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automobiles

TEST METHOD 1106

Noise Emission Tests

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1. Introduction

Test Method 1106 — Noise Emission Tests (August 2005) is to be used for demonstrating compliance with the requirements of Standard 1106 of Schedule V.1 to the *Motor Vehicle Safety Regulations*.

2. Definitions

Fast Meter Response means that the fast dynamic response of the sound level meter shall be used. The fast dynamic response shall comply with the meter dynamic characteristics in

- (a) the American National Standards Institute,¹ Standard ANSI S1.4-1971, *Specification for Sound Level Meters*, or
- (b) the International Electrotechnical Commission² (IEC), Publication 651, *Sound Level Meters* (1979), as amended by Amendment 1 (1993).

(réponse rapide du sonomètre)

Sound Level Meter means a sound level meter which is certified to conform with the requirements of

- (a) the American National Standards Institute, Standard ANSI S1.4-1971, *Specification for Sound Level Meters*, for Type 1 meters, or
- (b) the International Electrotechnical Commission (IEC), Publication 651, *Sound Level Meters* (1979), amended by Amendment 1 (1993).

(sonomètre)

¹ American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018.

² International Electrotechnical Commission, 1, rue de Varembé, Genève, Suisse.

3. Low Speed Exterior Sound Level Test Procedure for Buses with a GVWR Greater than 4 536 kg (10,000 lb.)

3.1 Instrumentation

The following instrumentation shall be used, where applicable.

- 3.1.1** A sound level meter set at the A-weighting "fast meter response".
- 3.1.2** A sound level measuring system with a magnetic tape recorder, a graphic level recorder, or an indicating meter may be used, providing the system meets the requirements of Appendix A.
- 3.1.3** A windscreen must be employed with the microphone during all sound measurements. The windscreen shall not affect the A-weighted sound levels from the vehicle in excess of ± 0.5 dB.
- 3.1.4** A sound level calibrator producing a sound level, at the microphone diaphragm, that is within an accuracy of ± 0.5 dB shall be used. The calibrator shall be checked annually to verify that its output has not changed.
- 3.1.5** An engine-speed tachometer which is accurate to within ± 2 percent of the meter reading.
- 3.1.6** An anemometer or other device for measurement of ambient wind speed accurate to within ± 10 percent at 19 km/h (12 mph).
- 3.1.7** A thermometer for measurement of ambient temperature accurate to within $\pm 1^\circ\text{C}$.
- 3.1.8** A barometer for measurement of ambient pressure accurate to within ± 1 percent.

3.2 Test Site Requirements

- 3.2.1** The test site shall be such that the vehicle radiates sound into a free field over a reflecting plane. This condition may be considered fulfilled if the test site consists of an open space free of large reflecting surfaces such as parked vehicles, signboards, buildings, or hillsides, located within 30.5 m (100 ft.) of either the vehicle path or the microphone (see Figure 1).

