AHRI Standard 1120

2012 (R2021) Standard for

Acoustical Test Methods and Sound Power Rating Procedures for Transport Refrigeration Equipment

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IMPORTANT

SAFETY RECOMMENDATIONS

It is strongly recommended that the product be designed, constructed, assembled and installed in accordance with nationally recognized safety requirements appropriate for products covered by this standard.

AHRI, as a manufacturers' trade association, uses its best efforts to develop standards employing state-of-the-art and accepted industry practices. However, AHRI does not certify or guarantee safety of any products, components or systems designed, tested, rated, installed or operated in accordance with these standards or that any tests conducted under its standards will be non-hazardous or free from risk.

Note:

This standard supersedes ANSI/AHRI Standard 1120-2007.

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ACOUSTICAL TEST METHODS AND SOUND POWER RATING PROCEDURES FOR TRANSPORT REFRIGERATION EQUIPMENT

Section 1. Purpose

1.1 *Purpose.* The purpose of this standard is to establish acoustical test methods for Transport Refrigeration Equipment and to provide definitions; test requirements; rating requirements; minimum data requirements for Published Ratings; and conformance conditions.

1.1.1 Intent. This standard is intended for the guidance of the industry, including manufacturers, engineers, installers, contractors and users.

1.1.2 Review and Amendment. This standard is subject to review and amendment as technology advances.

Section 2. Scope

2.1 *Scope.* This standard applies to factory-made Transport Refrigeration Equipment.

Section 3. Definitions

All terms in this document shall follow the standard industry definitions in the current edition of ASHRAE Terminology of Heating, Ventilation, Air-Conditioning, and Refrigeration unless otherwise defined in this section.

3.1 *Transport Refrigeration Equipment.* A combination of one or more factory-made assemblies, which may include a compressor, an internal combustion engine or electric motor, and condenser combination; an evaporator or air-cooler; all necessary refrigerant lines and electrical wiring; and means whereby the unit can be suitably mounted and installed on a vehicle which it is intended to serve. Where such equipment is used in more than one assembly, the individual assemblies are designed to be used together, and the rating requirements outlined in this standard are based upon the use of matched assemblies. Examples of Transport Refrigeration Equipment include:

3.1.1 *Truck Transport Refrigeration Unit*. A refrigeration unit typically mounted above the truck cab on the front of an insulated box that is part of a unified chassis. Truck units may be autonomous or non-autonomous. Small non-autonomous truck units are often mounted to the roofs of vans or insulated boxes on small trucks.

3.1.2 *Autonomous Transport Refrigeration Unit.* Autonomous refrigeration equipment has its own power supply, most frequently a self-contained engine, and a means of moving refrigerant enabling it to control temperature without the support of a vehicle or electric power supply.

3.1.3 *Container Transport Refrigeration Unit.* Container units are non-autonomous electric refrigeration units comprising one end of insulated shipping containers that control temperature most frequently in ocean-going shipping containers. Power for container units is supplied by the electric mains in port, by the ship at sea, and by Gensets when the container is being moved by road or rail.

3.1.4 *Cryogenic Transport Refrigeration Unit.* Cryogenic units utilize the heat transfer from a cryogenic fluid flowing through a coil in an insulated space to maintain temperature. These units can be autonomous if the energy of the fluid is used to power fans or non-autonomous when fans receive their power from the truck.

3.1.5 *Eutectic Transport Refrigeration Unit*. Temperature in the refrigerated space is maintained at the designed melting temperature of an encased fluid lining the interior walls and/or ceiling of the insulated cargo space. A non-autonomous electric refrigeration unit is part of a eutectic system, which freezes the fluid while the vehicle is stationary and plugged into the electric mains. Temperature control is available in eutectic units until the fluid has completely melted. Noise from a eutectic unit exists when the electric power is connected and the fluid is being frozen.

3.1.6 *Genset.* In transport refrigeration applications, a Genset is comprised of an engine, a generator, and a fuel tank and is designed to supply electrical power to container units being transported over land on rail cars or trailers. Some Gensets mount to the container unit itself while others mount under the chassis carrying the container.

