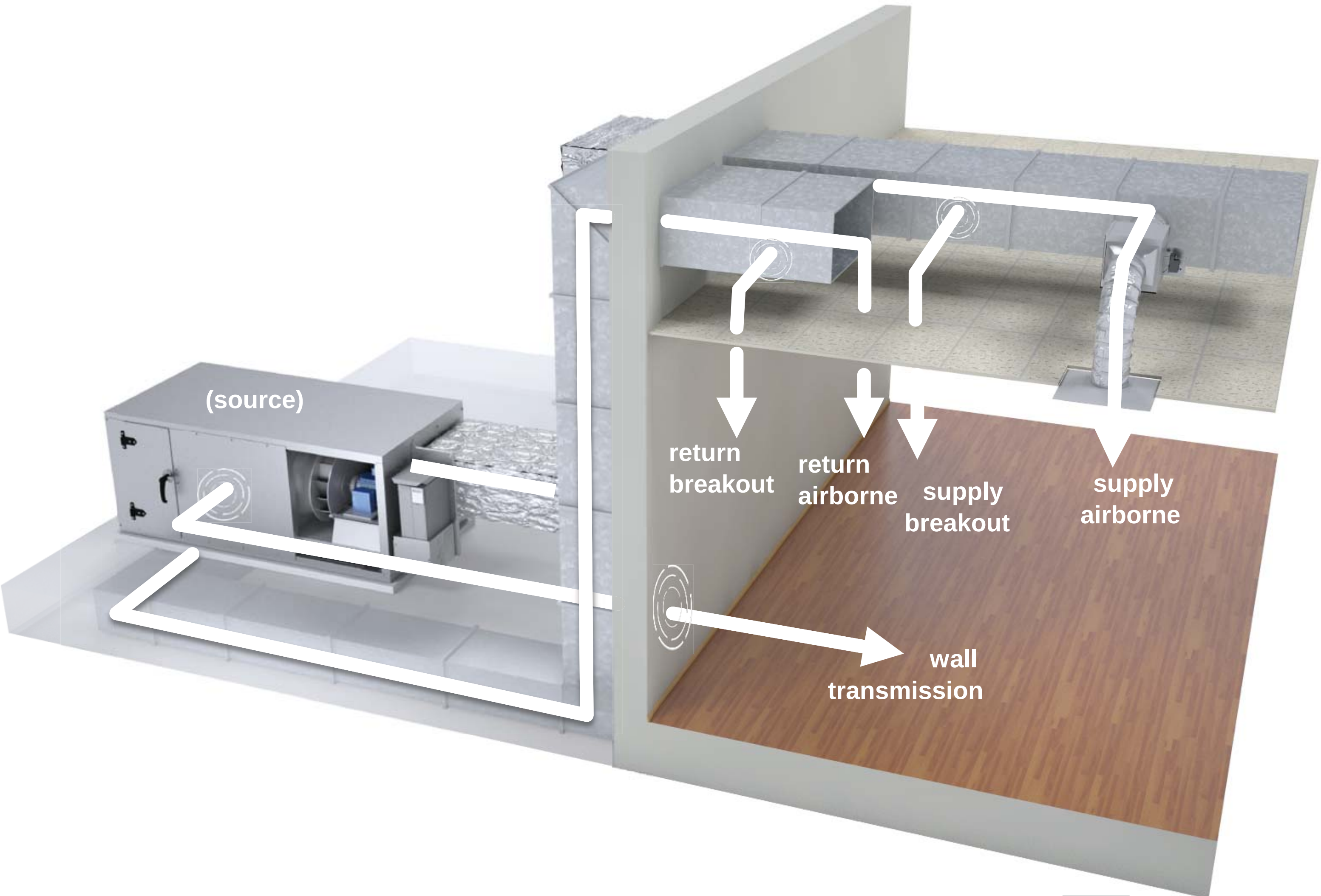
TRANE

Trane Engineers Newsletter Live

Evaluating Sound Data

Presenters: Dave Edmonds, Dave Guckelberger, Dustin Meredith, Eric Sturm and Jeanne Harshaw (host)



TRANE

Agenda

Trane *Engineers Newsletter Live* Series

Evaluating Sound Data

Abstract
Sound data is the foundation of acoustical analysis and it is often used for comparing equipment from different manufacturers. Unfortunately not all manufacturers present sound data in the same format. This ENL will focus on clarifying sound data terms and weighting methods so that the differences in sound data presentation are apparent. Examples of the common mistakes made when comparing chillers, air-handlers, VAV units, and fan coils are discussed.

Presenters: Trane engineers Dustin Meredith, Dave Guckelberger, Eric Sturm, Dave Edmonds

After viewing attendees will be able to:

1. Understand how various types of sound data are generated.
2. Identify the differences in sound data presented for HVAC equipment (e.g. sound power, sound pressure, dBA)
3. How to properly evaluate sound data to ensure accuracy and sensibility (A-weighting)
4. How to specify sound data to compare apples-to-apples

Agenda

- Why is data confusing
- How is sound data generated
- How is sound data commonly presented
- Problems when comparing data sets (examples)
- Summary

Ingersoll Rand

Presenter biographies

Evaluating Sound Data

Dustin Meredith | applications engineer | Trane

Dustin joined Trane in 2000 as a marketing engineer. In his current role as an applications engineer he specializes on airside products. His expertise includes sound predictions, fan selection, and vibration analysis. He also leads development and implementation projects for new and upcoming air-handling options. Dustin has authored various technical engineering bulletins and applications engineering manuals.

Dustin earned his BSME, BSCS and MBA degrees from the University of Kentucky. He is a corresponding member on ASHRAE TC 2.6 – Sound & Vibration Control – and ASHRAE TC 5.1 – Fans. He is a member of ASHRAE and is the primary Trane contact for AMCA.

Eric Sturm | applications engineer | Trane

Eric joined Trane in 2006 after graduating from the University of Wisconsin – Platteville with a Bachelor of Science degree in mechanical engineering. Prior to joining the applications engineering team, Eric worked in the Customer Direct Services (C.D.S.) department as a product manager for the TRACE™ 700 load design and energy simulation application. As a C.D.S. marketing engineer he supported and trained customers globally. As the newest member to the applications engineering team, Eric's areas of expertise include acoustics and airside systems. Eric is currently involved with ASHRAE at the local and national levels serving as a member of SSPC 140, SPC 205, TC 2.5, and TC 2.6.

Dave Edmonds | acoustics & mechanics test engineer | Trane

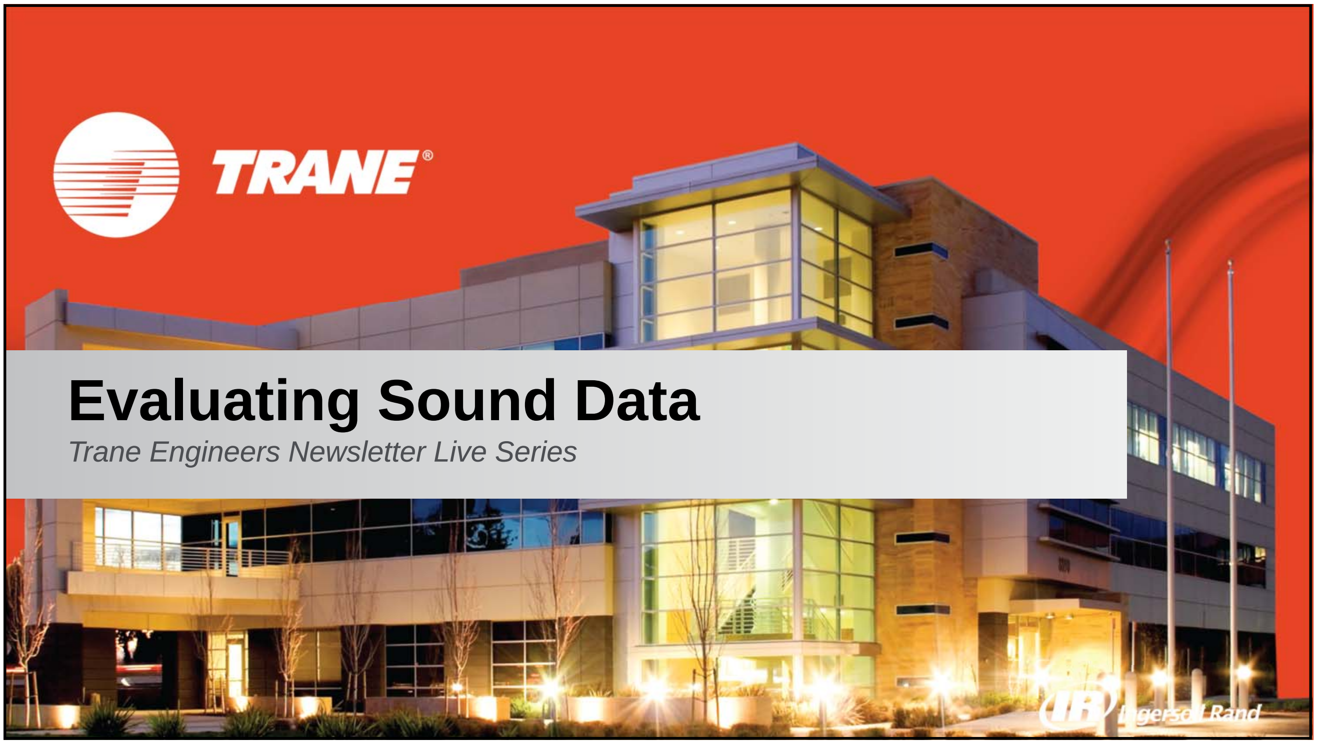
Dave joined Trane in 2005. His 25 years of acoustics experience ranges from underwater defense, to human body vibration and human perception of noise, and automotive noise control. In his current role his primary focus is product acoustics development and laboratory data collection for both development and catalog data.

