet	97		98.8		95.7	IMI C
	97.7		98.6		96.6	IMI C
	97.2		98.6		95.8	IMI C
		1 1/2		2 1/2		
	91		95.0		91	IMI E
	89		92.8		88	IMI E
	91.5		95.2		91	IMI E
		4		4 1/2		
4350 rpm, idle			87			
4350 rpm, idle + talk			96			
Motorcycle Number 731, No Helmet	95.0		101.8		94.7	IMI C
	93.6		101.2		93.6	IMI C
	94.6		101.8		94.6	IMI C
		7		7 1/2		
	95.2		101.8		95.7	IMI E
	94.5		101.2		94.2	IMI E
	96.0		101.4		96.2	IMI E
		6		6		

TABLE H-13

EAR LEVEL MOTORCYCLE NOISE

NOISE LEVEL DIFFERENCES RE FORMAL TEST

Motorcycle No.	J331a	F76	F76a,t	F76a,q	F76a,v
705	25	23	19	19	
710		19			
710A	23				
712	20	18	20	18	
718		14	17		18
722				14	
723	21		19		
725	20	21	19		
725R			19	18	
729	19	20	20	22	
730	23	20	20		20
731	22		17		

TABLE II-14

EAR LEVEL MOTORCYCLE NOISE DURING DYNAMOMETER TESTS

Motorcycle No. 703, Blue Helmet

RPM	TORQUE (2nd gear)	50' La Equiv.	Ear La	Δ db
5400	27	78 1/2	99	20 1/2
5400	27	78 1/2	100	21 1/2
5400	27	78 1/2	99 1/2	21
5400	17	77	96	19
5400	11	76 1/2	95	18 1/2
4200	24	76	97 1/2	21 1/2
4200	20	73 1/2	93	20 1/2
4200	13	72	90 1/2	18 1/2
5400	27	79 1/2	99 1/2	20
Rider's Voice			90-100	
" " Max			102	
" Shout (Mark!)			118	

TABLE H-15

WIND EFFECTS AND VOICE LEVELS

D (Downwind) —— Travel Direction ——> U (Upwind)

Wind Direction
7-12 mph

Motorcycle Number	Test	Upwind	Downwind	Voice/Comments
703	Dyno	--	--	90-100/Talk
703	Dyno	--	--	102/Loud Voice
703	Dyno	--	--	118/Shout
705	J331a	105.8	101.6	--
705	F76	108.1	106.4	--
705	F76at	104.6	99.2	--
705	F76ag	105.3	96.8	--
710	Idle	--	--	96/Talk Max
725	F76at	95.5	93.4	104/Voice Cue
730	55mph coast	97	92	--
731	J331a	98.7	96.7	98.4/Horn

Major results of the ear level study are a) the rider will experience noise levels approximately 20 dB higher than the vehicle's 50-ft. noise emission level (with or without helmet), and b) inexpensive miniaturized noise recording equipment is available for operator noise exposure studies; application not limited to motorcycles.

IMI TEST PROCEDURES

1. IMI-C Test Procedure

Microphone Location: Two microphones, each located 10 ft. from the center of the vehicle, 9 inches above the ground surface, perpendicular to the vehicle centerline at a point midway between the front and rear wheels.

Operation of Vehicle: Stabilize the engine rpm at 50% of max. rated rpm, then open the throttle fully and as rapidly as possible; initiate rapid and full closure of the throttle when the tachometer needle is observed passing through the F76a closing rpm.

Readings: Three sound level readings (dBA, fast response) within 2 dB shall be obtained. The final tachometer reading corresponding with each sound level measurement shall also be recorded.

2. IMI-E Test Procedure

Microphone Location: Same as IMI-C

Operation of Vehicle: Stabilize the engine rpm at 500 to 1000 rpm above idle (such that the engine will respond without hesitation to rapid throttle opening), then open the throttle fully and as rapidly as possible; initiate rapid and full closure of the throttle when the tachometer needle is observed passing through an rpm equal to the F76a rpm minus 15% of the F76a rpm.

Readings: Same as IMI-C

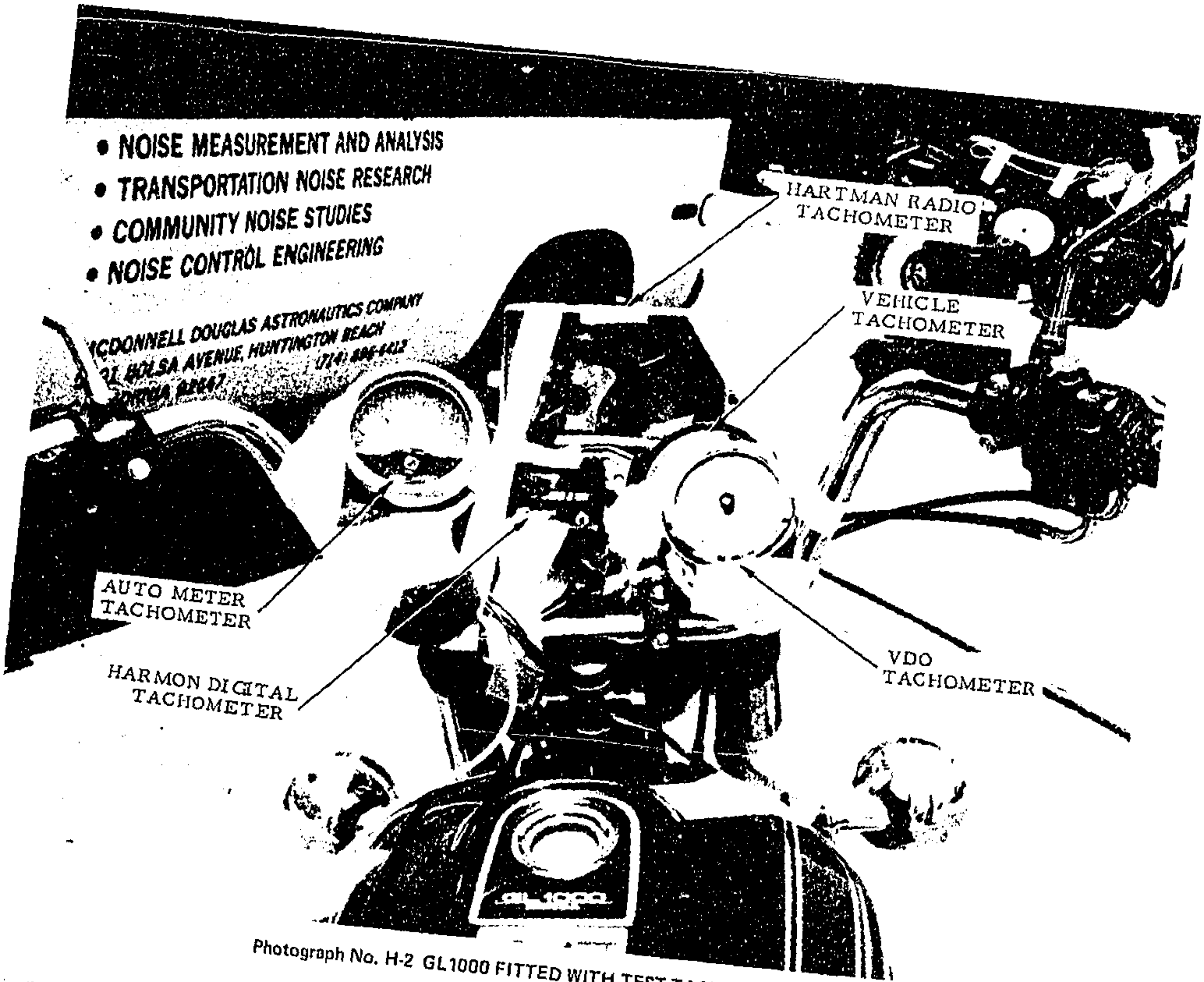
3. IMI -C50 Test Procedure

Same as IMI-C except for microphone location; the microphones are located four feet above the ground, 50 ft. to the side and 25 ft. aft of the front of the vehicle, thereby duplicating the vehicle/microphone relationship of the F76a test.

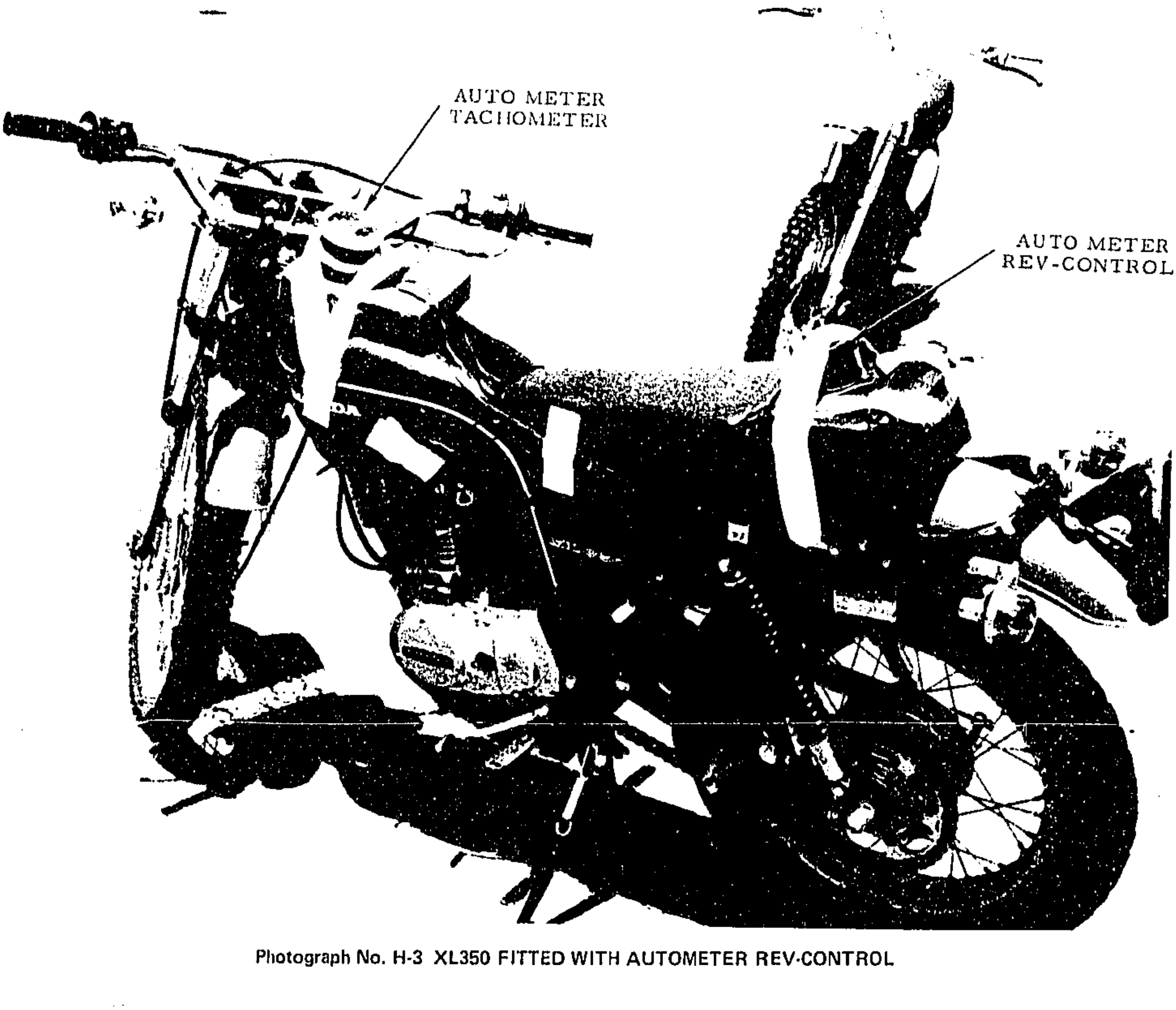
4. IMI by Ignition Disable

Same as the above IMI tests except that closing rpm is effected automatically by ignition disable, pre-set at the specified rpm. The throttle should be closed promptly after ignition disable to avoid backfire.

Photograph No. H-1 INSTRUMENTATION VAN

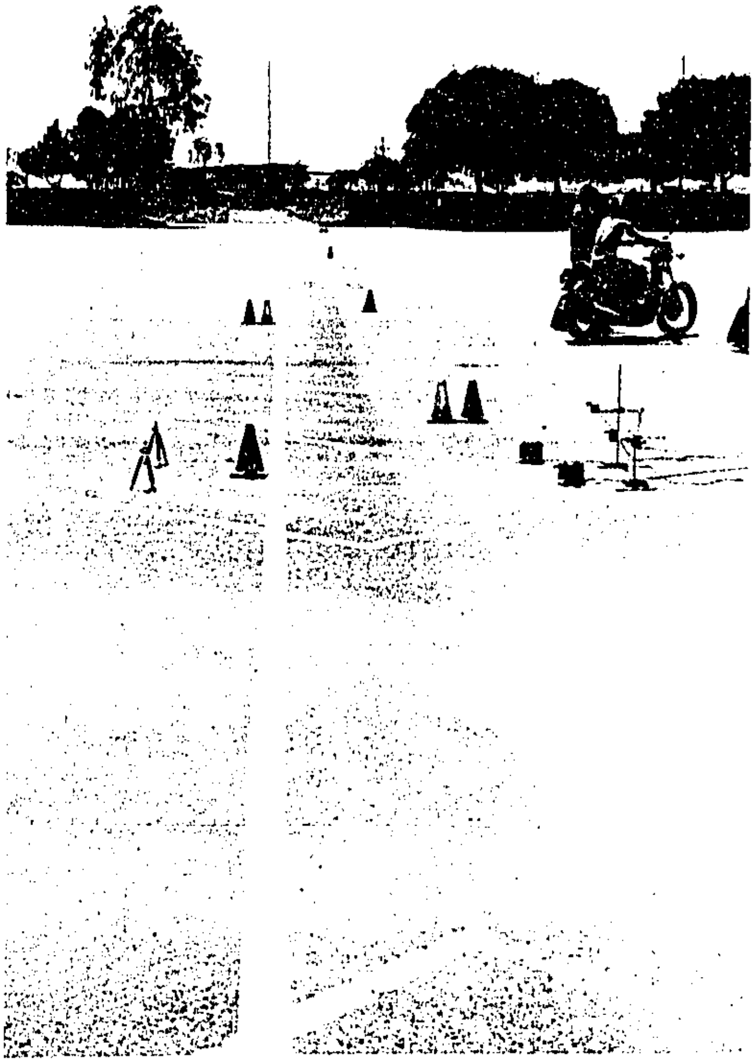


Photograph No. H-2 GL1000 FITTED WITH TEST TACHOMETERS

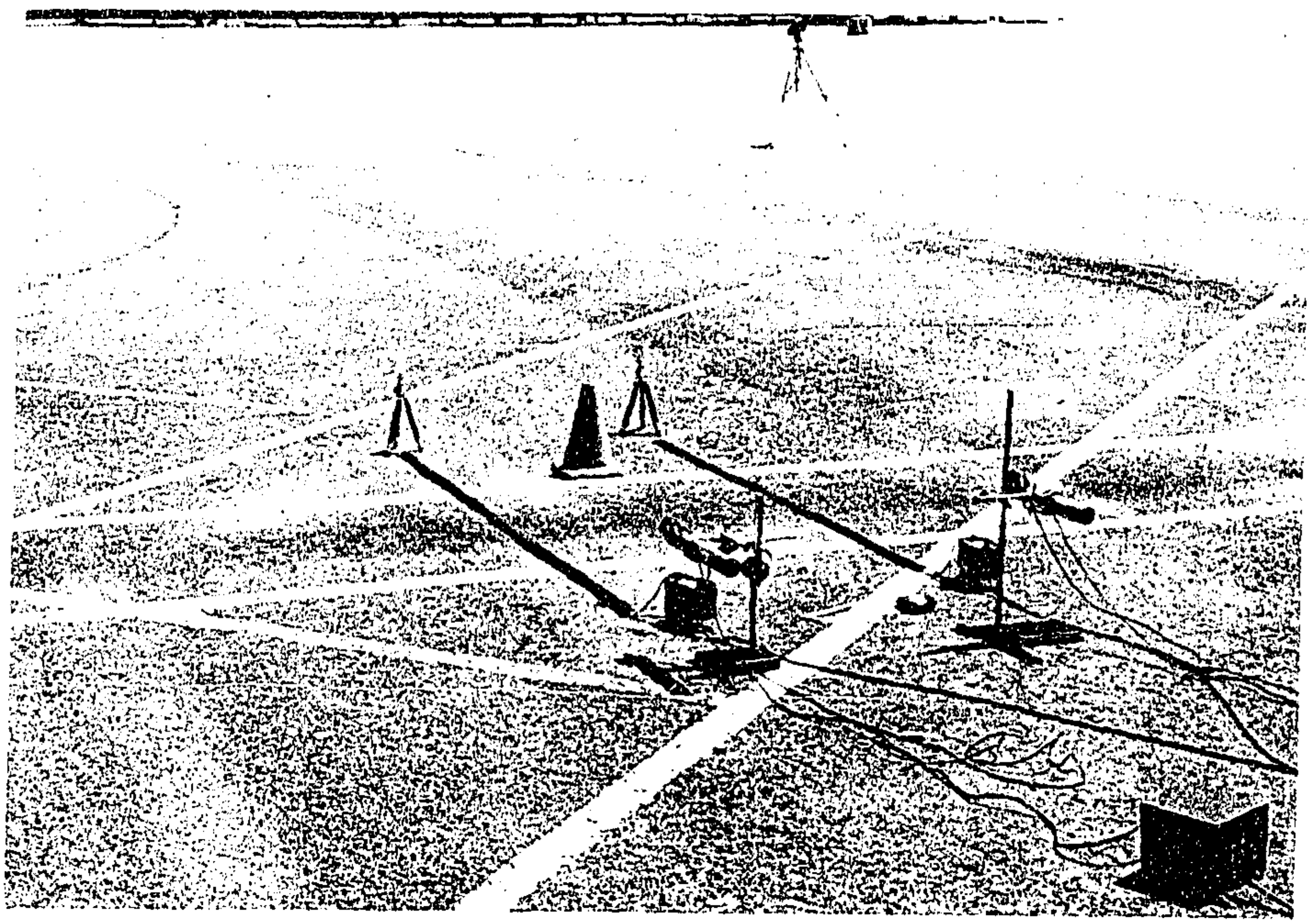


Photograph No. H-3 XL350 FITTED WITH AUTOMETER REV-CONTROL

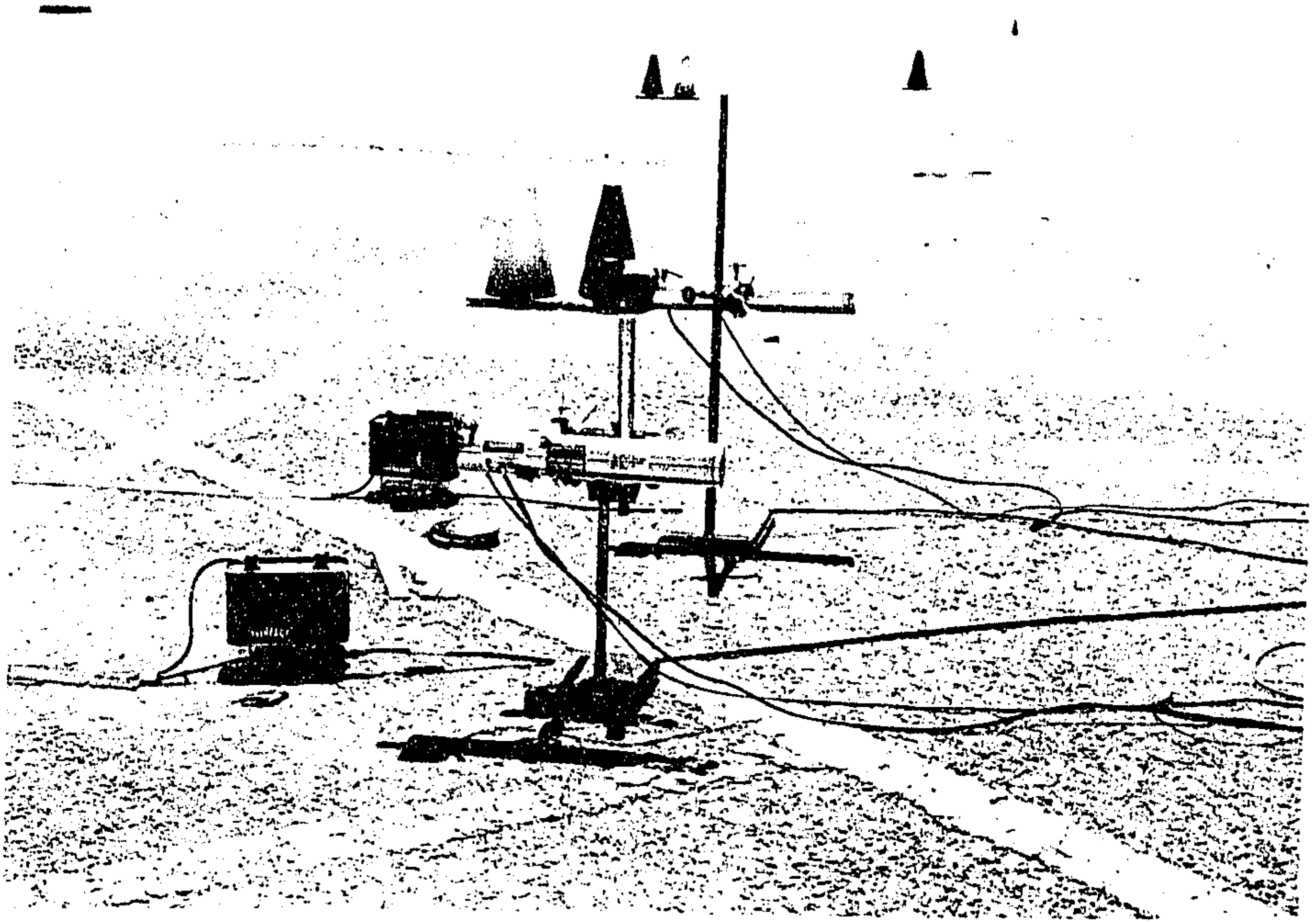
Photograph No. H-4 SPEED SENSORS



Photograph No. H-5 TEST TRACK

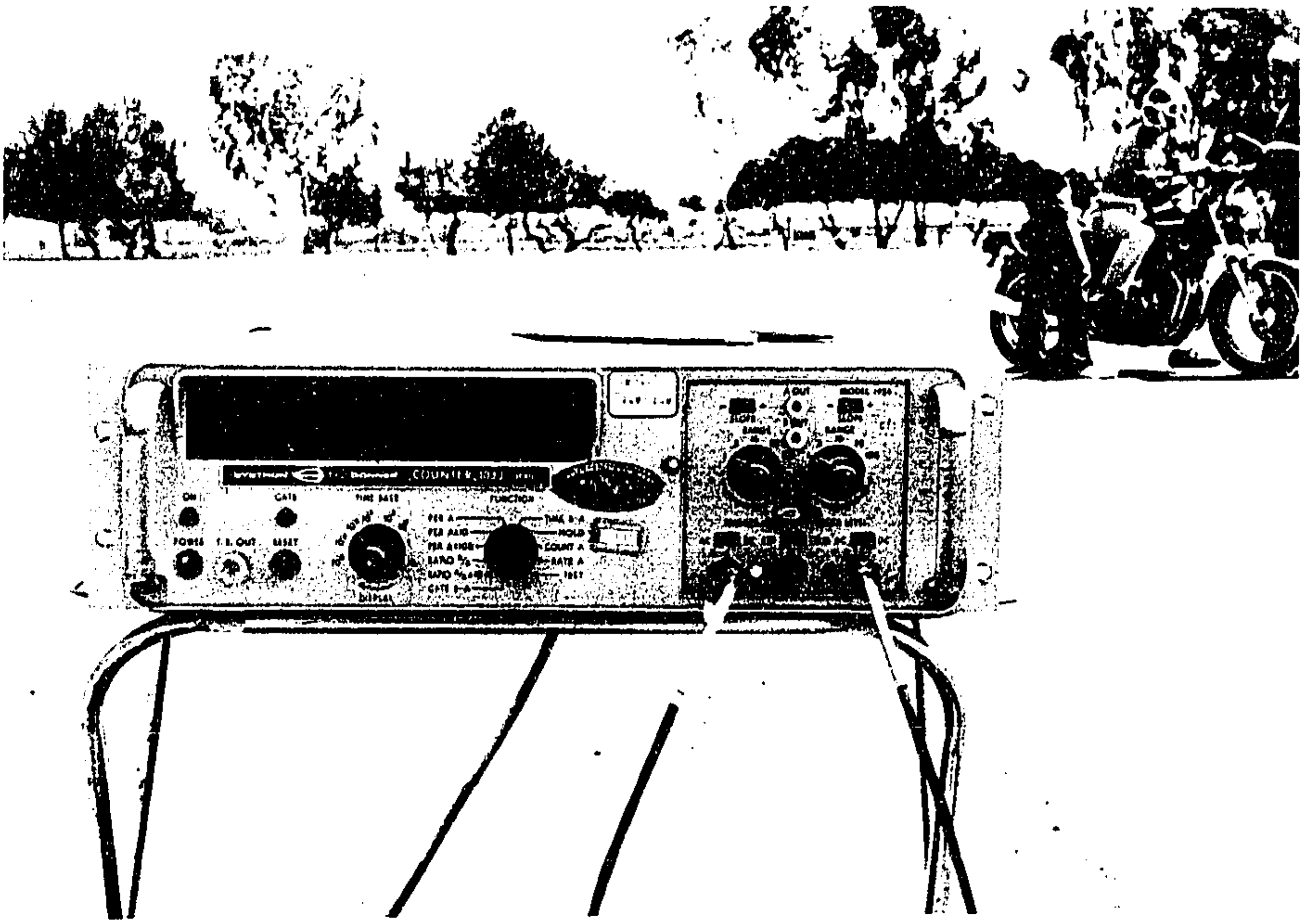


Photograph No. H-6 LASER AND TAPE SWITCHES

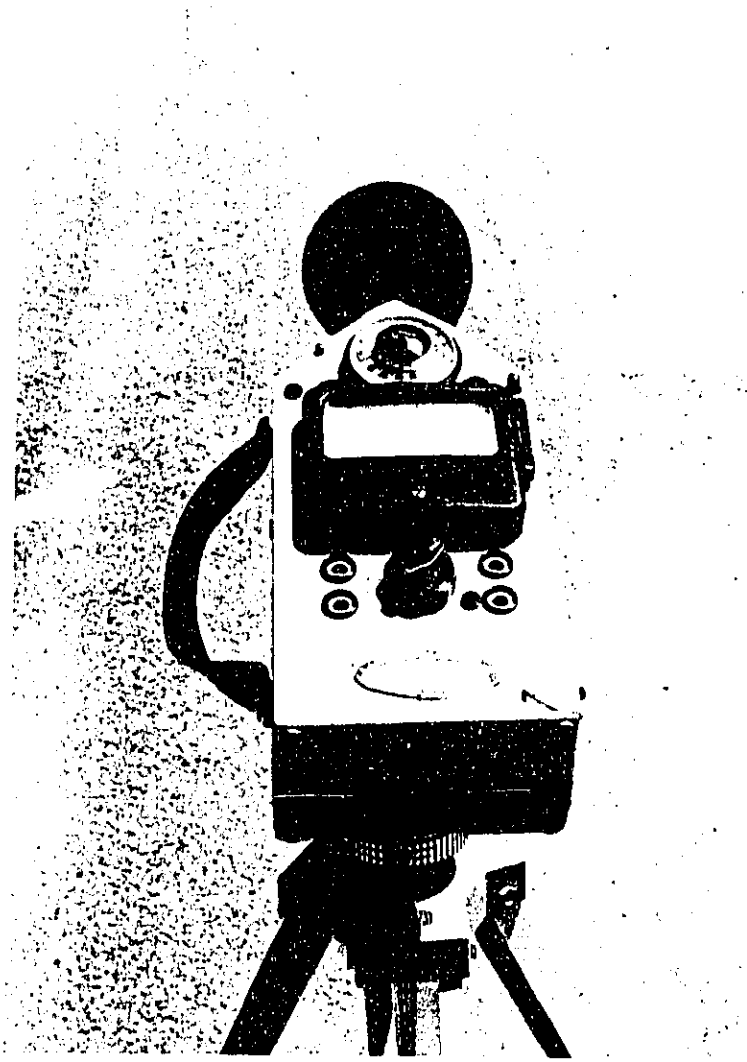


Photograph No. H-7 LASER SPEED GATE

BLACK COPY

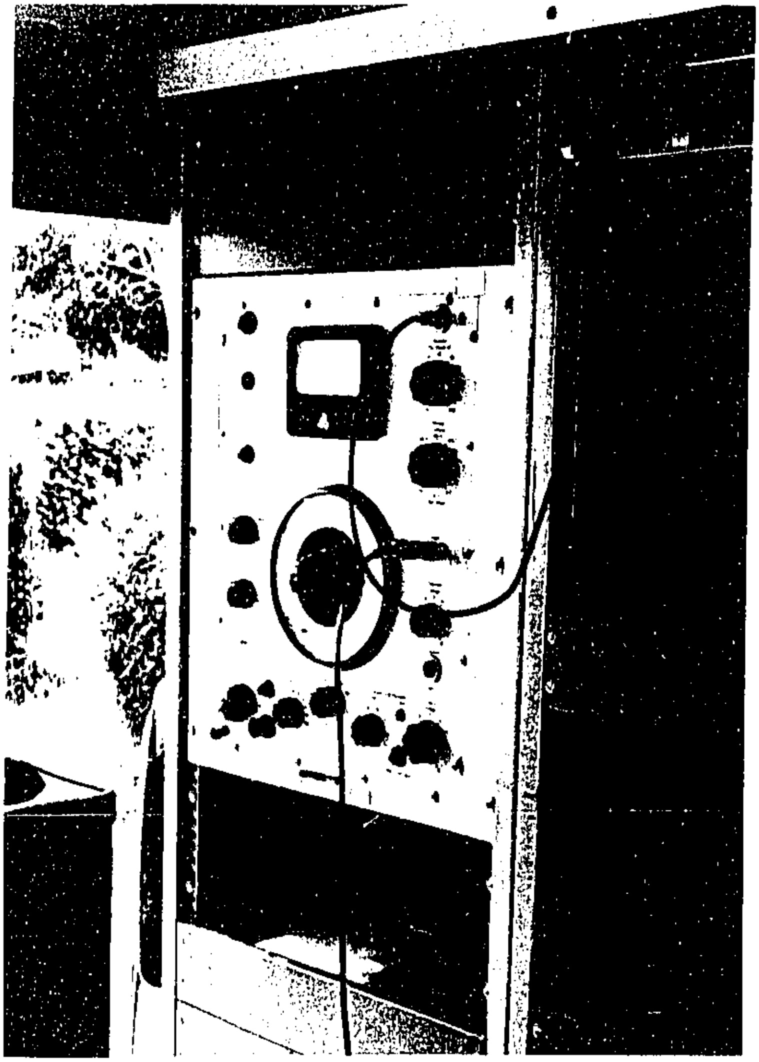


Photograph No. H-8 TIME INTERVAL COUNTER

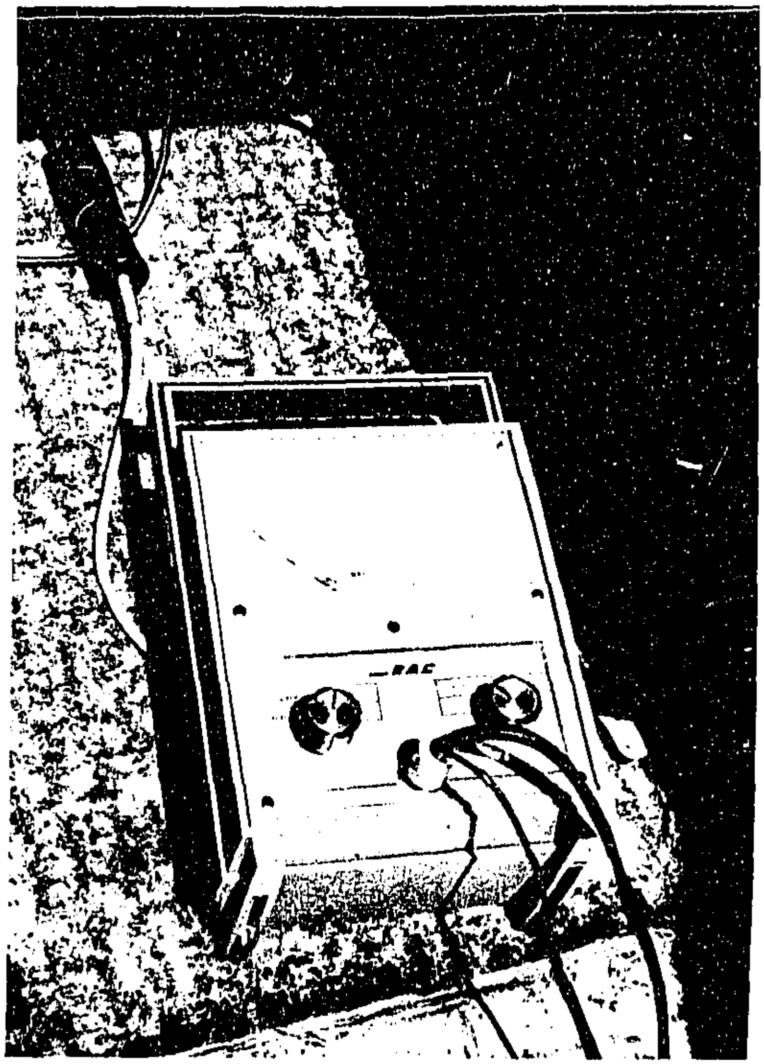


Photograph No. H-9 SOUND LEVEL METER

BLACK COPY

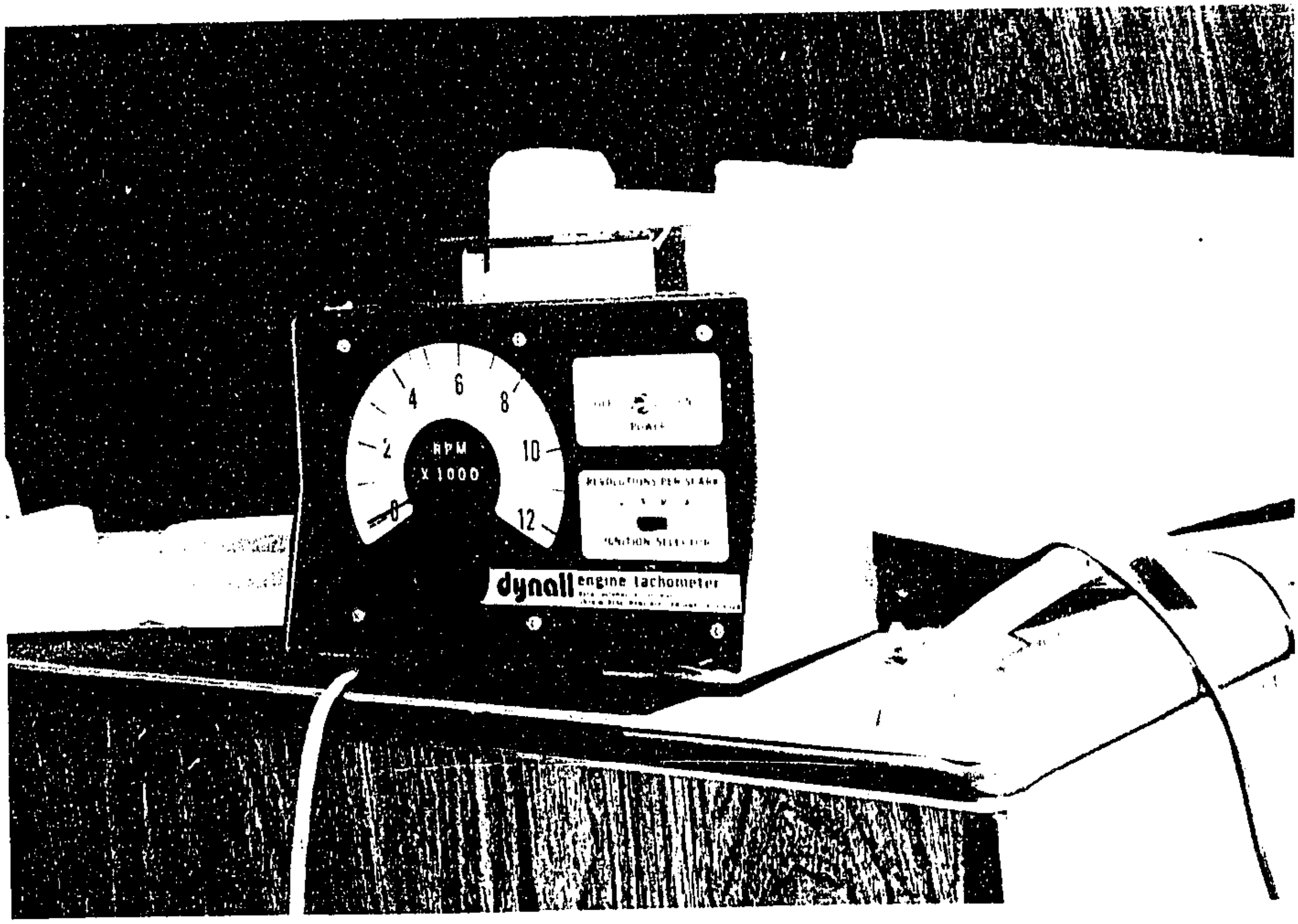


Photograph No. H-10 SIGNAL GENERATOR AND FREQUENCY COUNTER

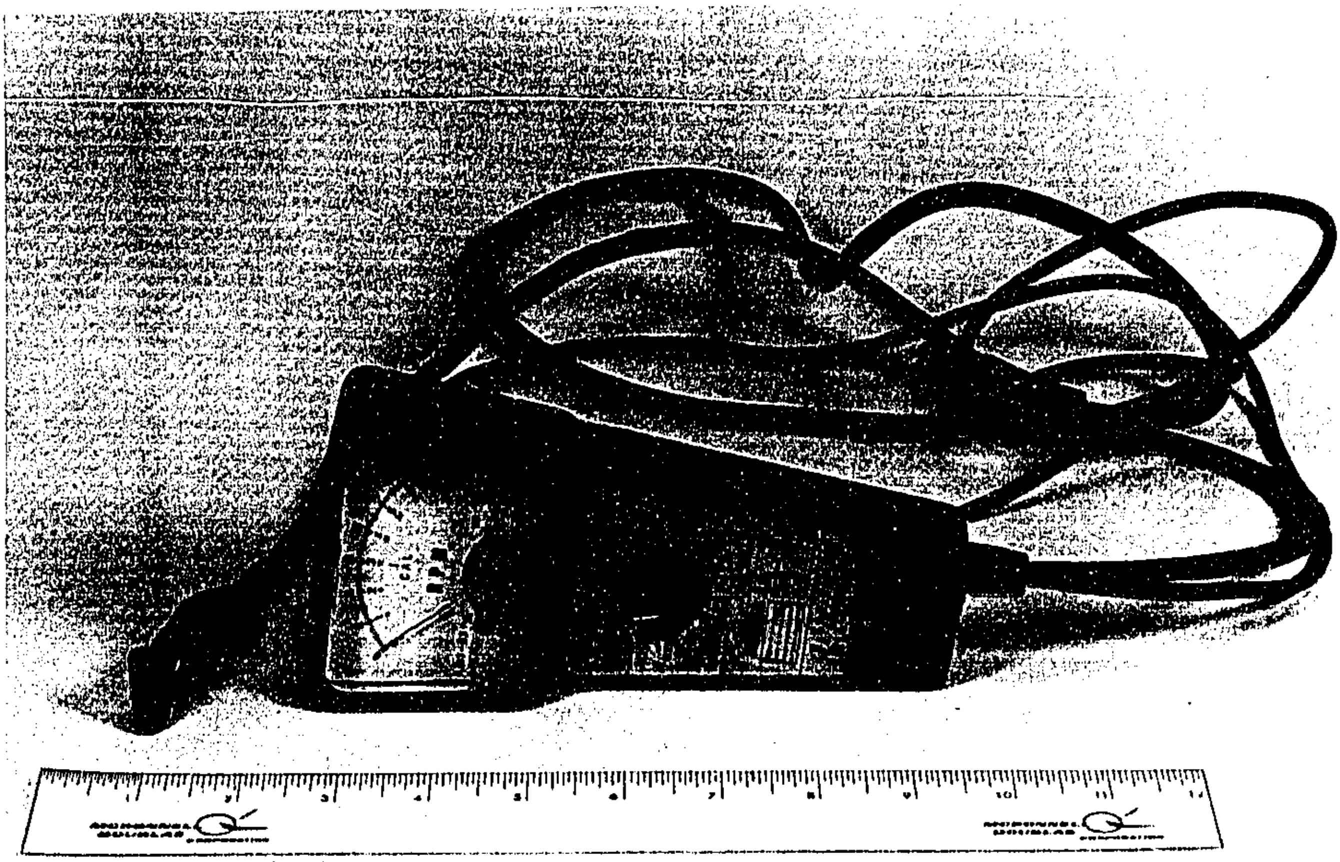


Photograph No. H-11 RITE AUTOTRONICS TACHOMETER

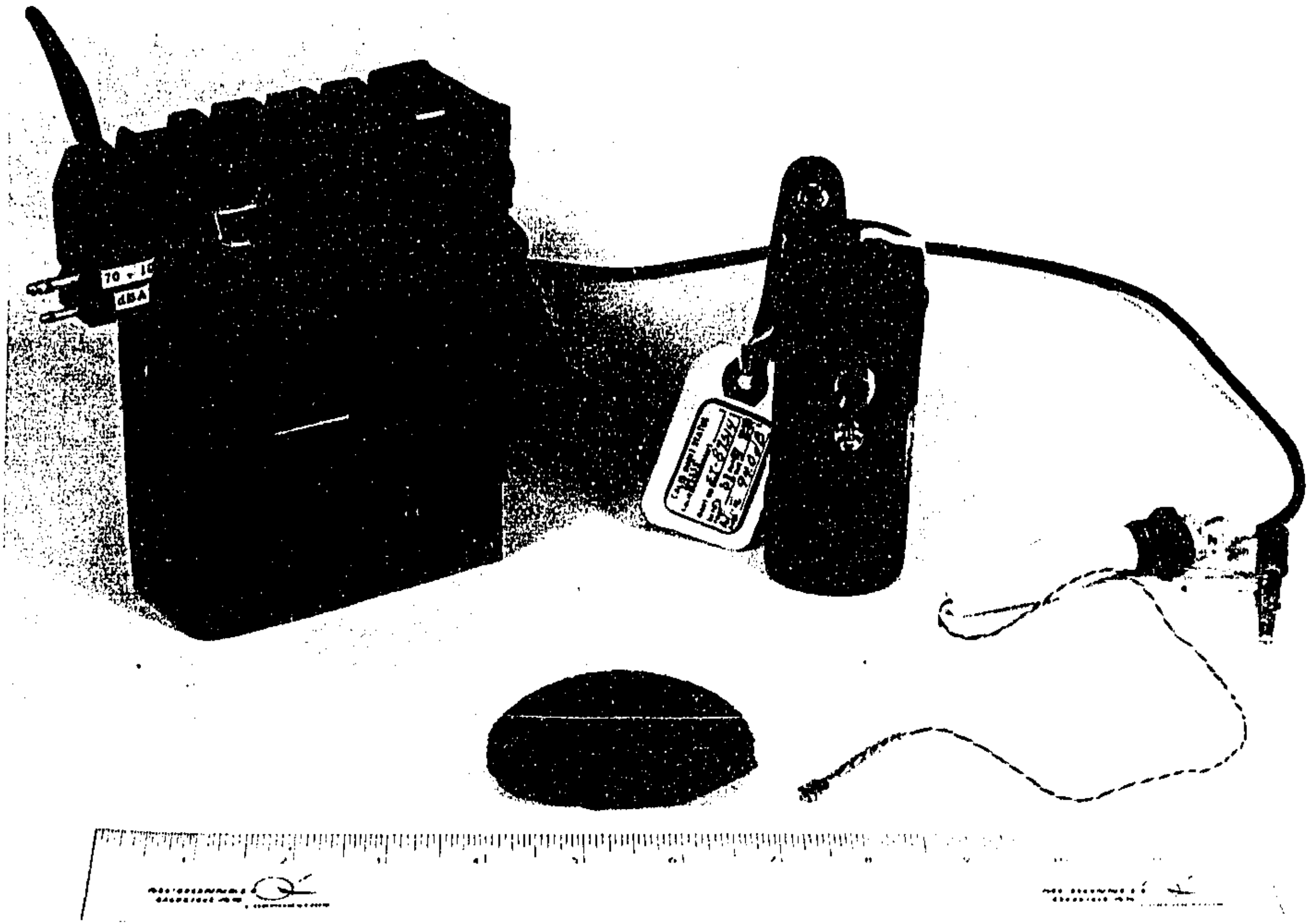
BLACK COPY



Photograph No. H-12 DYNALL TACHOMETER



Photograph No. H-13 SANWA TACHOMETER



Photograph No. H-14 EAR LEVEL SOUND MEASURING EQUIPMENT

APPENDIX I

REFINEMENT OF MOTORCYCLE TESTING PROCEDURE

1. INTRODUCTION

The F-76a test procedure was developed by EPA and its contractors with initial inputs from concerned state and manufacturer representatives. The first draft of this procedure specified testing all motorcycles at 75% of maximum rated RPM. EPA conducted a testing program using this draft procedure (in addition to J-331a) to build a data base on this measurement methodology. During the course of that testing program several motorcycle models were also tested at closing RPM different from the specified 75% (Table C-12). It was apparent from the data gathered that a constant 75% of maximum rated RPM would represent an unfair comparison of large and small motorcycles if the full-throttle-constant microphone distance concepts were retained. Accordingly, a sliding scale of closing RPM was developed based on those motorcycles tested at more than one closing RPM. In the absence of other information, the J-331a test was felt to represent a fair comparison of large and small motorcycles so the sliding scale was developed to reflect that comparison. Further, noise levels comparable to J-331a values would allow consideration of standards in familiar terms.

The sliding scale developed was, however, using interpolated and extrapolated data so additional data were required both using the F-76a as drafted and on variations thereof should the sliding scale need refinement. Another area where additional data was desirable was the phenomenon of tachometer lag and its effect on noise level readings. The testing program described in Appendix H was intended to address these and other issues.

2. TACHOMETER SPECIFICATION

The information developed in that program showed that tachometer lag was indeed a serious consideration with unequal impact on different motorcycle models. American and European motorcycle tachometers generally showed little lag under the F-76a test. Certain Japanese models, however, displayed either a great deal of lag <u>or</u> showed a particular sensitivity to small amounts of lag. As the data <u>used</u> in developing F-76a was largely based on measurements of Japanese motorcycles using <u>vehicle</u> tachometers it is clear that adjustment to F-76a's sliding scale <u>would be</u> necessary if engine speed measurement systems other than vehicle tachometers were to be allowed.

If the lag phenomenon affected all motorcycle models equally, requiring the use of vehicle tachometers could be considered. Since that is not the case, the refinement of F-76a specifically allows the use of other tachometers or other engine speed measurement systems. Indirect engine speed measurement systems have shown the potential for eliminating "lag" as it is associated with tachometers.

Indirect engine speed measurement systems are sometimes cumbersome to set up, however, so it is not felt advantageous to require by specification that indirect systems be used when very fast reacting tachometers are available. Listed in Appendix H are several mechanical and electrical tachometers, both analog and digital, which display very low dynamic response lag. In the interest of test simplicity, the refined procedure allows use of any tachometer which meets a certain dynamic response characteristic. The specification in the refined procedure is spelled out in terms of the maximum allowable lag <u>on a specific motorcycle at the closing conditions during the test</u>.

The "window" of allowable tachometer lag should be small enough that tachometer characteristics will not materially affect noise level readings, yet be large enough to allow use of currently available fast responding tachometers. The specification in the refined procedure allows use of any tachometer that does not lag actual engine speed by more than three percentage points of maximum rated RPM when closing RPM under the specified methodology is indicated. It appears that this specification can be met for virtually all motorcycles tested by one or several of the tachometers mentioned in Appendix H. Several vehicle tachometers meet the specification although many Japanese vehicle tachometers display more than six percentage point lag and hence could not be used.

Figures I-1, I-2, and I-3 display the noise levels of the motorcycles tested as a function of closing RPM. For most motorcycles at least three data points were plotted: (1) a baseline which was the noise level at closing RPM for that specific motorcycle (2) the noise level at a percentage value greater than the closing RPM and (3) the noise level at a percentage value lower than the closing RPM. From these graphs it is apparent that a three percentage point lag translates into a 0.6-0.7 dB difference for most street motorcycles tested, 0.5 dB for most combination motorcycles tested, and 0.3 dB for most off-road motorcycles tested.

3. SPECIFICATION OF CLOSING RPM

Since indirect or fast-responding tachometers are required to be used in the refined procedure as mentioned above, the specification of closing RPM must be adjusted in the draft F-76a procedure.

The program gave EPA the first direct data on motorcycle noise levels measured under F-76a. In addition, manufacturers have supplied EPA with additional F-76a data for specific models. Examination of these data indicates that further changes to the closing RPM specification would improve the large motorcycle/small motorcycle comparison relative to the J-331a procedure.

Figure I-4 plots EPA and manufacturer data on F-76a (indirect engine speed measurement system) relative to J-331a as a function of engine displacement. This figure indicates that the average of F-76a values of the large motorcycles plotted exceeds J-331a values by several dB. The average of the noise levels of small motorcycles, however, are below J-331a by several dB. To correct this situation the sliding scale of closing RPMs has been revised. The end points of 90% and 60% of maximum rated RPM for small and large motorcycles have been raised and lowered 5 percentage points, respectively. Four hundred cc motorcycles, which were specified to be tested at 75% of maximum rated RPM (observed, vehicle tachometer - or approximately 80% indicated, indirect engine measurement system, for most motorcycles), are specified to be tested at 77% of maximum rated RPM (with allowance for an up-to-three percentage point increase in actual engine speed due to allowable tachometer lag). Figure I-5 shows the revised closing RPM chart.

The variation of noise level with engine speed measured during the testing program can be used to determine the comparisons with J-331a that would be expected with this revised specification. Table I-1 shows this comparison for all street and combination motorcycles tested. Off-road motorcycles showed such insensitivity to engine speed that they are not included.

