ANSI S12.30-1990
(ASA 94-1990)
[Revision of ANSI S1.30-1979]

AMERICAN NATIONAL STANDARD

GUIDELINES FOR THE USE OF SOUND POWER STANDARDS AND FOR THE PREPARATION OF NOISE TEST CODES

Accredited Standards Committee S12, Noise

Standards Secretariat
c/o Acoustical Society of America
335 East 45th Street
New York, New York 10017-3483

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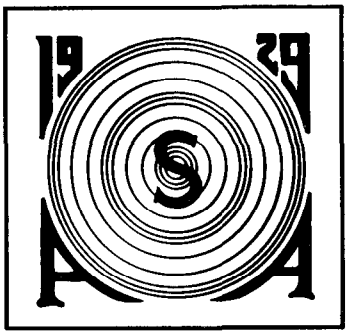

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Guidelines for the Use of Sound Power Standards and for the Preparation of Noise Test Codes

ACCREDITED STANDARDS COMMITTEE S12, NOISE

ABSTRACT

This standard introduces a series of six standards specifying various methods for determining the sound power levels of machines and equipment. When applying these six standards to sound measurements on specific machines, it is necessary to decide which one or more of these standards is most appropriate for the required precision for the particular class of machine or equipment and for the purpose of the test. It is also necesssary to decide on specific details for mounting and operating the machine to be tested within the general principles stated in the standards. Guidelines for making these decisions are provided in this standard. These guidelines are essential for the proper application of these acoustical measurement standards and for the preparation of specific sound test codes for various types of machines and equipment.

AMERICAN NATIONAL STANDARDS ON ACOUSTICS

The Acoustical Society of America provides the Secretariat for Accredited Standards Committees S1 on Acoustics, S2 on Mechanical Shock and Vibration, S3 on Bioacoustics, and S12 on Noise. These committees have wide representation from the technical community (manufacturers, consumers, and general-interest representatives). The standards are published by the Acoustical Society of America through the American Institute of Physics as American National Standards after approval by their respective standards committees and the American National Standards Institute.

These standards are developed and published as a public service to provide standards useful to the public, industry, and consumers, and to Federal, State, and local governments.

This standard was approved by the American National Standards Institute as ANSI S12.30-1990 on 2 August 1990.

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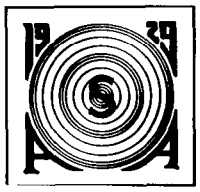

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FOREWORD

[This Foreword is for information only and is not a part of American National Standard Guidelines for the Use of Sound Power Standards and for the Preparation of Noise Test Codes, ANSI S12 30-1990 (ASA Catalog No 94-1990)]

This Standard comprises a part of a group of definitions, standards, and specifications for use in acoustical work. It has been developed under the American National Standards Institute by the Accredited Standards Committee Procedure under the Secretariat of the Acoustical Society of America.

Accredited Standards Committee S12, Noise, under whose jurisdiction this Standard was developed, has the following scope.

> Standards, specifications, and terminology, in the field of acoustical noise pertaining to methods of measurement, evaluation and control; including biological safety, tolerance and comfort, and physical acoustics as related to environmental and occupational noise

This standard, originally developed in Accredited Standards Committee S1, Acoustics, as ANSI S1.30-1979 (ASA 10-1979), now comes under the jurisdiction of Accredited Standards Committee S12, Noise. It has therefore been redesignated as ANSI S12.30-1990, the year of its approval by ANSI, with its editorially revised text, to include references to the series of sound power standards, all of which now bear S12 designations (ANSI S12.30-ANSI S12.36).

This standard is in harmony with International Standard ISO 3740-1980, Acoustics—Determination of the Sound Power Levels of Noise Sources—Guidelines for the Use of Basic Standards and for the Preparation of Noise Test Codes, which was originally developed by Working Group 6 of Technical Committee 43/Subcommittee 1 of the International Organization for Standardization (ISO/TC 43/SC1/WG6).

This standard introduces a series of six standards specifying various methods for determining the sound power levels of machines and equipment Taken together, the six standards specify the acoustical requirements for measurements appropriate for test environments as shown in the table on p. iv.