3.1.7 *Non-autonomous Transport Refrigeration Unit.* Non-autonomous refrigeration equipment cannot operate without external power. Some non-autonomous equipment requires a truck engine to run the compressor that moves the refrigerant and/or a truck engine turning an alternator to supply electrical power. Other non-autonomous equipment requires power from the electric mains.

3.1.8 *Trailer Transport Refrigeration Unit*. A refrigeration unit mounted on the front of an insulated trailer. Fuel for trailer units is supplied from a tank mounted under the trailer enabling the unit to run independent of a tractor. Trailer units are autonomous equipment.

3.1.9 *Undermount Transport Refrigeration Unit*. Undermount units are designed to mount just below insulated boxes on a unified chassis as well as short trailers. Undermount units can be autonomous or non-autonomous.

3.2 *Octave Band*. A band of sound covering a range of frequencies such that the highest is twice the lowest, as used in this standard and shown in Table 1.

Table 1. Standard Frequency Bands[1]

Octave Band			One-third Octave Band		
Lower Frequency Limit, Hz	Center Frequency, Hz[2]	Upper Frequency Limit, Hz	Lower Frequency Limit, Hz	Center Frequency, Hz[2]	Upper Frequency Limit, Hz
44	63[3]	90	44 56 71	50[3] 63[3] 80[3]	56 71 90
90	125	180	90 112 140	100 125 160	112 140 180
180	250	355	180 224 280	200 250 315	224 280 355
355	500	710	355 450 560	400 500 630	450 560 710
710	1,000	1,400	710 900 1,120	800 1,000 1,250	900 1,120 1,400
1,400	2,000	2,800	1,400 1,800 2,240	1,600 2,000 2,500	1,800 2,240 2,800
2,800	4,000	5,600	2,800 3,550 4,500	3,150 4,000 5,000	3,550 4,500 5,600
5,600	8,000	11,200	5,600 7,100 9,000	6,300 8,000 10,000	7,100 9,000 11,200

Notes:
1. The frequencies have been rounded off to whole numbers.
2. The geometric mean of the frequency limits.
3. These bands are considered to be optional.

3.3 *One-third Octave Band*. A band of sound covering a range of frequencies such that the highest frequency is the cube root of two times the lowest frequency. The One-third Octave Bands used in this standard are those defined in ANSI Standard S1.11.

3.4 *Published Rating.* A statement of the assigned values of those performance characteristics, under stated Rating Conditions, by which a unit may be chosen to fit its application. These values apply to all units of like nominal capacity and type (identification) produced by the same manufacturer. As used herein, the term Published Rating includes the rating of all performance characteristics shown on the unit or published in specifications, advertising or other literature controlled by the manufacturer, at stated Rating Conditions.

3.4.1 *Application Rating*. A rating based on tests performed at application Rating Conditions (other than Standard Rating Conditions).

3.4.2 *Standard Rating*. A rating based on tests performed at Standard Rating Conditions.

3.5 *Rating Conditions*. Any set of operating conditions under which a single level of performance results and which causes only that level of performance to occur.

3.5.1 *Standard Rating Conditions*. Rating Conditions used as the basis of comparison for performance characteristics.

3.6 *"Shall" or "Should".* "Shall" or "should" shall be interpreted as follows:

3.6.1 *Shall.* Where "shall" or "shall not" is used for a provision specified, that provision is mandatory if compliance with the standard is claimed.

3.6.2 *Should.* "Should" is used to indicate provisions which are not mandatory but which are desirable as good practice.

3.7 *Sound Power Level, L_w*. Ten times the logarithm to the base ten of the ratio of the sound power radiated by the source to a reference sound power, expressed in decibels, dB. The reference sound power used in this standard is 1 picowatt, pW.

3.7.1 *A-weighted Sound Power Level, L_{wA}*. The logarithmic summation of A-weighted, one-third octave band Sound Power Levels.

3.8 *Sound Pressure Level, L_P*. Twenty times the logarithm to the base ten of the ratio of a given sound pressure to a reference sound pressure of 20 μPa, dB.

Section 4. Requirements for Conducting Sound Tests

4.1 *Testing Requirements for Equipment.* Sound tests shall be conducted in accordance with the test methods (Grade 1 or Grade 2 as identified in ISO Standard 12001) specified in ANSI S12.51/ISO 3741, ISO Standards 3744, 3745, or 9614-Parts 1 or 2. The choice of a test method is left to the discretion of the user.