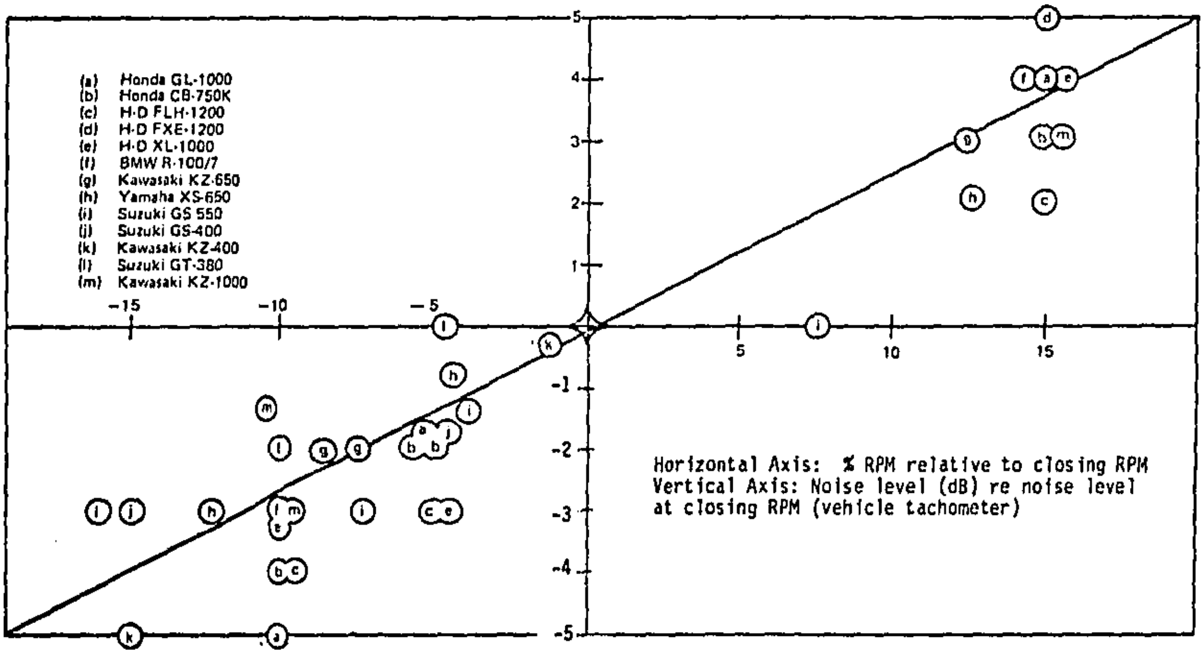


FIGURE I-1 NOISE LEVEL AS A FUNCTION OF CLOSING RPM
STREET MOTORCYCLES

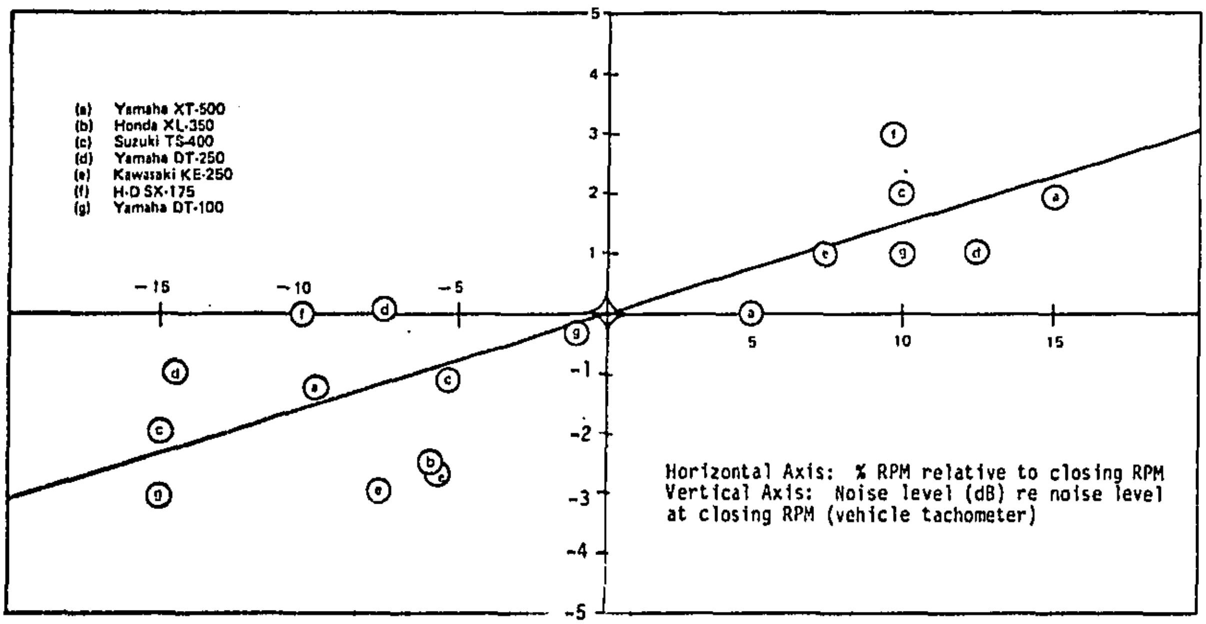


FIGURE I-2 NOISE LEVEL AS A FUNCTION OF CLOSING RPM
COMBINATION MOTORCYCLES

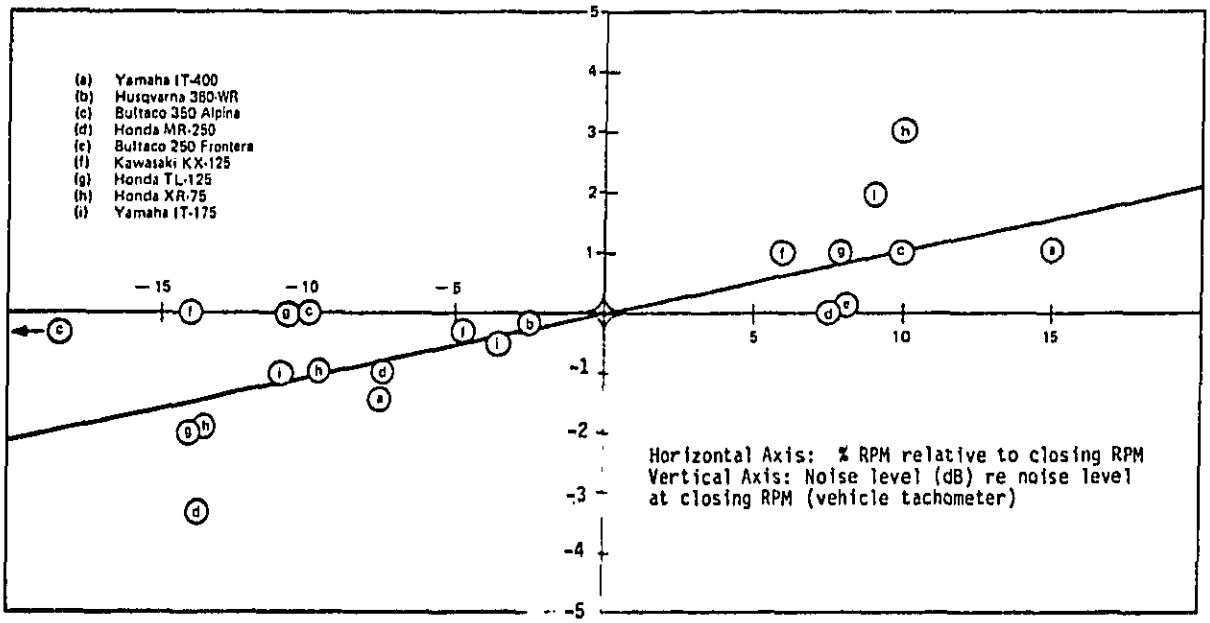
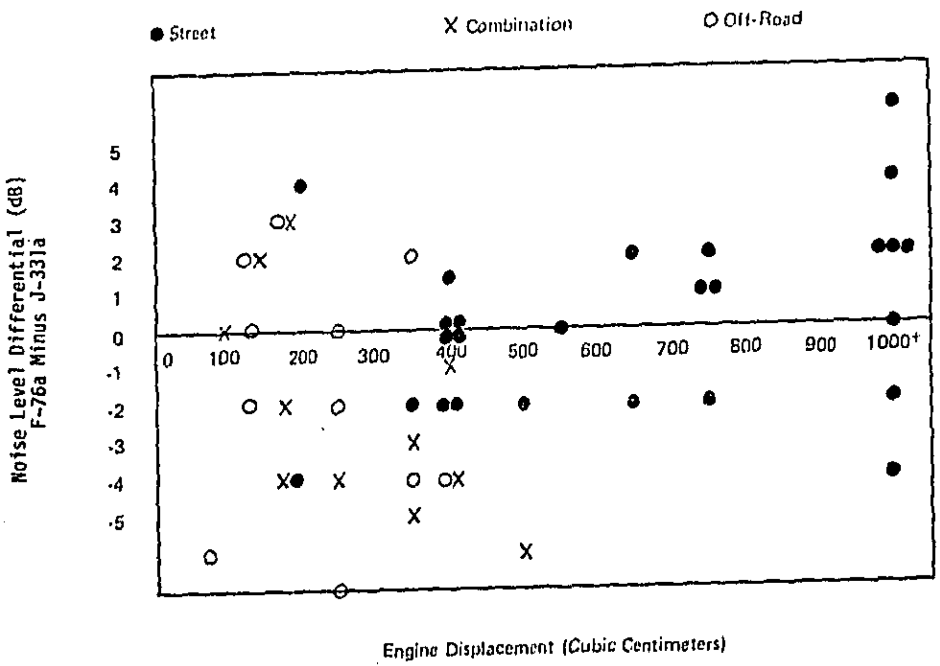


FIGURE I-3 NOISE LEVEL AS A FUNCTION OF CLOSING RPM
OFF-ROAD MOTORCYCLES (including trials and mini-cycles)



Source: EPA and Manufacturer Data

FIGURE I-4

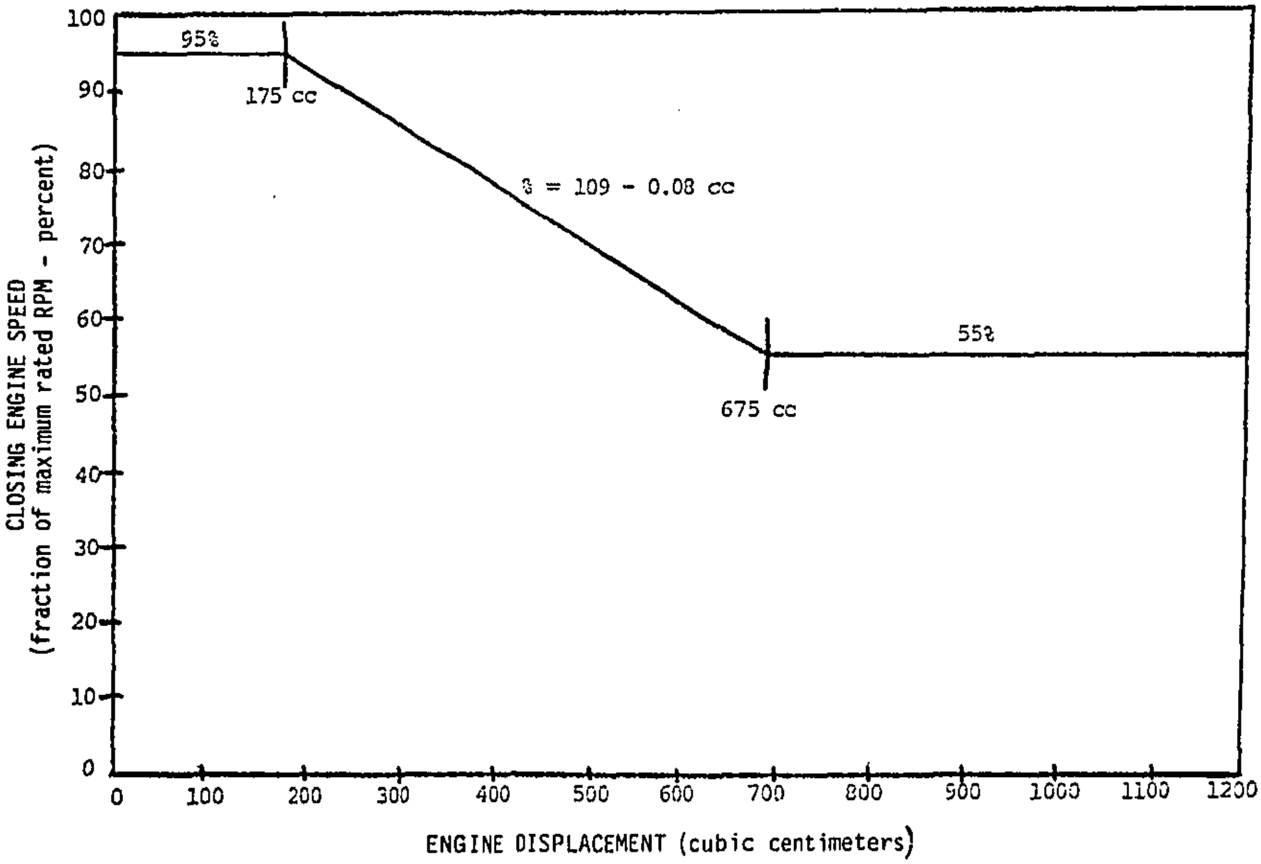


FIGURE I-5. CLOSING RPM

Table I-1

PROPOSED PROCEDURE/J-331a COMPARISON

	Motorcycle Model	J-331a (dB)	F-76a (dB)	Difference (dB	F-76a/ Revised Procedure Difference (dB)*	J-331a/ Revised Procedure Difference (dB)
(Street)						
Kawasaki	KZ 1000	77.2	78.4	+1.2	-1.0	+0.2
Honda	GL 1000	76.0	77.1	+1.1	-1.5	-0.4
Honda	CB 750K	78.4	78.5	+0.1	-1.75	-1.6
H-D	FLH 1200	82.0	83.2	+1.2	-2.5	-1.3
H-D	FXE 1200	83.7	83.2	-0.5	-1.0	-1.5
H-D	XL 1000	82.3	81.7	-0.6	-2.0	-2.6
BMW	R 100/7	82.1	80.4	-1.7	-1.5	-3.2
Kawasaki	KZ 650	77.9	77.1	-0.8	-0.5	-1.3
Yamaha	XS 650	82.8	84.0	+1.2	-0.5	+0.7
Suzuki	GS 550	78.5	79.4	+0.9	-0-	+0.9
Suzuki	GS 400	79.4	78.6	-0.8	+1.0	+0.2
Kawasaki	KZ 400	78.9	80.2	+1.3	+1.5	+2.8
Suzuki	GT 380	84.6	84.7	+0.1	+1.5	+1.6
(Combination)						
Yamaha	XT 500	79.7	76.6	-3.1	+0.2	-2.9
Honda	XL 350	80.8	75.1	-5.7	+2.5	-3.2
Suzuki	TS 400	84.6	82.5	-2.1	+1.0	-1.1
Yamaha	DT 250	83.5	82.4	-1.9	+1.0	-0.9
Kawasaki	KE 250	80.9	77.0	-3.9	+2.0	-1.9
H-D	SX 175	83.5	82.1	-1.4	+2.5	+0.9
Yamaha	DT 100	79.4	78.6	-0.8	+0.5	-0.3

*Translation for each model based on data displayed in Figures I-1, 2, and 3.

APPENDIX J

EXPLORATION OF A STATIONARY TEST INCORPORATING AN ELECTRONIC IGNITION DISABLE SYSTEM

INTRODUCTION

In the course of evaluating engine speed measurement techniques and tachometer accuracy requirements in the F76a test procedure (see Appendix H), EPA examined a technique known as ignition disable as means of controlling test closing rpm. In this technique, the specified closing rpm was pre-set in the ignition disabling device, causing the engine to be shut off automatically at the proper point during the acceleration run, rather than requiring the rider to close the throttle at the proper time. Evaluation indicated improved accuracy, repeatability, and reduced test time by use of this technique.

Also, the possibility was indicated for using the ignition disable technique in a stationary vehicle test, which might serve as a simpler substitute for the moving vehicle F76a test. In this concept, the engine would be accelerated against its own inertia (vehicle stationary) with engine shut-off effected automatically by the ignition disable device.

The objective of EPA's investigation was to evaluate the use of the ignition disable technique, both in the F76a moving vehicle test, and in a simulated F76a stationary vehicle test. The study was to encompass a representative sample of vehicles, or various engine and ignition types. Also, since a potentially important application of the stationary vehicle test method would be in relation to the aftermarket exhaust system industry, the study provided for the direct involvement of the aftermarket manufacturer and his products, as well as that of the new vehicle manufacturer and his vehicles.

Summary of Methods Used in this Study

Vehicle and Aftermarket Product Sample Size and Mix

The vehicle sample consisted of 22 1977/1978 motorcycles in OEM configuration, with ten of these vehicles additionally fitted with 21 aftermarket exhaust system, yielding a total of 43 different vehicle configurations. The sample encompassed street and off-road motorcycles, displacements of 175 to 1200 cc, two and four stroke engines, 1, 2, 3 and 4 cylinder engines, CDI and breaker-point ignition systems. The vehicles were provided by the respective manufacturers and/or the local representatives for CanAm, Harley-Davidson, Hodaka, Honda, Kawasaki, Suzuki, and Yamaha motorcycles.

The aftermarket exhaust system sample comprised 21 exhaust configurations designed specifically for the vehicles on which they were installed. In general, these systems were designed for improved performance, altered torque curve for specific applications, lower noise levels, or to permit optimized performance in combination use (street/off-road) vehicles. Additionally, some of the configurations tested were intended for competition use only. The aftermarket products were supplied, and installed, by the respective manufacturers and/or dealers: Alphabet, AMF, Bassani, Hooker, Jardine, Ocelot (Torque Engineering), Real Products and Skyway.

The vehicle and aftermarket product samples were selected to include to the extent practical, motorcycles and aftermarket exhaust systems having substantial sales volume, and to include vehicle technical parameters significant in the study objectives.

Moving Vehicle Test Procedures

The test procedures employed include:

J331a; conducted in accordance with the SAE procedure.

F76a by gate; correct closing rpm effected by use of an optical speed gate (Newport Research Corporation #SP145/248 lasers; technique described in Appendix H).

Note: The closing rpm/displacement relationship employed in F76a tests reported in Appendices H and J is:

0 - 100 cc : 90% rpm

100 - 700 cc : % rpm = 95 = (0.05 x displacement in cc)

over 700 cc : 60% rpm

F76a by Bike Tach; closing rpm effected manually using indicated reading on vehicle tachometer; tachometer calibrated under steady state conditions.

F76a AutoMeter Tach; closing rpm effected manually using indicated reading on AutoMeter tachometer Model 439; tachometer calibrated under steady state conditions.

F76a by Ignition Disable; closing rpm effected automatically by ignition disable using AutoMeter Rev-Control Model 439/451 or Model 455; disable rpm set under calibrated steady state conditions. The procedure is delineated in the discussion of the Stationary Noise Emission Test procedure of this appendix.

Stationary Vehicle Test Procedures The test procedures employed include:

F50; conducted in accordance with the procedure delineated in Appendix A.

Simulated F76a; conducted in accordance with the procedure delineated in the discussion of the stationary test procedures of this Appendix; the procedure involved stabilizing the engine rpm at the F76a entering rpm, full throttle acceleration of the engine (unloaded except for its inertia and friction), with automatic engine shut-off effected by pre-set ignition disable at the F76a closing rpm. A variety of microphone positions were evaluated.

Development/Evaluation of the Test Methods

Using commercially available ignition disabling equipment techniques were explored for interfacing the disabling device with the various types of ignition systems to be encountered. Noise levels measured in the F76a test using the ignition disabling technique were statistically correlated with those obtained using the optical speed gate which is taken as the baseline reference method.

The microphone position for the simulated F76a (stationary vehicle) test was optimized, and noise level measurements obtained by the technique were statistically correlated with the F76a moving vehicle data (both methods employing ignition disable).

Tabular comparisons of noise emission data obtained by the various moving and stationary vehicle test methods delineated in this Appendix have been made for all of the vehicle and exhaust system configurations tested.

RESULTS AND DISCUSSION

Summaries of the Tables

Tables J-1 and J-2 present vehicle identification, pertinent parameters, and measured sound levels yielded by the various test procedures employed, for the stock and modified motorcycles tested. A letter suffix to the motorcycle No. denotes a vehicle modified by installation of an aftermarket exhaust system; for example, motorcycle No. 801 (Table J-1) was a Honda GL1000 in stock configuration, whereas motorcycle 801A (Table J-2) was the same motorcycle fitted with an aftermarket exhaust system.

The significance of data presented in Tables J-1 and J-2 is discussed by topic in the following paragraphs.

F76a Measured Levels by Various Techniques

In Appendix H it was shown that measured levels frequently 2 to 3 dB higher than appropriate could result from tachometer lag, when using the vehicle tachometer as reference in effecting closing rpm. Precautions were exercised to achieve accuracy and control of closing rpm within acceptable limits; specifically, closing rpm in the F76a test should be accurate to $\pm$ 2% if the measured noise level is to be accurate to $\pm$ 0.5 dBA (ref. Appendix H).

Referring to table J-3, the F76a noise levels in the column "dB by Gate", obtained with closing rpm accuracy of $\pm$ 2%, constitute the reference to which measurements by other techniques may be compared. Difference levels obtained "by AutoMeter Tach" were small; this indicated that damping in that tachometer was near optimum for the F76a application, and reinforced the earlier findings that accurate F76a readings could be obtained with a properly damped vehicle tachometer. The difference levels obtained "by Ignition Disable" (using the same AutoMeter tachometer, but with the ignition disable function operative) remained in good correspondence, showing adequacy of the ignition disable technique. Not reflected in the tabulated figures is the improved consistency among repeated passes, and the shorter time required to conduct the test using the ignition disable technique. Difference levels obtained "by Motorcycle Tach", for most of the vehicles tested are moderately good, although there is one notable exception. The previous work (Appendix H) showed a number of cases where use of the motorcycle tach resulted in 2 and 3 dB discrepancies. Possible explanations of the variability using the vehicle tachometer are differing acceleration profiles among vehicles, and differing damping among tachometers.

TABLE J-1. 1977 - 1978 MOTORCYCLE (STOCK) NOISE LEVELS

Motorcycle Number	Make/Model	Cyl.	Stroke	Ign.	Rated Power RPM	J331a	F76a by Gate	F76a by Ignition Disable	F76a by Autometer Tach	F76a by Bike Tach	F76a Simulation at 50 ft.	F50
801	Honda GL1000	4	4		7500	--	--	75.6	--	--	75.3	--
802	Honda CB550F	4	4		8500	80.9	80.9	80.2	80.3	80.2	81.6	84.5
804	Yamaha 1T175	1	2	CDI	9500	92.6	91.1	90.8	90.6	--	90.9	99.0
805	Honda CB750F	4	4		9000	79.7	79.6	78.9	79.6	79.6	78.4	88.0
806	Suzuki GS400	2	4		9000	80.4	80.0*	79.2*	78.9*	80.5*	81.0*	88.5
807	Suzuki GT380	3	2		9000	88.2	88.4	88.0	88.3	87.4	87.4	94.5
808	Honda CJ360T	2	4		9000	77.1	80.6	80.3	80.8	81.0	82.9	88.0
809	Honda MR175	1	2		7000	84.7	84.0	84.2	83.9	--	86.9	93.0
810	Kawasaki KZ1000LTD	4	4		8000	84.2	82.8	83.0	83.0	83.8	86.4	96.0
811	Kawasaki KH400	3	2	CDI	7000	--	--	80.9	--	--	84.8	90.5
812	Kawasaki KE250	1	2	CDI	6000	82.7	78.2	77.3	77.4	81.2	81.7	83.0
813	Kawasaki KZ1000	4	4		8000	77.6	80.1	79.9	79.9	80.9	81.0	93.0
814	Harley FXE1200	2	4		5200	83.8	82.4	81.9	81.9	82.0	85.8	93.5
815	Harley XLH1000	2	4		6000	--	--	82.0	--	--	83.4	95.0
816	Yamaha DT250	1	2	CDI	6000	--	--	81.2	--	--	82.6	90.0
817	Yamaha SX750E	3	4		8000	--	--	80.3	--	--	82.6	92.5
818	Yamaha RD400	2	2		7000	--	--	81.4	--	--	85.9	92.0
819	Harley SX250	1	2	CDI	7000	82.9	81.8	81.5	81.2	82.2	84.3	94.5

*Tested at 6375 rpm; should be 6750 rpm.

TABLE J-1 (Cont'd) 1977 - 1978 MOTORCYCLE (STOCK) NOISE LEVELS

Motorcycle Number	Make/Model	Cyl.	Stroke	Ign.	Rated Power RPM	J331a	F76a by Gate	F76a by Ignition Disable	F76a by Autometer Tach	F76a by Bike Tach	F76a Simulation at 50 ft.	F50
820	Harley SX175	1	2	CDI	6800	82.2	83.2	82.1	82.3	83.6	84.3	89.0
821	Suzuki GS750	4	4		8500	82.0	79.4	79.6	79.6	80.0	82.9	90.0
822	CanAm 175 Qualifier	1	2	CDI	8500	--	--	85.0	--	--	87.3	90.0
823	Hodaka 175	1	2		7100	--	--	81.0	--	--	81.7	91.0
810A**	Kawasaki 1000LTD (Modified)	4	4		8000	--	85.0	85.0	84.8	84.8	84.7	99.0

**With aftermarket exhaust system

TABLE J-2. 1977 - 1978 MOTORCYCLES WITH AFTERMARKET EXHAUST SYSTEMS

Motorcycle. Number	Make/Model	Exhaust Make/Model	F76a *	F76a Δ dB * re OEM	F76a * Simulation	F50
801A	Honda GL1000	Sound level related to specific aftermarket product is proprietary. Products represented include Alphabet, AMF, Bassani, Hooker, Jardine, Ocelot, Real Products, and Skyway. All products installed on vehicles for which intended; some intended for competition use only.	75.1	-0.5	78.0	90.0
801B	Honda GL1000		78.0	2.4	79.3	93.0
801C	Honda GL1000		80.7	5.1	81.9	94.0
802A	Honda CB550F		85.6	5.4	91.5	--
802B	Honda CB550F		89.3	9.1	91.0	96.5
802C	Honda CB550F		88.6	8.4	91.4	97.0
802D	Honda CB550F		82.0	1.8	83.1	91.5
807A	Suzuki GT380		88.8	0.8	86.8	93.0
809A	Honda MR175		84.1	-0.1	85.4	96.5
809B	Honda MR175		83.4	-0.8	84.4	97.0
809C	Honda MR175		95.1	10.9	94.0	106.0
810A	Kawasaki 1000LTD		85.0	2.0	84.7	99.0
814A	Harley FXE1200		97.0	15.1	100.9	104.0
814B	Harley FXE1200		93.4	11.5	97.4	106.0
815A	Harley XLH1000		91.1	9.1	90.0	102.0
815B	Harley XLH1000		97.2	15.2	99.2	106.0
815C	Harley XLH1000		95.8	13.8	98.9	106.0
818A	Yamaha RD400		85.6	4.2	86.6	93.0
821A	Suzuki GS750		96.6	17.0	99.8	106.5
821B	Suzuki GS750		87.3	7.9	90.3	99.0
822A	CanAm 175		86.2	1.2	87.8	90.5

*By ignition disable

TABLE J-3. F76a NOISE LEVELS BY VARIOUS TECHNIQUES COMPARED TO REFERENCE LEVELS BY SPEED GATE

Motorcycle Number	Make/Model	Rated Power RPM	F76a Level: dBA by Gate	F76a Level: Δ dBA by Ignition Disable	F76a Level: Δ dBA by Autometer Tach	F76a Level: Δ dBA by Bike Tach	Closing rpm: rpm by Gate	Closing rpm: Δ rpm by Ignition Disable	Closing rpm: Δ rpm by Autometer Tach	Closing rpm: Δ rpm by Bike Tach
802	Honda CB550F	8500	80.9	-0.7	-0.6	-0.7	5740	-102	86	286
804	Yamaha 1T175	9500	91.1	-0.3	-0.5	--	8194	-332	-362	--
805	Honda CB750F	9000	79.6	-0.7	-0-	-0-	5400	-233	-89	120
806	Suzuki GS400	9000	80.0	-0.8	-1.1	0.5	6375*	-38	-113	271
807	Suzuki GT380	9000	87.9	-0.3	-0.7	-0.5	6840	-92	-136	210
808	Honda CJ360T	9000	80.6	-0.3		0.4	6930			
809	Honda MR175	7000	84.0	0.2	-0.1	--	6040	-45	99	--
810	Kawasaki KZ1000LTD	8000	82.8	0.2	0.2	1.0	4800	-126	-17	246
810A	Kawasaki K1000LTD	8000	85.0	-0-	-0.2	-0.2	4800	--	--	--
812	Kawasaki KE250	6000	78.2	-0.9	-0.8	3.0	4950	-126	-243	629
813	Kawasaki KZ1000	8000	80.1	-0.2	-0.2	0.8	4800	-9	145	385
814	Harley FXE1200	5200	82.4	-0.5	-0.5	-0.4	3120	-62	-103	-71
819	Harley SX250	7000	81.8	-0.3	-0.6	0.4	5775	--	--	--
820	Harley SX175	6800	83.2	-1.1	-0.9	0.4	5865	-190	-91	157
821	Suzuki GS750	8500	79.4	0.2	0.2	0.6	5100	--	133	207

Note: See also Tables B and D of Appendix H for more comprehensive data on the effect of tachometer lag on measured F76a sound levels.

The statistical relationship between change in noise level (Δ dB) and change in rpm (Δ % rpm) was examined, using the data in Table J-1 together with the data in Appendix H. If values of Δ dB of 1 and greater are considered,

$\bar{x}$ = 0.24 where $\bar{x} = \Delta dB / \Delta \% \text{ rpm}$
σ = 0.12 σ = standard deviation
η = 19 η = number of samples

If values of dB down to 0.5 are included, the figures become

$\bar{x}$ = 0.26
σ = 0.23
η = 37

The statistics become less significant as lower values of ΔdB are introduced, since repeatability of the noise level measurements better than $\pm$0.5 dB should not be assumed to exist.

Stimulated F76a (Stationary Vehicle) Test Method

Feasibility of employing ignition disable in a stationary test which might serve as a substitute for the moving vehicle test was explored. With the vehicle placed at the position where it would be at closing rpm in the moving test, and with the same microphone position as used in the moving test, noise level monitored as engine rpm was abruptly increased from the initial F76a rpm, with closing rpm pre-set on the AutoMeter ignition disable unit. The noise levels measured in this way are shown in Tables J-1 and J-2. Correspondence with the moving vehicle noise levels was sufficiently good that further consideration for use of the method was warranted. Statistically, the correlation coefficient was 0.96, with the simulated (stationary vehicle) level 2 dB higher than the moving vehicle level. This was based on a sample population of 50 vehicle/exhaust configurations (43 in the current study, plus 7 from Appendix H). Aftermarket exhaust systems were included in the study in order to:

a) increase the noise level range for the correlation studies, and

b) expose aftermarket manufacturers to the test procedures and to involve them in feasibility assessment.

In the aftermarket application, the procedure would be more useful if space requirements were reduced; that is, if a close-in microphone position could be used. Accordingly, ten additional microphone positions, in the range 5 to 25 feet from the vehicle, were evaluated. Various microphone heights were also investigated (noise level being quite dependent on height above the pavement); the selected heights were those giving the same difference between reflected and direct path as prevails at the 50 ft. (F76a) microphone position. Microphone positions employed are shown in Figure J-1.

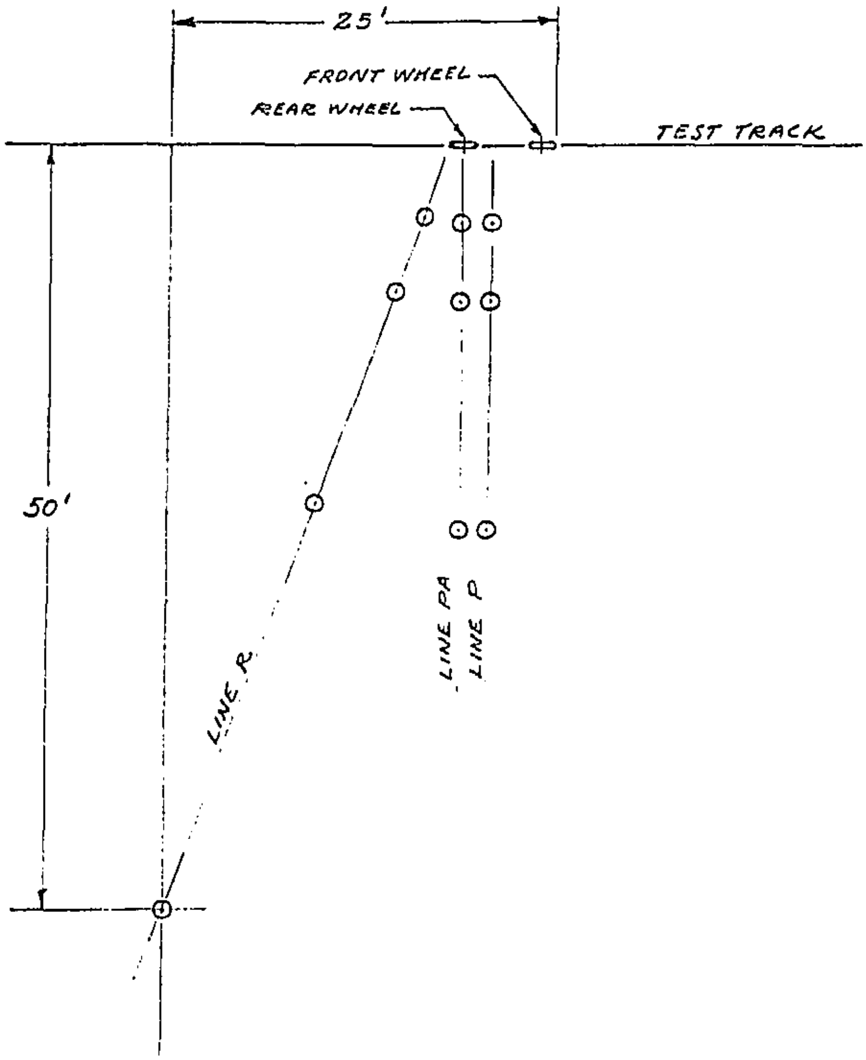


FIGURE J-1 MICROPHONE POSITIONS, SIMULATED F76a TESTS

TABLE J-4

CORRELATION OF SIMULATED F76a LEVELS AT CODED LOCATIONS WITH SIMULATED F76a LEVEL AT THE F76a MICROPHONE POSITION

Test	r_{xy}	a_0	a_1	S_{yx}	Number of Motorcycles
IMI-C25R21	0.99	8.64	0.97	0.55	14
IMI-C25R9	0.99	8.55	0.98	0.74	14
IMI-C25PA21	0.99	11.82	0.93	0.79	27
IMI-C25P21	0.98	-0.04	1.08	0.94	14
IMI-C10R9	0.99	15.04	0.99	0.73	14
IMI-C10PA9	0.88	33.41	0.76	0.88	4
IMI-C10P9	0.97	12.04	1.02	1.26	14
IMI-C3mPA20cm	0.99	17.07	0.96	0.92	23
IMI-C5R4	0.98	14.98	1.05	1.04	14
IMI-C5PA4	0.99	20.79	0.98	0.95	27
IMI-C5P4	0.97	14.60	1.06	1.14	14

Code: IMI-C50 Stationary vehicle measurement at the F76a microphone position

IMI-C25R21 Stationary vehicle measurements at coded positions:

Height of microphone above pavement; inches unless designated centimeters

R designates on Radial (See Fig. 1)
P designates on Perpendicular (See Fig. 1)
PA designates perpendicular to the motorcycle at the rear axle

Distance from bike reference; feet unless designated meters

r_{xy} = correlation coefficient

a_0 = y intercept

a_1 = slope of the regression line ($y = a_0 + a_1x$)

S_{yx} = standard error estimate of y on x

x = Simulated F76a levels at the F76a microphone position

y = Simulated F76a levels at the coded positions

TABLE J-5

F76a (MOVING VEHICLE) AND SIMULATED F76a (STATIONARY VEHICLE) NOISE LEVEL CORRELATIONS

Test	r_{xy}	a_o	a_1	S_{yx}	Number of Motorcycles
IMI-C50	0.96	0.34	1.02	1.63	50
IMI-C25 R21	0.97	12.27	0.94	1.22	14
IMI-C25R9	0.96	14.19	0.93	1.29	14
IMI-C25PA21) IMI-C25P21)	0.96	13.06	0.94	1.68	41
IMI-C10R9	0.96	19.36	0.95	1.37	14
IMI-C10PA9	0.88	26.26	0.88	1.16	4
IMI-C10P9	0.97	13.70	1.01	1.26	14
IMI-C3mPA20cm	0.96	18.36	0.97	1.67	23
IMI-C10PA9) IMI-C3mPA20cm)	0.97	20.50	0.94	1.59	27
IMI-C5P4	0.96	21.45	0.99	1.39	14
IMI-C5PA4	0.95	25.73	0.95	1.91	27

Code: IMI-C50 Stationary vehicle measurement at the F76a microphone position

IMI-C25R21 Stationary vehicle measurements at coded positions:

- Height of microphone above pavement; inches unless designated centimeters
- R designates on Radial (See Fig.J-1)
  P designates on Perpendicular (See Fig.J-1)
  PA designates perpendicular to the motorcycle at the rear axle
- Distance from bike reference; feet unless designated meters

r_{xy} = correlation coefficient

a_o = y intercept

a_1 = slope of the regression line ($y = a_o + a_1x$)

S_{yx} = standard error estimate of y on x

x = F76a moving vehicle noise levels

y = Simulated F76a stationary vehicle noise levels at the coded positions

Correlation data of these closer-in positions referred to the 50 ft. stationary vehicle levels are presented in Table J-4, and referred to the moving vehicle F76a levels are presented in Table J-5.

Referring to Tables J-4 and J-5, the apparent poorer correlation at the C10PA9 position is probably attributable to the small number in the sample. Regarding choice of microphone position, the statistical analysis indicates that any of the positions could be employed. However, other factors enter into the choice:

a) The closer in the microphone, the more sensitive was the measurement to source location; the predominant source may be exhaust, intake, or engine.

b) The further the microphone was out, the greater was the space requirement for test conduct.

Considering the above factors, a 10 ft. distance, on a line from the rear axle, perpendicular to the vehicle longitudinal axis, 9 inches above the pavement, appeared to be a good compromise.

The correlation coefficients presented in Tables J-4 and J-5 were computed using data typified by that presented in Table J-6. Referring to the table, six readings were first taken at the 50 ft. position on each side of the vehicle. Subsequent readings at intermediate microphone positions were then taken only on the side found to be loudest; simultaneous readings were taken at the 50 ft. position. For Table J-4, individual measurement pairs were entered into the correlation computation; that is, four data pairs per vehicle. For Table J-5, the average of the four stationary values was paired with the "reported" F76a value; that is, one data pair per vehicle.

Table J-5 provides information to permit estimation of the F76a level by use of the stationary vehicle test: for example, if the 10 ft. distance, 9 inch height microphone position is used, the equation of the regression line indicates that 14 dB would be subtracted from the stationary vehicle emission measurement to arrive at the F76a noise emission level. Correlation plots for the microphone position are presented in Figure J-2 and J-3.

F50 Stationary Vehicle Test Method

In Tables J-1 and J-2, the F50 levels may be compared with the F76a levels for 20 stock and 20 modified motorcycles. The figures yield a correlation coefficient of 0.87, with a standard error of estimate 3 db, and a nominal difference of 10 dB between the F50 and F76a levels (Fig. J-4). This correlation was much better than the F50 test has shown with previously evaluated moving vehicle tests, and was such that the method could potentially be considered for preliminary screening for new product compliance, or for in-use enforcement at the state or local level against flagrant violations of noise regulations.

TABLE J-6

EXAMPLE OF MEASUREMENT REPEATABILITY
USING IGNITION DISABLE TECHNIQUE
(Motorcycle No. 802)

IMI-C50	L	80.0	79.5	79.5	80.1	80.1	80.4
	R	81.0	81.5	81.6	82.0	81.9	82.0
IMI-C25R21	R	87.0	87.6	88.0	88.0		
IMI-C50	R	81.4	81.9	82.0	82.0		
IMI-C25R9	R	95.8	90.1	89.5	90.2		
IMI-C50	R	82.2	82.5	82.0	82.6		
IMI-C10R9	R	95.8	96.2	96.2	95.5		
IMI-C50	R	82.2	82.1	82.1	81.9		
IMI-C5R4	R	100.4	100.6	101.0	101.4		
IMI-C50	R	81.2	82.2	81.2	82.0		
IMI-C25P21	R	87.6	87.2	87.8	87.9		
IMI-C50	R	82.1	81.9	82.2	82.2		
IMI-C10P9	R	95.3	95.2	95.0	95.0		
IMI-C50	R	82.2	81.7	81.4	81.6		
IMI-C5P4	R	101.6	100.6	100.6	100.5		
IMI-C50	R	82.1	81.2	81.2	81.0		

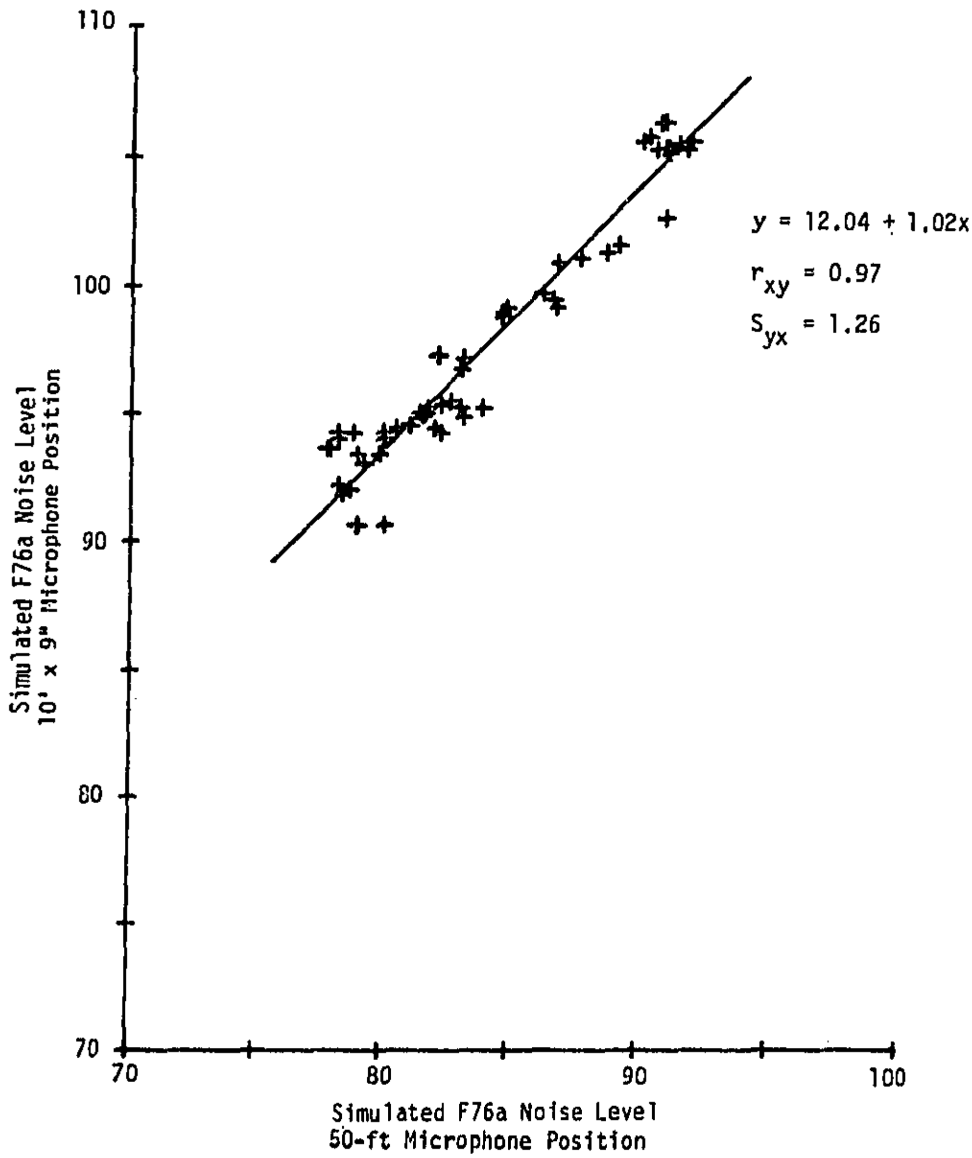


Fig. J-2 CORRELATION OF STATIONARY VEHICLE NOISE LEVELS AT 50 FT. AND 10 FT. (9" ht.) MICROPHONE POSITIONS (SIMULATED F76a TEST)

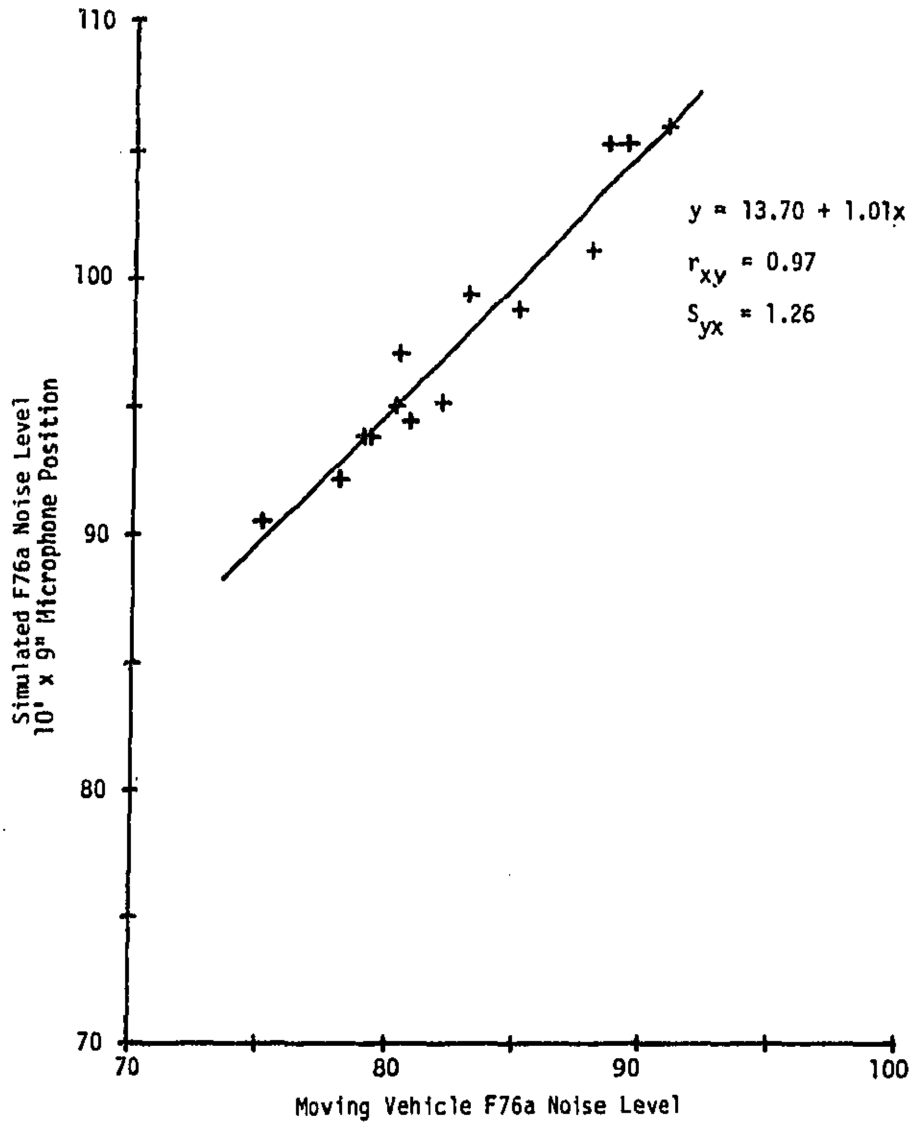


Fig. J-3 CORRELATION OF STATIONARY VEHICLE NOISE LEVELS AT 50 FT. AND 10 FT. (9" ht.) MICROPHONE POSITIONS (SIMULATED F76a TEST)

Effect of Gear Selection

The opportunity was taken to test selected vehicles in both 2nd and 3rd gears, particularly those vehicles reaching specified closing rpm in a 25 ft. to 35 ft. acceleration distance in 2nd gear. Comparative results are shown in Table J-7; a 1 DB difference appears not uncommon. Except for the Table J-7 data, all F76a tests conducted in this study employed 2nd gear unless a 25 ft. minimum acceleration distance was not attained, in which case the next higher gear was used; as a result, the great majority of vehicles were tested in 2nd gear, and no operational difficulties were encountered. A stipulation of a longer minimum acceleration distance, such as 35 ft. or 50 ft. as considered, would result in more vehicles encumbered with a 1 dB ambiguity in reported level (3rd gear vs. 2nd gear), and would also result in substantially higher speeds and longer acceleration distances, which require greater rider precision in reaching closing rpm at the specified end point.

Ignition Disable Equipment

The equipment used in this study to effect ignition disable was either the AutoMeter Model 439 Tachometer together with the Model 451 Rev-Control, or the Model 455 Rev-Control (which incorporated the tachometer and ignition disable unit in a single case). The 439/451 required hard-wire connection to the ignition primary for Tachometer signal, and could be used only on vehicles having breaker-points ignition systems; the 455 unit incorporated an inductive pickup, and functioned on all ignition systems. For conventional ignition systems having breaker points, the inductive pickup (which provided the tachometer signal) was placed over the wire from the points to the coil primarily; for CDI systems the inductive pickup was placed over the conductor from the "trigger coil" or the conductor from the CDI unit to the ignition coil primary. (On most of the motorcycles tested, the inductive pickup could be placed over the entire wire bundle incorporating the desire wire, rather than searching out the specific wire). The disable element was a shorting switch (activated by the tachometer); for breaker-point systems, it was connected to short across the "kill button". For vehicles having more than one pair of points, it was necessary to connect the disabling circuit to each set of points thru a diode (see Figure J-5) in order to maintain electrical isolation between pairs of breaker points.

The objective in this part of the study was to demonstrate feasibility of the ignition disable technique using commercially available equipment, with application to present generation new motorcycles and aftermarket exhaust systems subject to regulations. (The scope of the study did not extend to the comparative evaluation of various devices commercially available). The equipment employed demonstrated that the ignition disable technique, using the subject equipment was effective in controlling closing rpm in the moving test, and in possible making feasible the conduct of a stationary vehicle test which could substitute for the moving test.