In order to conduct a test in accordance with one of the six methods, it is necessary to decide which one is most appropriate for the conditions and purposes of the test. The operating and mounting conditions of the machine or equipment to be tested must be in accordance with the general principles stated in the six standards. Guidelines for making these decisions are provided in this standard.

At the time this Standard was submitted to Standards Committee S12, Noise, for approval, the membership was as follows:

W. Melnick, *Chairman*
R. K. Hillquist, *Vice-Chairman*
A. Brenig, *Secretary*

Acoustical Society of America ● W Melnick, W Hillquist (*Alt*)
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American National Standards and International Standards specifying various methods for determining the sound power levels of machines and equipment.

American National Standard	International Standard	Classification of method	Test environment	Size of source	Character of noise	Sound power levels obtainable	Optional information obtainable
S12.31 (revision of S1.31-1980)	**ISO 3741**	Precision (Grade 1)	Reverberation room meeting specified requirements	Volume of source preferably less than 1% of test room volume	Steady, broad-band	In one-third octave or octave bands	A-weighted sound power level
S12.32 (revision of S1.32-1980)	**ISO 3742**				Steady, discrete-frequency or narrow-band		
S12.33 (revision of S1.33-1982)	**ISO 3743**	Engineering (Grade 2)	Special reverberant test room		Steady, broad-band narrow-band, discrete-frequency	A-weighted and in octave bands	Other weighted sound power levels
S12.34 (revision of S1.34-1980)	**ISO 3744**	Engineering (Grade 2)	Outdoors or in large room	Greatest linear dimension less than 15 m; otherwise limited only by available test environment	Any	A-weighted and in one-third octave or octave bands	Directivity information and sound pressure levels as a function of time; other weighted sound power levels
S12.35 (revision of S1.35-1979)	**ISO 3745**	Precision (Grade 1)	Anechoic or hemi-anechoic room	Volume of source preferably less than 0.5% of test room volume	Any		
S12.36 (revision of S1.36-1979)	**ISO 3746**	Survey (Grade 3)	No special test environment	No restrictions; limited only by available test environment	Steady, broad-band narrow-band, discrete-frequency	A-weighted	Sound pressure levels as a function of time; other weighted sound power levels
---	**ISO 3747**	Survey (Grade 3)	No special test environment	No restrictions	Steady, broad-band narrow-band, discrete-frequency	A-weighted	Sound power levels in octave bands

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American Industrial Hygiene Association ● C D Bohl
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American Otological Society ● R F Naunton
American Society of Heating, Refrigerating, and Air-Conditioning Engineers ● H S Pei, G F Hohn (*Alt*)
American Speech-Language-Hearing Association ● R Kasten
American Welding Society ● (Vacant), M E Kennebeck, Jr (*Alt*)
Audio Engineering Society ● M R Chial
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U.S. Army Construction Engineering Research Laboratory ● P D Schomer, M White (*Alt*)
U.S. Department of the Navy, Naval Medical Command ● J Page, L Marshall (*Alt*)

Individual experts of the Accredited Standards Committee S12, Noise, were:

P K Baade
R G Bartheld
L Batchelder
R W Benson
L Beranek
K M Eldred
R S Gales
W J Galloway
R Guernsey
W W Lang
G C Maling
A H Marsh
L Wilber
G Winzer
R W Young

Working Group S12/WG 23 on Determination of Sound Power, which has cognizance of the subject matter in this standard, had the following membership:

P K Baade, *Chairman*

R G Bartheld
G Diehl
D R Flynn
R K Hillquist
G C Maling, Jr
J Malosh
A H Marsh
R J Peppin

Suggestions for improvement in this standard will be welcomed. They should be sent to **Accredited Standards Committee S12 at the Standards Secretariat, in care of the Acoustical Society of America, 335 East 45th Street, New York, NY 10017-3483. Telephone (212) 661-9404.**

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American National Standard Guidelines for the Use of Sound Power Standards and for the Preparation of Noise Test Codes

INTRODUCTION

The most important factor in the selection of a noise measurement method is the ultimate use of the data that are to be obtained. This standard introduces a series of six standards describing various methods for determining the sound power levels of machines and equipment. Sound power level data are useful for:

(a) calculating the approximate sound pressure level at a given distance from a machine operating in a specified environment;

(b) comparing the noise radiated by machines of the same type and size;

(c) comparing the noise radiated by machines of different types and sizes;

(d) determining whether a machine complies with a specified upper limit of sound emission;

(e) planning in order to determine the amount of transmission loss or noise control required under certain circumstances;

(f) engineering work to assist in developing quiet machinery and equipment.