4.2 *Data To Be Taken.* Sound Power Levels, L_w shall be determined in decibels (ref. 1 pW) for the One-third Octave Bands from 100 to 10,000 Hz or the full Octave Bands from 125 to 8,000 Hz as listed in Table 1. Alternatively, A-weighted Sound Power Levels, L_{wA} can be determined in decibels as an overall value. Sound Power Levels shall be determined in accordance with the specific ISO acoustic standard used to conduct the test (see Appendix A, Normative References).

4.3 *Special Test Considerations*

4.3.1 High air speeds from the unit under test may affect the sound measured by a microphone. These effects will tend to result in an overestimation of the sound power of the product. Thus, the air speed at the microphone shall not exceed 2 m/s. The error due to air-streams may be checked by repeating the measurement at a larger distance from the product. If the resulting Sound Power Levels at both measurement distances are within 1.0 dB, the air-stream effects are negligible.

4.3.2 If testing is conducted in accordance with ISO Standard 9614, data is to be reported only for frequencies up to and including 6.3 kHz. Data above 6.3 kHz can only be provided for information purposes when using ISO Standard

9614 because the uncertainties are not defined above 6.3 kHz. In addition, special consideration must be given to the determination of the overall A-weighted Sound Power Level rating from Section 5.4 using the procedures established in Appendix C.

When testing to ISO Standard 9614, a larger microphone spacer will allow measurements at lower frequencies, but the field indicators of this standard shall be satisfied.

4.3.3 When extending the testing procedures below 100 Hz while following ANSI S12.51/ISO 3741, the standard deviation shall not exceed 5 dB.

Additionally, when information on Sound Power Levels in the 50, 63 and 80 Hz One-third Octave Bands or the 63 Hz Octave Band is to be optionally provided, the standard rating temperature conditions and the measurement methods in the applicable standards shall be used.

4.3.4 When testing to ISO Standard 3744, the acoustical environment shall have an acoustical environmental correction K_2 of less than or equal to 2 dB. Additionally, the hemispherical measurement grid shall be used. Use of the parallelepiped or conformal measurement grids when measuring transport refrigeration equipment sound typically produces inaccurate results and is therefore not allowed.

4.3.5 When testing to ISO Standard 3745, the acoustical environment shall have an acoustical environmental correction K_2 of less than or equal to 0.5 dB.

4.4 *Use of windscreens.* The use of a foam windscreen on the microphone is required in these tests. The effect of the windscreen on the microphone response shall not be more than 1 dB for frequencies of 50 to 4,000 Hz or 1.5 dB for frequencies of 4 to 10 kHz.

4.5 *Equipment Mounting.*

4.5.1 All equipment is to be mounted according to the manufacturer's installation instructions. If any deviations from these instructions are necessary, they must be made in a manner that will not affect the acoustic performance of the equipment and such mounting deviations shall be reported. Following these guidelines, it is permissible to mount the equipment on a fabricated support structure provided that said structure is representative of an actual installation and does not affect the acoustic performance of the equipment under test. For example, in all cases the bottom of the test unit shall be located no closer to the ground/floor than 0.5 m to insure that sound radiating from the bottom of the test unit is included in the measurement. When testing indoors, the use of ducts, hoses or other devices to remove exhaust gases shall not reduce or alter the characteristics of the exhaust sound. A description of the mounting structure shall be reported.

Section 5. Sound Rating Procedures

5.1 *General.* Use of this standard results in a single number, A-weighted sound power level rating for the unit under test. One-third octave band Sound Power Levels, octave band Sound Power Levels or calculated A-weighted Sound Power Levels may be used to obtain this rating. Sound ratings for each operating condition of interest shall be determined with the equipment under test operating in a fully loaded, pull down mode of operation. Care must be exercised to ensure that there is a sufficient difference between the set point and the outdoor/box temperatures such that the unit under test does not cycle or unload during the test.