After graduating from Michigan Tech with a BSME specializing in vibrations, Dave earned an MSME at The University of Texas at Austin specializing in acoustics. He teaches an acoustics test for non-acoustics engineers called The Acoustics Road Show. He has been a member of the Acoustical Society of America since 1988.

Dave Guckelberger | applications engineer | Trane

Dave's expertise includes acoustic analysis and modeling of HVAC systems, electrical distribution system design, and the refrigeration system requirements established by ASHRAE Standard 15. He also provides research and interpretation on how building, mechanical, and fire codes impact HVAC equipment and systems. In addition to traditional applications engineering support, Dave has authored a variety of technical articles on subjects ranging from acoustics to ECM motors to codes.

Dave is a past president of the Wisconsin Mechanical Refrigeration Code Council and has served on several ASHRAE committees at the national level. After graduating from Michigan Tech with a BSME in thermo-fluids, he joined Trane as a development engineer in 1982 and moved into his current position in Applications Engineering in 1987.



Evaluating Sound Data

Trane Engineers Newsletter Live Series

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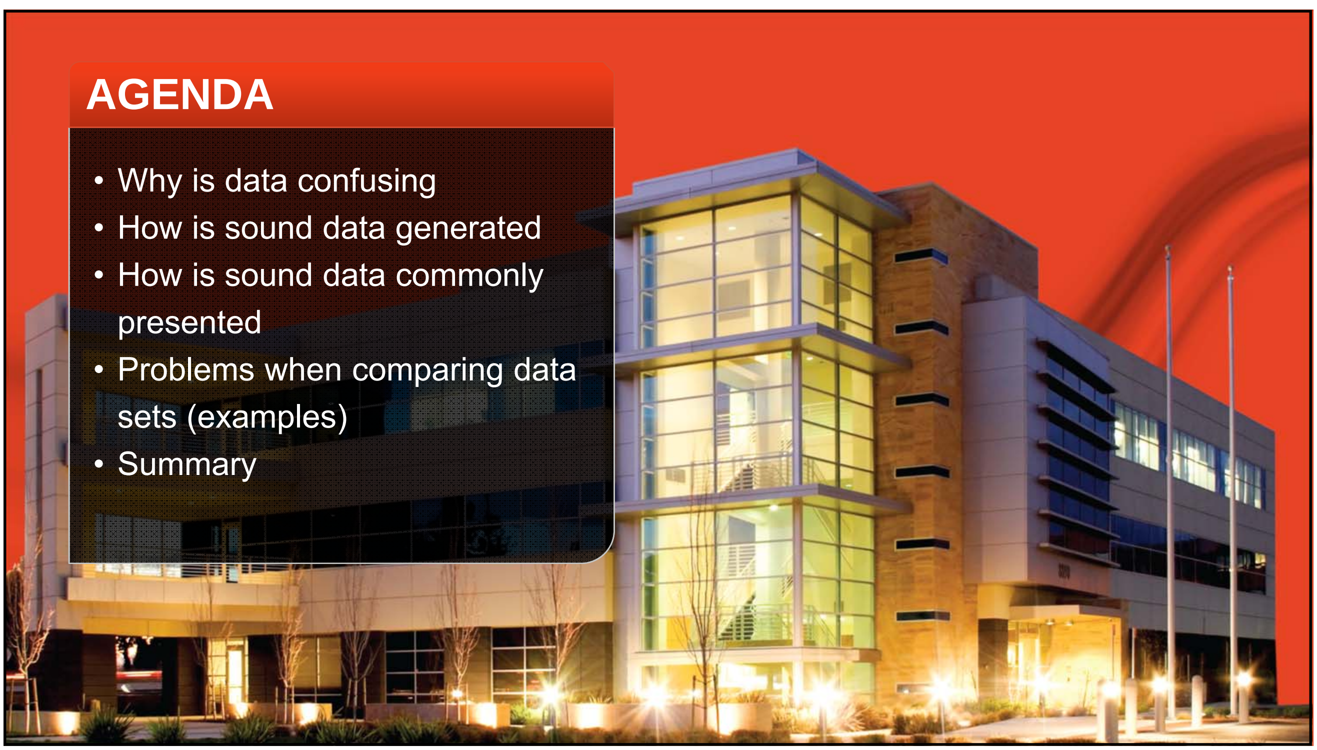
Learning Objectives

After attending today's program, you will be able to:

- Summarize how various types of sound data are generated.
- Identify the differences in sound data presented for HVAC equipment (e.g. sound power, sound pressure, dBA)
- Properly evaluate sound data to ensure accuracy and sensibility (A-weighting)
- Specify sound data to compare apples-to-apples



Today's Presenters

Eric Sturm	Dave Edmonds	Dave Guckelberger	Dustin Meredith
Applications Engineer	Test Engineer	Applications Engineer	Applications Engineer

Why Is Data Confusing?

Common acoustics terminology

- Sound pressure
- Sound power
- A-weighting
- B-weighting
- C-weighting
- NC
- NCB
- RC
- RC Mark II

Example Sound Level Requirements

Room Type	
Apartment	Living Area
Office Building	Open-plan
Performing Arts	Concert Hall
Hospital	Patient Room
Places of Worship	General Assembly
School	Classroom

Example Sound Level Requirements

Room Type		NC	RC
Apartment	Living Area	30	30 (N)
Office Building	Open-plan	40	40 (N)
Performing Arts	Concert Hall	20	20 (N)
Hospital	Patient Room	30	30 (N)
Places of Worship	General Assembly	25	25 (N)
School	Classroom	30	30 (N)

Example Sound Level Requirements

Room Type		NC	RC	dBA	dBC
Apartment	Living Area	30	30 (N)	35	60
Office Building	Open-plan	40	40 (N)	45	65
Performing Arts	Concert Hall	20	20 (N)	25	50
Hospital	Patient Room	30	30 (N)	35	60
Places of Worship	General Assembly	25	25 (N)	30	55
School	Classroom	30	30 (N)	35	60

Example Manufacturer Data

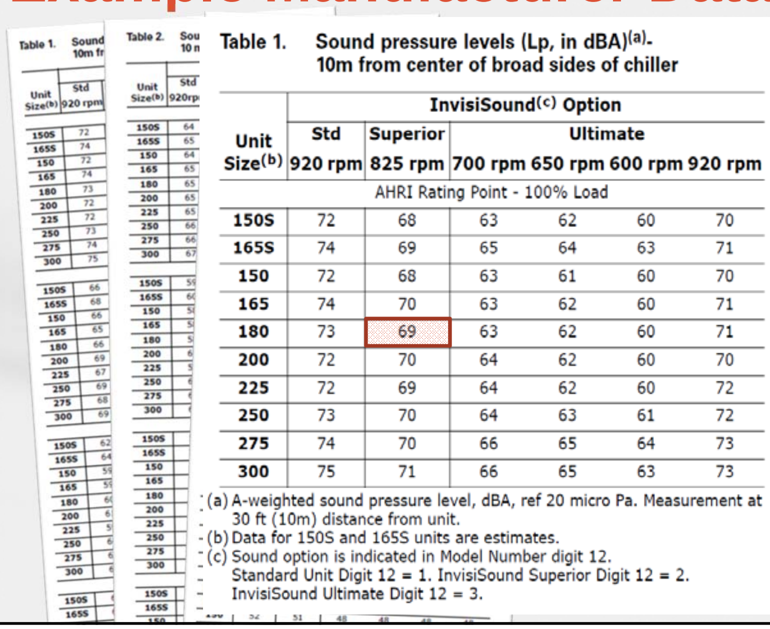


Table 1. Sound pressure levels (Lp, in dBA)[a]. 10m from center of broad sides of chiller

Unit Size[b]	InvisiSound[c] Option					
	Std	Superior	Ultimate			
	920 rpm	825 rpm	700 rpm	650 rpm	600 rpm	920 rpm
AHRI Rating Point - 100% Load						
150S	72	68	63	62	60	70
165S	74	69	65	64	63	71
150	72	68	63	61	60	70
165	74	70	63	62	60	71
180	73	69	63	62	60	71
200	72	70	64	62	60	70
225	72	69	64	62	60	72
250	73	70	64	63	61	72
275	74	70	66	65	64	73
300	75	71	66	65	63	73

(a) A-weighted sound pressure level, dBA, ref 20 micro Pa. Measurement at 30 ft (10m) distance from unit.
(b) Data for 150S and 165S units are estimates.
(c) Sound option is indicated in Model Number digit 12. Standard Unit Digit 12 = 1. InvisiSound Superior Digit 12 = 2. InvisiSound Ultimate Digit 12 = 3.

