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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

NOISE EMISSION STANDARDS FOR TRANSPORTATION VEHICLES

PROPOSED MOTORCYCLE NOISE EMISSION REGULATIONS

BACKGROUND DOCUMENT APPENDIX

November 1977

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF NOISE ABATEMENT AND CONTROL
WASHINGTON, D.C. 20460

APPENDIX

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APPENDIX A

MOTORCYCLE NOISE EMISSION TEST PROCEDURES

Sound Levels for Motorcycles — SAE J331a

SAE RECOMMENDED PRACTICE

APPROVED MAY 1975

LAND
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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 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 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 ± 10%.

2.1.5 An anemometer with steady-state accuracy of at least ± 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 not affect the microphone response more than ± 1 dB for frequencies of 20-4000 Hz or ± 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 microphone 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 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 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.

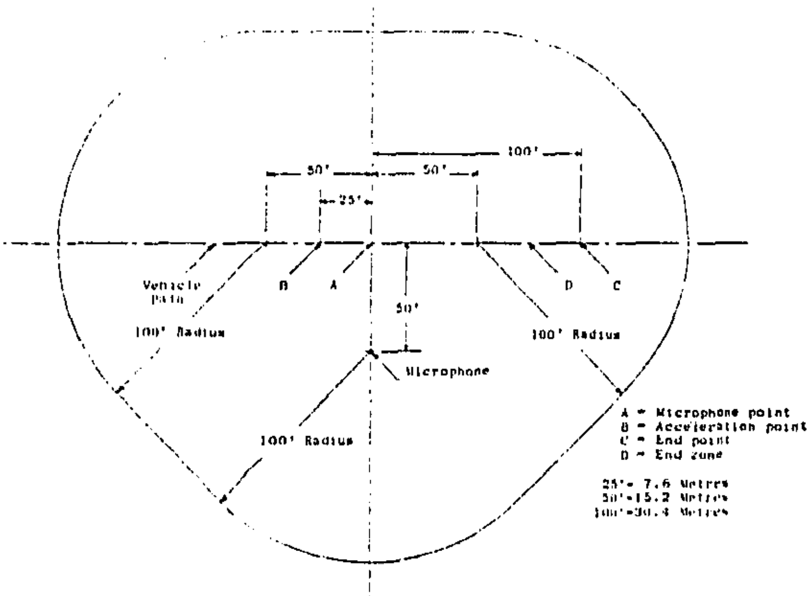


FIG. 1

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 horsepower 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.

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. 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.

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

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

8.5 SAE J184, Qualifying a Sound Data Aquisition System.

8.6 SAE J47, Maximum Sound Level Potential for Motorcycles.

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.

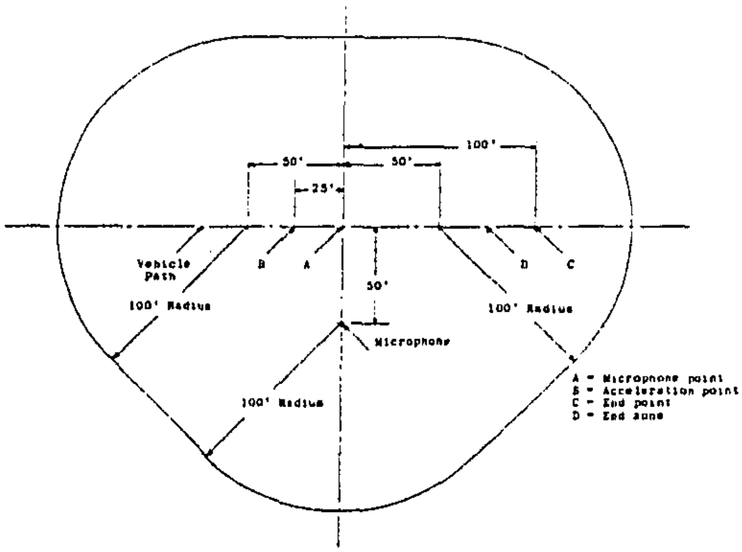


Fig. 3-2. Test Area Layout
for Light Trucks, Buses, and Passenger Cars

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.

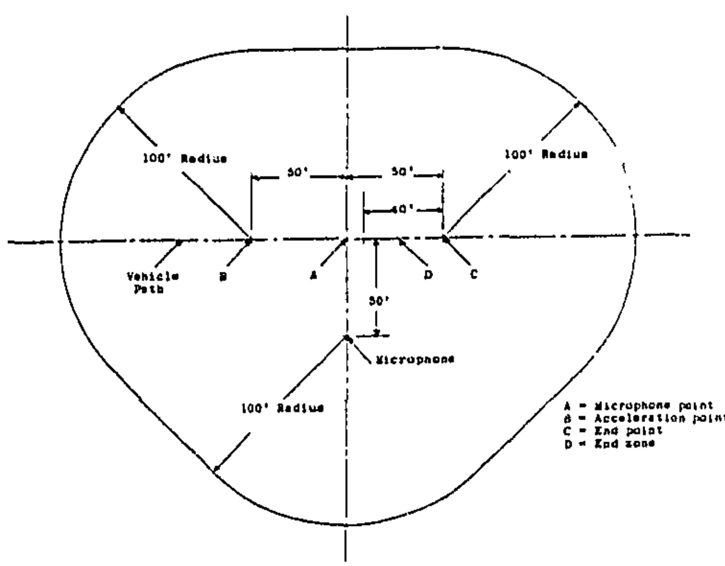


Fig. 3-3. Test Area Layout for Heavy Trucks and Buses

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.

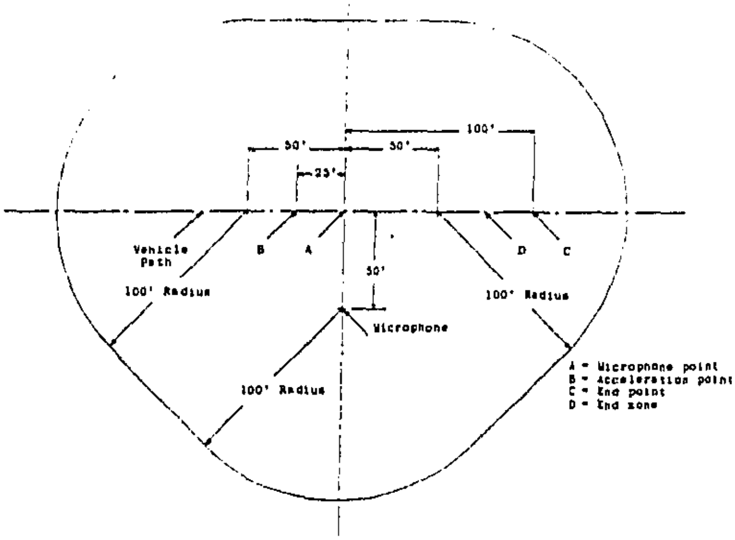


Fig. 3-4. Test Area Layout for Motorcycles

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.

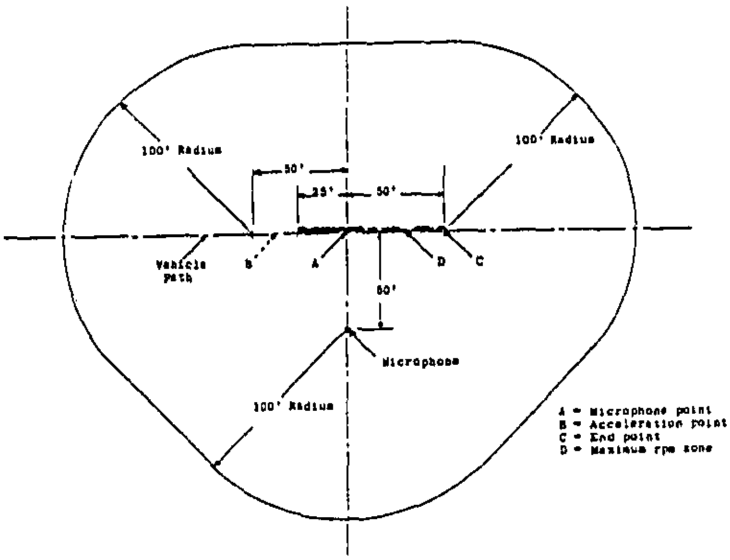


Fig. 3-5. Test Area Layout for Snowmobiles

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

YEAR	VEHICLE MAKE	VEHICLE TYPE	I.D. NO.	DATE / 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

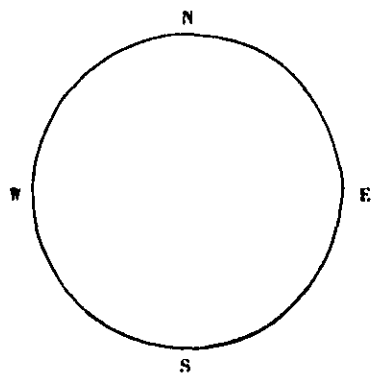
OPERATING CONDITIONS	TIME	dB(A) READINGS[1]		MAXIMUM	
		LEFT SIDE OF VEH.	RIGHT SIDE OF VEH.	R.P.M.	M.P.H.

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

SOUND LEVEL FOR PASSENGER CARS AND LIGHT TRUCKS – SAE J986a

SAE Standard

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 Electrotechnical Commission (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 techometer.

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 dbA 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 an 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 affects 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 measurements 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 technically trained personnel select the equipment and that the tests be conducted only by 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 multi-instrument 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 violated.

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).

Applications 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

LAND
SEA
AIR
SPACE

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

MAXIMUM SOUND LEVEL
POTENTIAL FOR MOTORCYCLES -
SAE J47

SAE Recommended Practice

Report of Vechile 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 ±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 ±1 dB for frequencies of 20-4000 Hz or $\pm1\text{-}1/2$ 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) (100ft) 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 th test site shall meet the following requirements and be laid out as described:

3.2.1 The surface of the ground withi 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 dr concrete or asphalt, free from snow, soi or other extraneous material.

3.2.2 The vehicle path shall be of relatively smooth, dry concrete or asphalt, free of extraneous materials suc 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 th 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 t right with one microphone location for purposes of clarity. Sound level measurements are to be made on both sides of th 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 directio

4. PROCEDURE

4.1 To establish the acceleration point, the end point shall be approache 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)(24ft) 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.

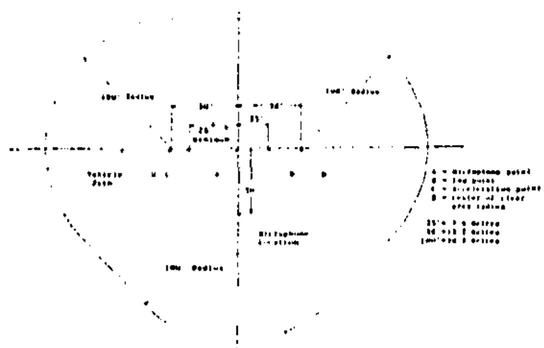


FIG. 1

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 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 Aquisition 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 ± 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 focussing 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.

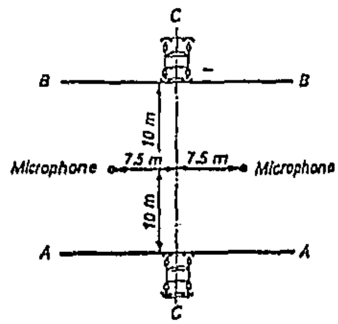


Fig. 1. — Measuring positions for measurement with vehicles in motion

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.

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* "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 readino 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. REFERENCES

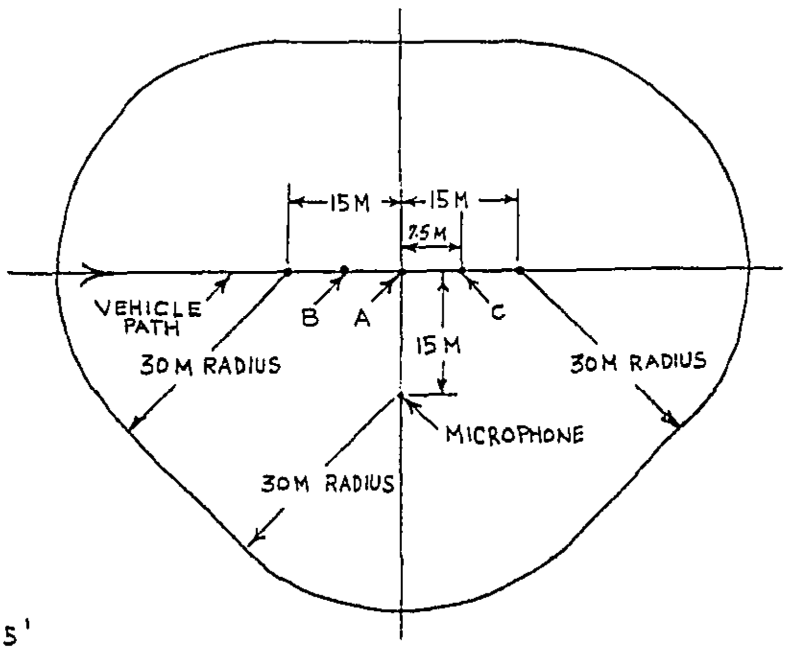
7.1 ANSI S1.1 - 1960, Acoustical Terminology.

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-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).

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* "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

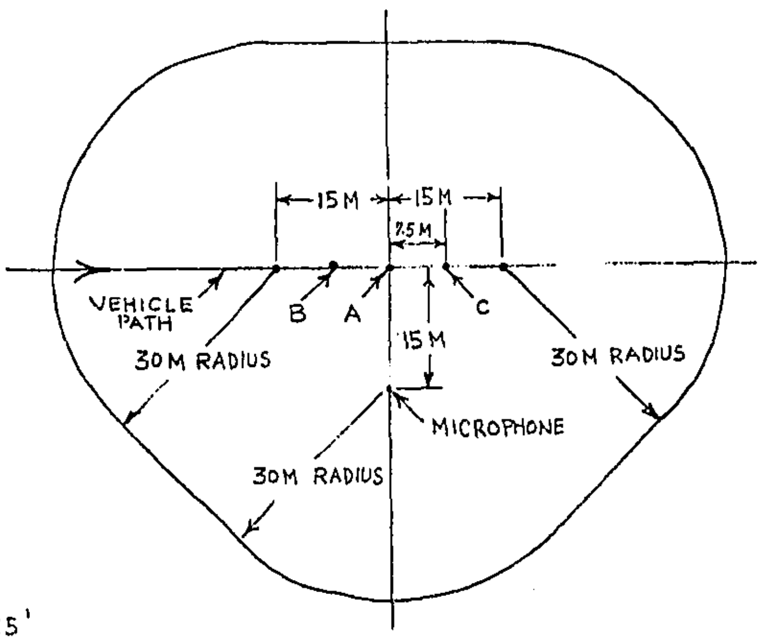
7.1 ANSI S1.1 - 1960, Acoustical Terminology

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

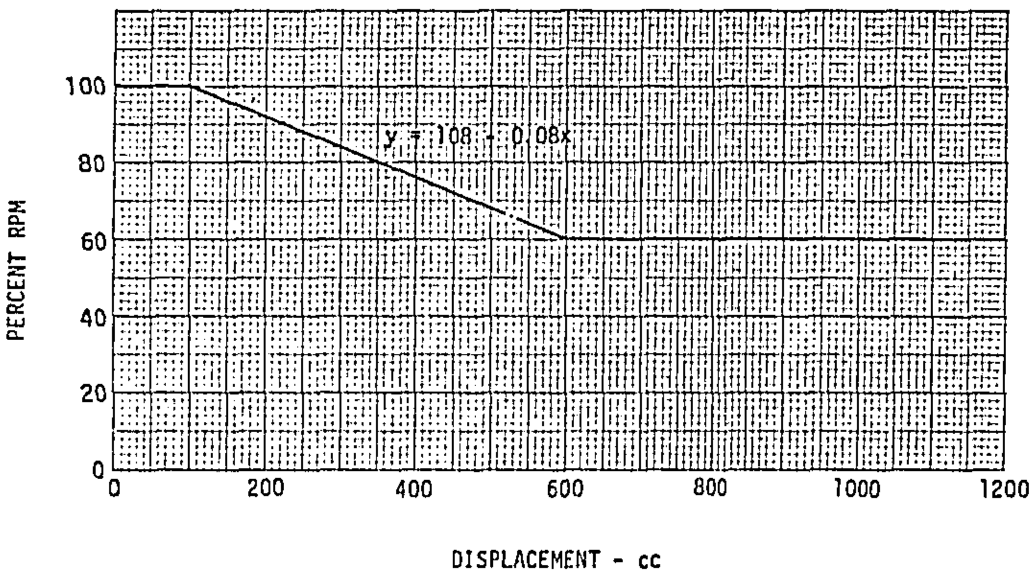


FIGURE 2. CLOSING RPM FOR F76a MOVING VEHICLE ACCELERATION TEST

R_{60} SOUND LEVEL TEST METHOD FOR MOTORCYCLES

FIRST DRAFT

R_{60} 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 micropnone 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.

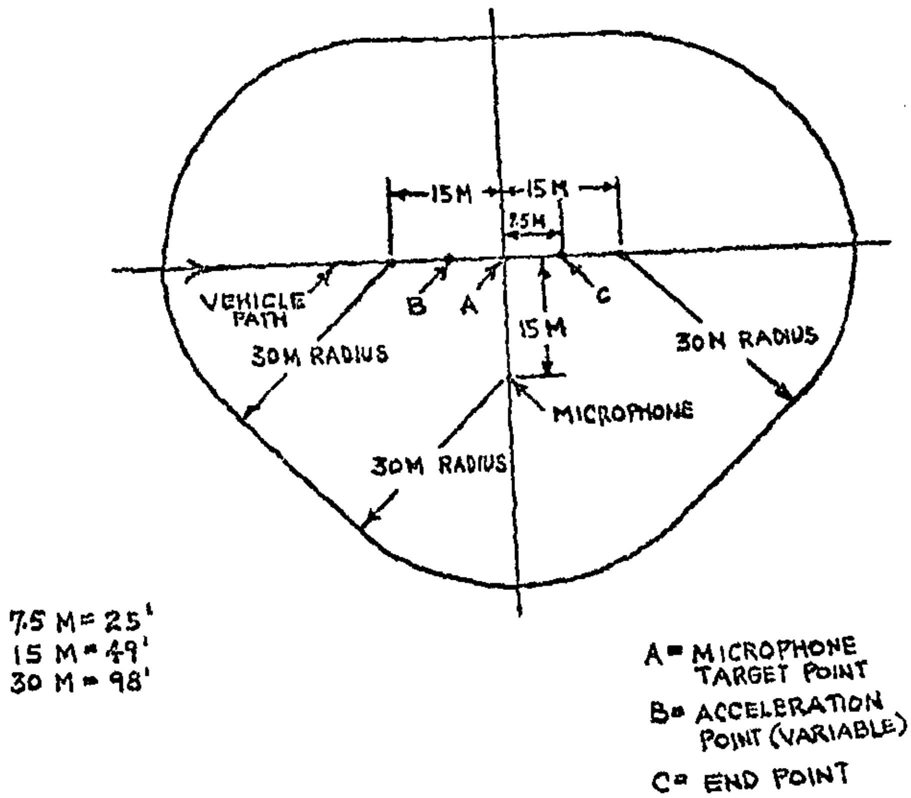


Figure 1

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 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 ± 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. <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.

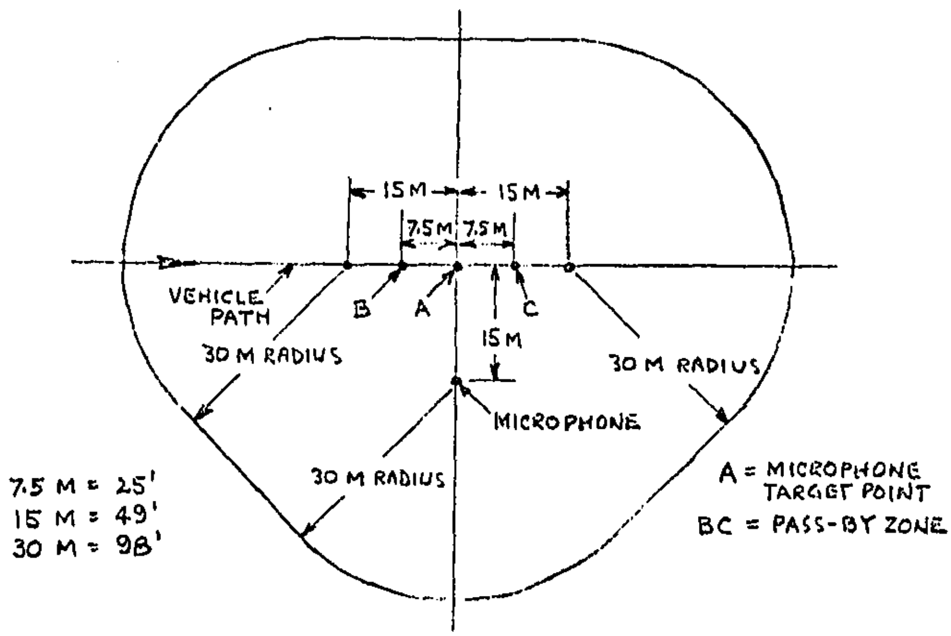


FIG. 1 – TEST MEASUREMENT AREA, PROCEDURE NO. F-77

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)

Revised 1-30-76
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 ± 1 dB(A) for frequencies of 63-4000 Hz and ± 1½ 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 ± 5% shall be used. The tachometer may be a pointer type or a vibrating reed type as long as the accuracy specification is met.

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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) (± .01m($\frac{1}{2}$ in) from, and at the same height as, the rearmost exhaust outlet and at a 45-degree angle (± 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:

$N = 306{,}000 \div$ stroke, mm or $N = 12{,}000 \div$ stroke, inches

5. Measurements.

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. General Comments.

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.

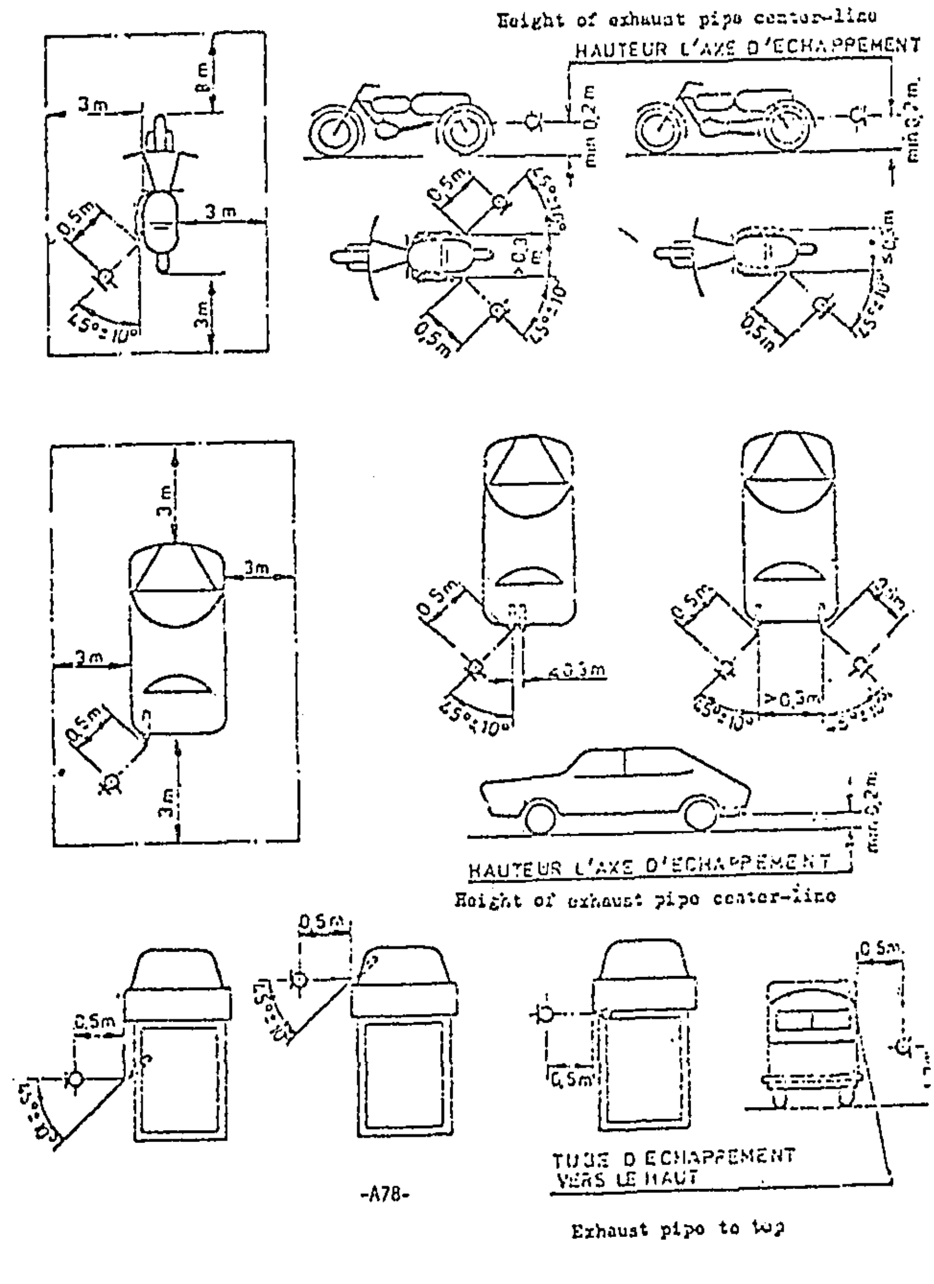
If checks are carried out on vehicles of the same type in use and if the corresponding measurement results exceed the values obtained during type approval by a quantity stated by regulations, the vehicles will be considered to be too noisy.

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.

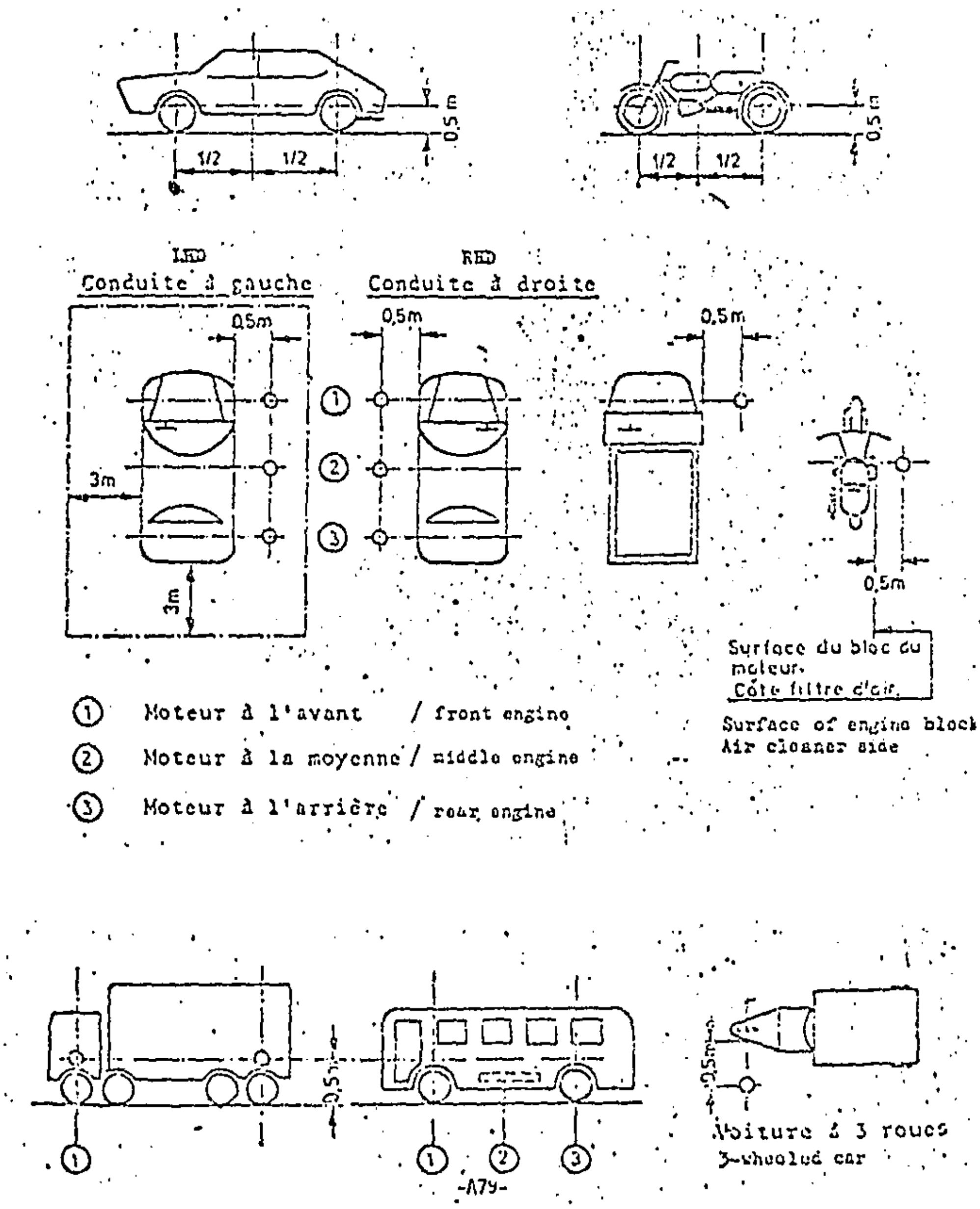
The values obtained by this method are not representative of the total noise emitted by the vehicles in motion, as measured in other ISO standards. They should not be used to make comparisons between the levels emitted by different vehicles.

6.3 CONTROLE DE BRUIT D'ECHAPPEMENT

Exhaust noise control



6.4 Contrôle du bruit de moteur
Engine noise control



APPENDIX B

TEST SITES AND INSTRUMENTATION

APPENDIX B

TEST SITES AND INSTRUMENTATION

The various test sites used to acquire data during the course of this study 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 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 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 noted deviations the site conforms to the 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 feet wide, 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 deviations in site configuration from the J331a requirements.

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

The 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 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 asphalt. Because of these deviations the track is not in conformance with the requirements of 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 J331a.

Site H. Albany, Georgia

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

Site K. Fort Belvoir, Virginia

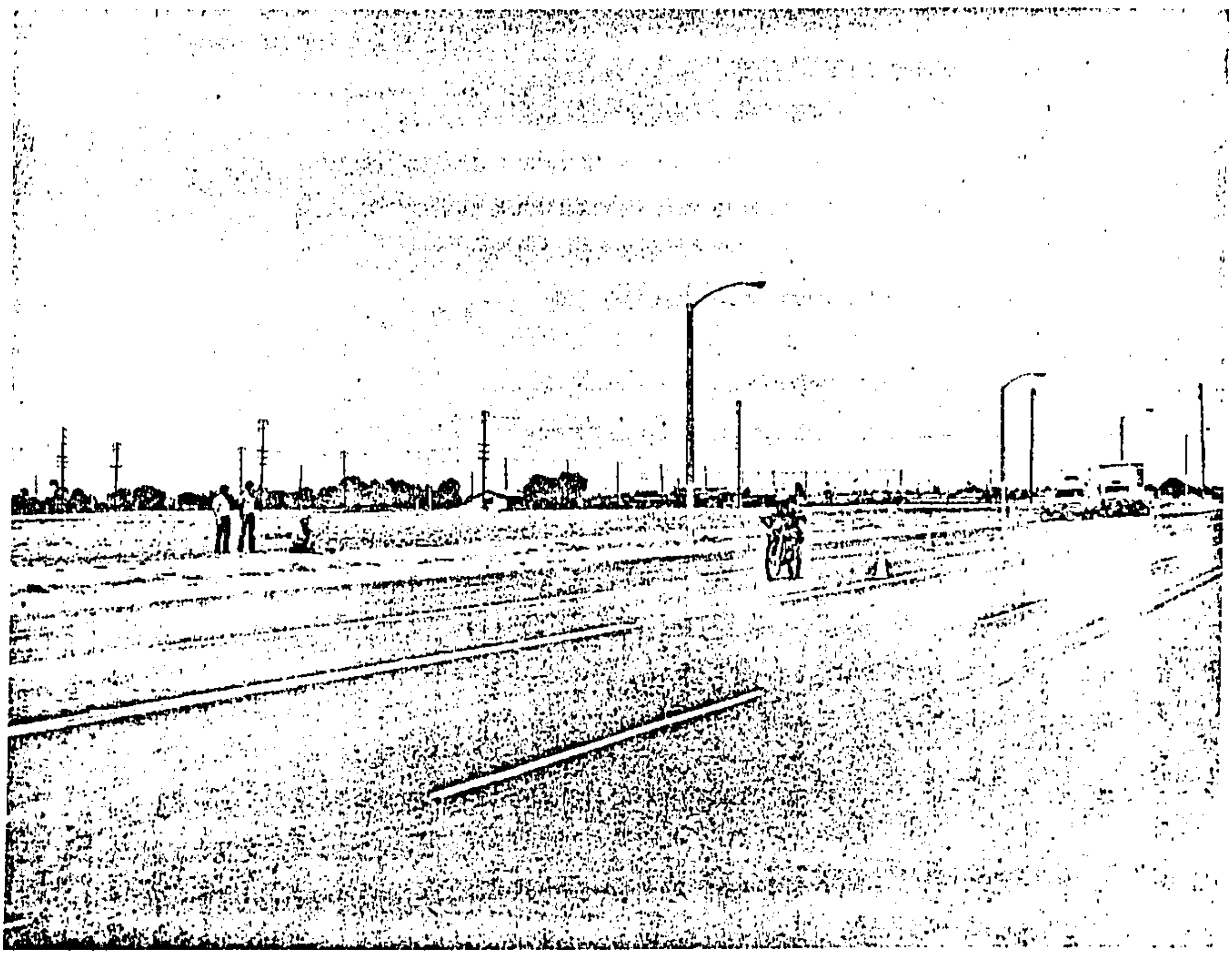
This test site was located at the Army Vehicle Proving Ground at Fort Belvoir, Virginia. The site deviated from J331a specifications in the following manner: a) Approximately 40 feet of hard packed earth was between the microphone and the concrete track, and b) A ditch, earth beam and small pine trees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

Instrumentation

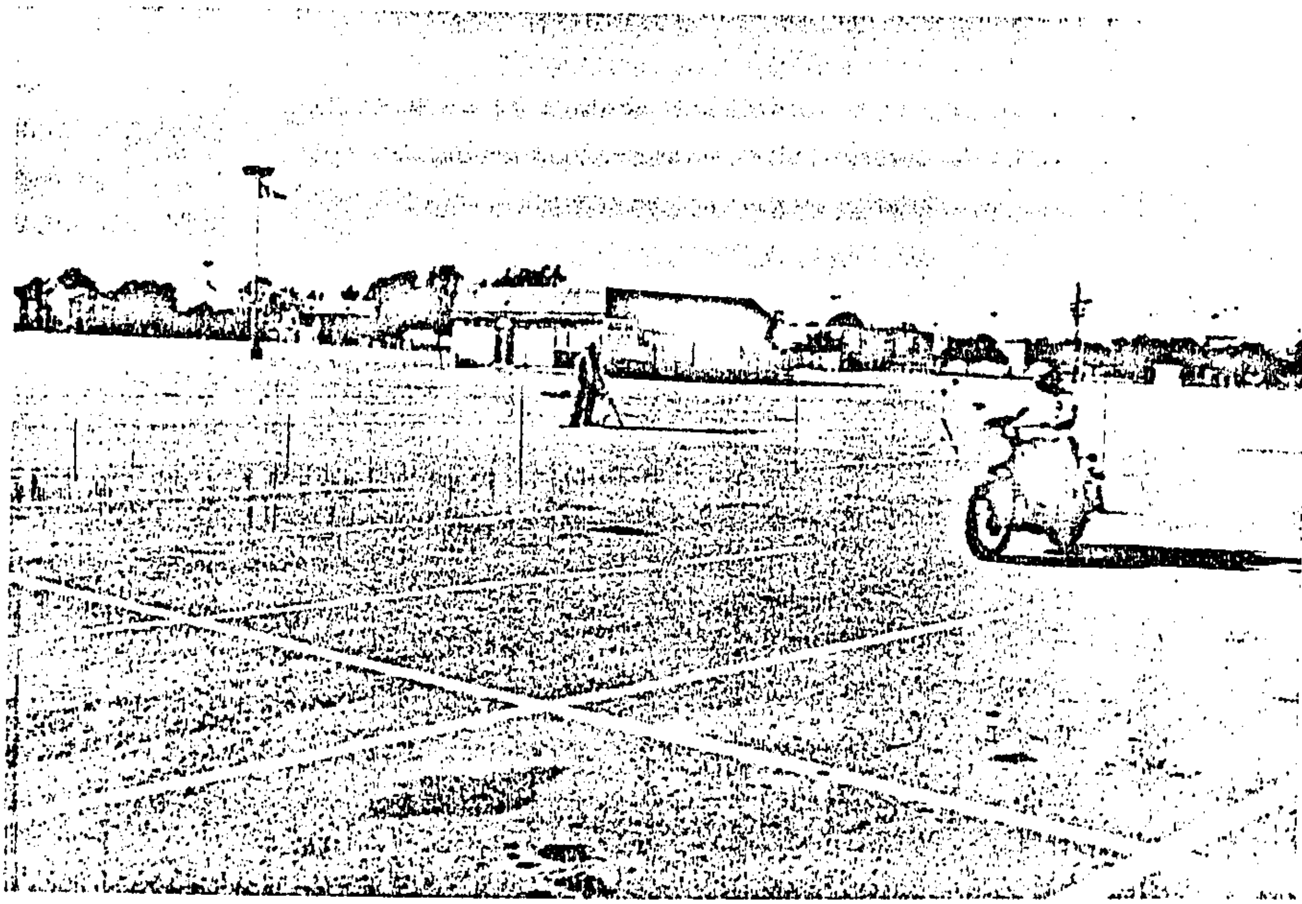
Two Bruel & Kjaer (B&K) model 2204 sound level meters, fitted with B&K model 4145 microphones, were used to obtain the reported sound level measurements. B&K UA0207 windscreens were used in all cases. A-weighted sound pressure levels (fast response) were read directly from the meters as the vehicle made successive 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.