5.2 *Determination of Equipment Sound Power Levels.* Equipment Sound Power Levels for each Octave Band or One-third Octave Band shown in Table 1 shall be determined in accordance with Section 4. The Sound Power Levels shall be expressed in decibels (ref. 1 pW) for each Octave Band or One-third Octave Band.

5.3 *Determination of the A-weighted Overall Sound Power Level Rating.* The single-number, A-weighted overall sound power level rating is obtained either by direct measurement of sound pressure or intensity and conversion to sound power following the standard of reference or by logarithmically summing either the converted A-weighted one-third or full octave band sound power data.

5.3.1 *Conversion of One-third or Full Octave Band Sound Power Levels to A-weighted Sound Power Band Levels.*

5.3.1.1 When testing is conducted in accordance with ANSI S12.51/ISO 3741, ISO Standard 3744, or ISO Standard 3745, the equipment Sound Power Levels obtained per Section 5.2 shall be converted to A-weighted

Sound Power Levels by adding the appropriate conversion values from Table 2. The overall A-weighted sound power level rating shall then be calculated per Section 5.3.2.

5.3.1.2 When testing is conducted in accordance with ISO 9614, the special procedure described in Appendix C shall be employed to determine if an overall A-weighted sound power level rating can be considered to be valid.

5.3.2 *Calculation of the A-weighted Overall Sound Power Level Rating (L_{wA}).* The A-weighted overall sound power level rating for the specified conditions shall be determined from the A-weighted full or one-third octave band Sound Power Levels obtained in Section 5.4.1 by using Equation 1 below.

$$L_{wA} = 10 \cdot \log \left[\sum_{n=1}^{N} 10^{L_{wA(n)}/10} \right] \quad (1)$$

Where:
L_{wA} = A-weighted overall Sound Power Level, dB
$L_{wA(n)}$ = A-weighted one-third octave or the octave band level in the n^{th} band, dB
N = Total number of A-weighted One-third Octave Bands or Octave Bands

Note 1: N is equal to 21 for 100 to 10,000 Hz for standard One-third Octave Bands
Note 2: N is equal to 24 for 50 to 10,000 Hz to include low frequency One-third Octave Bands
Note 3: N is equal to 7 for 125 to 8,000 Hz for standard Octave Bands
Note 4: N is equal to 8 for 63 to 8,000 Hz to include low frequency Octave Bands

Table 2. A-weighted Conversions

Band Center Frequency, Hz	One-third Octave Band Conversions, dB	Octave Band Conversions, dB
50	-30.2	
63	-26.2	-26.2
80	-22.5	
100	-19.1	
125	-16.1	-16.1
160	-13.4	
200	-10.9	
250	- 8.6	-8.6
315	- 6.6	
400	- 4.8	
500	- 3.2	-3.2
630	- 1.9	
800	- 0.8	
1,000	0	0
1,250	+ 0.6	
1,600	+ 1.0	
2,000	+ 1.2	+1.2
2,500	+ 1.3	
3,150	+ 1.2	
4,000	+ 1.0	+1.0
5,000	+ 0.5	
6,300	- 0.1	
8,000	- 1.1	-1.1
10,000	- 2.5	

5.4 *Standard Rating Conditions.* Standard declared sound ratings shall be determined at the Rating Conditions specified in Sections 5.4.1 through 5.4.3.

5.4.1 *Operating Points.* Tests shall be performed at the manufacturer's specified highest rated capacity operating condition and may be performed at other operating conditions as desired. For each test, all components required for

proper unit operation and necessary to achieve rated capacity shall be present and operating at maximum capacity and within specified manufacturers' tolerances. For example, with a diesel driven unit, the unit shall be operating in a fully loaded, pull-down condition and the diesel engine and condenser fan speeds shall be operating at the manufacturer's recommended speed. For variable speed equipment, the test shall be conducted at the highest rated speed.

Electrically powered units or units designed to operate in an electrical standby mode shall be tested at the manufacturer's rated speed for that mode of operation with the condenser fan speed falling within the manufacturer's tolerance.

5.4.2 *Airflow.* The condenser and evaporator airflow shall be the same as that required to produce the rated cooling and/or heating capacities for the specific type of equipment being tested.

5.4.3 *Operation of Equipment.* All components required to conduct the standard thermal rating test shall be operated while sound data is being taken.