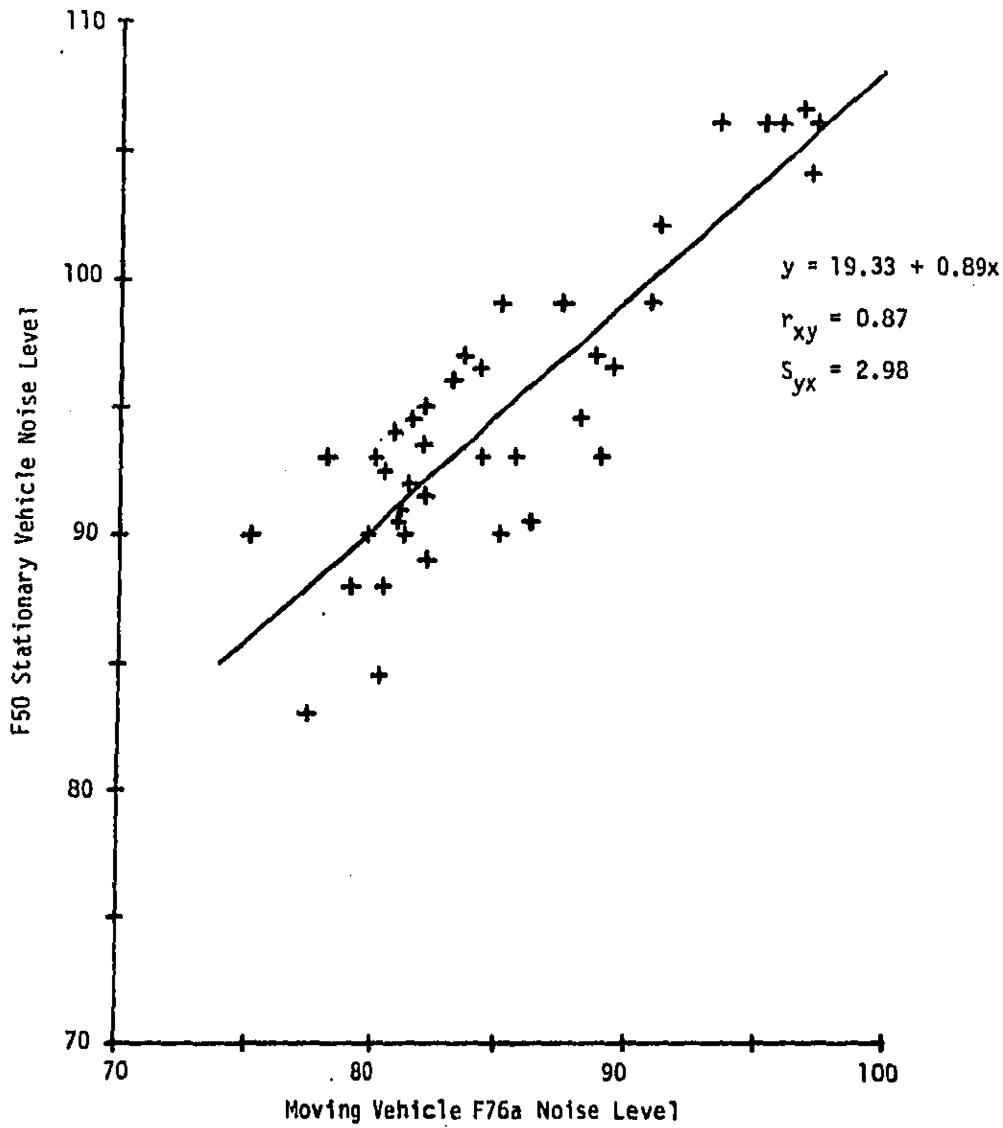


Fig. J-4 CORRELATION OF STATIONARY VEHICLE NOISE LEVELS (F50 TEST) AND MOVING VEHICLE F76a TEST

TABLE J-7 EFFECT OF GEAR SELECTION

MOTORCYCLE NO.	MANUFACTURER/MODEL	F76a by Ignition Disable					
		2nd Gear			3rd Gear		
		dB	Accel (ft.)	Dist	dB	Accel. (ft.)	Dist
805	Honda CB750F	78.9	28		--	80	
812	Kawasaki KE250	77.3	28		78.7	67	
815B	Harley XLH1000 (with aftermarket exhaust)	97.2	26		96.9	80	
816	Yamaha DT-250	81.2	25		81.8	66	
817	Yamaha XS750 E	80.3	40		81.1	70	
820	Harley SX175	82.1	35		82.2	90	
821	Suzuki GS750	79.6	40		80.0	80	
822	Can Am 175 Qualifier	85.0	37		85.8	80	
822A	Can Am 175 Qualifier (with aftermarket exhaust)	86.2	35		87.0	55	

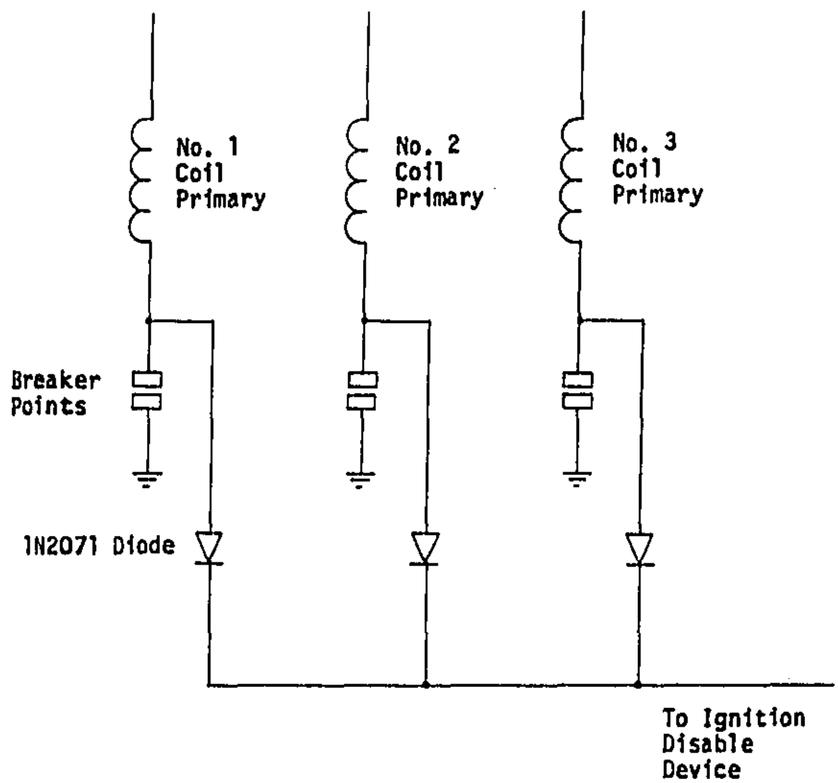


FIGURE J-5 METHOD OF CONNECTING DISABLE DEVICE TO MOTORCYCLE HAVING MORE THAN ONE PAIR OF POINTS

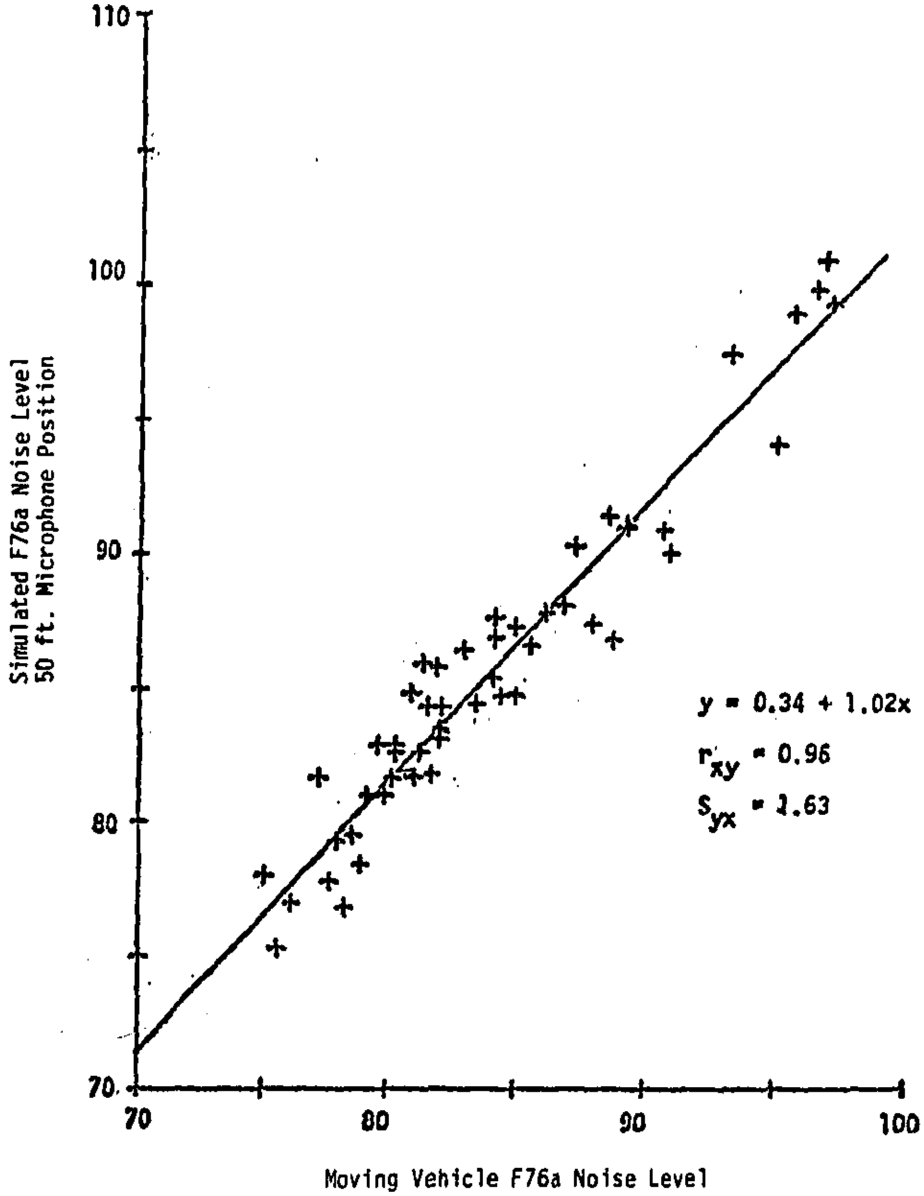


Fig. J-6 CORRELATION OF STATIONARY VEHICLE NOISE LEVELS AT 50 FT. MICROPHONE POSITION (SIMULATED F76a TEST) AND MOVING VEHICLE F76a TEST LEVELS

STATIONARY VEHICLE NOISE EMISSION TEST PROCEDURE

(a) Instrumentation

The following instrumentation shall be used, where applicable:

(1) A sound measurement system which meets the Type 2 or S2A requirements of American National Standards Specification for Sound Level Meters, ANSI S1.4-1971. As an alternative to making direct measurements using sound level meter, a microphone or sound level meter may be used with a magnetic tape recorder and/or a graphic level recorder or indicating instrument provided that the system meets the performance requirements of ANSI 1.4-1971.

(2) An acoustic calibrator with an accuracy of within ± 0.5 dB. The calibrator shall be checked annually to verify that its output is within the specified accuracy.

(3) An engine speed measurement system coupled with an ignition disable device having the following characteristics:

(i) Capable of being pre-set to disable the ignition at a specified closing engine speed;

(ii) Positive and continuous cut-off of ignition in all cylinders, with manual re-set;

(iii) Read-out of steady state engine rpm accurate within, or calibrated to ± 2% of true rpm for engine speeds specified in the test;

(iv) Response time to rpm step input in the operating range not more than 200 milliseconds, measured from step initiation to ignition disable. Operating range for general application to motorcycles is 2000 to 10,000 rpm, with rpm step magnitudes of 1.2 to 1.9 times the initial rpm. Response time may be verified by use of two signal generators, one set for the initial rpm, the other set for the disable rpm; the response time to disable command being measured as the signal to the disable device is switched from the first generator to the second.

(4) A microphone wind screen which does not affect the microphone response more than ± 0.5 dB in the frequency range 40-6000 Hz, taking into account the orientation of the microphone.

(5) An anemometer with steady-state accuracy within ± 10% at 30 km/h (19mph).

(b) Test Site

(1) The test site shall be flat, open surface free of large noise reflecting surfaces (other than the ground) such as parked vehicles, signboards, buildings, or hillsides, located within a 7 m (23 ft) radius of the motorcycle being tested and the location of the microphone.

(2) The microphone shall be located on a line perpendicular to the longitudinal axis of the motorcycle at the rear axle, 3.0 m (9.8 ft.) from the plane of symmetry and at a height of 22 ± 1 cm (8.6 ± 0.4 in.) above the pavement. The microphone shall be oriented with respect to the source so that the sound strikes the diaphram at the angle for which the microphone was calibrated to have the flattest frequency response characteristics over the frequency range 40 Hz to 6000 Hz.

(3) The surface of the ground within the triangular area formed by the microphone location and the front and rear extremities of the motorcycle shall be flat and level ± 5 cm and have a concrete or sealed asphalt surface.

(c) Measurement Procedure

(1) The engine temperature shall be within the normal operating range prior to conducting the measurement procedure.

(2) The electronic ignition disable device shall be set to require closing rpm determined according to the motorcycle engine displacement, as follows:

Displacement (cc)*	Closing RPM* (Percent of Maximum Rated RPM)
0 - 100	90
100 - 700	95 - 0.05 x (engine displacement in cc)
700 and above	60

(3) The rider shall sit astride the motorcycle in normal riding position with both feet on the ground and run the engine with the gearbox in neutral at a constant engine speed of 50% of maximum rated rpm or percent closing rpm less ten percentage points, whichever is lower (± 2.5% of specified rpm). With the engine stabilized at this constant engine speed, the test rider shall then open the throttle fully and as rapidly shut-down at the pre-set closing rpm. If no neutral is provided the motorcycle shall be operated either with the rear wheel 5-10 cm (2.0 - 4.0 in) clear of the ground, or with the drive chain belt removed if the vehicle is so equipped.

(d) Measurement

(1) The sound level meter shall be set for fast response and for the A-weighting network. The microphone wind screen shall be used. The sound level meter shall be calibrated as often as is necessary throughout testing to maintain the accuracy of the measurement system; this shall include pre- and post-test calibration of each daily sequence of testing.

(2) The sound level meter shall be observed throughout the engine acceleration period. The highest noise level obtained during the engine acceleration period shall be recorded.

(3) At least three measurements shall be made on each side of the motorcycle. Measurements shall be made until three readings from each side are within 2 dB of each other. The noise level for each side shall be the average of the highest three readings within 2 dB of each other. The noise level reported shall be for that side of the motorcycle having the highest noise level.

(4) While making noise level measurements not more than one person other than the rider and the observer reading the meter shall be within 7m (23 ft) of the vehicle or microphone, and that person shall be directly behind the observer reading the meter, on a line through the microphone and the observer.

(5) The ambient noise level (including wind effects) at the test site due to sources other than the motorcycle being measured shall be at least 20 dB lower than the noise level at the microphone location produced by the motorcycle under test.

(6) Wind speed at the site during test shall be less than 30 km/h (19 mph).

APPENDIX K

FURTHER STUDY OF THE IGNITION DISABLE DEVICE

APPENDIX K
FURTHER STUDY OF THE
IGNITION DISABLE DEVICE

INTRODUCTION

In previous EPA studies, excellent correlation between the moving vehicle and stationary vehicle roise tests for a wide range of motorcycles was demonstrated. The Auto Meter Model 451 Rev-Control ignition disable device was used for these tests.

The disabling device incorporated two moving elements (the tachometer pointer and the disable relay) with consequent lag between the preset and actual shut-down rpms. As a result the device permitted substantial rpm overshoot for the stationary test, which was undesirable for two reasons: a) for some motorcycles this results in exceeding red-line rpm, and b) if the noise standard is based on use of this device, and if a vehicle or aftermarket manufacturer were to develop and employ a device exhibiting less overshoot, a lower indicated noise level reading would be obtained.

To overcome this difficulty, the EPA developed a completely electronic ignition disable device which holds rpm overshoot well within acceptable values. However, occasionally a motorcycle is encountered on which the device does not function properly. Therefore, EPA investigated the character of ignition pulse wave trains exhibited by a broader range of representative motorcycles.

The results of this study to date explain the nature of the problem encountered by the completely electronic device, and suggest means by which the applicability of the device might be extended.

Viability of the stationary vehicle test is contigent on availability of a reliable, low-cost, easy to use, ignition disable device which does not exhibit excessive rpm overshoot, and one that will function on all or most bikes. The completely electronic device, with a suitable sensing pickup, may eventually offer the basis for the above requirements.

TESTING ACCOMPLISHED

On a group of 36 motorcycles, magnetic tape recordings of the ignition pulses have been obtained at a nominal 50% rpm and during acceleration, engine unloaded. Recordings, of both ignition secondary, and ignition primary, were obtained. The vehicle population comprised 10 Honda bikes, 13 Suzuki, 11 Kawasaki, 1 BMW, and 1 Maico. Engine types include 2 and 4 stroke; single, dual, four and six cylinders. Ignition types represented encompass conventional coil and points, transistorized breakerless, magneto, CDI and electronic advance.

The taped signals have been transcribed onto X-Y plots, showing the wave form and signal strengths exhibited by the various bikes. These plots were intended to permit definition of performance characteristics required in an ignition disable device, and the magnetic tape recordings themselves could be employed for preliminary evaluation of candidate disable devices.

The group of motorcycles was found to display a tremendous range of ignition pulse wave shapes and signal amplitudes. This is illustrated by Charts A thru F, which show in the lower trace the ignition pulse wave train at a steady low rpm, and in the upper trace, a transient high rpm situation. Both traces are pulses in the high tension (secondary) side of the ignition system, sensed by an inductive pickup placed over a spark plug wire:

Chart A. Representative of 4-cyl, 4-stroke motorcycles with "conventional" ignition. The plug fires on every revolution, although there is a power stroke on every second revolution only. The disable device must consistently ignore, or consistently read, the redundant spark pulse.

Chart B. This is a transistorized breakerless ignition system on a 4-cyl, 4-stroke bike. Pulse definition is considerable less distinct, and more "cross-talk" from other spark plug wires is seen.

Chart C. One of the cleanest wave trains encountered, magneto ignition, single cylinder 2-stroke, one pulse per revolution.

Chart D. One of the most complex wave trains encountered; a challenge to the ignition disable device designer; magneto ignition, single cylinder 2-stroke.

Chart E. This is a 6-cyl 4-stroke; as with the 4-cyl 4-stroke machines, there is a redundant spark, and considerable cross-talk. This signal would present difficulties for a disable device.

Chart F. This is the same bike as in previous chart, with a compressed time scale, showing the variability in the active pulses, redundant pulses, and cross-talk pulses.

All of the foregoing pulse trains were obtained using an inductive pickup placed over a spark plug wire. Performance of a capacitance pickup (clamped onto a spark plug wire) was also subject of a cursory check:

Charts G and H. Using the V-8 engine in a Dodge van, Chart G shows the ignition pulse train using the inductive pickup. While the signal is fairly good, cross-talk is in evidence. Chart H shows a spectacularly improved signal using the capacitance pickup.

Chart I. This is a repeat run on bike No. 30 (Chart E), using the capacitance pickup in lieu of the inductive pickup. The capacitance pickup incorporated an in-series neon bulb, which provided a go/no-go type of function. Note the complete absence of cross-talk, also absence of the redundant pulse. Not shown by the chart, the device exhibited drop-out, and should be investigated further.

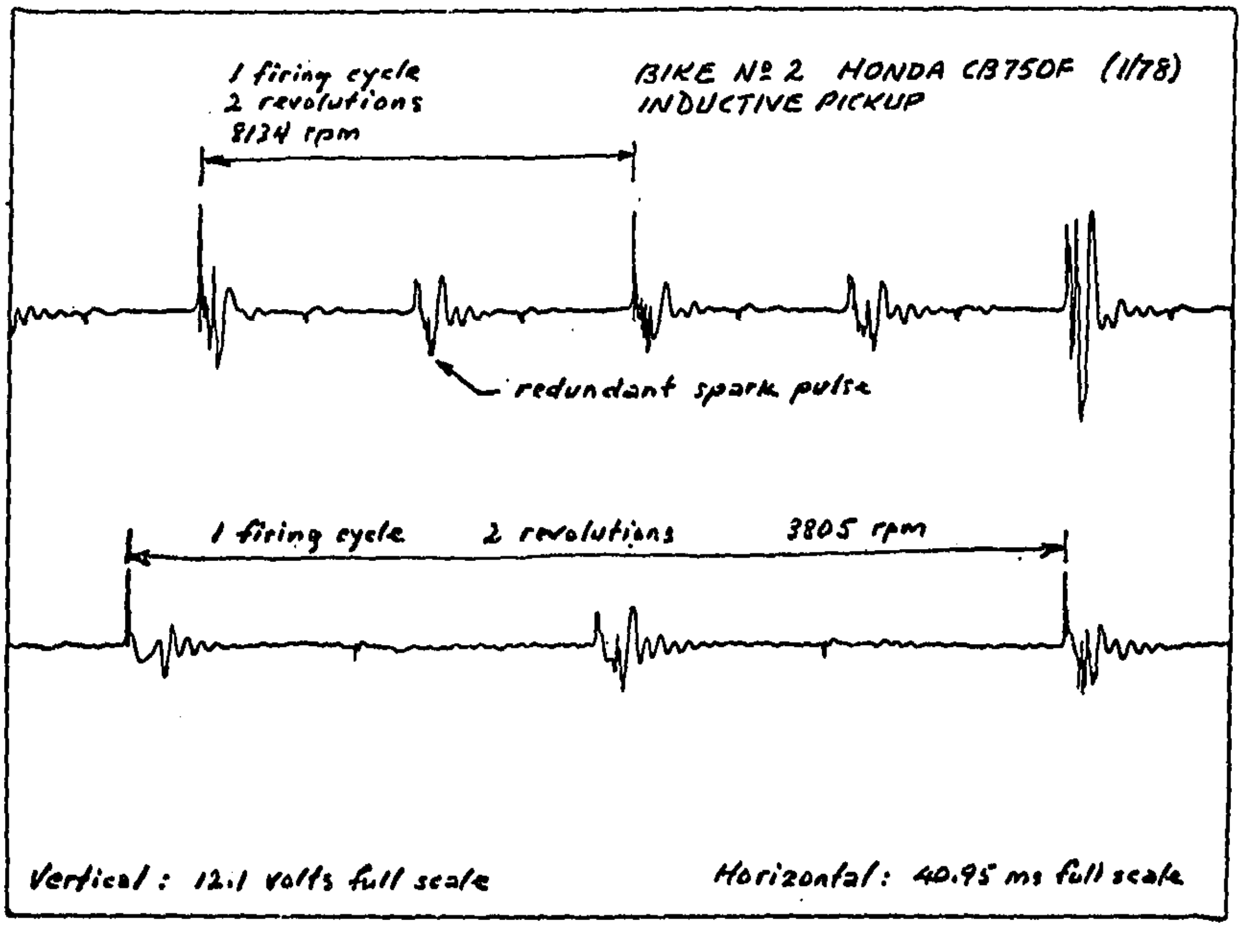

1 firing cycle
2 revolutions
8134 rpm
BIKE No 2 HONDA CB750F (1/78)
INDUCTIVE PICKUP
redundant spark pulse
1 firing cycle 2 revolutions 3805 rpm
Vertical: 12.1 volts full scale
Horizontal: 40.95 ms full scale

CHART A

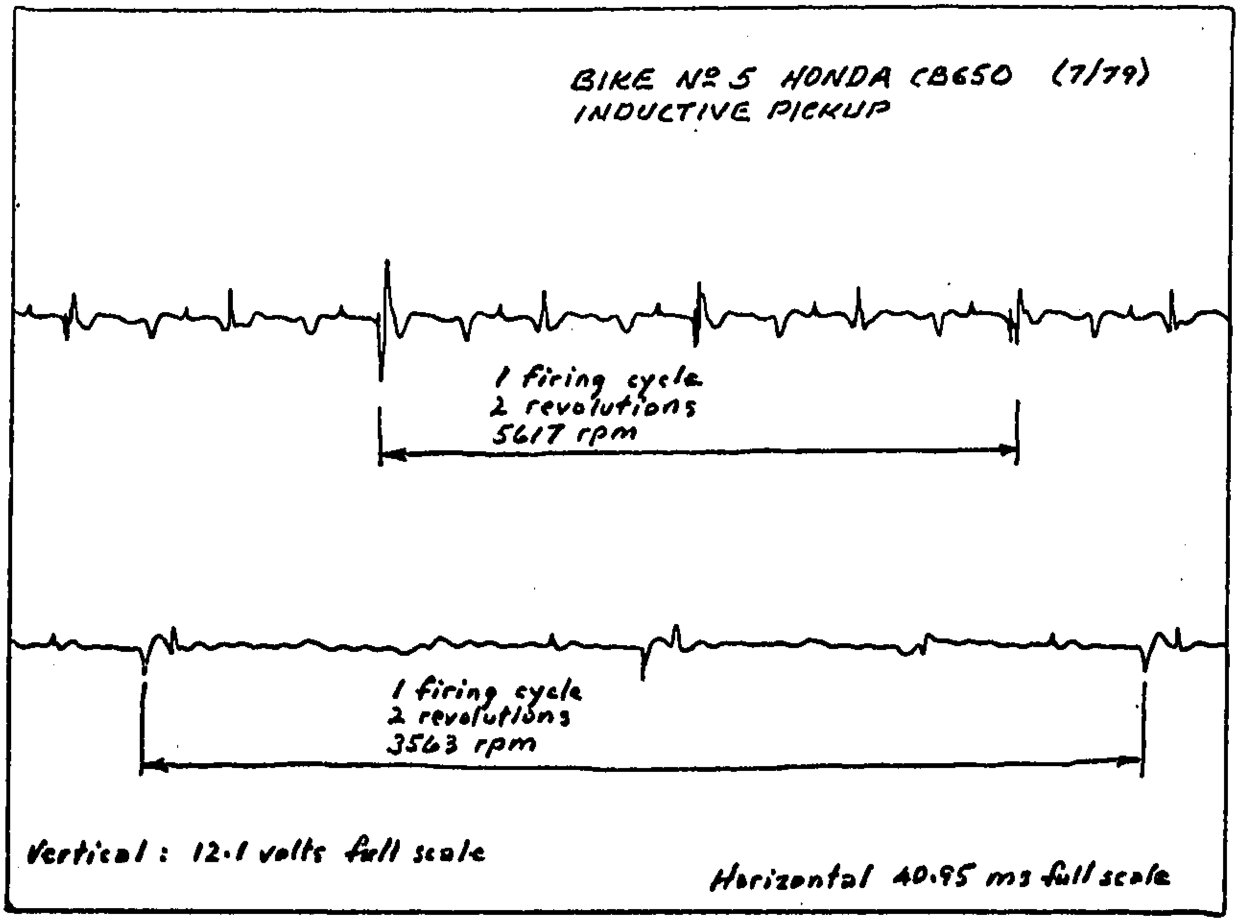

BIKE № 5 HONDA CB650 (7/79)
INDUCTIVE PICKUP
1 firing cycle
2 revolutions
5617 rpm
1 firing cycle
2 revolutions
3563 rpm
Vertical: 12.1 volts full scale
Horizontal 40.95 ms full scale

CHART B

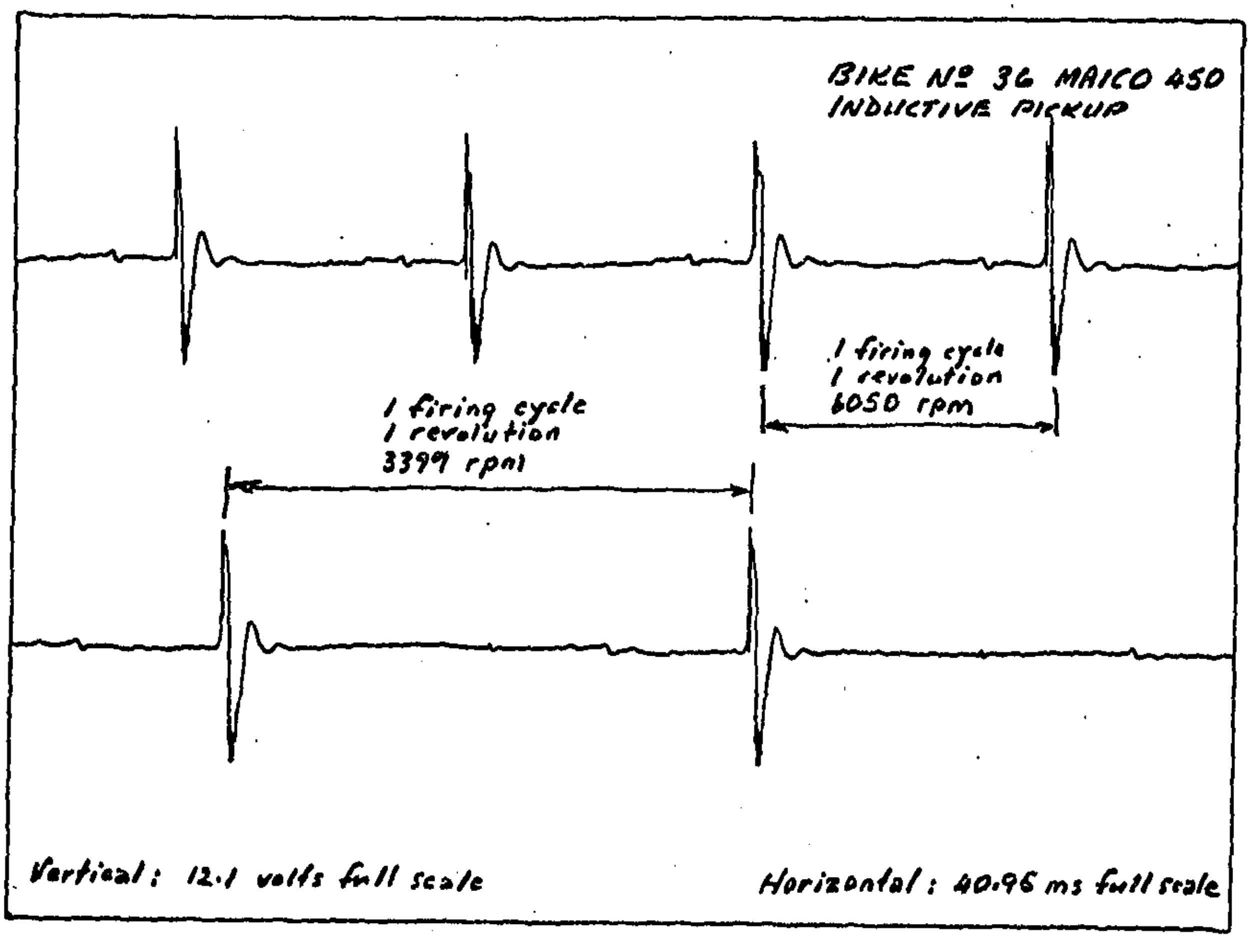

BIKE No 36 MAICO 450
INDUCTIVE PICKUP
1 firing cycle
1 revolution
6050 rpm
1 firing cycle
1 revolution
3399 rpm
Vertical: 12.1 volts full scale
Horizontal: 40.96 ms full scale

CHART C

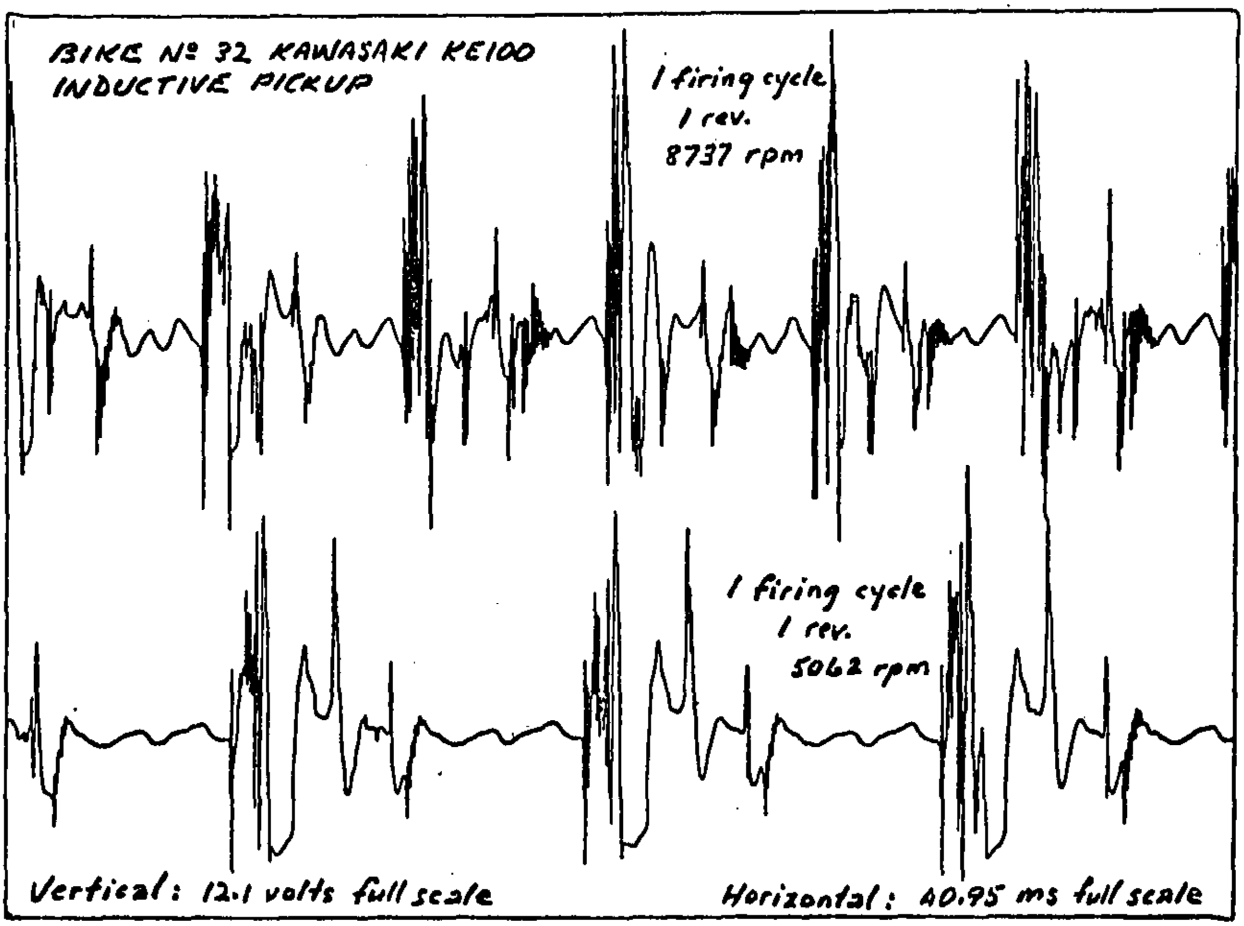

BIKE Nº 32 KAWASAKI KE100
INDUCTIVE PICKUP
1 firing cycle
1 rev.
8737 rpm
1 firing cycle
1 rev.
5062 rpm
Vertical: 12.1 volts full scale
Horizontal: 40.95 ms full scale

CHART D

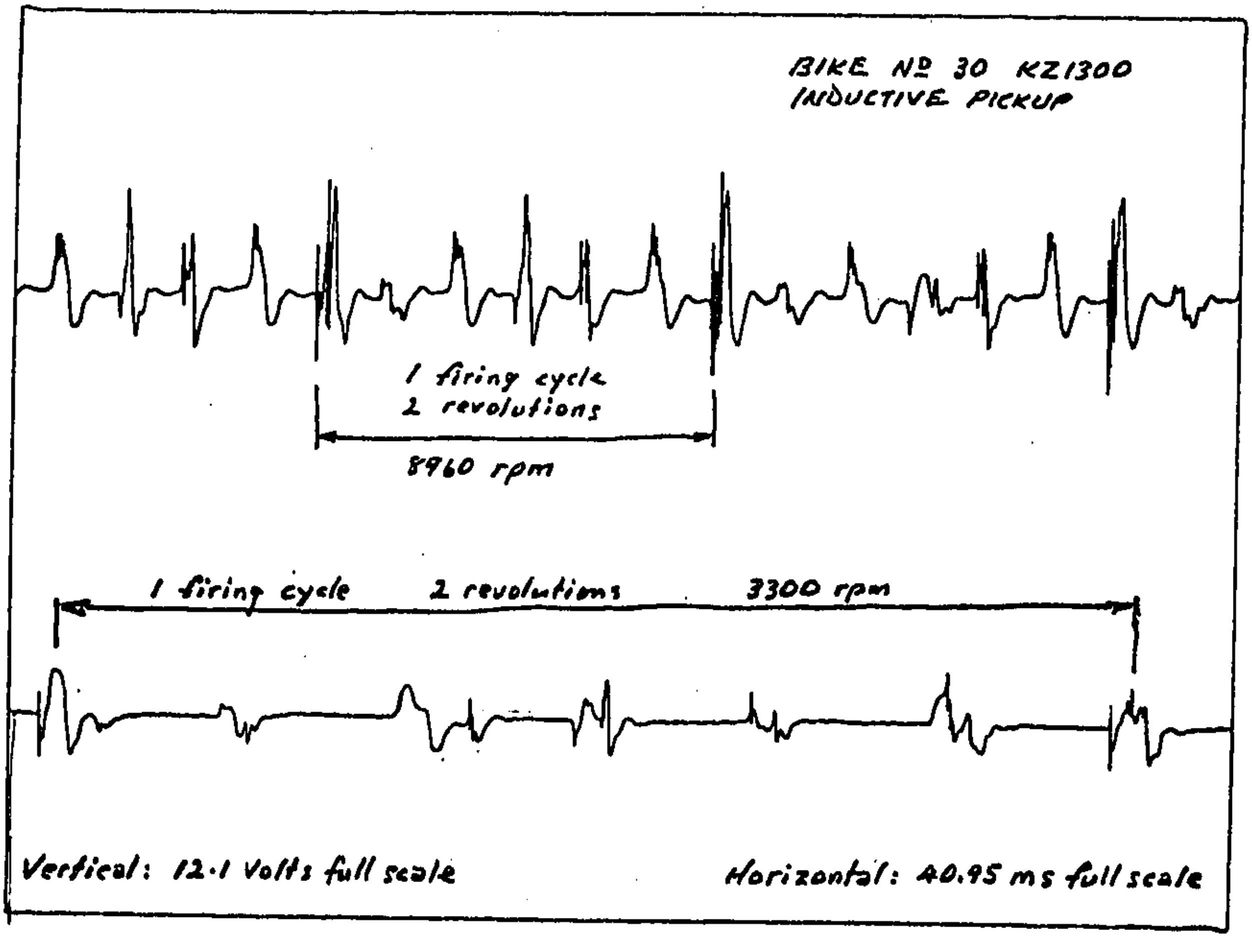

BIKE Nº 30 KZ1300
INDUCTIVE PICKUP
1 firing cycle
2 revolutions
8960 rpm
1 firing cycle
2 revolutions
3300 rpm
Vertical: 12.1 Volts full scale
Horizontal: 40.95 ms full scale

CHART E

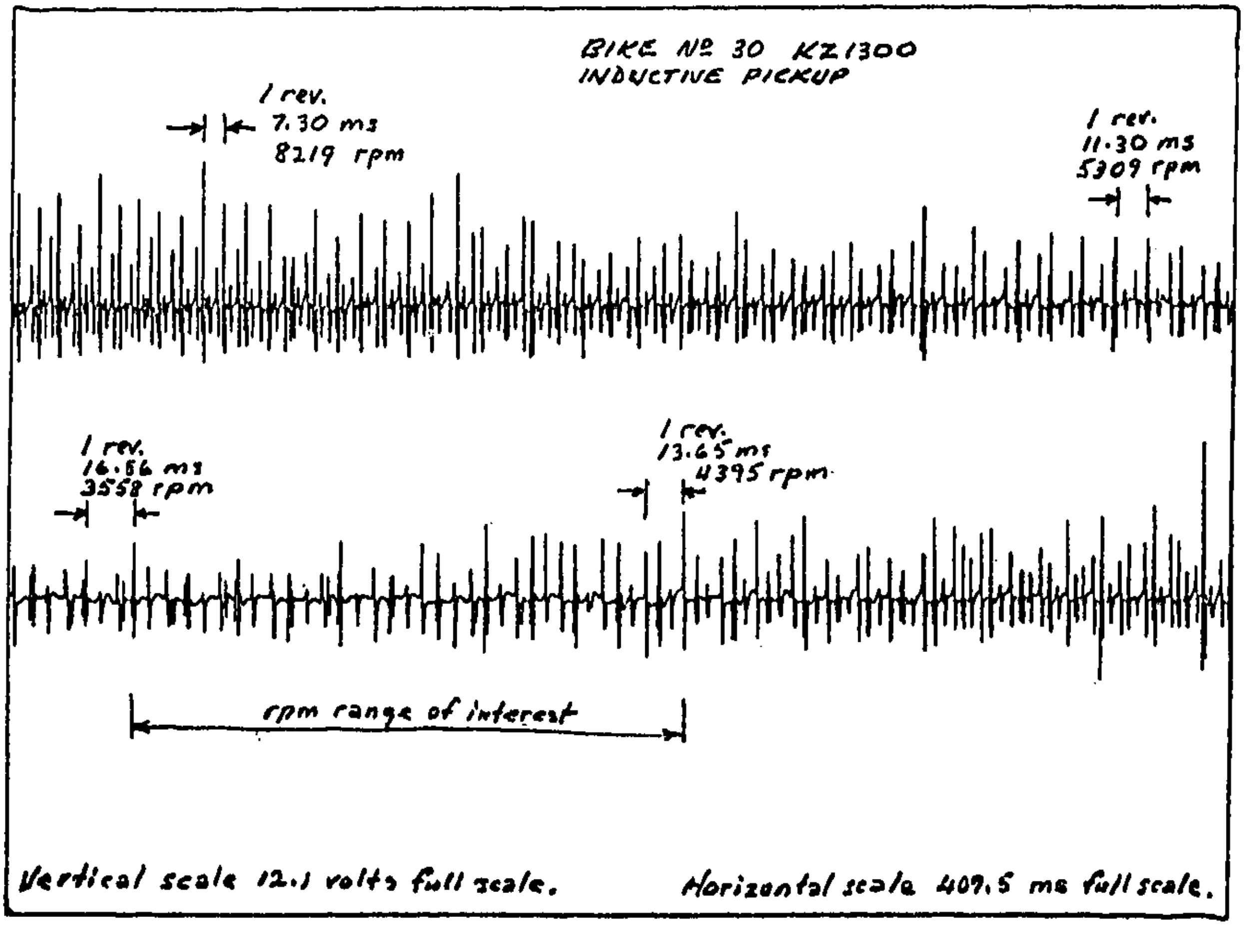

BIKE No 30 KZ1300
INDUCTIVE PICKUP
1 rev.
7.30 ms
8219 rpm
1 rev.
11.30 ms
5309 rpm
1 rev.
16.86 ms
3558 rpm
1 rev.
13.65 ms
4395 rpm
rpm range of interest
Vertical scale 12.1 volts full scale.
Horizontal scale 409.5 ms full scale.

CHART F

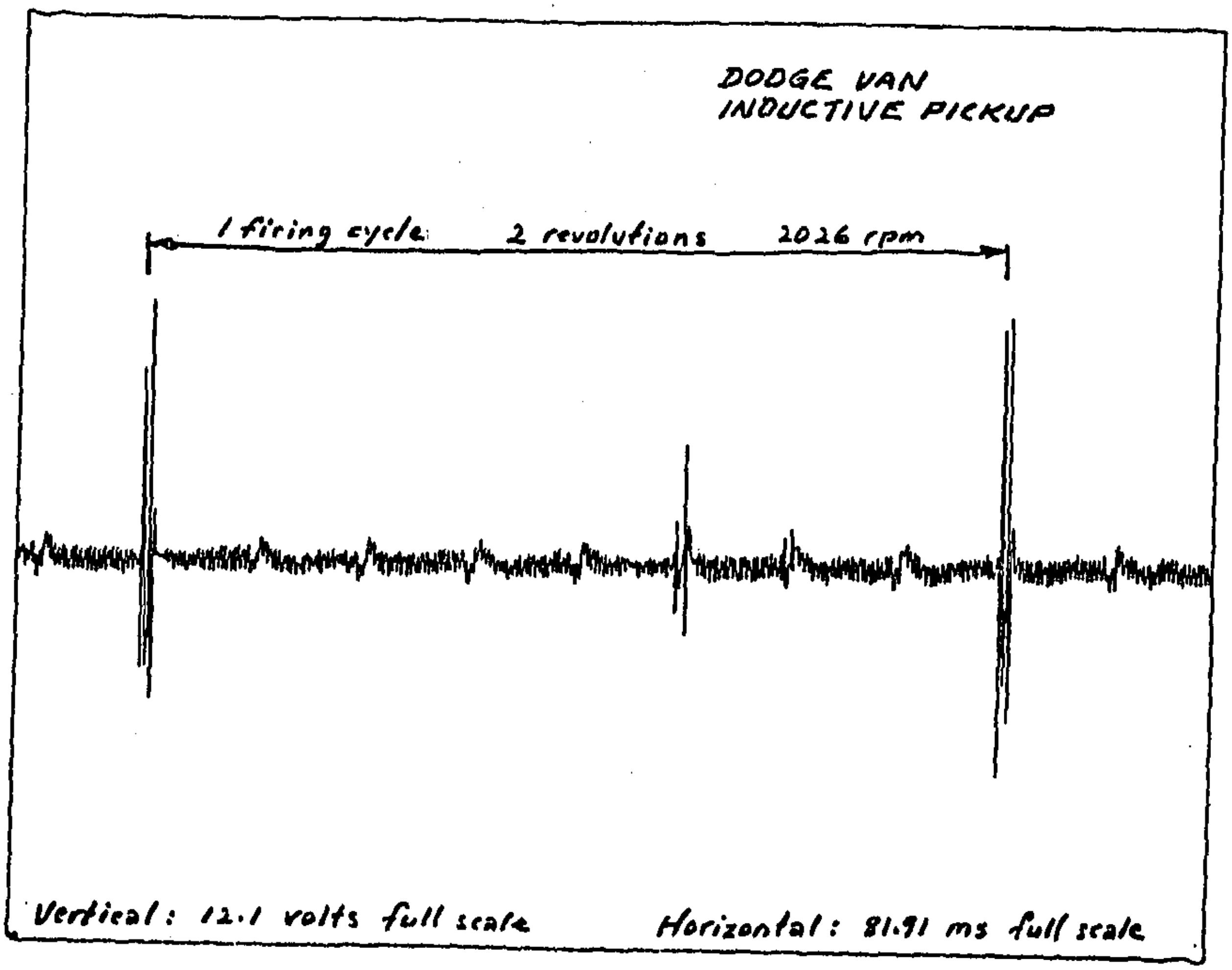

DODGE VAN
INDUCTIVE PICKUP
1 firing cycle 2 revolutions 2026 rpm
Vertical: 12.1 volts full scale
Horizontal: 81.91 ms full scale

CHART G

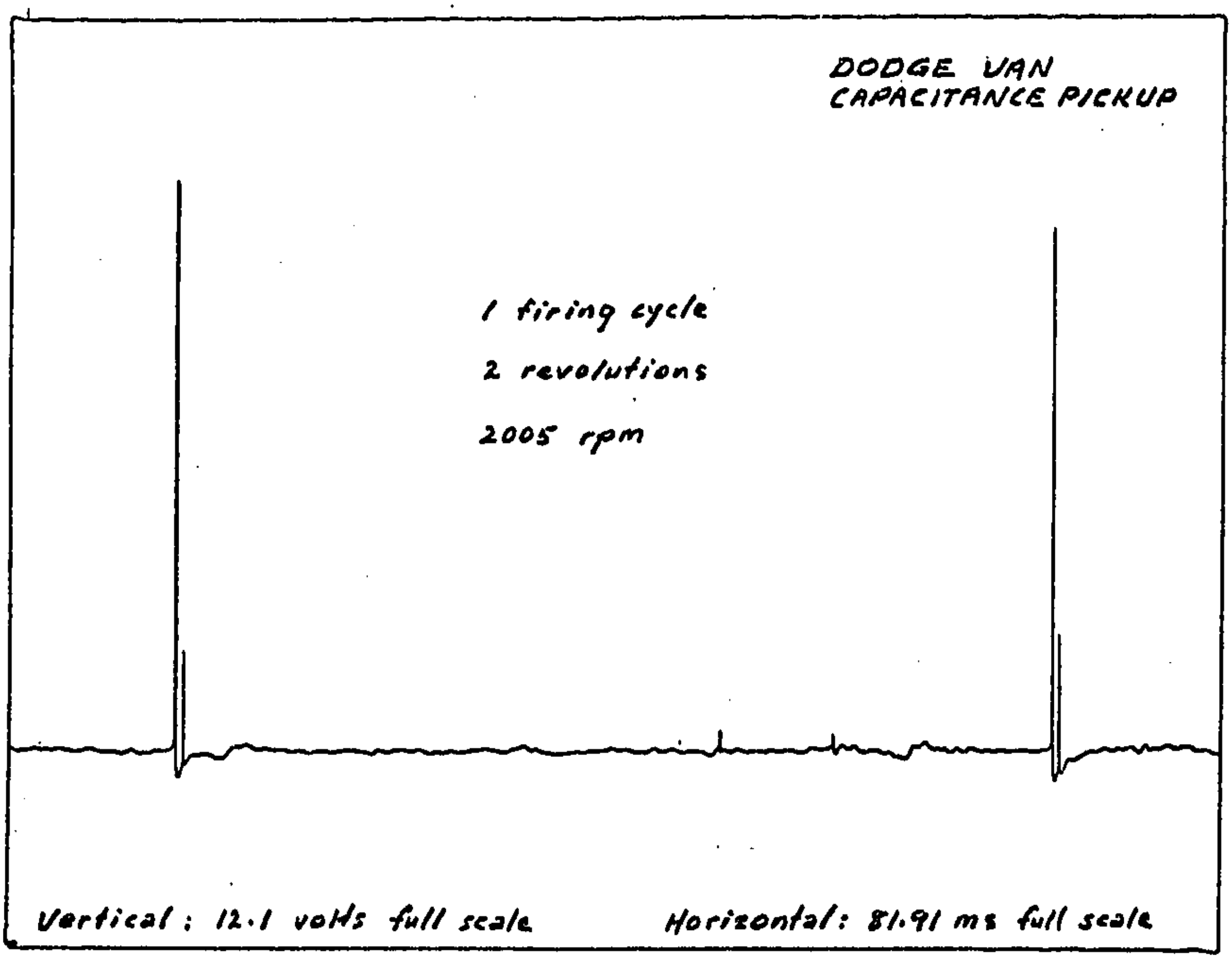

DODGE VAN
CAPACITANCE PICKUP
1 firing cycle
2 revolutions
2005 rpm
Vertical: 12.1 volts full scale
Horizontal: 81.91 ms full scale

CHART H

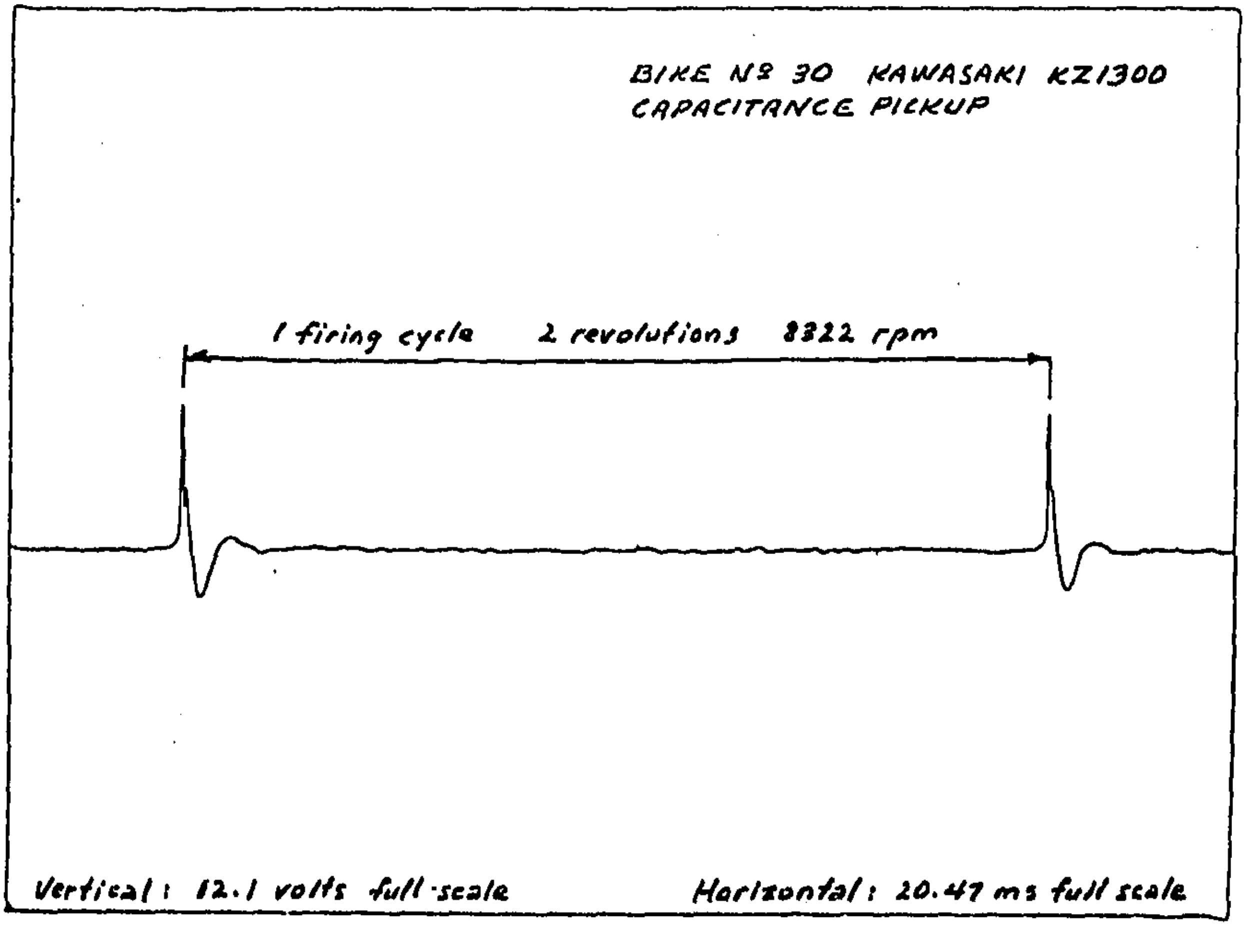

BIKE № 30 KAWASAKI KZ1300
CAPACITANCE PICKUP
1 firing cycle 2 revolutions 8322 rpm
Vertical: 12.1 volts full-scale
Horizontal: 20.47 ms full scale

CHART I

APPENDIX L

MOTORCYCLE NOISE

ESTIMATED FROM TIME/DISTANCE MEASUREMENTS

DURING ACCELERATION IN URBAN TRAFFIC SITUATIONS

INTRODUCTION

EPA undertook a test program to define motorcycle acceleration profiles, and associated noise emissions, as the vehicle operates typically in an urban traffic situation. Ground rules for the study required that the rider be unaware that observations were being made, that his vehicle be unimpeded by other traffic, and that his vehicle be accelerated from standstill at a traffic signal or stop sign.