The sound power level data determined according to one of the six standards are essentially independent of the environment in which the data are obtained. This is one of the reasons for using sound power level to characterize the noise emitted by various types of machines and equipment.

These six standards specify the acoustical requirements for measurements appropriate for different test environments and accuracies.

When applying these six standards to sound measurements on specific machines, it is necessary to decide which one or more of these standards is most appropriate for the required precision for the particular class of machine or equipment and for the purpose of the test. It is also necessary to decide on specific details for mounting and operating the machine to be tested within the general principles stated in the standards.

Guidelines for making these decisions are provided in this standard. These guidelines are essential for the proper application of these acoustical measurement standards and for the preparation of specific sound test codes for various types of machines and equipment.

Use of sound power as a descriptor for the noise emitted by the source does not include directivity information. Procedures are, however, given in the standards for the calculation of the directivity index when the measurements are made in a free field or in a free field over a reflecting plane.

If no specific sound test code exists for a particular type of machine, the most suitable of the standards should be followed and the mounting and operating conditions used should be described in the test report. These conditions should be in accordance with the general principles given in the standards.

Control of noise from machines or equipment requires effective exchange of acoustical information among the several parties concerned. These include the manufacturer, specifier, installer, and user of the machine or equipment. This acoustical information is obtained from measurements. These measurements are useful only if they are carried out under specified conditions to obtain defined acoustic quantities using standarized instruments.

The set of standards for which this standard serves as the introduction is as follows:

American National Standard Precision Methods for the Determination of Sound Power Levels of Broad-Band Noise Sources in Reverberation Rooms, S12.31-1990.

American National Standard Precision Methods for the Determination of Sound Power Levels of Discrete-Frequency and Narrow-Band Noise Sources in Reverberation Rooms, S12.32-1990.

American National Standard Engineering Methods for the Determination of Sound Power Levels of Noise Sources in a Special Reverberation Test Room, S12.33-1990.

American National Standard Engineering Methods for the Determination of Sound Power Levels of Noise Sources for Essentially Free-Field Conditions over a Reflecting Plane, S12.34-1988.

American National Standard Precision Methods for the Determination of Sound Power Levels of

Noise Sources in Anechoic and Hemi-Anechoic Rooms, S12 35-1990.

American National Standard Survey Methods for the Determination of Sound Power Levels of Noise Sources, S12 36-1990

In principle, the methods of measurement described in ANSI S12.31 to ANSI S12.36 cover all types of machines and equipment. For noise measurements on a particular kind and size of machine or equipment when only certain kinds of facilities are available for the measurements, only one of these standards may be applicable. For type testing, however, only one method should be prescribed.

The six standards prescribe the acoustical conditions for the noise measurements and the instruments to be used. Only general information is given on the installation and operation of the sound source during the measurements. Different types of machines and equipment require more detailed instructions concerning the installation and operation of the equipment during the noise tests.

The standards in this series supersede ANSI S1.2-1962, American National Standard Method for the Physical Measurement of Sound, and ANSI S1.21-1972, American National Standard Method for the Determination of Sound Power Levels of Sound Sources in a Reverberation Room.

1 GENERAL

1.1 Scope

This standard provides guidelines comprising:

(a) brief explanations of the principles underlying the set of standards for measuring the noise emitted by machines and equipment;

(b) assistance in the selection of the appropriate sound power standard; and

(c) general information on supplementing the standards with instructions concerning the installation and operating conditions for the particular type of machine or equipment; such instructions are usually incorporated in test codes.

1.2 Applicability

These guidelines are applicable to the preparation of all noise test codes for any type of machine or equipment, with the exception of moving vehicles or other nonstationary equipment. These guidelines apply only to airborne sound and are applicable only to test codes requiring the determination of sound power levels of noise sources.

