AN AMERICAN NATIONAL STANDARD

ASME B56.11.5a-1994

ADDENDA

to

ASME B56.11.5-1992
MEASUREMENT OF SOUND EMITTED BY LOW LIFT, HIGH LIFT AND ROUGH TERRAIN POWERED INDUSTRIAL TRUCKS

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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ASME B56.11.5a-1994

Following approval by the ASME B56 Committee and ASME, and after public review, ASME B56.11-5a-1994 was approved by the American National Standards Institute on August 30, 1994.

Addenda to the 1992 edition of ASME B56.11.5 are issued in the form of replacement pages. Revisions, additions, and deletions are incorporated directly into the affected pages. It is advisable, however, that this page, the Addenda title and copyright pages, and all replaced pages be retained for reference.

SUMMARY OF CHANGES

This is the first Addenda to be published to ASME B56.11.5-1992.

Replace or insert the pages listed. Changes given below are identified on the pages by a margin note, **(a)**, placed next to the affected area. The pages not listed are the reverse sides of the listed pages and contain no changes.

Page	*Location*	*Change*
1	General	(1) Third paragraph revised (2) Footnote deleted
5	5.5.3	Second paragraph revised

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POWERED AND NONPOWERED INDUSTRIAL TRUCKS

(92) (a)

GENERAL

This Standard is one of a series that has been formulated with the American Society of Mechanical Engineers as Sponsor in accordance with the Accredited Organization method, the procedures accredited by the American National Standards Institute, Inc., and the following scope.

> Establishment of the safety requirements relating to the elements of design, operation, and maintenance; standardization relating to principal dimensions to facilitate interchangeability, test methods, and test procedures of powered and nonpowered industrial trucks (not including vehicles intended primarily for earth moving or over-the-road hauling); and maintenance of liaison with the International Organization for Standardization (ISO) in all matters pertaining to powered and nonpowered industrial trucks.

One purpose of the Standard is to serve as a guide to governmental authorities having jurisdiction over subjects within the scope of the Standard. It is expected, however, that the Standard will find a major application in industry, serving as a guide to manufacturers, purchasers, and users of the equipment.

For convenience, Standards for Powered and Nonpowered Industrial Trucks have been divided into separate volumes:

Safety Standards

B56.1	Low Lift and High Lift Trucks
B56.5	Guided Industrial Vehicles and Automated Functions of Manned Industrial Vehicles
B56.6	Rough Terrain Forklift Trucks
B56.7	Industrial Crane Trucks
B56.8	Personnel and Burden Carriers
B56.9	Operator Controlled Industrial Tow Tractors
B56.10	Manually Propelled High Lift Industrial Trucks

Standardization Standards

B56.11.1	Double Race or Bi-Level Swivel and Rigid Industrial Casters
B56.11.3	Load Handling Symbols for Powered Industrial Trucks
B56.11.4	Hook-Type Forks and Fork Carriers for Powered Industrial Forklift Trucks
B56.11.5	Measurement of Sound Emitted by Low Lift, High Lift, and Rough Terrain Powered Industrial Trucks
B56.11.6	Evaluation of Visibility From Powered Industrial Trucks

Safety standards that were previously listed as B56 volumes but now have different identification due to a change in standards development assignments are as follows.

NFPA 505	Fire Safety Standard for Powered Industrial Trucks — Type Designations, Areas of Use, Maintenance and Operation (formerly B56.2)
UL 583	Standard for Safety for Electric-Battery-Powered Industrial Trucks (formerly B56.3)
UL 558	Standard for Safety for Internal Combustion-Engine-Powered Industrial Trucks (formerly B56.4)

If adopted for government use, the references to other national standards in the specific volumes may be changed to refer to the corresponding governmental regulations.

The use of powered and nonpowered industrial trucks is subject to certain hazards that cannot be completely eliminated by mechanical means, but the risks can be minimized by the exercise of intelligence, care, and common sense. It is therefore essential to have competent and careful operators, physically and mentally fit and thoroughly trained in the safe operation of the equipment and the handling of the loads. Serious hazards are overloading, instability of the load, obstructing the free passage of the load, collision with objects or pedestrians, poor maintenance, and use of equipment for a purpose for which it was not intended or designed.

Suggestions for improvement of these volumes, especially those based on actual experience in their application, shall be submitted to the Secretary of

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ASME B56.11.5A 94 ■ 0759670 0547782 T67 ■

the B56 Committee, ASME, United Engineering Center, 345 East 47th Street, New York, NY 10017.

Comments shall be written in accordance with the following format:

(a) specify paragraph designation of the pertinent volume;

(b) indicate suggested change (addition, deletion, revision, etc.);

(c) briefly state reason and/or evidence for suggested change;

(d) submit suggested changes to more than one paragraph in the order in which they appear in the volume.

The appropriate B56 Subcommittee will consider each suggested revision at its first meeting after receipt of the suggested revision(s).

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point and end point as established by the vehicle travel path.

A substantially level open space of not less than 165 ft (50 m) radius, of which the central area of 33 ft (10 m) radius, consists of concrete, sealed asphalt or similar hard material, free from any soft covering, shall be deemed to satisfy the requirement, but a smaller area may be used if it meets the requirements for hemispherical divergence.

NOTE: In practice, any departure from the so-called "ideal" arises from four main causes:
(a) sound absorption by the surface of the ground;
(b) reflections from objects such as buildings, trees, or persons;
(c) ground which is not of uniform slope over a sufficient area;
(d) wind; care should be taken that gusts of wind do not affect results of the measurements.

It is impractical to specify in detail the effect produced by each of these influences. It is considered important, however, that the surface of the ground and hard surface specifically within the measurement area be free from snow, grass, loose soil, ashes, standing water, etc.

To minimize the effect of reflection, it is further recommended that the sum of the angles subtended at the position of the test truck by surrounding buildings within a 165 ft (50 m) radius, shall not exceed 90 deg. and that there be no substantial obstructions within the radius of 100 ft (30 m) from the truck. See Fig. 1.

Sites located between parallel walls should be avoided due to the effect of acoustical focusing.

The presence of bystanders may appreciably influence the meter reading if such persons are in the vicinity of the truck or microphone. No person other than the operator shall be in the operator station area of the truck. All bystanders shall be excluded from the test site.

5.3 Background Noise

5.3.1 The ambient sound level, including wind noise, due to sources other than the truck being measured should be at least 10 dB below the lowest sound level generated by the machine being tested during the work cycle.

5.3.2 If the difference between the A-weighted sound level measured with the sound source, the truck operating, and the ambient sound level alone is less than 10 dB, corrections for the influence of background noise shall be made in accordance with the following table:

Corrections for Background Noise

Difference between sound level measured with sound source operating and background sound pressure level alone		Corrections to be subtracted from sound level measured with sound source operating to obtain sound level due to sound source alone
dB		dB
Less than	6	Measurements invalid
	6	1.0
	7	1.0
	8	1.0
	9	0.5
	10	0.5
Greater than	10	0.0

5.3.3 If, when testing at an outdoor location, it is determined that the wind speed in the vicinity of the truck and microphone is in excess of 2 mph (1 m/s), a windscreen around the microphone shall be used. Also, appropriate compensation for the effect of the windscreen shall be allowed in calibration of the recording instrumentation.