Example Manufacturer Data

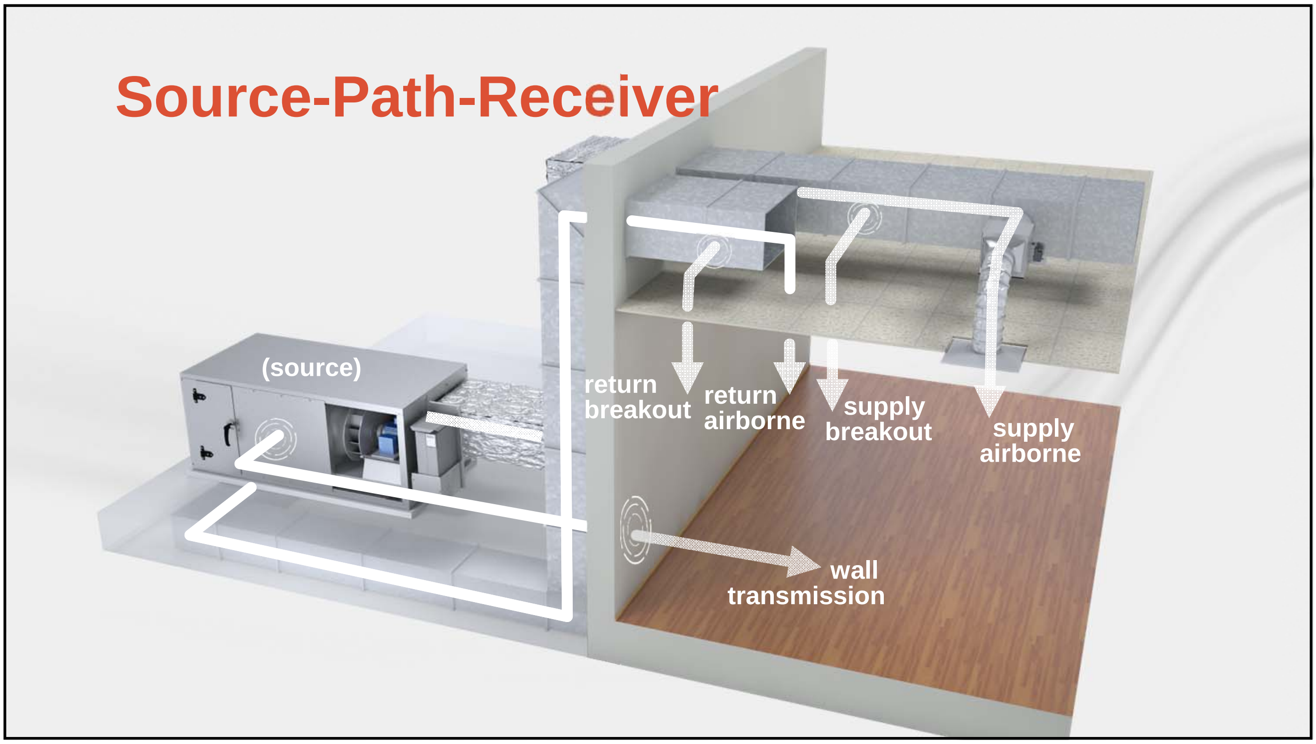
Table 10. Sound pressure levels (Lp, in dB) InvisiSound Standard[a], max fan 920rpm 10m from center of broad sides of chiller

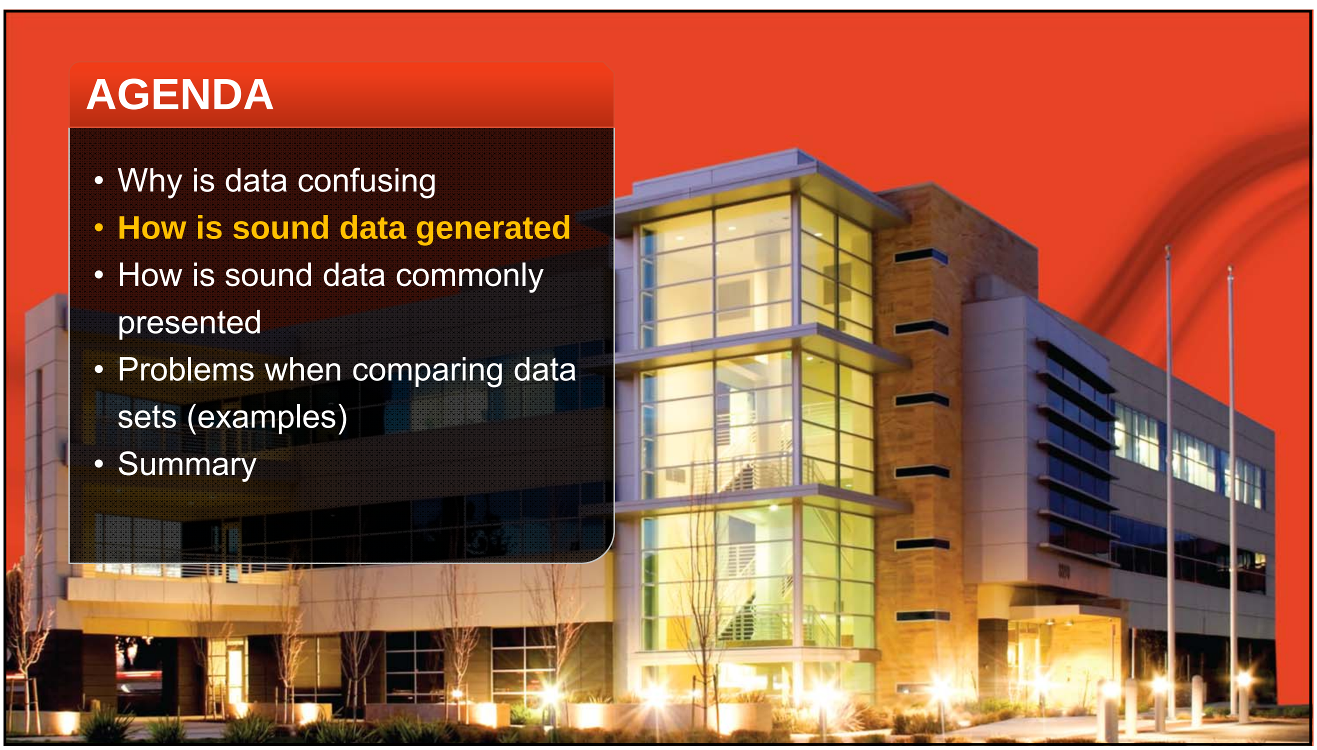
Unit Size [b]	Octaves 63	125	250	500	1000	2000	4000	8000	Overall A Wtd
	AHRI Rating Point - 100% Load								
150S	64	69	65	63	70	62	55	46	72
165S	65	69	65	64	72	64	56	48	74
150	64	69	65	62	70	64	55	46	72
165	65	69	65	62	73	66	56	48	74
180	65	70	66	63	72	64	56	49	73
200	65	69	65	64	70	63	57	49	72
225	65	71	66	64	70	64	56	47	72
250	65	71	66	64	72	64	56	47	73
275	66	71	67	65	72	65	57	48	74
300	67	72	68	66	74	65	58	49	75