Urban commuting, and urban recreational traffic situations were to be included, over a range of speed limit zones.

In addition to defining typical acceleration profiles and associated noise levels, the study examined motorcycle noise emission associated with a traverse of 100 feet in 4.8 seconds, which in a previous study[1] was selected as an acceleration profile under which "motorcycles can be driven in a reasonable fashion, keep up with traffic, and minimize excessive noise."

The test work in this Appendix was carried out in Los Angeles and Orange Counties, California, during August 1978.

[1] Motorcycle Noise Levels, a Report on Field Tests, conducted by the Illinois Task Force On Noise, June 1975.

TEST PROCEDURE AND RESULTS*

Test Sites

Sites selected for the observation of acceleration profiles included:

A. Urban commuting traffic, 45 mph zone
B. Urban commuting traffic, 40 mph zone
C. Urban recreational traffic, 35 mph zone
D. Urban recreational traffic, 25 mph zone

These sites are shown in Map L-1 and Map L-2.

Observed Acceleration Profiles

The acceleration profiles were defined in terms of time and distance from standstill to first and second shift points. Time was measured with a stop watch, distances with a measuring wheel. No noise measuring equipment was employed at the observation sites.

The observed acceleration profiles on 153 motorcycles are presented in Table L-1.

Noise Emissions Associated with Acceleration Profiles

At the McDonnell Douglas (EPA's Contractor) test track, Huntington Beach, California, motorcycles representative of the field motorcycles were operated under controlled conditions, and noise levels measured over a range of acceleration profiles. The motorcycles employed are listed in Table L-2, together with their J331a noise level, F76b noise level, and the noise level associated with a 100 foot traverse from standstill in 4.8 seconds.

For these motorcycles, curves of noise level vs traverse time to first shift point are presented in Figure L-1 thru Figure L-11. The noise level associated with an acceleration rate corresponding to a traverse of 100 feet in 5.3 seconds is identified on these plots. (A 4.8 second traverse time results in noise levels 2 dB higher). The 5.3 second figure is highlighted since it is the upper bound (lowest acceleration) in the observations at the commuting traffic sites (only one vehicle exceeding this figure).

While a 100 foot traverse in 4.8 seconds has previously been selected as prudent (based on automobile driving habits), it is far from typical of present motorcycle operations. The time/distance data of Table L-1 can be normalized to a 100 ft. distance, yielding the following statistical results:

* Tables and Figures are at the end of this Appendix.

	100' Traverse Time		
	$\bar{X}$	σ	η
Commuting traffic, 45 mph	3.9	0.7	38
Commuting traffic, 40 mph	4.0	0.5	51
Recreational traffic, 35 mph	4.4	0.9	33
Recreational traffic, 25 mph	3.8	0.7	31

where $\bar{X}$ = means time for 100' traverse, seconds
σ = standard deviation
η = sample size

A traverse time of 4.0 seconds typically is seen (Figure L-1 thru L-11) to result in noise levels 5 to 6 dB higher than does the 4.8 second traverse.

ISO Noise-Level Grids

Using the data from Figures L-1 thru L-11, lines of constant noise level can be constructed on plots of traverse time vs traverse distance. As a useful expedient, the constant noise level lines can be labeled "ΔdB re F76b level," instead of noise level. Grids thus constructed are present in Figures L-12 thru L-19. Superimposed on the grids are the time/distance data points from the field observations (from Table L-1), from which in-use motorcycle noise levels in urban traffic acceleration situations can be estimated.

The above construction recognizes that within a category of motorcycles, although their F76b noise levels may differ, similarity in their noise emission variance as a function of acceleration may be expected.

Statistical Distribution, Estimated Noise Emission Variance

Using the field data from the iso-noise level grids, (Figure L-12 thru L-19), statistical distribution charts of in-use motorcycle acceleration noise levels (presented as variance from their F76b level) can be constructed. These are presented in Figure L-20 thru L-36. Statistical distributions are shown first (in Figure L-20 for the total vehicle population, all sites; then broken down by site type and vehicle size. The distribution of motorcycle noise during acceleration in the traffic situations tends to center around 4 dB below the F76b level.

Significance of Microphone Measurement Position

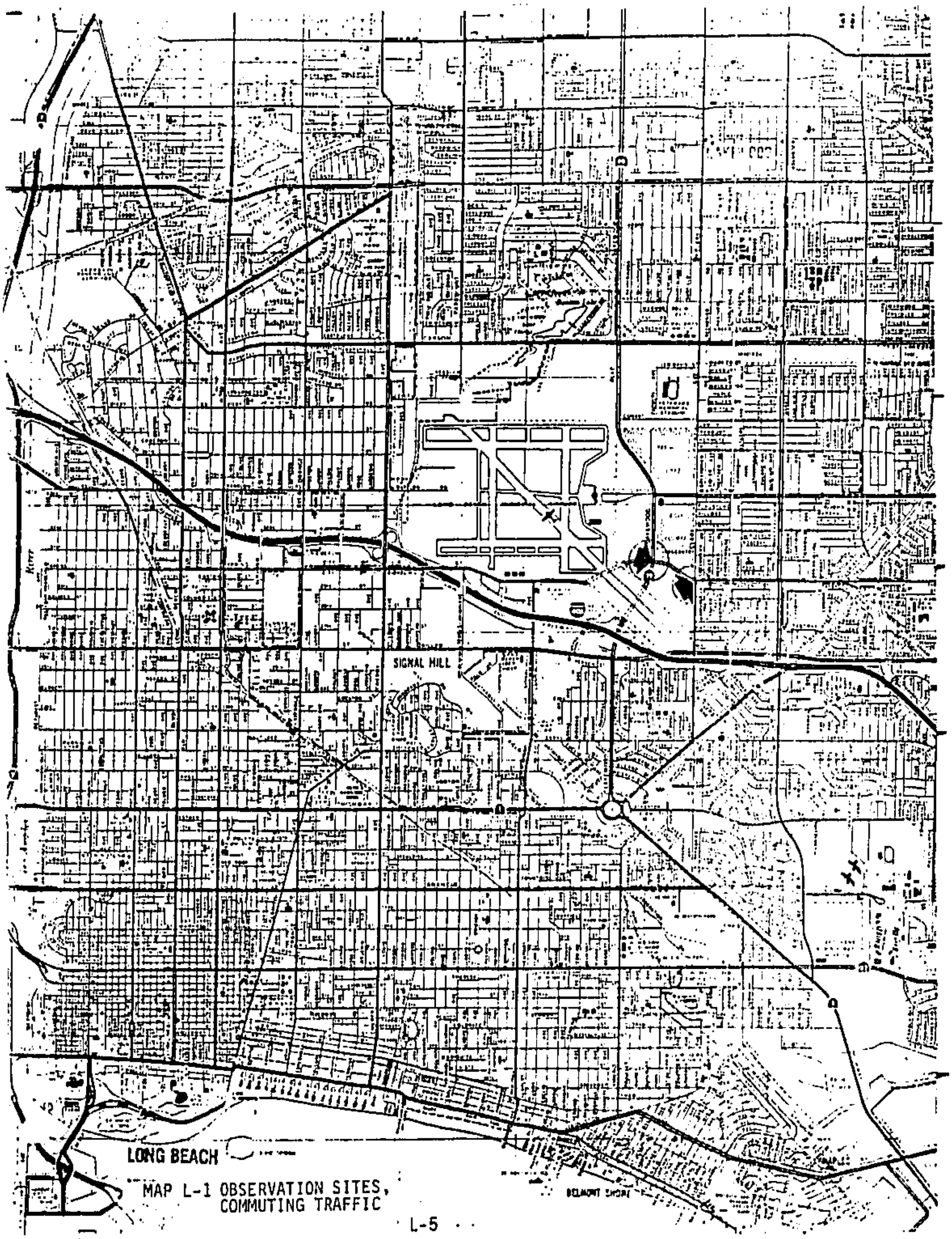
In the course of measurements taken under the controlled tests at the McDonnell Douglas test track, noise levels (using a Honda CB750F) were taken simultaneously at three microphone positions:

(1) 50' from track centerline, 4' height (shift point 25' past microphone)

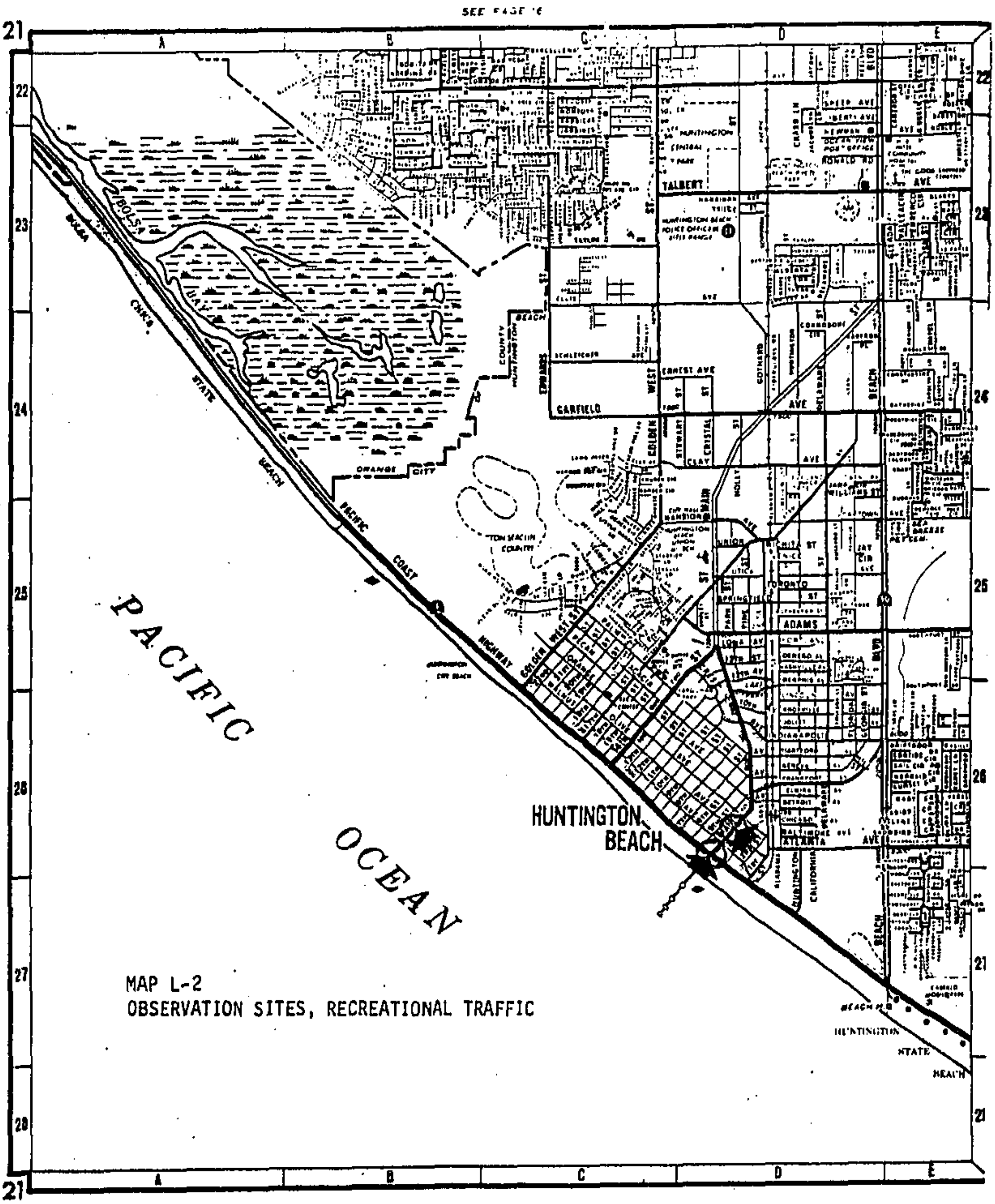
(2) 10' from track centerline, 4' height (shift point at microphone)

(3) 10' from track centerline, 9.6" height (shift point at microphone)

Positions 1 and 3 have the same direct/reflected path interference effects, assuming a one-foot source height; position 2 is one that conceivably might be employed in an enforcement situation. The data obtained from the three microphones are presented in Table 3. The data show a 13 dB difference between the 50' and 10' distances (instead of 15 calculated by the inverse square law), and further show that there is little difference between the 10' readings at a 4' height and the 9.6" height.



MAP L-1 OBSERVATION SITES, COMMUTING TRAFFIC



MAP L-2
OBSERVATION SITES, RECREATIONAL TRAFFIC

TABLE L-1 OBSERVED RIDING PATTERNS;
ACCELERATION FROM STOP SIGNAL

A. COMMUTING TRAFFIC, 45 MPH ZONE

Motorcycle	Time/distance to first shift point (seconds/ft)	Time/distance to second shift point (seconds/ft)
Honda 550	2.5/82	
Yamaha 175	3.0/40	
Honda 250	2.0/45	
Honda 550		4.0/165
Honda CX500	2.2/50	4.2/110
Yamaha 360	2.0/45	4.2/90
Suzuki 750	3.0/80	5.3/180
Harley 1000	3.5/70	
Honda 750	4.6/95	5.5/150
Norton 850	2.5/95	5.2/150
Honda 360	2.5/50	8.2/285
Honda 500	3.0/50	5.5/120
Harley 1000	3.0/60	7.2/200
Honda 360	3.0/50	6.2/140
BMW 750	3.5/70	7.2/225
Honda 500	3.1/70	
Kawasaki 1000	3.3/93	
Yamaha 650	2.5/50	
Honda 750	3.2/70	6.2/210
Honda 400	2.5/55	5.8/230
Honda 750	2.0/50	3.5/130
Yamaha 650	3.2/85	6.2/240
Harley 1000	3.0/65	
Honda 550	4.0/75	6.5/230
Honda 350	3.3/50	4.8/140
Honda 750	5.0/130	8.2/300
Honda 750	3.0/50	5.0/150

(Continued)

TABLE L-1 (cont'd) OBSERVED RIDING PATTERNS; ACCELERATION FROM STOP SIGNAL

A. COMMUTING TRAFFIC, 45 MPH ZONE

Motorcycle	Time/distance to first shift point (seconds/ft)	Time/distance to second shift point (seconds/ft)
Honda 1000	3.2/60	4.6/200
Honda 175	3.0/50	4.5/100
Honda 750	3.0/40	6.0/200
Yamaha 750	2.5/60	6.2/300 (3rd gear)
BMW 750	3.0/70	
Yamaha 650		5.0/205
Yamaha 600	3.3/95	5.5/240
Kawasaki 1000	2.3/55	6.7/200
Kawasaki 1000	2.0/40	3.4/100
Honda 1000		5.5/100
Yamaha 500	3.8/90	8.2/350
Honda 350	3.2/90	5.5/185

B. COMMUTING TRAFFIC, 40 MPH ZONE

Kawasaki KZ1000	3.8/75	7.0/190
Kawasaki KZ1000	4.9/90	
Yamaha 500	4.0/75	6.5/165
Yamaha RD400	3.7/65	5.3/145
Honda 360	3.5/55	
Harley 1200	2.5/65	5.5/155
Honda 450	2.9/55	5.1/135
Honda 550	2.9/70	5.5/165
Honda 750	3.1/75	5.0/155
Honda 750	3.3/85	7.3/250
Honda 200	2.1/45	3.8/75
Honda 500	2.8/95	7.8/300
Honda 400		6.5/210
Honda 750	2.4/60	4.6/135
Yamaha 650	3.2/105	6.0/340
Honda 550	3.0/55	5.2/190
Honda 750	3.5/65	7.2/300

(Continued)

TABLE L-1 (cont'd) OBSERVED RIDING PATTERNS; ACCELERATION FROM STOP SIGNAL

B. COMMUTING TRAFFIC, 40 MPH ZONE

Motorcycle	Time/distance to first shift point (seconds/ft)	Time/distance to second shift point (seconds/ft)
Honda 350	3.1/55	5.2/180
Honda 350	2.5/50	
Honda 750	4.0/100	7.0/380
Honda 750	4.0/100	
Kawasaki 1000	4.0/135	8.0/350
Honda 750	4.0/65	6.7/400
Honda CX500	2.9/45	5.2/135
Kawasaki 400	4.0/65	6.5/145
Suzuki 550	4.0/125	6.8/300
Honda 750	3.0/45	
Honda 750	2.5/45	3.8/95
Yamaha 750	3.2/50	
Honda 750	2.0/50	
Honda 750	3.1/65	
Honda 350	2.9/50	
Suzuki 750	3.5/70	
Honda 400	3.1/55	8.0/270
Norton 850	3.0/70	6.3/190
Honda 175	2.3/45	4.2/130
Kawasaki 900	2.5/50	5.4/170
Honda 305	3.1/60	4.7/170
Honda 400	2.3/60	4.9/140
Truimph 650	3.1/65	
Honda 550	2.7/65	5.1/160
Yamaha 125	1.3/35	5.2/170
Honda 350	2.7/60	
Honda 350	2.8/60	7.6/180
Honda 175	2.5/35	3.9/90
Honda (small) 125	1.5/20	4.1/90

(Continued)

TABLE L-1 (cont'd) OBSERVED RIDING PATTERNS; ACCELERATION FROM STOP SIGNAL

B. COMMUTING TRAFFIC, 40 MPH ZONE

Motorcycle	Time/distance to first shift point (seconds/ft)	Time/distance to second shift point (seconds/ft)
Honda 550	2.4/50	
Honda 550	2.5/60	5.3/170
Honda 175	3.1/55	4.5/140
Honda Chopper	2.5/60	4.5/120
Honda 750	3.6/65	8.5/390
Honda 500	2.3/50	4.0/150

C. RECREATIONAL TRAFFIC, 35 MPH ZONE

Motorcycle	Time/distance to first shift point (seconds/ft)	Time/distance to second shift point (seconds/ft)
Harley Chopper	2.5/45	6.3/200
Honda 550	2.9/65	5.5/180
Honda 500		7.8/220
Honda 650	4.0/75	
Harley 1200	2.0/45	4.7/110
Honda 350	2.3/45	4.4/100
Honda 550	3.0/75	6.3/220
Honda 750	3.4/45	5.4/95
Honda 350	3.4/70	8.8/250
Yamaha 750	4.0/95	
BMW 900	7.0/150	
Kawasaki 1000	3.2/120	
Honda 500	2.6/50	5.5/180
Honda 500	3.9/90	8.5/250
Honda 350	3.8/95	6.3/220
Honda Chopper	3.9/50	8.0/180
Honda 350	2.8/60	7.0/200
Honda 750	1.5/10	5.8/160
Honda Chopper	3.0/45	10.8/220
Harley 1000	6.0/110	

(Continued)

TABLE L-1 (cont'd) OBSERVED RIDING PATTERNS; ACCELERATION FROM STOP SIGNAL

C. RECREATIONAL TRAFFIC, 35 MPH ZONE

Motorcycle	Time/distance to first shift point (seconds/ft)	Time/distance to second shift point (seconds/ft)
Honda 550	3.2/65	6.8/240
Kawasaki 250	2.5/55	4.5/75
Kawasaki 400		4.0/120
Yamaha 400	2.6/40	5.0/150
Honda Chopper	3.4/45	6.2/170
Kawasaki 400		4.0/120
Yamaha 400	2.6/40	5.0/150
Honda Chopper	3.4/45	6.2/170
Kawasaki 400		6.3/200
Kawasaki 1000	4.6/150	
Honda GL1000	3.9/90	7.0/230
Kawasaki 1000	2.9/65	
Honda 750	4.0/100	6.8/200

D. RECREATIONAL TRAFFIC, 25 MPH ZONE

Kawasaki 900	2.8/50	
Honda 350		5.0/90
Kawasaki 1000	2.8/50	
Honda 400	6.0/	
Honda 500	2.8/50	
Honda 400	2.0/40	
Honda 1000	6.4/145	
Kawasaki 1000	2.0/40	
Honda 360	4.9/110	
Norton 850	4.0/85	
Benelli 500	2.0/35	
Suzuki 550	2.2/45	

(Continued)

TABLE L-1 (cont'd) OBSERVED RIDING PATTERNS; ACCELERATION FROM STOP SIGNAL

D. RECREATIONAL TRAFFIC, 25 MPH ZONE

Motorcycle	Time/distance to first shift point (seconds/ft)	Time/distance to second shift point (seconds/ft)
Honda 750	2.8/70	
Honda 175	2.3/60	
Honda 550	2.6/70	
Kawasaki 1000	2.6/60	
Triumph 500	2.2/60	
Honda 750	3.0/60	
Honda 550	2.4/50	
Yamaha 650	4.2/80	
Yamaha 650	3.5/70 (2nd trial)	
Honda 1000	3.4/50	
Kawasaki 400	2.4/50	
Norton 850	3.5/70	
Triumph 650	4.4/80	
Honda 750	2.4/50	
Honda 750	2.8/50	
Honda 750	3.2/70	
Honda 750	2.2/60	
Yamaha 100	1.8/40	
Honda 750	3.4/70	
Hamaha 650	3.0/50	

TABLE L-2 MOTORCYCLES USED TO DEVELOP NOISE EMISSION LEVELS ASSOCIATED WITH A RANGE OF ACCELERATION PROFILES

Motorcycle Make/Model	Stock (S)* or Modified (M)*	Noise Level dB @ 50'		
		J331a	F76b	L(4.8 sec)**
Harley Sportster 1000	S	86	85	76
Harley Sportster 1000	M	98	94	87
Honda GL1000	S	74	76	68
Honda CB750F	S	79	80	74
Honda CB750F	M	99	99	95
Honda CB750K	S	78	80	74
Honda CB550	S	79	80	70
Honda CJ360T	S	79	83	74
Honda CB125S	S	81	85	83
Kawasaki KZ900	S	84	85	75
Kawasaki KZ900	M	86	91	76
Yamaha XS650	S	84	84	75

* Represented by owner as being stock or modified.
** Noise Level when motorcycle traverses 100 feet in 4.8 seconds from standstill.

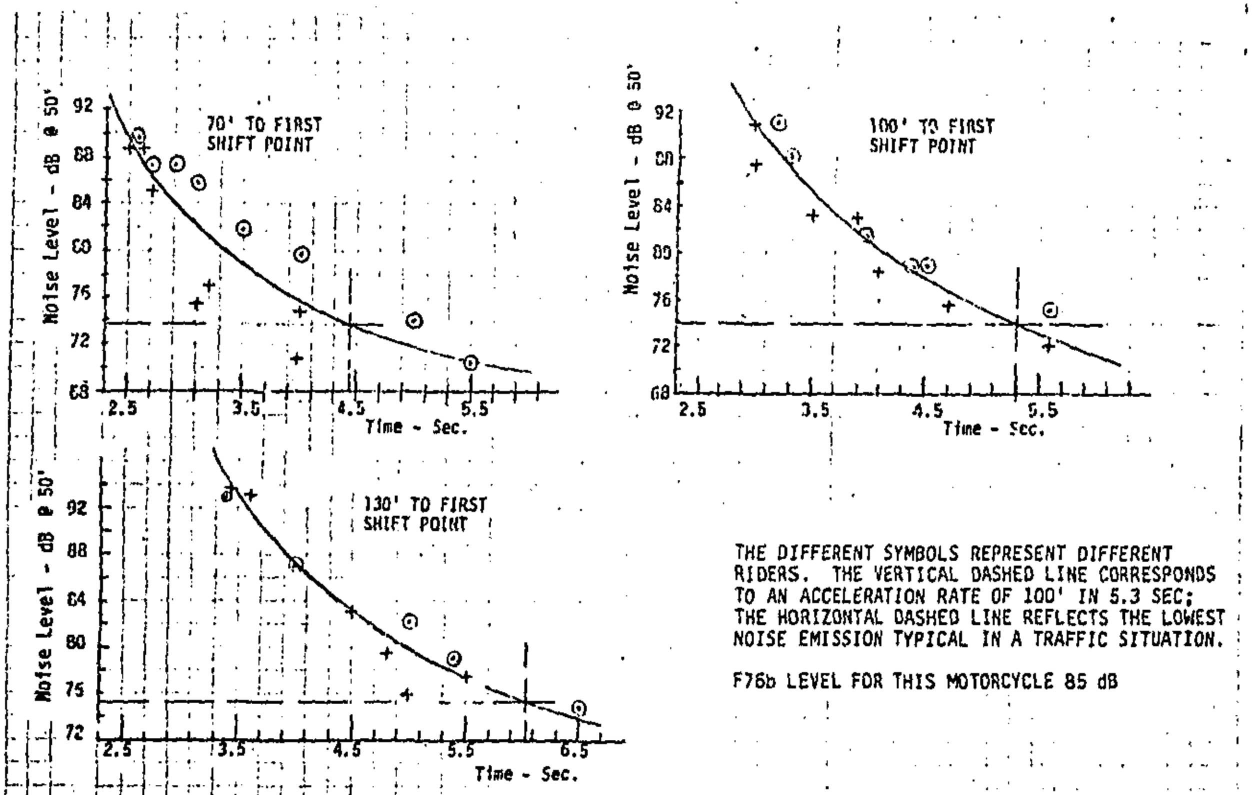
TABLE L-3 EFFECT OF MICROPHONE POSITION ON MEASURED NOISE EMISSION (dB)
(HONDA CB750F, VARIOUS ACCELERATION PROFILES)

	D = 70'				D = 100'				D = 130'			
	① 50'@4'	② 10'@4'	③ 10'@9.6"	t	① 50'@4'	② 10'@4'	③ 10'@9.6"	t	① 50'@4'	② 10'@4'	③ 10'@9.6"	t
Rider A	70.5	84.0	84.1	4.2	72.7	85.2	-	4.5	74.8	89.5	90.2	5.2
	71.0	84.5	85.1	4.1	-	87.5	87.6	4.3	75.6	89.0	90.0	5.3
	73.8	85.8	86.2	3.7	76.0	90.5	91.0	4.0	76.3	91.0	91.2	4.7
	75.6	87.8	88.2	3.1	77.0	91.1	91.2	3.6	79.0	92.0	92.6	4.5
	79.9	93.5	93.2	3.0	82.1	93.8	94.5	3.4	82.9	96.2	95.9	3.9
	82.2	96.0	96.5	2.5	86.6	99.5	99.0	3.1	89.9	100.2	100.3	3.7
	82.0	96.7	96.5	2.5								
Rider B	71.5	82.2	83.0	5.0	73.5	82.4	82.9	6.0	76.1	88.1	89.6	5.6
	72.5	84.0	84.6	4.8	74.0	86.4	87.0	5.5	75.9	86.0	87.8	5.7
	75.2	86.7	86.5	4.3	75.5	88.8	88.8	4.9	79.1	92.0	93.1	5.3
	78.2	90.8	91.0	3.5	78.0	90.0	90.4	4.2	80.4	92.6	93.3	4.5
	81.9	95.2	95.5	3.0	81.3	93.4	93.9	3.8	85.1	97.5	97.3	4.0
	84.2	98.0	97.8	3.0	83.1	96.5	96.5	3.5	87.4	100.1	100.3	3.5
	82.5	96.4	96.1	2.6	85.1	99.5	99.3	3.3				

NOMENCLATURE:

D = distance from standstill to first shift point.
t = time (sec.) to first shift point
①; Mic 50' from track centerline, 4' height
②; Mic 10' from track centerline, 4' height
③; Mic 10' from track centerline, 9.6" height
$\bar{X}$ = Mean of differences.
σ = Standard deviation of differences.
η = Sample Size

	Difference ② - ①	Difference ③ - ①	Difference ③ - ②
$\bar{X}$ =	12.75	13.10	0.34
σ =	1.33	1.24	0.50
η =	38	37	38



THE DIFFERENT SYMBOLS REPRESENT DIFFERENT RIDERS. THE VERTICAL DASHED LINE CORRESPONDS TO AN ACCELERATION RATE OF 100' IN 5.3 SEC; THE HORIZONTAL DASHED LINE REFLECTS THE LOWEST NOISE EMISSION TYPICAL IN A TRAFFIC SITUATION.

F76b LEVEL FOR THIS MOTORCYCLE 85 dB

FIGURE L-1 NOISE LEVEL AS A FUNCTION OF TIME AND DISTANCE FROM STANDING START TO FIRST SHIFT POINT, HARLEY 1000 SPORTSTER

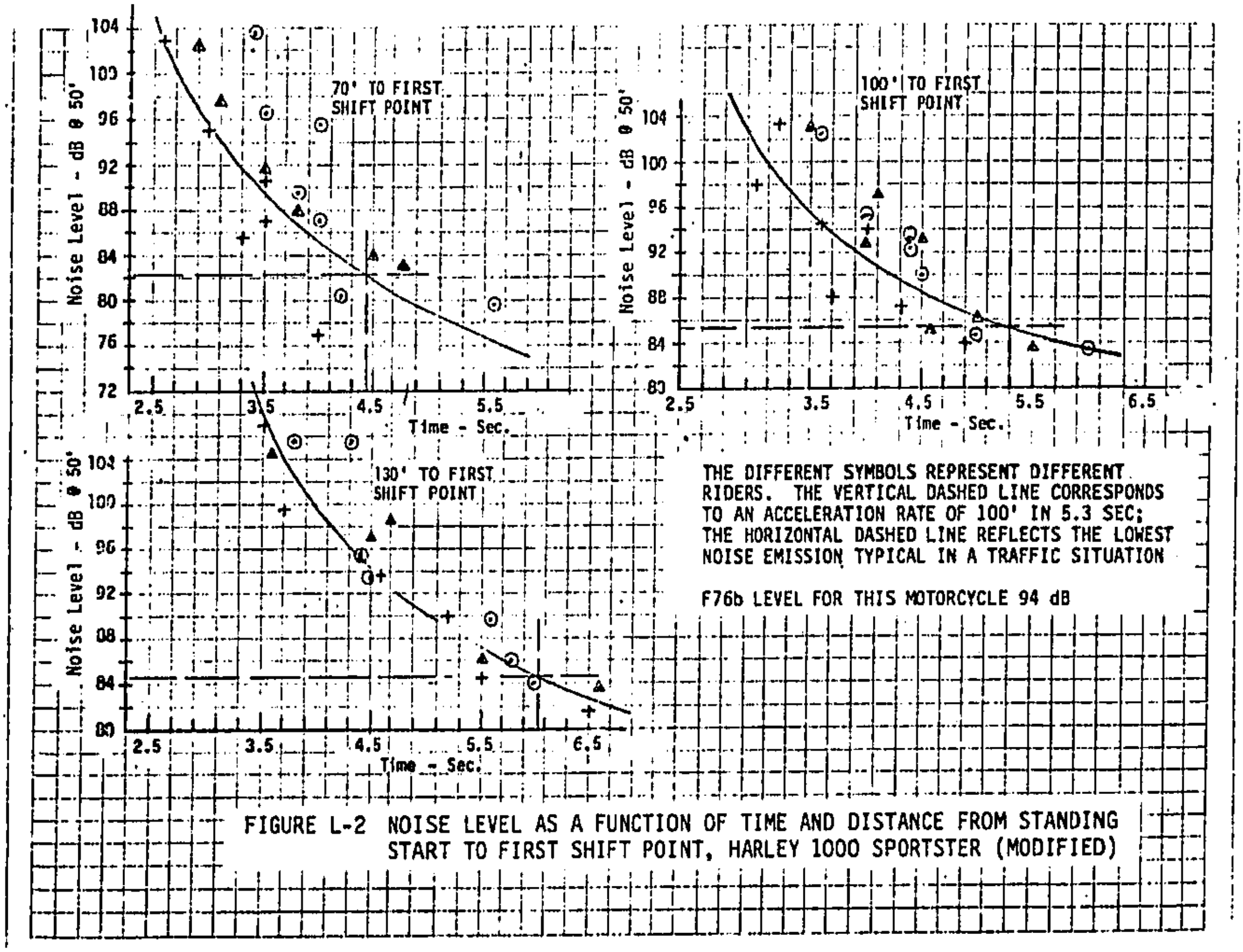
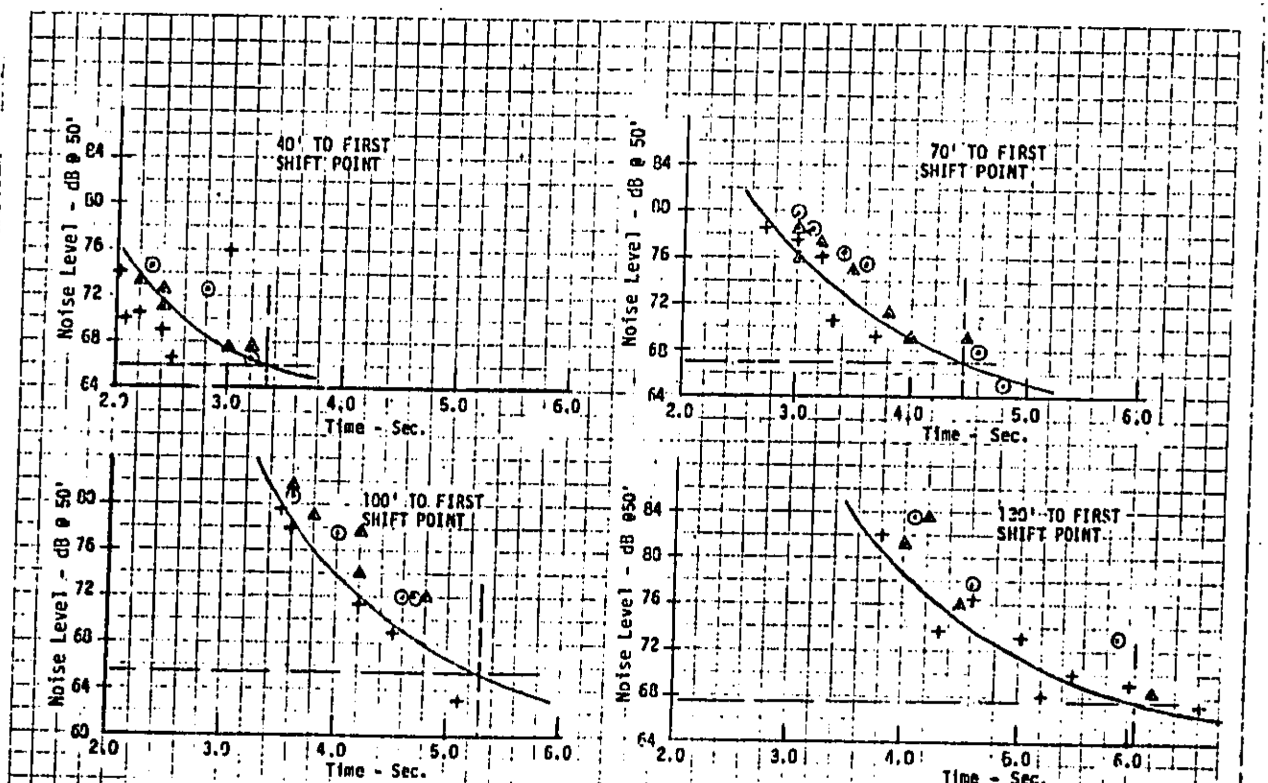


FIGURE L-2 NOISE LEVEL AS A FUNCTION OF TIME AND DISTANCE FROM STANDING START TO FIRST SHIFT POINT, HARLEY 1000 SPORTSTER (MODIFIED)



THE DIFFERENT SYMBOLS REPRESENT DIFFERENT RIDERS. THE VERTICAL DASHED LINE CORRESPONDS TO AN ACCELERATION RATE OF 100' IN 5.3 SEC; THE HORIZONTAL DASHED LINE REFLECTS THE LOWEST NOISE EMISSION TYPICAL IN A TRAFFIC SITUATION.

F76b LEVEL FOR THIS MOTORCYCLE 76 dB

FIGURE L-3 NOISE LEVEL AS A FUNCTION OF TIME AND DISTANCE FROM STANDING START TO FIRST SHIFT POINT; HONDA GL1000

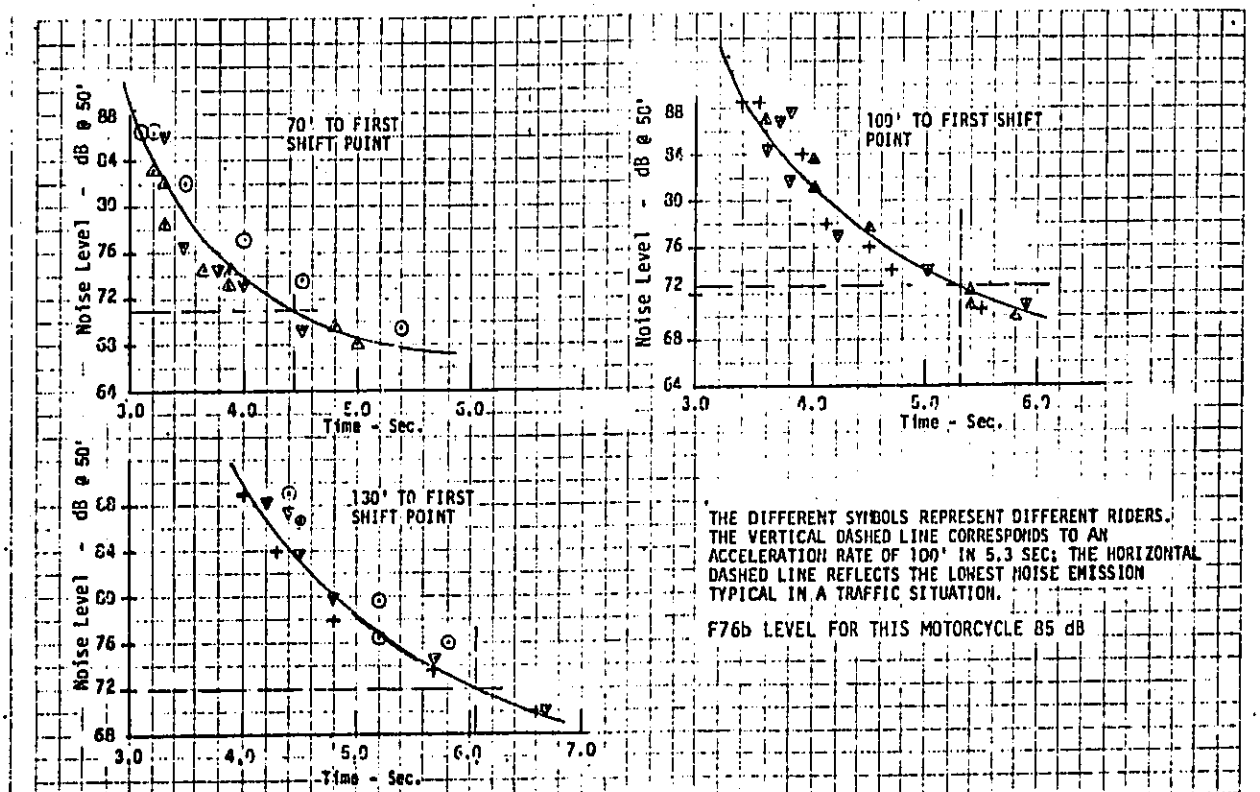


FIGURE L-4 SOUND LEVEL AS A FUNCTION OF TIME AND DISTANCE FROM STANDING START TO FIRST SHIRT POINT; KAWASAKI KZ900

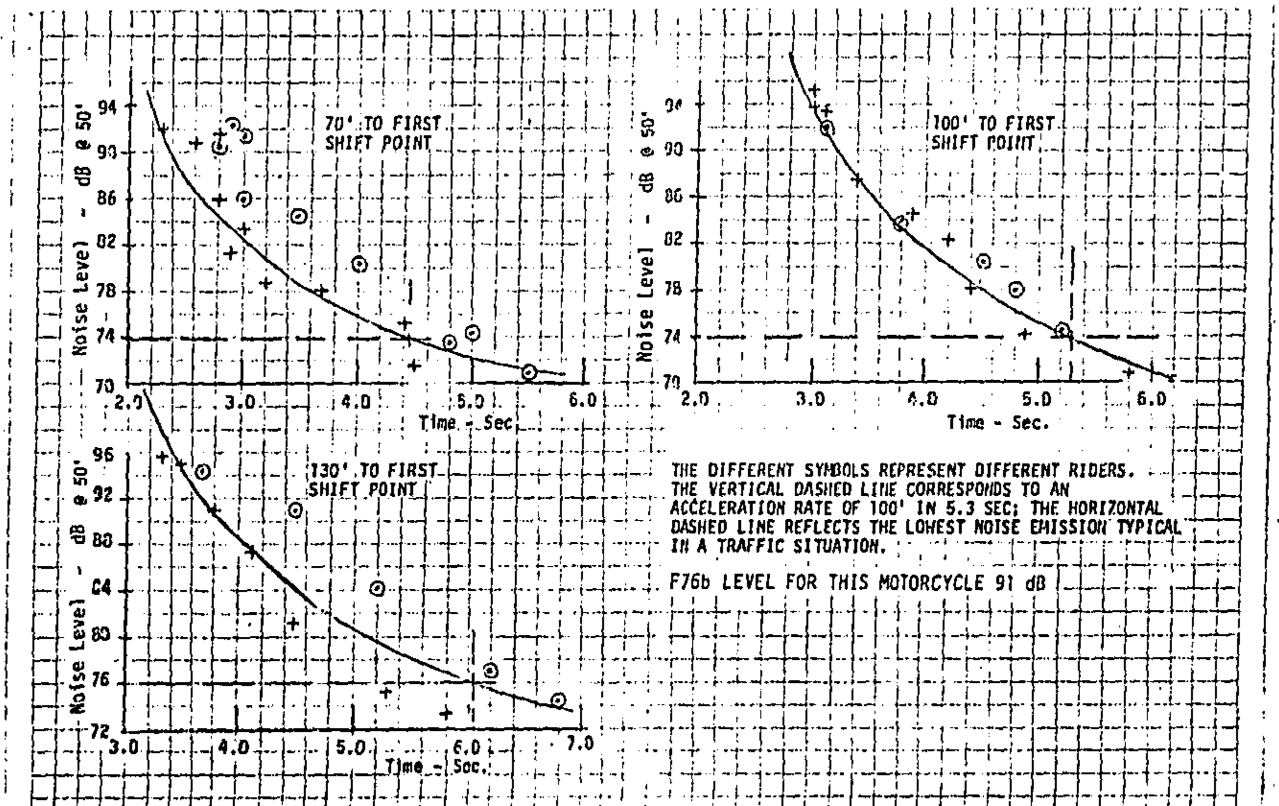


FIGURE L-5 NOISE LEVEL AS A FUNCTION OF TIME AND DISTANCE FROM STANDING START TO FIRST SHIFT POINT; KAWASAKI KZ900 (MODIFIED)

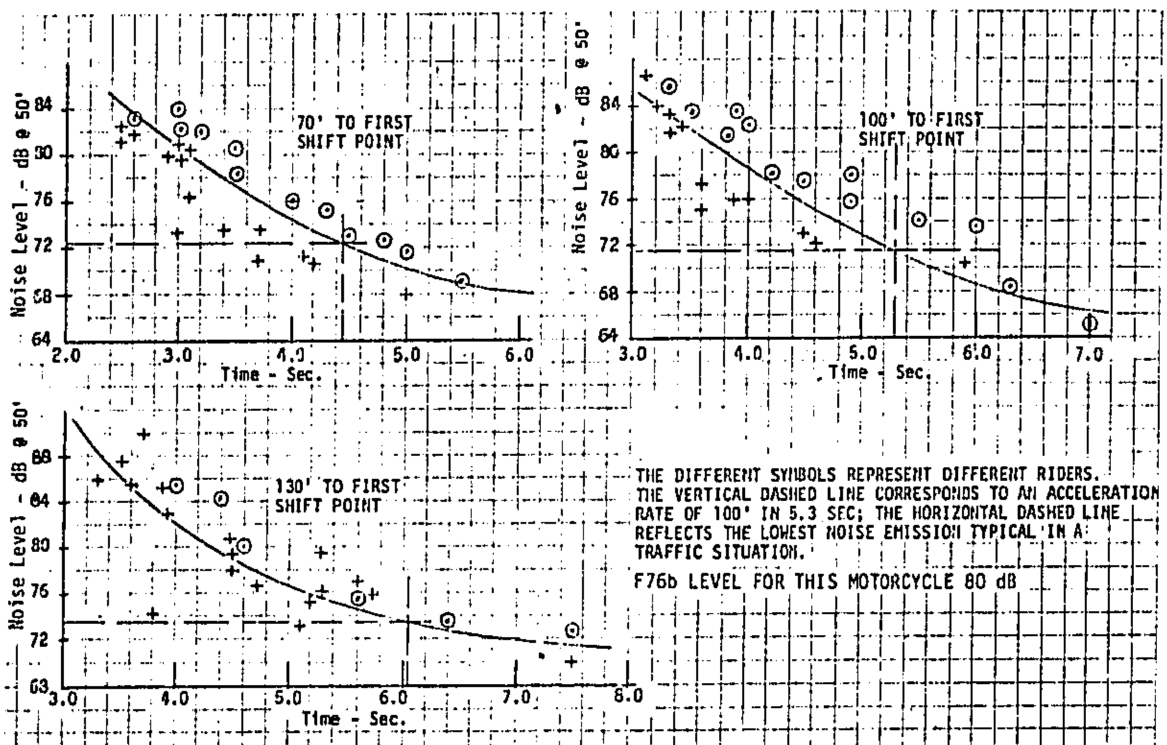


FIGURE L-6 NOISE LEVEL AS A FUNCTION OF TIME AND DISTANCE FROM STANDING START TO FIRST SHIFT POINT; HONDA CB750K AND HONDA CB750F.