5.4 Environmental Conditions

All instruments employed in the making of sound measurements shall be used in accordance with the electrical and environmental conditions recommended by the manufacturer.

5.5 Operator

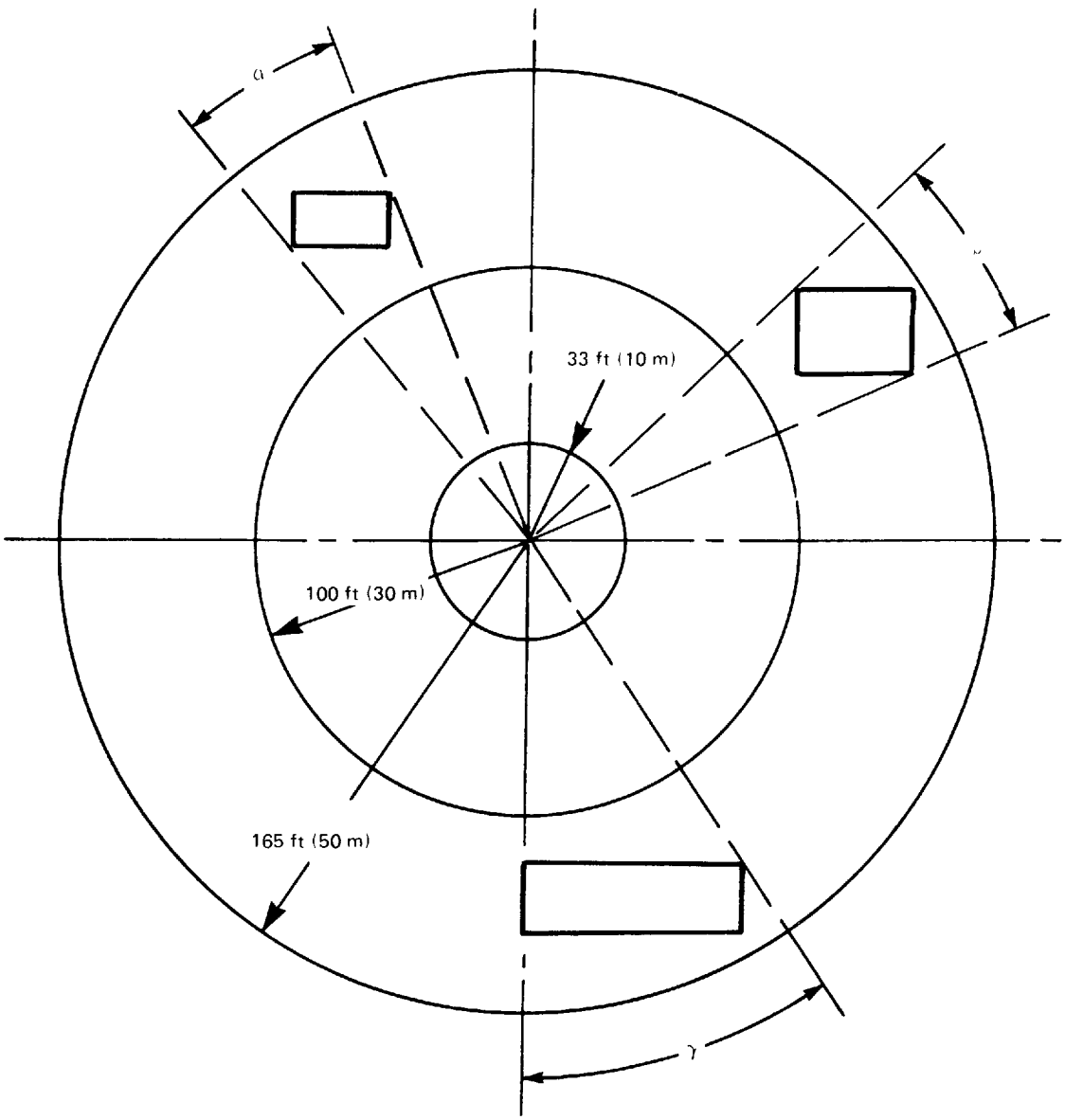
5.5.1 The operator shall be in the usual driving position. No observers shall be in close proximity to the driver or truck or in the cab (when provided) during the taking of measurements.

5.5.2 Observers shall be remote from and behind those microphones in use during the specific test.

5.5.3 Operators shall not wear abnormally sound absorptive clothing. A "hard hat" may be worn, however, no hat, scarf, or bulky jacket which might influence the sound measurements shall be worn. (a)

In those tests where the microphone is positioned at a point 2 in. (50 mm) measured laterally, from the operator's ear, only the mounting frame or shoulder harness for the microphone shall be used.

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$\alpha + \beta + \gamma \cdot$ 90 deg.

NOTE:

(1) The 33 ft (10 m) radius area at center shall be of hard smooth material. (See para. 5.2.3.)

FIG. 1 TEST SITE ARRANGEMENT GENERAL REQUIREMENTS

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SPECIAL NOTICE

ASME B56.11.5-1992
MEASUREMENT OF SOUND EMITTED BY LOW LIFT, HIGH LIFT, AND ROUGH TERRAIN INDUSTRIAL TRUCKS

There will be no addenda or interpretations for 1993 published to ASME B56.11.5-1992. Within the past year neither changes to, nor inquiries regarding, the technical requirements of this document have been issued.

OCTOBER 1993

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
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ASME B56.11.5-1992

(REVISION OF ASME B56.11.5-1989)

POWERED AND NONPOWERED INDUSTRIAL TRUCKS

REAFFIRMED 2000

FOR CURRENT COMMITTEE PERSONNEL
PLEASE SEE ASME MANUAL AS-11

Measurements of Sound Emitted by Low Lift, High Lift, and Rough Terrain Powered Industrial Trucks

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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AN AMERICAN NATIONAL STANDARD

POWERED AND NONPOWERED INDUSTRIAL TRUCKS

Measurements of Sound Emitted by Low Lift, High Lift, and Rough Terrain Powered Industrial Trucks

ASME B56.11.5-1992

(REVISION OF ASME B56.11.5-1989)

The American Society of Mechanical Engineers

345 East 47th Street, New York, N.Y. 10017

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Date of Issuance: November 15, 1992

The 1992 edition of this Standard is being issued with an automatic subscription service. The use of an addenda allows revisions made in response to public review comments or committee actions to be published on a regular yearly basis; revisions published in addenda will become effective 1 year after the Date of Issuance of the addenda. The next edition of this Standard is scheduled for publication in 1995.

ASME issues written replies to inquiries concerning interpretations of technical aspects of this Standard. The interpretations will be included with the above addenda service. Interpretations are not part of the addenda to the Standard.

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FOREWORD (92)

(This Foreword is not part of ASME B56.11.5-1992.)