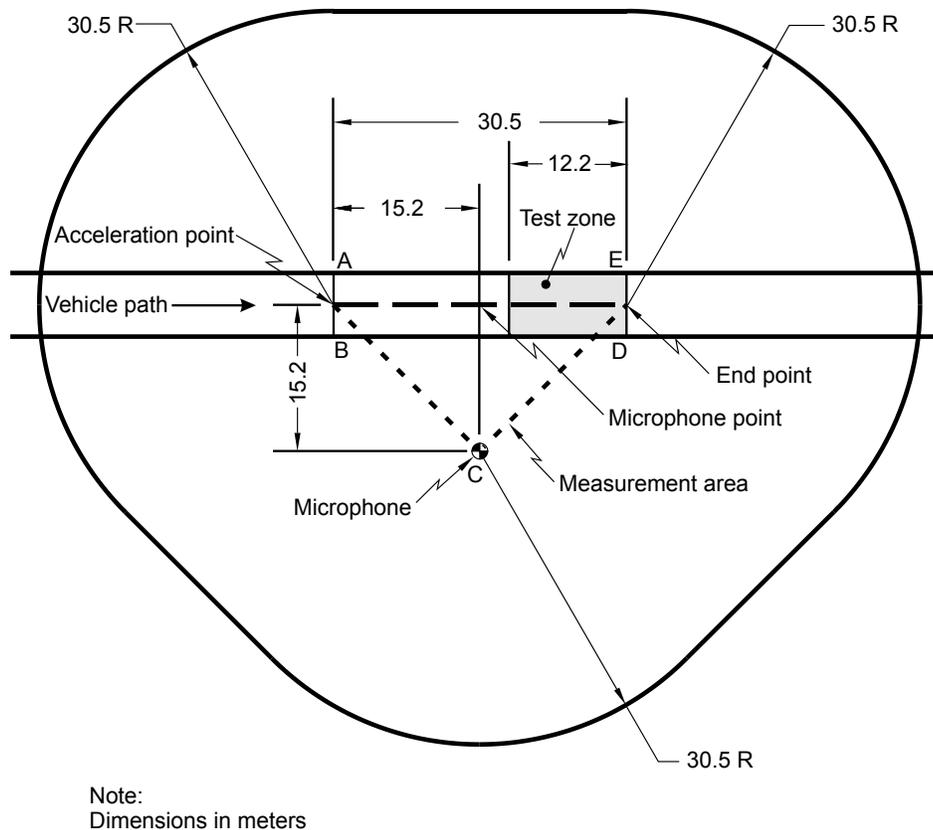


Figure 1: Test Site for the Low Speed Exterior Sound Level Test Procedure for Buses with a GVWR Greater than 4 536 kg (10,000 lb.)

- 3.2.2** The microphone shall be located 15.2 ± 0.1 m (50 ft. \pm 4 in.) from the centerline of vehicle travel and 1.2 ± 0.1 m (4 ft. \pm 4 in.) above the ground plane. The microphone point is defined as the point of intersection of the centreline of vehicle path and a line normal to the vehicle path drawn from the microphone. The microphone shall be oriented with respect to the source in a fixed position so as to minimize the deviation from the flattest frequency response over the frequency range 100 Hz to 10 kHz for a vehicle traversing the test zone.
- 3.2.3** For vehicles with manual transmissions or for vehicles with automatic transmissions which can manually be held in gear, an acceleration point shall be established on the vehicle path 15.2 m (50 ft.) ahead of the microphone point.
- 3.2.4** For vehicles with automatic transmissions which cannot be manually held in gear, a starting point shall be established as described in paragraph 3.3.2(a) of this test method.
- 3.2.5** An end point shall be established on the vehicle path 30.5 m (100 ft.) from the acceleration point and 15.2 m (50 ft.) beyond the microphone point.

- 3.2.6** The test zone is the distance 12.2 m (40 ft.) on the vehicle path just ahead of the end point.
- 3.2.7** The measurement area shall be the triangular paved (concrete or smooth sealed asphalt) area formed by the acceleration point, the end point, and the microphone location (point C).
- 3.2.8** The reference point on the vehicle, used to indicate when the vehicle is at any of the points on the vehicle path, shall be the front of the vehicle, except as follows:
- (a) If the engine is front-mounted and the horizontal distance from the front of the vehicle to the exhaust outlet is more than 5 m (200 in.) tests shall be run using both the front and rear of the vehicle as reference points, or
 - (b) If the main body of the engine is located rearward of the center of the chassis or at the approximate center (± 1.5 m [± 5 ft.]) of the chassis, the rear of the vehicle shall be used as the reference point.
- 3.2.9** The plane containing the vehicle path and the microphone location (plane ABCDE in Figure 1) shall be flat to within ± 0.05 m (± 2 in.).
- 3.2.10** Measurements shall not be made when either the road surface or the measurement surface area is wet, or covered with snow, or during precipitation.
- 3.2.11** Not more than one person, other than the observer reading the meter, shall be within 15.2 m (50 ft.) of the vehicle path or instrument and the person shall be directly behind the observer reading the meter, on a line through the microphone and observer. A cable should be used between the microphone and the sound level meter. No person shall be located within 1 m (3.3 ft.) in any direction of the microphone location.
- 3.2.12** The maximum A-weighted fast response sound level observed at the test site immediately before and after the test shall be at least 10 dB below the regulated level.
- 3.2.13** The road surface within the test site upon which the vehicle travels and the measurement area shall be smooth concrete or smooth sealed asphalt, free of extraneous material such as gravel.
- 3.2.14** Vehicles with diesel engines shall be tested using Number 1D or Number 2D diesel fuel possessing a cetane rating of from 42 to 50, inclusive.
- 3.2.15** Vehicles with gasoline engines shall use the grade of gasoline recommended by the manufacturer for use by the purchaser.
- 3.2.16** If the vehicle's engine radiator fan drive is equipped with a device that automatically reduces the rotational speed of the fan, the vehicle may be tested with or without the device being operational.