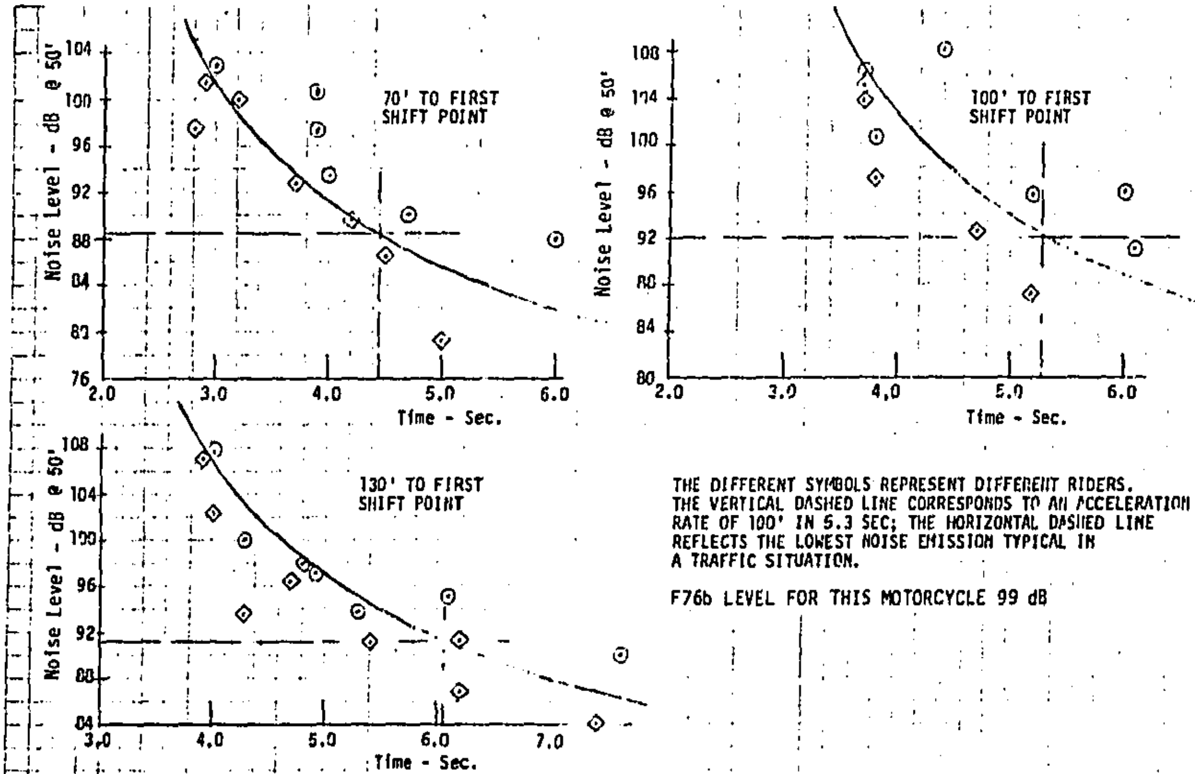
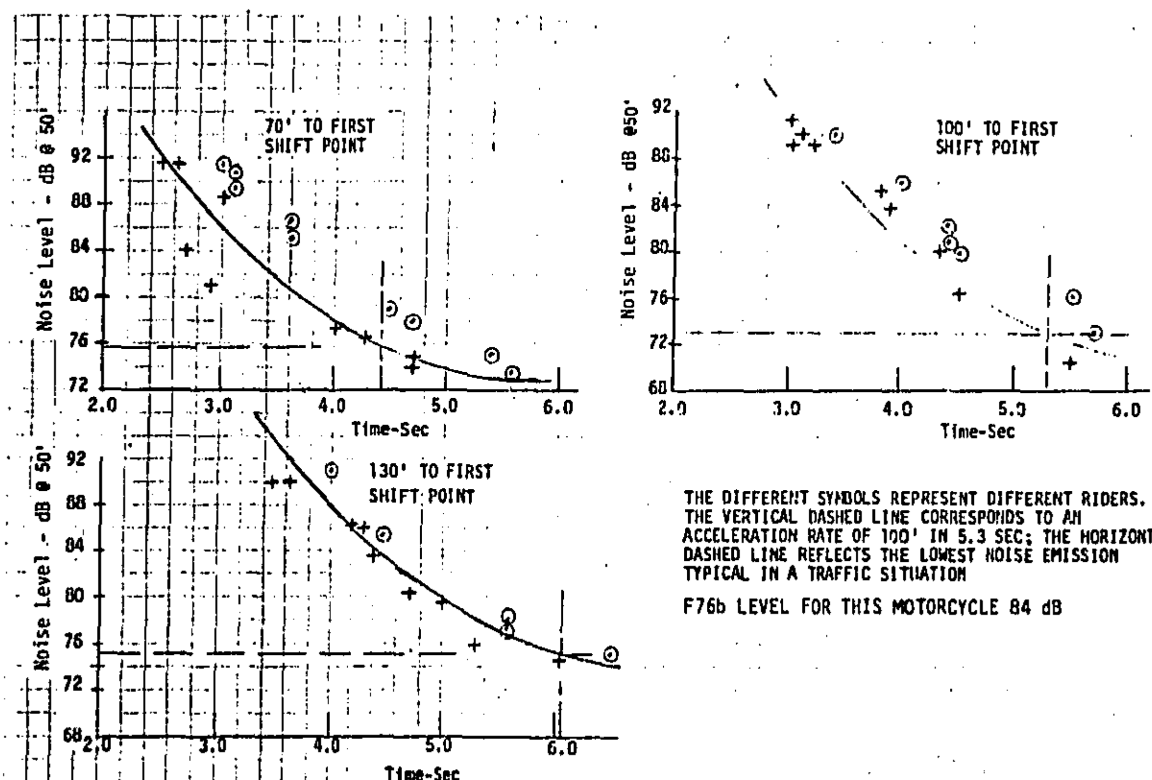


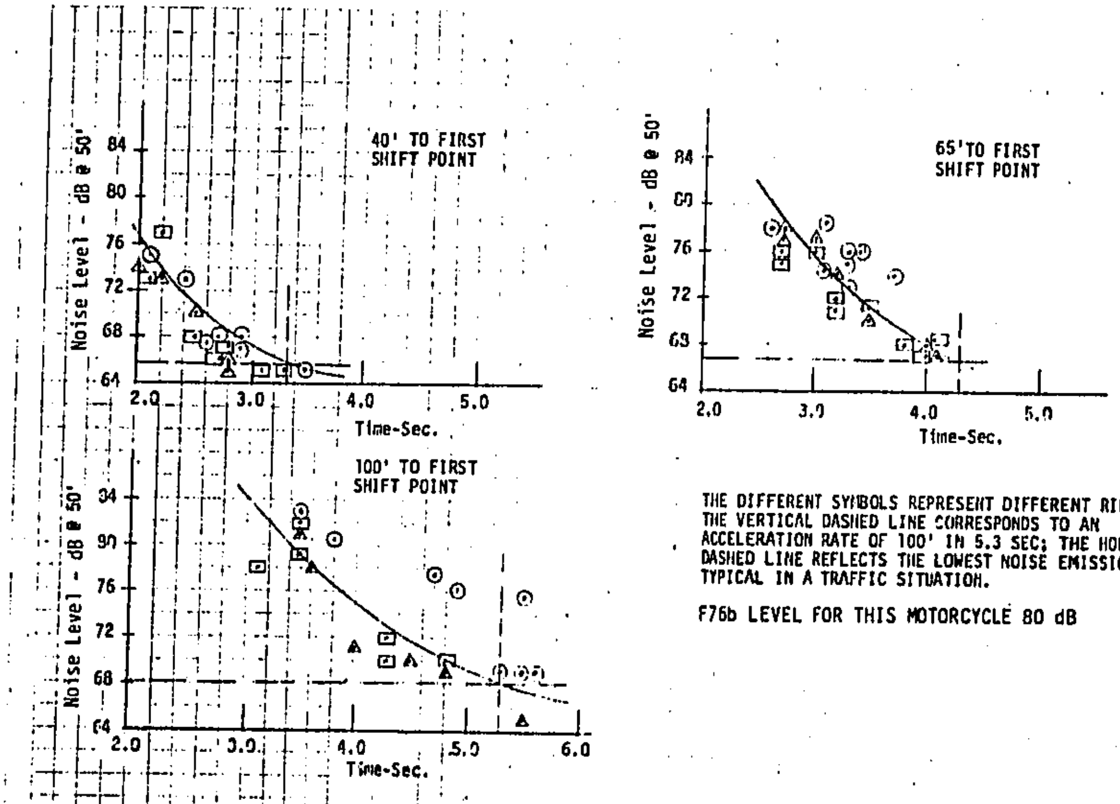
FIGURE L-7 NOISE LEVEL AS A FUNCTION OF TIME AND DISTANCE FROM STANDING START TO FIRST SHIFT POINT; HONDA CB750F (MODIFIED)



THE DIFFERENT SYMBOLS REPRESENT DIFFERENT RIDERS. THE VERTICAL DASHED LINE CORRESPONDS TO AN ACCELERATION RATE OF 100' IN 5.3 SEC; THE HORIZONTAL DASHED LINE REFLECTS THE LOWEST NOISE EMISSION TYPICAL IN A TRAFFIC SITUATION

F76b LEVEL FOR THIS MOTORCYCLE 84 dB

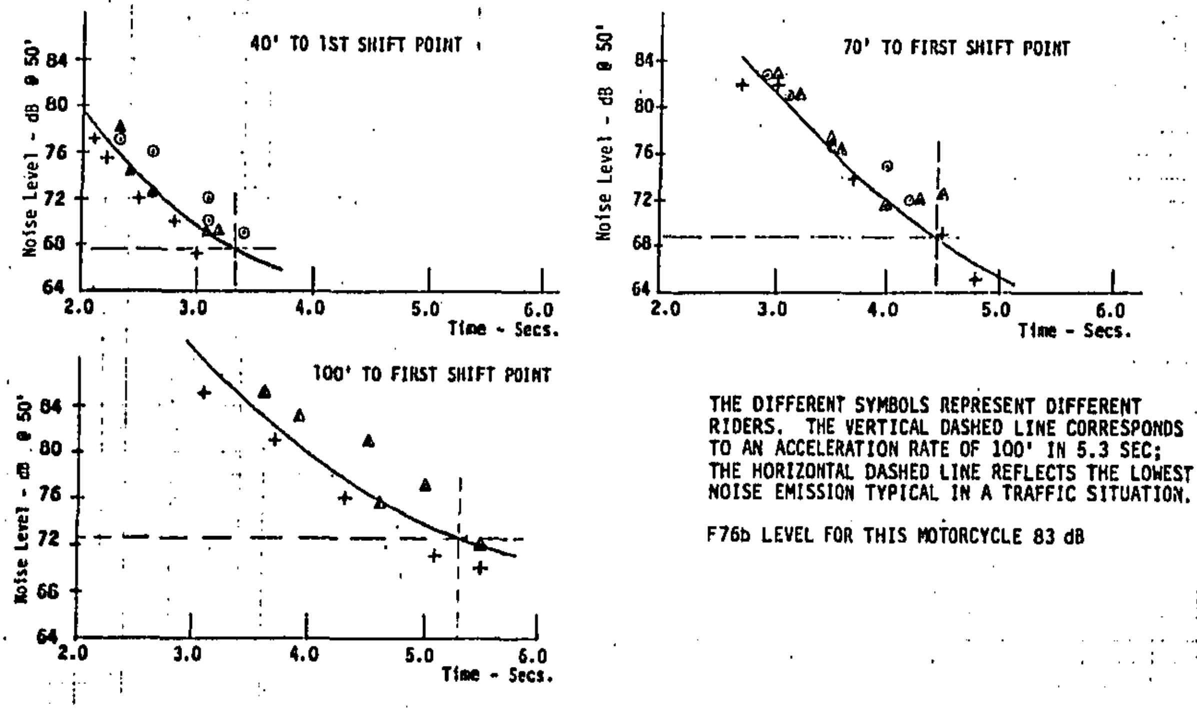
FIGURE L-8 NOISE LEVEL AS A FUNCTION OF TIME AND DISTANCE FROM STANDING START TO FIRST SHIFT POINT; YAMAHA XS650



THE DIFFERENT SYMBOLS REPRESENT DIFFERENT RIDERS. THE VERTICAL DASHED LINE CORRESPONDS TO AN ACCELERATION RATE OF 100' IN 5.3 SEC; THE HORIZONTAL DASHED LINE REFLECTS THE LOWEST NOISE EMISSION TYPICAL IN A TRAFFIC SITUATION.

F76b LEVEL FOR THIS MOTORCYCLE 80 dB

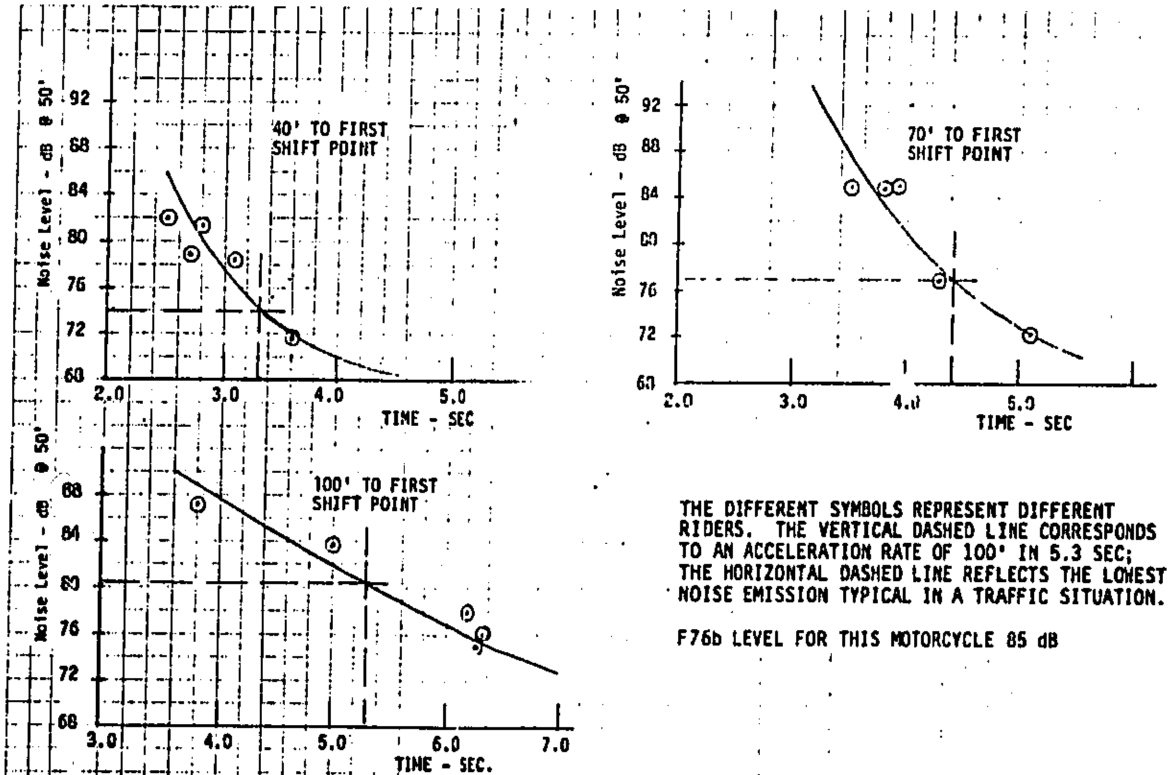
FIGURE L-9 NOISE LEVEL AS A FUNCTION OF TIME AND DISTANCE FROM STANDING START TO FIRST SHIFT POINT; HONDA CB550



THE DIFFERENT SYMBOLS REPRESENT DIFFERENT RIDERS. THE VERTICAL DASHED LINE CORRESPONDS TO AN ACCELERATION RATE OF 100' IN 5.3 SEC; THE HORIZONTAL DASHED LINE REFLECTS THE LOWEST NOISE EMISSION TYPICAL IN A TRAFFIC SITUATION.

F76b LEVEL FOR THIS MOTORCYCLE 83 dB

FIGURE L-10 NOISE LEVEL AS A FUNCTION OF TIME AND DISTANCE FROM STANDING START TO FIRST SHIFT POINT; HONDA CJ360



THE DIFFERENT SYMBOLS REPRESENT DIFFERENT RIDERS. THE VERTICAL DASHED LINE CORRESPONDS TO AN ACCELERATION RATE OF 100' IN 5.3 SEC; THE HORIZONTAL DASHED LINE REFLECTS THE LOWEST NOISE EMISSION TYPICAL IN A TRAFFIC SITUATION.

F76b LEVEL FOR THIS MOTORCYCLE 85 dB

FIGURE L-11 NOISE LEVEL AS A FUNCTION OF TIME AND DISTANCE FROM STANDING START TO FIRST SHIFT POINT; HONDA CB125S

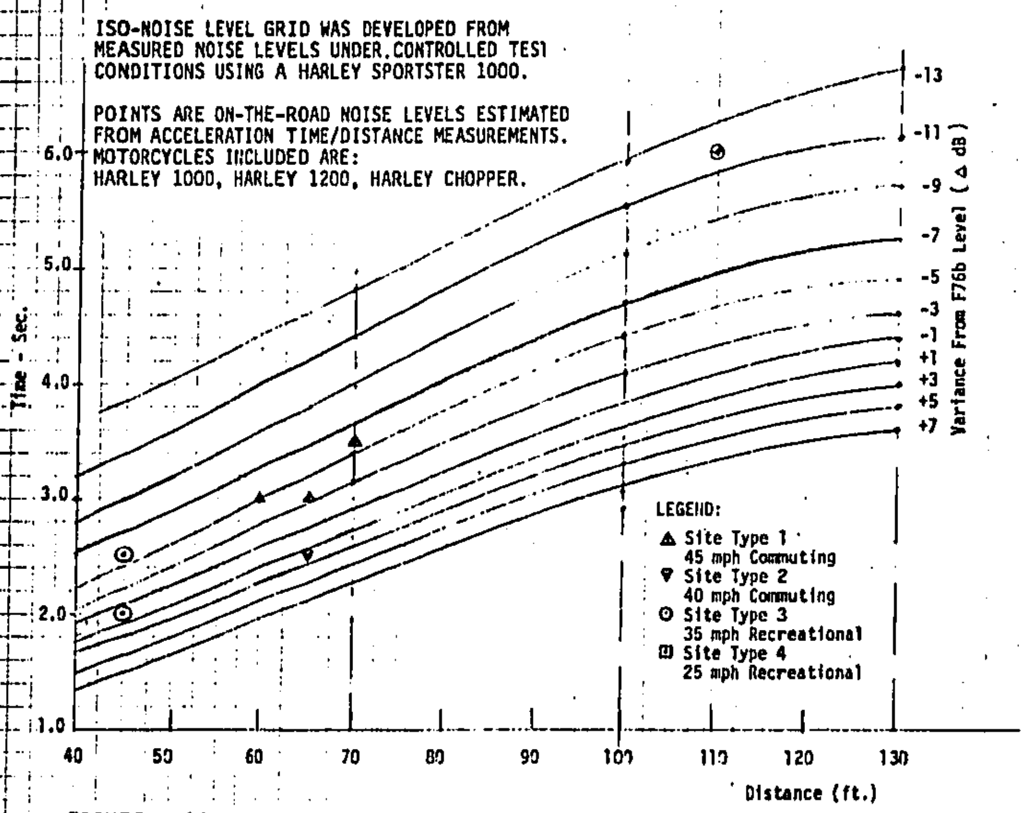


FIGURE L-12 ESTIMATED NOISE EMISSION LEVELS BASED ON ACCELERATION FROM STANDSTILL TIME/DISTANCE MEASUREMENTS; HARLEY-DAVIDSON 1000 AND 1200

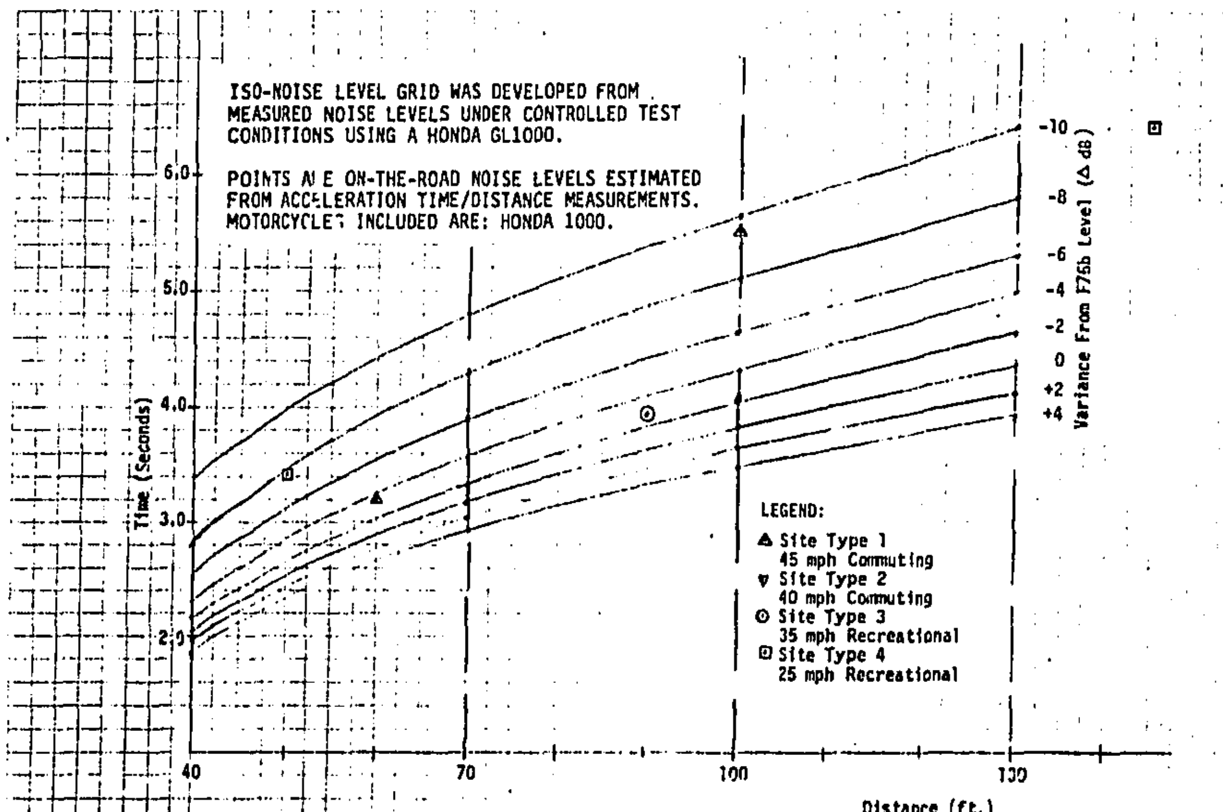


FIGURE L-13 ESTIMATED NOISE EMISSION LEVELS BASED ON ACCELERATION FROM STANDSTILL TIME/DISTANCE MEASUREMENTS; HONDA GL1000

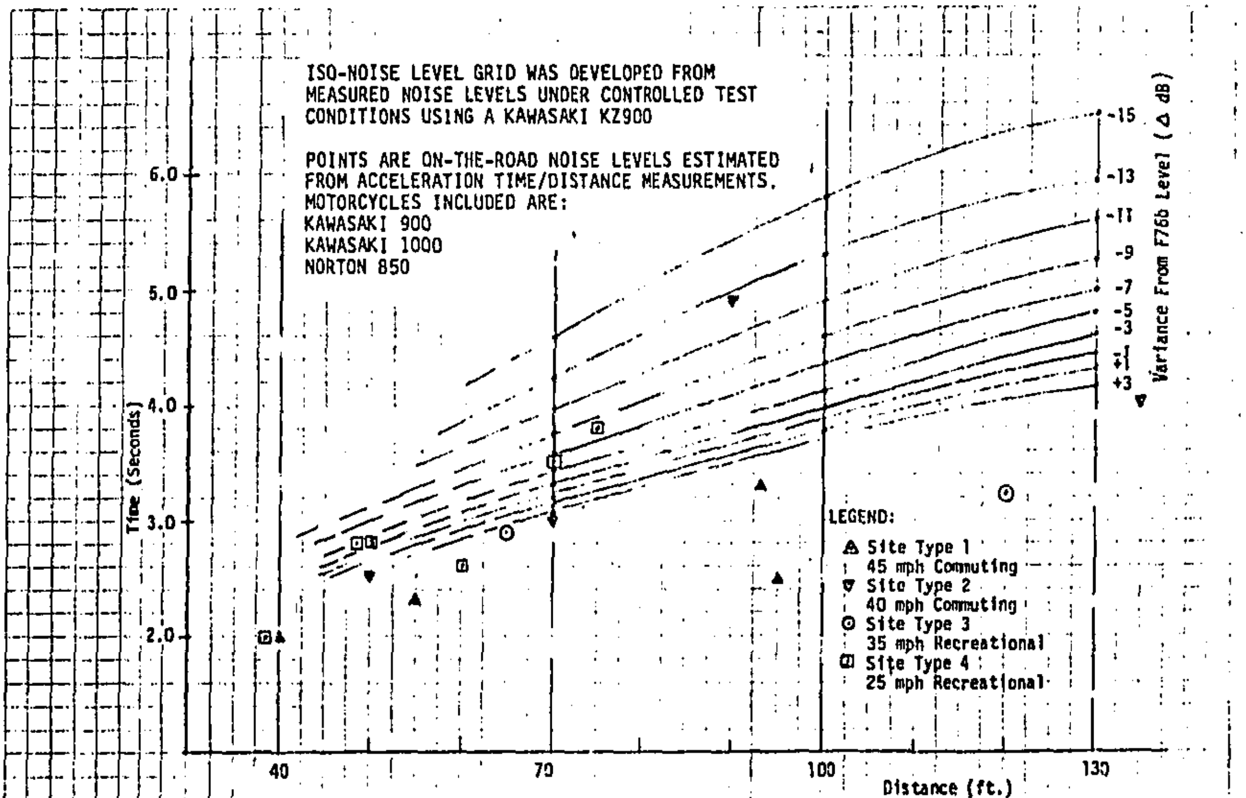


FIGURE L-14 ESTIMATED NOISE EMISSION LEVELS BASED ON ACCELERATION FROM STANDSTILL TIME/DISTANCE MEASUREMENTS; 800-1000 cc BIKES

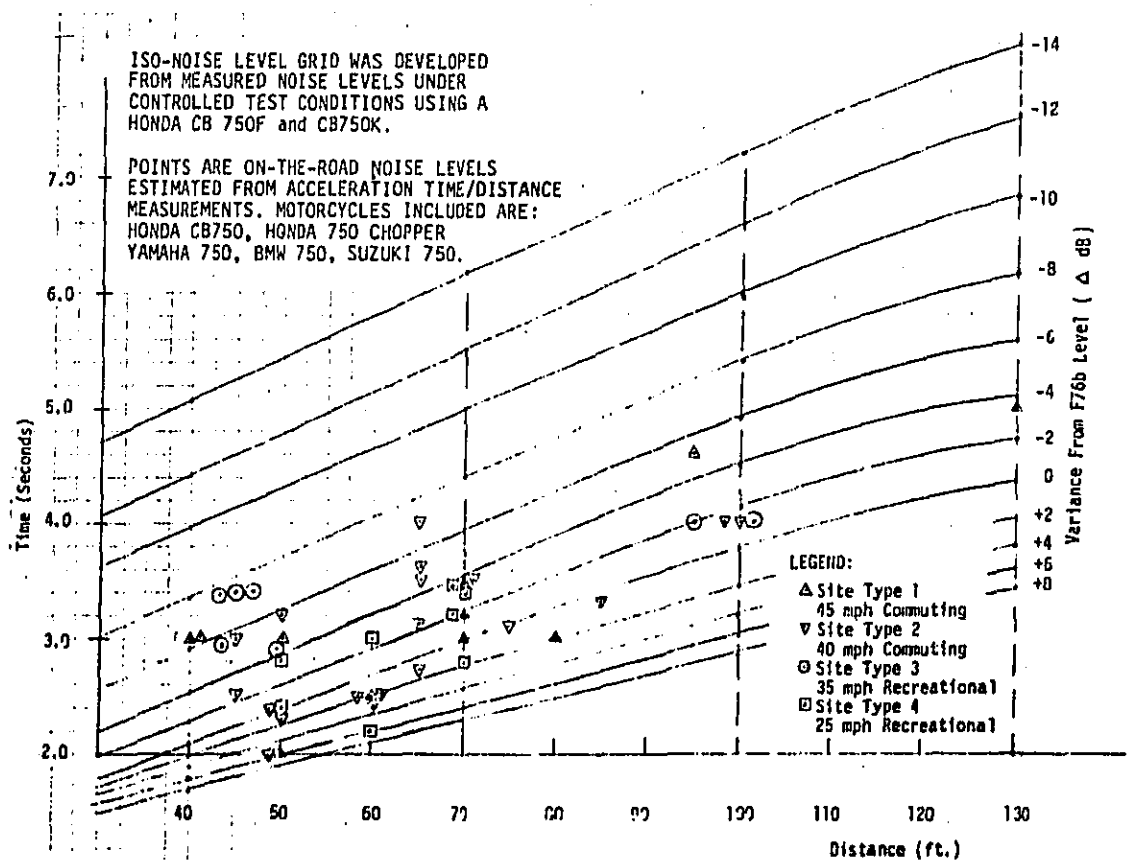


FIGURE L-15 ESTIMATED NOISE EMISSION LEVELS BASED ON ACCELERATION FROM STANDSTILL TIME/DISTANCE MEASUREMENTS; 750 cc BIKES

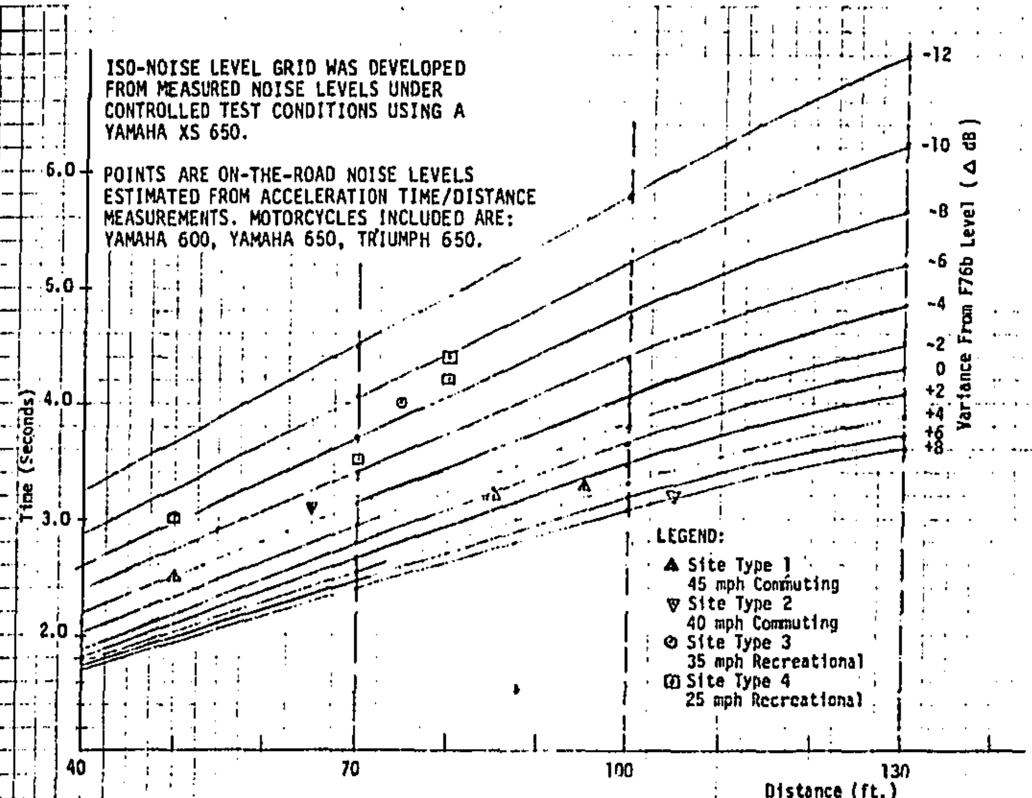


FIGURE L-16 ESTIMATED NOISE EMISSION LEVELS BASED ON ACCELERATION FROM STANDSTILL TIME/DISTANCE MEASUREMENTS; 600-650 cc BIKES

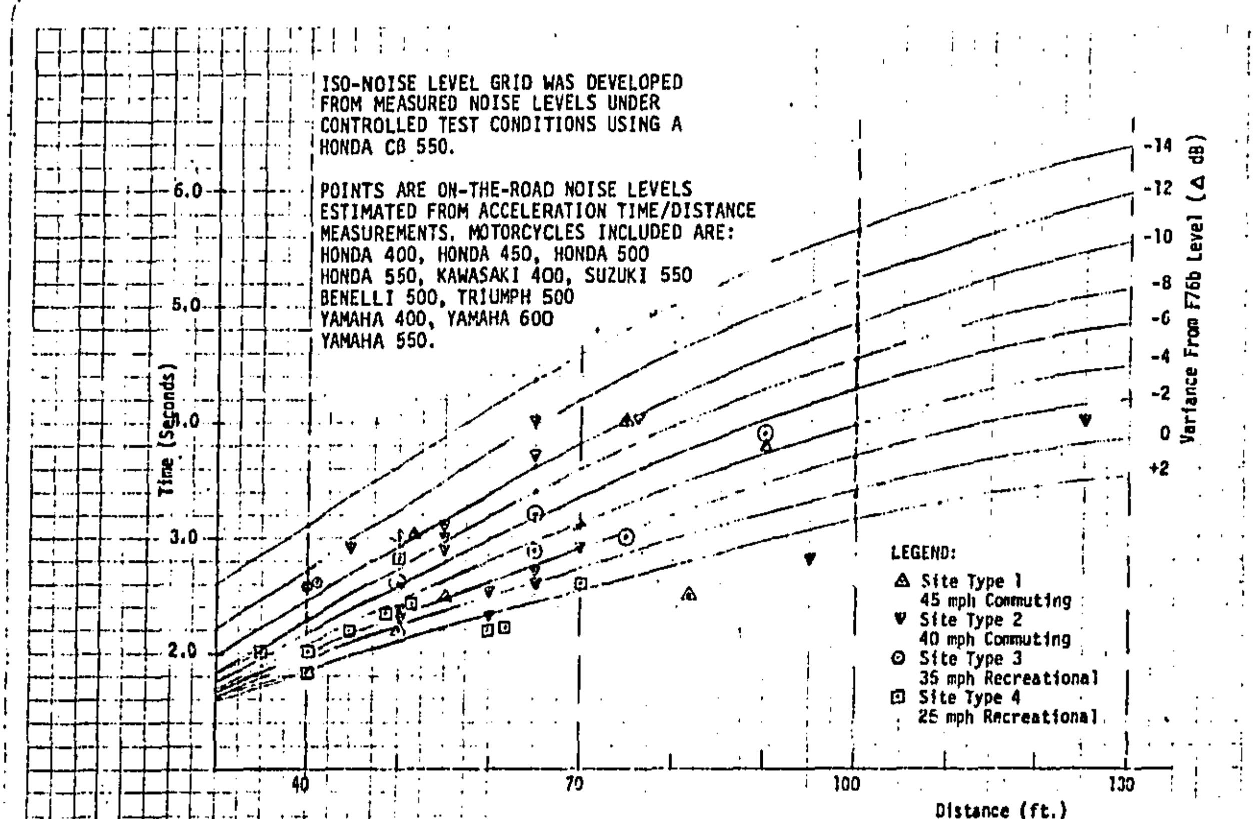


FIGURE L-17 ESTIMATED NOISE EMISSION LEVELS BASED ON ACCELERATION FROM STANDSTILL TIME/DISTANCE MEASUREMENTS; 450-550 cc BIKES

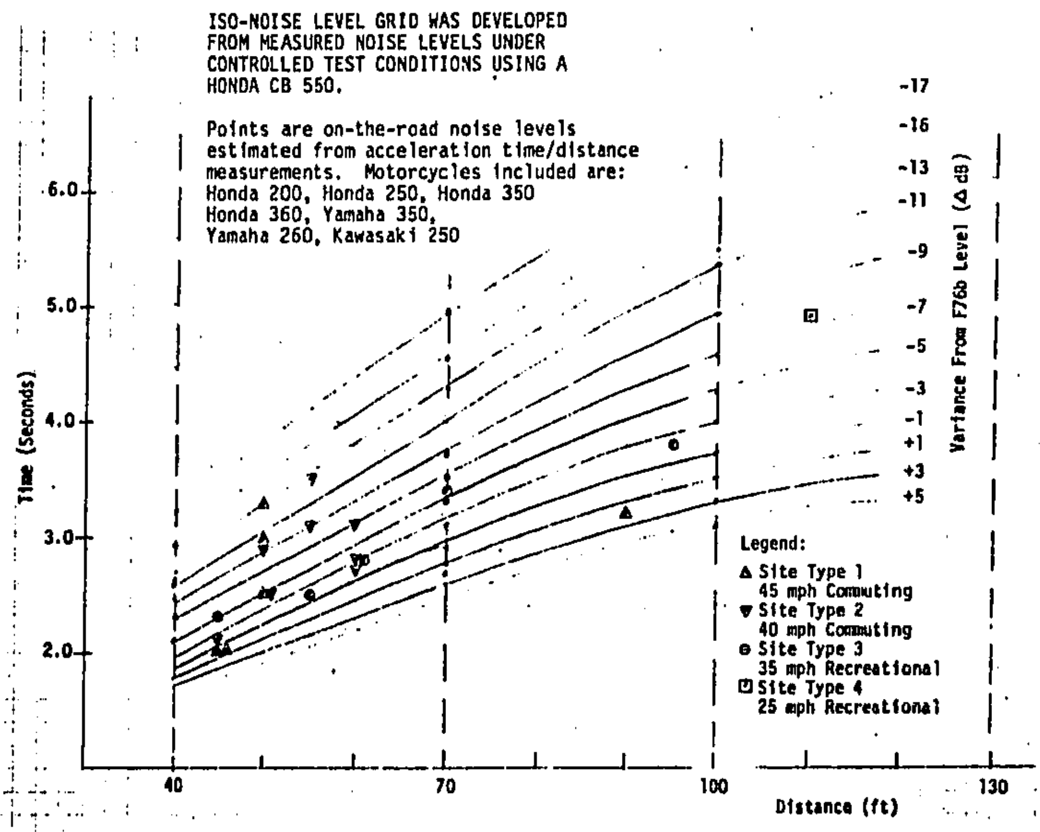


FIGURE L-18 ESTIMATED NOISE EMISSION LEVELS BASED ON ACCELERATION FROM STANDSTILL TIME/DISTANCE MEASUREMENTS; 250-360 cc BIKES

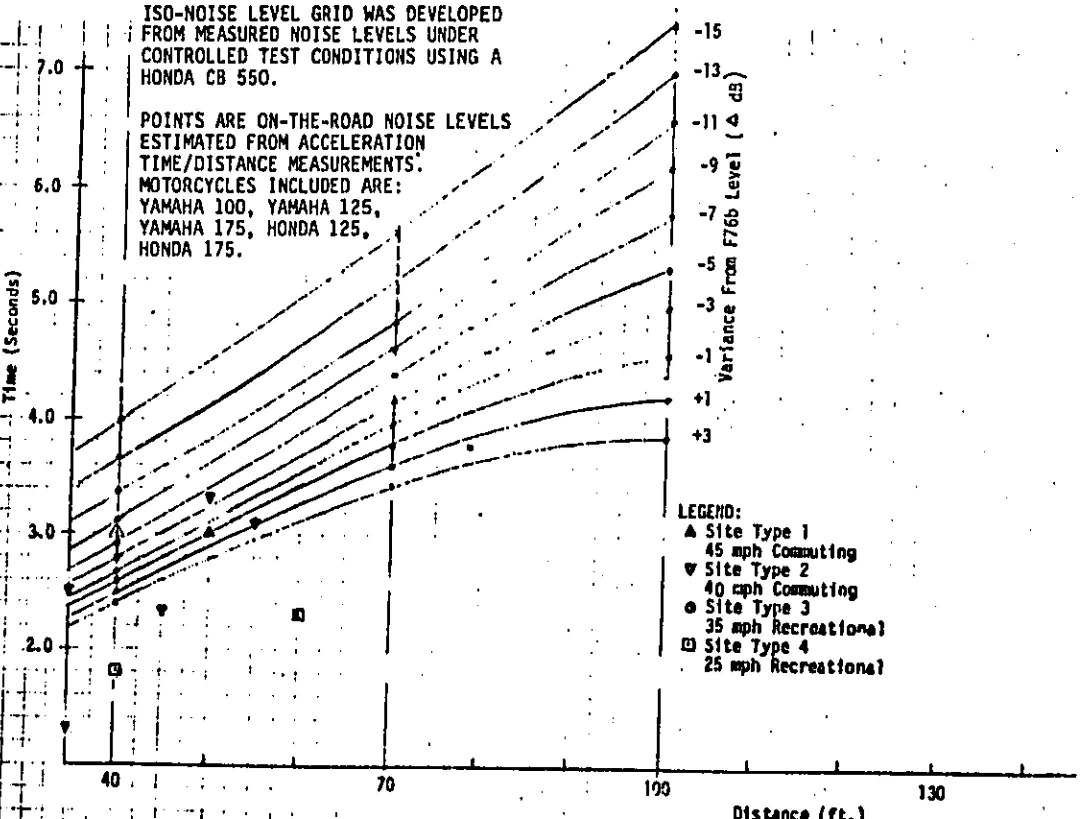


FIGURE L-19 ESTIMATED NOISE EMISSION LEVELS BASED ON ACCELERATION FROM STANDSTILL TIME/DISTANCE MEASUREMENTS; 100-175 cc BIKES

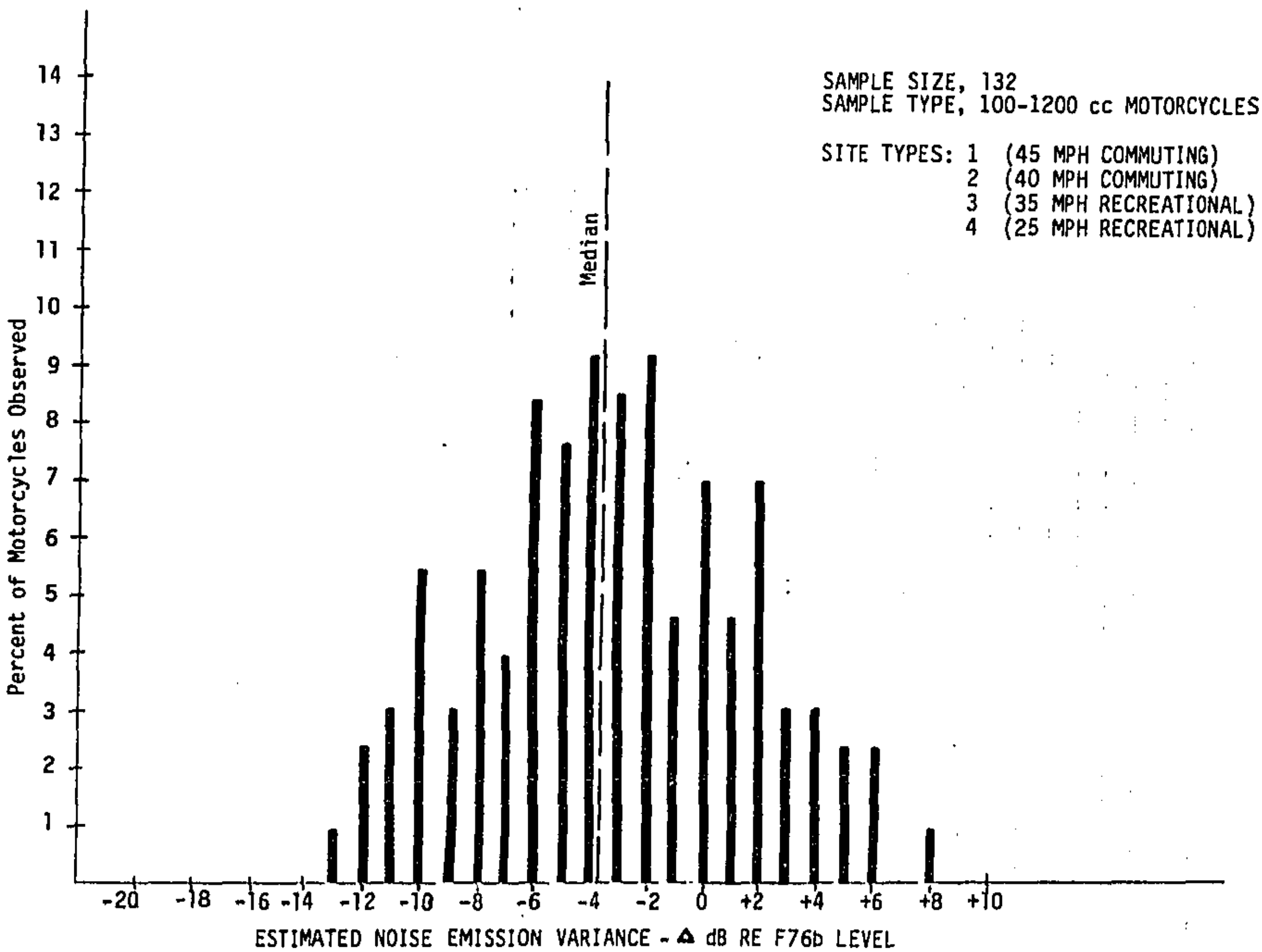


FIGURE L-20 COMPOSITE DISTRIBUTION (ALL MOTORCYCLES, ALL SITE TYPES) OF ESTIMATED NOISE EMISSION VARIANCE (RE F76b LEVEL)

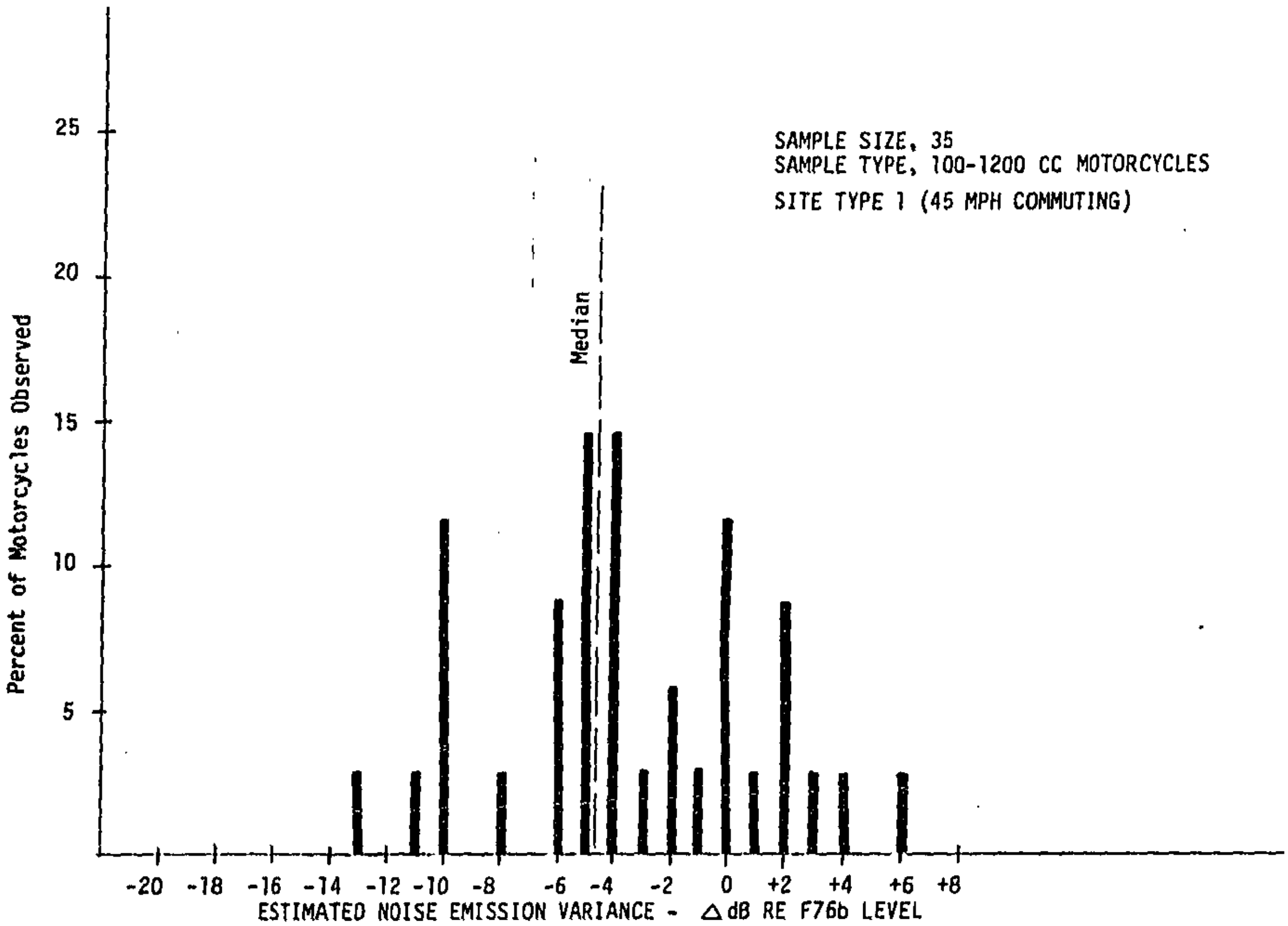


FIGURE L-21 COMPOSITE DISTRIBUTION (ALL MOTORCYCLES, SITE TYPE 1) OF ESTIMATED NOISE EMISSION VARIANCE (RE F76b LEVEL)

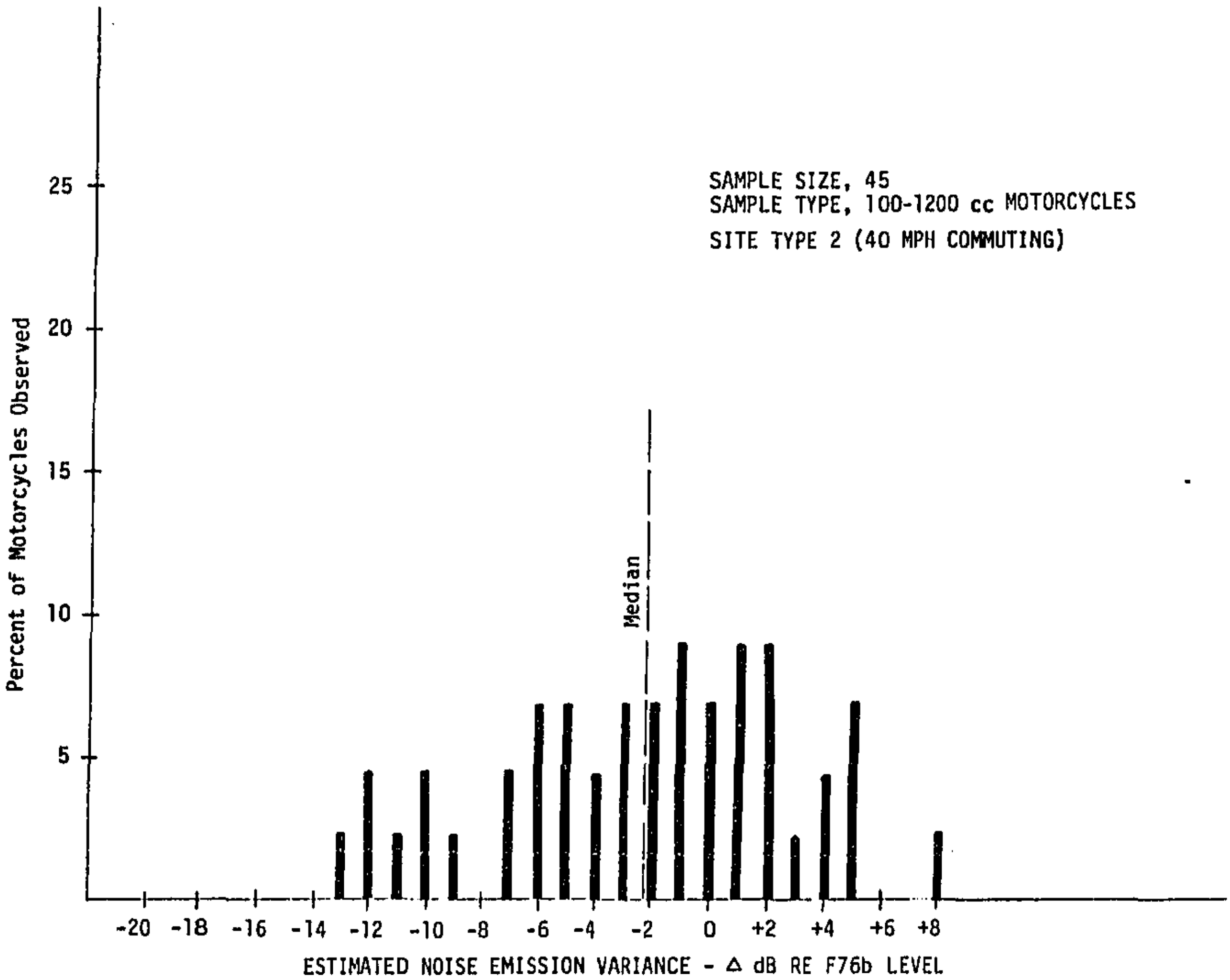


FIGURE L-22 COMPOSITE DISTRIBUTION (ALL MOTORCYCLES, SITE TYPE 2) OF ESTIMATED NOISE EMISSION VARIANCE (RE F76b LEVEL)