Work on this Standard, originally designated as MH11.5M, was begun by the MH11 Committee. With the consolidation of the activities of the MH11 and B56 Committees, the MH11 Committee became the B56.11 Subcommittee, under the jurisdiction of the B56 Committee. The B56.11 Subcommittee continued the development of this Standard, redesignated as B56.11.5.

After several B56 Committee ballots and public review, the standard was approved by the Sponsor. After obtaining such approval, the standard was submitted to the American National Standards Institute, Inc. (ANSI). ANSI approval to issue the standard as American National Standard B56.11.5 was granted on October 5, 1989.

A revision to the 1989 Edition of B56.11.5 was approved by the B56 Committee, by ASME, and after public review, by the American National Standards Institute, Inc., on June 10, 1992.

Safety codes and standards are intended to enhance public health and safety. Revisions result from committee consideration of factors such as technological advances, new data, and changing environmental and industry needs. Revisions do not imply that previous editions were inadequate.

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Powered and Nonpowered Industrial Trucks

(The following is the roster of the Committee at the time of approval of this Standard.)

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ASME B56.11.5-1992
SUMMARY OF CHANGES

The 1992 edition of B56.11.5 includes the following changes, identified by **(92)**.

Page	*Location*	*Change*
iii	Foreword	Revised
1	General	Revised

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Suggestions for improvement of these volumes, especially those based on actual experience in their application, shall be submitted to the Secretary of

[1] B56.10 and B56.11.6 are in the developmental stage.

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MEASUREMENT OF SOUND EMITTED BY LOW LIFT, HIGH LIFT, AND ROUGH TERRAIN POWERED INDUSTRIAL TRUCKS

1 SCOPE

This Standard establishes the conditions, test procedures, environment, and instrumentation for the determination and reporting of the A-weighted sound pressure level of electric battery and internal combustion engine powered, low lift, high lift, and rough terrain industrial trucks. It excludes earthmoving machinery, industrial cranes, and vehicles intended primarily for use on public roads.

It provides test procedures for measuring both operator and bystander exposure to sound produced by the trucks.

The test procedures set forth in this Standard provide the basis for determining the contribution powered industrial trucks make to the overall sound level of a selected work area.

2 FIELD OF APPLICATION

This Standard applies to all types of low lift, high lift, and rough terrain powered industrial trucks.

This Standard provides methods for testing and reporting sound levels emitted by powered industrial trucks.

This Standard provides specifications for instrumentation, measurement site, microphone locations, and sound analysis, as well as operating conditions for the truck under test.

Tests are provided for trucks both in motion and static, and with lifting gear in operation when appropriate. It is of primary importance that the measurements taken relate to normal operation and procedures, thus including transmission, hydraulic, and mast elevating sounds.

The tests and procedures detailed in Section 6 of this Standard provide a means of establishing Equivalent Sound Levels (L_{eq}) by dividing a simplified work cycle into basic elements. This avoids the inconveniences involved in recording measurements during the work cycle, either by the use of tape recorders or dosimeters. The work cycle used reflects the highly cyclical nature of powered industrial truck sound. Details of the work cycle used in computing the tables are shown in Appendix A.

3 REFERENCES

3.1 American National Standards

ANSI S1.4-1971(R1976) Specification for Sound Level Meters

3.2 International Organization for Standardization

ISO/R 1999-1975, Acoustical Assessment of Occupational Noise Exposure for Hearing Conservation Purposes

ISO 2204-1979, Acoustical Guide to International Standards on the Measurement of Airborne Acoustical Noise and Evaluation of its Effects on Human Beings

3.3 International Electrotechnical Commission

IEC Publication 651(1979), Sound Level Meters

4 DEFINITIONS

capacity — the capacity of a truck equipped with load carriage and forks, or with attachments, is the weight at a specified load center that a given truck can transport in a carry position and stack to the maximum elevation of the load engaging means

NOTE: Capacity is used to designate the weight handling ability of a particular truck as equipped.

maximum lift speed — the lift speed attainable, either laden or unladen, as directed by this test procedure:

(a) internal combustion engine powered truck — with engine at maximum governed speed established by the truck manufacturer and lift control held in maximum position

(b) electric battery powered truck — with a fully charged battery when the lift control is held in maximum position

Maximum lift speed, either laden or unladen, shall be accomplished without relief valve bypassing.

maximum travel speed — the travel speed attainable, either laden or unladen, as directed by the specific test procedure. Traveling tests shall be performed at the maximum governed speed of the truck [but not to exceed 20 mph (32 km/h) – see paras. 7.2.2(b) and

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7.2.2(c)]. This may necessitate operating the truck in other than high gear.

(a) internal combustion engine powered truck — when instrument readings are taken, the engine speed shall be as close as possible to the maximum governed speed. This may necessitate operating the truck in other than high gear.

(b) electric battery powered truck — with a fully charged battery when travel speed control is held in maximum position

sound pressure level (L_p) — twenty times the logarithm to the base 10 of the ratio of the sound pressure to the reference sound pressure, expressed in decibels

NOTE: For the purposes of this Standard, the A-weighting network shall always be used, yielding the A-weighted sound pressure level L_{pA}. The reference sound pressure is 20 μPa.

sound pressure level, A-weighted (L_{pA}) — the frequency-weighted value of the sound pressure level determined with a sound level meter set for the A-weighting network. The unit is the decibel (dB).

5 GENERAL REQUIREMENTS

5.1 Measurement Equipment

5.1.1 A sound level meter which meets the requirements of either ANSI S1.4-1971(R1976) (Type 1 — Precision), or IEC Publication 651 (1979) (Type 1).

The sound level meter should be calibrated at intervals of not more than 2 years, using an internationally accepted primary standard.

Before and after conducting each series of measurements, the overall acoustic performance of the sound level meter shall be checked, using an acoustical calibrator. This check shall be made at least daily, when tests are being conducted.

The calibration before and after conducting each series of tests shall not vary by more than 0.5 dB for the tests to be valid.

5.1.2 The use of a wind screen may be required under some test conditions, otherwise its use is optional providing it does not affect the A-weighted sound level of the source being measured by more than ±0.5 dB, under zero wind speed conditions.

5.1.3 An anemometer or other device for measurement of ambient wind speed and direction. The accuracy shall be ±10% at the highest recommended wind speed.

5.1.4 A power source speed indicator or tachometer having an accuracy within ±2% of the indicated reading.

5.1.5 A thermometer for measurement of ambient temperature having an accuracy within ±2°F (1°C).

5.1.6 A barometer for measuring atmospheric pressure having an accuracy within ±0.3 in. Hg (1.1 kPa) of the indicated reading.

5.1.7 A microphone having a diameter of 0.5 in. (13 mm) or less shall be used.

If a microphone which has not been provided as a component of a Type 1 sound level meter is used, it shall meet the microphone characteristics described in ANSI S1.4-1971(R1976).

5.1.8 An acoustic calibrator with an accuracy of ±0.5 dB shall be used.

5.1.9 When the alternate test procedure provided in Section 6.4 is used in lieu of the tests provided in paras. 6.2.5, 6.2.6, 6.2.7, and 6.2.8, a microphone or sound level meter with a magnetic tape recorder and/or graphic level recorder or indicating instrument is required. This system shall meet the requirements of SAE Recommended Practice J184a — Qualifying a Sound Acquisition System, for the frequency range that is of primary concern.