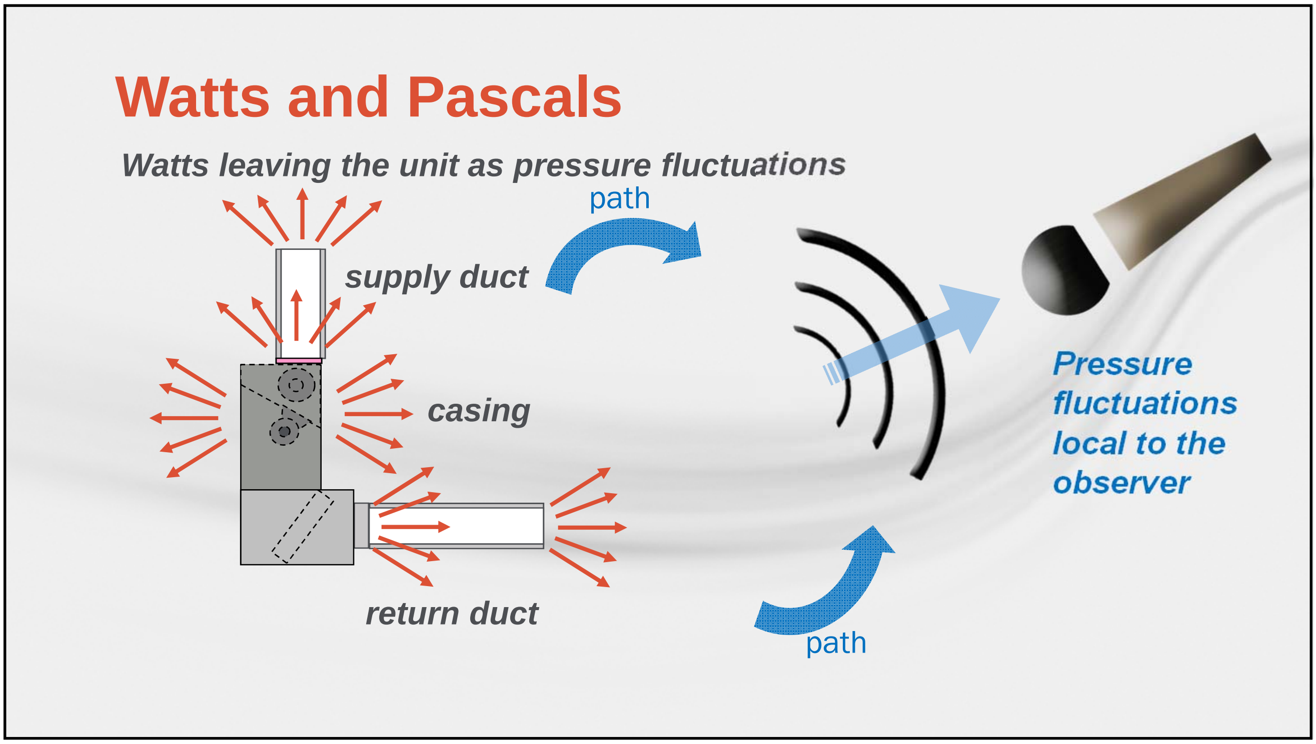
Example Manufacturer Data

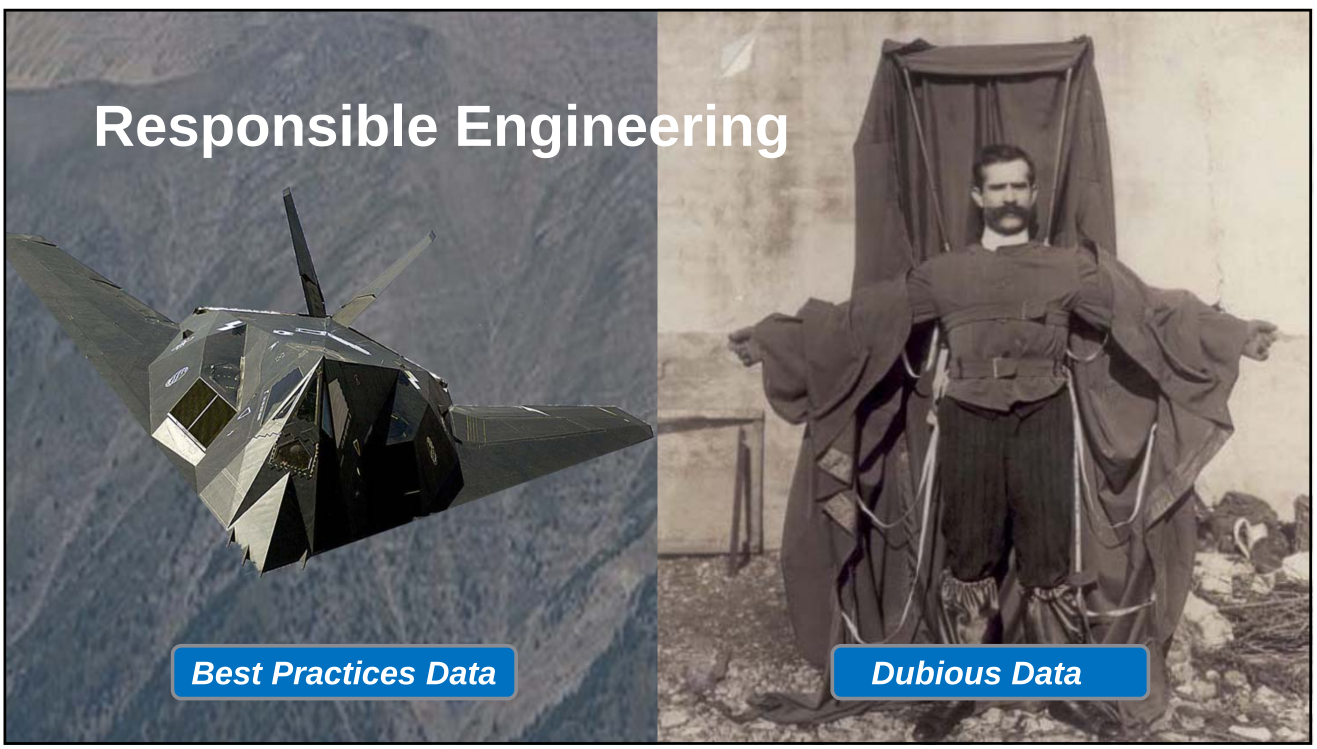
Table 4. Octave band sound power levels — InvisiSound Standard[a] unit— fan 920 rpm

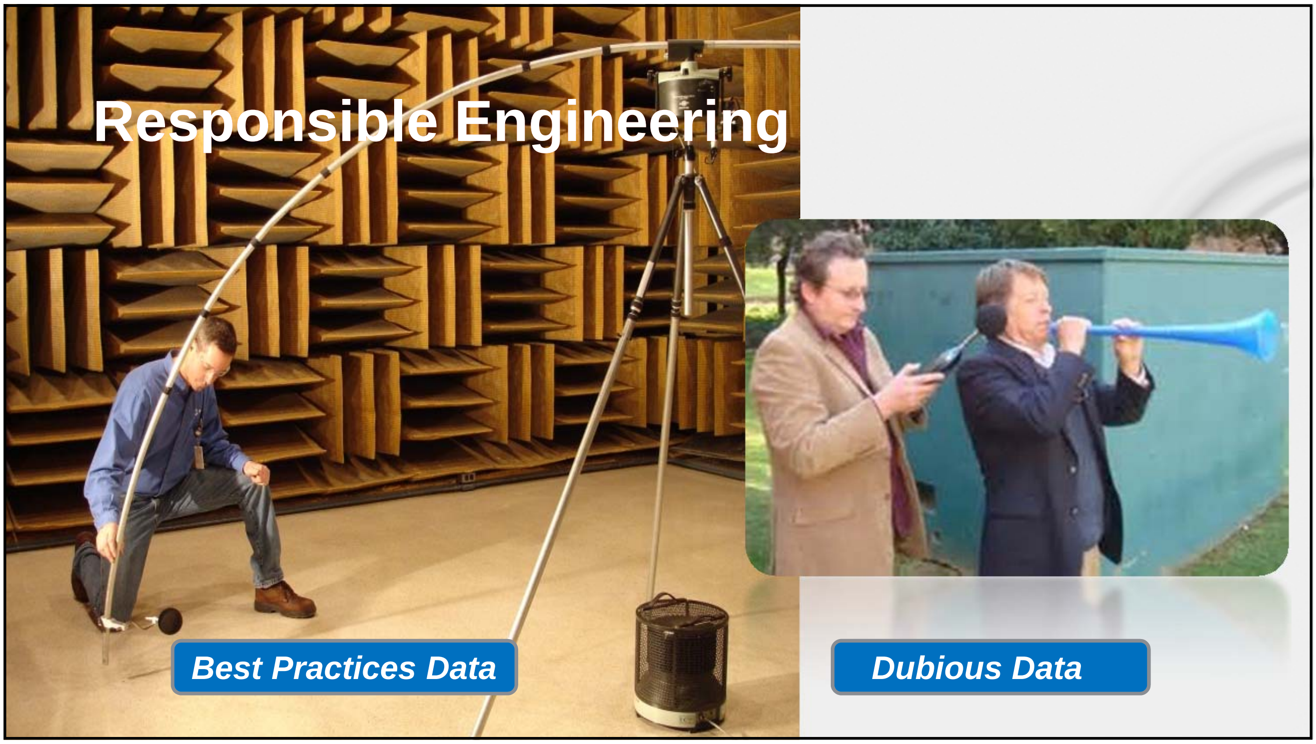
Unit Size[b]	Octaves 63	125	250	500	1000	2000	4000	8000	Overall A Wtd
	AHRI Rating Point - 100% Load								
150S	94	100	97	96	96	88	82	74	99
165S	95	101	98	97	98	90	84	76	100
150	94	100	97	95	98	89	82	75	100
165	95	101	98	96	98	91	83	76	100
180	95	101	98	97	97	90	83	77	100
200	95	101	98	97	96	89	85	77	100
225	95	102	99	98	97	89	83	75	100
250	96	102	99	98	100	90	84	76	102
275	96	102	100	98	99	90	85	76	101
300	97	103	100	99	99	91	85	77	102


Source-Path-Receiver
(source)
return breakout
return airborne
supply breakout
supply airborne
wall transmission


AGENDA
• Why is data confusing
• How is sound data generated
• How is sound data commonly presented
• Problems when comparing data sets (examples)
• Summary


Watts and Pascals
Watts leaving the unit as pressure fluctuations
path
supply duct
casing
return duct
path
Pressure fluctuations local to the observer


Responsible Engineering
Best Practices Data
Dubious Data


Responsible Engineering
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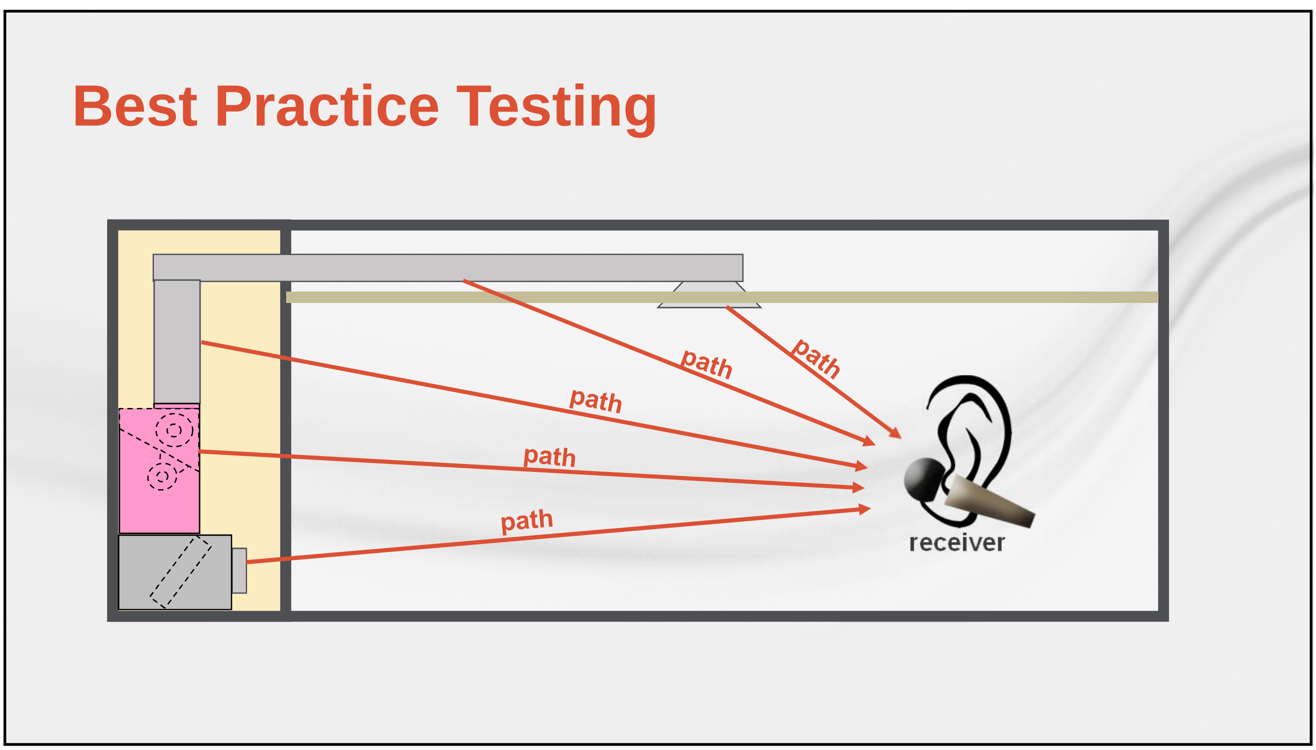