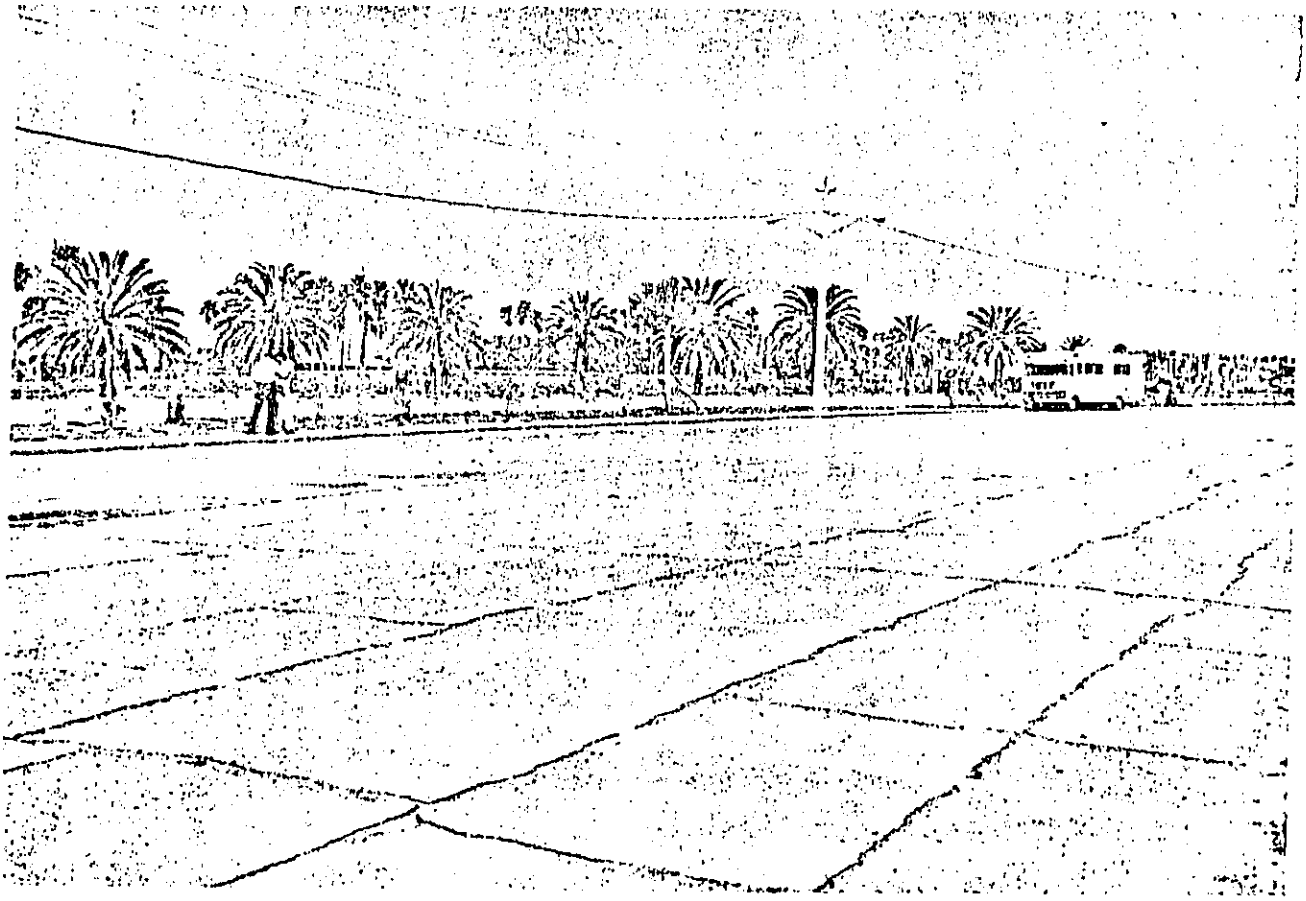
Wet and dry bulb temperatures were measured using a Bendix Psychrometer model 566-2. Barometric pressure was read from a B&K model UZ0001 Barometer, and wind velocity from a Dwyer wind gauge.



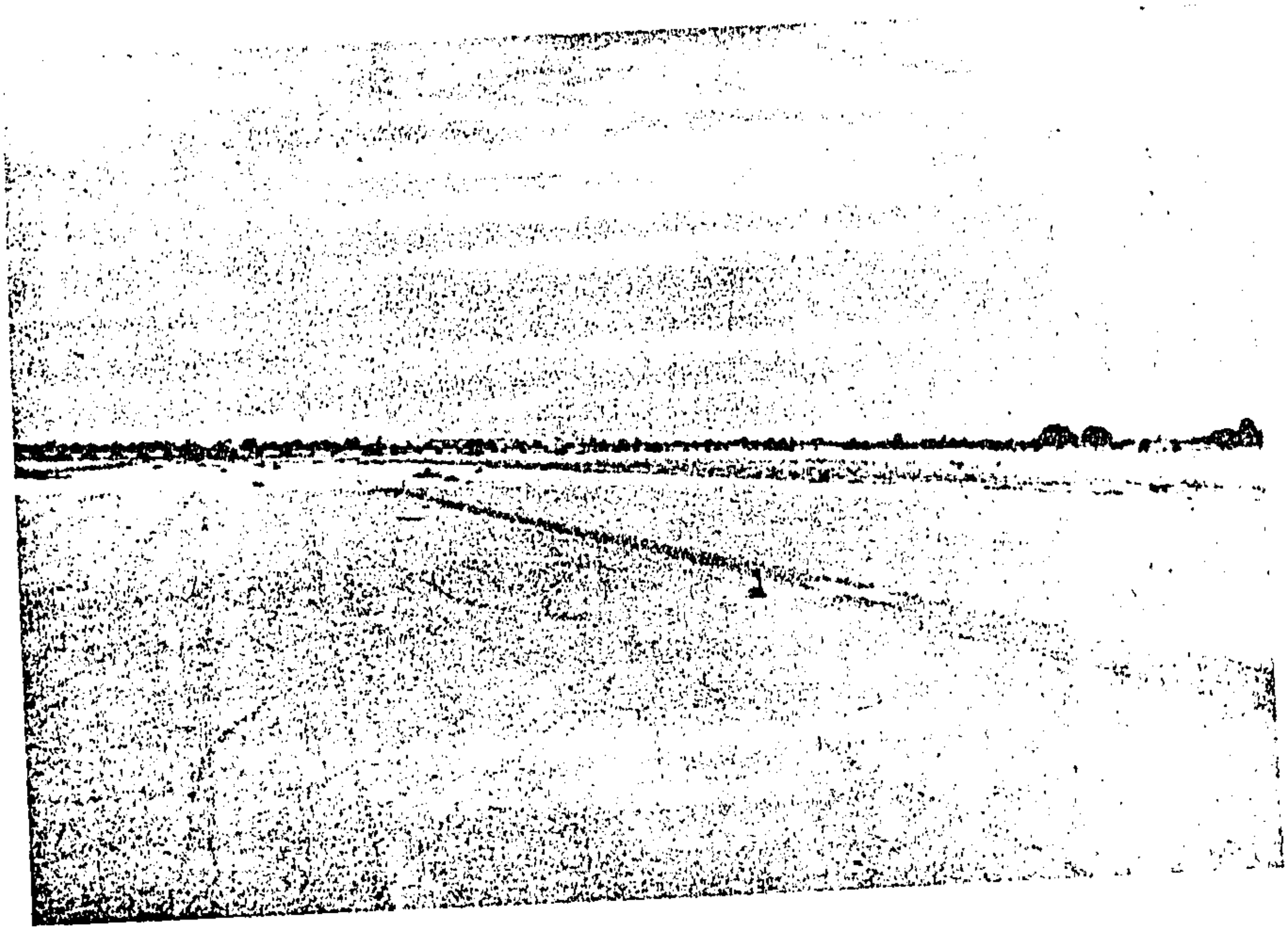
TEST SITE A, ARGOSY AVENUE, HUNTINGTON BEACH, CALIFORNIA



TEST SITE B, ORANGE COUNTY FAIR GROUNDS, CALIFORNIA

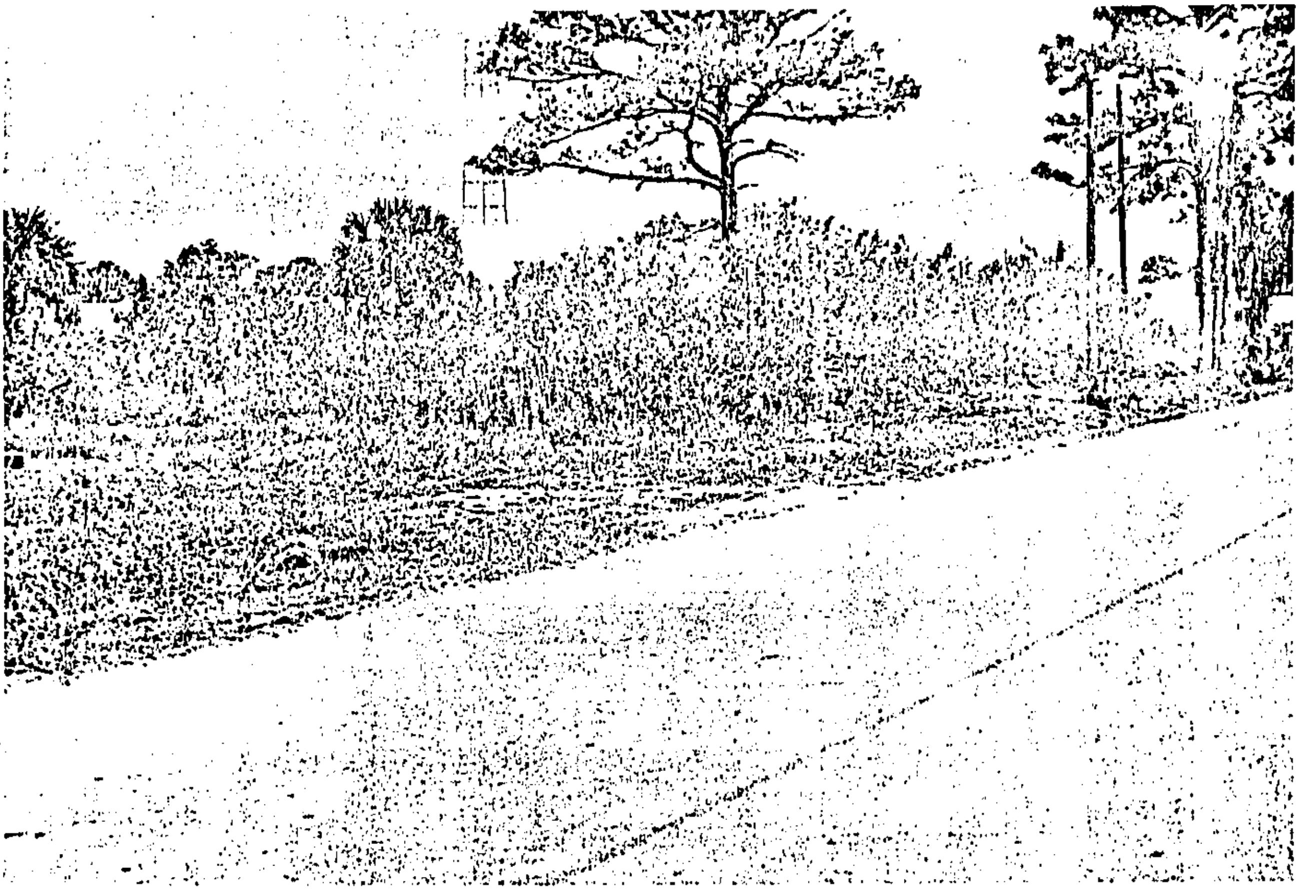


TEST SITE C, DAYTONA BEACH, FLORIDA

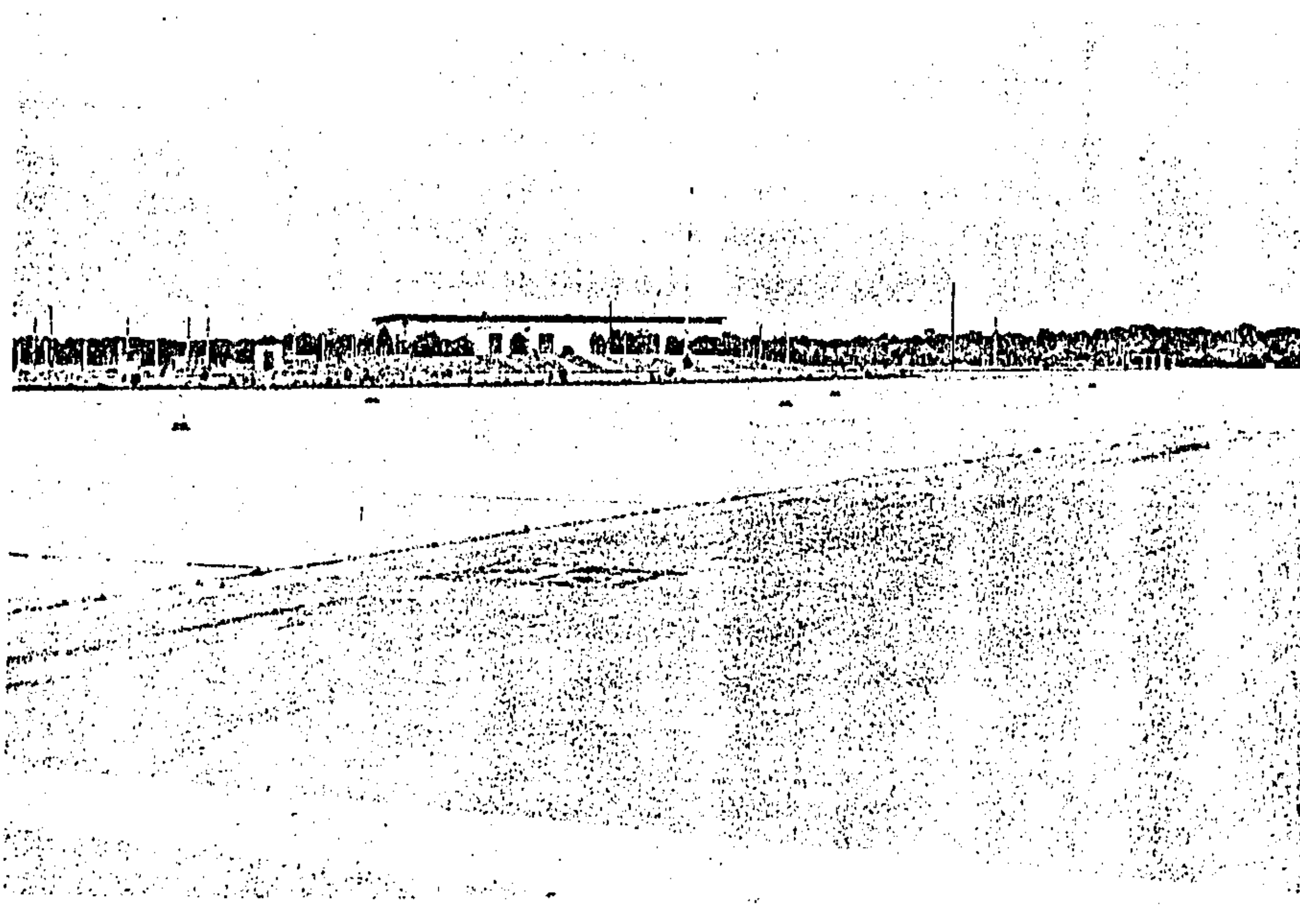


TEST SITE D, LOS ALAMITOS NAVAL AIR STATION, CALIFORNIA

TEST SITE F, HOUSTON, TEXAS

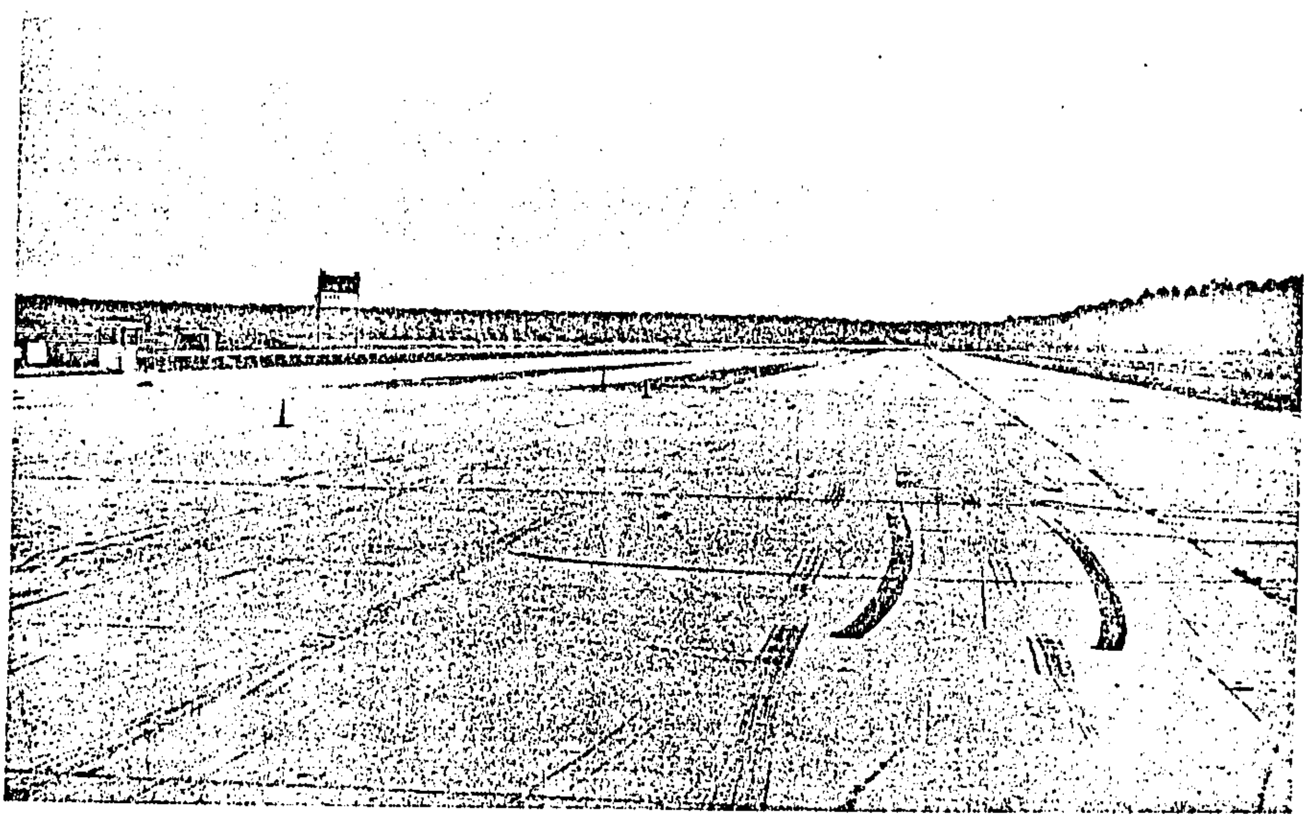


TEST SITE G, ST. PETERSBURG, FLORIDA

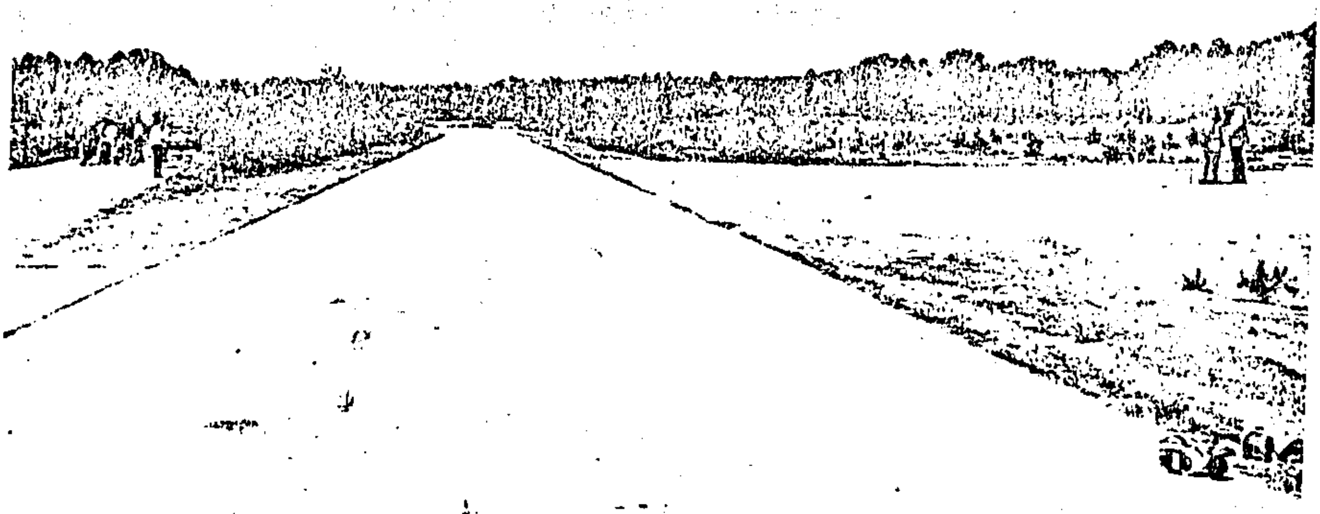


TEST SITE H, ALBANY, GEORGIA

TEST SITE I, CHAPEL HILLS, NORTH CAROLINA



TEST SITE J, SUFFOLK, VIRGINIA



TEST SITE K, WASHINGTON, D.C.

APPENDIX C

PRODUCT IDENTIFICATION AND SOUND LEVELS

TABLE C-1 LISTING OF NEW MOTORCYCLES TESTED -- YEAR OF MFG. '75 AND '76

BIKE NO.	MO./YR. OF MFG.	MAKE	MODEL	DISPL.	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

Cont'd.

TABLE C-1 (CONT'D.)

BIKE NO.	MO./YR. OF MFG.	MAKE	MODEL	DISPL.	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	MVT	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

Cont'd.

TABLE C-1 (CONT'D)

BIKE NO.	MO./YR. OF MFG.	MAKE	MODEL	DISPL.	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

Cont'd.

TABLE C-1 (CONT'D)

BIKE NO	MO./YR. OF MFG.	MAKE	MODEL	DISPL.	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	246	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

TABLE C-1 (CONT'D.)

BIKE NO.	MO./YR. OF MFG.	MAKE	MODEL	DISPL.	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

TABLE C-2 LISTING OF '74 YR. OF MFG. MOTORCYCLES TESTED (STOCK CONFIGURATION)

BIKE NO.	MO./YR. OF MFG.	MAKE	MODEL	DISPL.	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

TABLE C-2 (CONT'D)

BIKE NO.	MO./YR. OF MFG.	MAKE	MODEL	DISPL.	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

TABLE C-3 MOTORCYCLE 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
AB	MOTO-BECANE
AC	YAMAHA
AD	TRIUMPH

TABLE C-4 SOUND LEVELS, NEW MOTORCYCLES, YEAR OF MFG. '75 AND '76

USE* CATEGORY	DISPL. CC	ENG. TYPE	SOUND LEVEL - dBA						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	398	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	SOUND LEVEL - dBA 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			B	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

(Cont'd)

TABLE C-4 (CONT'D.)

USE CATEGORY	DISPL. CC	ENG. TYPE	SOUND LEVEL - dBA 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

Cont'd.

TABLE C-4 (CONT'D.)

USE CATEGORY	DISPL. CC	ENG. TYPE	SOUND LEVEL - dBA 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	O	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

Table C-5 Sound Levels - New Motorcycles, Year of Mfg. '75 and '76 (By Manufacturer)
For off-road motorcycles (mx) means motocross 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
HONDA– (Cont.)

Model	J-331a	F-76	F-50	35mph	55mph	Site
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

Model	J-331a	F-76	F-50	35mph	55mph	Site
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-175C	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

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

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 3½	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

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	104			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
	250Frontera	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
Garelli		66	J
Velosolex	4600	60	D
MotoBecane	Mobylette	67	D
Vespa	Ciao	69	D
NVT		74	D
Peugeot	103 LVS v3	69	D
Honda	NC-50	71	D
Other small motorcycles			
Honda MR-50		74	H
Honda MR-50		69	I
Honda All Terrain Cycle		73	D

TABLE C-6 SOUND LEVELS,

'69-'74 (YEAR OF MFG.) IN-SERVICE MOTORCYCLES IN STOCK CONFIGURATION

USE* CATEGORY	DISPL. CC	ENG. TYPE	SOUND LEVEL - dBA J331a	F76	F77	F50	35 MPH	55 MPH	TEST SITE	MFG'R	BIKE NO.
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	SOUND LEVEL - dBA 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

Cont'd.

TABLE C-6 (CONT'D)

USE CATEGORY	DISPL. CC	ENG. TYPE	SOUND LEVEL - dBA 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

Cont'd.

TABLE C-6 (CONT'D)

USE CATEGORY	DISPL. CC	ENG. TYPE	SOUND LEVEL - dBA 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

Cont'd.

TABLE C-6 (CONT'D.)

USE CATEGORY	DISPL. CC	ENG. TYPE	SOUND LEVEL - dBA						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

Cont'd.

TABLE C-6 (CONT'D.)

USE CATEGORY	DISPL. CC	ENG. TYPE	SOUND LEVEL - dBA						TEST SITE	MFG'R	BIKE NO.
			J331a	F76	F77	F50	35 MPH	55 MPH			
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			88	71	78	A		A5
SX	248	4 S	81			89	69	74	A		A60
SX	248	4 S	80			88	73	75	A		A88

Cont'd.

TABLE C-6 (CONT'D)

USE CATEGORY	DISPL. CC	ENG. TYPE	SOUND LEVEL - dBA J331a	F76	F77	F50	35 MPH	55 MPH	TEST SITE	MFG'R	BIKE NO.
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		A183
SX	99	4 S	79			88	72	79	A		A85
SX	99	4 S	81			87	77	79	A		A116

Cont'd.

TABLE C-6 (CONT'D)

USE CATEGORY	DISPL. CC	ENG. TYPE	SOUND LEVEL - dBA						TEST SITE	MFG'R	BIKE NO.
			J331a	F76	F77	F50	35 MPH	55 MPH			
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 SOUND LEVELS, '69 - '76 MODEL IN-SERVICE MODIFIED MOTORCYCLES

USE CATEGORY	DISPL. CC	ENG. TYPE	SOUND LEVEL - dBA 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	Q	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	Q	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	Q	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	Yamaha	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
Kaw KZ-900	10-1502 4:2
Kaw 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

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

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

Model	Manufacturer Part No.
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 SOUND 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

		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	85	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

		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

		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

		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

Inserts and Baffles Removed

	Δ 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

	Δ 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	398	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

(Continued)

TABLE C-11 (Continued)

BIKE NO.	DISPL.	J331a CLOSING CONDITIONS % RPM	FT. PAST MIC.	MPH
159	750	70	100	50
160	736	69	100	45
161	247	100	25	
162	124	100	40	25
163	903	68	100	52
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	43
196	995	75	100	46
197	242	1-0	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 SOUND LEVELS RELATED TO CLOSING RPM.

The sound level data presented in this table were obtained using the F76, J47, R_{60}, 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 '75 or '76 year of manufacture except as noted.

			dBA @ % rpm			
BIKE NO.	USE	MAKE/MODEL	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	82.6	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	82.6	83.8		
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	81.3	84.3		
117	SX	Kawasaki KV 100	81.2	83.9		
118	SX	Kawasaki KE 175	79.3	82.6*	80.9 @ 80%	
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	83.3		
124	X	Kawasaki KT 250	87.6	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 @ 40%	
174	S	Yamaha XS 650C	86.2		81.4 @ 49%	
176	S	Suzuki GT 750	84.6	88.0	82.1 @ 50%	
180	S	Suzuki RE5 (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 @ 83%	

* Lower gear used

(Continued)

TABLE C-12 (Continued)

BIKE NO.	USE	MAKE/MODEL	dBA @ % rpm 75%	100%	NOTED	REMARKS
189	S	Harley SS 175	81.3		81.1 @ 89%	
190	S	Harley SS 250	79.1		80.8 @ 70%	
191	SX	Harley SX 250	89.9	90.9		'74 yr. of mfg.
192	S	Harley SS 125	78.3		79.6 @ 80%	
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%	

TABLE C-13 CALCULATED F-76a SOUND LEVELS

The F-76a sound level presented in this table have been obtained by linear interpolation and extrapolation 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
$\bar{X}$ =	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
$\bar{X}$ =	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
$\bar{X}$ =	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
$\bar{X}$ =	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
$\bar{X}$ =	80.6	86.6	82.6
σ =	3.58	2.54	1.91
N =			

The above tabulation includes only unmodified '75 - '76 yr of mfg. street and combination street/off-road motorcycles

TABLE C-14 VARIABILITY IN SOUND LEVEL DATA

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

BIKE NO.	TEST SITE	NORMALIZED* SOUND LEVEL - dBA			
		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	

Continued

*For each vehicle model in each test method, measured sound 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	F	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" TURF ON MEASURED SOUND LEVELS

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

J331a	:	90.7 dBA
F76	:	97.8 dBA

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

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

Note: 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 FOREIGN LAWS

1. STATE LAWS REGULATING MOTORCYCLE NOISE

Summarized in the chart following this section are state laws regulating motorcycle noise for:

CALIFORNIA	MINNESOTA
COLORADO	MONTANA
CONNECTICUT	NEVADA
FLORIDA	NEW JERSEY
HAWAII	NEW YORK
IDAHO	OREGON
INDIANA	PENNSYLVANIA
MARYLAND	RHODE ISLAND
	WASHINGTON

The chart is applicable essentially to law regulating noise of highway motorcycles.

NOTES FOR STATE LAW CHART
(beginning page 4)

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

2. Connecticut also specifies noise limits for level, low speed roads. For motorcycles, 77 dbA.

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

4. Noise level limits vary with both posted speed and measurement distance. The indicated value is for a posted speed of 35 mph and a measurement distance of 50 feet.

5. Idaho's muffler statute prohibits the operation of a motor vehicle which produces unusual or excessive noise, defined as any sound which exceeds 92 dbA under any conditions, when measured from a distance of 20 feet.

5a. Idaho Code section 43-835 authorizes the Board of Health and Welfare to prescribe more strict limits. According to a letter from Howard L. Burkhardt, Chief, Bureau of Environmental Health, dated 29 Nov. 1976, the Board has not exercised this authority.

6. After January 1, 1979, sound level limits will be measured at speeds greater or less than 45 mph.

7. Noise level limits vary with the distance from center lane of travel at which the measurement is made. The indicated value is for a distance of 50 feet.

8. 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.

