RECOMMENDED PRACTICE SAE J1074

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ENGINE SOUND LEVEL MEASUREMENT PROCEDURE—SAE J1074

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SAE Recommended Practice

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1. Introduction—This SAE Recommended Practice sets forth the equipment, environment, and test procedures to be used in measuring sound levels of engines. The purpose is to provide a uniform method of measuring the maximum acoustical radiation from the exterior surfaces of an engine under representative engine operating conditions. The measured sound levels will be useful in development of engines, comparison of engines, and installation of engines in various applications. The correlation of the measured engine sound levels to the various application sound levels will have to be developed.

2. Engine Classifications

2.1 Bare Engine—An engine equipped with only the built-in accessories essential to its operation, such as flywheel, fuel pump, oil pump, water pump, and intake and exhaust manifolds. The sound from the exhaust, intake, flywheel housing opening, test stand, and dynamometer shall be minimized in order to measure the sound level of the basic or bare engine: although for aircooled engines where the cooling air flows from the flywheel housing opening, the flywheel housing opening should not be covered. The exhaust and intake sounds shall be minimized by using remote mufflers and air cleaners, with heavy, acoustically treated piping to bare engine manifolds. Watercooled engines should not use a cooling fan. Isolation type engine mounts should be used to minimize the vibrations to the engine test equipment.

2.2 Fully Equipped Engine—An engine equipped with all mounted accessories necessary to perform its intended function unaided. The accessories shall be specified and described. If the sound from the exhaust, intake, and cooling systems are included, the systems should be specified and described. The sound from the flywheel housing opening, test stand, and dynamometer shall be minimized: although for aircooled engines where the cooling air flows from the flywheel housing opening, the flywheel housing opening should not be covered. The effect of the cooling fan airflow on the microphone should also be minimized (see paragraph 7.3).

3. Instrumentation—The following instrumentation shall be used, where applicable, for the measurement required:

3.1 A sound level meter which meets the Type 1 requirements of S1.4-1971, Specification for Sound Level Meters.

3.2 An octave band filter set which meets the Class II requirements of ANSI S1.11-1966, Specifications for Octave, Half-Octave, and Third-Octave Band Filter Sets.

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

3.4 An acoustic calibrator (see paragraph 7.4).

3.5 An engine speed indicator, accurate to ±1% or ±10 rpm, whichever is greater.

3.6 An anemometer (if outside tests are being performed).

3.7 A windscreen may be used (see paragraph 7.3). The windscreen must not affect the microphone response more than ±1 dB for the frequencies of 20–4000 Hz or ±1½ dB for frequencies of 4000–10,000 Hz.

4. Environment—The engine sound levels shall be measured in an environment such that results are equivalent to those obtained in a free field above a reflecting plane. Measurements may be made at a flat open space or in a calibrated acoustically treated test cell.

4.1 If a flat open space is used, it shall be free of the effect of large reflecting surfaces, such as signboards, buildings, or hillsides located within 100 ft (30.4 m) of either the engine or microphone. The surface within 50 ft (15.2 m) of either the engine or microphone shall be free from snow, grass, loose soil, or other acoustical absorption materials. The area directly between the engine and the microphone shall be concrete or asphalt paving extending at least 10 ft (3.0 m) in all directions from the line between the engine and the microphone.

4.2 If an acoustically treated test cell is used, it must be calibrated for comparison to the flat open space for each octave band, A-weighted, and linear (or C-weighted) sound pressure level. The measurements from test cells and outdoor test sites may not be directly comparable without a correction factor, because of a reverberant sound field contribution to the test cell measurements. The test cell correction factor and method of determining the correction factor should be reported with the measured engine sound levels (see paragraph 8.6).

4.3 The ambient sound pressure levels (including wind effects) coming from sources other than the engine being measured shall be at least 10 dB below the level of the tested engine.

4.4 Because bystanders have an appreciable influence on meter response when they are in the vicinity of the engine or microphone, not more than one person, other than the observer reading the meter, shall be within 50 ft (15.2 m) of the engine or instrument, and that person shall be directly behind the observer reading the meter, on a line through the microphone and the observer. If the meter operator or engine/dynamometer operator are in the test cell, they should be to the rear of the engine or at the maximum allowable distance from the engine or microphones.

5. Measurements

5.1 The microphone shall be located 3.3 ft (1.0 m) from the longitudinal centers of the vertical planes forming the smallest rectangle which completely encloses the bare engine. Measurements shall be made on both sides and in front of the engine at the height of the exhaust manifold, but not less than 3.3 ft (1.0 m) above the floor. A survey of the A-weighted sound level shall be made at this microphone height and distance from the rectangular box. If the survey indicates a reading(s) more than 3 dB above the highest reading at the three specified locations, the sound level at this location(s) shall be also reported. The microphone positions thus referred to the bare engine shall be used for tests on fully equipped engines.

5.1.1 If the flat open space is used for optional correlation with most of the SAE sound level measurements of vehicles, additional sound measurements may be made with the microphone located at a height of 4 ft (1.2 m) above the surface and at 50 ft (15.2 m) from the center of the engine.

5.1.2 If the flat open space is used for optional correlation with most ISO sound level measurements, additional sound measurements may be made with the microphone located at a height of 4 ft (1.2 m) and 25 ft (7.5 m) from the center of the engine or 23 ft (7.0 m) from major surfaces.

5.2 The sound level meter or other indicating instrument shall be set for slow response. At each of the microphone locations, the following measurements shall be made:

(a) The sound level using the A-weighted network.

(b) The sound pressure level using the linear or C-weighted network; the network used shall be reported.

(c) The octave band sound pressure levels for center frequencies of 63–8000 Hz at the microphone location having the highest A-weighted sound level, as determined in paragraph 5.1.

(d) The reported data shall be identified as to the microphone location. The reported sound pressure level shall be the average of two or more readings that are within 2 dB of each other.

6. Engine Operation—The engine shall be previously checked for rated performance and proper tune-up and shall be operated at the following steady conditions after reaching normal operating conditions:

(a) Rated speed and load.

(b) For governed engines, maximum governed speed at no load; for ungoverned engines, rated speed at no load.

(c) Speed and load resulting in peak torque.

(d) Recommended low idle speed.

7. General Comments

7.1 It is essential that technically trained personnel select the equipment and that the tests be conducted only by persons trained in the current techniques of sound measurement.

7.2 Instrument manufacturer's specifications for orientation of the microphone relative to the source of sound and the location of the observer relative to the meter should be followed. The microphone or sound level meter temperatures should be monitored to prevent overheating from the exhaust manifold.

7.3 It is recommended that measurements be made only when wind speed is below 12 mph (19 km/h). The microphone windscreen may be used to minimize the effects of wind gusts and other changes in wind velocity.

7.4 Instrument manufacturer's recommended calibration should be made at appropriate times. Field calibrations should be made immediately before and after each test sequence. Either an external calibration or internal calibration means is acceptable for field use, provided that external calibration is accomplished before or after the field test.

7.5 If a tape recorder is used, record a calibration tone of a known sound pressure level on the tape, using the same microphone and the same recorder attenuation settings immediately before and after the series of recordings.

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, Specifications for Sound Level Meters.

8.4 ANSI S1.11—1966, Octave, Half-Octave, and Third-Octave Band Filter Sets.