Best Practice Testing
path
path
path
path
path
receiver

Best Practice Testing

- Qualified facility
- Calibrated instruments
- Trained personnel
- Standardized test

Standardized Tests

AHRI 260	sound rating of ducted air moving and conditioning equipment
AHRI 270	sound rating of outdoor unitary equipment
AHRI 350	sound rating of non-ducted indoor air-conditioning equipment
AHRI 370	sound rating of large outdoor HVAC&R equipment
AHRI 880	sound rating of air terminals (VAV)
AMCA 300	sound rating of fan (only) in a Reverberant Room
AMCA 320	sound rating of fan (only) using acoustic intensity method
ANSI S12.12	noise measurement using acoustic intensity method (generic)
ISO 3741	noise measurement in reverberant rooms (generic)
ISO 3745	noise measurement in anechoic rooms (generic)
ISO 3744	noise measurement in free field over a reflecting plane (generic)

Variable Risk

Best Practices Data | Good Estimates | Ballpark Estimates | Dubious Data

Best Practices Data
- Standard, qualified test facility
- Trained personnel
- Calibrated equipment

Good Estimates
- Empirical fan sound plus empirical cabinet effect
- Standard data with small adjustment for new feature
- Small change fan diameter
- A/B compare/ identical test set up

Ballpark Estimates
- Handbook calculations
- Non-standard tests
- Bare-fan catalog used in cabinet test
- Small extrapolations of published data

Dubious Data
- No standard
- No description of test setup
- No units (watt/pascal)
- No unit performance
- Substantial scaling or extrapolation
- Walk around unit with microphone/meter

Best Practices

Key points

- Standard test
- Qualified facility
- Calibrated instruments
- Trained personnel

Catch-phrases

"Sound Power obtained using AHRI 260-2012"

"Reverberation room sound power per AHRI 270-2008"

Best Practices Data

Partial Test

Key points

- Based on standard test
- Small adjustments
- Documented

Catch-phrases

"Sound based on AHRI 880 compliant data with small adjustments made for hot water coil option."

"Ducted sound Power from data for size 35 unit adjusted for the size 40 cabinet."

Good Estimates

A/B Comparison of Sound Pressure

Key points

- Single change:
  - Option A/B
  - w/w/o feature x
  - Before/after mod
- All-else-same
  - Installation
  - Operation
  - Mic. location

Good catch-phrases

"Coil option A vs B, all other things equal."

"Identical installations and operating points with and without sound option."

Good Estimates

Dubious catch-phrases

"Coil A in one 'typical installation,' Coil B in another 'typical installation.'"

"dBA w/w/o new grill in place"

Dubious Data

"Parking Lot" (AHRI 370…and not AHRI 370)

Key points

- Standardized sound power tests correct for microphone placement issues (Best Practice)
- Free field over a reflecting plain
- Sound pressure tests:
  - Specific mic. location
  - Operating condition

Good catch-phrases

"Data collected using AHRI 370 adapted for this equipment configuration."

"Sound Pressure at 10m, 1.5m off the ground, centered on the narrow end of the unit opposite the control panel.

Good Estimates

Dubious catch-phrases

"Radiated Sound."

"dBA 10m"

Dubious Data

Calculated/Theoretical Estimates

Key points

- Handbook Data
- Estimates!
- Better-than-nothing
- Can be worse-than-nothing

Ballpark catch-phrases

"Calculated per ASHRAE handbook models using bare fan sound power from the manufacturer's catalog."

"Sound pressure estimated from empirical radiated sound power (AHRI 370) using spherical spreading assumptions."

Ballpark Estimates

Dubious catch-phrases

"Estimated Sound."

"Calculated Sound."

Dubious Data

Extrapolation

Key points

- Data often not linear
- Danger of Stall/Surge

Table 28-1

S_HF 30 Ton

COMMERCIAL PACKA(

30 Ton Exhaust Fan --- Sound Pow

CFM	TSP	RPM	63	125	2!
6000	0.50	570	71	69	6
6000	1.00	765	74	73	7
6000	1.75	975	78	78	7
8000	0.50	619	72	70	6
8000	1.00	797	74	74	7
8000	1.75	1013			7
10000	0.50	712			7
10000	1.00	837			7

"My operating point is…um… here..."

Dubious Data

Walk Around (One Sound Meter)

Key points

- Only useful:
  - Particular position
  - Particular installation
- Easy to confuse for real data

Catch-phrases

"dB at typical installation site"

"sound pressure at 1m"
(no indication of operation or placement)

"Sound: 68 dB"

Dubious Data

Best Practices Data

- Standard, qualified test facility
- Trained personnel
- Calibrated equipment

Good Estimates

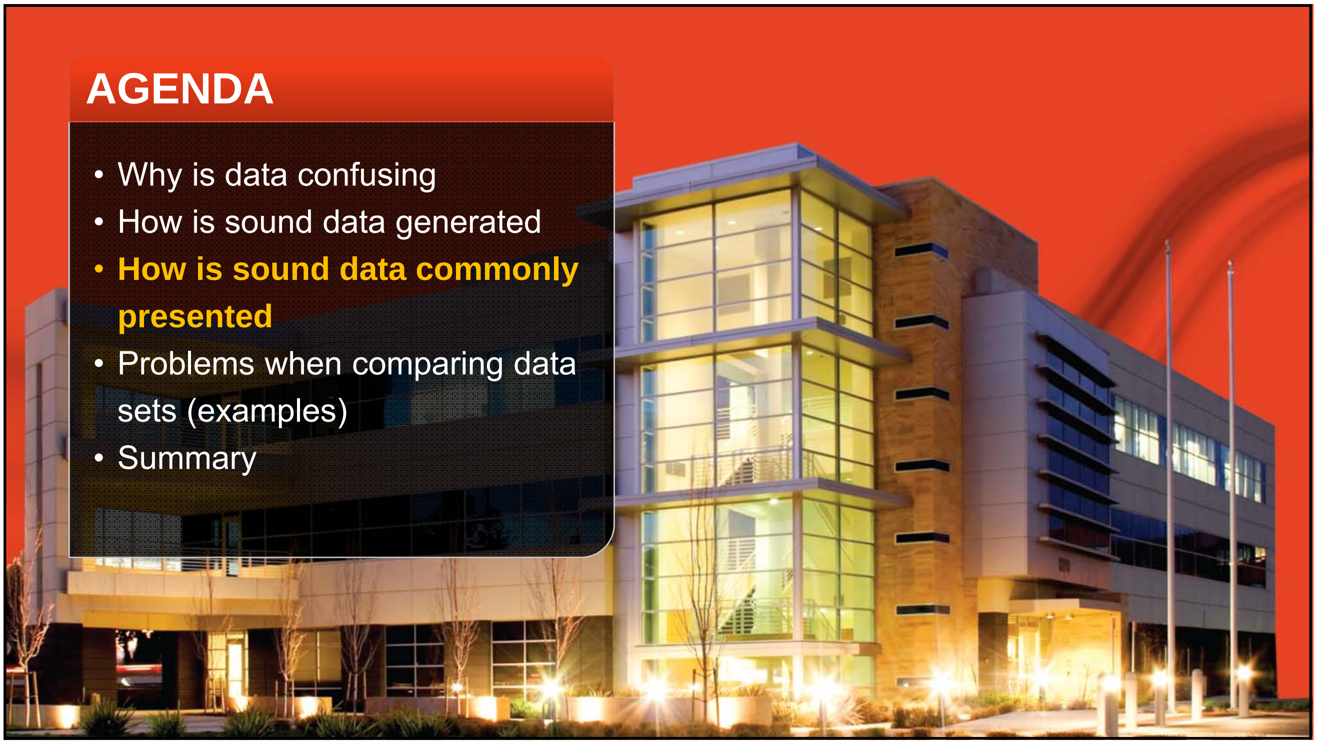
- Empirical fan sound plus empirical cabinet effect
- Standard data with small adjustment for new feature
- Small change fan diameter
- A/B compare/ identical test set up

Ballpark Estimates

- Handbook calculations
- Non-standard tests
- Bare-fan catalog used in cabinet test
- Small extrapolations of published data

Dubious Data

- No standard
- No description of test setup
- No units (watt/pascal)
- No unit performance
- Substantial scaling or extrapolation
- Walk around unit with microphone/meter



How Is Data Commonly Presented?

Refer to Specifying "Quality Sound" newsletter for information on:

- Sound power
- Sound pressure
- Single number ratings

www.trane.com/EN

Minimum Required per Standard

Section 6. Minimum Data Requirements for Published Ratings

6.1 *Published Ratings*. Published sound power ratings shall be for the unit with all components running that are necessary to produce the ARI standard thermal rating. The sound power ratings shall include items 1 and 2 as listed below; Items 3 and 4 are optional. Additionally, sound power data may be published for the unit operating with only the fan(s) running.

1. The octave band Sound Power Levels to the nearest decibel from 125 Hz to 8,000 Hz (63 Hz is optional).
2. The overall A-Weighted Sound Power Level to the nearest decibel covering the range of 100 Hz to 10,000 Hz (or optionally from 50 Hz to 10,000 Hz).
3. Optionally, the Sound Quality Indicator (SQI) may be published. The SQI shall be rounded to the nearest 0.1.
4. Optionally, the one-third octave band Sound Power Levels to the nearest 0.1 decibel may be published.