8a. North Dakota Century Code section 23-01-17 grants authority to establish motor vehicle noise control regulations to the Department of Health. According to a letter from John R. Giedt, Environmental Engineer, Division of Environmental Engineering, Radiological Health Program, dated 29 Nov. 1976, no statewide regulations have been adopted, though the Department is aiding localities in establishing their own regulations.

9. Moving test at 50 feet.

10. Moving test at 50 feet or greater and indicated speed. Oregon also provides for a stationary test at 25 feet for in-use motorcycles. The current stationary standard is 91 dbA; the standard after 1978 is 83 dbA.

11. Rhode Island's vehicle noise limits do not take effect until July 1, 1977.

CODE FOR STATE NOISE ABATEMENT EQUIPMENT LAW CHART
(... beginning page 4)

A. Motor vehicles ... have adequate muffler in good working order and in constant operation

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

C. No equipment modification to increase noise emission above that of 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 not meeting established requirements.

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

G. Restrictions on the type of repairs allowed.

	CAL		COL		CONN	
Definitions	Specific Motorcycle Definition Seat or saddle for driver, < 3 wheels, ≤ 1500 lbs.	Motor Driven Cycle Motorcycle or Motor scooter with 15 gross brake horsepower; bicycle with motor.	Specific Motorcycle Definition ≤ 3 wheels except tractors.	Motor Driven Cycle Motorcycle or motor scooter with < 6 brake horsepower; bicycle with motor.	Specific Motorcycle Definition Seat or saddle for driver or platform on which he stands, ≤3 wheels, bicycles with motors.	Motor Driven Cycle
Enforcement Authority	Dept Trans/DMV/High Pat		Dept Revenue/Local Govt		Comm MV/Env Pro Agency	
Test Procedure	Established Dept Trans/ High Pat	Type of Procedure Based on SAE J331a	Established Dept Revenue/ Local Govt	Type of Procedure Based on SAE procedures, measured at 50 ft	Established Comm MV/Env Pro Agency	Type of Procedure Measured at 50 ft, constant speed
New Vehicle Noise Limits	Current Std. 83 (1974-78) 80	Ultimate Std. 70 (1989) 80	Current Std. 86 (1973)	Ultimate Std.	Current Std. 85 (1975)	Ultimate Std.
Operational Noise Limits	Current [1] <45 >45 82 86 76 82	Ultimate	Current <35 >35 86 90 82 86	Ultimate	Current [2] <35 >35 80 84	Ultimate
Equipment Modification Prohibited	A, B, C, D, E		A, B, C		A, B, C, G	
Equipment Replacement Stds.	X				X	
Penalty for Violation	X		X		X	

	FLA		HA[3]		ID	
initions	<u>Specific Motorcycle Definition</u> Seat or saddle for rider, < 3 wheels, excluding tractors.	<u>Motor Driven Cycle</u> Motorcycle or motor scooter with < 5 brake horsepower; bicycle with motor.	<u>Specific Motorcycle Definition</u> Seat or saddle for rider, < 3 wheels, excluding tractors.	<u>Motor Driven Cycle</u> Motorcycle with < 5 brake horsepower.	<u>Specific Motorcycle Definition</u> ≤3 wheels, except tractors.	<u>Motor Driven Cycle</u>
rcement ority	Dept. Highway Safety		Dept. Health		Bd. Health and Welfare	
edure	<u>Established</u> Dept Env Reg/ Dept Highway Safety	<u>Type of Procedure</u> Based on SAE J331a	<u>Established</u> Dept. Health	<u>Type of Procedure</u> May be measured at between 20 & 50 ft	<u>Established</u> Statute	<u>Type of Procedure</u> Measured at not less than 20 ft under any condition of grade, speed or acceleration
Vehicle e Limits	<u>Current Std.</u> 83 (1975-78) 80 (1975-78)	<u>Ultimate Std.</u> 78 (1979) 75 (1979)	<u>Current Std.</u>	<u>Ultimate Std.</u>	<u>Current Std.</u>	<u>Ultimate Std.</u>
ational e Limits	<u>Current</u> < 35 > 35 82 86 76 82	<u>Ultimate</u> <35 >35 78 (1979) 82 70 (1979) 79	<u>Current</u>[4] 35 73	<u>Ultimate</u>[4] 35 65 (1977)	<u>Current</u>[5] 5a 92	<u>Ultimate</u>
ment fication ibited	A, C, D, F		C		A, B, C, F, G	
ment Re- ment Stds.	X				X	
ty for tion			X			

	IND		MD	
Definitions	Specific Motorcycle Definition Saddle for use of rider, ≤ 3 wheels, except tractors.	Motor Driven Cycle	Specific Motorcycle Definition Saddle for rider, ≤ 3 wheels, including motor scooter & bicycle with motor, but excluding tractor.	Motor Driven Cycle
Enforcement Authority			Dept Trans/State Police	
Test Procedure	Established	Type of Procedure Measured at least 50 ft from center lane of traffic	Established Dept Trans	Type of Procedure SAE J331a as of 5/10/76
New Vehicle Noise Limits	Current Std.	Ultimate Std.	Current Std. 83 (1975-78)	Ultimate Std. 75 (1980)
Operational Noise Limits	Current <35 82 >35 86	Ultimate	Current <35 82 >35 86	Ultimate [6] <35 75 (1980) >35 79
Equipment Modification Prohibited	A, B		C, D, F	
Equipment Replacement Stds.			X	
Penalty for Violation				

	MINN		MONT		NEV	
Definitions	Specific Motorcycle Definition Seat or saddle for driver, ≤ 3 wheels, including motor scooters & bicycles with motors, excluding tractors & motorized bicycles with <1 horsepower engines.	Motor Driven Cycle	Specific Motorcycle Definition Saddle for rider, ≤3 wheels, or platform on which rider stands, bicycles with motors.	Motor Driven Cycle	Specific Motorcycle Definition ≤3 wheels, excluding tractors & mopeds.	Motor Driven Cycle ≤ 3 wheels, excluding tractors, max. speed ≤ 30 mph.
Enforcement Authority	Pollution Control Agency				DMV	
Test Procedure	Established Pollution Control Agency	Type of Procedure Measured at ≥ 20 feet under any condition of grade, speed or acceleration	Established	Type of Procedure Measured at 50 ft	Established DMV	Type of Procedure Based on SAE J331a
New Vehicle Noise Limits	Current Std.[7] <35 >35 80 83 75	Ultimate Std.	Current Std. 80 (1974-77)	Ultimate Std. 70 (1987)	Current Std. 86 (1973) 84 (1973)	Ultimate Std.
Operational Noise Limits	Current <35 >35 80 83 75	Ultimate	Current	Ultimate	Current <35 >35 82 86 76 82	Ultimate
Equipment Modification Prohibited	A, B, C, E, F		A		A	
Equipment Replacement Stds.	X					
Penalty for Violation			X		X	

North Dakota[9a]

	NJ[8]		NY		ORE	
Definitions	Specific Motorcycle Definition piston displacement ≥ cc, rated in excess of 1.5 brake horsepower	Motor Driven Cycle	Specific Motorcycle Definition Seat or Saddle for rider, ≤ 3 wheels, excluding tractor.	Motor Driven Cycle Motorcycle or motor scooter < 5 brake horsepower, bicycle with motor.	Specific Motorcycle Definition Seat or saddle for rider, ≤ wheels, excluding tractor.	Motor Driven Cycle
Enforcement Authority					Env Quality Comm	
Test Procedure	Established	Type of Procedure Measured at 50 ft under any condition of grade, load or acceleration	Established Statute	Type of Procedure SAE J672, measured at 50 ft at < 35	Established Env Quality Comm	Type of Procedure Based on J331a
New Vehicle Noise Limits	Current Std.	Ultimate Std.	Current Std.	Ultimate Std.	Current Std. 83 (1976)[9]	Ultimate Std. 75 (1978)[9]
Operational Noise Limits	Current < 35 > 35 82 86	Ultimate <35 > 35 75 (1980) 78	Current <35 88	Ultimate	Current[10] <35 >35 81 85	Ultimate[10] < 35 > 35 73 (1978) 77
Equipment Modification Prohibited	A, B		A, B, C		A, B, C	
Equipment Replacement Stds.						
Penalty for Violation					X	

	PA		RI [11]		WA	
Definitions	Specific Motorcycle Definition Saddle for rider, ≤3 wheels, bicycles with motors, scooters, excluding tractors.	Motor Driven Cycle	Specific Motorcycle Definition Saddle for rider, ≤ 3 wheels; bicycles with motors and a driving wheel in contact with the ground	Motor Driven Cycle motorcylce or motor scooter with ≤5 brake horsepower; bicycles with motors attached	Specific Motorcycle Definition Saddle for rider, ≤3 wheels, excluding tractor.	Motor Driven Cycle Motorcycle or motorscooter with ≤ 5 brake horsepower, bicycle with motor
Enforcement Authority	Sec. Trans.				Dept. Ecology	
Test Procedure	Established Sec. Trans.	Type of Procedure Measured at 50 ft	Established	Type of Procedure Measured at 50 ft under any condition of grade, load or acceleration	Established State Comm on Equipment	Type of Procedur Based on J331a
New Vehicle Noise Limits	Current Std. 90 (1973)	Ultimate Std.	Current Std.	Ultimate Std.	Current Std. 83 80	Ultimate Std.
Operational Noise Limits	Current <35 > 35 90 92	Ultimate	Current <35 > 35 86 90	Ultimate	Current <35 >35 76 80	Ultimate
Equipment Modification Prohibited	A, B, C, G				A, B, C	
Equipment Replacement Stds.	X					
Penalty for Violation	X				X	

2. LOCAL LAWS REGULATING MOTORCYCLE NOISE

Local laws regulating motorcycle noise are not reported nationally in the standard legal references. Thus a library search does not yield a full account of the type and number of local ordinances governing motorcycle noise. To date, records of relevant local ordinances have been obtained directly from jurisdictions the laws of which are of special interest and from compilations of an industry association, from two different associations of local governments, and from environmental groups.

Following is a chart of ordinances compiled and analyzed.

CODE FOR LOCAL NOISE ABATEMENT EQUIPMENT LAW CHART
(beginning page 12)

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

B. All engines required to have muffler.

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

D. No equipment modification to increase noise emission above that of original equipment.

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

F. No modification of equipment which causes vehicle to fail noise emission test.

NOISE ORDINANCES OF
COUNTIES AND MUNICIPALITIES

	Measurement Procedures	Community Noise Standards	Motor Vehicle Noise Standards	Penalties for Violation	Equipment Standards
ALASKA					
Anchorage	X	X	X	X	
ARIZONA					A, C
Scottsdale	X	X	<35mph >35 street vehicles 82dbA 86 ORV's 86dbA	X	
Tempe	X	X	<35mph >35 motor-cycles 88 92 motor-bikes 82 86	X	
CALIFORNIA					
Alhambra	X	X	X	X	
Beverly Hills	X	X	X	X	
Burbank	X	X	Adopts State Std.	X	
Inglewood	X	X	Adopts State Std.	X	
Modesto	X	X			
Palo Alto	X	X			
Pasadena	X	Exempts Motor vehicles on public roads		X	
Pleasant Hill			<35mph >35 motor-cycles 88 92		
San Diego	X	X	Adopts State Std.	X	
San Francisco	X	X	motorcycles 77 ORV's 70	X	
San Luis Obispo		X	Adopts State Std.		
Santa Rosa	X	X	Adopts State Std.		
Stockton			Adopts State Std.		

	Measurement Procedures	Community Noise Standards	Motor Vehicle Noise Standards	Penalties for Violation	Equipment Standards
CALIFORNIA (Continued)					
Thousand Oaks			X	X	
Torrance	X	X	Adopts State Std.		
COLORADO					C, D
Denver	X	X	7am-10pm 10pm-7am motor-cycles 88 80		
Colorado Springs	X	X	80		C
Lakewood		X	80		B, C, D
DELAWARE					
Rehoboth Beach	X		X	X	
FLORIDA					
West Palm Beach	X	X	<35mph >35 motor-cycles 78(1979) 82 motor-bikes 70 79	X	B, D
Broward County	X	X	<35mph >35 88 92 after 1978 82 86	X	D
ILLINOIS					D
Barrington	X	X	86 motorcycle 75 (1980)		
Chicago	X	X	New: motorcycle 75 (1980) motorbike 75 (1980) (1978) <35mph >35 motor-cycle 78 82 motor-bike 70 79	X	D

	Measurement Procedures	Community Noise Standards	Motor Vehicle Noise Standards	Penalties for Violation	Equipment Standards
ILLINOIS (Continued) Cook County	X	X	Motorcycle 75 (1980) < 35mph > 35 (1978) 78 82	X	D
Des Plaines	X	X	New: 75 (1980) (1978) < 35mph > 35 motor-cycle 78 82 motorbike 70 79 ORV's: New 73 (1975) Oper. 82 (1973)	X	D
Park Ridge	X		X	X	A, C
Rockford			< 35mph > 35 motor-cycle 82 86 motorbike 76 82 ORV 76	X	D, E
Urbana	X	X	New: Motor-cycle 74 (1980) Motorbike 75 (1980) (1978) < 35 mph > 35 Motor-cycle 78 82 Motorbike 70 79 ORV's 70 (1975)	X	D
INDIANA Evansville	X	X	< 35mph > 35 motor-cycle 80 84 other 76 82 Grade ≤1% 35 motor-cycle 77 other 74		C

	Measurement Procedures	Community Noise Standards	Motor Vehicle Noise Standards	Penalties for Violation	Equipment Standards
INDIANA (Continued) Hammond	X	X	< 35mph > 35 motor-cycles 86 90 ORV's 82 Provides for federal pre-emption of stds. for interstate motor carriers	X	B, D
IDAHO Boise	X	X	Mufflers Required	X	A, C, D
IOWA Cedar Falls	X	X	< 35mph > 35 motor-cycle 86 90 motorbike 78 84	X	A, C
Dubuque	X		< 35mph > 35 motor-cycle 86 90 motorbike 78 84	X	
Storm Lake	X		< 35mph > 35 motor-cycle 86 90 motorbike 78 84	X	
KANSAS Prairie Village	X	X	New: Motorcycle 75 (1980) Motorbike 75 (1978) < 35mph > 35 motor-cycle 78 82 motorbike 70 79 ORV's New 73 (1975 oper. 82 (1973)	X	D

	Measurement Procedures	Community Noise Standards	Motor Vehicle Noise Standards	Penalties for Violation	Equipment Standards
MARYLAND					
Baltimore		X			
Montgomery County	X	X	< 35mph > 35 motor-cycle 82 86 motorbike 76 82	X	
MASSACHUSETTS					
Boston		X	75 (1980)		
Pittsfield	X	X		X	
MICHIGAN					
Ann Arbor	X		90		A, D, E
Birmingham	X		< 35mph > 35 1978 78 82		
Charleston Twp.	X	X	82	X	B, D
Comstock Twp.	X	X	82	X	B, D
Detroit	X		86		A, C, F
Kalamazoo	X	X	< 35mph > 35 motor-cycle 82 86 motorbike 74 78	X	B, D
MINNESOTA					
Cannon Falls	X		Varies with speed and distance		D
Minneapolis			Varies with speed and distance		
MISSOURI					
Gladstone	X	X	Motorcycle 86 ORV, minibike 82	X	D
MONTANA					
Billings	X	X	74	X	B, D

	Measurement Procedures	Community Noise Standards	Motor Vehicle Noise Standards	Penalties for Violation	Equipment Standards
MONTANA (Continued)					
Great Falls	X	X	Motorcycle 74 @ 50 ft	X	
Helena	X	X	Motorcycle & Minibike 80	X	B, D
Missoula	X	X	Motorcycle & Motorbike 80	X	A
NEBRASKA					
Lincoln	X	X	< 35mph > 35 motor- cycle 82 86 motorbike 76 82	X	B
Omaha	X	X	< 35mph > 35 motor- cycle 82dbA 86 motorbike 76 82	X	
NEW MEXICO					
Albuquerque	X	X	< 40mph > 40 82 86	X	
Los Alamos County	X		Light Motor Vehicles 80 Exempts Vehicles on Public Roads	X	
NEW YORK					
New York	X		< 35mph > 35 motor- cycle 78 82 motorbike 70 79	X	
OHIO					
Cincinnati			Motor Vehicles 95		
Cleveland			Motor Vehicles 95		A, C, D
Shaker Heights	X		Motor Vehicles 90		
Toledo		X	< 35mph > 35 motor- cycle 82 86 minibike 82		

	Measurement Procedures	Community Noise Standards	Motor Vehicle Noise Standards	Penalties for Violation	Equipment Standards
OREGON Eugene			X		B
TENNESSEE Knoxville	X		< 35mph >35 motor- cycle 86 (1975) 90 motorbike 82 (1973) 86	X	A, C
UTAH Ogden City	X	X	Residen-tial Zones / Other Zones motor- cycle 90 95	X	B
Salt Lake City	X	X	<40 = 80		B
Salt Lake County	X	X	< 35mph > 35 82 86	X	B, D
VIRGINIA Alexandria	X	X		X	B
Arlington	X	X	< 35mph >35 motor- cycle 80 84 motorbike 70 79	X	
WASHINGTON College Place			Motorcycle 95	X	A, C
Medina			Adopts State Std.	X	B
Pullman	X		Motorcycle 88 Motorbike 82		
Snohomish	X	X	Motorcycle 87	X	
Walla Walla			Motor Vehicles 95		A, C
WISCONSIN Milwaukee	X	X	Motor- <35mph >35mph cycle 80 84 X	X	A, F D

	Measurement Procedures	Community Noise Standards	Motor Vehicle Noise Standards	Penalties for Violation	Equipment Standards
WYOMING					
Cheyenne	X	80			C, D
Lander	X		Motor Vehicles 80		
Powell	X	80			
Riverton	X	80			

3. SPECIFIC REGULATION OF OFF-ROAD MOTORCYCLES

STATE LAWS

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

California

Scope: Equipment of Off-Highway Vehicles
Noise Limit: new vehicles must meet 86 dbA limit if manufactured after January 1, 1975.

Idaho

Scope: Registration of Off-Highway Motorbikes
Noise Limit: motor vehicle noise statute specifically applicable to off-highway motorbikes - 92 dbA

Maryland

Scope: Off-Road Vehicle Regulations
Noise Limit: for vehicles manufactured after July 1, 1985 - 78 dbA

Michigan

Scope: Operating Restrictions on Off-Road Vehicles
Noise Limit: for vehicles manufactured after January 1, 1975 - 86 dbA

New Hampshire

Scope: Off-Highway Recreational Vehicle Regulations
Noise Limit: 78 dbA by 1983

Oregon

Scope: Off-Road Vehicles
Noise Limit: mufflers must meet standards for noise emission adopted by the Environmental Quality Comission
new vehicle noise limits: 75 dbA by 1978
operational noise limits: 83 dbA by 1978

Washington

Scope: All-Terrain Vehicles
Noise Limit: new vehicle noise limits for all terrain vehicles manufactured after January 4, 1973 - 82 dbA

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

Colorado

Montana

The following states may be said to have made their general motorcycle noise statutes applicable to off-road vehicles by implication:

Connecticut

Florida

Idaho

Indiana

Minnesota

New York

Pennsylvania

REGULATION OF OFF-ROAD MOTORCYCLES WITHIN MUNICIPALITIES

Increasingly, municipalities are regulating off-road motorcycles by laws passed to meet local needs. There may be a trend to local regulation of motorcycles on private property such as alleys and vacant lots. See compilation materials under the headings, Off-Road Vehicles, State Laws, Local Laws.

FEDERAL REGULATION OF OFF-ROAD MOTORCYCLES ON FEDERAL LANDS

It appears that recently proposed federal regulation of off-road vehicles on federal lands will be subject to a change based on 1977 amendment of Executive Order 11644 and on further policy considerations. At this point, it should be noted that the law presently regulating noise of off-road vehicles on federal lands may be based on federal regulation; on terms of a federal contract, lease, or permit; or on state or local standards incorporated in federal regulations. The question of authority to regulate noise of off-road vehicles on federal lands is not a new one. Basic legal discussion of this matter may be found in Jurisdiction Over Federal Areas Within the States: Report of the Interdepartmental Committee for the Study of Jurisdiction Over Federal Areas Within the States. U. S. Government Printing Office, 1956.

Non-uniformity of law resulting from the mix of federal regulation and state law on off-road motorcycle noise--as well as questions of enforcement authority--can be better discussed once knowledge on the proposed federal regulations is more complete.

Following is a summary of significant federal legal controls of off-road vehicle noise.

Executive Order 11644 - Directs Departments of Agriculture, Defense, and Interior and the Tennessee Valley Authority to establish policies and procedures to insure that ORV use on public lands will be controlled.

1. Department of the Interior
   a. Bureau of Land Management - ORV's must have mufflers to prevent excessive noise (43 CFR 6295.3)
   b. Bureau of Reclamation - ORV's must have conform to State laws and vehicle registration requirements; must have a muffler (43 CFR 420.11)
   c. Fish and Wildlife Service - ORV's must conform to applicable state laws; must have a muffler (50 CFR 28.7)
   d. National Park Service - ORV's must have a muffler (36 CFR 4.12)

2. Department of Defense
   a. Corps of Engineers - no muffler requirements

3. Department of Agriculture
   a. Forest Service - ORV's must conform to applicable State laws and regulation requirements; must have a mffler (36 CFR 295.6)

4. Tennessee Valley Authority
   a. Land Between the Lakes - ORV's must have mufflers and may not emit unusually loud noise (18 CFR 305.3)

4. ENFORCEMENT OF DOMESTIC LAWS REGULATING MOTORCYCLE NOISE

Education on Vehicle Noise Control

Noise control education of the general public, the motorcycle user, the motorcycle repairman, and the motorcycle industry is essential. State and local publications and circulars are used effectively in some jurisdictions. Incorporation of vehicle noise control materials in public school driver education curricula may be helpful. Driver education manuals could include information on basic vehicle noise control law. Industry-published owner manuals could also assist motorcycle operators in their efforts at low-noise maintenance and repairs.

Laws Regulating Vehicle Noise Control

Clear legal authority to regulate motorcycle noise is a basic requirement of a motorcycle noise control plan. Laws should be written so that those regulated can understand them.* Laws should be specific enough for enforcement personnel to understand how to apply them. Laws should also

*Helpful to regulated persons would be a government-published chart abstracting all of the motorcycle noise control laws and administrative regulations enforced within a particular government jurisdiction.

be drafted so that proof in court of a violation is not overly complicated. Laws regulating motorcycle noise should also be complemented with arrest authority for moving violations and for pull-over authority for stationary tests when it appears that a given jurisdiction needs this type of enforcement.

Modified Muffler Regulation

Modified mufflers are considered the most frequent cause of motorcycle noise. Whatever the structure of vehicle regulation in a given jurisdiction, a good motorcycle noise enforcement program will regulate exhaust system modification, replacement, and repair. Ideally, there would be provisions for tamper-proof exhaust systems protected by seals the deliberate breaking of which could constitute a legal violation; for exhaust system certification tied to inspection and/or registration programs; and for enforcement that results in restoration of noisy vehicles to reasonable noise levels.

Funding of State and Local Enforcement

State and local implementation of motorcycle noise control will not be possible without specific budget appropriations for both office administration and field enforcement. Effort could be made to fund programs through the use of fines collected and inspection fees charged on vehicle noise control offenses.

Training of Enforcement Personnel

Specialized training in noise measurement for vehicle enforcement is particularly important for highway enforcement. Compilation materials on enforcement describe governmental programs to enable enforcement personnel to measure noise correctly.

Noise Measurement Techniques for Highway Use

Efforts to develop more practical highway measurement procedures are still needed, as measurement of noise on the highway usually involves the time of two enforcement people: one person to record the noise and one person to chase the violator.

5. FOREIGN MOTORCYCLE NOISE REGULATION

Canada

In 1976, the Canadian Transport Ministry advised GWU Policy Studies orally that the current noise standard for motorcycles is 88dbA measured by testing method J986a.

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 dbA and adopting SAE J47 as the official test procedure.

(ECE) United Nations Economic Commission for Europe

ECE Regulation No. 9, dated March 20, 1958, 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.

Noise limits vary with engine displacement and engine type:

2-stroke engines

50 cc - 125 cc	82 dbA
over 125 cc	84 dbA

4-stroke engines

50 cc - 125 cc	82 dbA
125 - 500 cc	84 dbA
over 500 cc	86 dbA

France

The Inter-Ministerial Decision of April 13, 1972 set motor vehicle noise limits in France. ECE Regulation No. 9 is used as the measurement procedure.

Vehicle Type	Current Standard	Std. for Vehicles Mfg. Prior to 10/1/72
Auto-cycles	73 dbA	76 dbA
Motorized cycles	80 dbA	
Motorcycles	84 dbA	86 dbA

Great Britain

Great Britain has both new vehicle and operational standards.

Regulation 29 provides a manufacturer-type test for vehicles first used after April 1, 1970. Vehicles are tested under full acceleration in second gear with the microphone placed 7.5 m from the center lane of travel.

Vehicle		Standard
Motorcycles	<50 cc	77 dbA
Motorcycles	>125 cc	86 dbA
Other motorcycles		82 dbA

Regulation 108 is an operational standard in which the vehicle may not exceed the limiting value under any operating condition.

		Standard	
Vehicle		Vehicles Used Before 11/1/70	Vehicles Used After 11/1/70
Motorcycles	<50 cc	80 dbA	80 dbA
Motorcycles	>50 cc	90	89
Other motorcycles		90	85

Japan

Environment Agency Bulletin No. 53, Sept. 4, 1975, sets 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 Kph (25 Kph 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.

Vehicle Type	Standard: Normal Operating Noise and Exhaust Noise	Acc
2 wheel vehicles	74 phons*	83
2 wheel vehicles with side-cars	74	85

*The phon is the unit of measurement for loudness level. The loudness level in phons equals the sound intensity level in decibels for any sound of the same frequency.

See compilation materials, Japan, for unofficial English-language translations of more current laws.

Netherlands

The Road Traffic Regulations of August 28, 1950, which implement the Road Traffic Act, and the Traffic Rules and Sign Regulations of May 4, 1966, contain noise abatement provisions. Sections 66 and 80a of the Road Traffic Regulations stipulate that the exhausts of motor vehicles and mopeds must be fitted with a proper silencer and that they are not allowed to produce noise in excess of levels laid down by the Minister of Transport and Public Works.

Sweden

The Swedish Traffic Noise Committee issued its final proposals on motor vehicle noise in 1974. Vehicle levels are proposed for measurement under two different standards--ISO R362 for moving vehicles, and a stationary noise test similar to the ISO method.

Moving Vehicle Limits

Vehicle	Pre-1978 Model	Post 1978 Model	Second Stage	
Motorcycle: < 50 cc	78 dbA	74 dbA	72 dbA	- dbA
50 - 125 cc	86	81	77	-
125 - 490 cc	88	82	79	-
> 490 cc	90	83	80	88
3 wheel cycle	89	83	79	87
cross country scouter	87	81	78	86
moped	72	72	69	-

The "second stage" represents levels which will be enforced approximately 5 years after the initial standards are instituted.

Stationary Vehicle Limits

Vehicle	Pre-1978 Model	Post-1978 Model
2 wheel motorcycle	99	To be set
3 wheel motorcycle	93	
cross country scooter	99	
moped	99	

Switzerland

New motor vehicle noise standards took effect January 1, 1977. Measurement is conducted on standing vehicles at a distance of 7 m.

Vehicle	Former Limit	Limit as of 1/1/77
Motorized bicycles	70	68
Motorcycles < 50 cc	73	71
> 50 cc	82	78
> 200 cc	82	82

See foreign law compilation materials for European Community directives on motorcycle noise regulation and for abstract of law on the Federal Republic of Germany.

APPENDIX E

OPERATOR AND PASSENGER EXPOSURE TESTING PROGRAM

1.0 INTRODUCTION

The reasons for regulating motorcycle noise are:

a) to reduce the contribution of motorcycles to total environmental noise levels,

b) to decrease the annoyance factors caused by single event noise instrusions, and

c) to reduce or prevent possible operator hearing damage due to noise exposure.

The work described in this report is directed at item c.

For any noise standard to effectively reduce possible rider hearing loss hazards caused by the operation of a motorcycle, the contribution of the motorcycle noise to the total self induced rider and passenger noise environment must be determined.

EPA, through its motorcycle contractor McDonnell Douglas Astronautics, conducted a program, which included an evaluation of measurement methodologies, was intended to obtain baseline data on wind induced noise. This program was divided into the following three major tasks.

1) development and checkout of a portable data acquisition system.
2) measurement of wind noise at motorcycle operator and passenger ear.
3) analysis of data to determine the contribution of wind noise to the total motorcycle noise on rider and passenger, with and without helmets.

2.0 INSTRUMENTATION SYSTEM

A search of the literature was made to determine the current state-of-the-art in ear level noise data acquisition systems. A significant amount of literature exists for the free field calibration of microphones for probing inside the ear canal, such as "The Pressure Distribution in the Auditory Canal in a Progressive Sound Field", by Francis M. Weiner and Douglas A. Ross, JASA, Vol. 18 No. 2, October 1964; "Sound Measurements of Psychophysical Tests", by W. A. Munson and F. M. Wiener, JASA, Vol. 22, No. 3, May 1950; "Free Field Calibration of Earphones", JASA, Vol. 46, No. 6, 1969; and "Probe Tube Microphone Assembly", Villchur and Killian, JASA, Vol. 57, No. 1, January 1975. Other useful data on the problem of ear measurements were obtained from "Sound Pressures Generated in an External Ear Replica and Real Human Ears by a Nearby Point Source", by E. A. G. Shaw and R. Teranishi, JASA, Vol. 44 No. 1, 1968; "Ear Canal Pressure Generated by Circumaural and Supraaural Earphone Systems", E. A. G. Shaw, JASA, Vol. 39, No. 3, 1966; and "Ear Canal Pressure Generated by a Free Sound Field", by E. A. G. Shaw, JASA, Vol. 39 No. 3, 1966. Each of the systems described in these documents requires a lengthy calibration procedure and have a probe that is inserted in the ear canal. These methods are not particularly suitable to a system that must bounce around on a motorcycle at high speed and be capable of being easily transferred from rider to rider. Furthermore, the system required for Phase 1 of the test program must acquire the data accurately, in a form that lends itself to either narrow band or one-third octave band analysis. Analysis of the data presented in the USDA report by Harrison entitled "The Effectiveness of Motorcycle Helmets as Hearing Protectors" would indicate that small diameter microphones mounted at right angles to the ear are wind sensitive and do not represent the true noise that the ear would hear. Recent work performed by the National Research Council of Canada entitled "Monitoring Sound Pressures Within the Ear; Application to Noise Exposure", by Bramer and Piercy, indicated that some lightweight systems are being used. However, these systems are somewhat band limited for the application of Phase 1, in which we felt it necessary to go broad-band recording with a narrow-band analysis to specifically determine the sources of the noise.

For the application of Phase 1, we chose a B&K Model 4143 one-half inch microphone to which we added a B&K Model UA0386 Nose Cone. This microphone system is specifically designed for wind tunnel use and has extremely low sensitivity to wind induced noise. The rest of the system consisted of battery operated B&K microphone power supplies, Burr-Brown instrumentation amplifiers and a B&K FM tape recorder. These equipments were attached to a backpack frame which could be worn confortably by the test rider.

3.0 PRELIMINARY EAR LEVEL MEASUREMENTS

These measurements were conducted to establish instrumentation range settings and to obtain an idea of the approximate noise levels to be expected during our test runs.

3.1 Stationary Measurements

The measurements were made during dynamometer tests on a Honda 750cc motorcycle with various non-stock mufflers installed. A B&K Model 2204 sound level meter with a 1 inch microphone was used to measure ear level "A" weighted sound levels with the microphone pointed both up and down. These data are shown in Table 1, together with measurements made at 50 cm and 25 feet. Different power settings, from 50% to 100% of power at rated rpm were made and the sound level measured for each setting.

The ear level measurements obtained covered the range of 101 to 110 dBA while the levels measured with the microphone oriented up and down showed small differences except for the 100% setting on both runs on the Kerker muffler where the variation was 3 and 4 dBA respectively.

3.2 Moving Measurements

Preliminary moving vehicle tests were performed at the Los Alamitos test site to check out the data acquisition system. For these tests, the microphone was attached to a head-band which was worn by the rider.

Sound levels were measured during the F76 test run (with a BMW R90/6 motorcycle) and at various coasting speeds (with engine off) from 30 to

60 mph (in 10 mph increments). During the F76 run, data were recorded at 50 ft. and 25 ft., as well as at ear level.

Wind at the site during these tests was 16 mph out of the South-West; motorcycle runs were North-South. Exit speed on the F76 test was 48 mph.

Data from these tests are shown in Table 2. Typically, during the F76 test, ear level maximum sound levels were 102 dBA, 25 ft. levels were 88.7 dBA and 50 ft. levels were 81.2 dBA.

During the coast phase sound levels ranged from 89 to 102 dBA for coasting speeds of 30 to 60 mph respectively. A significant effect and potential source of interpretive error was uncovered during these coast tests. The driver had been instructed to merely shout his coasting speed at the decades, but he assumed that his voice would not be heard over the wind noise, so he cupped one hand and placed it in front of his mouth as a sort of funnel toward his ear immediately prior to each shout. However, the presence of fingers about 2 inches in front of (air-streamwise) the ear/microphone created a turbulent air flow with pressure fluctuations greatly in excess of both engine noise and undistributed wind noise. This effect is illustrated in Figure 1, which for clarity shows only a 2000 Hz 1/3 octave band sound pressure level history; the notations are based on field notes and careful listening of the recording. Typical differences in spectra are shown in Figures 2 (F76 ear level), 3 (60 mph coasting ear level), and 4 (55 mph cupped hand turbulence). In all cases the weighted overall level is in dBA.

4.0. STATIONARY EXTERNAL NOISE MEASUREMENTS

To obtain reference data on the helmet, which had been modified for instrumentation, and also a latex swim cap which could be used over the microphones to reduce the effects of wind noise, we performed a series of stationary tests. Because the data from these tests were to be the baseline reference, a very repeatable and stable sound source had to be chosen. The device selected is called an I.L.G., and is normally used as a sound power reference source in reveberation rooms. The I.L.G. was taken outdoors and placed on an asphalt surface, the octave band sound pressure level (SPL) was measured at 8 locations around the I.L.G. as shown in Figure 5. The background SPL was also measured.

These data, presented in Table 3, show that the radiation pattern around the I.L.G., is fairly uniform. Although the sound pressure in each octave band is fairly low, approximately 70 dB, it is sufficiently above the background noise at frequencies greater than 125 Hz to be a useful test noise source.