3.3 Test Procedure

3.3.1 To determine the sound level of vehicles equipped with manual (standard) transmissions or for vehicles with automatic transmissions which can be manually held in gear, full throttle acceleration tests shall be used. An initial engine speed and associated gear ratio shall be determined for use during measurements. In this procedure, the phrase "governed engine speed" applies to vehicles which are equipped with engine speed governors, while the phrase "maximum rated engine speed" applies to vehicles which are not equipped with engine speed governors.

- (a) Select a rear axle or transmission gear ratio and initial vehicle speed such that the following conditions are met:
 - (i) Start at no more than two-thirds (66 percent) of maximum rated or governed engine speed.
 - (ii) Reach the maximum rated engine speed or governed engine speed within the test zone.
 - (iii) Do not exceed a speed of 56 km/h (35 mph) before reaching the end point.
 - (iv) Should maximum rated or governed engine speed be attained before reaching the test zone, decrease the approach rpm in 100 rpm increments until maximum rated or governed engine speed is attained within the test zone.
 - (v) Should maximum rated or governed engine speed not be attained until beyond the test zone, select the next lowest gear until maximum rated or governed engine speed is attained within the test zone.
 - (vi) Should the lowest gear still result in reaching maximum rated or governed engine speed beyond the permissible test zone, unload the vehicle or increase the approach engine speed in 100 rpm increments until the maximum rated or governed engine speed is reached within the test zone.
- (b) For the acceleration test, approach the acceleration point using the engine speed and gear ratio selection in paragraph 3.3.1(a) of this test method and at the acceleration point rapidly establish wide open throttle. The vehicle reference point shall be as indicated in subsection 3.2.8. Acceleration shall continue until maximum rated or governed engine speed is reached.
 - (i) Vehicles equipped with governed engines must be held at wide open throttle until the entire vehicle is out of the test zone.
 - (ii) Vehicles equipped with ungoverned engines must not be allowed to drop more than 100 rpm below maximum rated engine speed until the vehicle is out of the test zone.
- (c) Wheel slip which affects maximum sound level must be avoided.

3.3.2 Full throttle acceleration tests are to be used for vehicles equipped with automatic transmissions which cannot be manually held in gear.

- (a) Select the highest rear axle or transmission gear, namely, the lowest numerically, to accelerate the vehicle under wide open throttle from a stationary position (usually this is the "D" position on the shift column). The stationary starting point is determined as follows:
 - (i) The vehicle's reference point shall be placed at the midpoint (± 0.3 m [± 1 ft.]) of the test zone with the front end of the vehicle facing back along the test path in the opposite direction of travel that is used for the sound measurement tests.
 - (ii) The vehicle shall then be accelerated as rapidly as possible to establish a wide open throttle, until the first transmission shift point is reached.
 - (iii) The location along the test path at which the front end of the vehicle is passing when the first transmission shift point occurs during the wide open throttle acceleration shall be the designated stationary starting point.
 - (iv) The vehicle's direction of travel shall then be reversed for sound testing.
- (b) For the acceleration test, accelerate the vehicle from a standing position with the front of the vehicle at the selected stationary starting point, obtained by using paragraph 3.3.2(a) of this test method, as rapidly as possible to establish a wide open throttle. The acceleration shall continue until the entire vehicle has vacated the test zone.
- (c) Wheel slip which affects maximum sound level must be avoided.

3.3.3 Measurements

- (a) The meter shall be set at the A-weighting "fast meter response".
- (b) The sound meter shall be observed during the period in which the vehicle is accelerating. The applicable reading shall be the highest sound level obtained for the run. The test shall be rerun if unrelated peaks should occur due to extraneous ambient noises.
- (c) Sound level measurements shall be taken on both sides of the vehicle. The recorded sound level associated with any given side of the vehicle shall be the average of the highest measurements that are within 2 dBA of each other. The reported vehicle sound level shall be the higher of the two averages. (The average of the measurements on each side shall be computed separately.)