5.2 Test Site

5.2.1 The test method prescribed calls for an acoustical environment which can be obtained only in an extensive open space or hemi-anechoic chamber.

5.2.2 When a hemi-anechoic chamber is used, the hemispherical divergence should be within ±1 dB, for the frequency range that is of primary concern as determined by the truck undergoing test; i.e., the acoustical performance of the chamber should be within ±1 dB of the theoretical value.

5.2.3 If an outdoor test site is used, it shall be a flat open space with not over ±1% grade in the direction of travel and not over ±3% grade at right angles to the direction of travel. The test site shall be free of large reflecting surfaces such as parked vehicles, signboards, buildings or hillsides, located within 82 ft (25 m) of the measurement area defined by the microphone location, and the vehicle entrance

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point and end point as established by the vehicle travel path.

A substantially level open space of not less than 165 ft (50 m) radius, of which the central area of 33 ft (10 m) radius, consists of concrete, sealed asphalt or similar hard material, free from any soft covering, shall be deemed to satisfy the requirement, but a smaller area may be used if it meets the requirements for hemispherical divergence.

NOTE: In practice, any departure from the so-called "ideal" arises from four main causes:
(a) sound absorption by the surface of the ground;
(b) reflections from objects such as buildings, trees, or persons;
(c) ground which is not of uniform slope over a sufficient area;
(d) wind; care should be taken that gusts of wind do not affect results of the measurements.

It is impractical to specify in detail the effect produced by each of these influences. It is considered important, however, that the surface of the ground and hard surface specifically within the measurement area be free from snow, grass, loose soil, ashes, standing water, etc.

To minimize the effect of reflection, it is further recommended that the sum of the angles subtended at the position of the test truck by surrounding buildings within a 165 ft (50 m) radius, shall not exceed 90 deg. and that there be no substantial obstructions within the radius of 100 ft (30 m) from the truck. See Fig. 1.

Sites located between parallel walls should be avoided due to the effect of acoustical focusing.

The presence of bystanders may appreciably influence the meter reading if such persons are in the vicinity of the truck or microphone. No person other than the operator shall be in the operator station area of the truck. All bystanders shall be excluded from the test site.

5.3 Background Noise

5.3.1 The ambient sound level, including wind noise, due to sources other than the truck being measured should be at least 10 dB below the lowest sound level generated by the machine being tested during the work cycle.

5.3.2 If the difference between the A-weighted sound level measured with the sound source, the truck operating, and the ambient sound level alone is less than 10 dB, corrections for the influence of background noise shall be made in accordance with the following table:

Corrections for Background Noise

Difference between sound level measured with sound source operating and background sound pressure level alone		Corrections to be subtracted from sound level measured with sound source operating to obtain sound level due to sound source alone
dB		dB
Less than	6	Measurements invalid
	6	1.0
	7	1.0
	8	1.0
	9	0.5
	10	0.5
Greater than	10	0.0

5.3.3 If, when testing at an outdoor location, it is determined that the wind speed in the vicinity of the truck and microphone is in excess of 2 mph (1 m/s), a windscreen around the microphone shall be used. Also, appropriate compensation for the effect of the windscreen shall be allowed in calibration of the recording instrumentation.

5.4 Environmental Conditions

All instruments employed in the making of sound measurements shall be used in accordance with the electrical and environmental conditions recommended by the manufacturer.

5.5 Operator

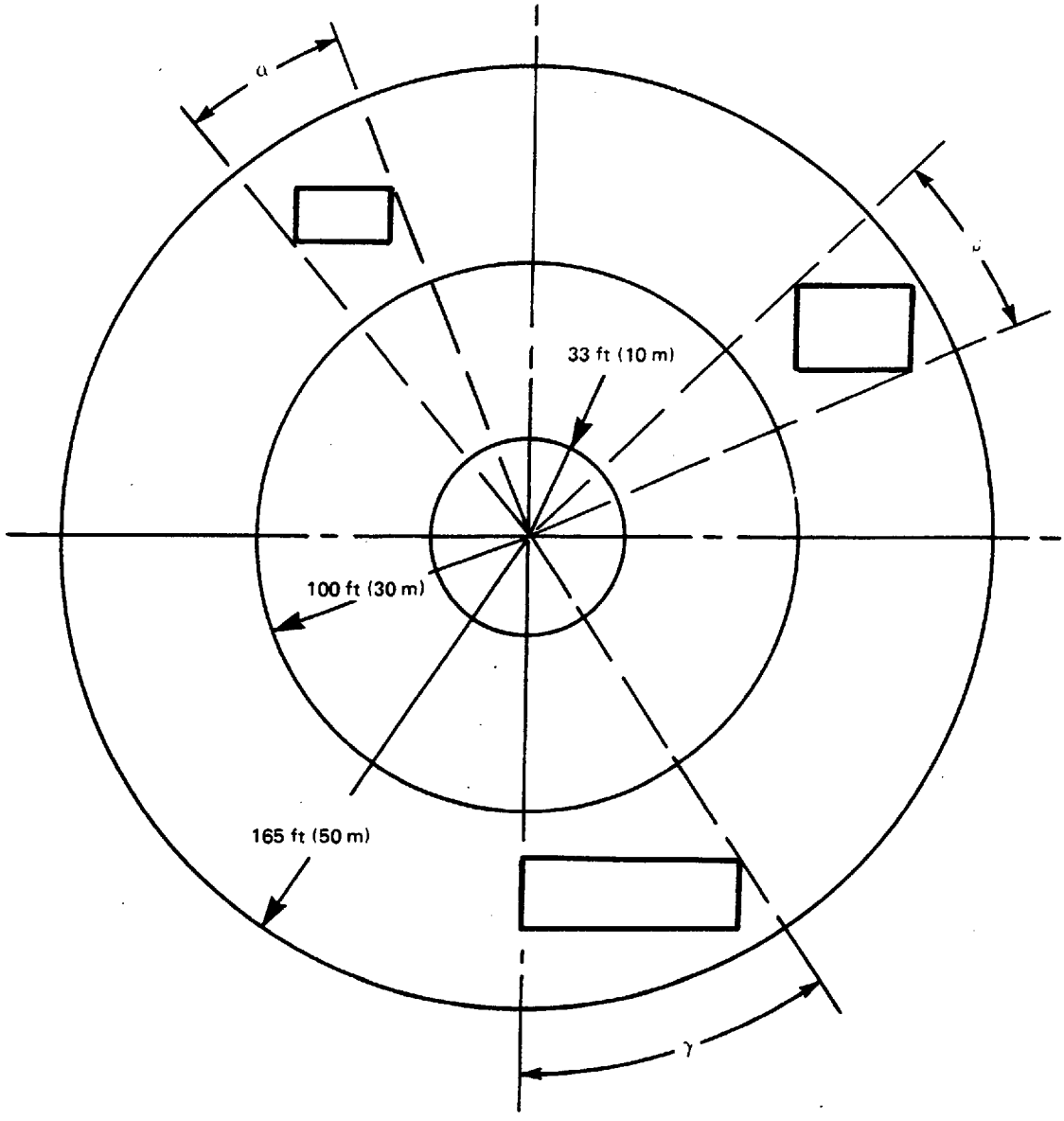
5.5.1 The operator shall be in the usual driving position. No observers shall be in close proximity to the driver or truck or in the cab (when provided) during the taking of measurements.