This test noise source was then located at ear height in front, left and right of a rider sitting on a stationary motorcycle. Sound pressure measurements were made with the rider wearing the helmet with the microphones inside, wearing the helmet with the microphone outside, bare headed with microphones mounted at ear level and with the latex cap over the rider's head and microphones. These data were analyzed into one-third octave bands; the differences between various configurations are shown in Table 4.

An interesting phenomenon is noted in these data. It appears, that below 1 kHz, the helmet has negative attenuation on the side furthest from the source. That is, if the signal at the ear furthest from the sound source is 10 dB below the signal at the source side ear without the helmet, the introduction of the helmet changes this difference to between 3 and 5 dB. Furthermore the sound pressure level at the source side ear appears louder with the helmet on than without it. This phenomenon is probably due to excitation of the helmet surface material which then transmits the sound around the head more efficiently than the air. At frequencies above 4 kHz the helmet appears to act as an attenuator. For the sound source in front of the rider the helmet reduces the noise level by an average of 6 dB.

The same tests were performed using a motorcycle in the high idle mode (3000 rpm) as a sound source instead of the I.L.G. These data, shown in Table 5, clearly show that the helmet and the swim cap raise the sound level by a small amount rather than reducing it as would be expected. Furthermore, head orientation to the left or right show some differences. With the microphone on the left side of the head and the head turned to the left at a 45° angle the sound level is 2 to 3 dB lower than when the microphone is facing forward or 45° to the right. This phenomenon is probably due to the masking of the motorcycle engine/intake noise sources by the fuel tank and the rider's calf and torso.

These tests indicated that the helmet does affect the noise level at the ear when the excitation is from a stationary motorcycle or from external sound sources. Also either the one-half or one-quarter inch microphones could be suitable for the moving tests.

5.0 MOVING VEHICLE NOISE TESTS

Full scale moving vehicle tests were performed at the Los Alamitos Naval Air Station test site using a Harley-Davidson XLH 1000 as the test vehicle. Both powered and coasting runs were made upwind and downwind.

As an aid to data reduction an accurate knowledge of the vehicle speed was necessary. This was achieved by using a dc voltage generator driven by the speedometer cable. The output of this device was a dc voltage proportional to speed. This voltage was recorded on channel 3 of the FM recorder. Two microphones were used during the test series, a half inch microphone with a nose cone and a quarter inch microphone without a nose cone. The rest of the acquisition system is the same as previously described.

The helmet was modified so that the ear level microphones could be inserted through the back of the helmet to avoid cables and microphones being inserted under the lower helmet lip and disturbing helmet fit.

Data were obtained for bare head, with swim cap, and with helmet at three head attitudes: facing forward, 45° leftward, and 45° rightward. Data were also obtained on the passenger environment and on the effect of wind on the microphone when it was out of the influence of the rider's body. This was achieved by mounting the microphone on the end of a pole 9 feet above the ground plane. The configurations tested are listed in Table 6. The 1/2" microphone had a wind bullet tip (nose cone) and the 1/4" microphone was used without nose cone. In general, each run listed in Table 6 consisted of a round trip northward (downwind) and southward (upwind), although the wind was actually at 30 to 45° from the track run direction. The average wind component in the run direction was ±5 mph.

Data reduction and analysis was based primarily on "A" weighted level recorder playback of taped data and one-third octave band spectral analysis at selected intervals. A typical (but fully annotated) example is shown in Figure 6, a history of the sound level at the rider's right ear, with the head facing forward. The motorcycle speeds are indicated in five miles per hour increments, gear and rpm are noted as are engine cut-off and other pertinent parameters. Note that with the exception of first gear acceleration from stand-still, maximum power acceleration in 2nd, 3rd and 4th gear all produce about the same maximum Sound Level of 97 dBA. The marks "a" through "f" are the intervals where spectra (Figures 6a through 6f) were obtained, with matching speeds between the powered and coasting phases for direct comparison of spectral differences. The spectrum of 65 mph wind noise inside a helmet is shown in Figure 7; a nominal ambient noise spectrum is shown in Figure 8.

Summary data from the coasting runs are presented in Table 7. These same data are shown graphically in Figure 9. Powered run data are shown in Figure 9 also, in left margin.

The data acquired during coasting measure the effect of wind at the rider's ear. The effect of wind impingement on the half-inch microphone with the nose cone is negligible, as evidenced in Figure 9, from 60 dBA at 35 mph to 73 dBA at 65 mph. Comparison of "bare head" to "in helmet" facing forward levels show in-helmet noise levels to be 5 to 10 dB higher than the bare head levels. Bare head levels are significantly different when the head attitude is changed from the facing forward position. With the head turned 45° to the left or right the sound levels at the trailing ear are 20 to 30 dBA higher than at the leading ear depending on wind speed. This is clearly shown in Figure 10, runs R5D and R5U, where, even though the 1/4 inch microphone is extremely sensitive to wind noise, the relative intensity of the 1/4 and 1/2 inch microphone, are reversed as a function of head attitude. Incidentally, the traces of runs R4D and R4U (same run as

Figure 6 but at a slower level recorder paper speed) also show the longer duration of coasting runs upwind (R4U) than downwind (R4D). The head attitude effect is significantly reduced by use of a helmet, the difference now being 2 to 7 dBA. These differences in sound level between front and back are attributed to turbulence around the head with the downstream ear in the vortex shedding zone. The helmet provides some apparent attenuation of the turbulence induced noise at the downstream ear, and because of its smooth surface probably produces a less turbulent flow down stream. We attempted to pick up helmet produced noise with a coasting run past a stationary microphone. This run was made at approximately 54 mph. The distance between stationary microphone and helmet was six inches. The sound level recorded at the stationary microphone was 87 dBA while the simultaneous outside helmet ear level was 96 dBA. This indicates that the turbulence generated near the helmet is significant in exciting the helmet but does not radiate sound toward the stationary microphone. The helmet interior noise levels are probably caused by turbulence generated by the air flow across the edges of the helmet cut-out. It should be noted that the external measurement of 87 dBA may be misleading because of the extremely short duration of the pass-by level, as shown in Figure 11. The pen speed selected corresponds to the Sound Level Meter Fast response, and the traces shown on Figure 11 could be interpreted as 86 dBA maximum (other runs reached 87 dBA). A real time analyzer set on fast random and maximum hold yielded a maximum of 86.6 dBA.

The passenger environment was determined by a measurement at the passenger location, outside the passenger helmet. These sound levels are compared to sound levels measured outside the driver's helmet; 6 dBA to 9 dBA differences were noted; with the passenger environment being higher than the driver environment. This occurs because the passenger sits in the driver's turbulent stream.

Comparison of powered to non-powered runs show that turbulent noise, although significant, is generally masked by the motorcycle noise during maximum power acceleration as evidenced by the rapid drop in Sound Level after engine cut-off, as shown on Figure 6. Maximum powered noise levels at the ear for bare head are fairly constant over the 30 to 65 mph speed range with only a 3 dBA variation.

6.0 PRELIMINARY RESULTS

From the data presented in this report, it can be concluded that:

1. The noise spectrum of up to 40 mph wind turbulence is primarily in the low frequency region, and masking of motorcycle noise only occurs at higher speeds, (above 60 mph) where both the intensity of wind noise increases, and the spectrum shifts towards the mid frequencies.

2. Turbulence-generated noise occurring at the bare headed operator's ear is significantly affected by head attitude, the trailing ear being 20 dBA louder than the leading ear.

3. Operator ear noise levels can be somewhat higher when the test helmet is worn than without, for specific operating conditions, as noted in this report, but the head attitude effect is sharply reduced.

4. Motorcycle noise (during maximum power acceleration) is the significant contributor to ear level noise at speeds up to 60 mph for both a helmeted and bare-headed operator facing forward on the motorcycle used in these tests.

5. The passenger environment turbulence-generated noise is from 6 to 9 dBA higher than the driver's, leading to a masking of motorcycle noise at about 10 mph lower speed than the driver's.

6. The data acquisition system used for this test, produced excellent laboratory quality data, but it is not suitable for day-to-day use due to its cost and complexity.

For a simple data acquisition system to record sound level only, it is recommended that:

1. The input signal be prefiltered to at least eliminate frequencies below 25 Hz, and preferably provide the "A" weighting correction prior to the tape recording stage.

2. A superminiature microphone be included as part of the system, for insertion into the ear canal to measure the noise actually incident on the ear.

HONDA 750 SOUND LEVELS (dBA)

DYNAMOMETER TESTS

MUFFLER TYPE & TEST CONDITION	25	50 cm MUFFLER SOUND LEVEL (dBA)	LEFT EAR MICROPHONE FACING UP	DOWN
ALFABET				
1st, 100%	91.5	117	104	105
WINNING				
1st, 100%	104	126	108	110
2nd, 100%	104	126	110	108
2nd, 70%	101	121	107.5	107
2nd, 60%	94	116	104	104
2nd, 50%	93	114	101	101
KERKER				
1st, 100%	102	123	109	106
1st, 70%	94	115	105	103
1st, 60%	92	114	102.5	101
1st, 50%	90	113	101	100
2nd, 100%	103	126	110	106
2nd, 70%	97.5	117	105	105.5
2nd, 60%	94.5	115	103	102
2nd, 50%	92	114	102	101

TABLE 1

4-14-76 ALAMITOS TEST SITE

BMW MOTORCYCLE, TEST F-76, #139

SOUND LEVELS (dBA)

RECORDED AT 25'	RECORDED AT 50'	RECORDED AT EAR LEVEL
R 88.2	81.9	101.8
L 89.6	81.1	102.3
R 88.2	81.4	102.1
L 89.3	81.0	102.6
R 88.2	81.1	102.2
L 88.8	81.0	102.3
$\overline{SL}$ = 88.7	$\overline{SL}$ = 81.2	$\overline{SL}$ = 102.2

COASTING SPEED (MPH)	EAR WIND SUCCESSIVE RUNS NOISE SOUND LEVELS (dBA)				
60	100	102		102	
50	91	95	95	96	
40	88.5	92	92	94	93
30	88	89			

TABLE 2

OCTAVE BAND SOUND SOUND PRESSURE
LEVELS 1.5 METERS FROM ILG (dB re 20 uPa)

OB fc	B.G. PRE.	0.0°	45°	90°	135°	180°	270°	315°	ABOVE	B. G. POST.	$\overline{\Delta}$
31.5	63	70	67	76	74	68	70	68	73	63	10
63	64	70	71	75	74	68	74	72	71	63	8
125	62	70	70	71	71	70	73	71	66	60	6
250	54	69	70	72	72	70	72	71	69	54	15
500	53	69	70	72	71	68	71	70	69.5	49	20
1000	51	71	71	71	71	71	70	71.5	68	46	22
2k	44	73	72.5	71	71	67	71	72.5	69.5	41	28
4k	48	68	71	71	69	62	71	72	69.5	39	30
8k	31	65.5	71	72	70	60	71	70	66.5	35	31
C	68	78.5	79	81	80.5	77	81	80	78	66	
A	54	77	78	78	77	74	78	78	75.5	52	

ILG SOUND PRESSURE LEVELS

TABLE 3

DIFFERENCES IN 1/3-OCTAVE BAND SOUND PRESSURE LEVEL (dB)
AND SOUND LEVEL (dBA)

NOISE SOURCE LOCATION	MICROPHONE LOCATION AND CONFIGURATION	1/3 OCTAVE BAND CENTER FREQUENCY (kHz)																	A SL
		.2			.4			.8	1			2			4			8	
Right	Right side, (bare)-(in-helmet)	-2	-3	0	2	0	-2	-4	-3	0	3	9	13	15	16	13	17	17	
	Left side, (bare)-(in-helmet)	-3	-4	-4	-4	-3	-4	-3	-2	-1	0	3	5	6	8	13	-	-	
	Right-Left, in helmet	2	0	-2	-4	0	3	6	7	7	7	9	7	1	1	9	6	-	
	Right-Left, bare	3	1	2	2	4	6	6	8	7	11	15	15	10	9	9	11	12	10
Left	Left side, (bare)-(in-helmet)	-4	-2	3	5	2	-3	-4	-1	1	4	10	14	14	14	16	21	17	2
	Right side, (bare)-(in-helmet)	-6	-7	-7	-4	-5	-5	-4	-2	0	1	2	-1	5	7	7	7	9	-3
	Left-Right, in helmet	0	-4	-8	-7	-3	1	4	4	5	4	2	-1	0	-3	-3	0	-	2
	Left-Right, bare	2	1	2	2	3	4	4	4	6	8	14	14	8	4	6	11	8	8
Front	Left side, bare-helmet	-1	-1	1	6	7	6	6	6	5	8	11	7	9	12	13	15	18	6
	Right side, bare-helmet	-1	-3	-2	1	6	7	0	3	4	11	7	9	8	12	10	11	12	6
	Left, (helmet over M)-	1	-1	1	3	0	0	0	1	4	7	6	6	8	8	6	1	6	5

ILG STATIONARY TEST SOUND PRESSURE LEVEL DIFFERENCES

TABLE 4

SOUND LEVELS (dBA)

HEAD ATTITUDE

	LEFT	FRONT	RIGHT	
Bare Head	89	90	92	1/2" microphone
Swim Cap	90	93	93	
Helmet	89	91	92	
Bare Head	88	90	92	1/4" microphone
Helmet	90	91	92	
Outside Helmet	87	87	91	

IDLE STATIONARY TEST SOUND LEVELS FOR DIFFERENT HEAD ATTITUDE

TABLE 5

RUN. NO.	TAPE COUNTER	LOCATION AND ATTITUDE	1/4" M CAL	1/2" M CAL
--	10	Cal. & Ident.		
1	19	Tach. Cal.	R	L
2	65	Bare Head, Facing Fwd.	R	L
3	102	Bare Head, Facing Fwd.	R	L
4	138	Bare Head, Facing Fwd.	L	R
5		Bare Head, 45°R, 45°L	L	R
7	205	Bare Head, 45°L, 45°R	L	R
8	240	Swim Cap, Facing Fwd.	L	R
9	276	L* on shoulder/sleeve; R* on shoulder/Neck	L*	R*
10	314	In Helmet, Facing Fwd.	R	L
11	350	In Helmet, 45°R	R	L
12	385	In Helmet, 45°L	R	L
13	420	Outside Helmet, Facing Fwd.	R	L
14	460	Outside Helmet, 45°R	R	L
15	496	Outside Helmet, 45°L	R	L
16	538	Outside Helmet, Passenger, Fwd	R	L
17	585	°Back of Helmet; *Outside Helmet	°	*
18	627	°On Top of Rack;*Outside Helmet	°	*
19	673	°On Top of Rack;*On Top of Pole 9'	°	*

CH2 = 1/2"M; CH3 = Speed (DC); CH4 = 1/4"M

MOVING TEST RUN SCHEDULE

TABLE 6

SOUND LEVELS (dBA) AVERAGES DURING COASTING. 5 MPH ADDED TO MOTORCYCLE SPEED UPWIND, SUBTRACTED DOWNWIND

TYPICAL MAX. MOTORCYCLE NOISE AT TOP OF ACCELERATION : 98 dBA

RUNS NUMBER	MICROPHONE LOCATIONS	ATTITUDE OF MICROPHONE & HEAD	APPARENT WIND SPEED (MPH) 35	40	45	50	55	60	65	
3-4	Bare Head	Facing	75	77	81	81	85	88	91	
5-7		Leading		79	85	83	87	88	89	
5-7		Trailing	94	99	105	110	113	111	113	
10		Facing	80	85	87	91	94	98	100	
11	In Helmet	Leading	80	81	85	88	91	95	97	
12		Trailing	82	83	87	93	99	99	103	
13		Facing				85	91			Down Wind Only
14	Outside Helmet,	Leading	75	78	83	82	85			
15	Driver	Trailing	74	78	77	88	92			
16	Outside Helmet, Pass.	Facing	78	82	86	91	100			
19	9' High, on Pole	Facing	60	62	64	66	68	69	73	