3.4 General requirements

3.4.1 Measurements shall be made only when wind speed is below 19 km/h (12 mph).

3.4.2 Proper usage of all test instrumentation is essential to obtain valid measurements. Operating manuals or other literature furnished by the instrument manufacturer shall

be referred to for both recommended operation of the instrument and the precautions to be observed. Specific items to be considered are:

- (a) The effects of ambient weather conditions on the performance of the instruments (for example, temperature, humidity, and barometric pressure).
- (b) Proper signal levels, terminating impedances, and cable lengths on multi-instrument measurement systems.
- (c) 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 or after field use.

3.4.3 A complete calibration of the instrumentation and external acoustical calibrator over the entire frequency range of interest shall be performed at least annually and as frequently as necessary during the yearly period to ensure compliance with the appropriate standards for each type of meter.

3.4.4 If calibration devices are utilized which are not independent of ambient pressure (e.g. a pistonphone), corrections shall be made for barometric or altimetric changes according to the recommendation of the instrument manufacturer.

3.4.5 The vehicle shall be brought to a temperature within its normal operating range prior to commencement of testing. During testing, appropriate caution shall be taken to maintain the engine at temperatures within the normal operating range.

4. Interior Sound Emission Test Procedure for Trucks and Buses with a GVWR Greater than 4 536 kg (10,000 lb.)

4.1 Instrumentation

The following instrumentation shall be used, where applicable.

4.1.1 A sound level meter set to the A-weighting "fast meter response".

4.1.2 A sound level measuring system with a magnetic tape recorder, a graphic level recorder, or an indicating meter may be used, providing the system meets the requirements of Appendix A.

4.2 Test Site Requirements

4.2.1 The vehicle is located on a smooth sealed asphalt or concrete surface so that no other vehicle or signboard, building, hill, or other large reflecting surface is within 15.2 m (50 ft.) of the driver's seating position.

4.3 Test Vehicle Preparation

4.3.1 All vehicle doors, windows, and ventilators are closed.

- 4.3.2 All power-operated accessories are turned off.
- 4.3.3 The driver is in the normal seated driving position and the person conducting the test is the only other person in the vehicle.
- 4.3.4 The microphone is located so that it points vertically upward 150 mm (6 in.) to the right and is directly in line with the same plane as the driver's ear.
- 4.3.5 If the vehicle's engine radiator fan drive is equipped with a device that automatically reduces the rotational speed of the fan, the vehicle may be tested with or without the device being operational.

4.4 Test Procedure

- 4.4.1 With the vehicle's transmission in neutral gear, the engine is accelerated to
- (a) its maximum governed engine speed, if it is equipped with an engine governor, or
 - (b) its maximum engine speed, if it is not equipped with an engine governor, and the engine is stabilized at that speed.
- 4.4.2 The A-weighted sound level reading on the sound level meter for the engine speed condition referred to in subsection 4.4.1 is observed and, if it has not been influenced by extraneous noise sources, is recorded.
- 4.4.3 The vehicle's engine speed is returned to idle, the procedures set out in subsections 4.4.1 and 4.4.2 are repeated until two A-weighted sound level readings within 2 dBA of each other are recorded. Those readings are then averaged.

APPENDIX A SOUND DATA ACQUISITION SYSTEM

A.1 Systems employing tape recorders and graphic level recorders may be established as equivalent to a sound level meter which meets the requirements of ANSI S1.4-1971, *Specifications for Sound Level Meters*, or IEC Publication 651, *Sound Level Meters* (1979), as amended by Amendment 1 (1993) by meeting the requirements of this appendix. (This sound data acquisition system qualification procedure is based primarily on ANSI S6.1-1973.)

A.1.1 Performance Requirements

- (a) **System frequency response.** The overall steady-state frequency response of the data acquisition system shall be within the tolerances prescribed in Table 1 when measured in accordance with this appendix. The tolerances in Table 1 are applicable to the A-weighted response (see paragraph A.1.3(c)).
- (b) **Detector response.** To ensure that a (true) rms indication is provided, the difference between the level indicated for a 1000-Hz sinusoidal signal equivalent to a sound level of 86 dB (rms) and the level indicated for an octave band of random noise of equal energy as the sinusoidal signal centered at 1000 Hz shall be no greater than

- 0.5 dB. A true rms voltmeter shall be used to determine equivalence of two input signals.
- (c) **Indicating meter.** If an indicating meter is used to obtain sound levels or band pressure levels, it must meet the requirements of paragraph A.1.1(b) and subparagraph A.1.1(f)(ii) and the following:
- (i) The scale shall be graduated in 1-dB steps.
 - (ii) No scale indication shall deviate by more than 0.2 dB from the true value of the signal when an input signal equivalent to an 86-dB sound level indicates correctly.
 - (iii) Maximum indication for an input signal of a 1000-Hz tone burst of 0.2 sec duration shall be within the range of -2 to 0 dB with respect to the steady-state indication for a 1000-Hz tone equivalent to an 86-dB sound level.