5.4.3.1 *Cooling Operation.* The operating condition for conducting the acoustical rating test during cooling shall be such that the equipment is in a fully loaded pull-down mode.

5.4.3.2 *Heating Operation.* The operating condition for conducting the acoustical rating test during heating shall be such that the equipment is in a fully loaded, heat producing mode.

5.4.3.3 *Standby Power Operation.* Electrical standby tests shall be performed at the manufacturer's rated speed for this mode of operation with the condenser fan speed falling within the manufacturer's tolerance. The unit shall be operating in a fully loaded pull-down condition.

5.5 *Rating Tolerances.* Any transport refrigeration equipment tested in accordance with this standard shall have an A-weighted Sound Power Level (L_{wA}) for the complete unit no higher than its Published Rating.

Section 6. Minimum Data Requirements for Published Ratings

6.1 *General.* Published Ratings shall consist of the declared A-weighted overall sound power level rating (L_{wA}) of the source under test expressed in decibels and reported to the nearest whole number.

The acoustical rating standard and the test method used to determine the sound power level rating shall be clearly identified and included with the published sound power ratings.

6.2 *Standard Ratings.* Standard Ratings obtained at cooling, heating, and standby power capacity Rating Conditions shall be stated for each condition in regards to Section 5.4.

6.3 *Application Rating.* Application Ratings are not required by this standard but when they are provided they shall include a full description of operational conditions for the equipment under test as well as information describing noise sources required for operation of the subject unit but not considered to be an integral part of said unit.

6.4 *Standard Sound Rating*. When AHRI standard thermal Rating Conditions have been established for the equipment, a standard sound rating shall be published for the unit operating at those conditions.

All claims to sound ratings within the scope of this standard shall include the statement "Rated in accordance with AHRI Standard 1120". All claims to ratings outside the scope of this standard shall include the statement "Outside the scope of AHRI Standard 1120". Wherever Application Sound Ratings are published or printed, they shall include a statement of the standard thermal Rating Conditions at which the ratings apply and be accompanied by the Standard Sound Rating.

Section 7. Conformance Conditions

7.1 *Conformance*. While conformance with this standard is voluntary, conformance shall not be claimed or implied for products or equipment within the standard's *Purpose* (Section 1) and *Scope* (Section 2) unless such product claims meet all of the requirements of the standard and all of the testing and rating requirements are measured and reported in complete

compliance with the standard. Any product that has not met all the requirements of the standard shall not reference, state, or acknowledge the standard in any written, oral, or electronic communication**.**

APPENDIX A. REFERENCES – NORMATIVE

A1 Listed here are all standards, handbooks, and other publications essential to the formation and implementation of the standard. All references in this appendix are considered as part of this standard.

A1.1 ANSI S12.51-2002/ISO:3741:1999, Acoustics — *Determination of sound power levels of noise sources using sound pressure — Precision method for reverberation rooms*, Nationally Adopted International Standard (NAIS Standard) American National Standards Institute, 25 West 43rd Street, 4th Fl., New York, NY 10036, U.S.A.

A1.2 ANSI/ASA Standard S1.11-2004, *Octave-Band and Fractional-Octave-Band Analog and Digital Filters*, 2009, American National Standards Institute, 25 West 43rd Street, 4th Fl., New York, NY 10036, U.S.A.

A1.3 *ASHRAE Terminology of Heating, Ventilating, Air-Conditioning and Refrigeration,* Second Edition, 1991, ASHRAE, Inc., 180 Technology Parkway, Peachtree Corners, GA 30092, U.S.A.

A1.4 ISO 3744:1994, *Acoustics – Determination of sound power levels of noise sources using sound pressure - Engineering method in essentially a free field over a reflecting plane,* 1996, International Organization for Standardization, 1, rue de Varembe, Case Postale 56 CH-1211 Geneva 20, Switzerland.

A1.5 ISO 3745: 2003*, Acoustics – Determination of sound power levels of noise sources using sound pressure – Precision methods for anechoic and hemi-anechoic rooms,* 2003, International Organization for Standardization, 1, rue de Varembe, Case Postale 56 CH-1211, Geneva 20, Switzerland.