Free AHRI downloads from www.AHRInet.org

Sound Rating Standards

AHRI 260
Sound Rating of Ducted Air Moving and Conditioning Equipment

AHRI 270
Sound Rating of Outdoor Unitary Equipment

AHRI 350
Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment

AHRI 370
Sound Rating of Large Outdoor HVAC&R Equipment

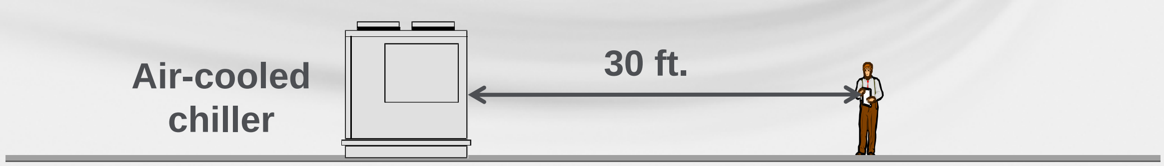
AHRI 880
Air Terminals (VAV)

Required per Standard

- Rating standards require octave band sound power
- Sound power required for
  - Acoustical analysis
  - Comparing unit to unit
- Ask for octave band sound power

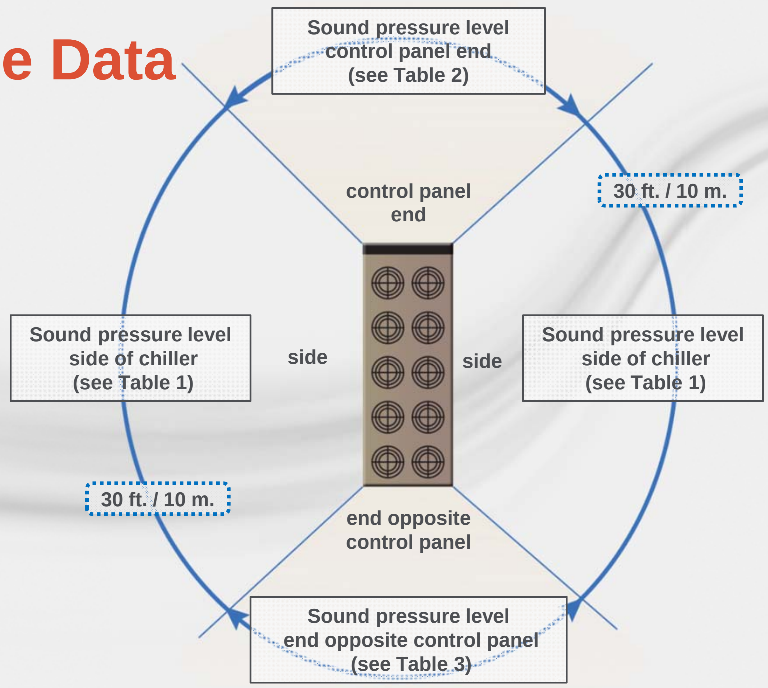
Sound Pressure Data

- Sound pressure
  - Pressure is dependent on the environment
- Where and how were the readings taken?



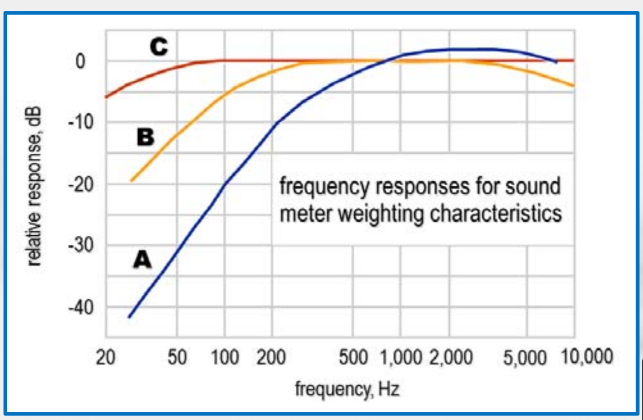
Sound Pressure Data

- Sound pressure readings on each side show directionality of source
- Measurements taken in a flat-plane, free-field environment:
  - No background interference
  - No reflective surfaces

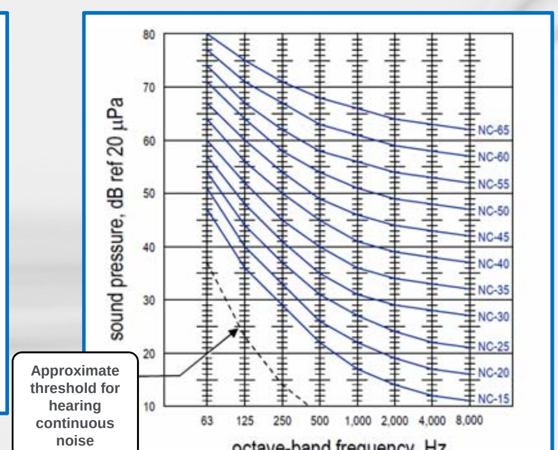


A Weighting and Noise Criteria

A-B-C Weighting



Noise Criteria (NC) Curves



A Weighting

Octave	63	125	250	500	1K	2K	4K	8K
Unweighted sound levels	68	70	67	68	64	56	53	48
A-weight adjustment	-26.2	-16.1	-8.6	-3.2	0	1.2	1	-1.1
Arithmetic sum	41.8	53.9	58.4	64.8	64	57.2	54	46.9

LOG Sum 69 dBA

A-weighting steps:

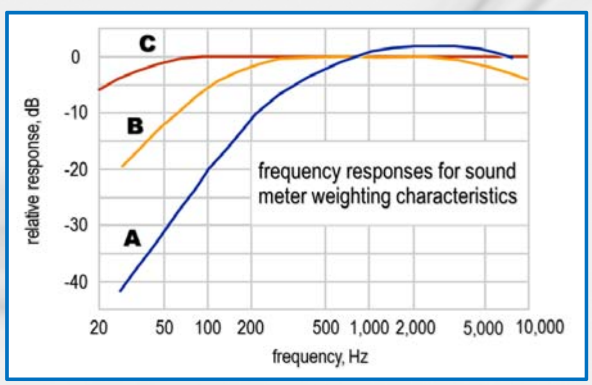
1) Add/subtract A weighting adjustments to octave band sound power or pressure levels (example sound levels show in blue).
2) Log sum the resulting octave band levels (log sum shown in red).

NOTE: it is ***not*** proper to display the intermediate values as "A-weighted octaves"

A Weighting

- A-weighting can be applied to
  - Sound power
  - Sound pressure
- Power and Pressure are both unitless
- How do you know which one you have?

A-B-C Weighting



Noise Criteria

- NC *only* applies to sound pressure
- Used to:
  - Specify room sound requirement
  - Describe measured sound in an occupied space

Noise Criteria

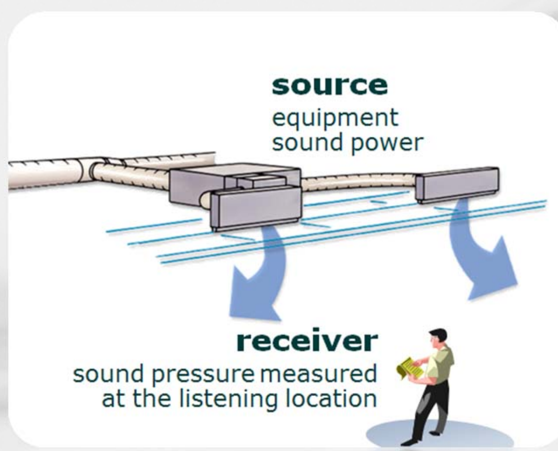
- Units rated in sound power
- Sound pressure required for NC
- Transfer function accounts for path details
- Unique transfer function for each environment
- Catalog NC ratings not likely to match actual NC

VAV NC Ratings

- VAV sound rating per AHRI 880
- Sound power ratings may be certified by AHRI
- NC ratings not part of AHRI 880

VAV NC Ratings

- AHRI 885 converts 880 sound power to sound pressure
- Conversion details unique for each occupied space
- Result is application specific NC



VAV NC Ratings

- AHRI 885 Appendix E
  "Typical Sound Attenuation Values"
- Provides power to pressure transfer functions
- Separate function for discharge and radiated
- Discharge functions for 3 box sizes
- Selection or catalog NC is the NC for the example room (not your room)

VAV NC Ratings

- AHRI 885 updated in 2008
- Transfer functions changed
  - Old transfer functions = lower NCs
- Ceiling types reduced
  - Gypsum board ceilings = lower NC
- Current version only includes mineral fiber ceiling

VAV NC Ratings

Acoustical Performance

Octave Band	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	NC*
Discharge	74 dB	67 dB	63 dB	59 dB	56 dB	56 dB	26
Radiated	63 dB	56 dB	53 dB	49 dB	50 dB	50 dB	27

Sound power level in dB re 1 pW. Acoustical data obtained in accordance with AHRI 880-11.

Noise criteria (NC) estimate is calculated using the following transfer function:

Discharge	AHRI 885-08
Radiated	AHRI 885-08 mineral fiber

The AHRI 885 -98 transfer functions are the same as AHRI 885 -08.

*NC levels below 15 are left blank.

VAV NC Ratings

- Some suggestions for comparing VAV units
  - Compare 2011 (or later) octave band certified sound power
  - Use 885 to make your own transfer function
  - Only compare manufacturer NCs based on AHRI 885 2008 or later version

Presentation Methods - Summary

- A variety of metrics may be used
- To avoid confusion:
  - Understand what the metrics represent
  - How the metrics are generated
- Octave band sound power per appropriate standard provides best comparison

Determining dBA

A-Weight calculation	Calculate A-weighted dB (dBA) from known octave band sound pressure or sound power levels								
Octave	*31.5*	*63*	*125*	*250*	*500*	*1K*	*2K*	*4K*	*8K*
Un-weighted sound levels		68	70	67	68	64	56	53	48
A-Weight Adjustment	-39	-26.2	-16.1	-8.6	-3.2	0	1.2	1	-1.1
Sum	-39	41.8	53.9	58.4	64.8	64	57.2	54	46.9	**69 dBA**

A-weighting steps:

1) Add/ subtract A weighting adjustments to octave band sound power or pressure levels (example sound levels show in blue).
2) Log sum the resulting octave band levels (log sum shown in red).