Table 1:
System Response Data

Frequency (Hz)	A weighted Response (dB)	Tolerance (dB)	
		Plus	Minus
31.5	-39.4	1.5	1.5
40.0	-34.6	1.5	1.5
50.0	-30.2	1.0	1.0
63.0	-26.2	1.0	1.0
80.0	-22.5	1.0	1.0
100.0	-19.1	1.0	1.0
125.0	-16.1	1.0	1.0
160.0	-13.4	1.0	1.0
200.0	-10.9	1.0	1.0
250.0	-8.6	1.0	1.0
315.0	-6.6	1.0	1.0
400.0	-4.8	1.0	1.0
500.0	-3.2	1.0	1.0
630.0	-1.9	1.0	1.0
800.0	-0.8	1.0	1.0

1000.0	0.0	1.0	1.0
1250.0	0.6	1.0	1.0
1600.0	1.0	1.0	1.0
2000.0	1.2	1.0	1.0
2500.0	1.3	1.0	1.0
3150.0	1.2	1.0	1.0
4000.0	1.0	1.0	1.0
5000.0	0.5	1.5	2.0
6300.0	-0.1	1.5	2.0
8000.0	-1.1	1.5	2.0
10 000.0	-2.5	2.0	4.0
12 500.0	-4.3	3.0	6.0

- (d) **Microphone.** If a microphone is used which has not been provided as a component of a sound level meter, it must conform with the microphone characteristics described in IEC Publication 651, *Sound Level Meters* (1979).
- (e) **Magnetic tape recorders.** No requirements are described in this document pertaining to tape recorders, except for frequency response. Generally, recorders of adequate quality to provide the frequency response performance required will also meet other minimum requirements for distortion, signal-to-noise ratio, etc.
- (f) **Graphic level recorder dynamic response.** When using a graphic level recorder, it is necessary to select pen response settings such that the readings obtained are statistically equivalent to those obtained by directly reading a meter which meets the "fast" dynamic requirements for sound level meters. To ensure statistical equivalence, at least 30 comparative observations of real test data shall be made and the average of the absolute value of the differences observed shall be less than 0.5 dB. The settings described in subparagraphs (i) and (ii) likely assure appropriate dynamic response; however, different settings may be selected on the basis of the above requirement.
- (i) Use a pen writing speed of nominally 60 – 100 dB/sec. If adjustable, low frequency response should be limited to about 20 Hz.
- (ii) Indicated overshoot for a suddenly applied 1000-Hz sinusoidal signal equivalent to an 86-dB sound level shall be no more than 1.1 dB and no less than 0.1 dB.

A.1.2 Frequency Response Qualification Procedure

- (a) Typical noise measurement and analysis configurations are shown in Figures 2 through 4. The qualification procedure described herein duplicates these