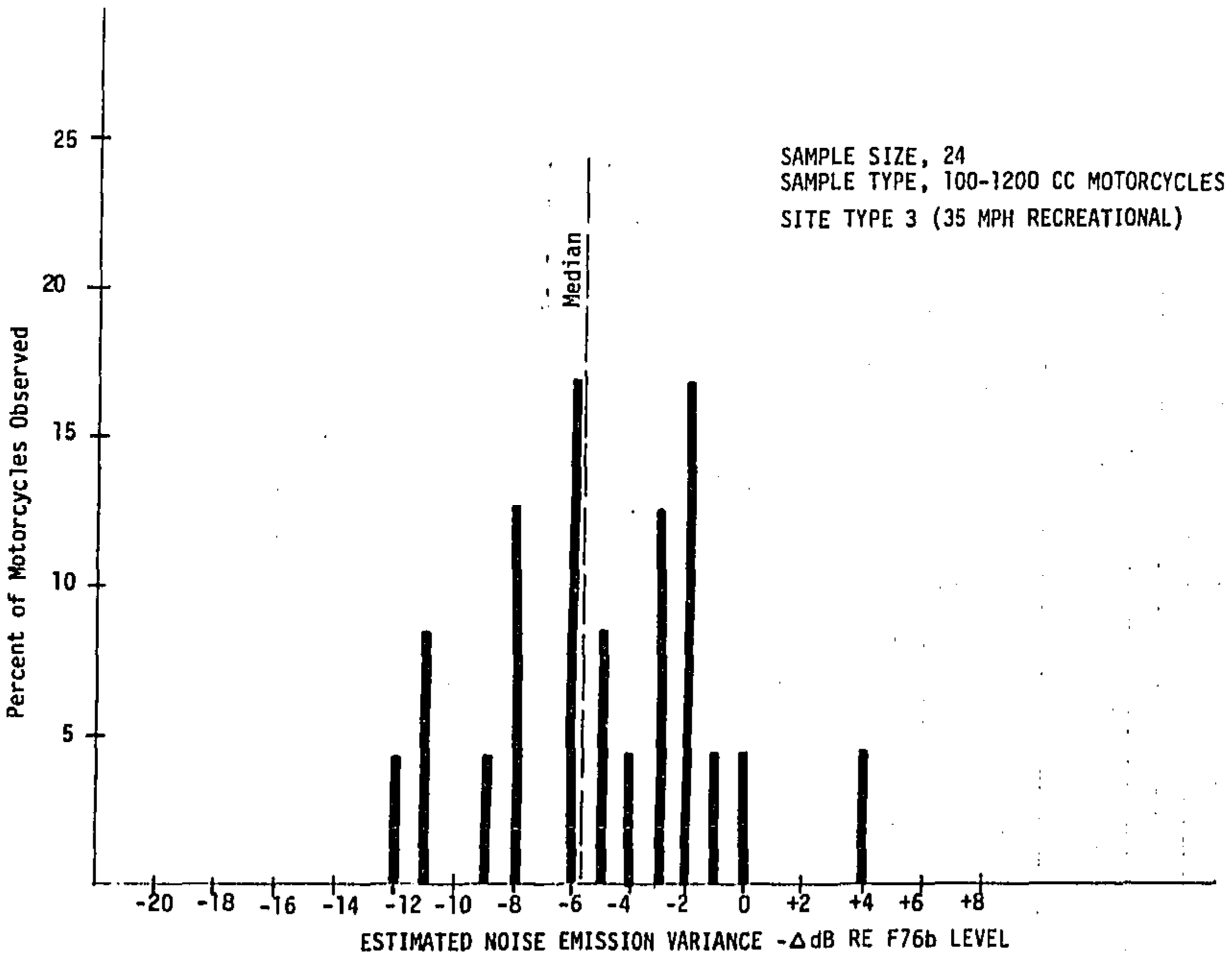


FIGURE L-23 COMPOSITE DISTRIBUTION (ALL MOTORCYCLES, SITE TYPE 3) OF ESTIMATED NOISE EMISSION VARIANCE (RE F76b LEVEL)

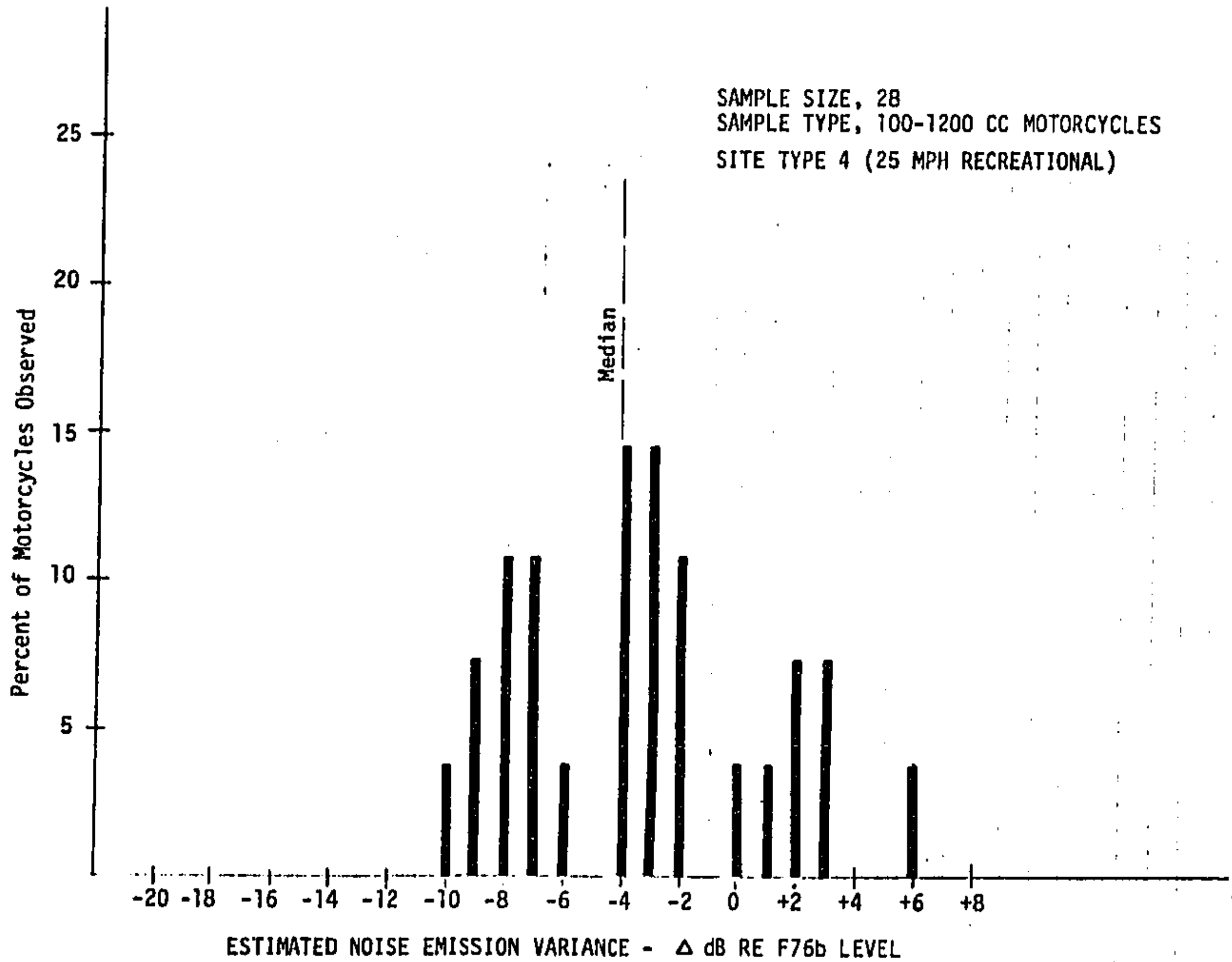


FIGURE L-24 COMPOSITE DISTRIBUTION (ALL MOTORCYCLES, SITE TYPE 4) OF ESTIMATED NOISE EMISSION VARIANCE (RE F76b LEVEL)

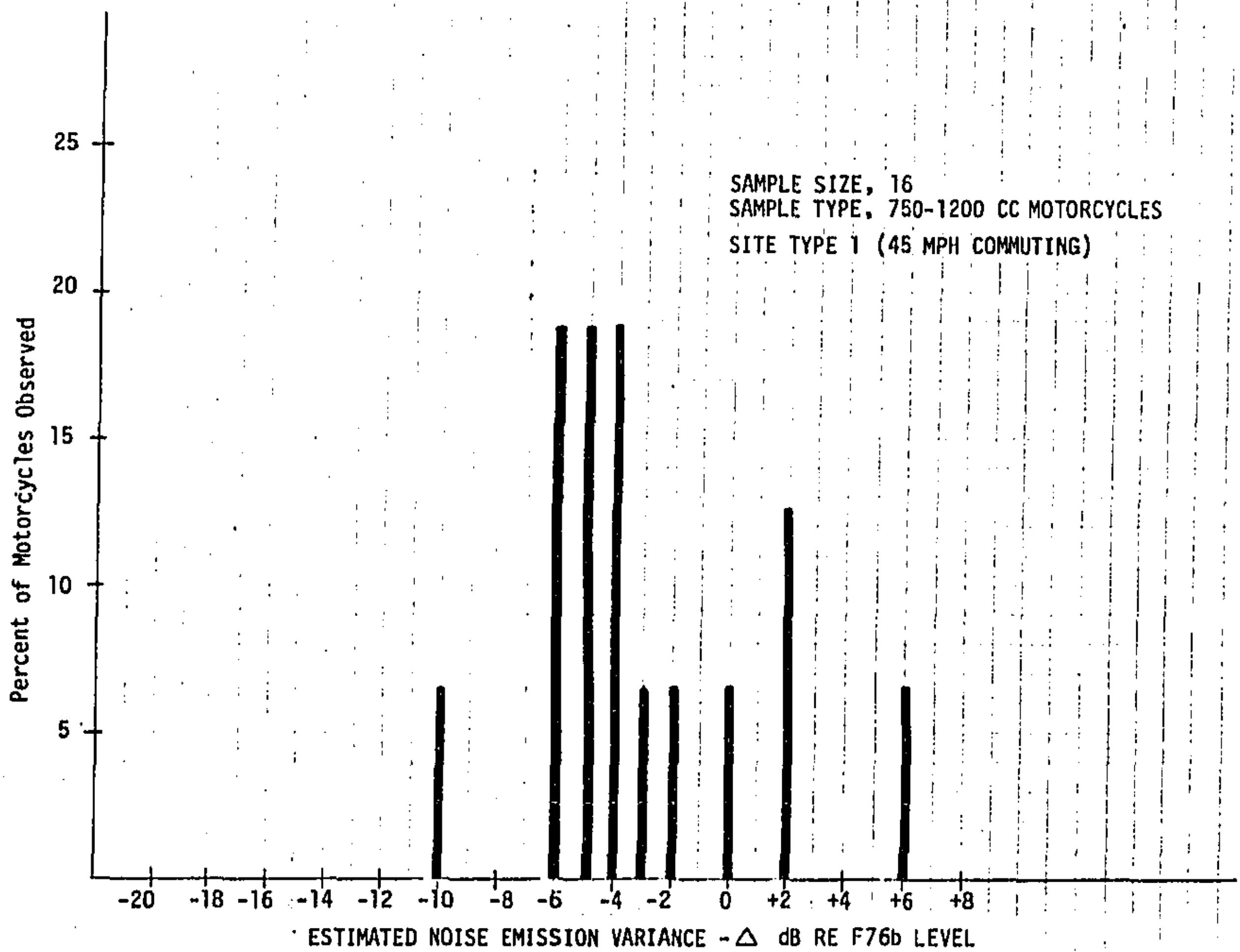


FIGURE L-25 DISTRIBUTION (750-1200 cc MOTORCYCLES, SITE TYPE 1) OF ESTIMATED NOISE EMISSION VARIANCE (RE F76b LEVEL)

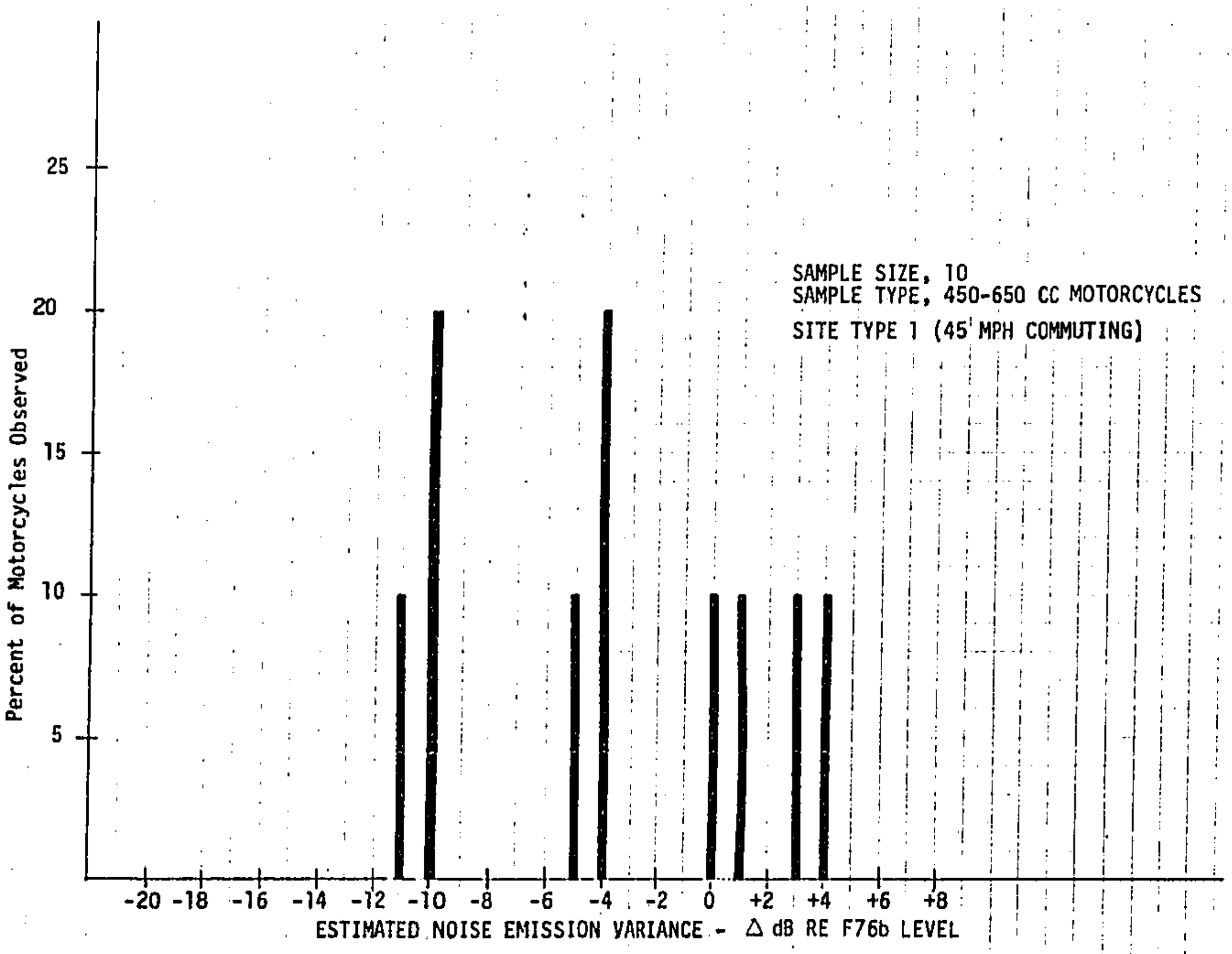


FIGURE L-26 DISTRIBUTION (450-650 cc MOTORCYCLES, SITE TYPE 1) OF ESTIMATED NOISE EMISSION VARIANCE (RE F76b LEVEL)

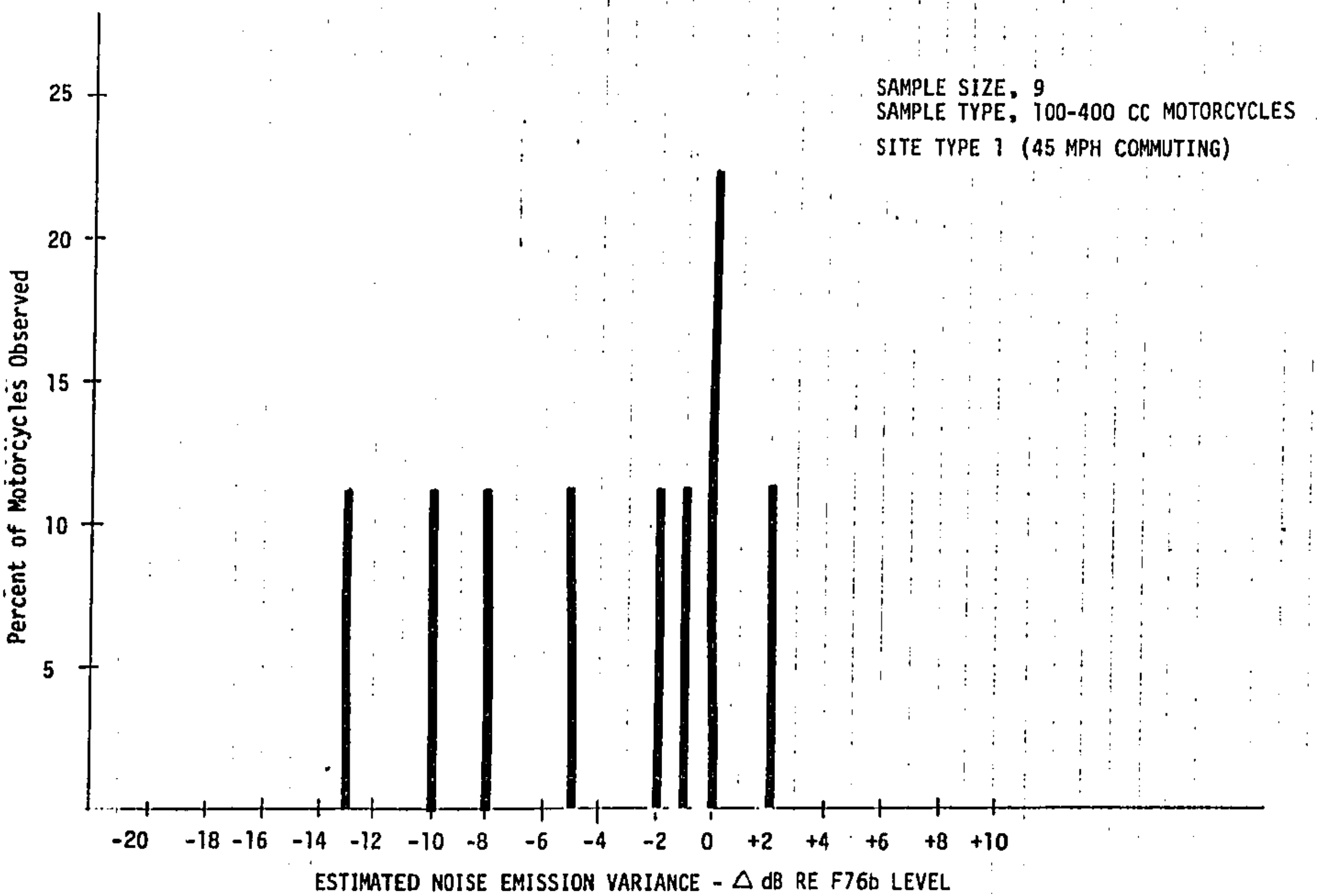


FIGURE L-27 DISTRIBUTION (100-400 cc MOTORCYCLES, SITE TYPE 1) OF ESTIMATED EMISSION VARIANCE (RE F76b LEVEL)

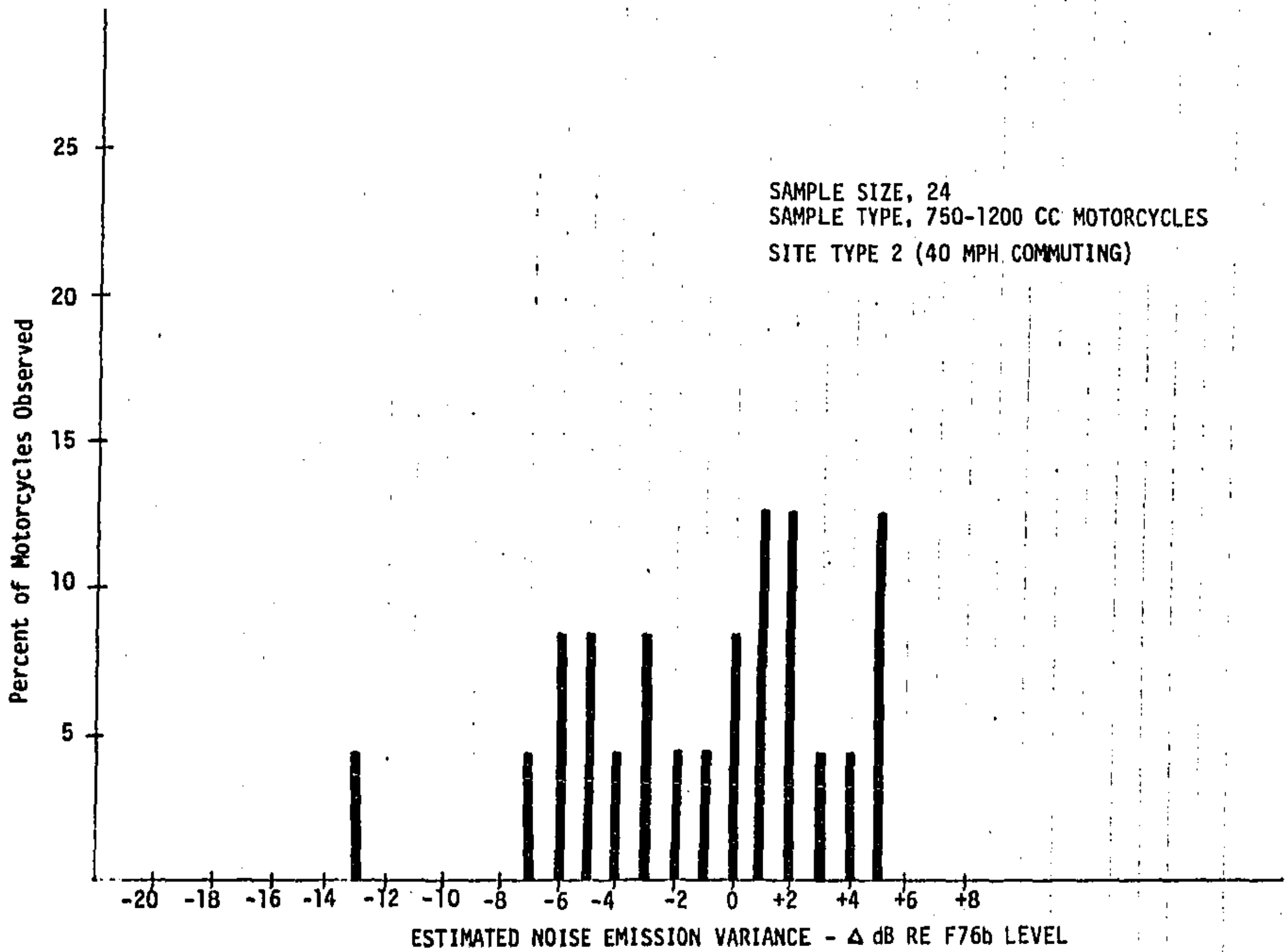


FIGURE L-28 DISTRIBUTION (750-1200 cc MOTORCYCLES, SITE TYPE 2) OF ESTIMATED NOISE EMISSION VARIANCE (RE F76b LEVEL)

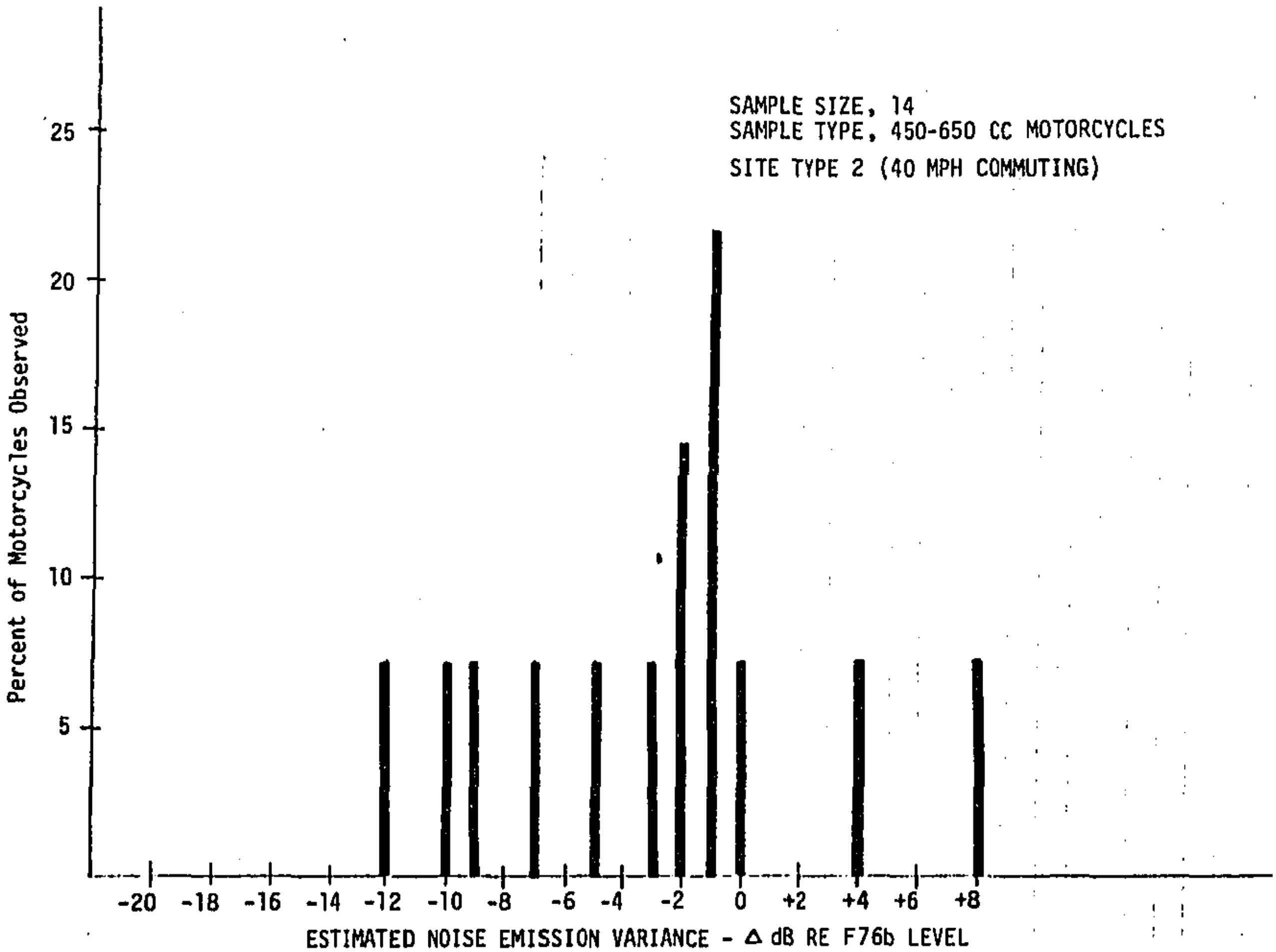


FIGURE L-29 DISTRIBUTION (450-650 cc MOTORCYCLES, SITE TYPE 2) OF ESTIMATED NOISE EMISSION VARIANCE (RE F76b LEVEL)

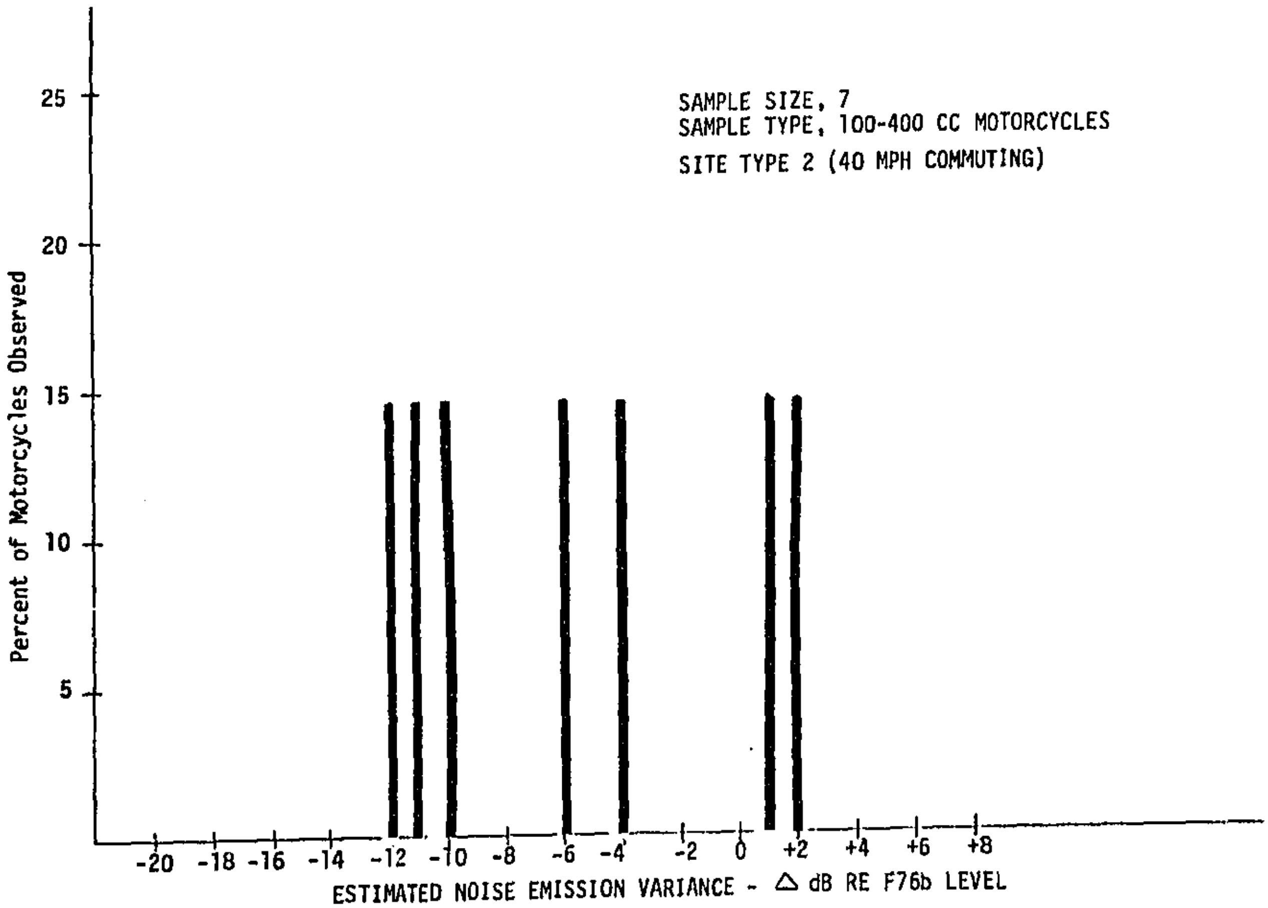


FIGURE L-30 DISTRIBUTION (100-400 cc MOTORCYCLES, SITE TYPE 2) OF ESTIMATED NOISE EMISSION VARIANCE (RE F76b LEVEL)

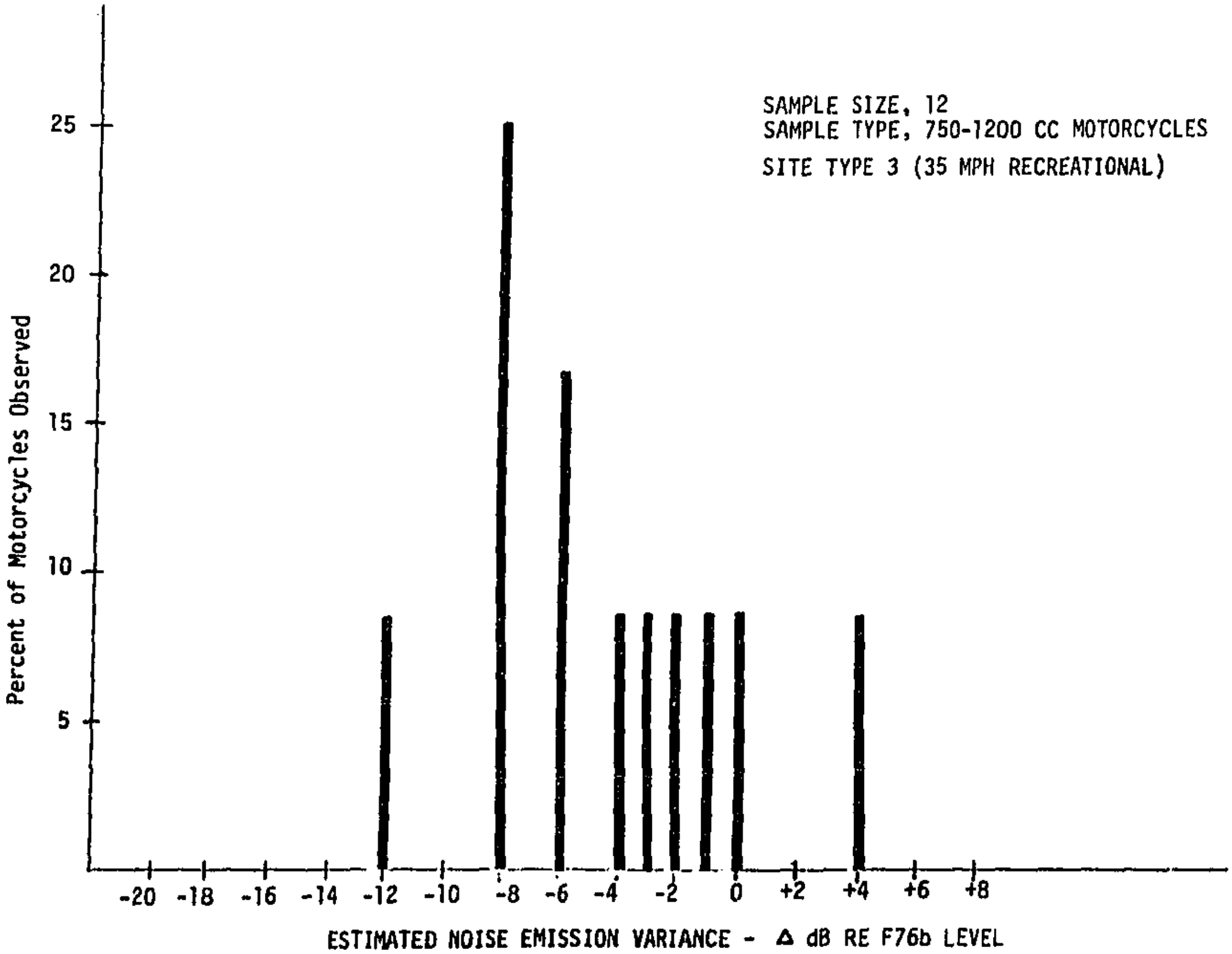


FIGURE L-31 DISTRIBUTION (750-1200 cc MOTORCYCLES, SITE TYPE 3) OF ESTIMATED NOISE EMISSION VARIANCE (RE F76b LEVEL)

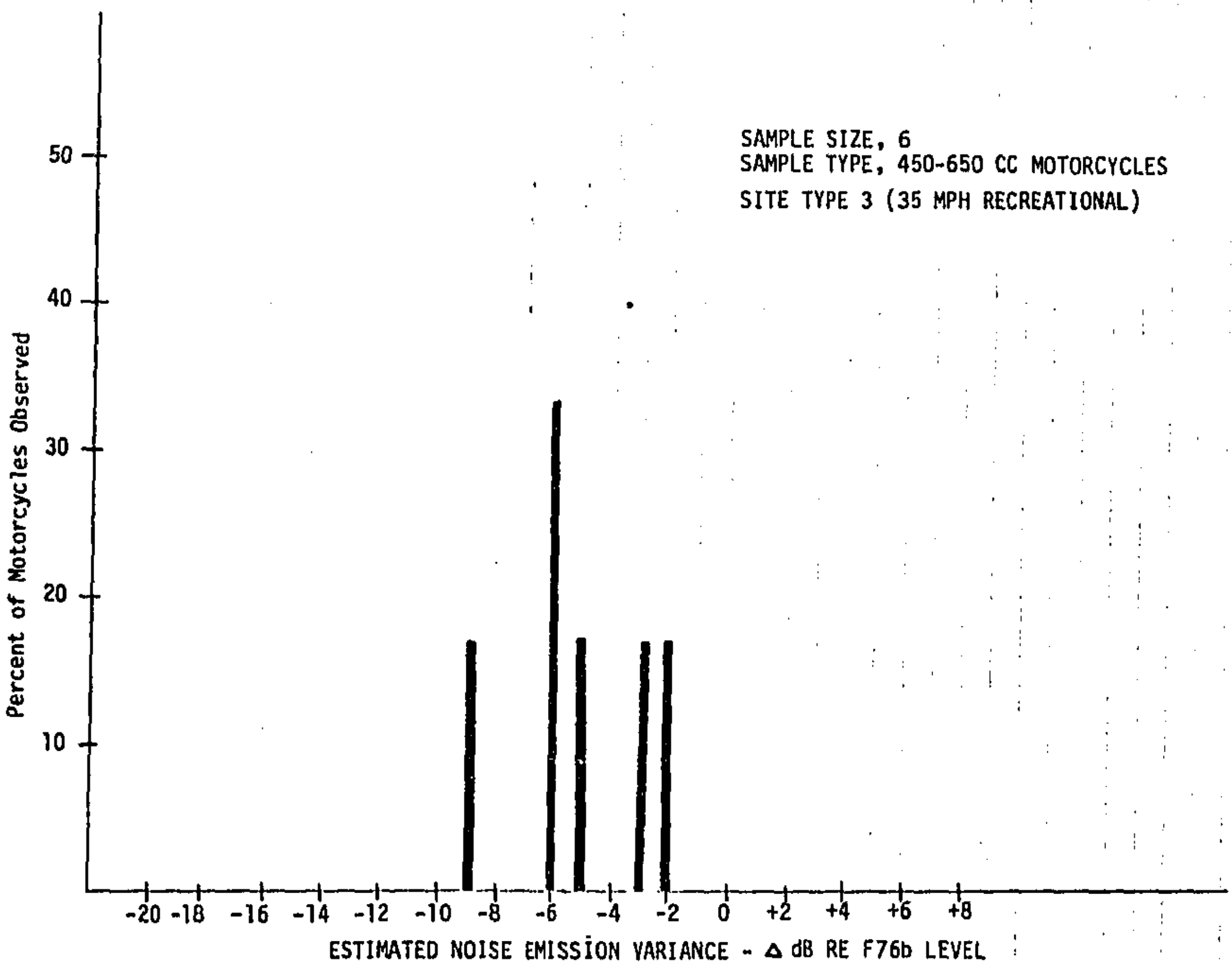


FIGURE L-32 DISTRIBUTION (450-650 cc MOTORCYCLES, SITE TYPE 3) OF ESTIMATED NOISE EMISSION VARIANCE (RE F76b LEVEL)

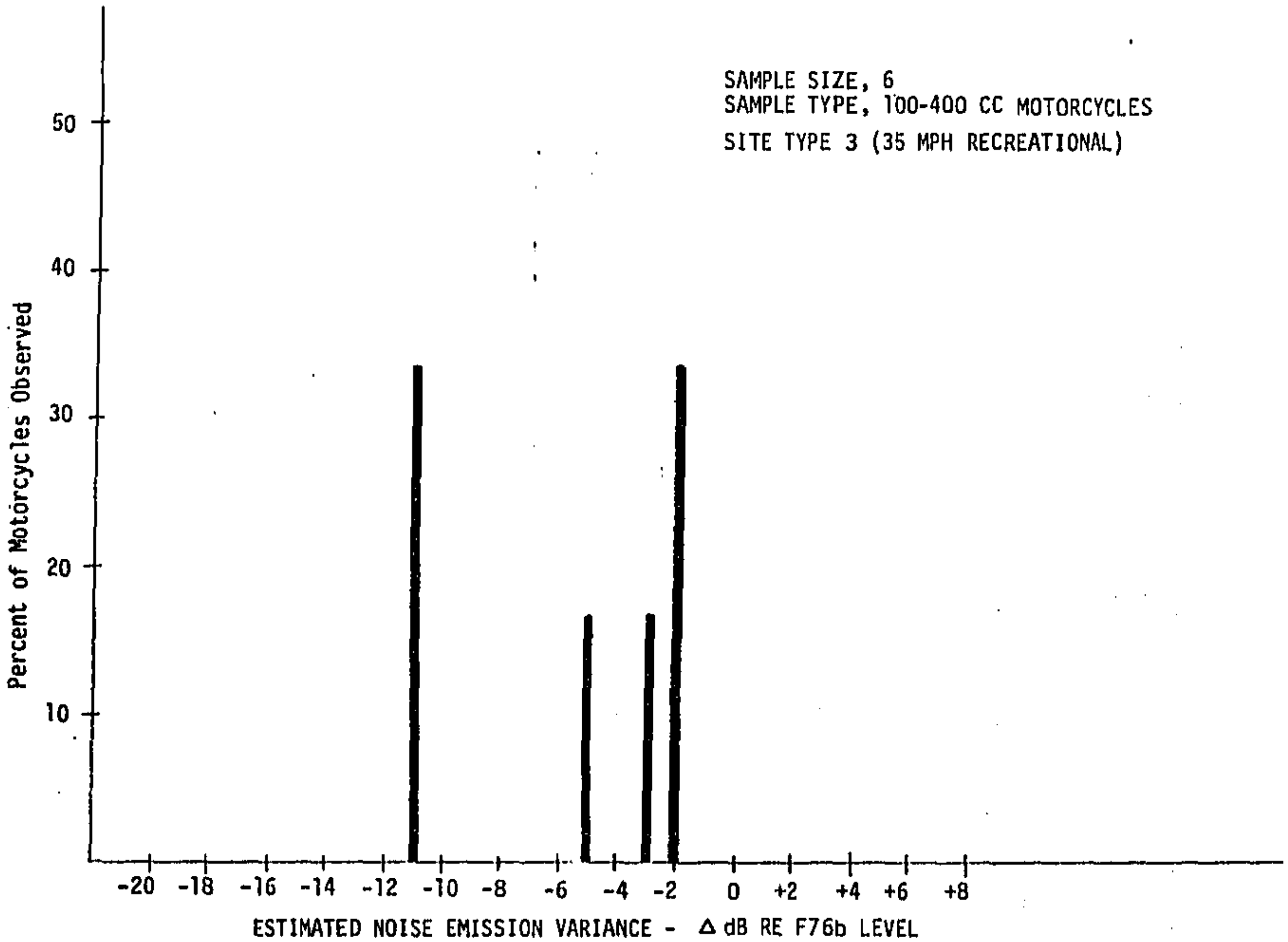


FIGURE L-33 DISTRIBUTION (100-400 cc MOTORCYCLES, SITE TYPE 3) OF ESTIMATED NOISE EMISSION VARIANCE (RE F76b LEVEL)

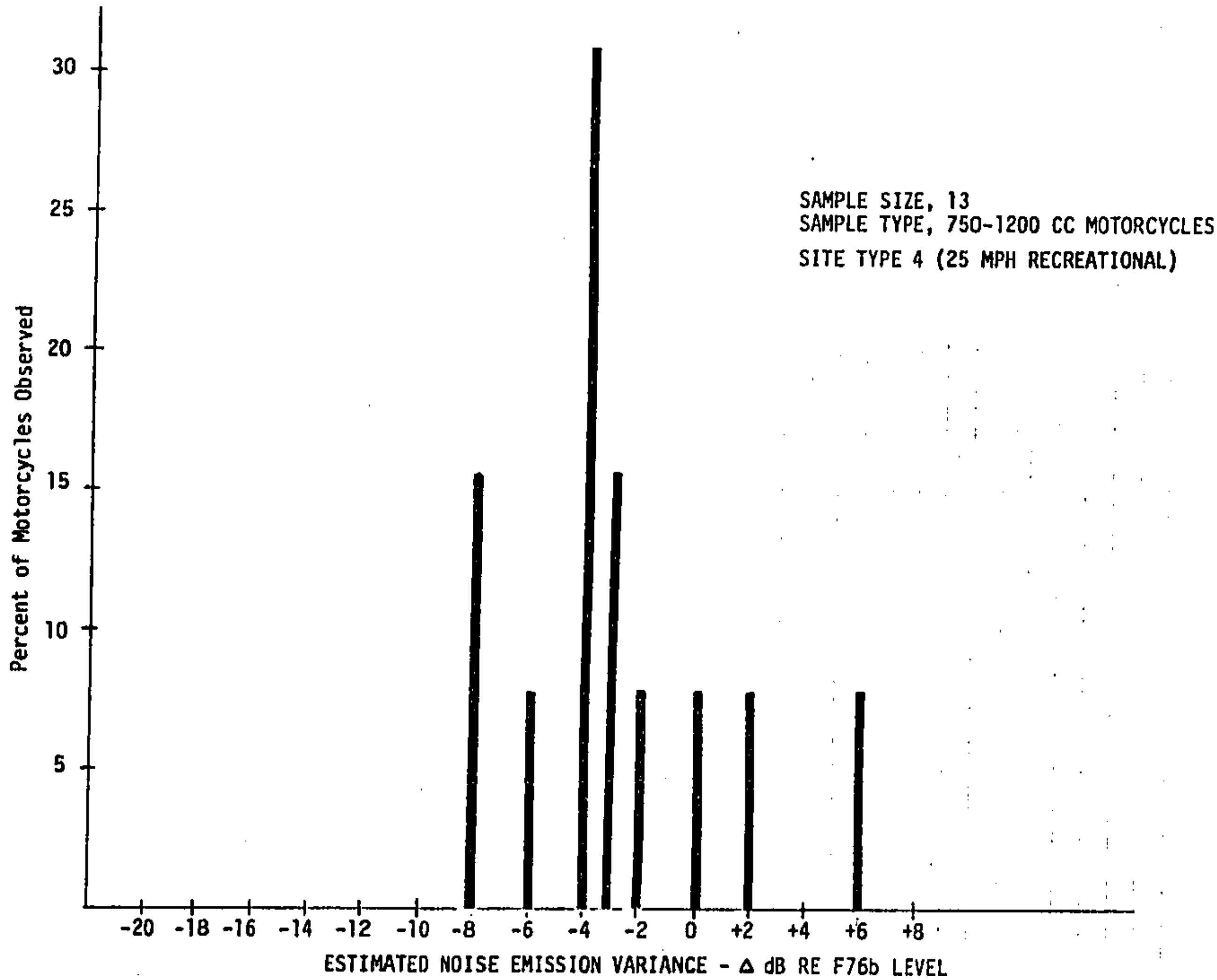


FIGURE L-34 DISTRIBUTION (750-1200 cc MOTORCYCLES, SITE TYPE 4) OF ESTIMATED EMISSION VARIANCE (RE F76b LEVEL)

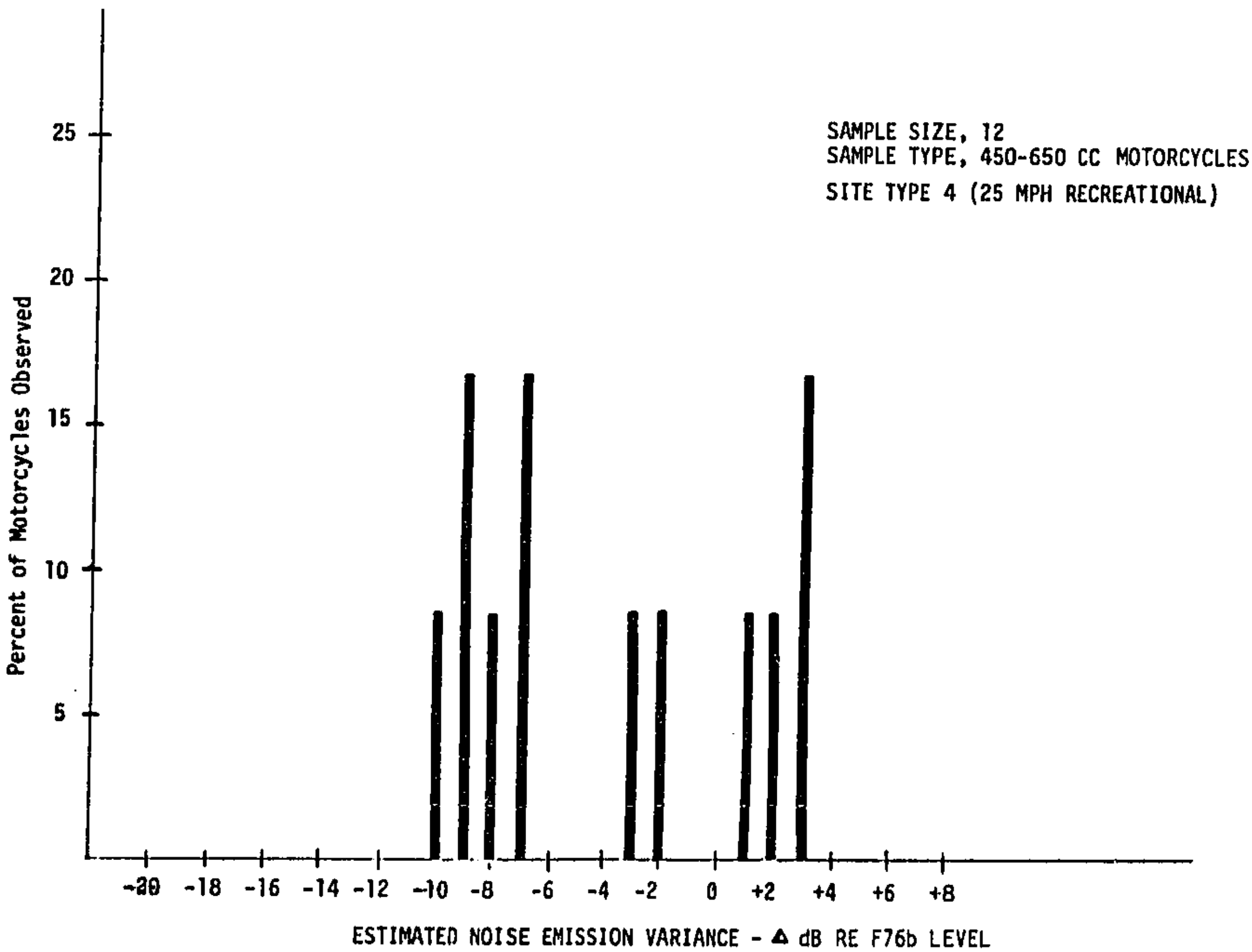


FIGURE L-35 DISTRIBUTION (450-650 cc MOTORCYCLES, SITE TYPE 4) OF ESTIMATED NOISE EMISSION VARIANCE (RE F76b LEVEL)

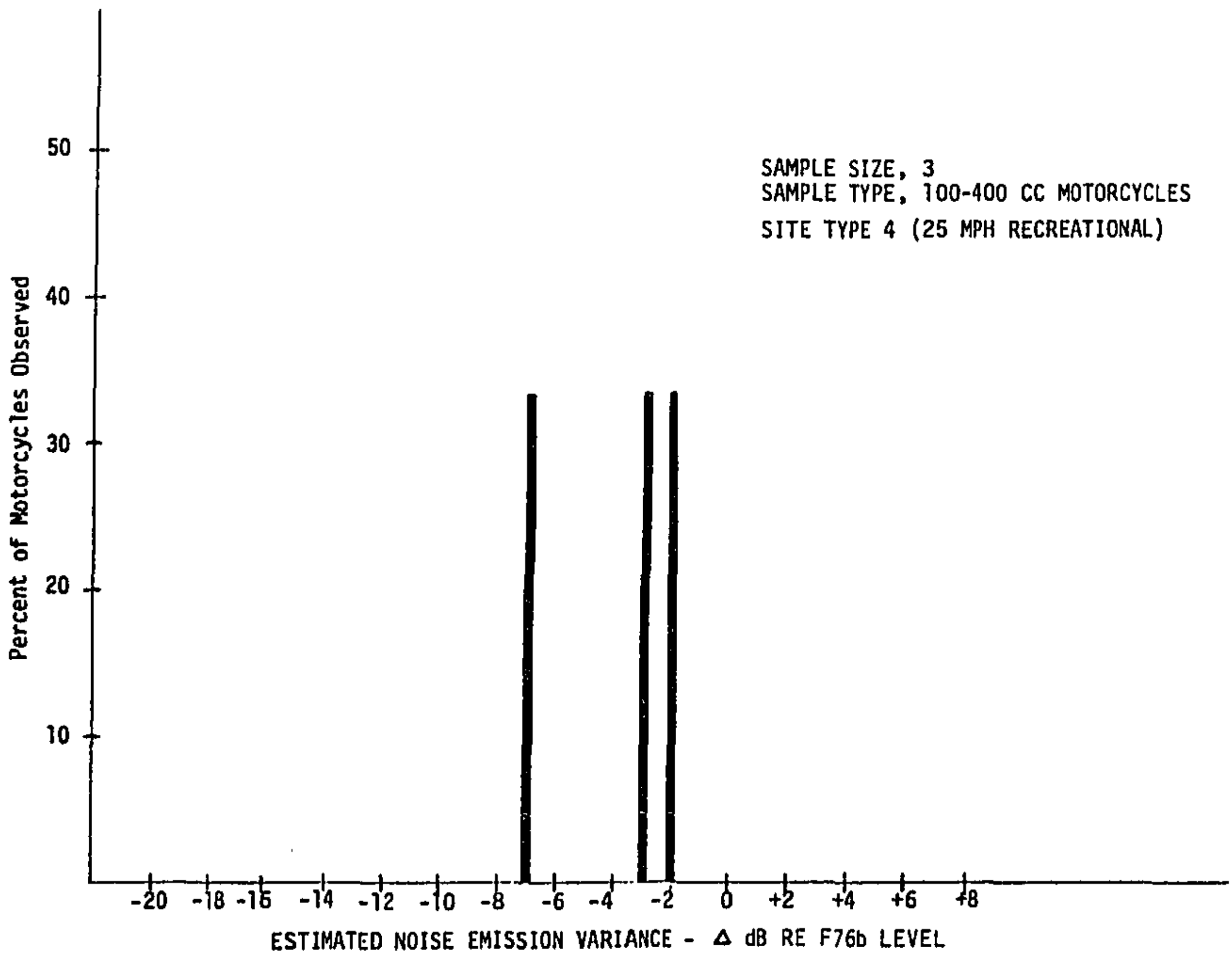


FIGURE L-36 DISTRIBUTION (100-400 cc MOTORCYCLES, SITE TYPE 4) OF ESTIMATED NOISE EMISSION VARIANCE (RE F76b LEVEL)

APPENDIX M

FRACTIONAL IMPACT PROCEDURE

APPENDIX M

FRACTIONAL IMPACT PROCEDURE*

An integral element of an environmental noise assessment is to determine or estimate the distribution of the exposed population to given levels of noise for given lengths of time. Thus, before implementing a project or action, one should first characterize the existing noise exposure distribution of the population in the area affected by estimating the number of people exposed to different magnitudes of noise as described by metrics such as the Day-Night Sound Level (L_{dn}). Next, the distribution of people who may be exposed to noise anticipated as a result of adopting various projected alternatives should be predicted or estimated. We can judge the environmental impact by simply comparing these successive population exposure distributions. This concept is illustrated in Figure M-1 which compares the estimated distribution of exposure for the population prior to inception of a hypothetical project (Curve A) with the population distribution after implementation of the project (Curve B). For each statistical distribution, numbers of people are simply plotted against noise exposure, where L_i represents a specific exposure in decibels to an arbitrary unit of noise. A measure of noise impact is ascertained by examining the shift in distribution of population exposure attributable either to increased or lessened project-related noise. Such comparisons of population exposure distributions allow us to determine the extent of noise impact in terms of changes in the number of people exposed to different levels of noise.