TABLE 7

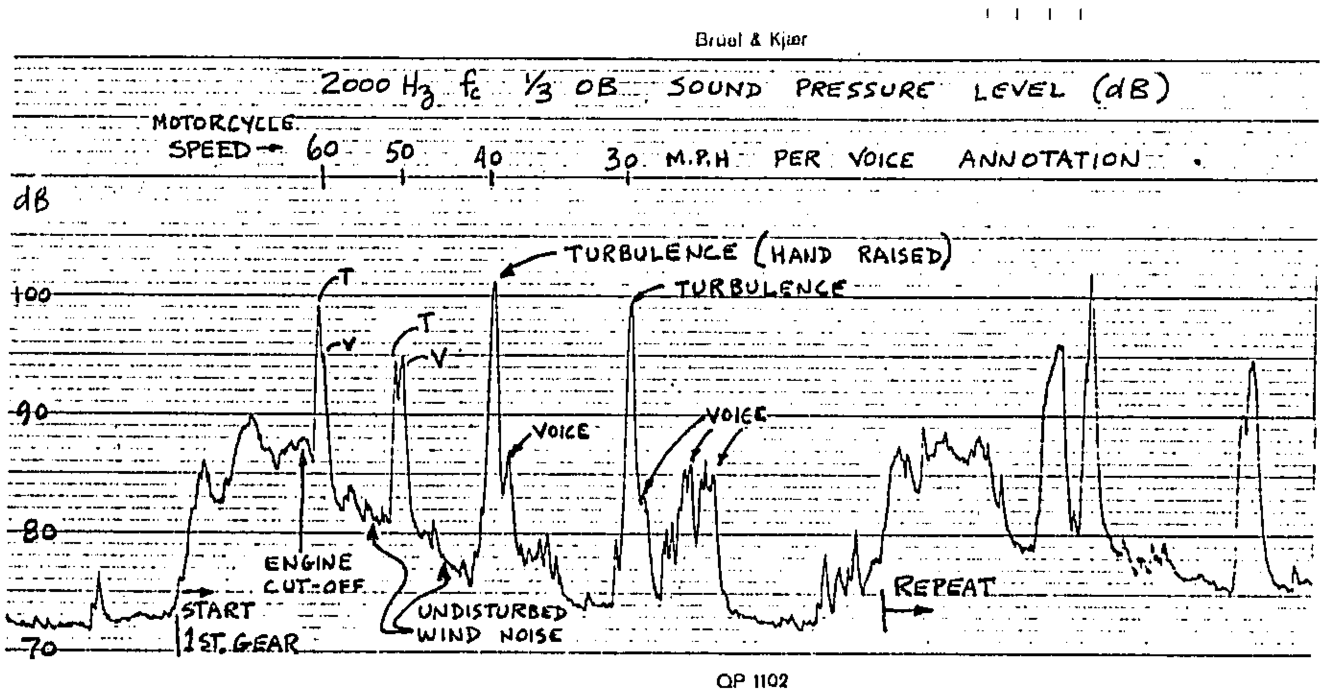


FIGURE 1. NOISE INDUCED BY TURBULENCE

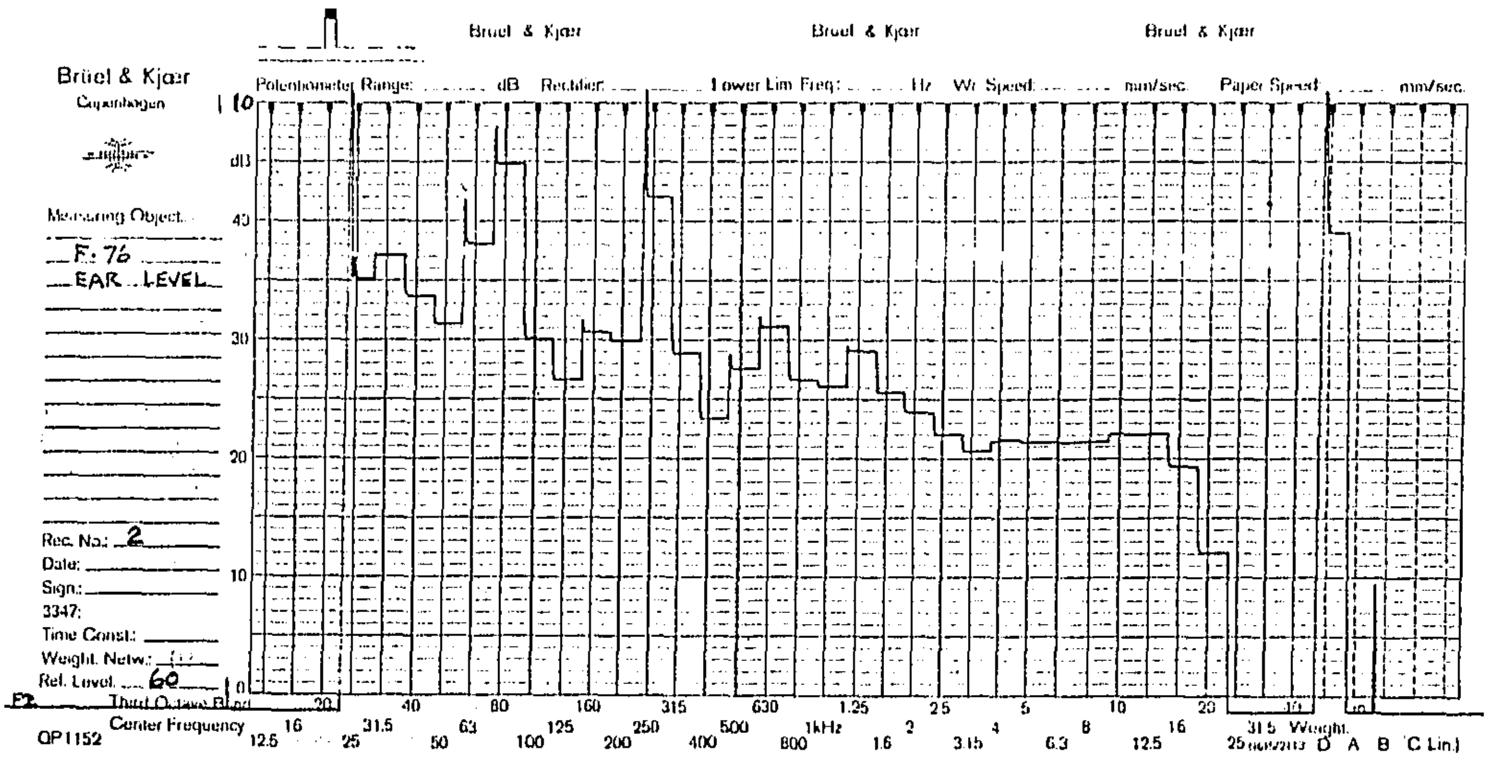


FIGURE 2. F-76 EAR LEVEL NOISE SPECTRUM

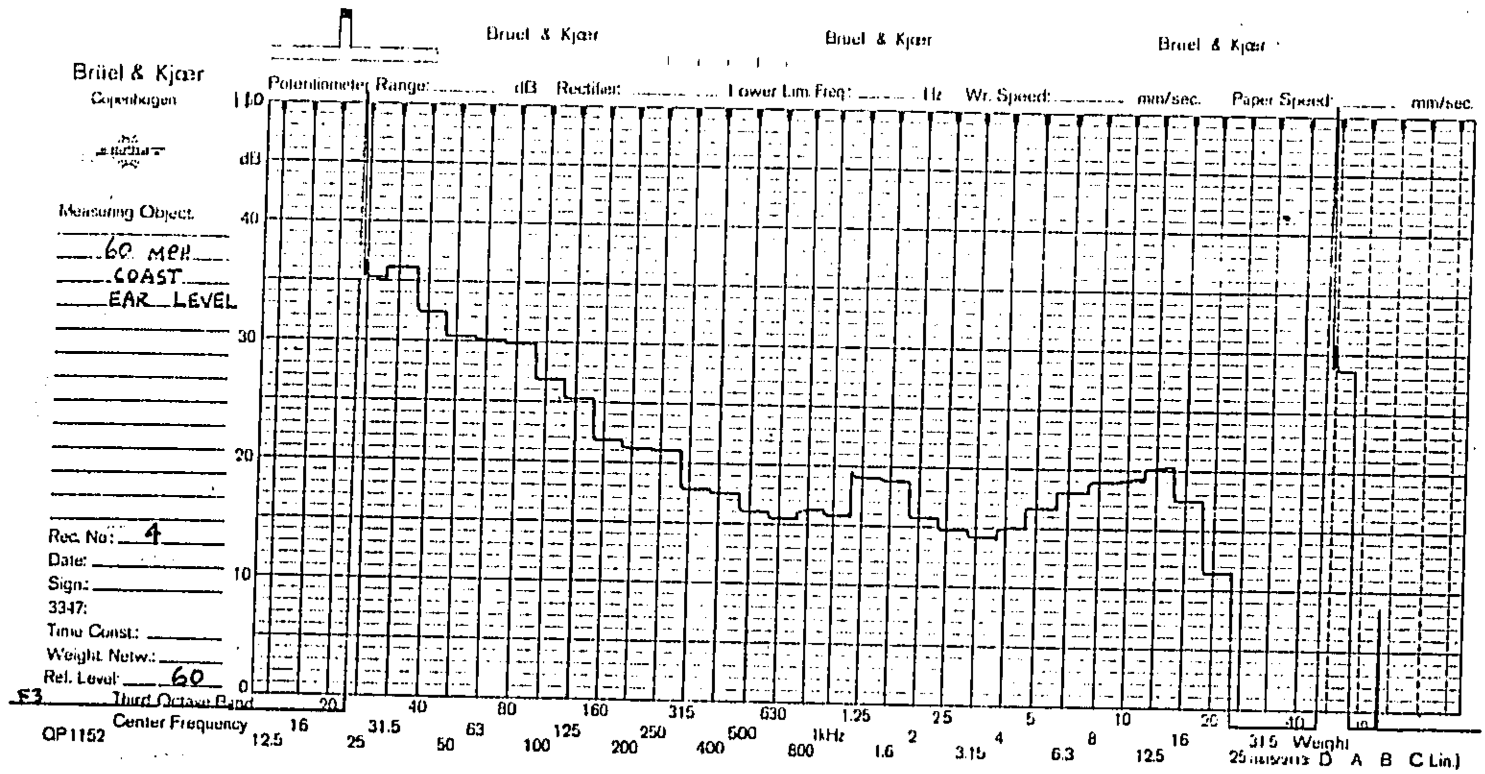


FIGURE 3. 60 MPH COASTING EAR LEVEL NOISE SPECTRUM

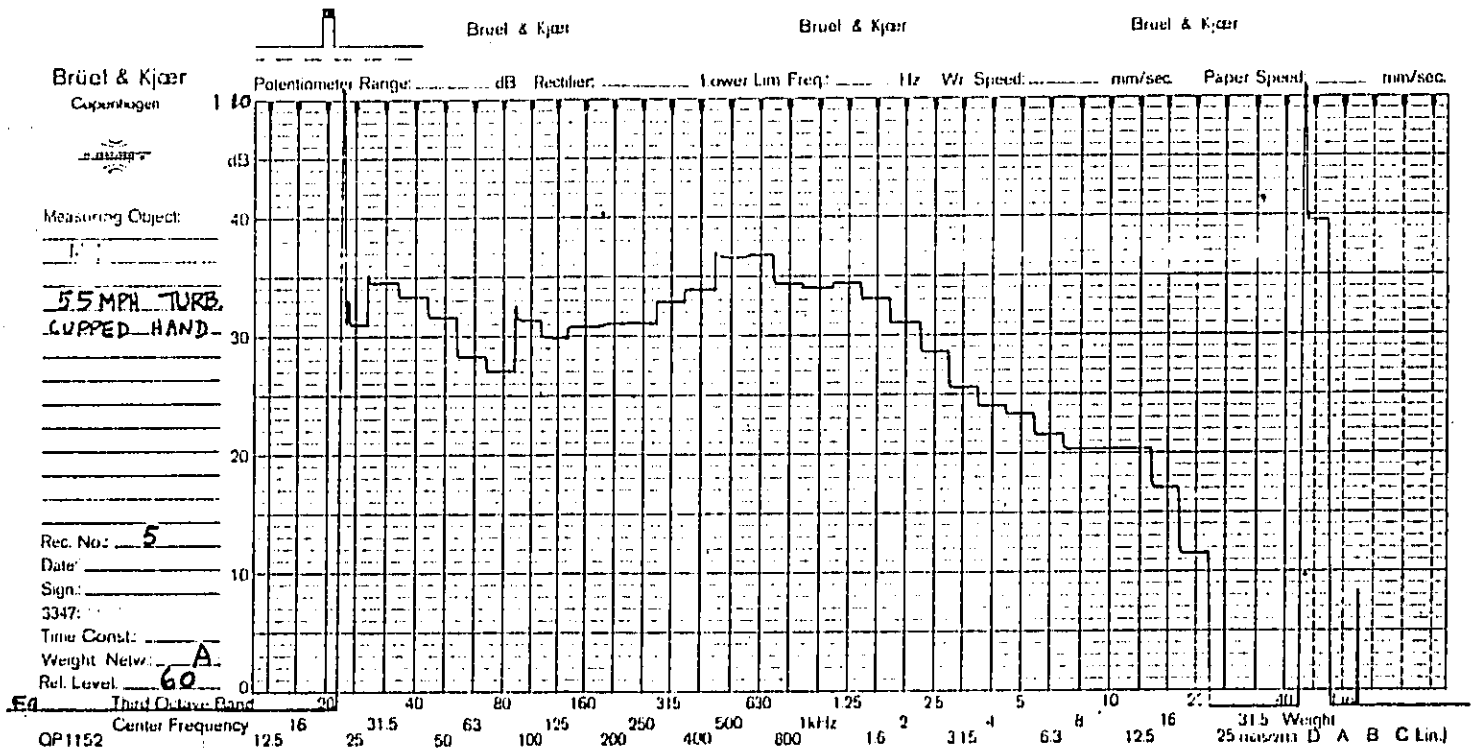


FIGURE 4. 55 MPH COASTING EAR LEVEL TURBULENCE SPECTRUM

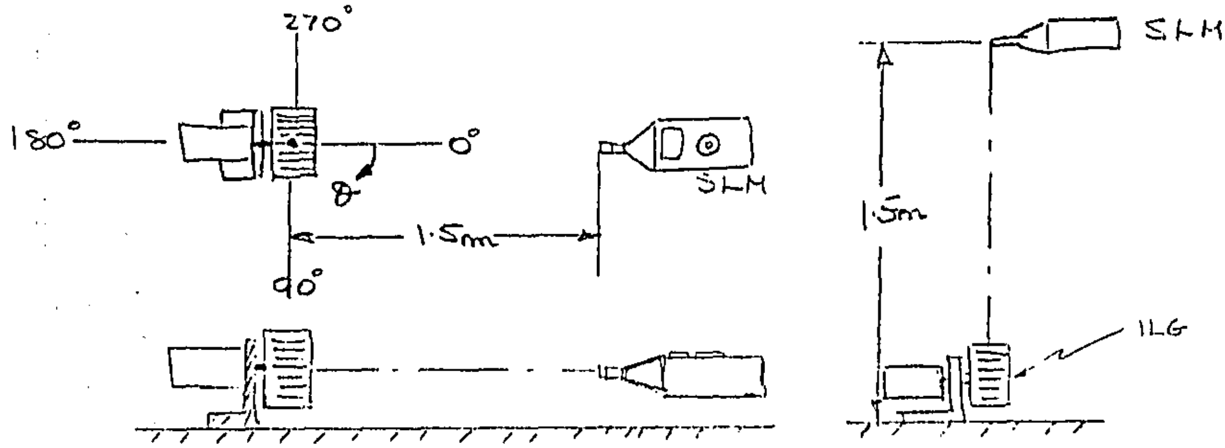


FIGURE 5. ILG FIELD VERIFICATION TEST SETUP

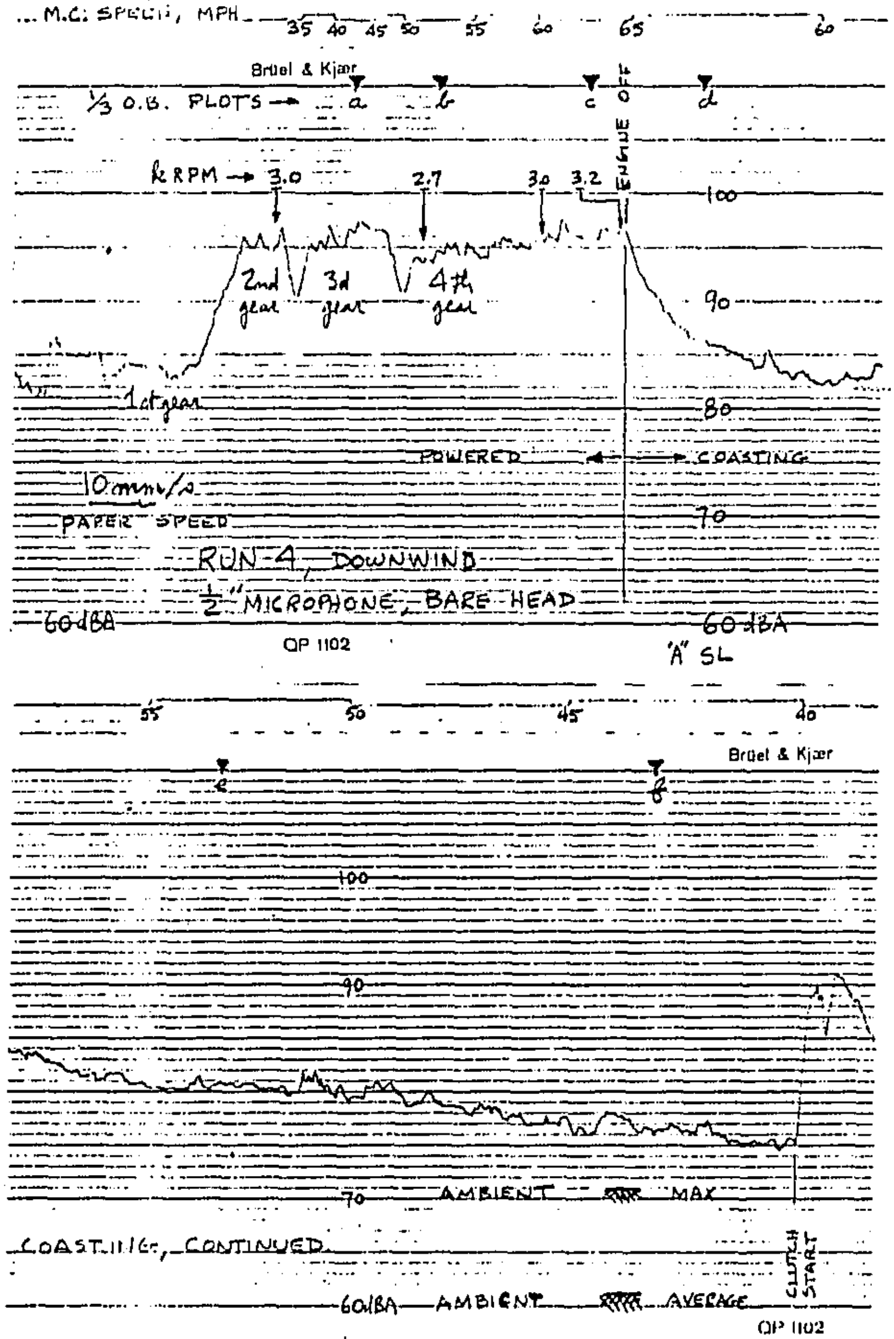


FIGURE 6. TYPICAL SOUND LEVEL HISTORY

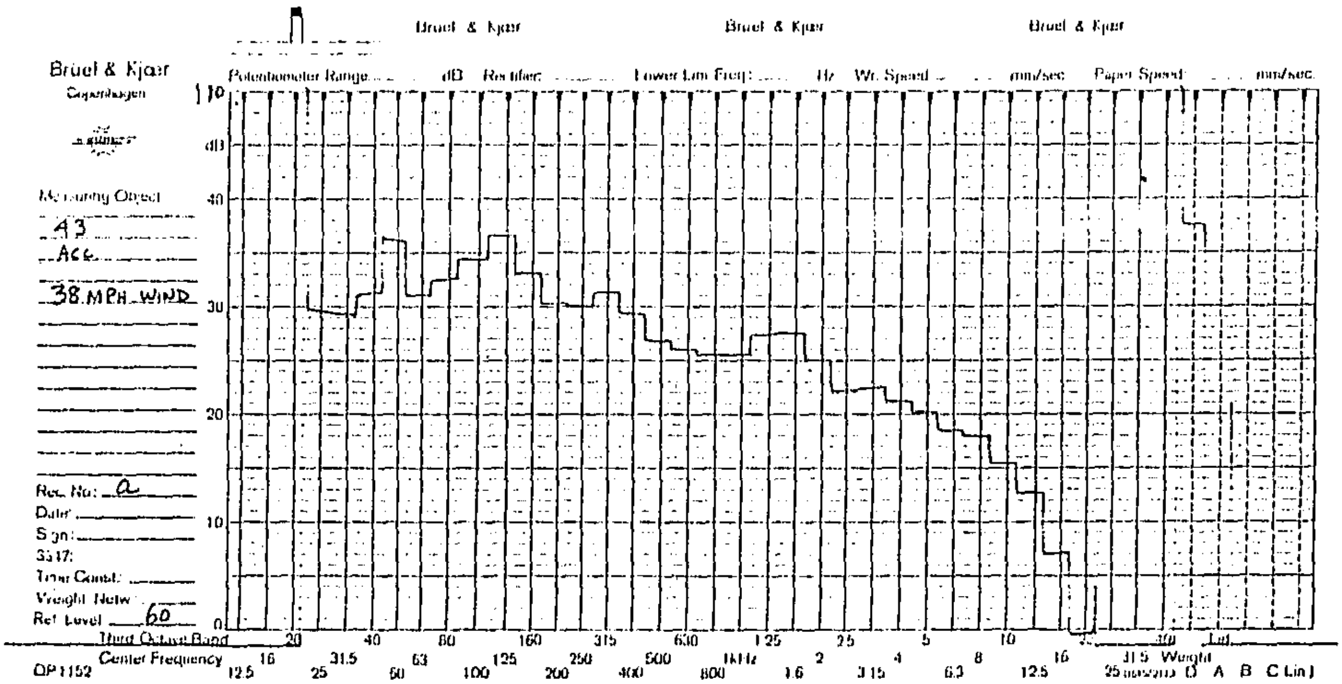


FIGURE 6a. SPECTRUM AT POINT "a" OF FIGURE 6

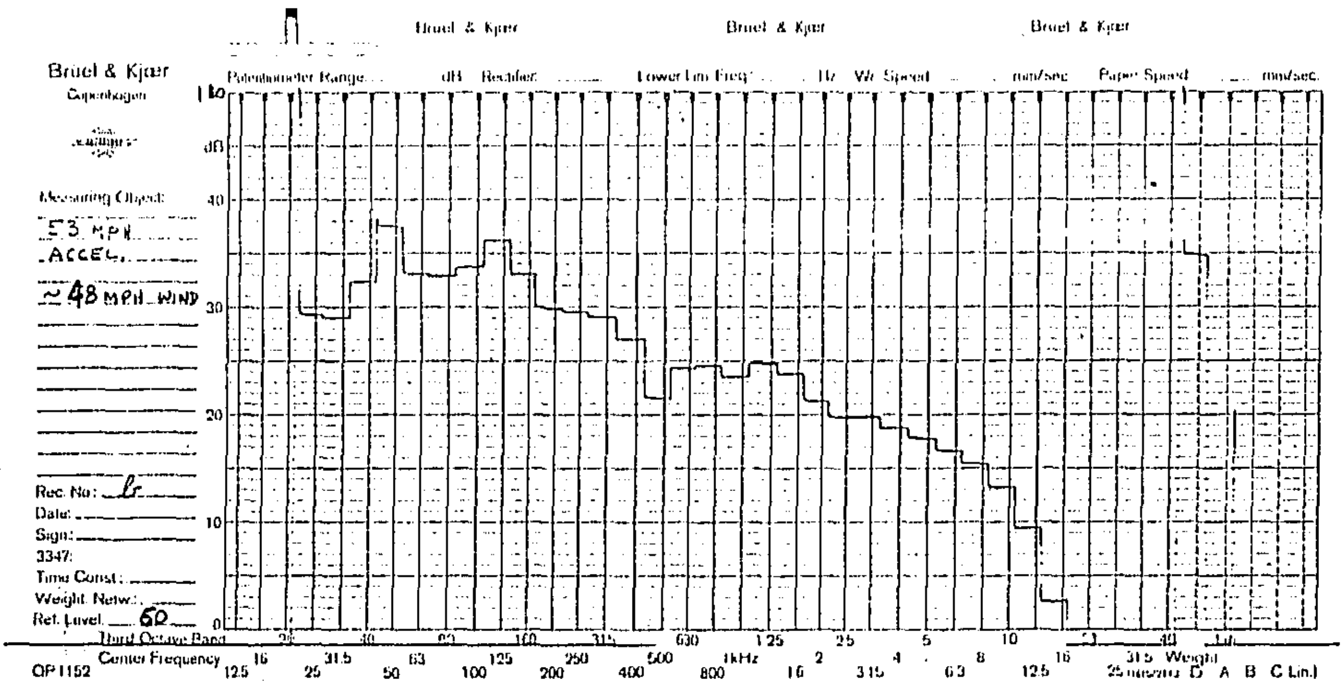


FIGURE 6b. SPECTRUM AT POINT "b" OF FIGURE 6

E-25

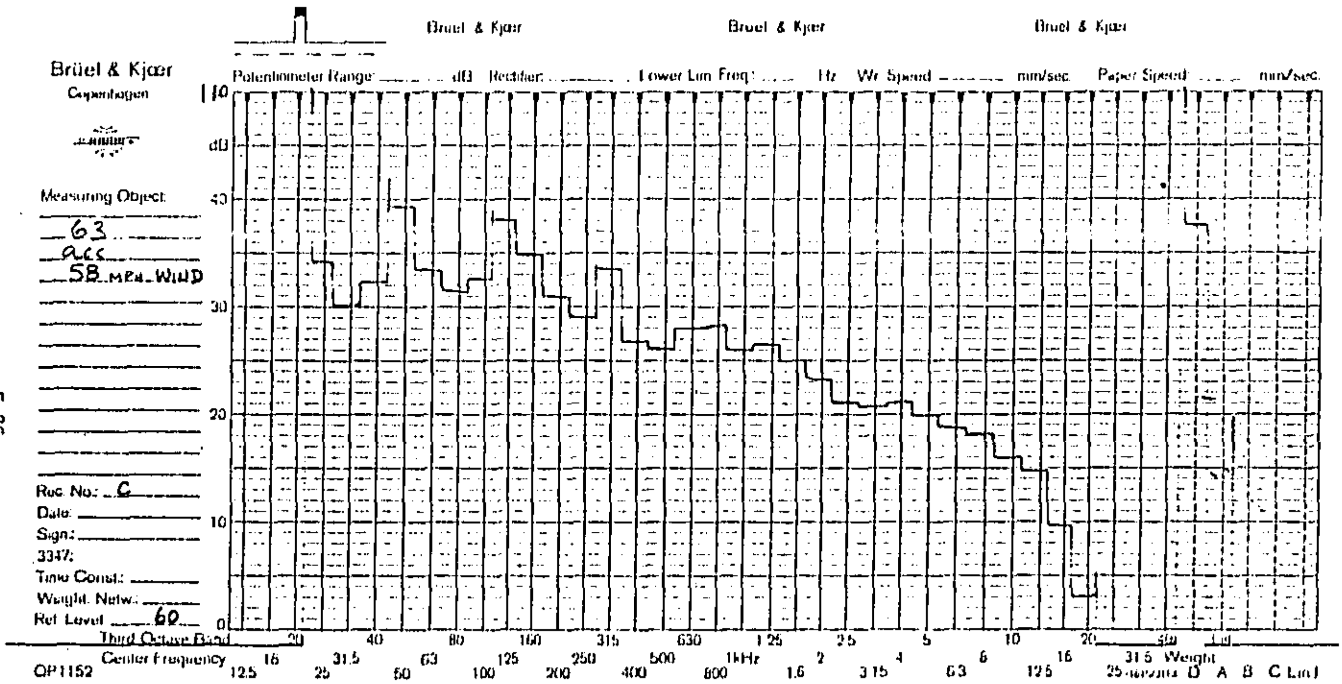


FIGURE 6c. SPECTRUM AT POINT "c" OF FIGURE 6

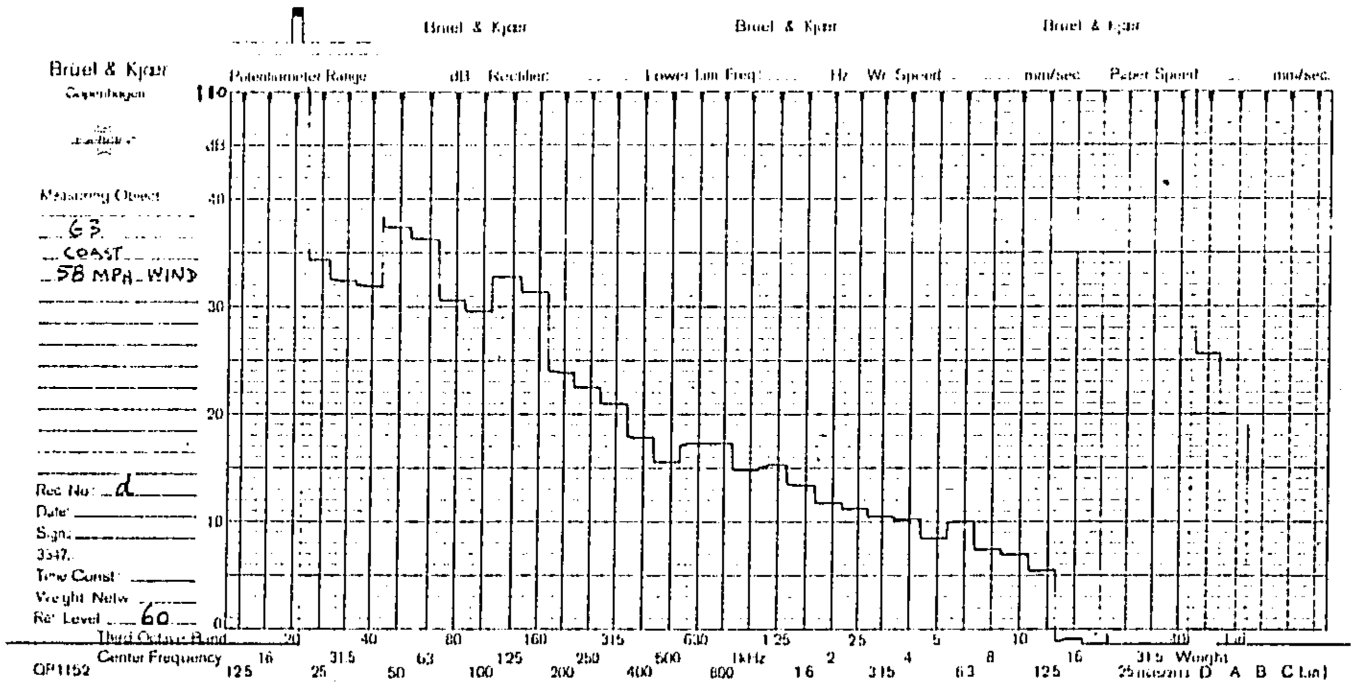


FIGURE 6d. SPECTRUM AT POINT "d" OF FIGURE 6

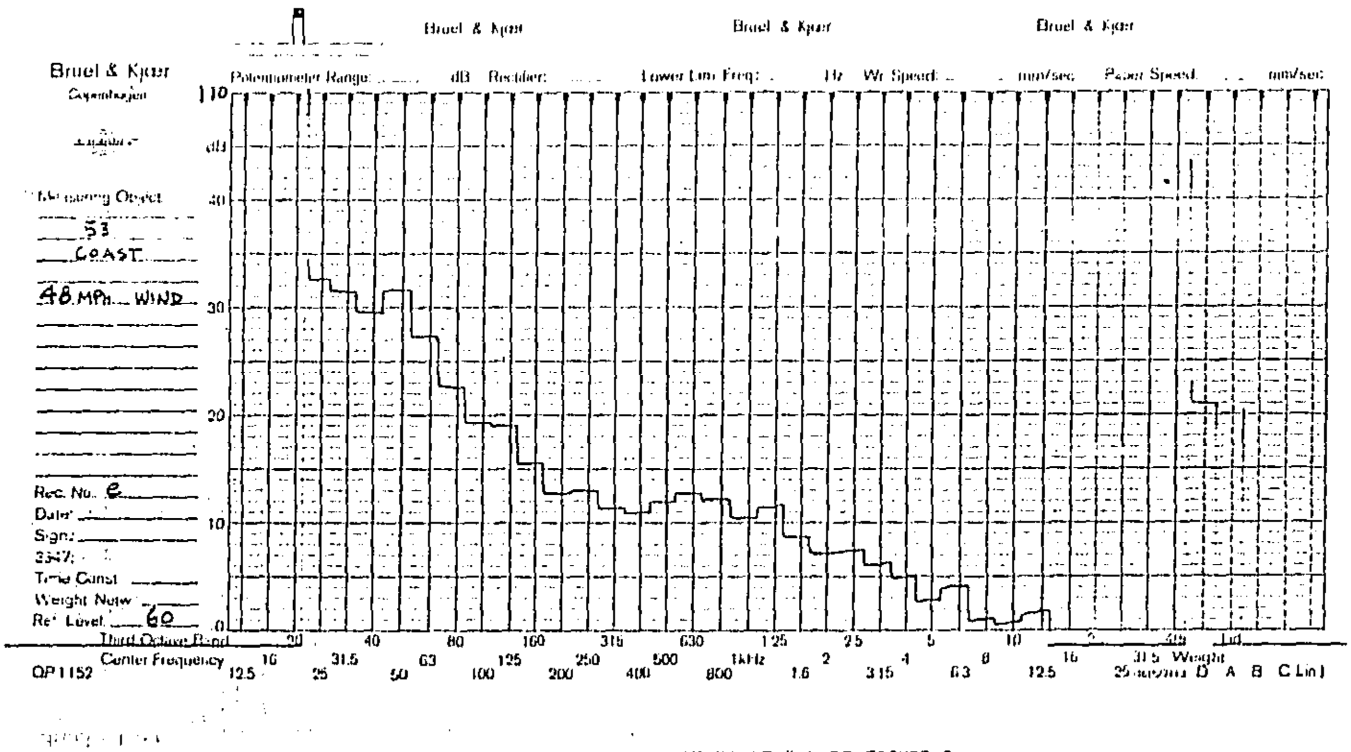


FIGURE 6e. SPECTRUM AT POINT "e" OF FIGURE 6

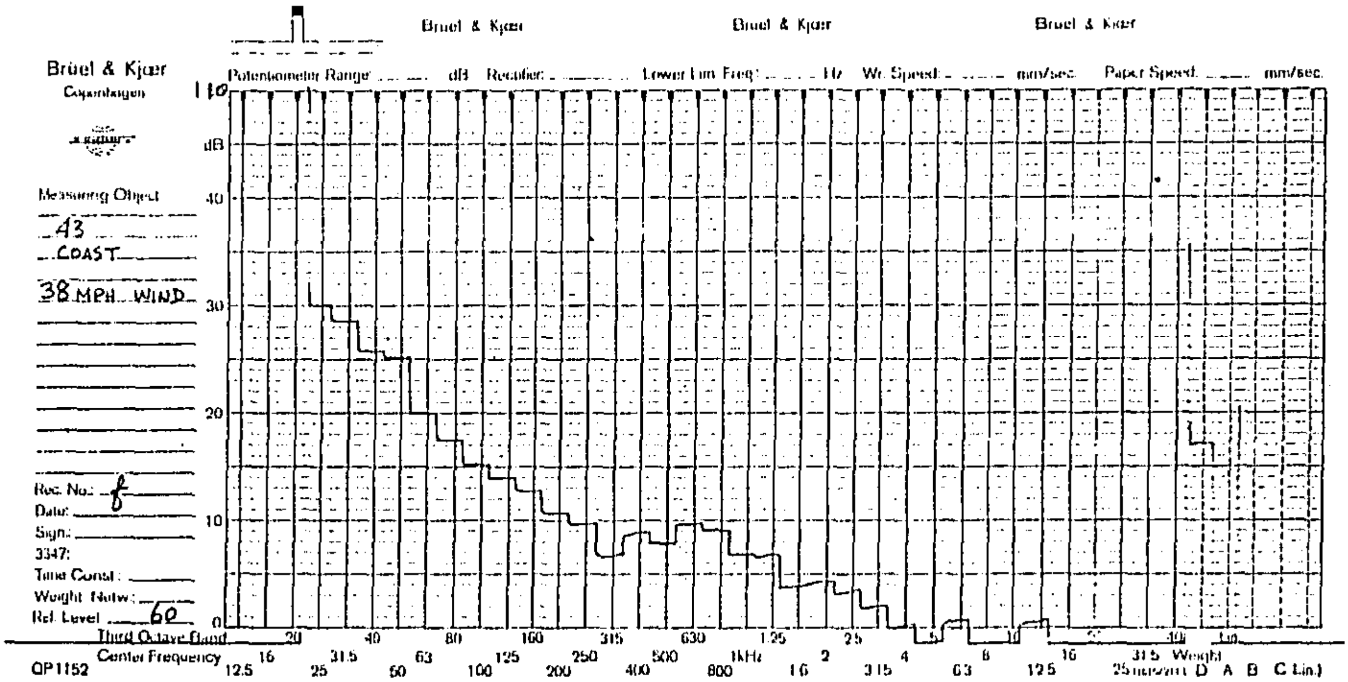


FIGURE 6f. SPECTRUM AT POINT "f" OF FIGURE 6

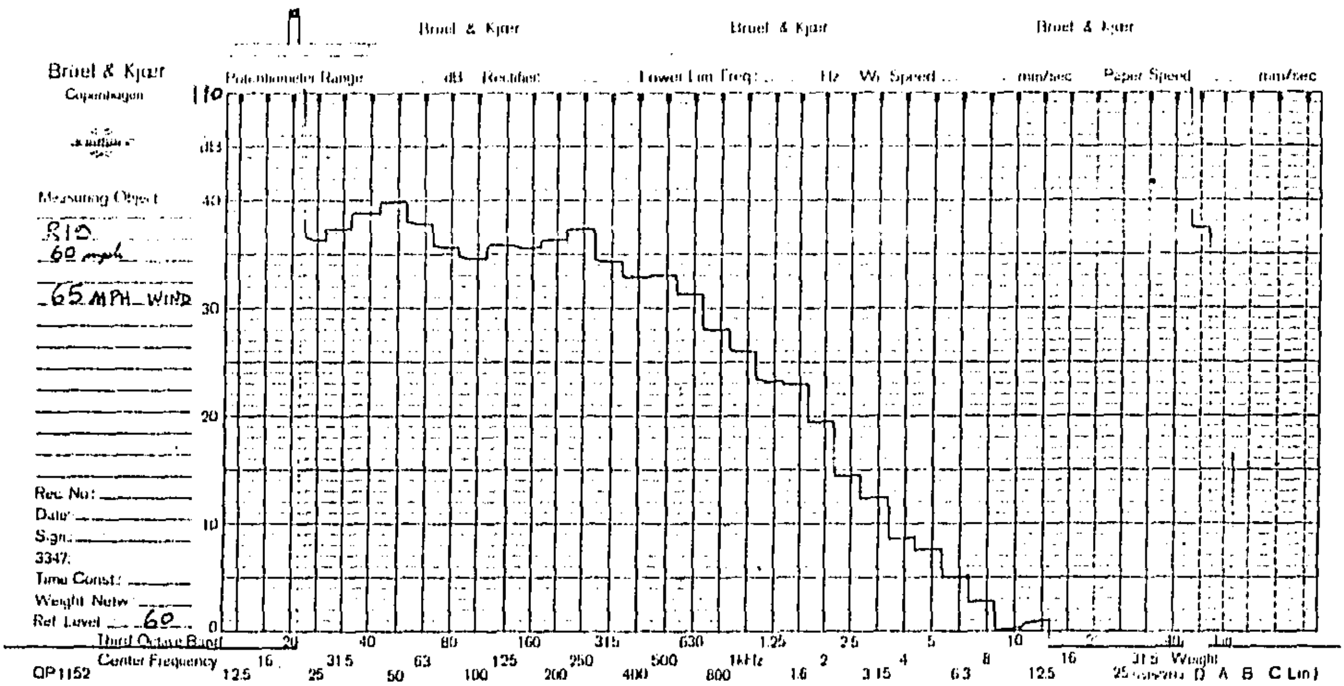


FIGURE 7. SPECTRUM OF EAR LEVEL WIND NOISE AT 65 MPH WITH HELMET ON

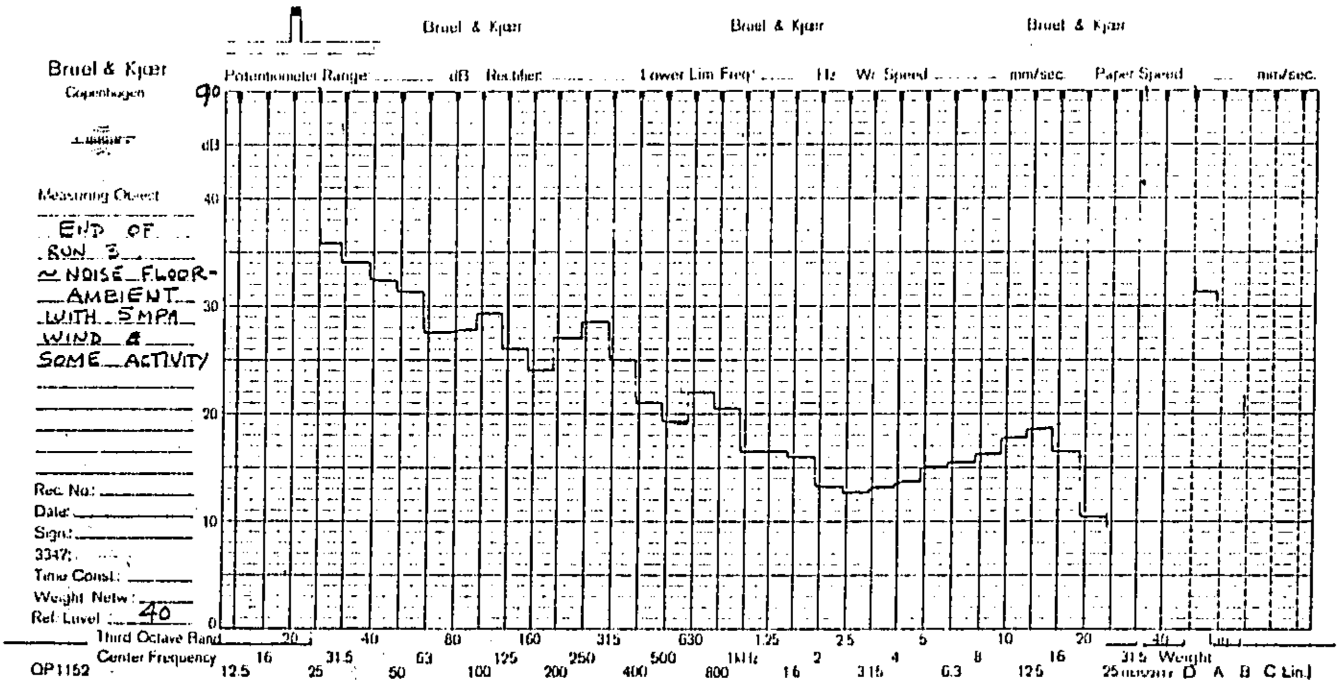
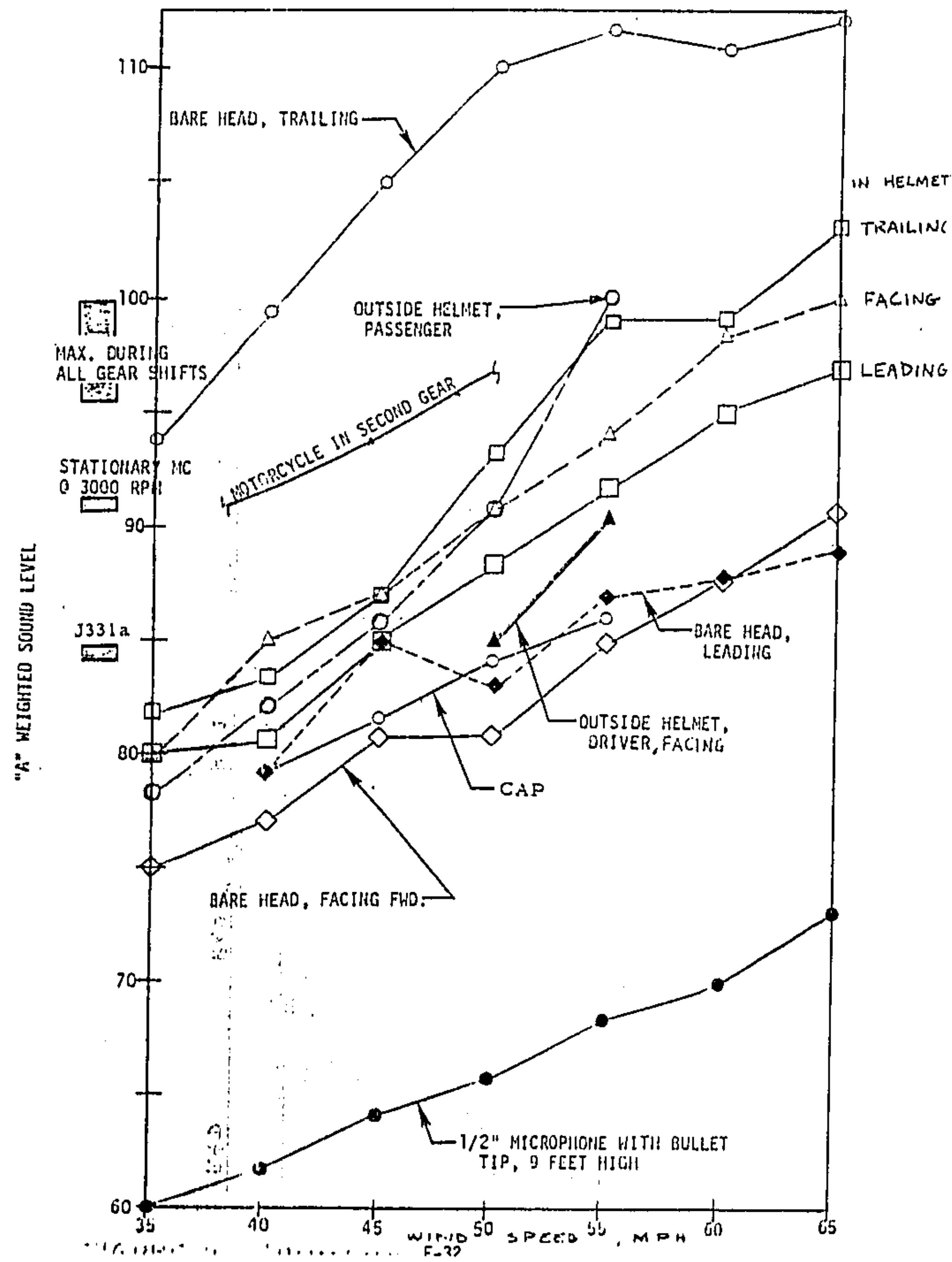


FIGURE 8. SPECTRUM OF NOMINAL AMBIENT NOISE AT TEST SITE

FIGURE 9. SUMMARY OF DATA



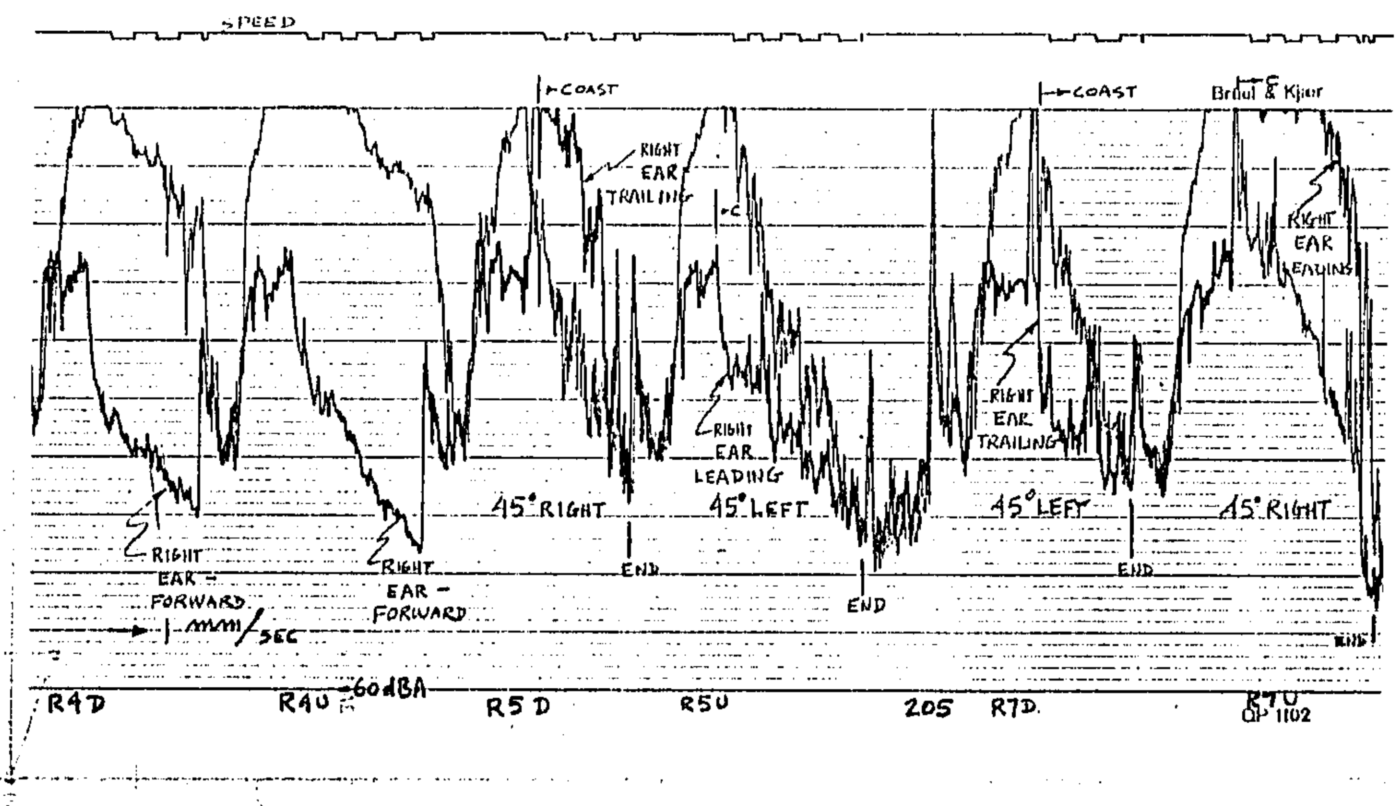


FIGURE 10. HEAD ATTITUDE EFFECTS

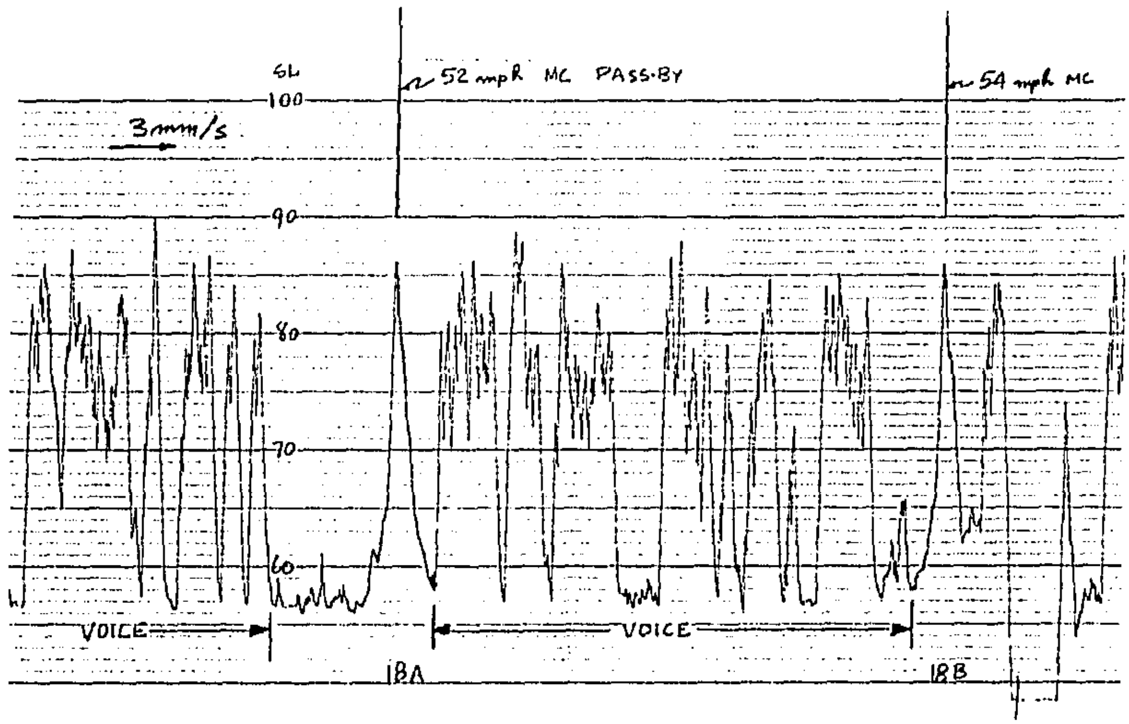


FIGURE 11. STATIONARY MICROPHONE MOTORCYCLE EAR LEVEL PASSBY AT LESS THAN 6 INCHES

APPENDIX F

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. Statistical equations were estimated econometrically by relating unit motorcycle sales (by type and function) to demographic, income, prices, and motorcycle characteristics (i.e., price) 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 was 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 number of males with income by age cohort is reported annually by the Bureau of the Census.