2 SELECTION OF THE APPROPRIATE STANDARD FOR DETERMINATION OF SOUND POWER LEVEL

2.1 Quantities to be measured and determined

Methods are prescribed for measuring the sound pressure levels, either *A*-weighted or in frequency bands, in a specified acoustical environment. From these data, the sound power level of the source is calculated either as an *A*-weighted value or in frequency bands.

NOTES:

(1) Other weightings, such as *C* weighting, may give additional information concerning low-frequency components.

(2) Other meter characteristics, such as "impulse," may give additional information concerning impulsive components, particularly when measurements are made in a free field or in a free field over a reflecting plane rather than in a reverberant environment.

The sound power levels are mean values obtained by time and space averaging. For certain kinds of noise and under certain measurement conditions, it is useful to supplement the sound power level data with information concerning fluctuations of the values in both space and time. Examples include calculation of the directivity index and determination of sound power level during a particular operating cycle of a machine.

2.2 Considerations affecting choice of measurement method

The applicability of the standards in this set is determined by

(a) the size of the noise source which, for laboratory measurements, is given in terms of the percentage of test room volume;

(b) the test environment available for the measurements;

(c) the character of the noise produced by the source (for example: broad-band, narrow-band, discrete-frequency; steady, nonsteady, impulsive); frequency range of interest;

(d) the highest grade of accuracy required; and

(e) the acoustical data required, including the sound power level data and other acoustical information (for example: directivity of source, temporal pattern).

2.3 Synopses

Synopses of ANSI S12.31 through ANSI S12.36 are to be found in Sec. 4.

2.4 Test environments

For descriptions of the several test environments described in ANSI S12.31 through ANSI S12.36 reference should be made to Appendix A.

2.5 Procedure for selection

Table I gives the uncertainties involved in the determinations of the sound power levels according to the six standards in the series.

Measurements made in conformity with this series of standards will, with very few exceptions, result in standard deviations which are equal to less than those given in Table I. The standard deviations of Table I reflect the cumulative effects of all causes of measurement uncertainty, excluding variations in the sound power level from test to test which may be caused, for example, by changes in the mounting or operating conditions of the source. The interlaboratory reproducibility and repeatability of the test results may be considerably better (i.e., smaller standard deviations) than the uncertainties given in Table I would indicate.

NOTES:

(1) The standard deviations listed in Table I are measures of the *uncertainties associated with the test methods* defined in these standards. If a stable noise source were transported to each of a large number of laboratories, and if at each laboratory, the sound power of that source were measured in accordance with the provisions of a particular standard, the standard deviation, as a function of frequency, of these many sound power determinations could be calculated. If a similar round robin series of measurements were carried out on each of a large number of other stable noise sources, it would be possible to calculate standard deviations that would correspond to the random selection of a sound source and the random selection of a laboratory. It is these standard deviations which have been estimated and listed in Table I and in the six standards.

(2) If two laboratories use similar facilities and instrumentation, the results of sound power determination on a given source in these laboratories may be in better agreement than would be inferred from the standard deviations in Table I.