A1.6 ISO 4871:1996, *Acoustics – Declaration and verification of noise emission values of machinery and equipment,* 1996, International Organization for Standardization, 1, rue de Varembe, Case Postale 56 CH-1211 Geneva 20, Switzerland.

A1.7 ISO 9614-1: 1993*, Acoustics – Determination of sound power levels of noise sources using sound intensity –Part 1: Measurements at discrete points,* 1993, International Organization for Standardization, 1, rue de Varembe, Case Postale 56 CH-1211 Geneva 20, Switzerland.

A1.8 ISO 9614-2:1996, *Acoustics – Determination of sound power levels of noise sources using sound intensity – Part 2: Measurement by scanning,* 1996, International Organization for Standardization, 1, rue de Varembe, Case Postale 56 CH-1211 Geneva 20, Switzerland.

A1.9 ISO 12001:1996, *Acoustics – Noise emitted by machinery and equipment - Rules for the drafting and presentation of a noise test code ,* 1996, International Organization for Standardization, 1, rue de Varembe, Case Postale 56 CH-1211 Geneva 20, Switzerland.

APPENDIX B. REFERENCES – INFORMATIVE

B1.1 ISO 9614-3:2002, *Acoustics – Determination of sound power levels of noise sources using sound intensity – Part 3: Precision method for measurements by scanning,* 2002*,* International Organization for Standardization, 1, rue de Varembe, Case Postale 56 CH-1211 Geneva 20, Switzerland.

B1.2 DIN 8958: 1998, *Testing of cooling equipment for insulated means of transportation - Part 1: Transport refrigerating systems with or without forced air circulation evaporator*, DIN Deutsches Institut für Normung e. V., Burggrafenstraße 6, 10787 Berlin, Germany.

B1.3 NFR 10-304: 1994, *Road vehicles – Determining the sound power level for refrigeration units fitted to temperature controlled goods transport units.* AFNOR, Association Française de Normalisation, 11, rue Francis de Pressensé, 93571 La Plaine Saint-Denis Cedex.

APPENDIX C. SPECIAL RATING PROCEDURE USING ISO 9614 - INFORMATIVE

C1 *Scope.* This special rating procedure is established to determine if ISO Standard 9614 can be used to obtain a valid overall A-weighted sound power level rating which is equivalent to a rating obtained using other ISO test methods specified in Section 4. This special rating procedure is required because the uncertainties are not defined for frequencies above 6.3 kHz when using ISO Standard 9614.

C2 *Procedure.*

C2.1 Calculate the overall A-weighted Sound Power Level using unrounded octave band data from 125 Hz to 4,000 Hz or using unrounded one-third octave band data from 100 Hz to 6,300 Hz (Section 5.4).

C2.2 Calculate the overall A-weighted Sound Power Level using unrounded octave band data from 125 Hz to 8,000 Hz or using unrounded one-third octave band data from 100 Hz to 10,000 Hz (Section 5.4).

C2.3 Compare the two overall A-weighted sound power level values, calculated in Sections C.2.1 and C.2.2 above.

C2.3.1 If the difference is 1 dB or less, the calculated A-weighted value using all bands can be considered to be valid. This value shall be rounded to the nearest dB and used as the rating.

C2.3.2 If the difference between the two overall A-weighted sound power level values is greater than 1 dB, a valid overall A-weighted sound power rating cannot be stated.

APPENDIX D. INFORMATION TO BE RECORDED - NORMATIVE

D1 *General.*

D1.1 Make, model, type (i.e. truck, trailer, container) and serial number of the unit under test

D1.2 Declared sound power rating value for each mode of operation tested. Indicate if rating is a Standard Rating or an Application Rating. ISO Standard 4871 provides guidelines for declaring and verifying noise emission values.