INCOME

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.

i.e.: $$S_t - S_{t-1} = \alpha(\overset{*}{S}_t - S_{t-1}) \qquad (1)$$

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 α = 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; 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 (from (2) above.

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 DRI's Age Income Matrix Model. These annual data were distributed linearly to generate monthly time series data.

INCOME

The income variable selected to reflect 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 age 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. This series is given in Appendix A.

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, the consumer price index for durable commodites, and the consumer price index for all commodities. 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 c.c. 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 by DRI 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 were dropped from the equations.

The basic hypothesis tested for unit motorcycle sales was:

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

Where:

$UNITSSA_i$ = Unit sales, seasonally adjusted, for the $_i$th 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_i = The price of the $_i$th 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.

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 DRI's Age Income Matrix. The forecast of the Consumer Price Index was generated by DRI'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 on-road, off-road and combination unit sales; on-road, off-road and combination unit sales by two-stroke/four-stroke breakouts, and on-road, off-road and combination unit sales by c.c. classes, were generated using DRI's MODSIM software. (Stored on-line on DRI'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. <u>Estimated Equations</u>

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.

This formulation reflected a) the adaptive purchasing behavior outlined above, b) the influence of aggregate 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. Firstly, <u>unit sales, seasonally adjusted, per consuming population group</u> was estimated econometrically. To determine how well these formulations implicitly explained <u>actual unit sales</u>, (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 statistcally 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 <u>increase</u> in the relative price of motorcycles vis-a-vis the CPI, total unit motorcycle sales will <u>decline</u> by .738 percent, holding everything else constant, b) for every 1 percent <u>increase</u> in the real income of the 20 to 34 male population age groups, total unit motorcycle sales will <u>increase</u> by approximately 1.4 percent, other things being equal.

This formulation explains over 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 above) 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 * UNITSTSACAPLAG1
(2.67635)
-4244.29 * RELPT
(3.17453)
+.613208 * MEAN20@34
(4.80927)
+5573.28 * DUM7312
(6.65)
+4638.40 * DUM741

$\bar{R}^2$ = .8255 FIT: MONTHLY 73:2 to 75:12

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

$\bar{R}^2$ = 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

UNITSTSACAPLAG1 = 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.

A plot of the actual unit sales against the estimated unit sales is given below. The detailed regression results are given in Appendix B.

The same basic specification and functional form of the equations was followed for each type of motorcycle (i.e., on-road, off-road, combination, by two-stroke and four-stroke breakout and by c.c. 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 c.c. classification, the price of competing types of motorcycles was introduced into the equations in order to generate estimates of elasticities of substitution between different types of motorcycles. However, on statistical grounds, this attempt proved unfeasible. Summary statistics of the estimated equations as well as plots of actual unit sales against estimated unit sales by motorcycle class are given below. Detailed regression results are given in Appendix I.

Summary tables for each motorcycle category, showing coefficients, t-statistics and elasticities of the explanatory variables, along with the transformed $\bar{R}^2$ and the Durban Watson Statistics are provided in Tables 46 through 50.

TABLE F-1

ON-ROAD DETAIL

	LAGGED UNIT SALES COEFFICIENT (T-STATISTIC)	RELATIVE PRICE		MEAN INCOME		TRANSFORMED $\overline{R}^2$	DURBIN WATSON
		COEFFICIENT (T-STATISTIC)	ELASTICITY	COEFFICIENT	ELASTICITY		
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 - DETAIL

	LAGGED UNIT SALES COEFFICIENT (T-STATISTIC)	RELATIVE PRICE		MEAN INCOME		TRANSFORMED $\bar{R}^2$	DURBIN WATSON
		COEFFICIENT (T-STATISTIC)	ELASTICITY	COEFFICIENT (T-STATISTIC)	ELASTICITY		
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

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 on-road, off-road and combination 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 (on-road, off-road and combination, by c.c. 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. These data are displayed in the appendix. 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.

TABLE F-3

COMBINATION - DETAIL

	LAGGED UNIT SALES COEFFICIENT (T-STATISTIC)	RELATIVE PRICE		MEAN INCOME		TRANSFORMED $\bar{R}^2$	DURBIN WATSON
		COEFFICIENT (T-STATISTIC)	ELASTICITY	COEFFICIENT	ELASTICITY		
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 (4.809	1.39	.8416	1.6054
TOTAL ON-ROAD UNIT SALES	.281494 (2.37492)	-1067.83 (2.79 59)	-.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 COMBINATION 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 $\bar{R}^2$	DURBIN WATSON
		COEFFICIENT (T-STATISTIC)	ELASTICITY	COEFFICIENT	ELASTICITY		
TWO-STROKE							
On-Road	.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
Combination	.4898 (5.88)	-1612.38 (2.17)	-.7999	.138436 (3.1487)	1.225	.8247	1.5949
FOUR-STROKE							
On-Road	---	-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
Combination	.619465 (6.368)	-419.938 (1.37)	-.545	.03336 (2.088)	.85	.7761	1.7129

APPENDIX G

RELATION BETWEEN STANDARD TEST METHODOLOGIES AND REPRESENTATIVE ACCELERATION CONDITIONS

1. Introduction

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

2. 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 has been investigating for use in Federal regalations (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 Chapter 3, sound 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 <u>average</u> 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.

3. Adjustment to Sound Level Measured Under Standardized Tests

Since J-331a and other tests are not directly useable for noise impact analysis, certain adjustments must be made to measured values. EPA is aware of several studies that 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 sound 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 generated sound levels.

Since direct relationships between operational sound levels and standardized test sound levels are not available, the health and welfare analysis requires several assumptions to be made. EPA attempted to develop a relationship between sound 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 sound 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 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, displayed 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 sound levels at ten percentage points less than F-76a closing RPM were obtained from the data in Appendix C. Table C-12 contains sound 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 sound 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 sound levels at ten percentage points below F-76a closing speed (full throttle) would be between one and two dB(A) 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 sound level as a function of acceleration rate, but that is not seen to be 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(A)). Wanting directly applicable information, it is assumed that the effect of less-than-full throttle acceleration amounts to one-to-two dB(A) for most motorcycles. Additional measurements to quantify this phenomenon are seen to be desirable.

The combination of the two assumed adjustments to J-331a or F-76a sound levels for representative accelerations amounts to a two to four dB(A) decrement across all model lines. Accordingly, the health and welfare analysis uses the assumption that F-76a or J-331a sound levels less 3 dB(A) are representative of accelerations in unconstrained traffic conditions.

4. 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.

(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 sound levels of motorcycles have fallen from the high to low 70's (dB(A)) over the past six years. Further, it was found that acceleration sound levels of motorcycles (with modified motorcycles included) range from mid-70's to high 80's. Differences between acceleration and cruise levels were found to vary between 3.5 and 12 dB(A). These differences between acceleration and cruise sound 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 sound levels. However, the sound 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 sound level would remain the same under both of these operating conditions. Examing Table G-3, it can be seen that the sound level representative of the upper tenth percentile of motorcycles shifts from 6.5 dB(A) below "present limit" under cruise conditions to 1 dB(A) below "present limit" under acceleration conditions, a change of 5.5 dB(A). 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(A) louder than cruise operations and that grade operation is about 7 dB(A) louder than cruise.

The Chicago Urban study[6] also measured sound 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 A-1 of that study (Figure G-2) shows acceleration sound levels of 80.1 dB(A) (s = 5.6) and cruise levels of 73.3 dB(A) (s = 4.4), a difference of 7 dB(A).

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 sound 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 sound level of 10.3 dB(A) (s = 3.2).

If 7 dB(A) is used as the difference between motorcycle sound levels under acceleration and cruise conditions, and if 10 dB(A) 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 sound levels less 3 dB(A) 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(A) 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 sound levels of unmodified motorcycles tended to be in the mid-to-low 70's (dB(A)) 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 sound levels some 5-12 dB(A) 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.

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.

TABLE G-1

MOTORCYCLE ENGINE SPEEDS AT 28 MPH

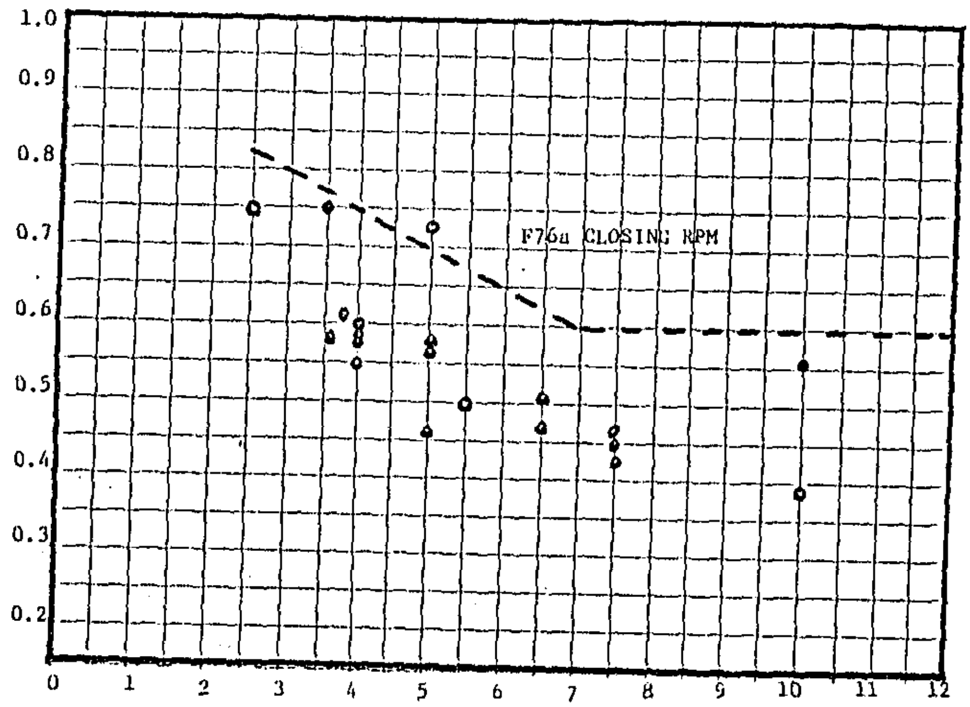
MODEL	ENGINE SPEED AT 28 MPH - 2ND GEAR (RPM)	RATED ENGINE SPEED (RPM)	FRACTION OF MAXIMUM RATED RPM AT 28 MPH
Honda			
CB-550K	4000	8000	0.50
CB-500T	3900	8500	0.46
CB-400F	5200	6000	0.58
XL-350	5500	7500	0.75
Yamaha			
XS-750D	3200	7000	0.47
XS-650D	3200	7000	0.47
XS-500C	4600	8000	0.58
RD-400C	4100	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 SOUND LEVELS AT TEN PERCENTAGE POINTS LESS THAN F-76a CLOSING ENGINE SPEED

Bike Number	Motorcycle Model		F76a Sound Level Less F-76a - 10% Sound Level (dB(A))
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(A) $s = 0.72$ dB(A)

Source: Table C-12

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	56	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	59	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

"Chicago Urban Noise Study"

1971

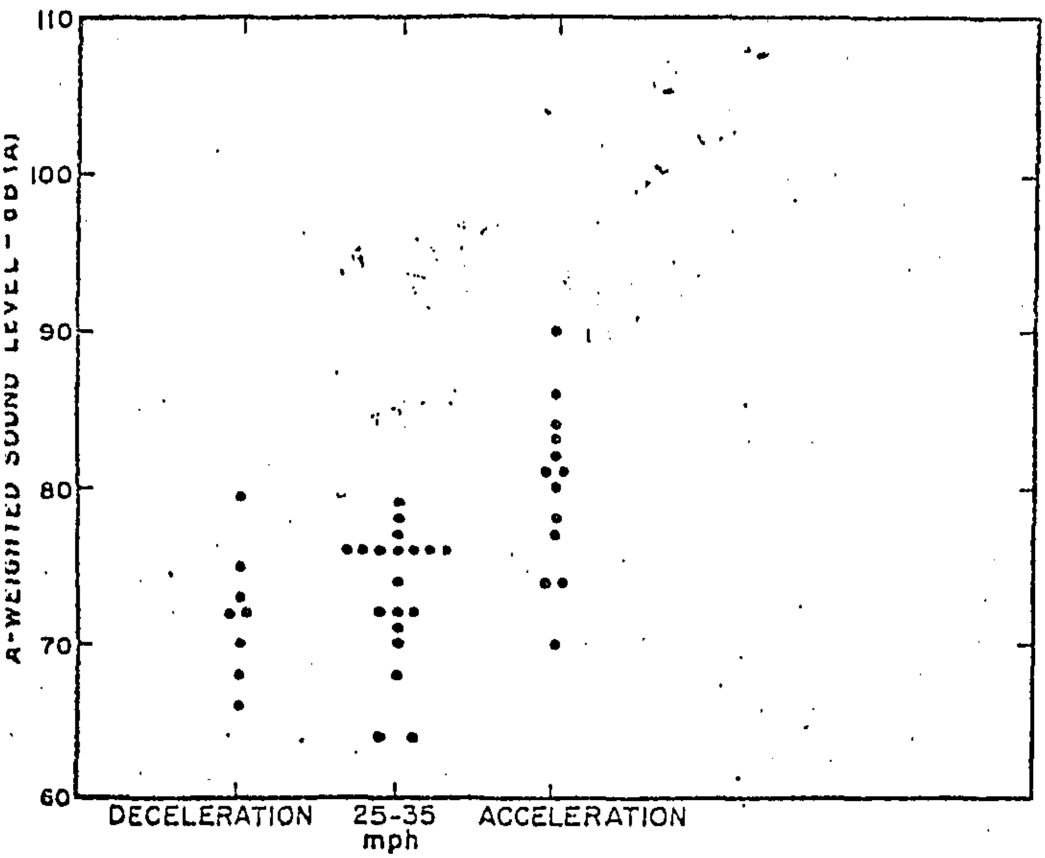


FIG. A-1 NOISE OF MOTORCYCLES WITH STOCK MUFFLERS
Data Normalized to 50 Ft — 40 Samples

Figure G-2

Source: Illinois Task Force on Noise Motorcycle Noise Levels - A Report on Field Tests (Ref. 7)

TABLE G-4

REPORTED RESULTS ON MOTORCYCLE ACCELERATION TESTING

(TABLE 1. MOTORCYCLE SUMMARY)

	Year	Make	Size (cc)	dB(A) Tendency	Maximum dB(A) Recorded	Overall Maximum dB(A)	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

Source: MOTORCYCLE NOISE LEVELS - A REPORT ON FIELD TESTS (Ref. 7)

TABLE G-5

J-331a SOUND LEVELS COMPARED WITH MOTORCYCLE SOUND LEVELS UNDER ACCELERATION

Motorcycle Model	J-331a Sound Level (dB(A))	Acceleration Sound Level (dB(A))	Difference (dB(A))
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

APPENDIX H

RECENTLY GATHERED MOTORCYCLE SOUND LEVEL DATA

INTRODUCTION

In a previous study conducted for the U. S. EPA, McDonnel Douglas obtained baseline noise emission data on new motorcycles and aftermarket products, evaluated existing noise test methodologies, developed improved testing concepts, and identified problem areas.

In that study, baseline data were obtained using the J331a test procedure. The J331a measured level however, is sensitive to sprocket ratio changes, not proportionate to any real change in the vehicle's noise emission. The method is similarly sensitive to gear selection in the test (which may be a subjective decision); for some vehicles ambiguity occurs, permitting two results differing by up to 6 dB. The reason for this variability is that the distance from the motorcycle to the microphone, at closing rpm and power, is not controlled.

To obviate this situation, a test procedure designated F76 was developed. In this procedure, 75% rpm at full throttle is always reached at a point 25 feet past the microphone. Statistically the F76 level is about 4 dB higher for the large motorcycles, and 2 dB lower for the small ones.

A variation of the F76 method, designated F76a was then developed empirically and was subjected to brief experimental verification. It differs from the F76 in that instead of testing at 75% rpm, the test rpm is 90% for 100 cc motorcycles, reducing with displacement to 60% rpm for motorcycles of 700 cc displacement and larger. The method was designed to yield statistical correspondence with the J331a method, and to recognize the fact that the smaller machines, both in acceleration and constant speed modes tend to operate closer to maximum rpm and power than do the large motorcycles.

In any of the above test procedures, tachometer accuracy, and tachometer lag, can affect the measured sound level. If the tachometer lags substantially the true rpm, the closing rpm will be higher than specified, resulting generally in a higher measured sound level.

The present study, reported herein, is an extension of the previous work, and is directed at further evaluation of the F76a method, and at means of eliminating tachometer variables. The present study also addresses stationary vehicle test methods which may be correlateable to the moving test method.

In the course of the current study, the opportunity was also taken to obtain sound levels prevailing at the rider's ear during various operational modes of the motorcycle.

SECTION 2

SCOPE OF WORK

The study reported herein encompassed the following tasks:

A. Measurement of noise emission of 32 representative motorcycles, using test procedures J331a, F76, F76a, and F50. This provides measured F76a data (in contrast to interpolated/extrapolated F76a data provided by the previous study), relateable to the other test methods. The vehicle tachometer was employed where so equipped; otherwise a portable tachometer was installed.

B. Measurement of noise emission of the same motorcycles using a variation of the F76a test, at an rpm different from the F76a and F76 rpms. This provides three data points per vehicle, for assessing effect of rpm (at full throttle) on noise emission.

C. Development of a technique for measuring road speed to verify the F76a closing rpm. Methods evaluated included use of a radar gun, a laser-beam speed gate, and a tape-switch speed gate. The tape-switch technique was adopted to provide the rpm reference, to which other methods of establishing rpm could be compared.

D. Measurement of noise emissions by F76a procedure using the tape-switch speed gate (instead of the vehicle tachometer) to establish specified closing rpm. This permits quantifying sound level measurement error in relation to tachometer lag.

E. Tachometer evaluation; evaluation of various tachometers in the F76a test application. Tachometers evaluated include:

    Vehicle Tachometers (Japanese, U.S., European)
    Sanwa MT-03 (inductive connection to secondary)
    Rite Autotronics 4036 (inductive connection to secondary)
    Dynall TAC-20 (series connection in secondary)
    Harmon Tack II (digital, Max. hold, direct connection to primary)
    AESi (prototype, digital, max. hold, direct connection to primary)

Hartman Wireless (no connection required)
VDO special (variable damping, mechanical drive)
Auto Meter 439 (direct connection to primary)
Auto Meter Rev-Control 451 (engine shut-off, direct connection to primary)

F. Evaluation of IMI test procedures: IMI-C, IMI-E and IMI-C50; manual operation and by ignition disable by Rev-Control. (Note: the letters IMI stand for idle-max-idle, a carry-over from the diesel truck stationary test; not an accurate descriptor in this case.) In the IMI-C test, with the vehicle stationary, the engine is stabilized at 50% rated rpm, the throttle rapidly fully opened and throttle closure initiated at the F76a rpm. Sound level measurements are taken at 10 ft. to the side of the vehicle. IMI-E is similar, except the throttle is opened at 500 rpm above idle, closure initiated at F76a minus 15% rpm. The IMI-C50 is the same as IMI-C except measurements are taken 50 ft. to the side, 25 ft. aft of the motorcycle, simulating the microphone-vehicle relationship of the moving F76a test.

Data from this task permit assessment of the degree of repeatability of the IMI methods, and their correlation with the moving test levels.

G. Dynamometer tests at part throttle. The F76a data, and similar data obtained at different closing rpms, show the effect of rpm at full throttle on noise emission. Dynamometer tests were carried out on one motorcycle to show the effect on noise emission of throttle setting (torque) at constant rpm.

H. Noise measurements at the rider's ear during various operational modes of the motorcycle. The data obtained permit generalized estimates of rider exposure to noise, relateable to vehicle noise emission levels.

SECTION 3

RESULTS AND DISCUSSION

3.1 Noise Emission Data Base, F76a Procedure

F76a noise emission data, obtained on 32 representative motorcycles, are presented in Table A. Included in the table are data obtained at other closing rpm's, and comparison J331a 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 (Fig. 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 by 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 consistency 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 bikes 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 occurring 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 A were obtained with closing rpm probable accuracy within 2%

Photographs B1 thru B14 show the McDonnell Douglas test track and instrumentation employed.

3.2 Effect of Tachometer Lag

In Table B, 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 sound levels. Although sound levels and sound level increments are shown to tenths, the incremental data must not be considered accurate or reproducible to better than 0.5 dB, nor the sound level data to better than 1 dB.

Analysis of those cases where a sound level difference of 0.5 dB or more is experienced between the gate and tach methods, the approximate relationship between sound level error and tachometer error is shown to be:

$$\Delta \text{dB}/\%\ \Delta \text{rpm} = 0.2 \pm 0.1$$

That is, a 1% error in rpm can be expected to result in a 0.2 dB error in sound level. For measurement accuracy within 0.5 dB, closing rpm should be controlled within 2%. Typical variations in sound level vs. engine rpm are shown graphically in Fig. 2.

3.3 Gear Selection and Acceleration Distance

The F76a 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. In the current study, 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 C extends the information presented in the previous study (Ref. 1) on the effect of gear selection, and shows the same trend: differences of 1 dB are not uncommon. This is much less than differences resulting in the J331a test. While the 1 dB difference is more than would be desired, it reinforces the earlier finding that 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 bikes cannot attain the 50 ft. distance before reaching the specified rpm even in highest gear;
- some bikes 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.

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.

3.4 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 in section 3.1).

3.4.1 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 activate 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 we placed one-inch wide metal strips over the tape switches; this is not a recommended procedure, however, 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 B-6 shows the tape switches, together with optical speed measuring instrumentation employed.

3.4.2 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 B-4 thru B-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 displaced vertically one-inch above the initial pass. In this way a high probability exists for the light beam to be interrupted by the forward edge of a knobby tire. Also, the higher accuracy inherent in this technique would permit 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 as to maintain alignment after repeated vehicle passes. Accordingly, for expediency in the test conduct, we reverted to the tape switches as being adequate for the objectives of the study.

3.4.3 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 can be supplied) are 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 derives from the fact that the rate of change of rpm in the F76a test is typically in the range 1000-2000 rpm/second. If resolution to 100 rpm is desired, sampling interval must be not greater than 0.05 seconds.

The radar gun can be either stationary, or mounted on the vehicle, reading a stationary target. The technique has the advantage that maximum speed determination is not tied to vehicle position; a position variation of $\pm$ 5 ft has no effect on measured noise emission, providing the correct closing rpm is attained. This permits greater latitude in vehicle operation than do the optical or tape switch techniques.

A further potential feature of the radar gun technique is that if the gun is 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 in this study to a) demonstration of feasibility of the concept, and b) identification of sources of commercially available units having the required features.

3.5 Engine RPM Measurement Techniques

The vehicle speed measurement techniques offer uniform application to a broad range of vehicles, but require correlation of vehicle speed with engine rpm; application to vehicles with automatic transmissions is excluded. Direct measurement of engine rpm has fundamental advantages, but such techniques must address 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 B-2) were evaluated in relation to their suitability for engine speed measurement in the F76a test:

3.5.1 Vehicle Tachometers

The tachometers supplied on the Japanese motorcycles (as opposed to the European and American motorcycles) are heavily damped, resulting in tachometer lag under vehicle acceleration. This damping is intentional, giving a very steady and smooth rpm indication. The associated lag, however, results in F76a closing rpm higher than specified; due to this, measured values of noise emission in the order of 2 dB higher than appropriate are not uncommon (Table B). This difficulty is not experienced in the BMW or the large Harley-Davidson street motorcycles.

3.5.2 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 is directly interchangeable with the vehicle tachometer, and because its internal configuration is 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 D). 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 shows that the vehicle manufacturer's options would include (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 D) is the Auto Meter (Auto Meter Products, Inc., Elgin, Illinois) Model 439. It is a fast response electronic tachometer, connecting to the ignition primary, but requiring interface electronics for connection to vehicles with CDI ignition. The tachometer has provisions for ignition disable (discussed later). At the present time, the unit must be ordered for a specific number of pulses per revolution; interestingly, one pulse per revolution was appropriate for all vehicles shown in Table D.

3.5.3 Digital Tachometers

The digital tachometer type offers potential for high accuracy, and its circuitry lends itself to additional features such as max-hold read-out and pre-set ignition disable. The digital display, however, is not well suited for rider control of closing rpm in the acceleration test; for rider control, an analog display is considerably easier to use.

3.5.4 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 D). The tachometer functioned well, requires no connection to the motorcycle, and can be mounted either on the motorcycle*or located remotely.

It was also demonstrated that the 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 sound levels can simultaneously verify that correct closing rpm has been attained on each pass.

3.5.6 Portable Tachometers

Motorcycles not equipped with tachometers necessarily require fitting a portable tachometer for conduct of the F76a test. Portable tachometers employed in the study include the Sanwa Model MT-03, the Rite Autotronics Model 4036, and the Dynall Model TAC-20. The Sanwa and Rite exhibit substantial lag (Table B); the Dynall is good in this respect but will not function on all motorcycles. The above three tachometers connect to the ignition secondary, which is an operational convenience.

The Auto Meter 439 (or 430 series) which although not designed for portable use, and requires connection to the ignition primary (e.g. to the kill button wire) is a suitable candidate for use in the F76a test. The additional option of ignition disable offers major additional advantages, discussed in the next section.

Other candidate portable tachometers include the Hartman Radio Tachometer (Section 3.5.4), and the Dixon Model 1081 Inductive Tachometer (Dixon, Inc., Grand Junction, Colorado). The latter is a close range RF tachometer, subjected to the specification review only, not evaluated in this study.

*The tachometer face must be vertical, otherwise the needle responds to inertial forces during vehicle acceleration.

3.6 Ignition Disable Techniques

Because of the dependence of measured sound 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, is the Auto Meter 451 Rev-Control. This combination of a low-lag tachometer with automatic ignition disable enhances 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 is connected to each system thru a diode, thus maintaining electrical isolation of the two systems (Fig. 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 D), the proper values were in the range 0.002 to 0.0072 mfd. For the test program a decade capacitor box having 0.0001 mfd steps was employed as an expediency measure; it is presumed that interface electronics could be selected to obviate need for such adjustment.

In the conduct of the F76a test using the Rev-Control, a single pass is sufficient to establish the acceleration start point. During the prescribed runs, when ignition disable occurs, the throttle is closed promptly, thus avoiding backfire when ignition is re-established by pressing the "re-set" button.

Referring to Table D, 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 is 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 in section 3.1).

3.7 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 is in 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) is in the order of 0.2 seconds, it appears that mental anticipation is 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 can be much greater than the rpm overshoot indicated by the tachometer. On bike No. 729, where the Dynall tach was used, indicated overshoot was 12,000 rpm (associated with an F76a rpm of 8200).

Sound level measurements taken on the various motorcycles by IMI-C and IMI-E procedures are presented in Table E. Considering the foregoing, the degree of repeatability and consistency among operators is better than might be expected - usually within a 3 dB range, although differences of 6 dB are 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 F. The substantial improvement in consistency is apparent. Also, comparing the IMI-C levels for bike No. 703 in Table F with that for the same bike in Table E, it is seen that considerably lower sound levels result with use of the Rev-Control. Table H provides further data on consistency among operators when the Rev-Control technique is employed in the IMI test.

In the IMI-C50 test, the same distance relationship between the vehicle and microphone prevails as in the F76a test at closing conditions. A comparison of noise emission measurements by the two methods is shown in Table G, and is seen to be sufficiently good as 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-C (sound level measurement at 10 ft.) and F76a, both by Rev-Control. We have such data on two motorcycles only: No. 703B where the difference is 14.8 dB, and No. 716A where the difference is 15.5 dB. The theoretical difference, by the inverse square law, is 15.0 dB. The closer distance offers obvious advantages in space requirements, environmental noise constraints, and perturbations by atmospheric factors.

3.8 Effect of Torque (Dynamometer Tests)

The objective in this task was to provide information on the effect of torque (at constant rpm) on sound levels. The portable dynamometer employed (Pabatco) was not well suited to this task, and only limited data were obtained (Table J). 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 effort on this task was discontinued.

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.

3.9 Operator Exposure to Motorcycle Noise

Sound 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 permit the use of a miniature piezoelectric ceramic microphone, two precision input attenuators, and an input filter network resulting in an A-weighted 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 the microphone, and inserting the microphone in a foam holder taked to the ear, solved the problem. The recorder, calibrator, microphone and microphone holder are shown in Photograph B14.

Tests were performed to determine the validity of the A-weighted sound 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 K, 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 K.

The average SL (rounded to the nearest dBA) at the ear of the operator during various moving motorcycle tests is shown in Table L; each of these SL is typically the average of from 6 to 12 passes. Ear level SL during IMI stationary tests are shown in Table M, and those obtained during stationary dynamometer tests are shown in Table N.

The difference between the formal 50 foot SL during passby tests and the average SL at the operator's ear during the same passby is shown in Table P. The mean SL difference for the whole set (n=31) is 19.6 dBA, with a standard deviation of 2.4. Note that it is about the same as the SL difference obtained in dynamometer tests (Table N).

Recordings of ear level motorcycle noise in presence of wind have clearly audible wind noise; this effect is shown in Table Q.

Typical SL at the operator's ear during the operator's verbalization are also shown in Table Q. Note that the highest recorded SL at the operator's ear is an operator's shout (118 dBA).

Major results of the ear level study are a) the rider will experience sound levels approximately 20 dB higher than the vehicle's 50-ft. noise emission level (with or without helmet), and b) inexpensive miniaturized sound recording equipment is available for operator noise exposure studies; application not limited to motorcycles.