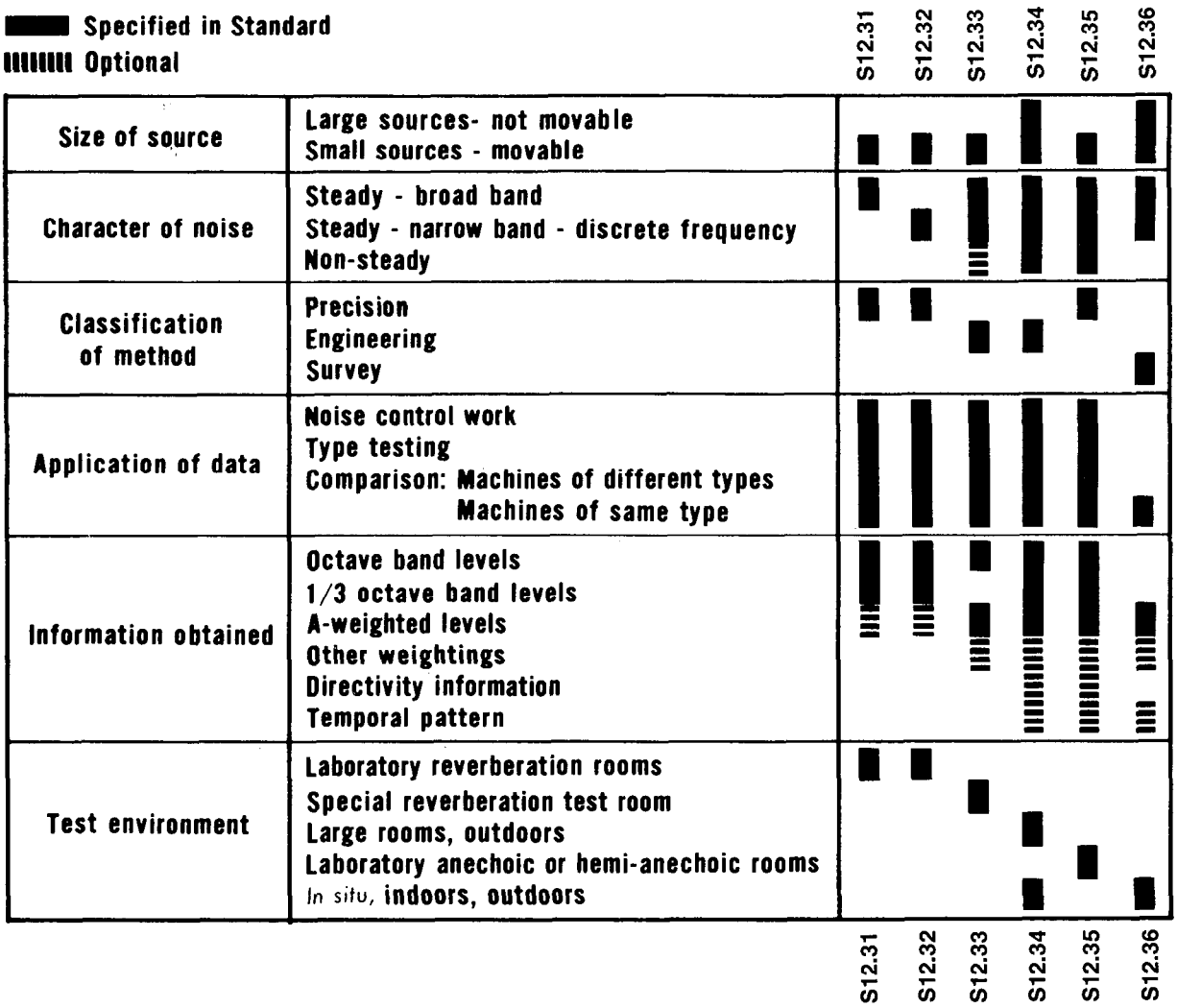
(3) For a particular family of sound sources, of similar size and with similar sound spectra, the standard deviations of sound power determinations in different laboratories may be significantly smaller than the values given in Table I. Thus, based on round robin data, a test code for a particular type of machinery may state standard deviations smaller than those given in Table I.

The purpose for which the noise measurements are to be made determines the grade of accuracy required. The several factors influencing the selection of an appropriate test method are shown in Table II This table gives guidance for the selection of the appropriate

TABLE I. Uncertainty in determining sound power levels, expressed as the largest value of the standard deviation in decibels.

American National Standard	International Standard	Octave bands (Hz)	125	250	500	1000 to 4000	8000	A
		1/3 Octave bands (Hz)	100 to 160	200 to 315	400 to 630	800 to 5000	6300 to 10000	
S12.31 S12.32	ISO 3741 ISO 3742		3	2	1.5		3	-
S12.33	ISO 3743		5	3	2		3	2
S12.34	ISO 3744		3	2		1.5	2.5	2
S12.35	ISO 3745	(Anechoic room)	1	1		0.5	1	-
		(Hemi-anechoic room)	1.5	1.5		1	1.5	-
S12.36	ISO 3746		-	-	-		-	5

TABLE II. Factors influencing the choice of the method.



standard. The left side of the table lists the selection criteria. In the right-hand column, bars along the vertical lines combine the appropriate test conditions according to each of the individual standards.