5.5.2 Observers shall be remote from and behind those microphones in use during the specific test.

5.5.3 Operators shall not wear abnormally sound absorptive clothing. A "hard hat" may be worn, however, no hat, scarf, or bulky jacket which might influence the sound measurements shall be worn.

In those tests where the microphone is positioned at a point 2 in. (50 mm) measured longitudinally, from the operator's ear, only the mounting frame or shoulder harness for the microphone shall be used.

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$\alpha + \beta + \gamma \cdot$ 90 deg.

NOTE:

(1) The 33 ft (10 m) radius area at center shall be of hard smooth material. (See para. 5.2.3.)

FIG. 1 TEST SITE ARRANGEMENT GENERAL REQUIREMENTS

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5.6 Operating Conditions

5.6.1 All parts of the propulsion and elevating systems (i.e., hydraulic system, engine, and transmission in the case of internal combustion engine powered trucks, gear boxes) shall have reached a stabilized operating temperature for the prevailing ambient conditions, before tests are recorded.

5.6.2 Oil reservoirs shall be filled within the range specified by the manufacturer.

5.6.3 In the case of combustion engine powered trucks, fuel tanks shall not be more than one-half full.

5.6.4 All auxiliary equipment which would normally be functioning during the work cycle shall be in operation during the taking of sound measurements, i.e., auxiliary attachments.

5.6.5 When a truck is fitted with a cab or enclosure, two sets of readings shall be recorded:

(a) with windows and ventilators open, climatization equipment off;

(b) with windows and ventilators closed, climatization equipment on.

When computing the equivalent sound level (see para. 6.3.2), the higher sum (E_1) of the values from (a) or (b) shall be used.

5.6.6 Only persons technically trained and experienced in the current techniques of sound measurement should select the instrumentation and conduct the tests.

5.6.7 The effects of ambient weather conditions on the performance of all instruments (i.e., temperature, humidity, and barometric pressure) should be known. Instrumentation can be influenced by low temperature or significant changes in temperature, hence caution should be exercised.

5.6.8 The relative speed of the air mass over the stationary microphone shall not exceed 4.5 mph (2 m/s) when tests are being conducted. Testing shall not be conducted where the windspeed in the vicinity of the test site exceeds 4.5 mph (2 m/s).

5.6.9 Proper signal levels, terminating impedances, and cable lengths on multi-instrument measurement systems should be known.

5.7 Measuring Characteristics

5.7.1 The sound level meter shall be set for the A-weighting network and for slow dynamic characteristics.

5.8 Test Load

5.8.1 The truck shall be laden or unladen as required for the specific tests.

5.8.2 Where a test load is specified in the test procedure the load shall be 70% of the capacity of the truck as equipped.

6 MEASUREMENT OF SOUND AT THE OPERATOR'S WORKPLACE

6.1 Microphone Orientation

6.1.1 Sound level measurements shall be made with the microphone located 2 in. (50 mm) measured horizontally from either the right or left ear of the operator. The side indicating the higher sound level shall be used. An open helmet frame or shoulder harness may be used as a fixing point for the microphone. The face of the microphone should be in line, vertically, and within ±1.0 in. (±25 mm) horizontally fore and aft, of the operator's ear canal. The microphone should point either in the direction of the operator's vision (head mounted) or upwards (shoulder mounted).

If the microphone is mounted on the truck being tested, it should point in the forward travel direction.

6.1.2 An operator shall be selected whose physical dimensions are as close as possible to the 50th percentile person:

(a) standing height – bare feet 63–68 in. (1600–1735 mm)

(b) ear height – sitting 28.4–30.5 in. (721–775 mm)

(c) head width – 5.1–5.3 in. (129–135 mm)

An operator with physical dimensions that fall outside the 5th percentile to the 95th percentile range [ear height – sitting 26.2–32.2 in. (665–818 mm)] should not be permitted to operate the truck during this sound evaluation test.

6.1.3 The microphone location shall be determined with an operator in the operator's position. (See para. 6.1.2.)

The operator's seat shall be set at or as near as possible to the mid-point of its horizontal and vertical adjustment. The seat suspension, when provided, shall be depressed to the midpoint of its dynamic range.

During the test, the microphone shall be at least 3.1 in. (80 mm) from the side of the operator's head

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and 2 in. (50 mm) above any clothing on the driver's shoulders.

When the microphone position has been determined, the operator shall be instructed to maintain this established position within ±2.0 in. (±50 mm) in all three coordinates (lateral, longitudinal, and vertical) while the truck is being driven in each of the four prescribed test modes.

6.2 Test Procedure

6.2.1 The test site shall comply with the requirements of para. 5.2.

6.2.2 A minimum of three cycles shall be conducted to provide a minimum of three sound level values at each microphone position for each test cycle or element of a test cycle. When necessary, each test shall be repeated until two of the values obtained at each microphone position are within 2 dB of each other. If there are two pairs of readings that are within 2 dB of each other, record the average of the higher pair of readings. For steady state tests (i.e., Tests 1 and 2), where there is more than one microphone location, additional readings need be taken only at the microphone location having the highest sound level.

For each microphone location, the arithmetic average of the two highest values obtained, which are within 2 dB of each other, shall be used as the reported sound level.

6.2.3 Statement of Test Results

(a) All readings taken on the sound level meter (except those obtained from trial runs) shall be stated in the report.

(b) The sound level readings recorded shall be the highest values obtained during the conduct of each test.

NOTE: It is suggested that preliminary measurements be made to ensure the measuring and recording equipment is performing in a satisfactory manner. Such preliminary measurements shall not be included in the final recorded results.

6.2.4 The equivalent sound level of the truck is established by measuring the sound level during four different tests listed below and converting these values by means of the tables in Appendices B and C.

6.2.4.1 Test Mode 1. With the truck stationary and laden (see para. 5.8.2), mast in lowered position, fully tilted back and fully retracted, where applicable, the maximum lift speed (see Section 4) obtainable shall be selected. Maximum readings in dB with the sound level meter set on "slow" response shall be recorded during consecutive lifting cycles before the mast reaches its stop.

6.2.4.2 Test Mode 2. With the truck stationary and the engine idling at manufacturer's recommended low idle speed, record the sound level in dB.

NOTE: On battery powered electric trucks where no equipment continues to operate when the truck is standing still and no load handling controls are being operated, this test need not be run. However, in those instances where the power steering pump (or other device) continues to operate when the truck is stationary, the test shall be conducted.

6.2.4.3 Test Mode 3. Drive the unladen truck at maximum travel speed (see Section 4) in both directions and record the sound level in dB. Travel with load-engaging means or load low and, where possible, tilted back.