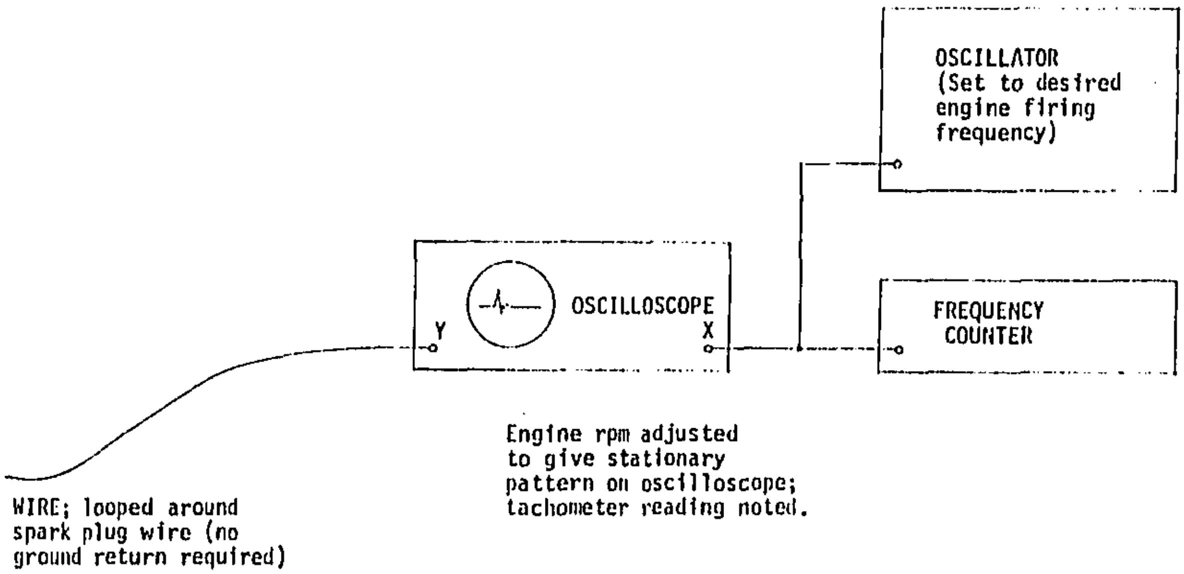


FIGURE 1. INSTRUMENTATION FOR CALIBRATING VEHICLE TACHOMETER

BIKE NO. 702 HONDA GL1000
705 KAWASAKI KZ1000
711 KAWASAKI KX125
719 HARLEY FLH-1200
724 HONDA XR75
733 CAN-AM 125

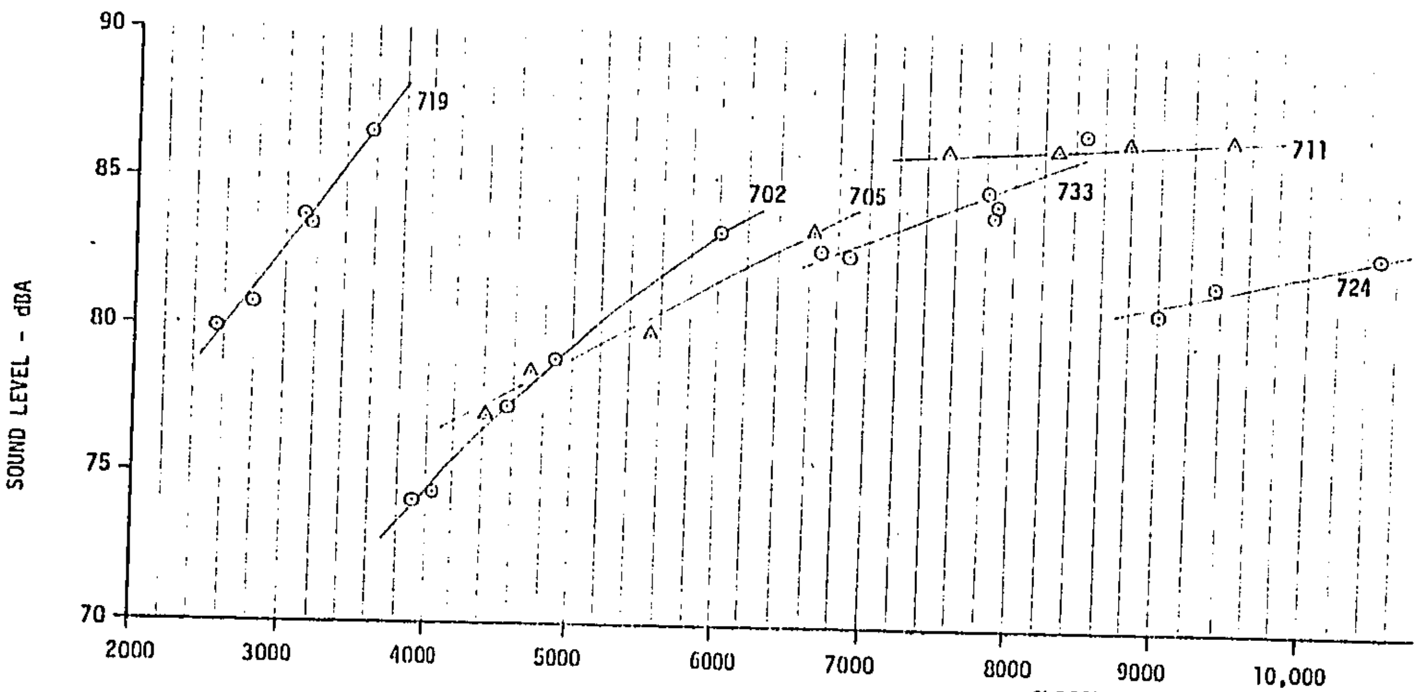


FIGURE 2. MEASURED SOUND LEVEL AS A FUNCTION OF CLOSING RPM

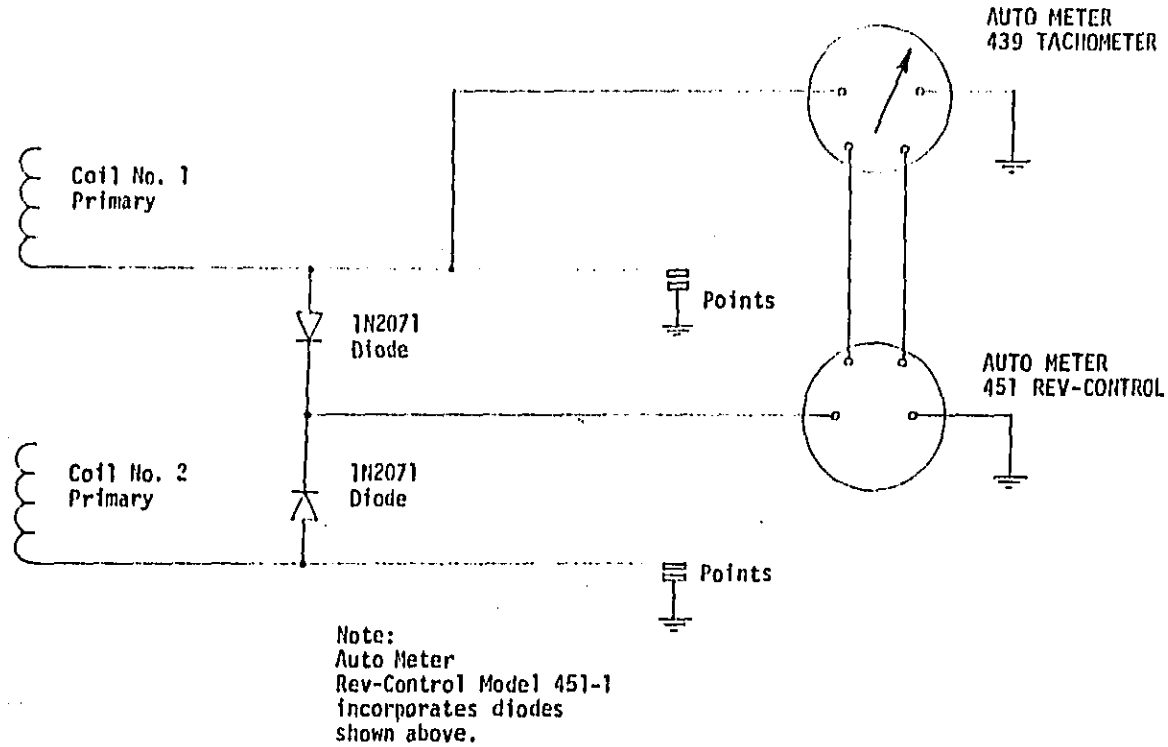


FIGURE 3. METHOD OF CONNECTING REV-CONTROL TO MOTORCYCLE HAVING DUAL IGNITION SYSTEM

TABLE A. 1977 MOTORCYCLE SOUND LEVELS

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
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 A. 1977 MOTORCYCLE SOUND 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 A. 1977 MOTORCYCLE SOUND 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	Δ 732*	83	81	83(2nd) 82(3rd)	83 82	50-82.5	83	50-90	
Can-Am Qualifier 125	Δ 733*	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

TABLE B. EFFECT OF TACHOMETER LAG, F76a TEST

Bike	Make/Model	Max. HP rpm	F76a Level dBA by gate	F76a Level Δ dB by tach	Closing rpm rpm by gate	Closing rpm Δ 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

*Bike tach employed where so equipped; portable tach employed as listed.

TABLE C. EFFECT OF GEAR SELECTION, F76a TEST

Bike No.	Make/Model	Tachometer	Gear	F76a	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
			34d	85.0	72

TABLE D. TACHOMETER AND REV. CONTROL COMPARISONS, F76a TEST

Bike 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

TABLE E. IMI SOUND 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

BIKE 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 E IMI SOUND LEVELS (Cont'd) (Procedures C and E)

BIKE 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 C IMI SOUND LEVELS (Cont'd) (Procedures C and E)

BIKE NO.	MAKE/MODEL		IMI "C"				IMI "E"					OPERATOR
704	Honda MR250 (Rite Tach.)	L	104	103	103		102	102	102			TB
		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 E IMI SOUND LEVELS (Cont'd) (Procedures C and E)

BIKE 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	70	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 E IMI SOUND LEVELS (Cont'd) (Procedures C and E)

BIKE 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 E IMI SOUND LEVELS (Cont'd) (Procedures C and E)

BIKE 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 E IMI SOUND LEVELS (Cont'd) (Procedures C and E)

BIKE 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 E IMI SOUND LEVELS (Cont'd) (Procedures C and E)

BIKE 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 E IMI SOUND LEVELS (Cont'd) (Procedures C and E)

BIKE NO.	MAKE/MODEL		IMI "C"			IMI "E"			OPERATOR
723	Bultaco Alpina 350 (Sanwa Tach)	L	104	104	104	104	104	105	IW
		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 (Rite Tach)	L	101	100	102	101	100	102	TB
		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 E IMI SOUND LEVELS (Cont'd) (Procedures C and E)

BIKE 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 E IMI SOUND LEVELS (Cont'd) (Procedures C and E)

BIKE NO.	MAKE/MODEL		IMI "E"				IMI "E"			OPERATOR
729	Yamaha IT175D (Dynall Tach)	L	107	108	108		107	105	106	IW
		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 (Dynall Tach)	L	94	95	94		93	94	94	TB
		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	

TABLE F. IMI SOUND LEVELS (BY REV-CONTROL)

Bike No.	Make/Model		Sound Level - dBA				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 G. F76a vs F76a STATIONARY SIMULATION

	F76a Stationary Simulation (50 ft.)	F76a by Rev. Control
Bike No. 703C, Honda XL350	77.0	76.2
Bike No. 720, Harley SS175	79.5	78.6
Bike No. 725, Yamaha DT250D	81.8	81.7
Bike No. 730, Yamaha DT100D	77.8	77.7
Bike No. 733, CanAm Qualifier 125	84.7	84.4
Bike No. 702A, Honda GL-1000	76.8	78.3
Bike No. 734, CanAm Qualifier 175	87.6	84.2

TABLE II. TACHOMETER AND REV. CONTROL COMPARISONS, IMI-C TEST

		Bike Tach			Auto-Meter Tach			Rev. Control			Operator
Bike No. 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 J. EFFECT OF TORQUE (DYNAMOMETER TESTS)

Bike 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 K

COMPARISON OF LABORATORY STANDARD
SYSTEM (NAGRA) AND FIELD SYSTEM (SONY)
SOUND LEVELS (dBA)

	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
$\bar{L}$	104.0	104.5	HIGH:83.0	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
$\bar{L}$	104.1	104.3	HIGH:83.5	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
$\bar{L}$	104.1	104.4	HIGH:83.0	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 L

EAR LEVEL MOTORCYCLE NOISE - SOUND LEVELS ROUNDED TO NEAREST dBA

Bike No.	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 M

EAR LEVEL MOTORCYCLE NOISE DURING IMI TESTS

	Left $La_{10'}$	$\bar{\Delta}$	Ear La	$\bar{\Delta}$	Right $La_{10'}$	Type
Bike 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		
Bike 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			
Bike 731, Red 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 N

EAR LEVEL MOTORCYCLE NOISE

SOUND LEVEL DIFFERENCES RE FORMAL TEST

Bike No.	J331a	F76	F76a,t	F76a,g	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 P

EAR LEVEL MOTORCYCLE NOISE DURING DYNAMOMETER TESTS

Bike No. 703, Blue Helmet

RPM	TORQUE (2nd gear)	50' La Equiv.	Ear La	ΔdBA
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 Q

WIND EFFECTS AND VOICE LEVELS

D (Downwind) —— Travel Direction ——→ U (Upwind)

Wind Direction
7-12 mph

Bike No.	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

APPENDIX

IMI TEST PROCEDURES

1. <u>IMI-C Test Procedure</u>

   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. <u>IMI-E Test Procedure</u>

   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.

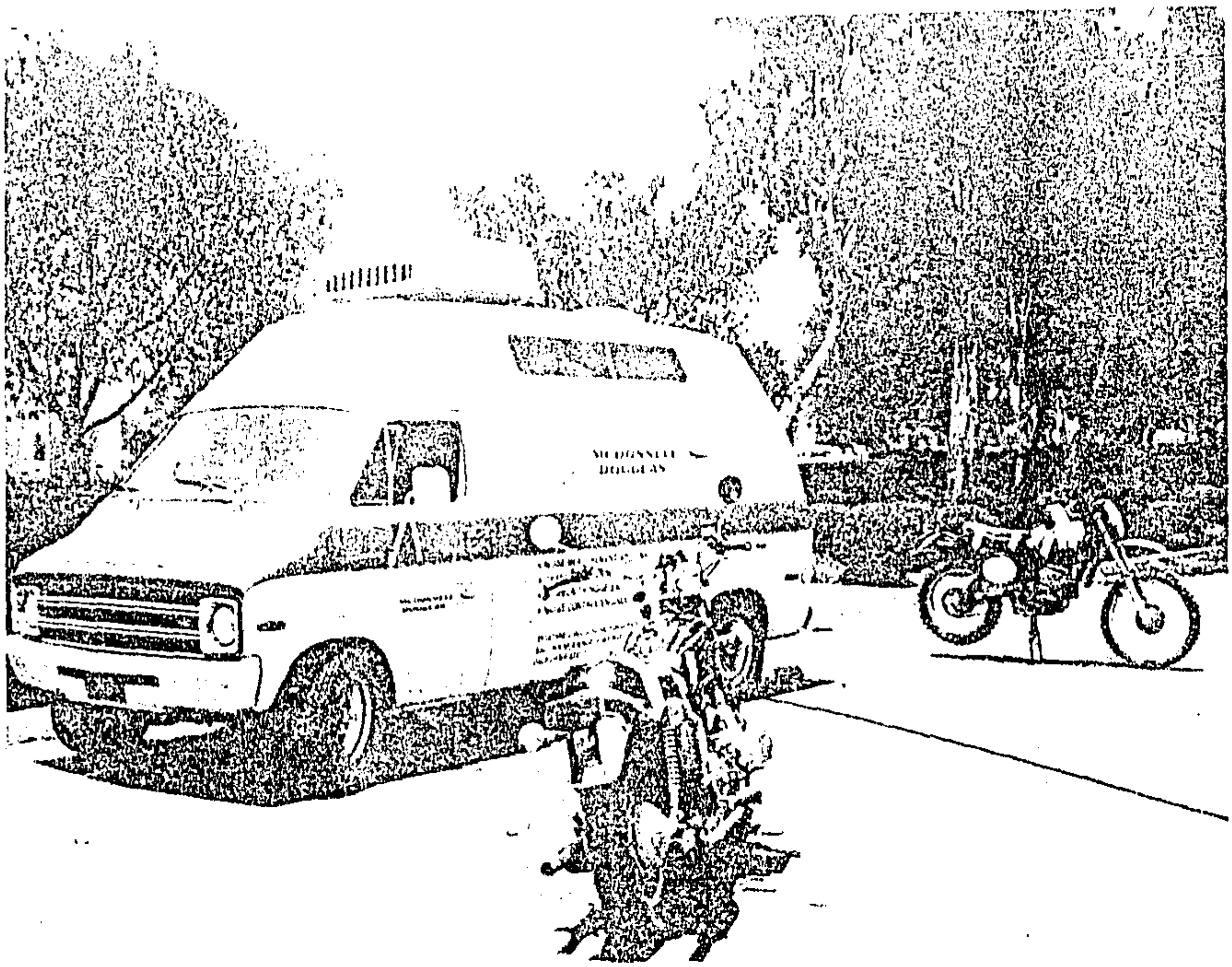
   Readings: Same as IMI-C

3. <u>IMI-C50 Test Procedure</u>

   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.



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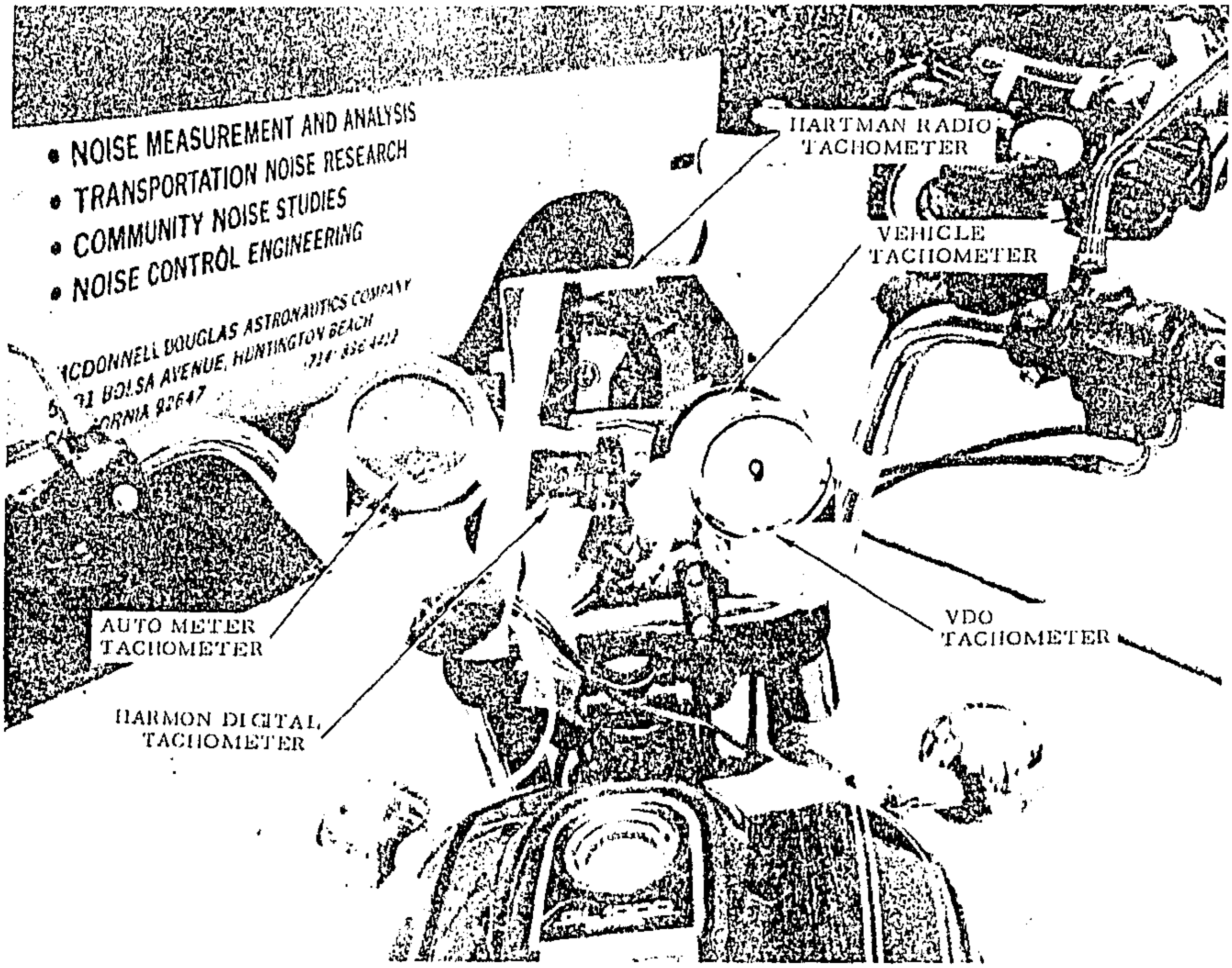

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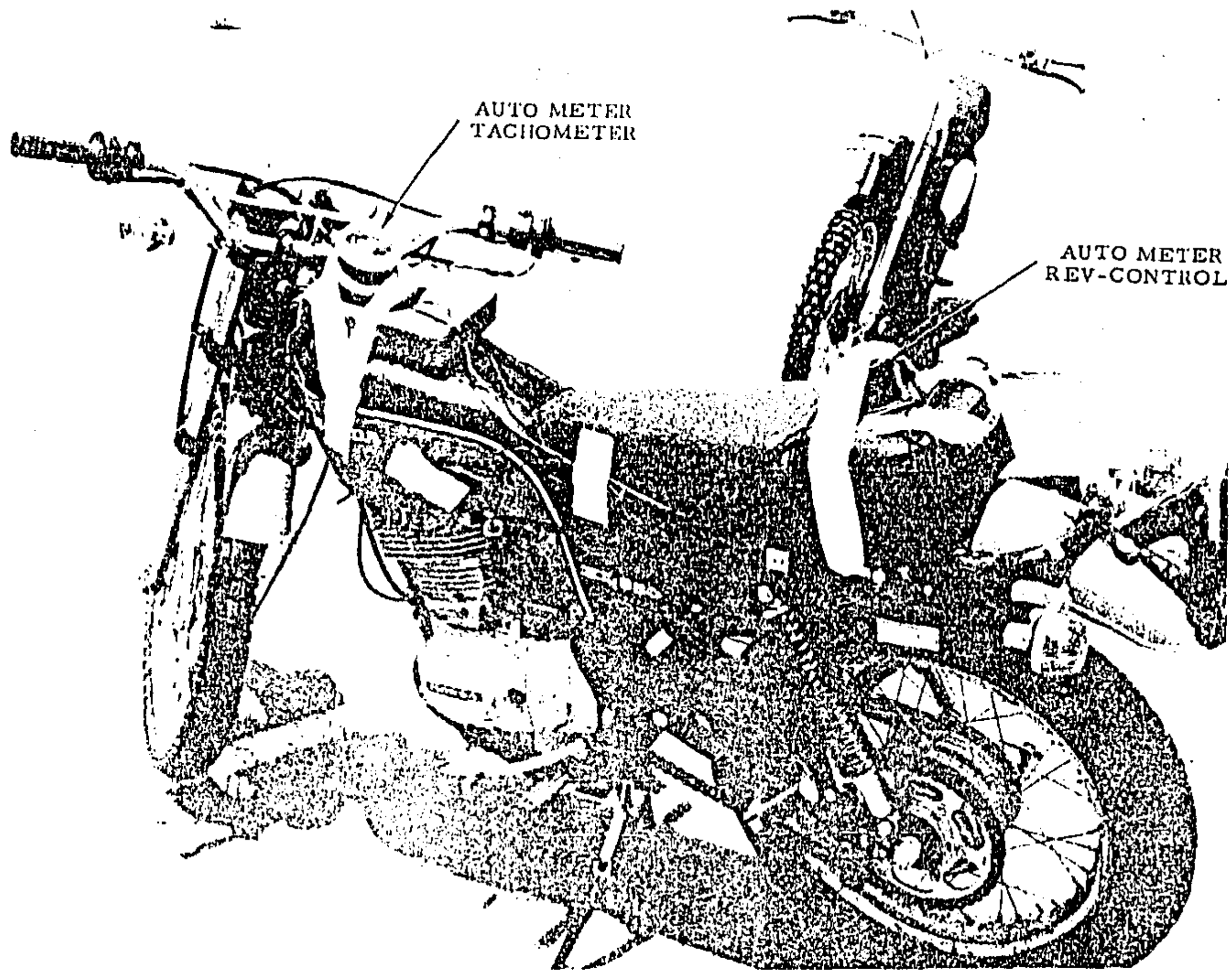

Photograph No. H-3 XL350 FITTED WITH AUTOMETER REV-CONTROL

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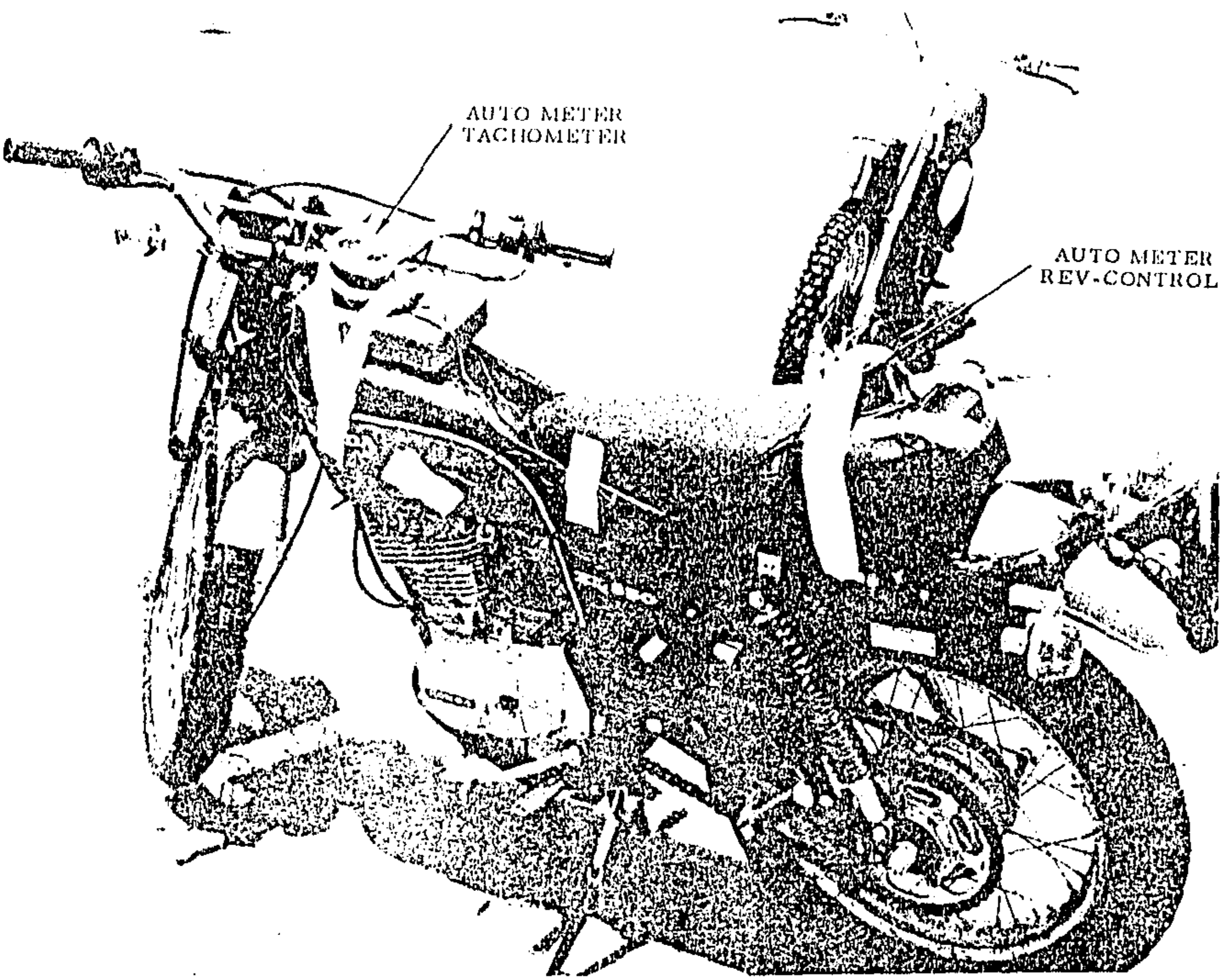

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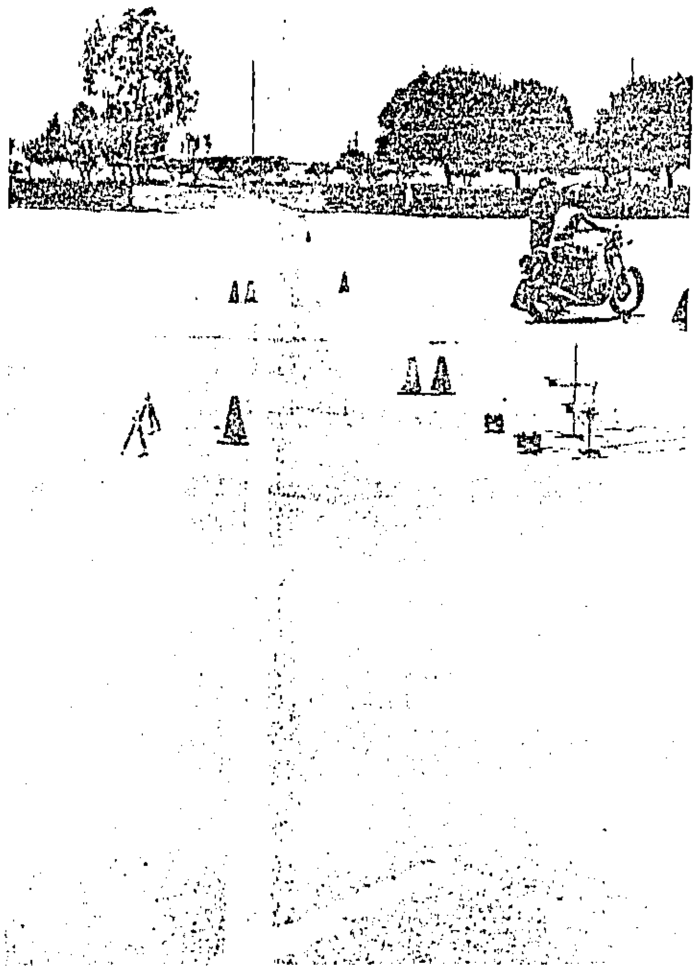

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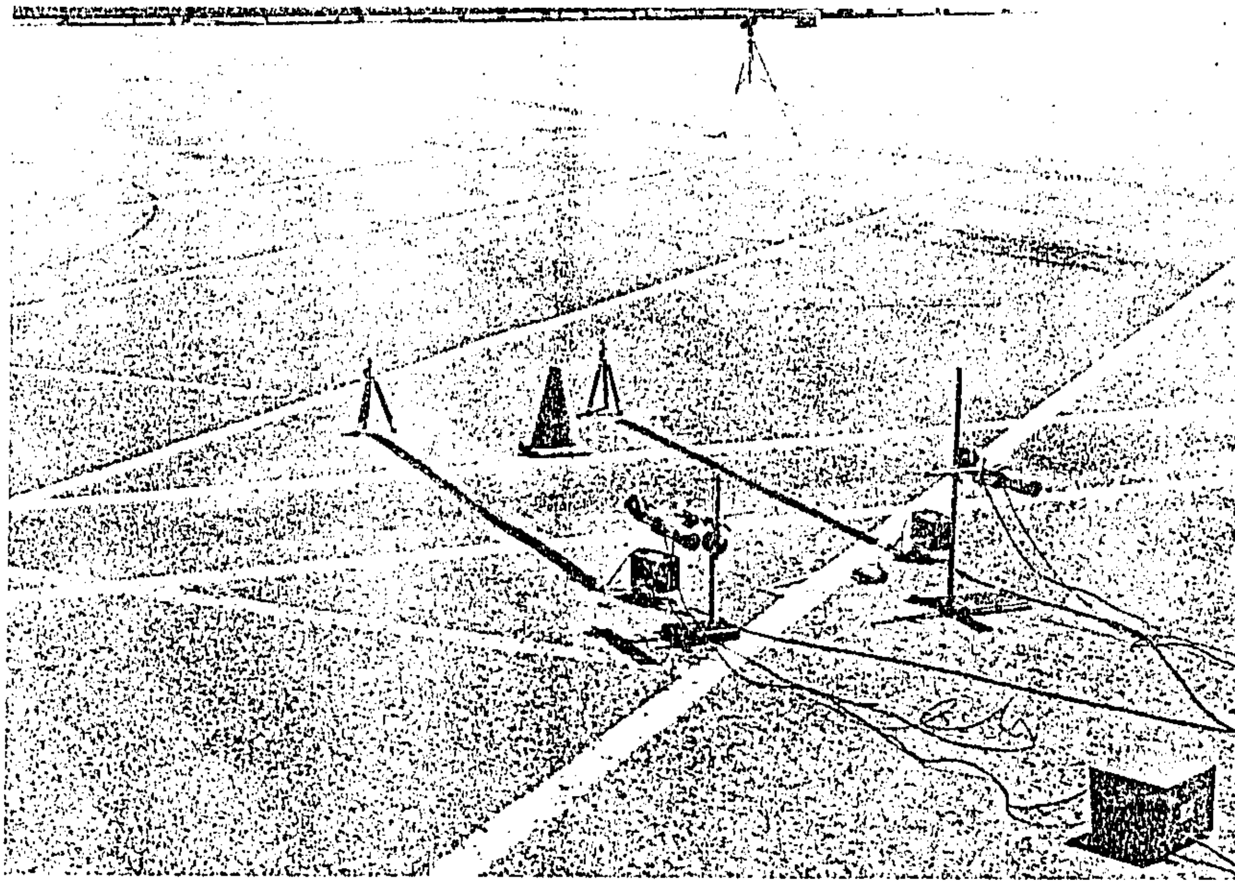

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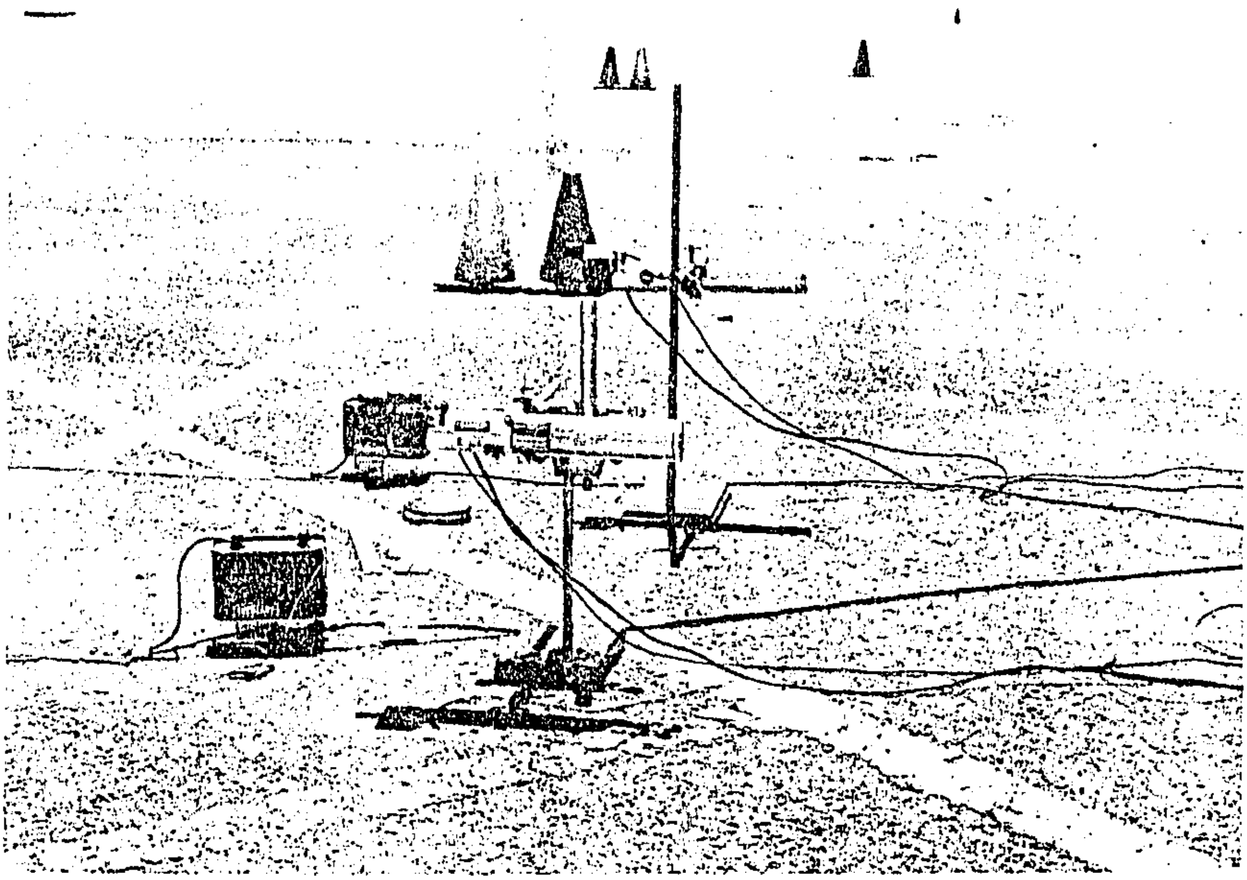