NOTE: it is not proper to display the intermediate values as “A-weighted octaves”

Some common terms

A Few Acoustics Terms You Should Know …

Decibel. Denotes the relative difference between the intensity of one sound and the lower intensity of a reference sound; equals 10 times the common logarithm of the ratio of the two intensity levels: $dB = 10 \log_{10} (N/N_{ref})$. Commonly used reference values are 10^{-12} watt (1 pW) for sound power and 20 micropascals (20 µPa) for sound pressure.

Frequency. Number of cycles that occur in one second. (A "cycle" is the complete sequence of motion comprising a sound wave.)

Octave Band. A frequency range with an upper limit that's twice the frequency of its lower limit.

Sound. Audible emissions resulting from the displacement/vibration of molecules in an elastic medium such as air or, in an HVAC context, the building structure.

Sound Power. Acoustical energy, measured in watts, emitted by a sound source. It's a calculated value unaffected by environment and distance.

Sound Pressure. An audible atmospheric disturbance that can be measured directly; its intensity is influenced by the surroundings and distance from the sound source.

Tone. A sound of distinct pitch, quality or duration with a narrow frequency range.

For more acoustics basics, consult the "Sound and Vibration" chapter of the *ASHRAE Fundamentals Handbook* or the Trane *Acoustics in Air Conditioning* manual (FND-AM-5).

Definitions

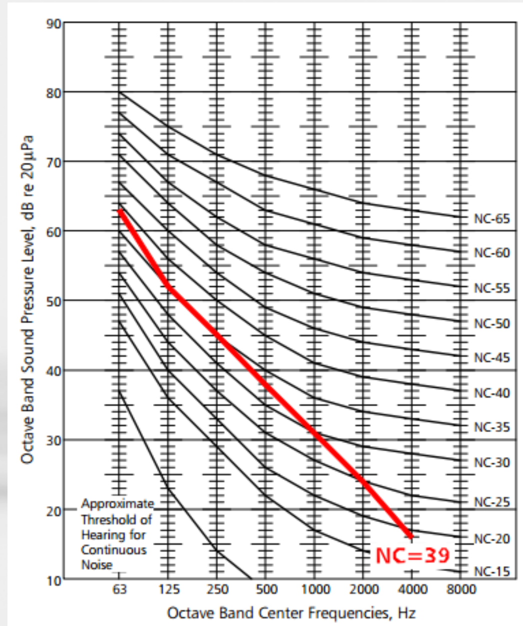
Sound Power Level (L_w). Sound power is acoustical energy that is emitted by the source, and that is neither affected by distance nor by the environment. Sound power level cannot be measured directly; instead, it must be calculated from sound-pressure measurements. Values include a reference (i.e. "1 picowatt or 10^{-12} W").

Sound Pressure Level (L_p). Sound pressure is an audible disturbance in the atmosphere that can be measured directly. Its magnitude is influenced not only by the strength of the source, but also by the environment and the distance between the source and the receiver. Sound pressure is what our ears hear and what sound meters measure. Sound pressure values include a reference (i.e. "ref 20 micro-pascals").

Determining NC

“Noise criteria” or NC curves are probably the most common single-number descriptor used to define the sound quality of indoor environments. The loudness along each NC chart curve is about the same. Each NC curve also slopes downward to reflect the ear’s increasing sensitivity at higher frequencies.

Determining the NC value for a given set of octave band data is easy. Simply plot the octave band sound pressure level data on the NC chart … the highest NC curve crossed by the data curve determines the NC rating.



How To Determine The RC Noise Rating …

[This excerpt is paraphrased from Chapter 42, “Sound and Vibration Control,” of the *1991 HVAC Applications ASHRAE Handbook*.]

The RC rating of a noise is usually based on sound pressure level data at center frequencies of 31.5 to 4000 Hz and consists of two descriptors. The first descriptor is a number representing the spectrum’s speech interference level (SIL), and is obtained by taking the arithmetic average of the noise levels in the 500-, 1000- and 2000- Hz octave bands. The second descriptor is a letter denoting the sound’s “quality” as it might subjectively be described by an observer. These steps describe how to determine an RC rating:

1. Plot the octave-band noise spectrum on an RC chart.
2. Calculate the SIL by arithmetically averaging the sound pressure levels at the 500-, 1000- and 2000-Hz octave band centers.
3. Draw a line with a slope of –5 dB per octave in the frequency range from 31.5 to 4000 Hz, and passing through 1000 Hz at the SIL calculated in Step 2. This is the reference curve for evaluating the sound quality of the spectrum.
4. Draw one line 5 dB above the reference curve extending from the 31.5 to 500 Hz. Draw a second line 3 dB above the reference curve, extending from 1000 to 4000 Hz. The range between these two lines and the reference curve represents the noise spectrum’s maximum permitted deviation above the reference curve to receive a neutral (N) rating.
5. Judge the sound’s quality by observing how the spectrum’s shape deviates from the boundary limits of the reference curve set in Step 4. Use the criteria described below to choose the appropriate letter descriptor.
6. Assign the spectrum an RC rating — i.e., the numerical part of the rating corresponds to the level of the reference curve at the 1000-Hz octave band center; then append the letter descriptor determined in Step 5.

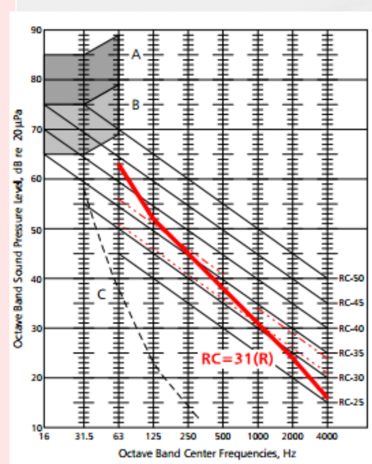
Characterize the subjective quality of the room’s background noise based on the following criteria.

Neutral (N). The levels in the octave bands centered at 500 Hz and below must not exceed the octave-band levels of the reference spectrum by more than 5 dB at any point in the range; the levels in the octave bands centered at 1000 Hz and above must not exceed the octave-band level of the reference spectrum by more than 3 dB at any point in the range.

Rumbly (R). The level in the octave bands centered at 500 Hz and below exceeds the octave-band levels of the reference spectrum by more than 5 dB at one or more points in the range.

Hissy (H). The level in the octave bands centered at 1000 Hz and above exceeds the octave-band level of the reference spectrum by more than 3 dB at one or more points in the range.

Acoustically Induced Perceptible Vibration (RV). The cross-hatched region in the 16-to-63-Hz octave band frequencies on an RC chart indicates sound pressure levels at which walls and ceiling can vibrate perceptibly — rattling cabinet doors, pictures, ceiling fixtures and other furnishings in contact with them.



Common Problems Encountered

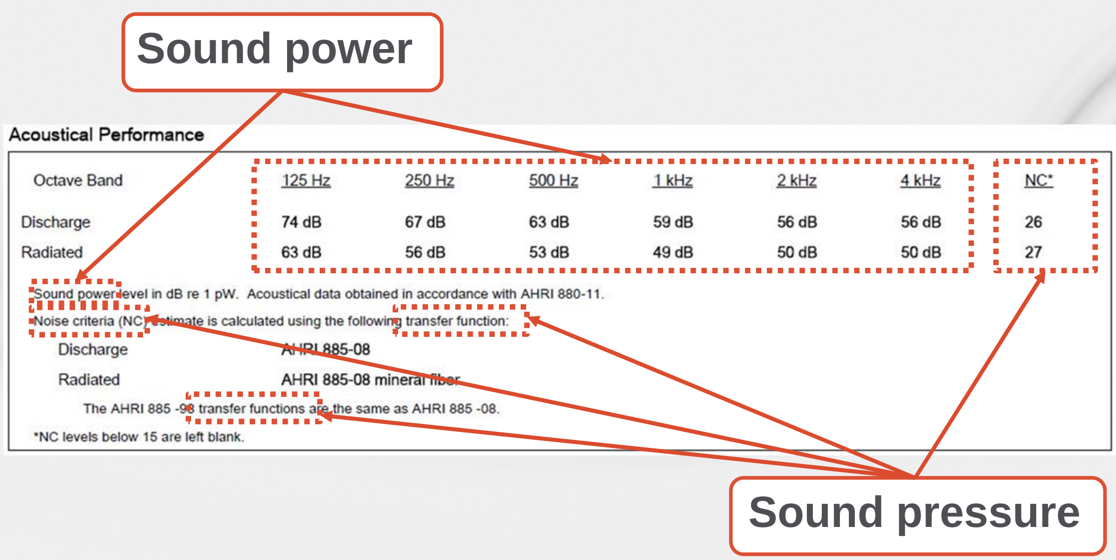
- Not clear whether the data is sound power or sound pressure
- Inappropriate or missing standards
  - Transmission Loss (TL) method example
  - Validity of plenum calculations
  - Misapplied measurement standards
- Different operating conditions
- Weighted octave data

Sound Power or Sound Pressure?

Clues that often indicate sound pressure:

- The symbol "Lp" is used (as-opposed-to "Lw" for sound power)
- The data includes a distance (e.g., "70dBA at 5 feet")
- A single number value is presented
  - Noise criteria (NC) in particular
- A transfer function has been applied

Sound Power or Sound Pressure?