The intensity or severity of a noise exposure may be evaluated by the use of suitable noise effects criteria, which exist in the form of dose-response or cause-effect relationships. Using these criteria, the probability or magnitude of an anticipated effect can be statistically predicted from knowledge of the noise exposure incurred. Illustrative examples of the different forms of noise effects criteria are graphically displayed in Figure M-2. In general, dose-response functions are statistically derived from noise effects information and exhibited as linear or curvilinear relationships, or combinations thereof. Although these relations generally represent a statistical "average" response, they may also be defined for any given population percentile. The statistical probability or anticipated magnitude of an effect at a given noise exposure can be estimated using the appropriate function. For example, as shown in Figure M-2 using the linear function, if it is established that a number of people are exposed to a given value of L_j, the

---

* Adapted, in part, from Goldstein, J., "Assessing the Impact of Transportation Noise: Human Response Measures," Proceedings of the 1977 National Conference on Noise Control Engineering, G. C. Maling (ed.), NASA Langley Research Center, Hampton, Virginia, 17-19 October 1977, pp. 79-98.

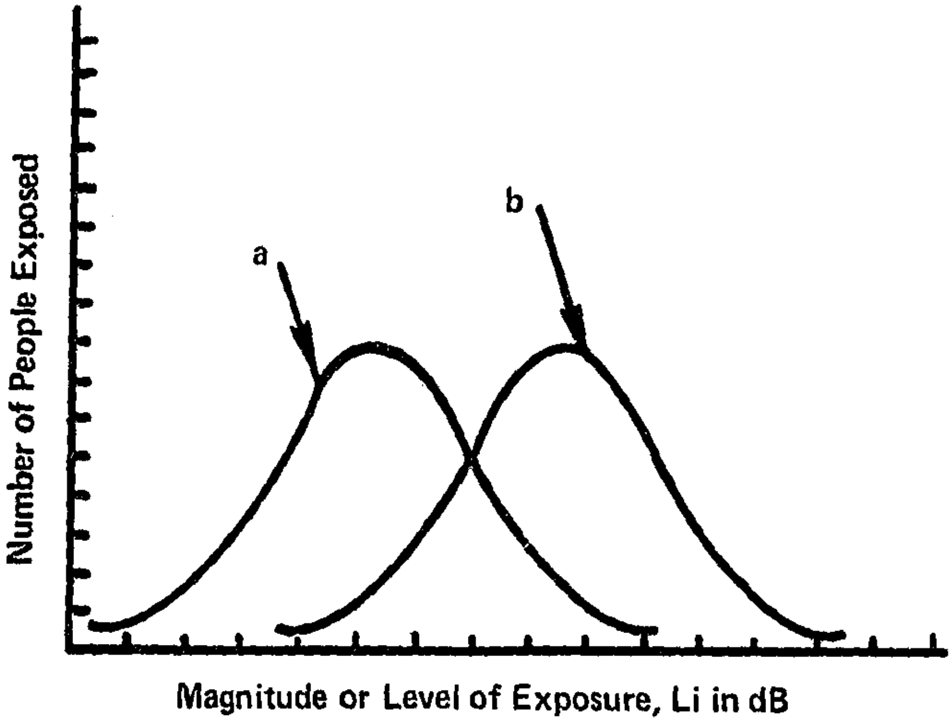


FIGURE M-1

.EXAMPLE ILLUSTRATION OF THE NOISE DISTRIBUTION OF POPULATION AS A FUNCTION OF NOISE EXPOSURE incidence of a specific response occurring within that population would be statistically predicted at 50 percent.

A more comprehensive assessment of environmental noise may be performed by cross-tabulating both indices of extent (number of people exposed) and intensity (severity) of impact. To perform such an assessment we must first statistically estimate the anticipated magnitude of impact upon each individual exposed at each given level, L_i, by applying suitable noise effects criteria. At each level, L_i, the impact upon all people exposed is then obtained by simply comparing the number of people exposed with the magnitude or probability of the anticipated response. As illustrated in Figure M-1, the extent of a noise impact is functionally described as a distribution of exposures. Thus, the total impact of all exposures is a distribution of people who are affected to varying degrees. This may be expressed by using an array or matrix in which the severity of impact at each L_i is plotted against the number of people exposed at that level. Table M-1 presents a hypothetical example of such an array.

TABLE M-1

EXAMPLE OF IMPACT MATRIX FOR A HYPOTHETICAL SITUATION

Exposure	Number of people	Magnitude or Probability of Response in Percent
L_i	1,200,000	4
L_{i+1}	900,000	10
L_{i+2}	200,000	25
L_{i+3}	50,000	50
. . .		
L_{i+n}	2,000	85

An environmental noise assessment usually involves analysis, evaluation and comparison of many different planning alternatives. Obviously, comparing multiple arrays of population impact information is quite cumbersome, and subsequently evaluating the relative effectiveness of each of the alternatives generally tends to become rather complex and confusing. These comparisons can be simplified by resorting to a single number interpretation or descriptor of the noise environment which incorporates both attributes of extent and

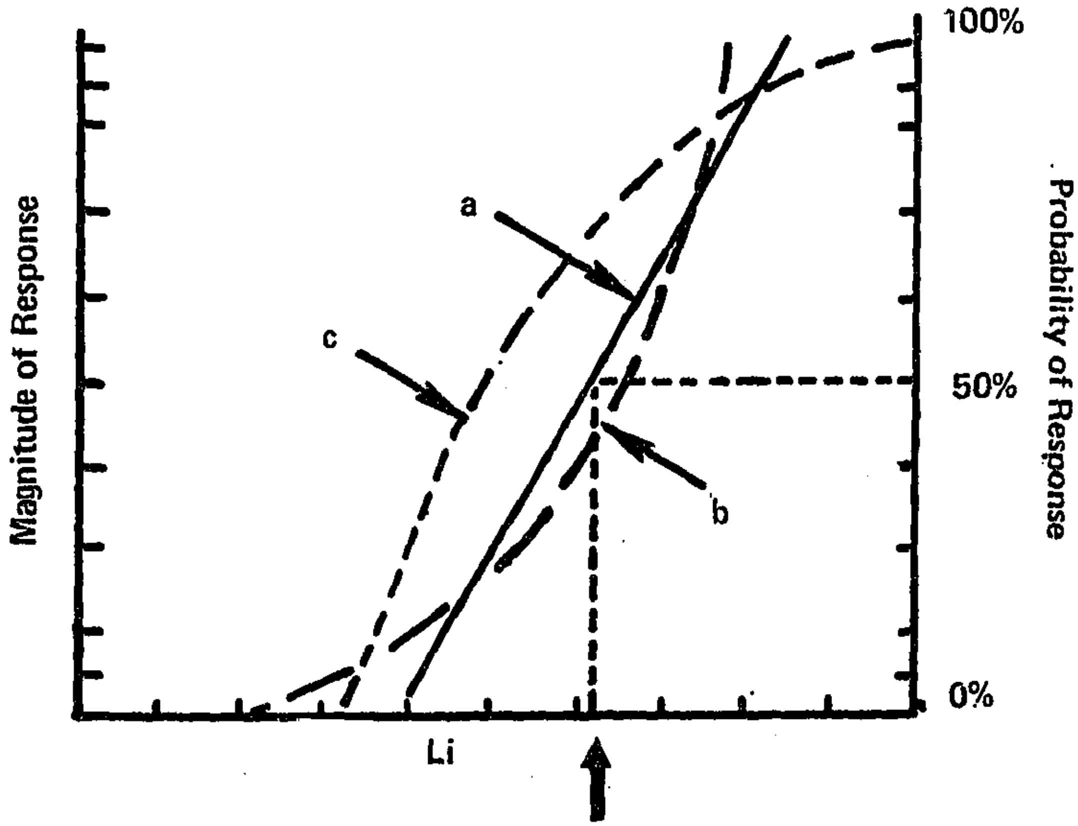


FIGURE M-2

EXAMPLE OF FORMS OF NOISE EFFECTS CRITERIA
(a) LINEAR, (b) POWER, (c) LOGARITHMIC

intensity of impact. Accordingly, the National Academy of Sciences, Committee on Hearing, Bioacoustics and Biomechanics (CHABA), has recommended a procedure for assessing environmental noise impact which mathematically takes into account both extent and intensity of impact.* This procedure, the fractional impact method, computes total noise impact by simply counting the number of people exposed to noise at different levels and statistically weighting each person by the intensity of response to the noise exposure. The result is a single number value which represents the overall magnitude of the impact.

The purpose of the fractional impact analysis method is to quantitatively define the impact of noise upon the population exposed. This, in turn, facilitates trade-off studies and comparisons of the impact between different projects or alternative solutions. To accomplish an objective comparative environmental analysis, the fractional impact method defines a series of "partial noise impacts" within a number of neighborhoods or groups, each of which is exposed to a different level of noise. The partial noise impact of each neighborhood is determined by multiplying the number of people residing within the neighborhood by the "fractional impact" of that neighborhood, i.e., the statistical probability or magnitude of an anticipated response as functionally derived from relevant noise effects criteria. The total community impact is then determined by simply summing the partial impacts of all neighborhoods.

It is quite possible, and in some cases very probable, that much of the noise impact may be found in subneighborhoods exposed to noise levels of only moderate value. Although people living in proximity to a noise source are generally more severely impacted than those people living further away, this does not imply that the latter should be totally excluded from an assessment where the purpose is to fully evaluate the magnitude of a noise impact. People exposed to lower levels of noise may still experience an adverse impact, even though that impact may be small in magnitude. The fractional impact method considers the total impact upon all people exposed to noise recognizing that some individuals incur a significantly greater noise exposure than others. The procedure duly ascribes more importance to the more severely affected population.

As discussed previously, any procedure which evaluates the impact of noise upon people or the environment, as well as the health and behavioral consequences of noise exposure and resultant community reactions, must encompass two basic elements of the impact assessment. The impact of noise may be intensive (i.e., it may severely affect a few people) or extensive (i.e., it may affect a larger population less severely). Implicit in the fractionalization concept is that the magnitude of human response varies commensurately with the degree of noise exposure, i.e., the greater the exposure, the more significant the response. Another major assumption is that a moderate noise exposure for a large population has approximately the same noise impact upon the entire community as would a greater noise exposure upon a smaller number of people. Although this may be conceptually envisioned as a trade-off between the intensity and extent of noise impact, it would be a misapplica-

*"Guidelines for Preparing Environmental Impact Statements on Noise," Report of Working Group 69, Committee on Hearing, Bioacoustics and Biomechanics, National Research Council, Washington, D.C., 1977.

tion of the procedure to disregard those persons severely impacted by noise in order to enhance the environment of a significantly larger number of people who are affected to a lesser extent. The fact remains, however, that exposing many people to noise of a lower level would have roughly the same impact as exposing a fewer number of people to a greater level of noise when considering the impact upon the community or population as a whole. Thus, information regarding the distribution of the population as a function of noise exposure should always be developed and presented in conjunction with use of the fractional impact method.

Because noise is an extremely pervasive pollutant, it may adversely affect people in a number of different ways. Certain effects are well documented. Noise can:

- o cause damage to the ear resulting in permanent hearing loss
- o interfere with spoken communication
- o disrupt or prevent sleep
- o be as source of annoyance.

Other effects of noise are not as well documented but may become increasingly important as more information is gathered. They include the nonauditory health aspects as well as performance and learning effects.

It is important to note, however, that quantitatively documented cause-effect relationships which may functionally characterize any of these noise effects may be applied within a fractionalization procedure. The function for weighting the intensity of noise impact with respect to general adverse reaction (annoyance) is displayed in Figure M-3.* The nonlinear weighting function is normalized to unity at L_{dn} = 75 dB. For convenience of calculation, the weighting function may be expressed as representing percentages of impact in accordance with the following equation:

$$W(L_{dn}) = \frac{[3.364 \times 10^{-6}]\,[10^{0.103 L_{dn}}]}{[0.2]\,[10^{0.03 L_{dn}}] + [1.43 \times 10^{-4}]\,[10^{0.08 L_{dn}}]} \qquad \text{(M-1)}$$

A simple linear approximation that can be used with reasonable accuracy in cases where day-night sound levels range between 55 and 80 dB is shown as the dashed line in Figure M-3, and is defined as:

* Ibid.

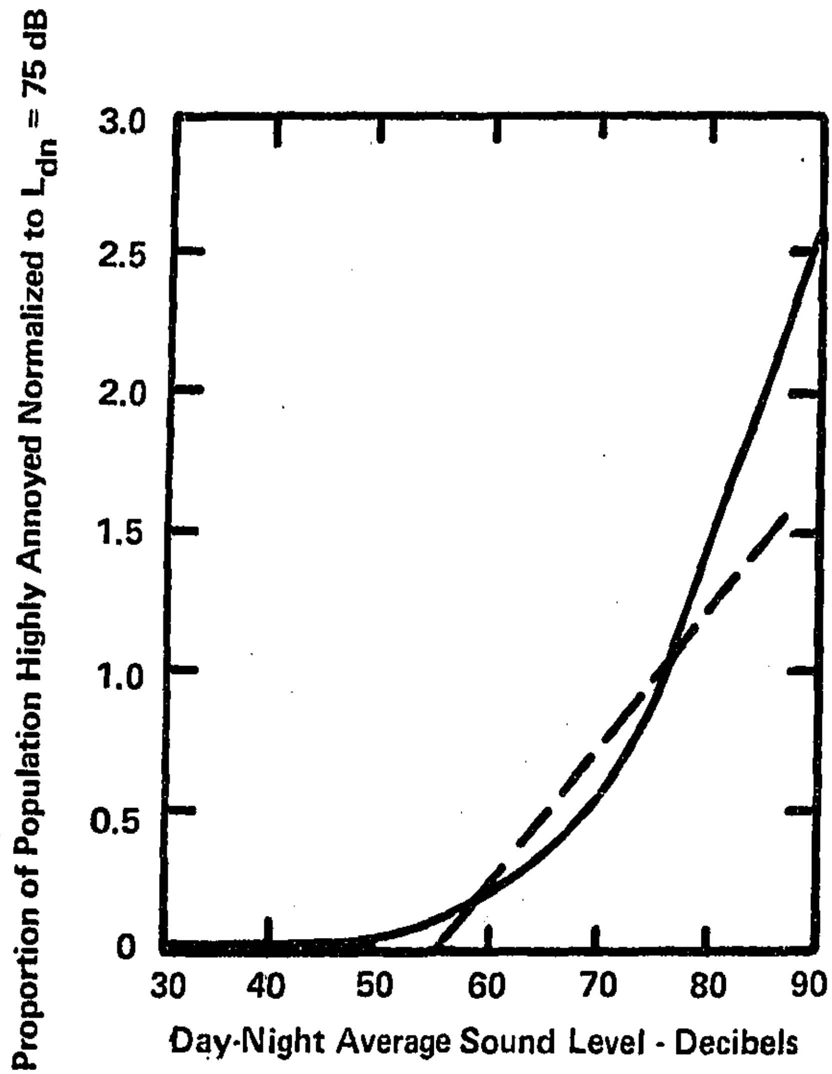


FIGURE M-3

WEIGHTING FUNCTION FOR ASSESSING
THE GENERAL ADVERSE RESPONSE TO NOISE

$$W(L_{dn}) = \begin{cases} 0.05\ (L_{dn} - 55) & \text{for } L_{dn} \geq 55 \\ 0 & \text{for } L_{dn} < 55 \end{cases} \qquad \text{(M-2)}$$

Using the fractional impact concept, an index referred to as the Level-Weighted Population (LWP)* may be derived by multiplying the number of people exposed to a given level of traffic noise by the fractional or weighted impact associated with that level as follows:

$$LWP_i = W(L_{dn}{}^i) \times P_i \qquad \text{(M-3)}$$

where LWP_i is the magnitude of the impact on the population exposed at $L_{dn}{}^i$, $W(L_{dn}{}^i)$ is the fractional weighting associated with a noise exposure of $L_{dn}{}^i$, and P_i is the number of people exposed to $L_{dn}{}^i$.

Because the extent of noise impact is characterized by a distribution of people all exposed to different levels of noise, the magnitude of the total impact may be computed by determining the partial impact at each level and summing over each of the levels. This may be expressed as:

$$LWP = \sum_i LWP_i = \sum_i W(L_{dn}{}^i) \times P_i \qquad \text{(M-4)}$$

The average severity of impact over the entire population may be derived from the Noise Impact Index (NII) as follows:

$$NII = \frac{LWP}{P_{total}} \qquad \text{(M-5)}$$

In this case, NII represents the normalized percentage of the total population who describe themselves as highly annoyed. Another concept, the Relative Change in Impact (RCI) is useful for comparing the relative difference between two alternatives. This concept takes the form expressed as a percent change in impact:

$$RCI = \frac{LWP_i - LWP_j}{LWP_i} \qquad \text{(M-6)}$$

where LWP_i and LWP_j are the calculated impacts under two different conditions.

An example of the Fractional impact calculation procedure is presented in Table M-2.

Similarly, using relevant criteria, the fractional impact procedure may be employed to calculate relative changes in hearing damage risk, sleep disruption, and speech interference.

*Terms such as Equivalent Population (Peq), and Equivalent Noise Impact (ENI), have often been used interchangeably with LWP. These indices are conceptually identical to the LWP notation.

TABLE M-2

EXAMPLE OF FRACTIONAL IMPACT CALCULATION
FOR GENERAL ADVERSE RESPONSE

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Exposure Range (L_{dn})	Exposure Median (L_{dn})	P_i	$W(L_{dn})$ (Curvilinear)	$W(L_{dn})$ (Linear approx.)	LWP_i (Curvilinear) (Column (3) x(4))	LWP_i (Linear) (Column (3) x (5)
55-60	57.5	1,200,000	0.173	0.125	207,600	150,000
60-65	62.5	900,000	0.314	0.375	282,600	337,500
65-70	67.5	200,000	0.528	0.625	105,600	125,000
70-75	72.5	50,000	0.822	0.875	41,000	43,750
75-80	77.5	10,000	1.202	1.125	12,000	11,250
		2,360,000			648,920	667,500

LWP (Curvilinear) = 648,920
LWP (Linear) = 667,500
NII (Curvilinear) = 648,920 ÷ 2,360,000 = 0.27
NII (Linear) = 667,500 ÷ 2,360,000 = 0.28

APPENDIX N

NATIONAL ROADWAY TRAFFIC NOISE EXPOSURE MODEL

APPENDIX N

NATIONAL ROADWAY TRAFFIC NOISE EXPOSURE MODEL

This appendix contains a detailed discussion of the National Roadway Traffic Noise Exposure Model. The discussion encompasses the data, calculations, and assumptions that underlie the model. Focus is on those details relevant to considerations of noise emission standards for motor cycles.

This detailed discussion shows the interrelation of the data groups presented in Table 5-6 (see Section 5). This interrelation centers around people, and how all persons are distributed throughout the United States. Briefly, each person is assigned to one of the 33 pop/density "cells" of Table 5-6. These cells are defined by (1) the total population in the city/town/area where that person lives, and (2) the population density in his neighborhood within his city/town/area. Then each person is matched to all the roadways within his own pop/density cell, and his total noise from these roadways is predicted.

The discussion that follows is based on Figures 5-12 through 5-15(see Section 5). The logic flow proceeds from vehicles, to roadways, to propagation, to the noise level experienced at each residential location in the United States. The analysis continues with the sorting of all person/noise pairs, and the conversion from noise levels to impact estimates. These impact estimates are then summed into total, nationwide impact.

Full details and references to this discussion are included in the single volume documentation report of the National Roadway Traffic Noise Exposure Model (Reference 31).*

Details of Vehicles (Figures 5-12 and 5-13, Key 1).

The model contains 14 vehicle types, as listed in Table 5-6. For each of these vehicle types, the model uses for computation a set of noise emission levels (ELs) that reflect operating modes, speed, and selected years. Noise emission levels may also be entered for the regulated vehicle of interest (or other vehicle types, if appropriate).

A vehicle's emission level is a measure of its total noise output. Technically, it is the noise level measured at a position perpendicular to the side of the vehicle and at a distance of 50 feet.

The vehicle emission level is a function of vehicle type, operating mode, and vehicle speed.

---

*References are listed at the end of Section 5.

$$\text{Emission levels} = f(\overbrace{\text{vehicle type}}^{14}, \overbrace{\text{operating mode}}^{4}, \underbrace{\text{speed}}_{5}, \underbrace{\text{year}}_{\text{base year + 4 user-chosen years}}) \qquad \text{(N-1)}$$

Equation N-1 shows the functional relationship between emission levels and the parameters upon which emissions depend. In other words, the noise emissions vary for each of the 14 vehicle types; for each vehicle type, noise varies for each of the 4 operating modes; and for each mode, noise varies for each of the 5 grouped speeds. Since the idle mode has only one speed (zero), this functional relationship yields 16 emission levels for each vehicle type, for a total of 224 emission levels.

These 224 emission levels are used to describe the average emissions of each type of vehicle operating on roadways in specified years.

The complete set of emission levels used within this regulatory analysis appear in Table N-1 (Reference 7). Each of the noise emission values in this table represents an energy-average level. The energy average represents a time average of the time-varying emissions for vehicles accelerating and decelerating. In addition, each energy average emission level is derived from a level-average emission level and a standard deviation, σ, of the level about that average. It is assumed that the scatter of levels among all the vehicles of each vehicle type is Gaussian, and thus the energy-average emission level is computed as (Reference 6):

$$\text{Energy-average EL} = \text{Level-average EL} + 0.115\sigma^2 \qquad \text{(N-2)}$$

Again, as indicated in equation N-1, sixteen emission levels are defined for each vehicle for each of four selected years.

The future-year emission levels for motorcycles as a function of regulatory option, speed, and mode appear in Table N-2. In this Table, baseline acceleration data are adjusted using equation N-2. Conversions to different modes and speed ranges are accomplished following the procedures presented in Reference 7.

In each year of interest, the model adds new vehicle sales to the vehicles already on the road, and depletes the general population of vehicles by those that retire from service. Only the new vehicles added each year are built to the reduced emission standard. For example, new motorcycles added for the years 1975 through 1981 will have current-value noise emissions, while those introduced after 1982 will have reduced noise emissions as shown in Table N-2. In other words, all new vehicle sales conform to the regulated limit in effect during the year of sale.

TABLE N-1

BASELINE VEHICLE NOISE EMISSION DATA*
(Source: Reference 54)

Type 1: Car/8-Cylinder/Automatic

Acceleration Mode					
Years>	1974				
0-20 MPH	59.60				
0-30	61.50				
0-40	63.10				
0-50	64.90				
0-60	66.80				
Deceleration Mode					
Years>	1974				
20-0 MPH	50.50				
30-0	56.10				
40-0	60.10				
50-0	63.20				
60-0	65.80				
Cruise Mode					
<25 MPH	59.80				
25-34	62.40				
35-44	66.40				
45-54	69.50				
>55	72.00				
Idle Mode					
Years>	1974				
	46.00				

Type 2: Car/6-Cylinder/Automatic

Acceleration Mode					
Years>	1974				
0-20 MPH	60.80				
0-30	62.50				
0-40	63.90				
0-50	65.50				
0-60	67.10				
Deceleration Mode					
Years>	1974				
20-0 MPH	50.50				
30-0	56.10				
40-0	60.10				
50-0	63.20				
60-0	65.80				
Cruise Mode					
<25 MPH	59.80				
25-34	62.40				
35-44	66.40				
45-54	69.50				
>550	72.00				
Idle Mode					
Years>	1974				
	46.00				

*Levels at 50 feet from vehicle

TABLE N-1 (cont.)

Type 3: Car/6-Cylinder/Manual

Acceleration Mode					
Years>	1974				
0-20 MPH	60.30				
0-30	62.50				
0-40	64.00				
0-50	65.60				
0-60	67.20				
Deceleration Mode					
Years>	1974				
20-0 MPH	50.50				
30-0	56.10				
40-0	60.10				
50-0	63.20				
60-0	65.80				
Cruise Mode					
<25 MPH	59.80				
25-34	62.40				
35-44	66.40				
45-54	69.50				
>55	72.00				
Idle Mode					
Years>	1974				
	46.00				

Type 4: Car and Light Truck/4-Cylinder/Automatic

Acceleration Mode					
Years>	1974				
0-20 MPH	62.90				
0-30	64.30				
0-40	65.40				
0-50	66.60				
0-60	68.00				
Deceleration Mode					
Years>	1974				
20-0 MPH	50.50				
30-0	56.10				
40-0	60.10				
50-0	63.20				
60-0	65.80				
Cruise Mode					
<25 MPH	59.80				
25-34	62.40				
35-44	66.40				
45-54	69.50				
>550	72.00				
Idle Mode					
Years>	1974				
	46.00				

TABLE N-1 (cont.)

Type 5: Car and Light Truck/4-Cylinder/Manual

Acceleration Mode

Years>	1974				
0-20 MPH	62.60				
0-30	64.60				
0-40	65.90				
0-50	67.30				
0-60	68.70				

Deceleration Mode

Years>	1974				
20-0 MPH	51.70				
30-0	57.30				
40-0	61.30				
50-0	64.40				
60-0	67.00				

Cruise Mode

Years>	1974				
<25 MPH	61.00				
25-34	63.60				
35-44	67.60				
45-54	70.70				
>55	73.20				

Idle Mode

Years>	1974				
	46.00				

Type 6: Light Truck/6-Cylinder

Acceleration Mode

Years>	1974				
0-20 MPH	63.30				
0-30	65.10				
0-40	66.50				
0-50	68.20				
0-60	69.90				

Deceleration Mode

Years>	1974				
20-0 MPH	53.40				
30-0	59.00				
40-0	63.00				
50-0	66.10				
60-0	68.70				

Cruise Mod^

Years>	1974				
<25 MPH	62.70				
25-34	65.30				
35-44	69.30				
45-54	72.40				
>550	74.90				

Idle Mode

Years>	1974				
	46.00				

TABLE N-1 (cont.)

Type 7: Car and Light Truck/Diesel

Acceleration Mode					
Years>	1974				
0-20 MPH	65.30				
0-30	66.70				
0-40	67.50				
0-50	68.40				
0-60	69.40				

Deceleration Mode					
Years>	1974				
20-0 MPH	52.30				
30-0	57.90				
40-0	61.90				
50-0	65.00				
60-0	67.60				

Cruise Mode					
Years>	1974				
<25 MPH	61.60				
25-34	64.20				
35-44	68.20				
45-54	71.30				
>55	73.80				

Idle Mode					
Years>	1974				
	46.00				

Type 8: Medium Trucks

Acceleration Mode					
Years>	1974	1978	1982		
0-20 MPH	75.10	75.10	74.80		
0-30	75.60	75.60	75.30		
0-40	76.20	76.20	75.90		
0-50	76.80	76.80	76.60		
0-60	77.70	77.70	77.50		

Deceleration Mode					
Years>	1974	1978	1982		
20-0 MPH	65.80	65.80	65.50		
30-0	70.00	70.00	69.80		
40-0	73.00	73.00	72.70		
50-0	75.10	75.10	74.90		
60-0	76.80	76.80	76.70		

Cruise Mode					
Years>	1974	1978	1982		
<25 MPH	77.20	77.20	76.90		
25-34	77.20	77.20	76.90		
35-44	78.10	78.10	77.90		
45-54	80.20	80.20	80.00		
>55	81.70	81.70	81.60		

Idle Mode					
Years>	1974	1978	1982		
	54.00	54.00	54.00		

TABLE N-1 (cont.)

Type 9: Heavy Trucks

Acceleration Mode

Years>	1974	1978	1982	
0-20 MPH	82.70	78.90	75.90	
0-30	82.80	79.10	76.30	
0-40	83.00	79.60	77.10	
.0-50	83.40	80.40	78.40	
0-60	84.00	81.50	80.10	

Deceleration Mode

Years>	1974	1978	1982	
20-0 MPH	73.90	70.20	67.50	
30-0	77.30	73.90	71.40	
40-0	79.60	76.50	74.40	
50-0	81.40	78.60	77.00	
60-0	82.70	80.40	79.10	

Cruise Mode

Years>	1974	1978	1982	
<25 MPH	83.60	79.80	77.00	
25-34	83.40	80.00	77.70	
35-44	84.20	81.50	79.90	
45-54	85.70	83.70	82.60	
>55	86.80	85.60	85.00	

Idle Mode

Years	1974	1978	1982	
	63.00	60.00	57.00	

Type 10: Intercity Buses

Acceleration Mode

Years>	1974	1981	1985	1987	
0-20 MPH	81.60	77.80	74.80	71.80	
0-30	82.00	78.30	75.30	72.40	
0-40	82.30	78.60	75.80	73.20	
0-50	82.60	79.00	76.50	74.30	
0-60	82.80	79.60	77.40	75.60	

Deceleration Mode

Years>	1974	1981	1985	1987	
20-0 MPH	68.10	64.50	61.80	59.30	
30-0	71.40	68.10	65.70	63.80	
40-0	73.80	70.80	68.90	67.40	
50-0	75.60	73.00	71.50	70.50	
60-0	77.10	75.00	73.90	73.20	

Cruise Mode

Years>	1974	1981	1985	1987	
<25 MPH	76.00	72.40	69.60	67.10	
25-34	76.00	73.00	71.00	69.60	
35-44	78.40	75.90	74.50	73.50	
45-54	80.20	78.30	77.40	76.80	
>55	81.70	80.50	80.00	79.70	

Idle Mode

Years>	1974	1981	1985	1987	
	62.00	59.00	56.00	53.00	

TABLE N-1 (cont.)

Type 11: Transit Buses

Acceleration Mode

Years>	1974	1981	1985	1987
0-20 MPH	81.00	81.00	78.20	75.20
0-30	81.00	81.00	78.20	75.30
0-40	81.10	81.10	78.40	75.60
0-50	81.20	81.20	78.70	76.20
0-60	81.50	81.50	79.20	77.10

Deceleration Mode

Years>	1974	1981	1985	1987
20-0 MPH	63.70	63.70	61.30	58.90
30-0	67.80	67.80	65.60	63.80
40-0	70.60	70.60	68.90	67.50
50-0	72.90	72.90	71.50	70.50
60-0	74.70	74.70	73.70	73.10

Cruise Mode

Years>	1974	1981	1985	1987
<25 MPH	73.00	73.00	70.40	67.80
25-34	73.00	73.00	71.10	69.60
35-44	75.80	75.80	74.50	73.60
45-54	78.10	78.10	77.30	76.80
>55	79.90	79.90	79.60	79.50

Idle Mode

Years>	1974	1981	1985	1982
	58.00	58.00	55.00	52.00

Type 12: School Buses

Acceleration Mode

Years>	1974	1981	1985	1987
0-20 MPH	77.60	77.60	74.80	71.80
0-30	78.10	78.10	75.30	72.40
0-40	78.40	78.40	75.80	73.20
0-50	78.90	78.90	76.50	74.30
0-60	79.40	79.40	77.40	75.60

Deceleration Mode

Years>	1974	1981	1985	1987
20-0 MPH	63.70	63.70	61.30	58.90
30-0	67.80	67.80	65.60	63.80
40-0	70.60	70.60	68.90	67.80
50-0	72.90	72.90	71.50	70.50
60-0	74.70	74.70	73.70	73.10

Cruise Mode

Years>	1974	1981	1985	1987
<25 MPH	73.00	73.00	70.40	67.80
25-34	73.00	73.00	71.10	69.60
35-44	75.80	75.80	74.50	73.60
45-54	78.10	78.10	77.30	76.80
>55	79.90	79.90	79.60	79.50

Idle Mode

Years>	1974	1981	1985	1987
	58.00	58.00	55.00	52.00

TABLE N-1 (cont.)

Type 13: Unmodified Motorcycles

Acceleration Mode					
Years>	1974				
0-20 MPH	72.3				
0-30	73.9				
0-40	74.4				
0-50	74.7				
0-60	74.9				

Deceleration Mode					
Years>	1974				
20-0 MPH	61.50				
30-0	65.90				
40-0	69.00				
50-0	71.40				
60-0	73.40				

Cruise Mode					
<25 MPH	66.90				
25-34	71.30				
35-44	74.40				
45-54	76.90				
>55	78.90				

Idle Mode					
Years>	1974				
	58.00				

Type 14: Modified Motorcycles

Acceleration Mode					
Years>	1974				
0-20 MPH	87.50				
0-30	89.10				
0-40	89.60				
0-50	89.90				
0-60	90.10				

Deceleration Mode					
Years>	1974				
20-0 MPH	75.70				
30-0	80.10				
40-0	83.20				
50-0	85.60				
60-0	87.60				

Cruise Mode					
<25 MPH	81.10				
25-34	85.40				
35-44	88.60				
45-54	91.10				
>55	93.10				

Idle Mode					
Years>	1974				
	72.00				

TABLE N-2

NOISE LEVELS FOR STREET MOTORCYCLES UNDER REGULATORY ALTERNATIVES

ACCELERATION MODE

REGULATORY LEVELS (A-Weighted)	BASELINE	83 dB	80 dB	78 dB	75 dB	65 dB
Speed Range						
0-20 MPH	72.30	71.50	68.50	66.50	63.50	53.10
0-30	73.90	73.10	70.10	68.10	65.10	55.10
0-40	74.40	73.60	70.60	68.60	65.60	55.60
0-50	74.70	73.90	70.90	68.90	65.90	55.90
0-60	74.90	74.10	71.10	69.10	66.10	56.10

DECELERATION MODE

REGULATORY LEVELS (A-Weighted)	BASELINE	83 dB	80 dB	78 dB	75 dB	65 dB
Speed Range						
20-0 MPH	61.50	60.70	57.70	55.70	52.70	42.70
30-0	65.90	65.10	62.10	60.10	57.10	47.10
40-0	69.00	68.20	65.20	63.20	60.20	50.20
50-0	71.40	70.60	67.60	65.60	62.60	52.60
60-0	73.40	72.60	69.60	67.60	64.60	54.60

CRUISE MODE

REGULATORY LEVELS (A-Weighted)	BASELINE	83 dB	80 dB	78 dB	75 dB	65 dB
Speed Range						
<25 MPH	66.90	66.10	63.10	61.10	58.10	48.10
25-34	71.30	70.50	67.50	65.50	62.50	52.50
35-44	74.40	73.60	70.60	68.60	65.60	55.60
45-54	76.90	76 10	73.10	71.10	68.10	58.10
>55	78.90	78.10	75.10	73.10	70.10	60.10

IDLE MODE

REGULATORY LEVELS (A-Weighted)	BASELINE	83 dB	80 dB	78 dB	75 dB	65 dB
	58.90	58.30	55.30	53.30	50.30	40.30

The sales rate and the vehicle depletion rate are discussed further in the following subsection.

In addition to noise emission levels, the model considers the fraction of time each vehicle spends in each of the four operating modes. These mode fractions also depend upon the roadway type, as shown in equation N-3.

$$\text{Fraction of time in mode} = f(\overset{\text{only 10}}{\text{vehicle type}},\ \overset{4}{\text{operating mode}},\ \underset{\text{only 2}}{\text{roadway type}}) \qquad \text{(N-3)}$$

The functional relationship in equation N-3 yields 80 values. These values are contained in 14 tables, one of which is included here as Table N-3. Specifically, Table N-3 documents the mode fractions for both modified and unmodified motorcycles. The remainder of the tables are contained in Reference 31. This information contained in all 14 tables was extrapolated from References 33 and 34.

It should be noted that the mode fraction does not vary for all 14 vehicle types. Similarly, as shown in Table N-3, it does not vary for all of the roadway types, but regroups all roadways into two groups for this purpose (roadways 1, 2, and 3 and roadways 4, 5 and 6).

<u>Details of Roadway</u> (Figures 5-12 and 5-13, Key 2)

The model contains 6 roadway types, as listed in Table 5-6. For each of these roadway types, the model contains six specific pieces of data:

- Fraction of mileage at each speed range
- Average daily traffic
- Traffic mix
- Lane width
- Number of lanes
- Clear-zone width

In actual fact, each roadway has a wide range of speeds associated with it. Although vehicle speeds vary on each roadway from moment to moment, the program considers only the average speed for any given segment of roadway. In other words, within each population area the program distributes all the mileage of a given type of roadway into the five speed groups, based upon that mileage's average speed. The result is the fraction of roadway mileage in each of the five speed groups for each population area.

These fractions of mileage contain only those miles that pass through occupied land areas. Other mileage is excluded before distribution into speed groups. This mileage exclusion was computed using Figure A.2.2 of Reference 31.

TABLE N-3 Mode Fraction (Percent of Time) in Operating Mode: Motorcycles

Roadway Type	OPERATING MODE				
	Acceleration M=1	Deceleration M=2	Cruise M=3	Idle M=4	Total
1	4.70	5.36	88.88	1.06	100.00
2	4.70	5.36	88.88	1.06	100.00
3	4.70	5.36	88.88	1.06	100.00
4	15.40	16.00	55.10	13.50	100.00
5	15.40	16.00	55.10	13.50	100.00
6	15.40	16.00	55.10	13.50	100.00

Roadway Type 1 = Interstate Highway
Roadway Type 2 = Freeways and Expressways
Roadway Type 3 = Major Arterials
Roadway Type 4 = Minor Arterials
Roadway Type 5 = Collectors
Roadway Type 6 = Local Roads and Streets

Next, the program multiplies these mileage fractions by the total mileages, to obtain the number of miles of that roadway type in the given speed group on a national basis.

$$\text{Number of miles in a given speed group} = f(\overbrace{\text{speed group}}^{5}, \overbrace{\text{roadway type}}^{6}, \underbrace{\text{population}}_{4}, \underbrace{\text{population density}}_{9}) \qquad \text{(N-4)}$$

This allocation of roadway mileage by speed group is also a function of the two population groups shown in equation N-4. These population groups are discussed further below.

In all, this functional relationship yields 216 values for each speed group, for a total of 1080 values. The complete set of values is contained in a set of 20 tables (Reference 31, Table A.3.2), two of which are included here in Table N-4.

A partial summary of these 20 tables appear in Table N-5. In this table, the total roadway mileage through occupied land is split by population and roadway type. Information concerning speed grouping and grouping by population density is not presented in Table N-5, although included in the 20 tables.

Next, the program contains average daily traffic for each of the roadway types.

$$\text{Average daily traffic} = f(\overbrace{\text{roadway type}}^{6}, \text{place } \overbrace{\text{population}}^{9}, \underbrace{\text{year}}_{\text{base year + 8 selected years}}) \qquad \text{(N-5)}$$

For the baseline year, this functional relationship yields 54 values (Reference 35). These are presented in Table N-6.

Each of these traffic values is then further divided by vehicle type. The resulting traffic mixes are presented in Table N-7 (References 47, 49 and 52).

$$\text{1974 Traffic mix} = f(\overbrace{\text{vehicle type}}^{\text{only 8}}, \overbrace{\text{roadway type}}^{6}, \underbrace{\text{population}}_{\text{only 4}}) \qquad \text{(N-6)}$$

TABLE N-4

ROADWAY MILEAGE DATA
AVERAGE TRAVEL SPEED 20 MPH

ID = 1

HIGH POPULATION DENSITY AREAS

	K = 1	2	3	4	5	6	All K
J = 1	0	3	16	41	37	94	191
2	0	7	21	71	71	172	342
3	0	1	4	11	12	31	59
4	0	3	17	45	42	119	226
5	0	5	24	58	61	149	297
6	0	5	29	67	69	171	341
7	0	1	6	14	15	33	69
8	0	3	27	59	63	140	292
9	0	0	0	8698	6159	215859	230716
ALL J>	0	28	144	9064	6529	216768	232533

ID = 2

MEDIUM TO HIGH POPULATION DENSITY AREAS

	K = 1	2	3	4	5	6	All K
J = 1	6	78	438	1085	989	2494	5090
2	1	19	59	201	203	491	974
3	1	6	31	84	95	242	459
4	7	69	360	963	886	2514	4799
5	2	23	110	273	283	699	1390
6	1	18	99	229	233	579	1159
7	1	10	97	210	228	504	1050
8	1	16	154	336	364	804	1675
9	0	0	0	0	0	0	0
ALL J>	20	239	1348	3381	3281	8327	16596

J 1 = Population over 2 million (M)
J 2 = 1 M to 2 M
J 3 = 500K to 1 M
J 4 = 200K to 500K
J 5 = 100K to 200K
J 6 = 50K to 100K
J 7 = 25K to 50K
J 8 = 5K to 25K
J 9 = Rural

K 1 = Interstate Highways
K 2 = Freeways and Expressways
K 3 = Major Arterials
K 4 = Minor Arterials
K 5 = Collectors
K 6 = Local Roads and Streets

TABLE N-5 Distribution of Road Mileage, Average Daily Traffic (ADT) and Daily Vehicle Miles Traveled (DVMT) by Place Size (J) and Roadway Type (K)

		ROADWAY TYPE					
		INTERSTATE	OTHER E'WAY & EXP'WAY	MAJOR ARTERIALS	MINOR ARTERIALS	COLLECTORS	LOCAL
>2M	Miles	1,998	1,749	9,861	14,103	12,854	84,247
	ADT	74,866	66,470	18,768	9,315	3,783	1,129
	DVMT	149,582,268	116,256,030	185,071,248	131,369,445	48,626,682	95,114,863
1M to 2M	Miles	1,869	1,527	5,156	10,219	10,308	64,678
	ADT	60,228	32,548	17,397	6,898	3,496	656
	DVMT	112,566,132	49,700,796	89,698,932	70,490,662	36,036,768	42,428,768
500K to 1M	Miles	1,477	739	4,034	6,320	7,190	47,466
	ADT	46,997	34,036	16,359	8,045	3,760	672
	DVMT	69,414,569	25,152,604	65,992,206	50,844,400	27,034,400	31,897,152
200K to 500K	Miles	1,743	1,076	5,566	8,569	7,897	58,252
	ADT	40,367	28,812	16,029	8,470	3,812	839
	DVMT	70,359,681	31,001,712	89,217,414	75,579,430	30,103,364	48,873,428
100K to 200K	Miles	854	803	3,851	5,502	5,714	36,697
	ADT	32,190	22,984	14,984	7,301	3,287	649
	DVMT	27,490,260	18,456,152	57,352,943	40,170,102	18,781,918	23,816,353
50K to 100K	Miles	512	600	3,335	4,445	4,534	29,284
	ADT	21,913	19,971	12,376	6,057	2,917	645
	DVMT	11,219,456	11,982,600	41,273,960	26,923,365	13,225,678	18,888,180
25K to 50K	Miles	397	447	4,282	5,377	5,828	33,454
	ADT	23,251	16,875	11,384	5,430	2,484	631
	DVMT	9,230,647	7,543,125	48,746,298	29,197,110	14,476,752	21,109,479
5K to 25K	Miles	899	1,099	9,652	12,124	13,130	75,431
	ADT	18,206	13,244	8,922	4,255	1,946	495
	DVMT	16,367,144	13,343,016	86,115,144	61,587,620	25,550,980	37,338,345
Rural	Miles	31,744	85,716	155,547	435,517	307,917	1,942,733
	ADT	13,700	4,623	2,523	899	370	98
	DVMT	434,892,800	396,265,068	392,445,081	387,174,613	113,929,290	190,387,834

Note: ADT-DVMT/Miles is the derived quality.

TABLE N-6

Average Daily Traffic (ADT)
By Roadway Type (K) and Place Size (J)
Baseline Year 1974

	K = 1	2	3	4	5	6
J=1	74866	66470	18768	9315	3783	1129
2	60228	32548	17397	6898	3496	656
3	46997	34036	16359	8045	3760	672
4	40367	28812	16029	8470	3812	839
5	32190	22984	14984	7301	3287	649
6	21913	19971	12376	6057	2917	645
7	23251	16876	11384	5430	2484	631
8	18206	13224	8922	4255	1946	495
9	13700	4623	2523	889	370	98

J 1 = Population over 2 million (M)
J 2 = 1 M to 2 M
J 3 = 500K to 1 M
J 4 = 200K to 500K
J 5 = 100K to 200K
J 6 = 50K to 100K
J 7 = 25K to 50K
J 8 = 5K to 25K
J 9 = Rural

K 1 = Interstate Highways
K 2 = Freeways and Expressways
K 3 = Major Arterials
K 4 = Minor Arterials
K 5 = Collectors
K 6 = Local Roads and Streets

TABLE N-7

Percentage Vehicle Mix in Traffic Flow by Place Size
and Functional Roadway Classification Baseline Conditions

URBAN PLACES SIZES: Over 2M; 1M-2M; 500K-1M

VEHICLE TYPE	ROADWAY TYPE (INDEX K)					
Light Vehicles	87.62	87.62	91.82	90.52	90.51	95.76
Medium Trucks	2.11	2.11	3.05	4.31	3.61	1.16
Heavy Trucks	9.17	9.17	4.03	3.11	3.82	0.99
Intercity Buses	0.03	0.03	0.03	0.00	0.00	0.00
Transit Buses	0.08	0.08	0.08	0.54	0.54	0.54
School Buses	0.00	0.00	0.00	0.02	0.02	0.02
Unmodified Motorcycles	0.88	0.88	0.88	1.32	1.32	1.32
Modified Motorcycles	0.12	0.12	0.12	0.18	0.18	0.18
	100.00	100.00	100.00	100.00	100.00	100.00

URBAN PLACES SIZES: Over 200K-500K; 100K-200K; 50K-100K

VEHICLE TYPE	ROADWAY TYPE (INDEX K)					
	1	2	3	4	5	6
Light Vehicles	87.64	87.64	91.84	90.71	90.70	95.98
Medium Trucks	2.11	2.11	3.05	4.31	3.61	1.16
Heavy Trucks	9.17	9.17	4.03	3.11	3.82	0.99
Intercity Buses	0.04	0.04	0.04	0.04	0.04	0.04
Transit Buses	0.04	0.04	0.04	0.30	0.30	0.30
School Buses	0.00	0.00	0.00	0.08	0.08	0.08
Unmodified Motorcycles	0.88	0.88	0.88	1.32	1.32	1.32
Modified Motorcycles	0.12	0.12	0.12	0.18	0.18	0.18
	100.00	100.00	100.00	100.00	100.00	100.00

NOTE: Some columns do not add up to exactly 100 because of rounding

K 1 = Interstate Highways
K 2 = Freeways and Expressways
K 3 = Major Arterials
K 4 = Minor Arterials
K 5 = Collectors
K 6 = Local Roads and Streets

TABLE N-7 (cont.)