After defining the requirements of the test, the appropriate standard can be selected by following the bars along the appropriate vertical line. A solid bar indicates that the corresponding standard is fully applicable to the test condition and the sound power levels are within their given ranges of uncertainty. An open bar means that the user of the standard may obtain data, but that the measurements are optional.

If the source can be moved and the test environments are available, one of the methods described in ANSI S12.31 through ANSI S12.35 should be selected. If the machine or equipment to be tested cannot be moved, only the methods described in ANSI S12.34 and ANSI S12.36 are applicable. The method selected will depend upon the factors discussed in 2.2.

Additional information concerning the topics covered in Table II is given in Appendix A.

3 PREPARATION OF NOISE TEST CODES

3.1 General

Each noise test code requiring the determination of the sound power level of a particular kind of machine or equipment should preferably be based on:

(a) one of the precision methods (ANSI S12.31, ANSI S12.32, or ANSI S12.35);

(b) one of the engineering methods (ANSI S12.33 or ANSI S12.34);

(c) the survey method (ANSI S12.36).

For the establishment of noise test codes for machines and equipment, the most appropriate method of measurement shall be selected from the standards listed in this standard. The decision shall then be made concerning the need for preparing supplementary requirements giving detailed specifications on:

(a) operating conditions;

(b) installation and mounting conditions; and

(c) microphone array, traverse and measurement surface.

The decision may be made that supplementary requirements are not necessary and that one of the six standards (ANSI S12.31 and S12.36) is sufficient for the purposes of the noise test code.

If one of these standards is to be used in preparing the noise test code for a particular class of machine or equipment, the code should cover the subjects listed in 3.2.

3.2 Use of sound power standards

3.2.1

Under "Scope," the test code should carefully define the types of machinery or equipment for which the test code is applicable. For large machines with many components and subassemblies, a clear definition should be made of the noise sources that are to be considered part of the machine under test.

3.2.2

Under "Purpose," the test code should define the specific purpose(s) for which the data are to be obtained (see the Introduction). The test code should state whether the noise emission is to be expressed in terms of a weighted sound power level or in terms of the sound power level spectrum (in octave or one-third octave bands).

3.2.3

A "General Statement" should state the limit of uncertainty to be achieved and should refer specifically to the selection of the standard which is to be used in applying the test code from among those which will yield results within the allowable uncertainty.

3.2.4

The text of the standard selected should not be included verbatim in the test code.

3.2.5

Under "Information to be Recorded," the test code should require that the source locations and microphone positions in the test environment be described in detail.

Under "Information to be Reported," the test code should indicate the result of the measurement and the minimum of technical information that will be communicated for general information. Details on measurement procedure, measurement instruments, rooms, etc., need not be reported.

3.2.6

All factors related to the installation, mounting, location and operation of the particular type of machinery and equipment covered by the code which could have an influence on the amount and character of the sound emitted should be studied. The installation and operating conditions to be specified in the noise test code should be selected. The section of the test code dealing with the installation and with the operating conditions will generally be the major section of the code.

NOTES:

(1) Mounting conditions: The equipment to be tested should be installed and mounted in one or more positions that are typical of normal usage, if practicable.

If the source is placed in close proximity to a wall (or ceiling) during normal usage, its sound radiation is influenced by these surfaces and special precautions should be taken to imitate their effects during measurements. For measurements in reverberation test rooms, the source should be placed with respect to the walls (or ceiling) as for normal use. If the source is normally in close proximity to two planes (e.g., wall and floor or wall and ceiling), it should be tested in a similar environment, simulated by erecting an auxiliary wall on the reflecting plane and mounting the source appropriately.

Mounting conditions should be described in detail.

Requirements should be given that all auxiliary equipment necessary for operating the equipment under test that is not a part of the source should be located outside the test environment.

(2) Operating conditions: During the acoustical measurements, the source shall be operated in a specified manner. One or more of the following operating conditions should be chosen and described in detail by means of specially defined operational parameters for the special kind of equipment covered by the test code:

(a) equipment under specified load and operating conditions;

(b) equipment under full load [if different from (a)];