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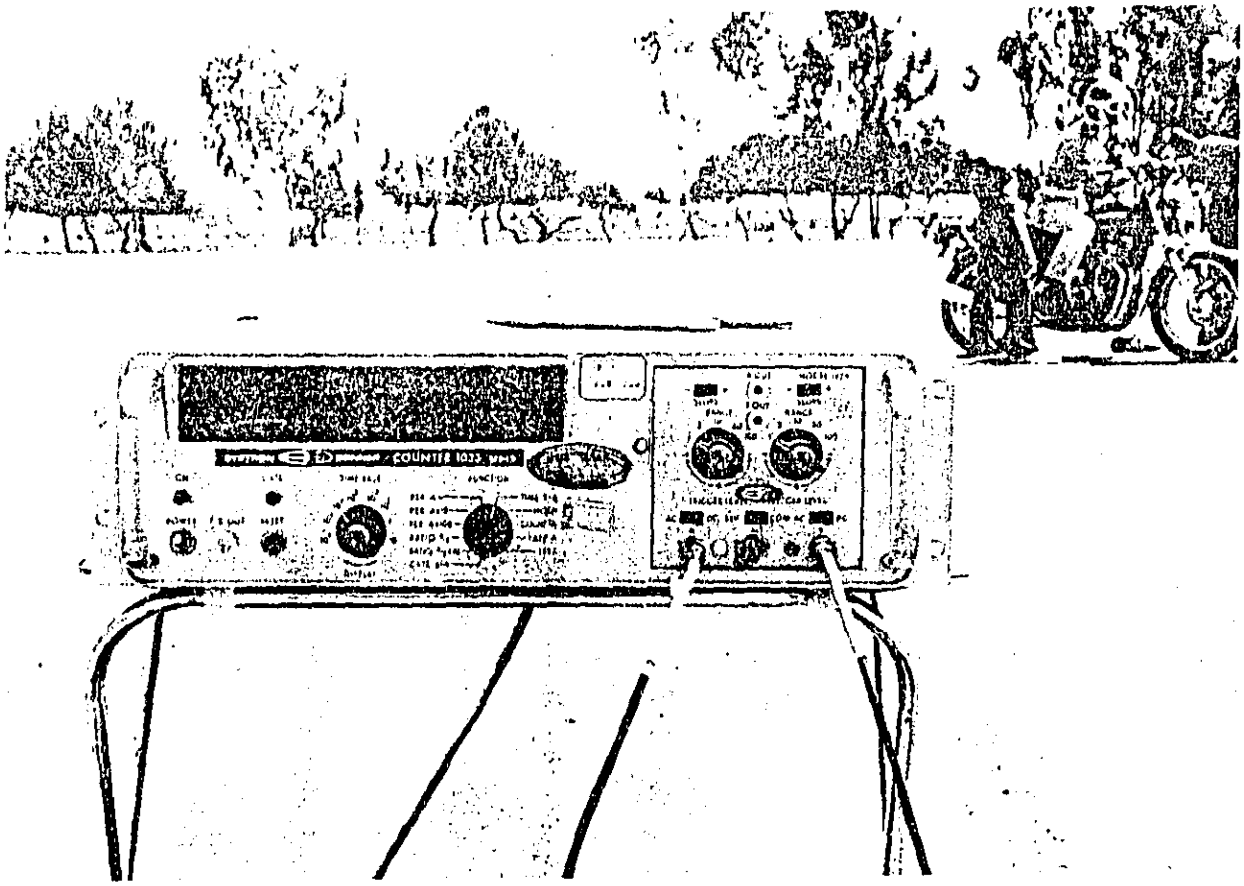

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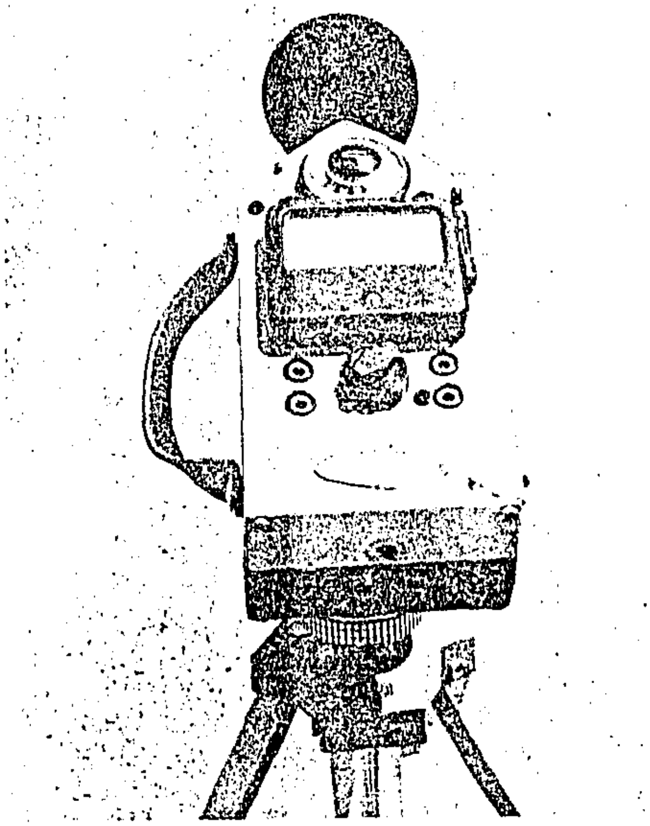

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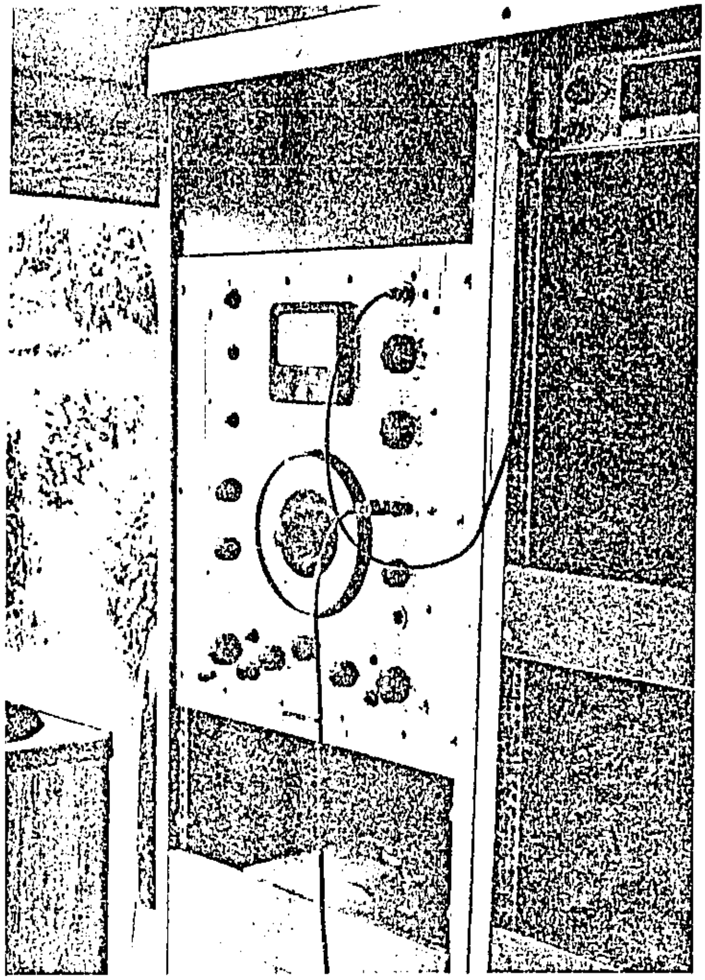

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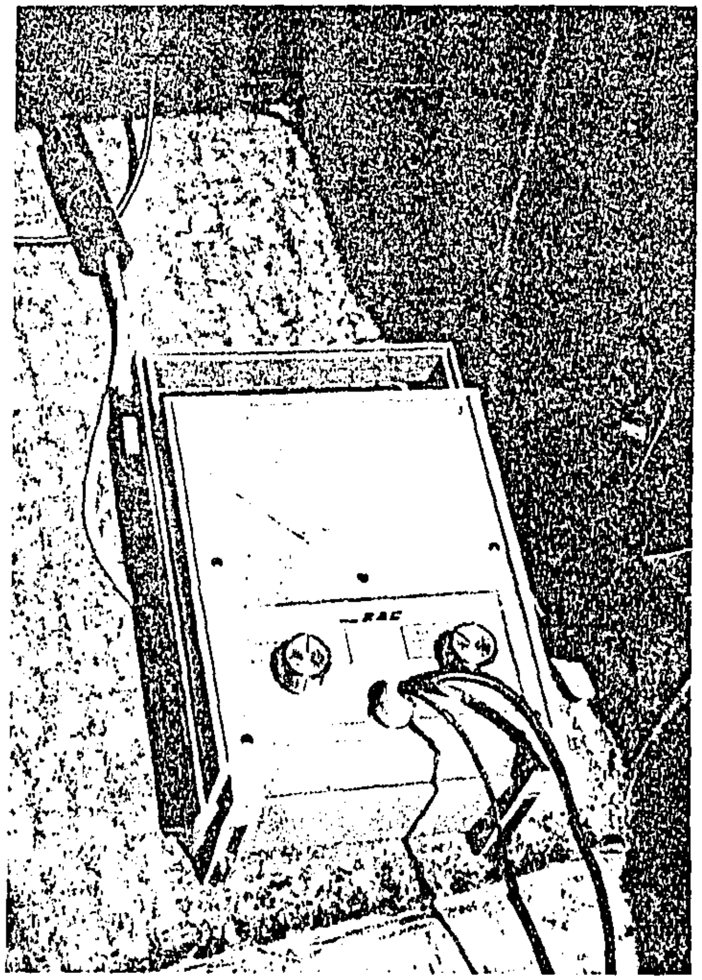

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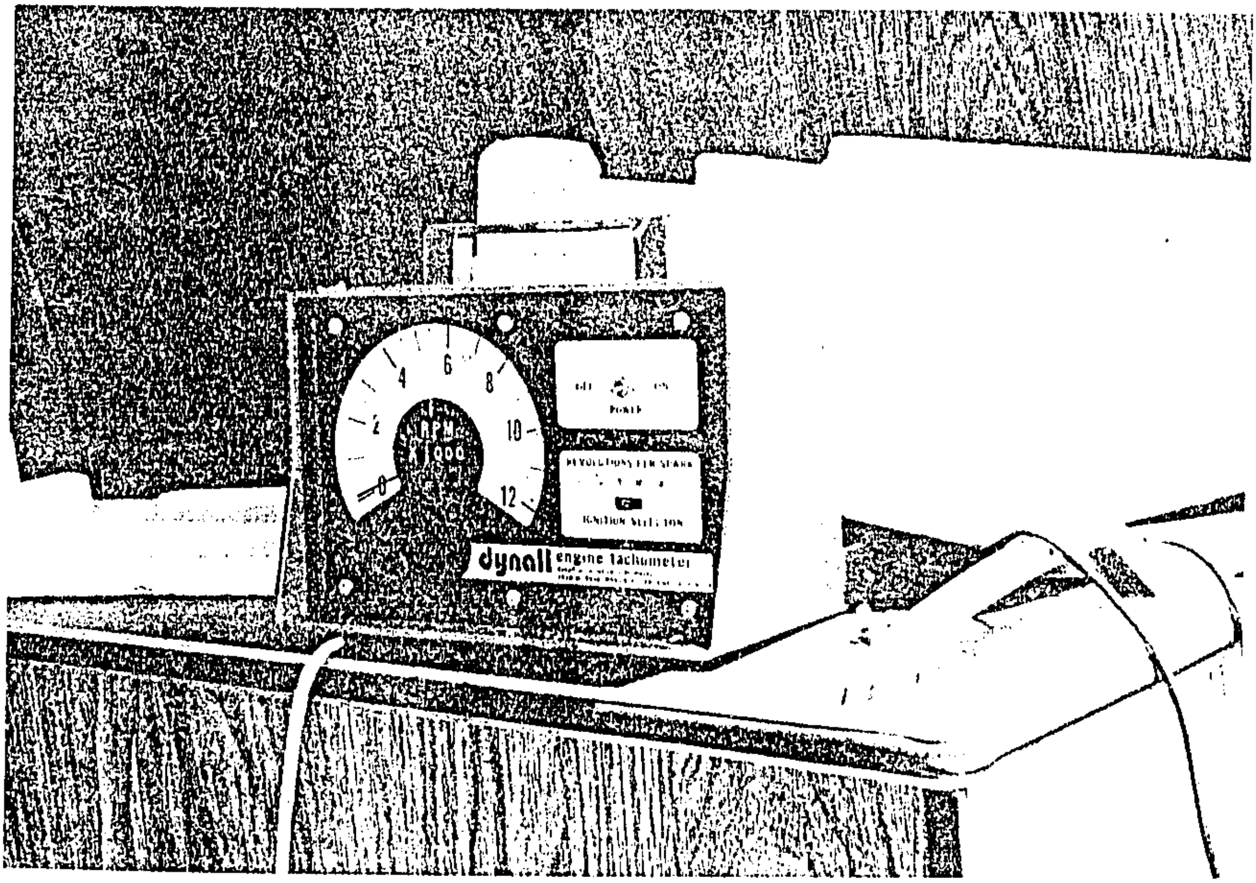

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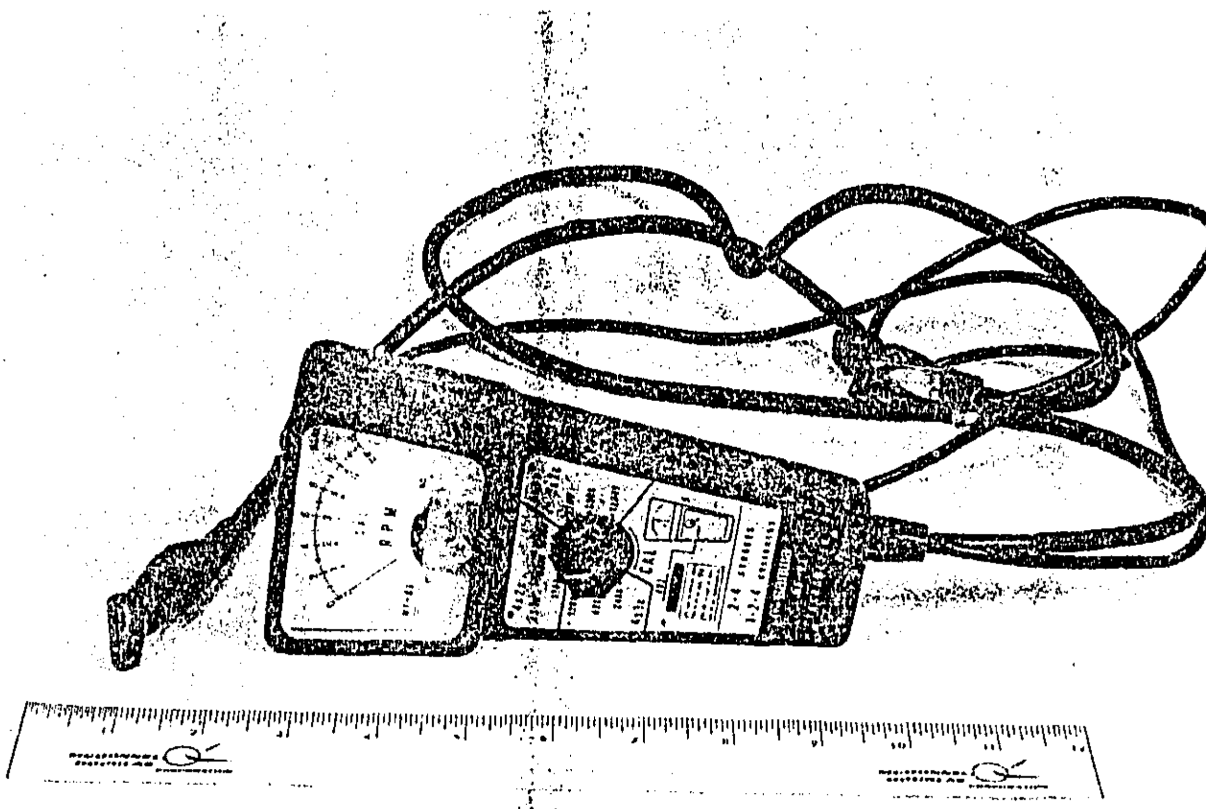

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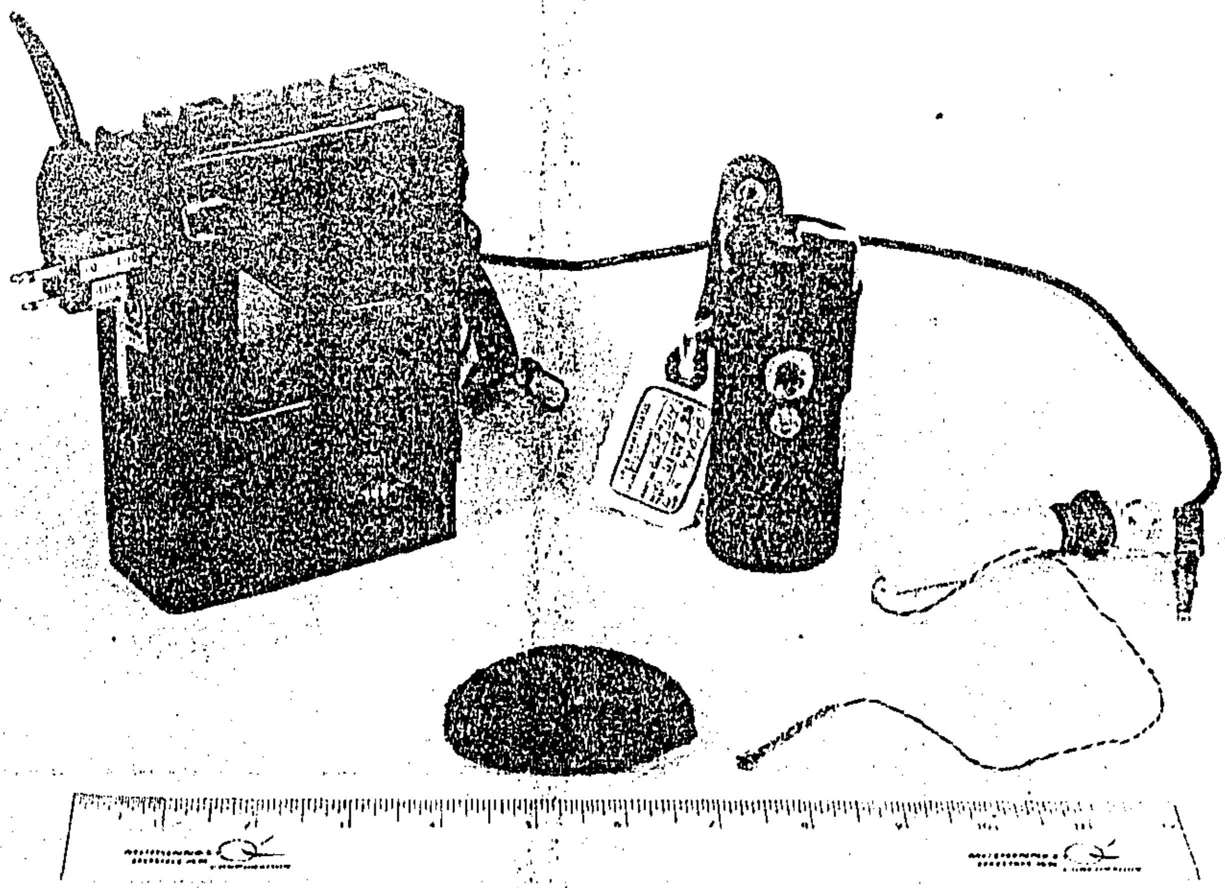


Photograph No. H-14 EAR LEVEL SOUND MEASURING EQUIPMENT

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 RPMs 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 RPMs 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, sound 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 sound 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 used 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 would be 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. Absolute dynamic response characteristic specifications have not yet been explored by EPA so 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>. This is not an ideal specification and attempts to improve it will be made.

The "window" of allowable tachometer lag should be small enough that tachometer characteristics will not materially affect sound 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 sound levels of the motorcycles tested in this recent program as a function of closing RPM. For most motorcycles, there are four points plotted: Baseline sound level (zero) at observed closing RPM (vehicle tachometer - baseline zero); a higher sound level (relative to baseline) at some higher closing RPM (observed, vehicle tachometer); a lower sound level (relative to baseline) at some lower closing RPM (observed, vehicle tachometer); and a lower sound level (relative to baseline) at some lower closing RPM (indicated, indirect engine measurement system). From these figures it is apparent that a three percentage point lag translates into a 0.6-0.7 dB(A) difference for most street motorcycles tested, 0.5 dB(A) for most combination motorcycles tested, and 0.3 dB(A) 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 RPMs must be adjusted from the draft F-76a procedure for that reason alone.

The recent program gave EPA the first direct data on motorcycle sound levels measured under F-76a. In addition, manufacturers have supplied EPA with additional F-76a data for certain of their 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 comparison inherent in J-331a.

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(A). The average of the sound levels of small motorcycles, however, are below J-331a by several dB(A). 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 sound 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.

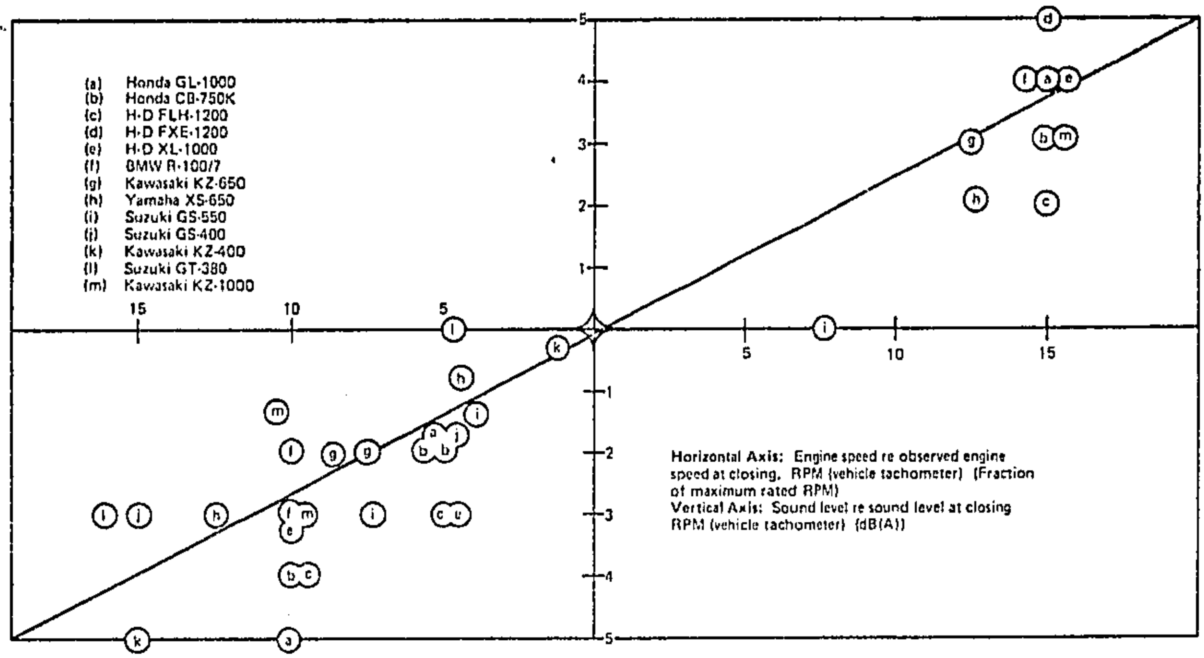


FIGURE I-1. SOUND LEVEL AS A FUNCTION OF CLOSING RPM
STREET MOTORCYCLES

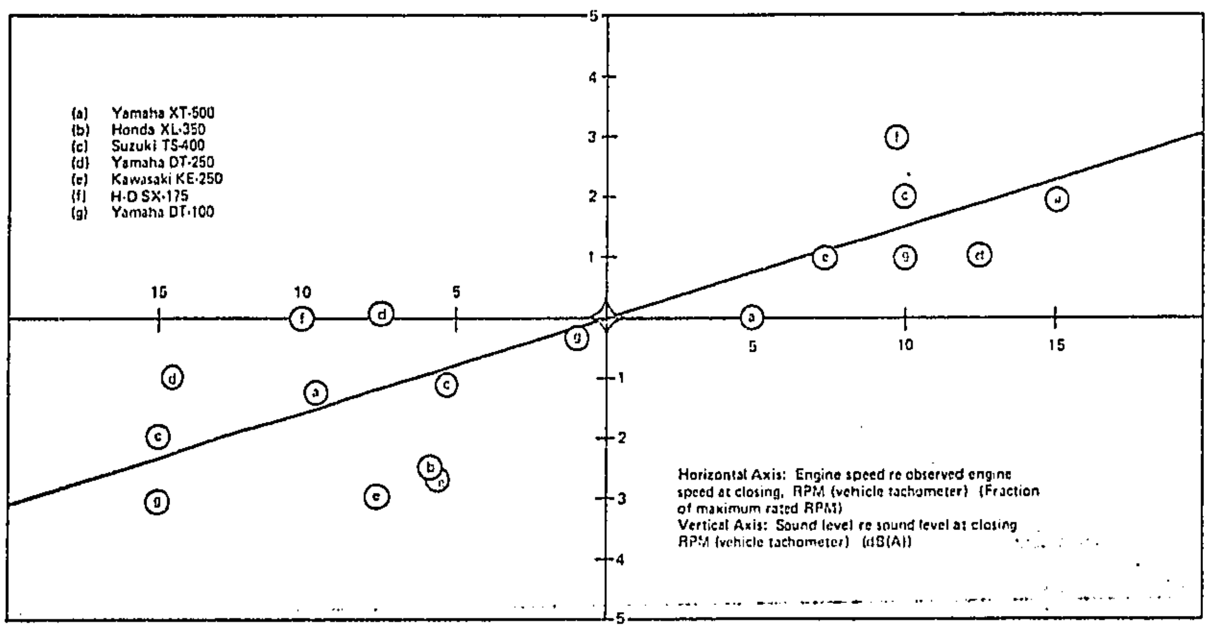


FIGURE I-2. SOUND LEVEL AS A FUNCTION OF CLOSING ENGINE SPEED COMBINATION MOTORCYCLES

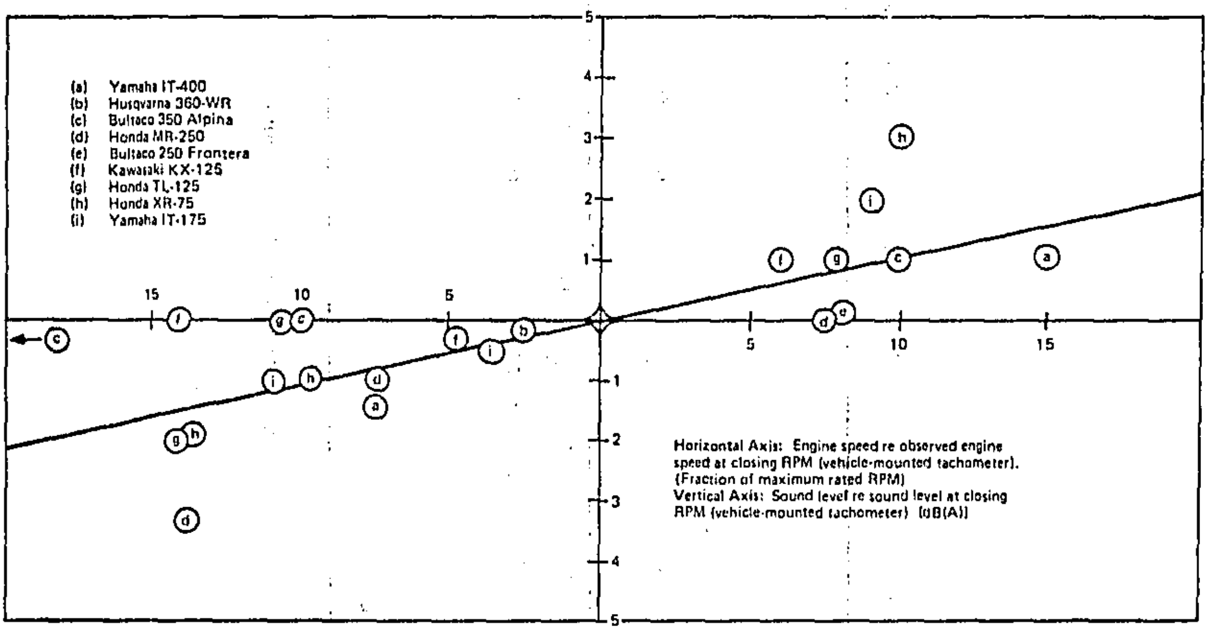
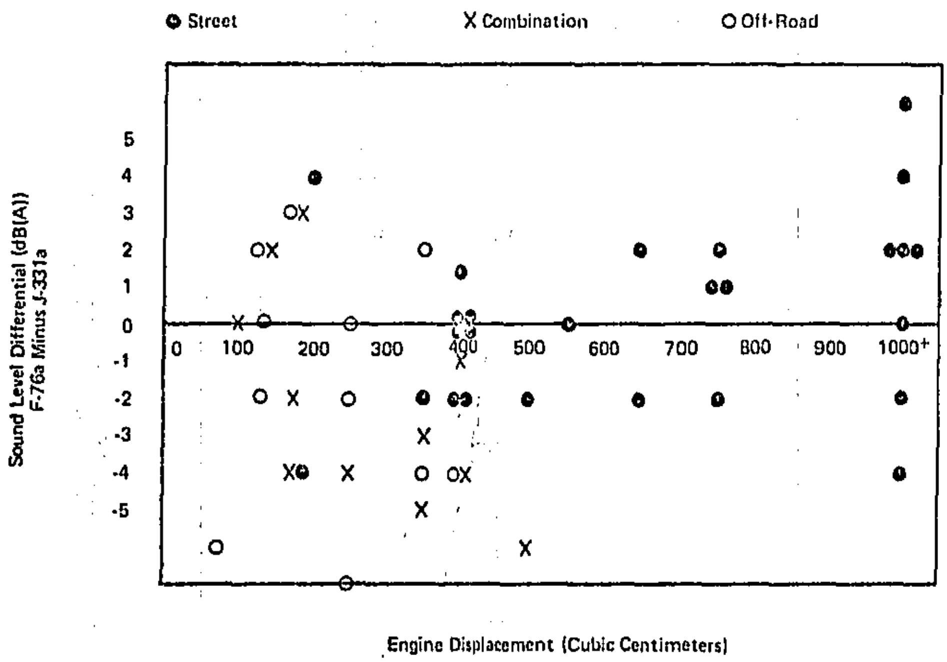


FIGURE I-3. SOUND LEVEL AS A FUNCTION OF CLOSING ENGINE SPEED OFF-ROAD MOTORCYCLES (including trials and mini-cycles)



Source: EPA and Manufacturer Data

FIGURE I-4

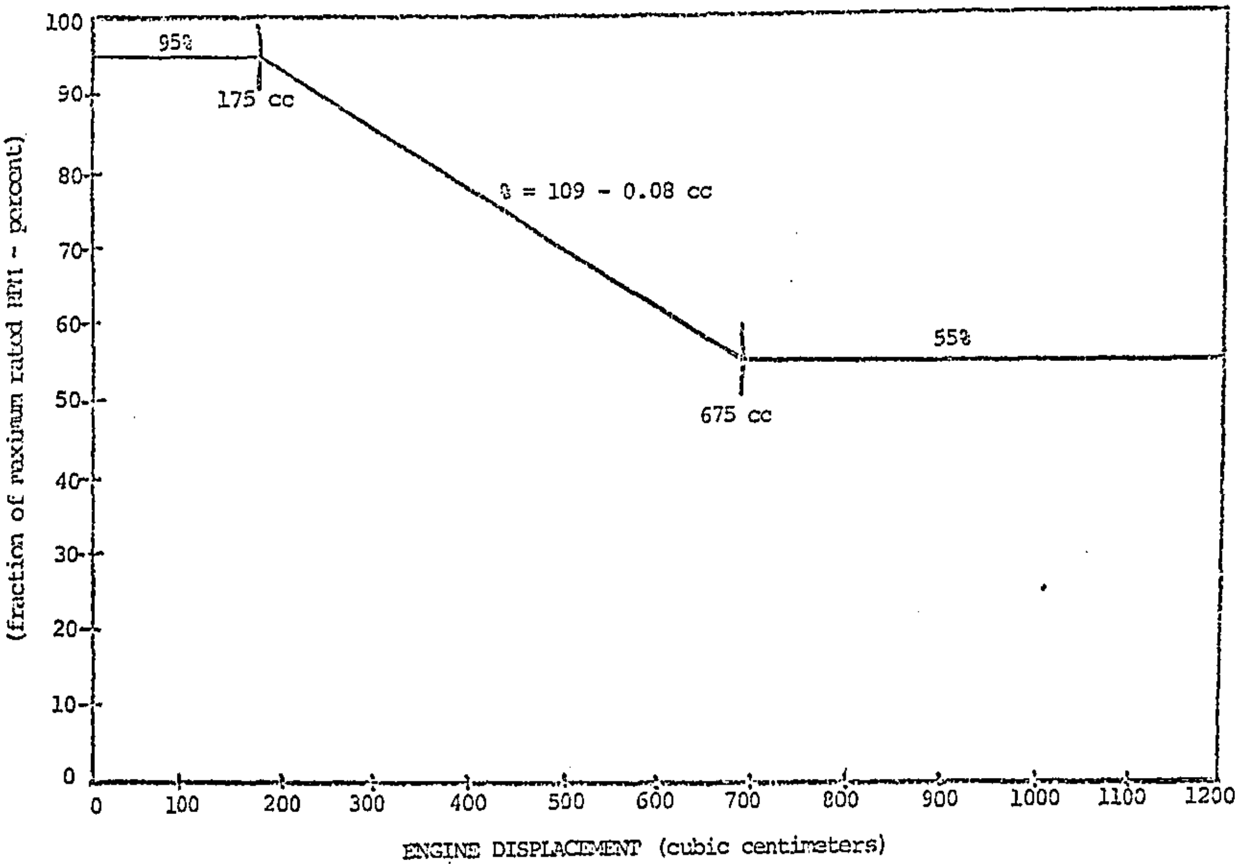


FIGURE I-5. CLOSING RPM

Table I-1

PROPOSED PROCEDURE/J-331a COMPARISON

	Motorcycle Model	J-331a (dB(A))	F-76a (dB(A))	Difference (dB(A))	F-76a/ Revised Procedure Difference (dB(A))*	J-331a/ Revised Procedure Difference (dB(A))
(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.

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