Percentage Vehicle Mix in Traffic Flow
by Place Size and Functional Roadway

URBAN PLACES SIZES: 25K-50K; 5K-25K

VEHICLE TYPE	ROADWAY TYPE (INDEX K)					
	1	2	3	4	5	6
Light Vehicles	87.67	87.67	91.67	90.34	90.33	95.61
Medium Trucks	2.11	2.11	3.05	4.31	3.61	1.16
Heavy Trucks	9.17	9.17	4.03	3.11	3.82	0.99
Intercity Buses	0.03	0.03	0.03	0.00	0.00	0.00
Transit Buses	0.05	0.05	0.05	0.21	0.21	0.21
School Buses	0.00	0.00	0.00	0.52	0.52	0.52
Unmodified Motorcycles	0.88	0.88	0.88	1.32	1.32	1.32
Modified Motorcycles	0.12	0.12	0.12	0.18	0.18	0.18
	100.00	100.00	100.00	100.00	100.00	100.00

RURAL AREAS
ROADWAY TYPE (INDEX K)

	1	2	3	4	5	6
Light Vehicles	79.67	79.67	85.78	88.27	93.33	96.74
Medium Trucks	2.74	2.74	3.80	4.39	0.56	0.41
Heavy Trucks	16.16	16.16	8.99	5.14	3.91	0.65
Intercity Buses	0.24	0.24	0.24	0.00	0.00	0.00
Transit Buses	0.00	0.00	0.00	0.00	0.00	0.00
School Buses	0.19	0.19	0.19	0.70	0.70	0.70
Unmodified Motorcycles	0.88	0.88	0.88	1.32	1.32	1.32
Modified Motorcycles	0.12	0.12	0.12	0.18	0.18	0.18
	100.00	100.00	100.00	100.00	100.00	100.00

NOTE: Some columns do not add up to exactly 100 because of rounding

These data are sufficient to define vehicle mix for the baseline year 1974. To predict future-year traffic mixes, however, a breakdown of vehicles by their year of production is carried out. This breakdown resides within the computer program, and appears here as Tables N-8 and N-9 (see Figure A-4.2 of Reference 31, derived from References 47 and 48). Table N-8 provides vehicle information in six vehicle groups, while Table N-9 further subdivides these groups into the total of 14 as illustrated in equation N-7.

$$\text{1974 vehicle mix} = f(\overset{14}{\text{vehicle type}}, \overset{17}{\text{model year}}) \qquad \text{(N-7)}$$

The average daily traffic is also derived for future years. First we account for new vehicles sold each year that increase the average daily traffic.

$$\text{Vehicle sales} = f(\overset{\text{only } 4}{\text{vehicle type}}, \overset{40}{\text{year}}) \qquad \text{(N-8)}$$

This functional relationship illustrated by equation N-8 represents growth factors relative to sales in 1974 (see Figure A-4.2 of Reference 31 for growth factors of vehicles other than buses, derived from References 47 and 48).

The projected number of motorcycle sales used in this regulatory health and welfare analysis are discussed in Section 8 of the main text.

For future years, the average daily traffic is also depleted as shown by equation N-9 by those vehicles that retire from service (References 47 and 48).

$$\begin{array}{l}\text{Percentage of} \\ \quad \text{vehicles retiring} = f(\overset{\text{only } 2}{\text{vehicle type}}, \overset{20}{\text{vehicle age}})\end{array} \qquad \text{(N-9)}$$

Examples of this depletion rate are contained in Appendix G of Reference 31. Table N-10 presents vehicle population by type for each year. This table takes into account vehicle sales and depletion rates.

In summary, average daily traffic flow plus vehicle mix starts at the 1974 values (baseline) for each roadway (equations N-5, N-6, and N-7). Daily traffic flow grows according to new-vehicle sales (equation N-8), and is depleted by the number of vehicles retiring (equation N-9). As the traffic changes in this manner, all new-vehicle sales consist of noise-regulated vehicles -- where such vehicles have been specified (equation N-1).

TABLE N-8

Baseline Year (1974) Vehicle Population
by Model Year and Vehicle Category

Model Year	Light Vehicles	Trucks	Intercity Buses	Transit Buses	School Buses	Motorcycles
1974	13,959,524	447,576	1,479	12,571	58,226	983,000
1973	14,599,524	457,770	2,246	6,706	47,511	1,120,000
1972	13,145,920	387,705	1,886	4,819	38,378	928,000
1971	11,107,210	281,879	1,084	3,319	28,263	802,000
1970	11,003,084	274,759	13,905*	42,057*	184,460*	541,000
1969	11,161,141	291,911	-	-	-	290,000
1968	10,274,987	229,451	-	-	-	155,000
1967	8,581,706	211,166	-	-	-	72,000
1966	8,461,220	211,814	-	-	-	36,000
1965	7,397,576	185,276	-	-	-	22,000
1964	5,151,096	152,266	-	-	-	11,009
1963	3,658,626	121,684	-	-	-	4,000
1962	2,348,827	97,573	-	-	-	2,000*
1961	1,167,288	69,094	-	-	-	-
1960	883,563	70,227	-	-	-	-
1959	506,559	59,871	-	-	-	-
1958	2,100,082*	370,391*	-	-	-	-

*Population includes all vehicles in this model year and older.

TABLE N-9

Distribution of Vehicle Population by Vehicle Type for Model Years 1974 and Earlier

Vehicle*		Fraction of Vehicle Category Population
Type 1		0.4673
Type 2		0.1420
Type 3		0.0167
Type 4		0.0168
Type 5		0.1603
Type 6		0.1514
Type 7		0.0005
	Total	1.0000
Type 8		0.6146
Type 9		0.3854
	Total	1.0000
Type 10		1.0000
Type 11		1.0000
Type 12		1.0000
Type 13		0.8800
Type 14		0.1200
	Total	1.0000

* See Table N-1

TABLE N-10

VEHICLE POPULATION BY TYPE

TYPE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	ALL TYPES
Cylinders	8	6	6&8	4	4	6&8									
Engine	Gas	Gas	Gas	Gas	Gas	Gas	Diesel								
Trans-mission	Auto-matic	Auto-matic	Man-ual	Auto-matic	Man-ual	---	---	---	---	---	---	---	---	---	
VEH, Type>	PC	PC	PC	PC&LT	PC&LT	LT TRK	PC&LT	MED TRK	HVY TRK	IC BUS	TR BUS	SCH BUS	UM MTCY	MD MTCY	
UNIT	MILLIONS									THOUSANDS X 0.01			MILLIONS		
Year															
1974	58.68	17.83	2.10	7.76	20.13	19.01	0.06	2.41	1.51	0.21	0.69	3.57	4.37	0.60	134.90
1981	61.49	21.84	2.77	12.61	22.82	26.84	4.23	2.94	1.85	0.17	0.97	5.22	5.02	0.68	163.72
1984	51.70	24.97	3.26	19.55	24.09	28.08	12.04	3.24	2.03	0.20	1.16	6.07	6.29	0.86	176.86
1986	41.87	27.51	3.63	25.65	25.07	27.76	19.09	3.41	2.14	0.22	1.28	6.41	7.32	1.00	185.23
1988	32.73	30.04	3.99	31.54	26.17	27.16	25.84	3.56	2.23	0.23	1.36	6.61	8.23	1.12	193.45
1990	25.16	32.48	4.32	36.85	27.39	26.58	31.86	3.71	2.32	0.24	1.42	6.74	8.94	1.22	201.68
1995	15.84	37.58	5.01	46.20	30.56	26.86	41.96	4.09	2.57	0.27	1.54	7.01	10.33	1.41	223.28
2000	15.79	41.73	5.56	51.79	33.76	29.28	47.28	4.52	2.83	0.30	1.64	7.28	11.47	1.56	246.52
2010	19.21	50.84	6.78	63.10	41.15	35.67	57.62	5.51	3.45	0.36	1.85	7.82	12.16	1.66	298.14

For the Single Event Response part of the model, the average daily traffic flow and vehicle mix is used in the same manner as above. However, the noise impact from only one vehicle type at a time is computed.

The basic roadway configuration appears in Figure N-1. A roadway is shown to the left, with the adjacent land extending to the right.

Each roadway type consists of a definite number of travel lanes, of definite width, then a clear zone of definite width, and then occupied land.

$$\text{Lane width} = f(\overset{\text{only 2}}{\text{roadway type}}) \qquad \text{(N-10)}$$

$$\text{Number of travel lanes} = f(\overset{\text{only 2}}{\text{roadway type}}) \qquad \text{(N-11)}$$

$$\text{Clear-zone width} = f(\overset{6}{\text{roadway type}}, \overset{9}{\text{population size}}, \underset{4}{\text{population density}}) \qquad \text{(N-12)}$$

Lane widths are 15 feet for interstate roadways and 12 feet for all other roadways. The number of travel lanes is two for all local roadways and four for all other roadways. The clear-zone widths are more complicated functions, as indicated in equation N-12. The clear-zone widths used in the model appear in Table N-11. The definition of the clear-zone distance is based upon the best information currently available (References 35, 37, 50).

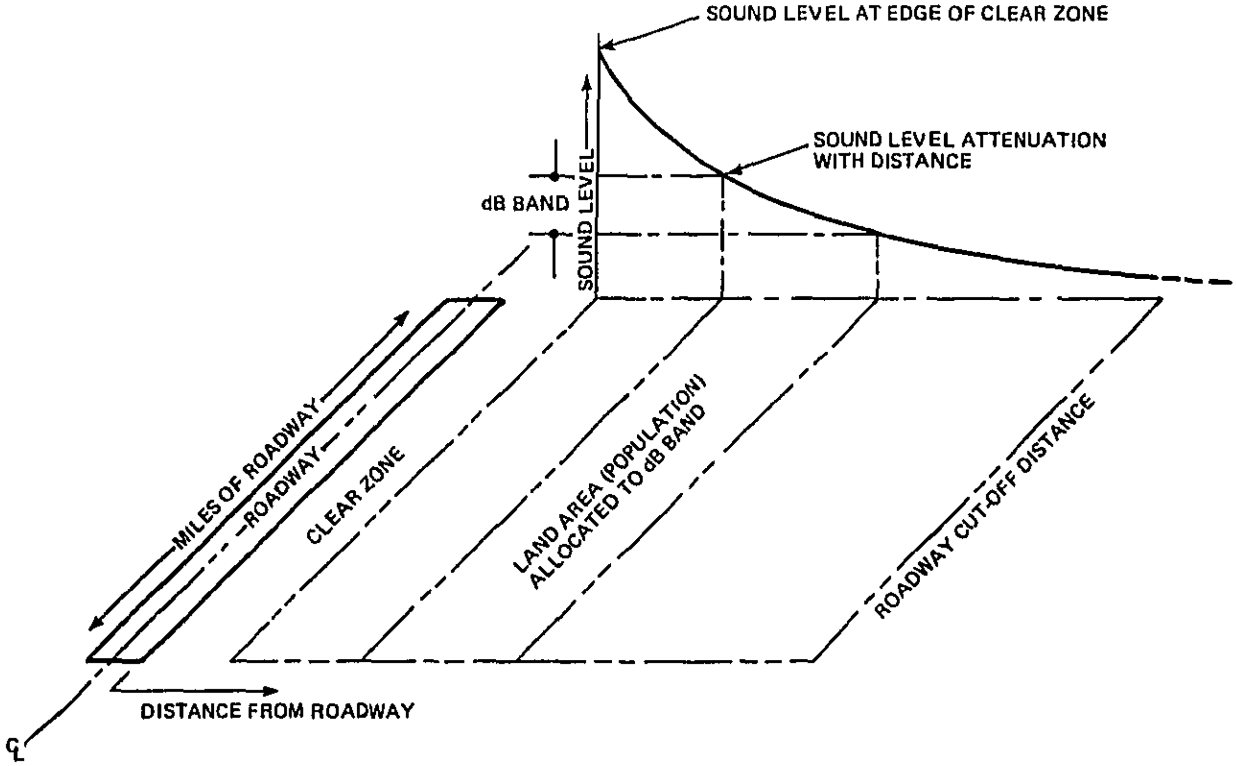
Clear-zones consist of the area between the roadway pavement and the adjacent, occupied land. These clear-zones include parking lanes, and sidewalks. In all but the rural population group, clear-zones also include front yards of residences -- but only along arterials, collectors, and local roadways. For interstates and freeways, clear-zones include the right-of-way adjacent to the roadway pavement.

<u>Details of Propagation</u> (Figures 5-12 and 5-13, Key 2)

Propagation of motorcycle noise from the roadway into the adjacent occupied land is influenced, in part, by:

FIGURE N-1

NOISE TRAFFIC NOISE EXPOSURE OF LAND AREA



NOTE: LAND AREA AND POPULATION IS UNIFORMLY DISTRIBUTED ON BOTH SIDES OF ROADWAY

TABLE N-11

CLEAR ZONE DISTANCES (IN FEET) BY ROADWAY TYPE (K), POPULATION DENSITY CATEGORY (ID), AND POPULATION PLACE SIZE (J)*

		Population Place Size, Index J								
K	ID	1	2	3	4	5	6	7	8	9
1	ALL	50.	50.	50.	50.	50.	50.	50.	50.	50.
2	ALL	30.	30.	30.	40.	40.	40.	40.	40.	40.
3	1	10.	10.	10.	10.	10.	10.	10.	10.	40.
	2	15.	15.	15.	20.	20.	20.	20.	20.	40.
	3	20.	20.	20.	30.	30.	30.	30.	30.	40.
	4	30.	30.	30.	40.	40.	40.	40.	40.	40.
4	1	10.	10.	10.	10.	10.	10.	10.	10.	40.
	2	15.	15.	15.	20.	20.	20.	20.	20.	40.
	3	20.	20.	20.	30.	30.	30.	30.	30.	40.
	4	30.	30.	30.	40.	40.	40.	40.	40.	40.
5	1	5.	5.	5.	10.	10.	10.	10.	10.	40.
	2	10.	10.	10.	20.	20.	20.	20.	20.	40.
	3	15.	15.	15.	30.	30.	30.	30.	30.	40.
	4	20.	20.	20.	40.	40.	40.	40.	40.	40.
6	1	5.	5.	5.	10.	10.	10.	10.	10.	40.
	2	10.	10.	10.	20.	20.	20.	20.	20.	40.
	3	15.	15.	15.	30.	30.	30.	30.	30.	40.
	4	20.	20.	20.	40.	40.	40.	40.	40.	40.

Index K denotes highway type; Index ID denotes population density category.

*See Table 5-6 for roadway type, population place size and population density groups

- o Distance
- o Ground effects
- o Shielding

For persons close by a roadway, the roadway appears relatively straight. The roadway also appears "infinitely long" to nearby persons. Both these approximations are made for all roadway propagation calculations in the model. Therefore, the only geometric quantity of concern is the perpendicular distance between the person and the roadway.

The model utilizes a random process to determine the perpendicular distances between all roadways and all persons. In essence, the model distributes people randomly over a well-defined land area (lying wholly outside the clear-zones for each roadway), and then the distribution of perpendicular distances is calculated. The details of this distance calculation are presented in the following subsection.

Once the distance between any person and roadway is determined, then the noise propagation can be measured in terms of this distance, the attenuation characteristics of the intervening ground (the clear-zone), and the shielding provided by intervening buildings.

To determine ground attenuation the model assumes a noise divergence of 3 dB per distance doubling from the roadway (line sources), and 6 dB per distance doubling for individual vehicles as they pass by. In addition, the model assumes an excess ground attenuation of 1.5 dB per distance doubling over absorptive clear-zones.

$$\text{Ground attenuation} = f(\overset{\text{only 2}}{\text{roadway type}}, \overset{\text{only 2}}{\text{population groups}}) \qquad \text{(N-13)}$$

Such excess attenuation is assumed for:

- o Interstate roadways plus freeways and expressways for place population groups over 25,000 people
- o Major and minor arterials plus collectors and local roadways, for place populations over 500,000 people

Average shielding due to intervening buildings is assumed to depend only the width of the clear-zone, and the population density as illustrated in equation N-14.

$$\text{Building shielding} = f(\overset{4}{\text{clear-zone width}}, \underset{3}{\text{population density}}) \qquad \text{(N-14)}$$

The building shielding and ground attenuation factors are combined with the 3 dB or 6 dB per distance doubling. The resulting propagation curves are provided in Figures N-2 and N-3. Figure N-2 applies to roadway line sources (where the source is made up of a stream of vehicles), and is used in the General Adverse Response part of the model. Figure N-3 is for individual vehicle point sources, and is used in the Single Event Response part of the model. Attenuation values extracted from these curves are used by the computer to calculate the propagation of the noise into occupied land, starting at the edge of the clear-zone. (See References 7, 31 and 51 for more detailed discussions of the propagation rates used.)

The Single Event part of the model accounts for building attenuation so that indoor noise can be predicted. To estimate indoor noise levels from outside noise sources, the sound attenuation offered by building walls and windows is calculated. Although dwelling walls effectively attenuate sound, windows generally provide poorer sound insulation from exterior noise. When windows are open the difference between indoor and outdoor noise varies from 8 to 25 dB; with windows closed, the attenuation varies from 19 to 34 dB, and with double-glazed windows, noise may be reduced as much as 45 dB. Average differences between values for open window and closed window conditions are 15 dB and 25 dB respectively (Reference 53).

The analysis assumes an attenuation value of 15 dB for the suburban single-family detached and the suburban duplex dwelling areas (assuming window open conditions), and a value of 20 dB for other dwellings to account for the attenuation of outdoor noise by the exterior shell of the house (assuming a mixture of windows open and closed). These attenuation values represent an average between summer and winter, and new construction and old construction.

$$\text{Building noise isolation} = f(\overset{\to 9}{\text{population}},\ \overset{\to 4}{\text{population density}}) \qquad \text{(N-15)}$$

The building noise insulation values used in the computer analysis are presented in Table N-12.

<u>Details of Receivers</u> (Figures 5-12 and 5-13, Key 3)

First, each person in the United States is assigned to one of the 33 pop/density "cells" of Table 5-6. These cells are defined by (1) the total population in the city/town/area where that person lives, and (2) the population density in his neighborhood within his city/town/area. These assignments to pop/density cells reside within the computer program, and appear here in Table N-13. The land areas of each of these pop/density cells also appear in the table. The model distributes the 1974 U.S. population of 216.7 million people over 3.549 million square miles.

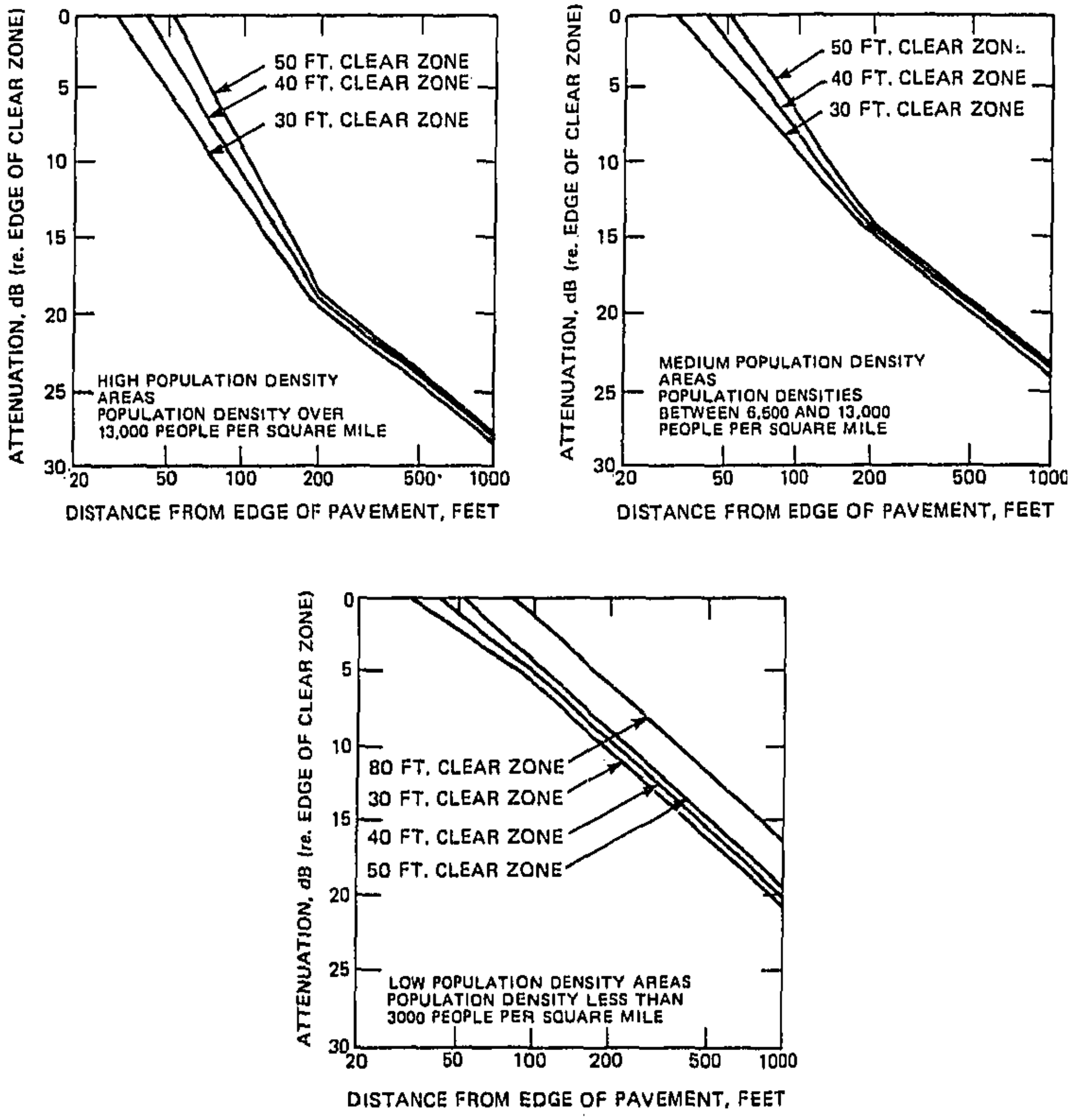


FIGURE N-2 SOUND LEVEL ATTENUATION CURVES: LINE SOURCE

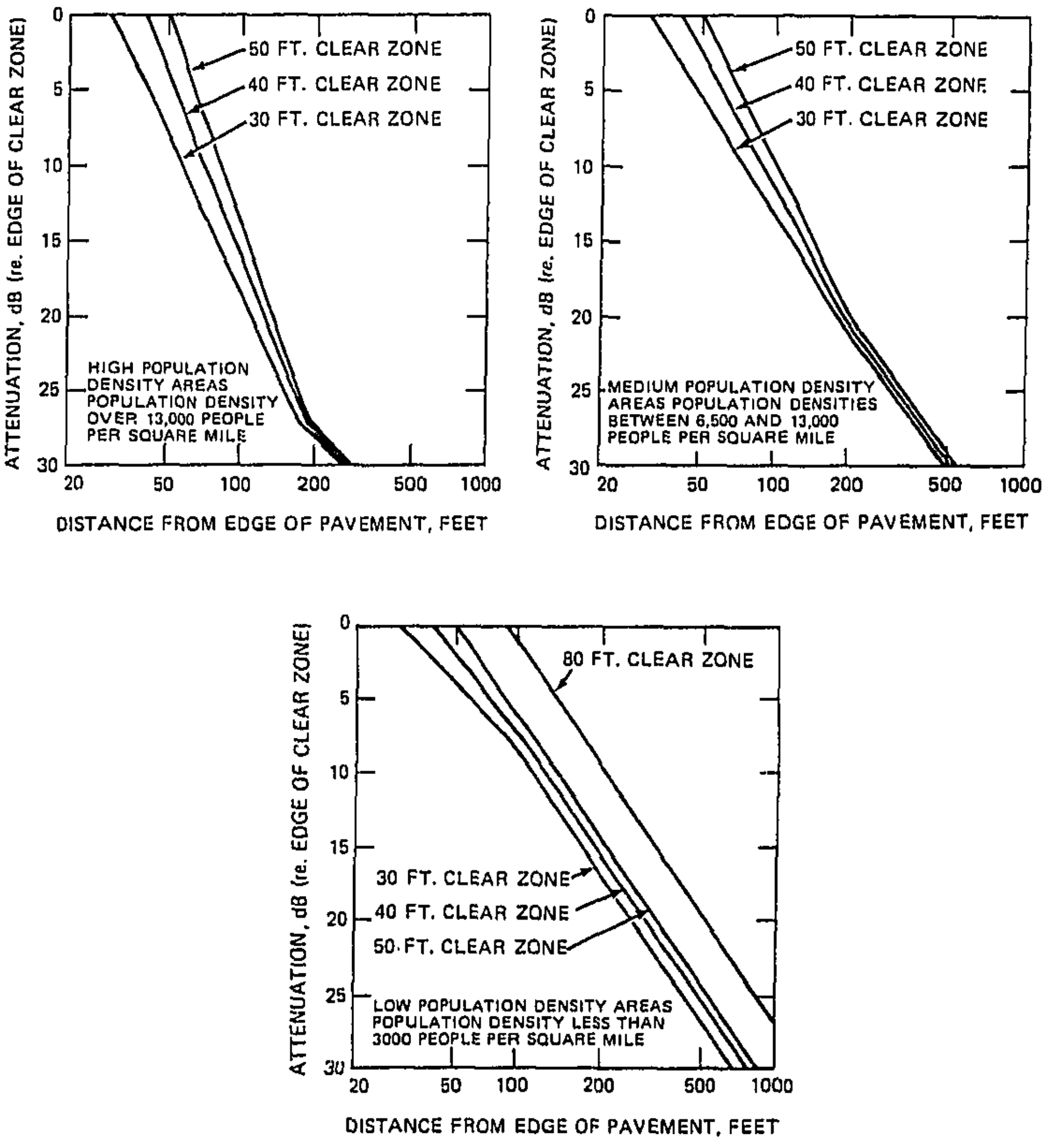


FIGURE N-3 SOUND LEVEL ATTENUATION CURVES: POINT SOURCE

TABLE N-12

Building Exterior Noise Reduction (in decibels)
by Place Size (Index J) and Population Density Area (Index ID)

Population Density Area Index, ID	Population Place Size, Index J								
	1	2	3	4	5	6	7	8	9
	Over 2M	1M 2M	500K 1M	200K 500K	100K 200K	50K 100K	25K 50K	5K 25K	Rural Areas
1 High Density	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
2 Medium to High Density	20.0	20.0	20.0	15.0	15.0	15.0	20.0	20.0	15.0
3 Medium to Low Density	20.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
4 Low Density	20.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0

TABLE N-13

DISTRIBUTION OF POPULATION AND LAND AREA BY PLACE SIZE
(INDEX J) AND POPULATION DENSITY CATEGORY (INDEX ID)

Population Density Area Index ID		1	2	3	4	5	6	7	8		9
	Parameter	>2M	1M -2M	500K -1M	200K -500K	100K -200K	50K -100K	25K -50K	5K -25K	Urban Total	Rural
1	Population	5.61	2.10	0.36	1.61	1.16	1.07	0.47	1.85	14.23	64.18*
	Area	134.2	272	63	215	279	329	58	220	1570.2	3,476,938
	p*	64,711	13,451	9,368	9,368	5,831	13,091	13,091	16,988	-	18.0
2	Population	22.28	4.08	2.04	10.43	2.93	2.12	2.98	4.97	51.83	0.0
	Area	3576	775	488	4558	1305	1115	8.96	1261	13970.0	0.0
	p*	12,638	9,092	6,967	3697.0	3,384	2,863	8,506	10,681	-	
3	Population	21.59	11.13	8.40	6.75	6.84	4.53	3.51	8.46	71.20	0.0
	Area	8358	5080	4426	5790	5266	4195	2230	4527	39072.0	0.0
	p*	6,107	5,014	3,842	2,264	2,011	1,612.0	4,698	6,271	-	
4	Population	0.0	5.35	5.30	0.0	0.0	0.0	1.92	2.70	15.27	0.0
	Area	0.0	4089	4584	0.0	0.0	0.0	2769	5820	17262.0	0.0
	p*	-	2,505	2,336	-	-	-	2,147	1,673	-	
Total Population		49.48	22.66	16.09	18.78	10.93	7.71	8.88	17.98	152.52	64.18
Total Area		12064.2	10216.0	9561.0	10563.0	6850.0	5639.0	5953.0	11828.0	72674.2	3476938

Total population = 216.70 million
Total land area = 3,549,612.2 square miles
p* = Population/(Area) (Area Factor), Adjusted Population Density in People per Square Mile

In Table N-13, population densities have been computed by dividing the population by occupied land area. This occupied land area excludes bodies of water, airports, roadways themselves (including their clear-zones), parking areas, and open spaces. The conversion from total area to occupied area is termed the "area factor" within the model. It is the fraction of total land area that is occupied. By this distribution, the average population density is 2,099 people per square mile for urban environments and 18 people per square mile for rural environments (see Figure A.2.2 of Reference 31).

The data in Table N-13 are based upon 1974 populations. For future years the population densities are assumed to increase as population grows.

$$\begin{array}{l}\text{Population} \\ \quad \text{growth factors} = f(\overset{9}{\text{population}}, \overset{9}{\text{year}})\end{array} \qquad \text{(N-16)}$$

The functional relationship of equation N-16 yields the 81 growth factors, presented in Table N-14. Growth factors were derived from the Bureau of Census' (Series I) assumption of an immigration and fertility rate based upon historical trends.

As discussed above, each person is assigned to one of 33 population/density cells. Each cell also contains a definite mileage value for each of the six roadway types (see Tables N-4 and N-5). The total mileage within each cell is used to compute the noise level to which persons in that cell are exposed.

To compute this noise level, the distance between people and roadways must be estimated. This estimation is done statistically, since the precise distance distributions are not known.

First the cell's occupied land area is divided by the roadway mileage within that cell to determine the area allotted to each roadway mile. This area is then split in half and placed on each side of a one mile length of roadway, beyond the clear-zone. The far edge of this portion of land area is shown as the cutoff distance in Figure N-1.

All persons within the cell are then randomly assigned a particular roadway mile. They are then distributed uniformly on both sides of that one mile of roadway, between the edge of the clear-zone and the cutoff distance. This assignment determines each person's "primary" roadway -- in essence, the roadway closest to that person's place of residence.

Statistically, this random distribution of all persons, over a well-defined area, determines each person's distance to his primary roadway.

Each person is also affected by noise from other roadways within his cell. These are called "secondary" roadways. To compute secondary-roadway noise exposure the distance between the receiver and these roadways is also determined statistically.

Table N-14

Population Growth Factors by Place Size
For Every Five Years in the Time Stream

		AREA TYPE, J									
		1	2	3	4	5	6	7	8	9	ALL J
PLACE SIZE, THOUSANDS		OVER 2000	1000-2000	500-1000	200-500	100-200	50-100	25-50	5-25	RURAL	
YEAR	VARIABLE	POP(YEAR)/POP(BASELINE)									
1975		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
1980		1.08	1.07	1.07	1.02	1.02	1.02	1.02	1.02	1.12	
1985		1.15	1.14	1.14	1.04	1.04	1.04	1.04	1.04	1.22	
1990		1.22	1.22	1.22	1.05	1.05	1.05	1.05	1.05	1.31	
1995		1.29	1.29	1.29	1.07	1.07	1.07	1.07	1.07	1.39	
2000		1.36	1.36	1.36	1.08	1.08	1.09	1.09	1.09	1.48	
2005		1.43	1.44	1.44	1.10	1.10	1.10	1.10	1.10	1.57	
2010		1.50	1.51	1.51	1.12	1.12	1.12	1.12	1.12	1.65	
2013		1.55	1.56	1.56	1.13	1.13	1.13	1.13	1.13	1.70	

The assumption is made that each secondary-roadway distance is greater than the cutoff distance computed for the "primary" roadway. In other words, it is assumed that each person is within the cutoff distance for one and only one roadway, his "primary" roadway. All others are further away. This cutoff distance then provides a minimum distance for the random distribution of person/secondary-roadway combinations.

The maximum distance between persons and roadways obviously depends upon the shape of the land area that comprises that person's cell. If the cell is near-circular in shape, then the maximum distances are not extreme. On the other hand, if the shape is very long and narrow, then the maximum distances could be huge. Thus the approximate shape is assumed to be rectangular, and is bisected by the secondary roadway of interest. The length of the rectangular area is equal to the total length of the secondary roadway in that cell. The rectangle's width is the cell's area divided by the rectangle's length, so that the total cell's area is included in the rectangle.

With this cell shape, then, all persons are distributed randomly within the rectangle, outside the cutoff distance. Statistically, this random distribution of all persons, over a well-defined area, determines each person's distance to each secondary roadway and considers the total mileage for each roadway type within the cell.

The rectangle mathematics are then repeated for all other secondary roadway types, until distances to all of them are determined in this random manner.

Out of this statistical process comes a full list of each person's distances to all roadways in his cell. His distance to his closest roadway is less than the cutoff distance, while his distances to all other roadways is larger than this cutoff distance.

Consequently, what is computed is the joint probability distribution of the set of all distances between each receiver and all roadways within his pop/density cell. For computational efficiency, the computer determines the noise level distribution instead of the distance distribution. And it determines this in 3-decibel increments, rather than in infinitesimal increments.

For the General Adverse Response part of the model, the average outdoor day-night noise level, L_{dn}, is the measure of noise exposure. This is calculated for each person at his place of residence. On the other hand, for the Single Event Response part of the model, several different noise level values are calculated, as presented in Figure 5-13. These measures are:

Single-event equivalent noise level, $L_{eq(T)}$:

- o Indoors, day and night
- o Outdoors, day

Sound exposure level, L_S:

- o Indoors, day and night

The single-event equivalent noise level, $L_{eq(T)}$, is used to measure speech communication interference. The sound exposure level, L_S, is used to measure sleep interference. To relate these noise levels to potential impact for a typical 24 hour day a person's activities over that 24 hours must also be allocated between indoors and outdoors, and separately for day and night as illustrated in equation N-17.

$$\text{Fraction of activity times} = f(\underset{\to 3}{\text{location}}, \underset{\to 2}{\text{time of day}}, \underset{\to 6}{\text{activity}}) \qquad \text{(N-17)}$$

This activity allocation is addressed at Key 3 in Figure 5-13 and it is detailed in Table N-15. Persons are located away from home, or at home outdoors, or at home indoors. Then separately by day and night, each person spends his time at the activities shown to the right of the table.

Separately, then, by these activity groups, the average person's time has been fractioned as in Figure N-4. (See Appendix B of Reference 31 for a more detailed discussion.) These activity fractions are a composite of separate fractions for distinct groups of persons within the U.S.: (1) employed men, (2) employed women, (3) housepersons, and (4) other persons (persons younger than 17, persons older than 65 and not employed, persons in institutions, and unemployed persons).

As Figure N-4 indicates, even during the daytime a small portion of the population is sleeping. This potential daytime sleep interference is accounted for in the impact estimates.

<u>Details of Noise-level Sorting</u> (Figures 5-14 and 5-15, Key 4)

As a result of the noise level predictions, all persons in the United States are paired with their respective noise levels. These person/noise pairs are then sorted by noise level. The sorting is done concurrently with the prediction procedure.

<u>Details of Conversion from Noise Level to Impact</u>(Figures 5-14 and 5-15, Key 5)

Exposure to a particular noise level does not necessarily mean that person is fully impacted by that noise (although he may be partially impacted). Therefore, the number of persons exposed at each noise level is multiplied by certain "impact fractions" or weightings. These fractions are close to zero for low noise levels, and then increase with noise level, until they reach unity.

For particular effects of noise on people, the weightings differ. The fractions result from a large number of attitudinal surveys and laboratory studies of the effects of noise on people.

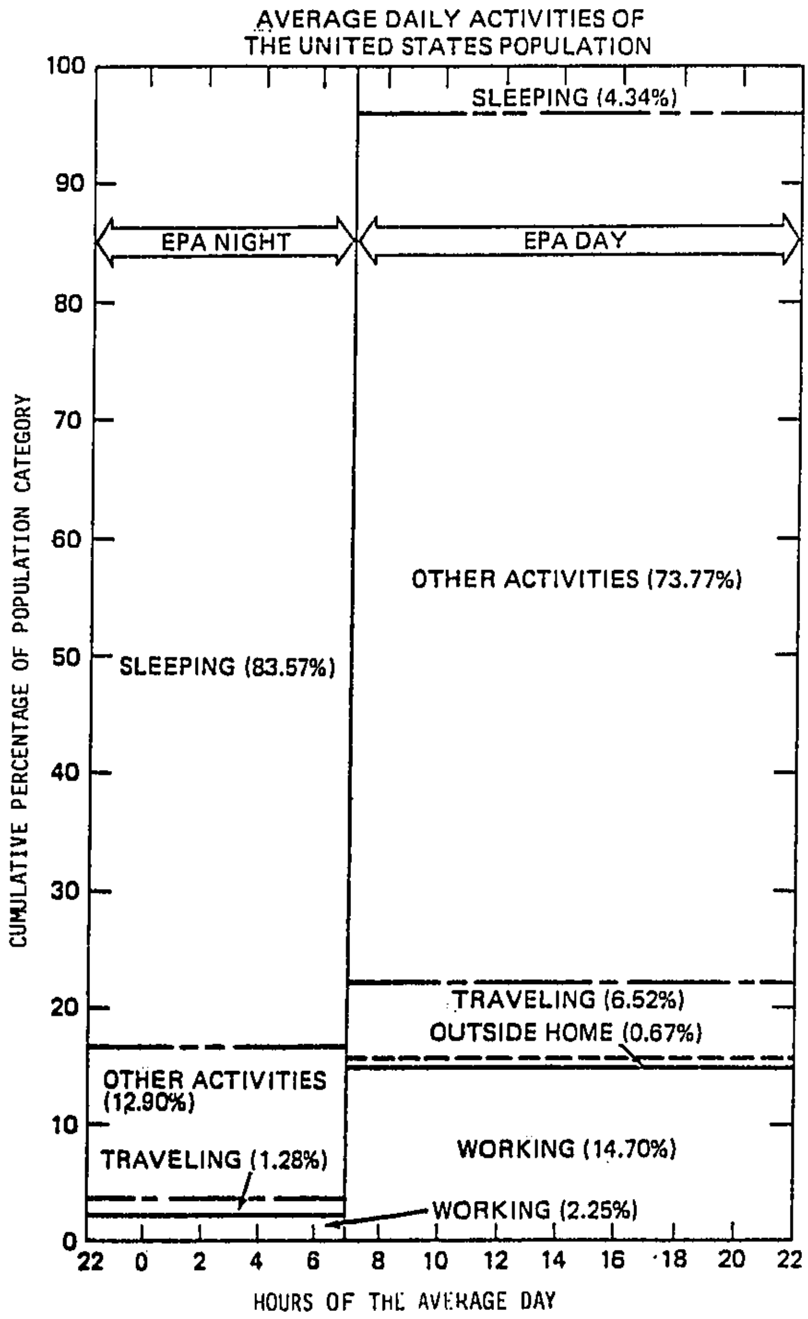


FIGURE N-4. AVERAGE ACTIVITY PATTERN FOR THE U.S. POPULATION

TABLE N-15

ACTIVITY GROUPS FOR THE SINGLE EVENT RESPONSE

PERSON's LOCATION	TIME OF DAY	ACTIVITY GROUP
Away from home	Day and Night	Working
		Traveling
At home, outdoors	Day	Walking
		Outside-home leisure activities
At home, indoors	Day	Sleeping
		Other indoor activities such as TV viewing, enjoying other media, other leisure or semi-leisure activities, home and family type activities, and eating
	Night	Sleeping
		Other indoor activities such as TV viewing, enjoying other media, other leisure or semi-leisure activites, home-and-family-type activities, and eating

NOTE: Day is the period between 7 am and 10 pm.
Night is the remainder of the 24-hours, 10 pm to 7 am.

For the General Adverse Response portion of the model, the fractional weighting is derived from equation 9 in Section 5, which is an approximation to a quadratic equation that is the best fit to a large number of attitudinal survey results. The weighting values along with noise level and population information are used in equation 10 by the model to compute Level Weighted Population within each noise level band.

For the Single Event Response portion of the model, the most current estimates of weighting values are presented in equations 14 and 15 (for sleep interference) and Figures 5-9 and 5-10 (for speech interference). These weightings are also used in equation 10 along with noise level and population information.

For speech interference, the noise descriptor is the single-event equivalent sound level, $L_{eq(T)}$. For sleep interference, it is the sound exposure level, L_S.

Details of Total Nationwide Impact (Figures 5-14 and 5-15, Key 6)

After impact is estimated for each noise level separately, then the total nationwide impact is added over all noise levels. This process is overviewed in Figures 5-14 and 5-15, and is detailed here.

The General Adverse Response depends upon a full year's worth of noise at the person's home. It is assessed from the prediction of yearly-average L_{dn} at the residences of all persons in the U.S.

The Single Event Response depends upon an average day's worth of noise, and the number of intrusive single events that potentially occur during the day or night. It also depends upon the activities of people during the day and night, indoors and outdoors. (See Table N-15).

The estimations within the model do not account for persons when they are away from their homes (first group in Table N-15). Omitted are 20.53 percent of the population during the daytime (7 am through 10 pm) while these people are traveling or working away from home. Similarly omitted are 3.06 percent of the population during the nighttime (See Appendix B of Reference 31).

As shown in Table N-16 the model estimates speech interference while the average person is outdoors, or is indoors but not sleeping. It estimates the two types of sleep interference while the average person is indoors sleeping.

One activity group in Table N-15 is unique -- the group for people outdoors walking. For these "pedestrains", speech interference is not evaluated at their residences, but rather is evaluated at the edge of the clear zone while that person is walking along streets in his neigh borhood. Speech interference is also estimated outdoors during a person's outside leisure activities around his home.

TABLE N-16

LOCATIONS OF ACTIVITES

Sleep Interference	
Disruption	People Indoors at home day/night
Awakening	People Indoors at home day/night
Speech Interference	
Indoors	People indoors at home not sleeping
Outdoors	People outdoors at home
Pedestrians	Walking outdoors at the edge of a clear zone

APPENDIX O

NATIONAL MOTORCYCLE NOISE CONTROL EMPHASIS PLAN

SUMMARY

NATIONAL MOTORCYCLE NOISE CONTROL EMPHASIS PLAN

SUMMARY

Motorcycle noise has been rated as the most significant noise problem in numerous community noise surveys. As a result, a number of States and communities currently have programs to control this noise source. Such controls include limits on vehicle pass-by noise, equipment laws, area and time controls, nuisance laws, and, in a few cases, new product emission limits. The Environmental Protection Agency (EPA), in response to the requirements of the Quiet Communities Act, has identified motorcycles as a major source of noise and has issued noise limits for newly manufactured motorcycles and motorcycle replacement exhaust systems. The Agency's approach in the regulations, which is outlined below, has been to develop programs which will supplement and strengthen these on-going attempts by cities and States to control motorcycle noise.

The primary Federal control which the Agency will provide will be the promulgation of regulations in setting permissible noise levels. These regulations, proposed in the Federal Register, March 15, 1978, will provide uniform levels for new motorcycles sold across the country and will result in quieter motorcycles being developed and produced. The benefits of this action will increase over the next decade as more and more of the motorcycle fleet is made up of regulated vehicles; nevertheless, some initial benefits will be gained in the first years of the regulation, particularly when this action is accompanied by State and local control of pre-regulated vehicles.

Besides controlling all new vehicles to quieter levels, the regulation contains provisions specifically designed to facilitate State and local control of replacement exhaust systems.

Under these provisions, manufacturers will be required to label both the motorcycles and the exhaust systems indicating the types and models of new (Federally regulated) motorcycles for which the exhaust system is designed, and whether the system is designed for pre-regulated or competition vehicles. The manufacturer has to assure that these systems when installed on a regulated motorcycle, will not cause that motorcycle to exceed the Federal standard. Thus, with proper enabling legislation, State or community police could enforce "label match-up" controls against vehicle owners who replace original equipment with noisier exhaust systems. This will not require noise measurements and, indeed, will not require the vehicle to be in operation or the driver to be present in order for citations to be made. This should greatly facilitate motorcycle noise enforcement.

Another feature of the regulations will also supplement the on-going State and local noise control program. Under the regulation manufacturers of new motorcycles will be required to identify to EPA those actions which will cause the motorcycle noise levels to increase beyond the legal limits. The Agency will encourage States and localities to adopt programs enforcing against the most obvious acts of tampering which do not necessarily require testing to establish a violation, because such regulations are relatively easy to enforce.

Besides tailoring its Federal noise emission regulations to facilitate State and local control, the EPA will further focus its State and local assistance programs to the area of motorcycle control. The Agency has already provided financial assistance to 24 States and 23 localities to start up and operate noise control programs.

The priority source which these States and cities are addressing currently is motor vehicle noise, including motorcycles. Support is also provided in motor vehicle control from the EPA Regional Offices, the Regional Technical Centers, and the ECHO (Each Community Helps Others) peer match. Such assistance includes funds for personnel and equipment, equipment loan, assistance in drafting legislation and advice on test methodology and enforcement. In the next two years these EPA support programs are intended to increasingly be oriented towards more specific motorcycle controls.

EPA's approach in developing tools which States and localities can adopt has three phases.

The first phase, which is currently in operation, is the development and publication of model legislation for vehicle operation controls (street pass-by-limits) and visual inspection of exhaust systems. This is being carried out in a joint project with the National Association of Noise Control Officers (NANCO). As indicated earlier, a number of cities have already adopted these types of control. Assistance to communities and States in drafting this type of legislation and in carrying out enforcement is also provided through the ECHO program, Regional Technical Centers and the EPA Regional Offices.

In the second phase, which will precede the effective date of the national emission regulation, the EPA will develop model legislation to implement the "label match up" scheme and anti-tampering controls against new (regulated) vehicles.

For this model motorcycle noise control legislation, the Agency will also develop a training manual to be used by police trainers to instruct officers in enforcing the ordinances. This manual will include discussion of instrumentation, enforcement procedures and the rationale behind the model provisions.

In addition, model legislation applicable to pre-regulated motorcycles will be revised to more specifically set out provisions controlling motorcycle modifications, tampering and operations. In all these model laws the Agency will avoid extensive noise measurement requirements and will include among its recommendations ordinances which can be enforced without noise measuring equipment and with only limited additional training for existing police personnel. The model label "match-up" legislation will also be drafted to include provisions for possible future Federal labeling requirements for automobiles and replacement exhaust systems for these vehicles. The label match-up and tampering list provisions (described earlier) provide a logical extension of the existing State and local control structure. As the percentage of Federally regulated vehicles in the fleet increases, the importance of these provisions will grow. Another feature of this phase will be the development by EPA of posters and brochures informing motorcycle owners, dealers and repair shops of their responsibilities under the Federal law. These will be designed in such a way that State and local officials can add references to applicable State and local laws, and will be made available to State and local officials who wish to distribute them to local motorcycle dealers, repair and parts shops. The effectiveness of the motorcycle noise control program depends, in part, on fully informing potential violators of the Federal, State and local laws.

Although the EPA's approach includes an emphasis on use by States and cities of the label match-up and other controls which will not require noise measurement tests, some States and communities may desire a stationary test which correlates well with the Federal pass-by test to facilitate State and local enforcement against tampering, and in identifying motorcycle exhaust systems which degrade rapidly in their noise attenuation capabilities. Accordingly, EPA will coordinate with interested parties the development of a "short test." If this proves feasible, the Agency will use it to develop and publish model implementation procedures and operational equipment ordinances based on this "short test." Such an effort would also include development of a compatible in-use streetside traffic measurement test. It should be noted, however, that communities will still be able to use existing operational ordinances controlling the use of motorcycles. Operational limits are analagous to street limits which only cover the operator performance and do not specify equipment limits.

In the development of all model legislation (and particularly the label "match-up" and anti-tampering provisions) the EPA will seek extensive review by State and local noise control personnel, police and legal officials and the industry. If there are difficult points, it may be necessary to field test some of the model laws prior to publication for voluntary adoption by interested States and cities.

The primary orientation of most State and local motorcycle noise control programs is to prevent excessive noise produced by individual motorcyclists. The programs here outlined assume that this orientation will continue in most States and cities while the Federal Government will have responsibility for enforcing the noise emission standards for new motorcycles and replacement exhaust systems, and the labeling provisions which require compliance by manufacturers. In one or two States, however, where there are currently noise programs with sufficient equipment and technical expertise, and where the replacement exhaust manufacturing industry is concentrated, the State may want to enforce compliance by the manufacturers. Such enforcement would require adoption of the Federal limits and test procedure. The EPA would strongly encourage this and will be prepared to assist any State which wishes to initiate such a program.

EPA's approach to control off-road vehicles at the state and local level is more oriented toward controlling the time and place of the use of these vehicles, rather than controlling individual vehicle emission limits. This is achieved by land use controls and curfews. The street motorcycle enforcement approach outlined above should facilitate control of illegal use of these vehicles on streets. EPA will also make available information on various programs to control use and influence driver habits (such as off-road and minibike "round-up where younger drivers are instructed in safe and legal use of these vehicles). The Agency may also develop legislation covering land use and area controls. This part of the EPA program will probably not begin until after the first standards go into effect.

The final feature of the EPA program will be on-going surveillance of the rate of motorcycle exhaust system (noise related) modifications and tampering. The Agency expects to initiate this program after the effective date of the first standards to provide a means of determining the effectiveness of the State, local, and Federal controls.

EPA's over-all technical assistance objective is to promote at least 400 local programs covering a minimum urbanized population of 72 million and 40 State programs by 1985. The agency's regulatory programs are designed to fit into this State and local control structure. This is consistent with Congressional intent, in the Quiet Communities Act, that noise control ought to be primarily the responsibility of State and local governments. The Federal motorcycle noise emission levels and the programs described above will help achieve the goal of a quieter nation through strengthened and expanded local control of this environmental problem.

*U.S. GOVERNMENT PRINTING OFFICE:1981 341-082/213 1-3

TECHNICAL REPORT DATA
(Please read instructions on the reverse before completing)

1. REPORT NO. EPA 550/9-80-218	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Regulatory Analysis Appendices for the Noise Emission Regulations for Motorcycles and Motorcycle Exhaust Systems		5. REPORT DATE December 1980
		6. PERFORMING ORGANIZATION CODE EPA/200/02
7. AUTHOR(S)		8. PERFORMING ORGANIZATION REPORT NO. EPA 550/9-80-218
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Environmental Protection Agency Office of Noise Abatement and Control (ANR-490) Washington, DC 20460		10. PROGRAM ELEMENT NO.
		11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Environmental Protection Agency Office of Noise Abatement and Control (ANR-490) Washington, DC 20460		13. TYPE OF REPORT AND PERIOD COVERED Final
		14. SPONSORING AGENCY CODE EPA/200/02
15. SUPPLEMENTARY NOTES		

16. ABSTRACT

This document includes detail information that supplements section 1 through 8 of the regulatory analysis. In addition it includes an analysis of State, local, and foreign motorcycle noise regulations and a summary of the motorcycle national emphasis plan.

17. KEY WORDS AND DOCUMENT ANALYSIS		
a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Street Motorcycles, mopeds, off-road motorcycles, motorcycle exhaust system, noise emission regulation, environmental benefits, health and welfare benefits, economic effects.		
18. DISTRIBUTION STATEMENT Release unlimited	19. SECURITY CLASS (This Report) Unclassified	21. NO. OF PAGES 410
	20. SECURITY CLASS (This page) Unclassified	22. PRICE

EPA Form 2220-1 (9-73)

United States
Environmental Protection
Agency

Washington DC 20460

Official Business
Penalty for Private Use
$300