6.2.4.4 Test Mode 4. Drive the laden truck (see para. 5.8.2) at maximum travel speed (see Section 4) in both directions and record the sound level in dB. Travel with load-engaging means or load low and, where possible, tilted back.

6.3 Interpretation of Results

6.3.1 The equivalent sound level may be calculated from the following formula which provides for use of the test data recorded for Test Modes 1, 2, 3, and 4 above. The formula is applicable for any selected doubling rate.

$$L_{eq} = 3.32K \cdot \log_{10} \sum_{i=4}^{i=1} T_i \cdot 2^{\left(\frac{L_i}{K}\right)}$$

where

L_{eq} = equivalent sound level

K = selected doubling rate

T_i = fractional weighting of mode i = $\dfrac{\text{time in test mode } i}{\text{total time for test}}$

L_i = maximum sound level measured for Test Mode i — see para. 6.2.4.

$T_1 = 0.15$, $T_2 = 0.76$, $T_3 = 0.045$, $T_4 = 0.045$

NOTES:

(a) OSHA has established that in determining sound in the workplace a doubling rate of 5 ($K = 5$) shall be used.

(b) A doubling rate of 3 is also used in determining equivalent sound level.

(c) The doubling rate used when calculating L_{eq} shall be clearly indicated (i.e., L_{eq} doubling rate 5).

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6.3.2 Appendices B and C provide an alternate method for establishing the equivalent sound level (L_{eq}) without use of the formula in para. 6.3.1.

(a) From Appendix B establish the sound level indices for the selected doubling rate for each of the four test modes E_1, E_2, E_3, and E_4.

(b) Add the indices, thus $E_i = E_1 + E_2 + E_3 + E_4$.

(c) Using the sum E_i, determine from Appendix C (depending on the desired doubling rate) the equivalent sound level (L_{eq}) of the truck (interpolating linearly if necessary).

6.3.3 Record the equivalent sound level (L_{eq}) of the truck, as determined from either paras. 6.3.1 or 6.3.2, in the test report.

6.4 Alternate Test Procedure

In lieu of the test procedures set forth in paras. 6.2.4.1, 6.2.4.2, 6.2.4.3, and 6.2.4.4 and the calculations provided in para. 6.3.1, an alternative test procedure using the actual work cycle outlined in Appendix A of this Standard in conjunction with a precision integrating sound level meter or a recording instrumentation system which meets the precision sound level meter specifications as provided in para. 5.1.9 may be used.

NOTE: When the alternate test procedure outlined in Appendix A is used in lieu of the tests prescribed in paras. 6.2.4.1, 6.2.4.2, 6.2.4.3, and 6.2.4.4, the following statement shall appear in the heading of any test report prepared:
NOTE: The alternate test procedure provided in Appendix A of this Standard was used in place of the test procedure as set forth in paras. 6.2.4.1, 6.2.4.2, 6.2.4.3, and 6.2.4.4.

7 MEASUREMENT OF AIRBORNE SOUND TO THE ENVIRONMENT

7.1 Test Load

During the conduct of these tests the truck shall be unladen.

7.2 Test With Truck in Motion

7.2.1 Microphone Location

7.2.1.1 The horizontal distance from the microphone to the near side of the truck shall be 23 ft (7 m). The path of the centerline of the truck shall follow as closely as possible the line CC from line AA to the line BB. The distance between AA and BB shall not be less than 66 ft (20 m) and the microphone shall not be less than 33 ft (10 m) from either. See Fig. 2.

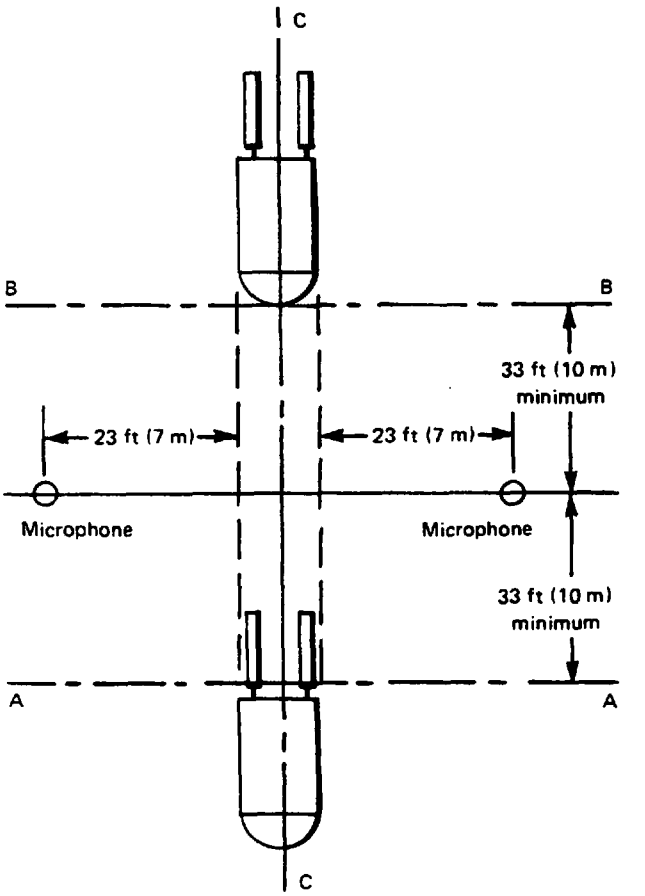


FIG. 2 TEST SITE ARRANGEMENT – MICROPHONE LOCATION (FOR TEST WITH TRUCK IN MOTION)

7.2.1.2 The microphone shall be located 4 ft (1.2 m) above ground level, and shall be oriented for the most uniform response characteristics according to the manufacturer's instructions.

7.2.2 Test Procedure

(a) The test site shall comply with the requirements of para. 5.2.

(b) For internal combustion engine powered trucks, the unladen truck shall pass between lines AA and BB (see Fig. 2), with maximum engine speed (RPM) and with the transmission ratio giving the maximum road speed closest to, but not exceeding, 20 mph (32 km/h).

(c) For electric battery powered trucks, the truck shall pass between lines AA and BB (see Fig. 2) with the speed control in maximum position.

(d) The sound level readings recorded shall be the

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highest value obtained during the conduct of each test run. The value recorded shall not include unusual transients or similar atypical noises.

(e) A minimum of three cycles shall be conducted to provide a minimum of three sound level values at each microphone position for each test cycle or element of a test cycle. When necessary, each test shall be repeated until two of the values obtained at each microphone position are within 2 dB of each other. If there are two pairs of values that are within 2 dB of each other, record the average of the higher pair. Where there is more than one microphone location, additional readings need be taken only at the microphone location having the highest sound level.

(f) For each microphone location, the arithmetic average of the two highest values obtained, which are within 2 dB of each other, shall be used as the reported sound level.

7.2.3 Statement of Test Results

(a) All readings taken on the sound level meter (except those obtained from trial runs) shall be stated in the report.

(b) The arithmetic average of the readings for each side of the truck (see para. 7.2.2) shall be calculated. The highest average, rounded to the nearest whole number shall be the sound level of the truck in motion. Rounding shall be upward for 0.5 dB and above, and downward for below 0.5 dB.