- configurations, but with the microphone replaced by an electronic sinewave oscillator. Caution should be exercised when connecting an oscillator to the input of a sound level meter to ensure, perhaps by using a restrictive voltage divider network, that the input is not overloaded (see A.1.3(b)).
- (b) Calibrate the oscillator to be used by measuring its output relative to the voltage which is equivalent to an 86-dB sound level at each of the 27 frequencies listed in Table 1 using a calibrated voltmeter. Record the resulting voltage level in dB corresponding to an 86-dB sound level at 1000 Hz. This will describe the frequency response characteristics of the oscillator.
 - (c) If a graphic level recorder is to be used, connect it to the oscillator output. If the oscillator and graphic level recorder can be synchronized, slowly sweep the frequency over the range of 31.5 to 12,500 Hz, recording the oscillator output. If they cannot be synchronized, record oscillator output for signals at the 27 frequencies given in Table 1. The differences between the combined response thus obtained and the oscillator response obtained previously will describe the frequency response of the graphic level recorder.
 - (d) If visual observation of an indicating meter is to be used for obtaining data, the oscillator should be connected to the indicating meter input (such as the microphone input of a sound level meter) and the meter reading observed for a fixed oscillator output voltage setting for signals at the 27 frequencies given in Table 1.
 - (e) To check a tape recorder, connect the instruments as shown in Figure 4. Using a 1000-Hz tone, adjust the oscillator output level to obtain a reading 15 dB below maximum record level. If the synchronized oscillator/graphic level recorder system is to be used for analysis, record an oscillator sweep over the range of 31.5 to 12,500 Hz, using an appropriate tape recorder input attenuator setting. Alternatively, tape-record frequency tones at the 27 frequencies given in Table 1. Replay the tape recordings using the setup shown in Figure 3. Record the data on a graphic level recorder or through visual observation of the indicating meter. Subtract the oscillator frequency response in paragraph A.1.2(b) from the response obtained through the record-playback sequence to obtain the record/reproduce frequency response of the system except for the microphone.
 - (f) To obtain the overall system frequency response, add the manufacturer's microphone calibration data to the response just obtained. This may be the frequency response for the specific microphone to be used, including calibration tolerances. Alternatively, use the manufacturer's "typical" microphone response plus or minus the maximum deviation expected from "typical", including calibration tolerances. Use the microphone response curve which corresponds to the manner in which it is used in the field. It may be necessary to add a correction to the response curves provided to obtain a field response; refer to the manufacturer's manual.
 - (g) Adjustment or repair of equipment may be necessary in order to obtain a response within the requirements of subsection A.1.1. After any adjustments, the system shall be requalified according to subsection A.1.2.

A.1.3 General Comments

- (a) Calibrate the tape recorders using the brand and type of magnetic tape that will be used for actual data acquisition. Differences in tape can cause an appreciable variation in the frequency response characteristics of a tape recorder.
- (b) It shall be ensured that the instrumentation used will perform within specifications and applicable tolerances over the temperature, humidity, and other environmental variation ranges that may be encountered in vehicle noise measurement work.
- (c) Qualification tests shall be performed using equipment (including cables) and recording and playback techniques identical to those used while recording vehicle noise. For example, if weighted sound level data are normally recorded, use similar weighting and apply the tolerances of Table 1 to the weighting curve for comparison with record-playback curves. Precautions should also be taken to ensure that source and load impedances are appropriate to the device being tested. Other data acquisition systems may use any combination of microphones, sound level meters, amplifiers, tape recorders, graphic level recorders, or indicating meters. The same approach to qualifying such a system shall be taken as described in this document for the systems depicted in Figures 2 to 4.

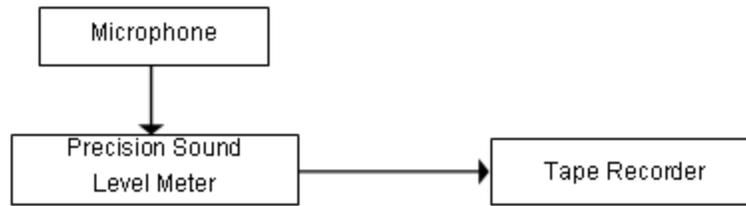


Figure 2: Data Recording

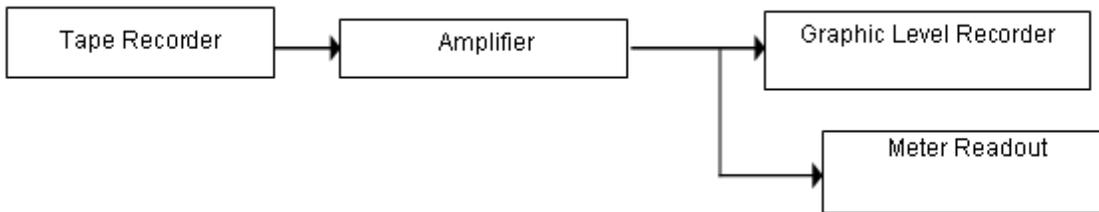


Figure 3: Data Analysis and Test Analysis

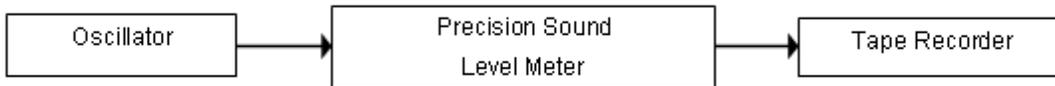


Figure 4: Test Recording