D1.3 Date and location of test

D1.4 Organization requesting the test

D1.5 Individual/organization conducting the test

D2 *Unit Description.*

D2.1 Combustion engine to include make, model, power, kW, at rated speed, Rev/s, number of cylinders, displacement, fuel type and speed, Rev/s, at unit rating points

D2.2 Electric motor to include make, power, kW, and type and speed, Rev/s, at unit rating points

D2.3 Generator to include make, model, power capacity, kW, voltage, V, and supply frequencies, Hz

D2.4 Compressor to include make, model, capacity, W, number of cylinders, type and speed, Rev/s, at unit rating points

D2.5 Condenser fan type, number of fans, number of blades per fan and speeds, Rev/s, at unit rating points

D2.6 Complete description of intake and exhaust components (i.e. silencers, mufflers, etc.)

Note: It is recommended that drawings and pictures of these components be included with the final report.

D2.7 Description of drive system (i.e. belts, gears, electric, etc.)

D2.8 Description of any noise abatement equipment or materials

Note: It is recommended that drawings, specifications and pictures of these components be included with the final report.

D2.9 Description of unit mounting arrangement. If mounted on a vehicle, include the vehicle make, type, total maximum permitted weight, kg, a description of the insulated body and position of the unit on the vehicle and/or container. If the unit is non-autonomous, include a description of the vehicle engine (make, type & rating).

D2.10 Refrigerant type.

D3 *Test Description.*

D3.1 Identification of ISO standard followed when determining sound rating value

D3.2 Measured sound power rating value for each mode of operation tested

Note: This is not a declared value. ISO Standard 4871 provides guidelines for declaring and verifying noise emission values.

D3.3 Set point, ambient box and ambient condenser air temperatures, ˚C

D3.4 Description of the test site to include air temperature, ˚C, wind speed, m/s, relative humidity, %, ground type & condition and any obstacles or acoustically reflecting surfaces (if testing outdoors)

Note: It is recommended that sketches and/or photographs of the test site be included.

D3.5 Ambient background noise levels for each set of operating conditions

D3.6 If it is an Application Rating, a full description of the unit operating condition shall be included.

D4 *Deviations.* Any deviations with respect to the procedures identified in this document shall be reported.

APPENDIX E. SOUND PRESSURE MEASUREMENT METHOD - INFORMATIVE

E1 *General.* Prior to the use of sound power to acoustically rate transport refrigeration equipment, a sound pressure method was commonly used in the industry. This pressure method was based upon DIN 8958 and was most commonly used to characterize diesel driven Truck and Trailer Transport Refrigeration Units.

This Appendix is provided to document the sound pressure procedure and to acknowledge the existence of a database obtained through its use. However, because the sound pressure method has been demonstrated to be less accurate than the sound power method for rating purposes, references to the sound pressure method will be omitted in future revisions of this document.

E2 *Procedure.*

E2.1 The sound descriptor resulting from this procedure will be a single number, A-weighted Sound Pressure Level.

E2.2 Measurements are to be made in a free field environment. Background ambient sound levels should be at least 10 dB below the sound level of the equipment to be measured.

E2.3 Any sound measuring device meeting Class 1 criteria is acceptable for use in making the sound measurements.

E2.4 The sound-measuring device used shall be calibrated prior to the start of the test and checked again upon completion of testing.

E2.5 The measurement microphone is to be located 1.2 m above the ground or floor.

E2.6 Five discreet measurement points are required, one directly to the front of the unit, one on each side of the unit at 90° to the front location, and one each side of the front location at 45°. Each microphone position is located 7 m from the front and center of the unit under test.

E2.7 The equipment under test shall be operating in a fully loaded pull-down condition when the sound measurements are conducted. The unit shall be mounted per manufacturer instructions. If deviations from the manufacturer instructions are required, they will be such that they do not change the sound levels or sound characteristics of the unit under test in any way and such deviations shall be reported.

E2.8 The Sound Pressure Levels from each of the five locations shall be logarithmically averaged together to yield a single sound pressure value. If an octave or fractional octave band analyzer is used, the discreet bands shall be A-weighted and then summed for each measurement location prior to calculating the average of the five points. If an instrument is used that provides only a single sound value for each measurement, the instrument shall be set to function such that it directly measures the A-weighted Sound Pressure Level at each measurement point. The five measurement points are then logarithmically averaged as previously stated to determine the single number A-weighted Sound Pressure Level.

E2.9 A full description of the unit under test (including information regarding sound reduction or sound altering components) shall be included.

E2.10 A description of the test site and weather conditions shall be included.