Report this A-weighted sound pressure level (L_{pA}) in the test report [see para. 8.3(a)].

7.3 Test With Truck Stationary

7.3.1 Microphone Location. For stationary tests, sound level measurements shall be made at a distance of 23 ft (7 m) normal to the centers of the four major surfaces of equipment with the microphone located 4 ft (1.2 m) above ground level. Generally, the four major surfaces refer to the front, rear, and sides of an imaginary box which would just fit over the machine and mast but does not include the forks. See Fig. 3.

7.3.2 Test Procedure (For Test With Truck Stationary)

(a) The test site shall comply with the requirements of para. 5.2.

(b) With mast in the lowered position, fully tilted back and fully retracted, where applicable, the maximum lift speed (see Section 4) obtainable with the unladen truck shall be selected. Readings shall be recorded during the lifting operation before the mast reaches its stop.

(c) A minimum of three cycles shall be conducted to provide a minimum of three sound level values at each microphone position for each test cycle or element of a test cycle. When necessary, each test shall be repeated until two of the values obtained at each microphone position are within 2 dB of each other. If there are two pairs of readings within 2 dB of each other, record the average of the higher pair. The additional readings need be taken only at the microphone location having the highest sound level.

For each microphone location, the arithmetic average of the two highest values obtained, which are within 2 dB of each other, shall be used as the reported sound level.

(d) The sound level readings recorded shall be the highest values obtained during the conduct of each test. The values recorded shall not include unusual transients or similar atypical noises.

7.3.3 Statement of Test Results

(a) All readings taken on the sound level meter (except those obtained from trial runs) shall be stated in the report.

(b) The arithmetic average of the readings for each position (see para. 6.2.2) shall be calculated to the nearest 0.1 (1/10). The nearest whole number, (rounding should be done upward for 0.5 dB and above and downward for below 0.5) shall be taken as the perimeter sound level of the truck. Record the highest of the four average readings as the A-weighted sound pressure level (L_{pA}) – item 8.3(d) of the test report.

8 TEST REPORT

The test report shall contain the following information.

8.1 Machine Under Test

(a) description of machine and any auxiliary equipment installed

(b) manufacturer

(c) type of machine

(d) serial number

(e) For trucks powered by internal combustion engines, the following additional data shall be provided:

(1) engine type;

(2) governed engine speed (high idle);

(3) gear ratio range (i.e., 1st, 2nd, 3rd) used during tests.

(f) For trucks powered by electric motors, the following additional information shall be provided:

(1) operating (battery) voltage;

(2) maximum truck speed in mph (km/h);

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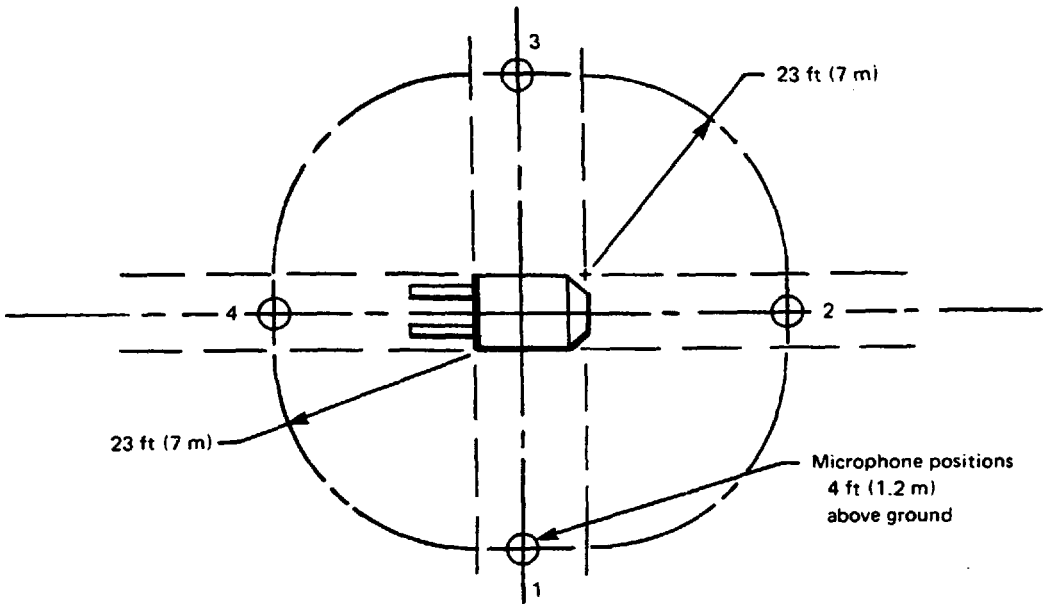


FIG. 3 TEST SITE ARRANGEMENT – MICROPHONE LOCATION (FOR TEST WITH TRUCK STATIONARY)

(3) total gear ratio between motor and drive wheels.

(g) location of test site

(h) type of surface at test site

(i) date of tests

(j) person responsible for conduct of tests

8.2 Instrumentation

Description of sound measuring equipment used, including make, models, and serial numbers.

8.3 Acoustical Data

The following acoustical data shall be included in the report.

(a) The A-weighted sound level (L_{pA}) of the background noise.

(b) All readings taken on the sound level meter (except those obtained from trial runs).

These are comprised of:

(1) 6.2.4.1 – Test Mode 1

(2) 6.2.4.2 – Test Mode 2

(3) 6.2.4.3 – Test Mode 3

(4) 6.2.4.4 – Test Mode 4

(5) 7.2.3 – Unladen truck in motion

(6) 7.3.3 – Unladen truck stationary

(c) The A-weighted equivalent sound level (L_{eq}) in decibels, as determined from para. 6.3.3. The doubling rate used (i.e., 3 or 5) shall be clearly indicated.

(d) The A-weighted sound level (L_{pA}) in decibels, for the empty truck in motion, as determined in accordance with para. 7.2.3(b).

(e) The A-weighted sound level (L_{pA}), in decibels, for the stationary unladen truck, as determined in accordance with para. 7.3.3(b).

8.4 Other Data

For record purposes only, the following data shall also be reported:

(a) time of day

(b) ambient temperature

(c) wind speed and direction, with respect to vehicle orientation

(d) barometric pressure

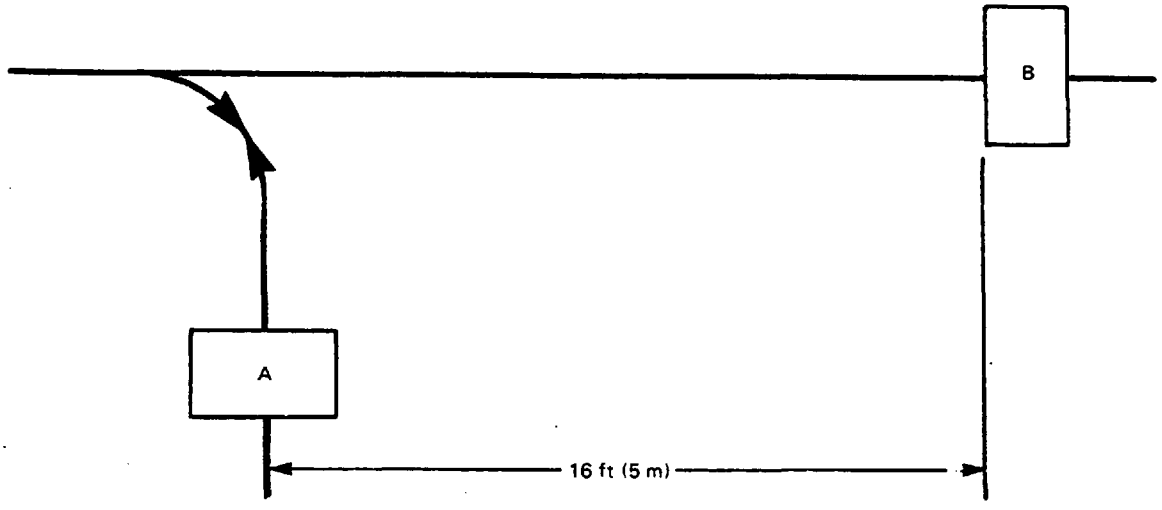
(e) relative humidity

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APPENDIX A
WORK CYCLE

(This Appendix is not part of ASME B56.11.5-1992, and is included for information purposes only.)

The four tests detailed in para. 6.2 are the basic elements of the work cycle, shown below, i.e., traveling laden and unladen, idling and lifting a load.



NOTE:
The travel distance between points A and B (see diagram above) is dependent upon the nature of the equipment, load and operating conditions. The diagram is illustrative of cycles for trucks up to and including 11,000 lb (5000 kg). It can be used as a guide for trucks of greater capacity. It is not intended to affect the conduct of the tests.

Work Cycle

(1) Pick up load (see para. 5.8) from ground level (A).

(2) Reverse, turn 90 deg., and travel.

(3) Drive forward to (B) at maximum speed (see Section 4).

(4) Raise the load (see para. 5.8) and place it on a platform (B) having a height of the maximum lift possible, but a minimum of this shall be accomplished without actuating hydraulic relief valve(s).

(5) Lower the fork arms without load, with engine at low idle speed.

(6) Reverse, turn forward 90 deg., and drive to starting position (A).

(7) Repeat, starting at (1) above.

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APPENDIX B

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TABLE B1 SOUND LEVEL INDEX E, FOR WORK CYCLE (3 dB DOUBLING RATE)

dB	Test 1 E_1	Test 2 E_2	Tests 3 & 4 E_3 & E_4
70	0.2	0.8	0.0
71	0.2	1.0	0.1
72	0.2	1.2	0.1
73	0.3	1.5	0.1
74	0.4	1.9	0.1
75	0.5	2.4	0.1
76	0.6	3.0	0.2
77	0.8	3.8	0.2
78	1.0	4.8	0.3
79	1.2	6.0	0.4
80	1.5	7.6	0.5
81	1.9	9.6	0.6
82	2.4	12.0	0.7
83	3.0	15.2	0.9
84	3.8	19.1	1.1
85	4.7	24.0	1.4
86	6.0	30.3	1.8
87	7.5	38.1	2.3
88	9.5	48.0	2.8
89	11.9	60.4	3.6
90	15.0	76.0	4.5
91	18.9	95.7	5.7
92	23.8	120	7.1
93	29.9	152	9.0
94	37.7	191	11.3
95	47.4	240	14.2
96	59.7	303	17.9
97	75.2	381	22.6
98	94.7	480	28.4
99	119	604	35.7
100	150	760	45.0
101	189	957	56.7
102	238	1,205	71.3
103	299	1,516	89.8
104	377	1,909	113
105	474	2,403	142
106	597	3,026	179
107	752	3,809	226
108	947	4,796	284
109	1,191	6,037	357
110	1,500	7,600	450

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TABLE B2 SOUND LEVEL INDEX E_1 FOR WORK CYCLE (5 dB DOUBLING RATE)

dB	Test 1 E_1	Test 2 E_2	Tests 3 & 4 E_3 & E_4
70	0.9	4.7	0.3
71	1.0	5.5	0.3
72	1.2	6.3	0.4
73	1.4	7.2	0.4
74	1.6	8.3	0.5
75	1.9	9.5	0.6
76	2.1	10.9	0.6
77	2.5	12.5	0.7
78	2.8	14.4	0.8
79	3.3	16.5	1.0
80	3.8	19.0	1.1
81	4.3	21.8	1.3
82	4.9	25.1	1.5
83	5.7	28.8	1.7
84	6.5	33.1	2.0
85	7.5	38.0	2.2
86	8.6	43.6	2.6
87	9.9	50.1	3.0
88	11.4	57.6	3.4
89	13.0	66.2	3.9
90	15.0	76.0	4.5
91	17.2	87.0	5.2
92	19.8	100.0	5.9
93	22.7	115.0	6.8
94	26.1	132.0	7.8
95	30.0	152.0	9.0
96	34.5	175.0	10.3
97	39.6	200.0	11.9
98	45.5	230.0	13.6
99	52.2	265.0	15.7
100	60.0	304.0	18.0
101	68.9	349.0	20.7
102	79.2	401.0	23.8
103	90.9	461.0	27.3
104	104.0	529.0	31.3
105	120.0	608.0	36.0
106	138.0	698.0	41.3
107	158.0	802.0	47.5
108	182.0	921.0	54.6
109	209.0	1,059.0	62.7
110	240.0	1,216.0	72.0

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APPENDIX C

(This Appendix is not part of ASME B56.11.5-1992, and is included for information purposes only.)

TABLE C1 EQUIVALENT SOUND LEVEL IN dB (3 dB DOUBLING RATE)

Sum of Sound Indices E_i	Equivalent Sound Level L_{eq} dB
3	75
4	76
5	77
6	78
8	79
10	80
15	82
20	83
25	84
30	85
40	86
50	87
60	88
80	89
100	90
125	91
160	92
200	93
250	94
315	95
400	96
500	97
630	98
800	99
1,000	100
1,250	101
1,600	102
2,000	103
2,500	104
3,150	105
4,000	106
5,000	107
6,300	108
8,000	109
10,000	110

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TABLE C2 EQUIVALENT SOUND LEVEL IN dB (5 dB DOUBLING RATE)

Sum of Sound Indices E_i (5)	Equivalent Sound Level L_{eq} dB
6.2	70
7.2	71
8.2	72
9.5	73
10.9	74
12.4	75
14.4	76
16.5	77
18.9	78
21.8	79
25.0	80
28.7	81
33.0	82
38.9	83
43.5	84
50.0	85
57.4	86
65.0	87
75.8	88
87.1	89
100	90
115	91
132	92
156	93
174	94
200	95
230	96
264	97
303	98
348	99
400	100
460	101
528	102
606	103
696	104
800	105
919	106
1,055	107
1,212	108
1,393	109
1,600	110

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Safety Standard for Rough Terrain Forklift Trucks	B56.6-1987
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