Acoustical Performance

Octave Band	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	NC*
Discharge	74 dB	67 dB	63 dB	59 dB	56 dB	56 dB	26
Radiated	63 dB	56 dB	53 dB	49 dB	50 dB	50 dB	27

Sound power level in dB re 1 pW. Acoustical data obtained in accordance with AHRI 880-11.
Noise criteria (NC) estimate is calculated using the following transfer function:

Discharge AHRI 885-08
Radiated AHRI 885-08 mineral fiber

The AHRI 885 -98 transfer functions are the same as AHRI 885 -08.

*NC levels below 15 are left blank.

Inappropriate or Missing Standards

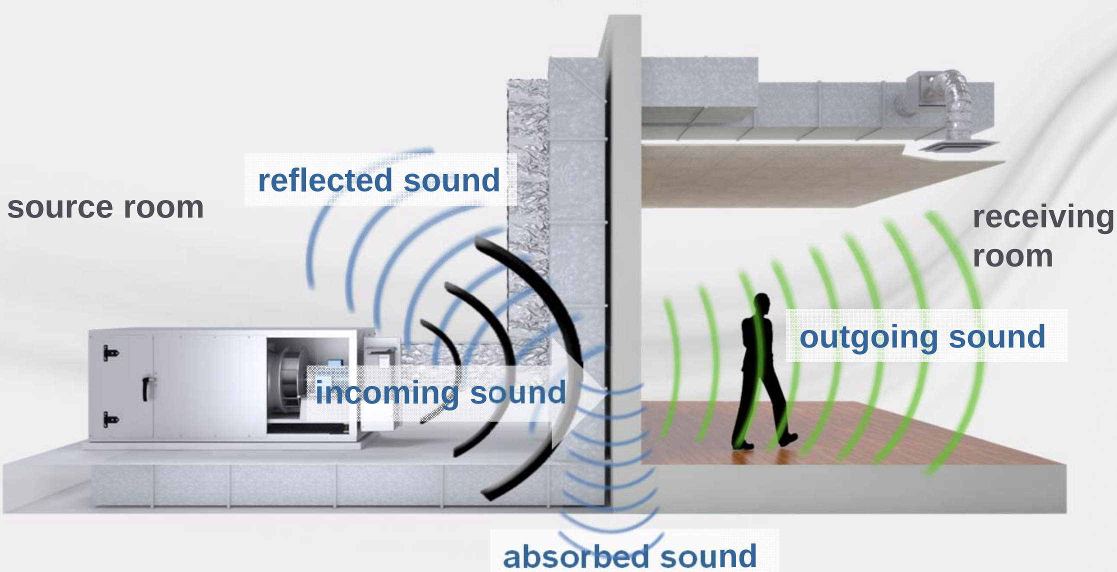
Common approaches:

- Source data + projections
- Equipment rating standard

Projection methods:

- Casing radiated component:
  - Transmission Loss (TL) Method
- Inlet or discharge components:
  - Plenum calculations

Transmission Loss (TL)



TL Method Example

Standards referenced:

Manufacturer X:

- AMCA Standard 300
- ASTM Standard E90

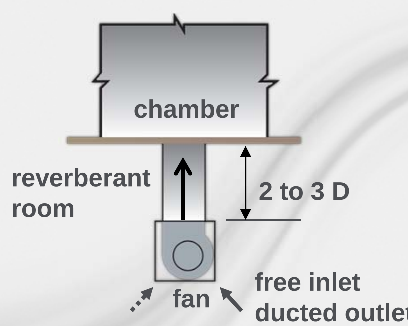
Manufacturer Y:

- AHRI Standard 260

Casing Lw	63	125	250	500	1K	2K	4K	8K
Manufacturer X	83	73	61	64	63	38	25	25
Manufacturer Y	97	92	63	87	76	66	56	57

TL Method Example

Bare fan per AMCA 300	63	125	250	500	1K	2K	4K	8K
inlet	92	91	85	91	82	84	79	75
discharge	96	95	85	87	82	81	77	77

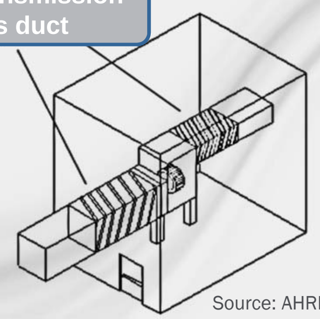


TL per ASTM E90	63	125	250	500	1K	2K	4K	8K
TL Values	13	22	24	27	19	46	54	52

TL Method vs. Equipment Standard

Other effects:

- Cabinet itself
- Cabinet's effect on the fan
- Airflow-generated noise
- Additional sides (more surface area)



Source: AHRI 260

AHU-1 Overall	63	125	250	500	1K	2K	4K	8K
Casing Lw	97	92	73	87	76	66	56	57

TL Method vs. Equipment Standard

TL per ASTM E90	63	125	250	500	1K	2K	4K	8K
TL Values	13	22	24	27	19	46	54	52

Bare fan per AMCA 300	63	125	250	500	1K	2K	4K	8K
inlet	92	91	85	91	82	84	79	75
discharge	96	95	85	87	82	81	77	77

Casing Lw	63	125	250	500	1K	2K	4K	8K
TL Method	83	73	61	64	63	38	25	25
AHRI 260	97	92	73	87	76	66	56	57
difference	-14	-19	-12	-23	-13	-28	-31	-32

Inappropriate or Missing Standards

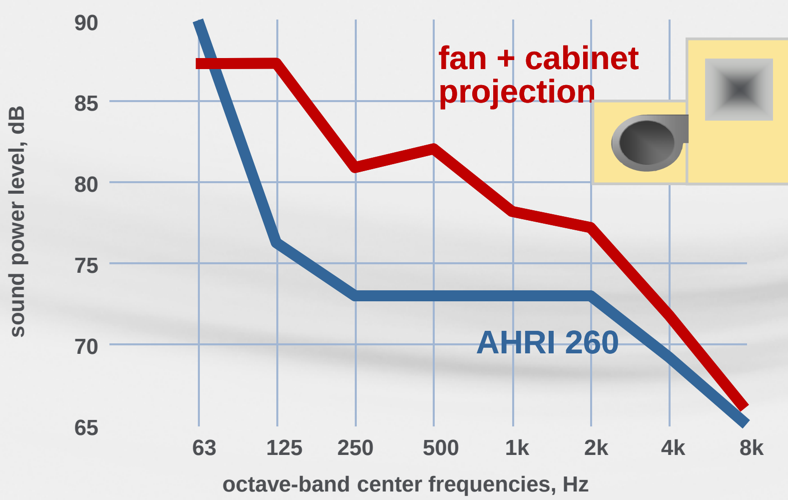
Common approaches:

- Source data + projections
- Equipment rating standard

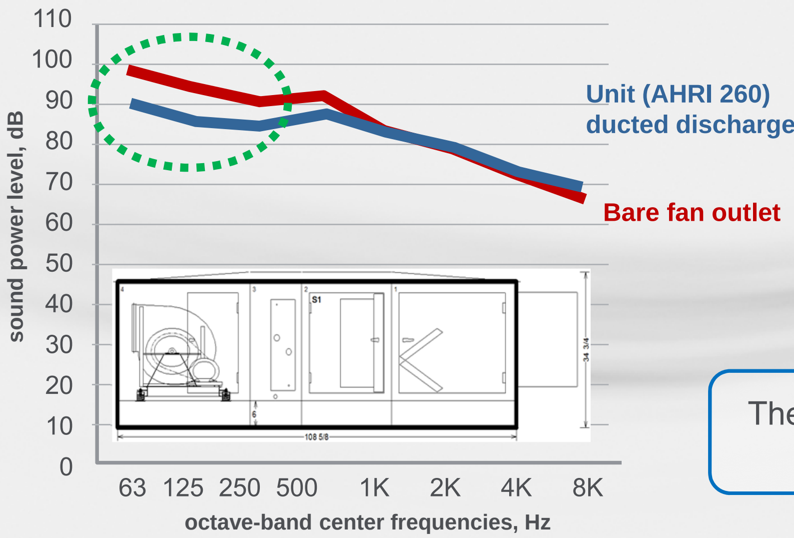
Projection methods:

- Casing radiated component:
  - Transmission Loss (TL) Method
- Inlet or discharge components:
  - Plenum calculations

Plenum Calculations



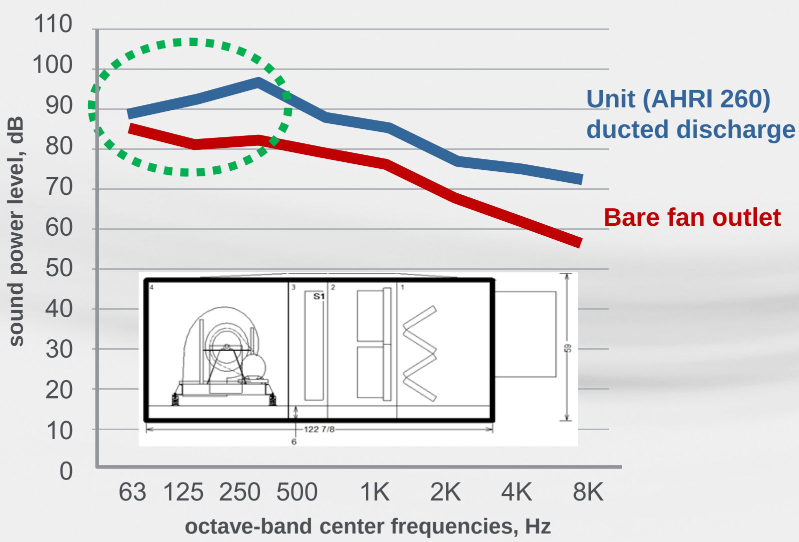
Plenum Calculation Validity



Bare fan (AMCA 300) exceeds unit (AHRI 260)

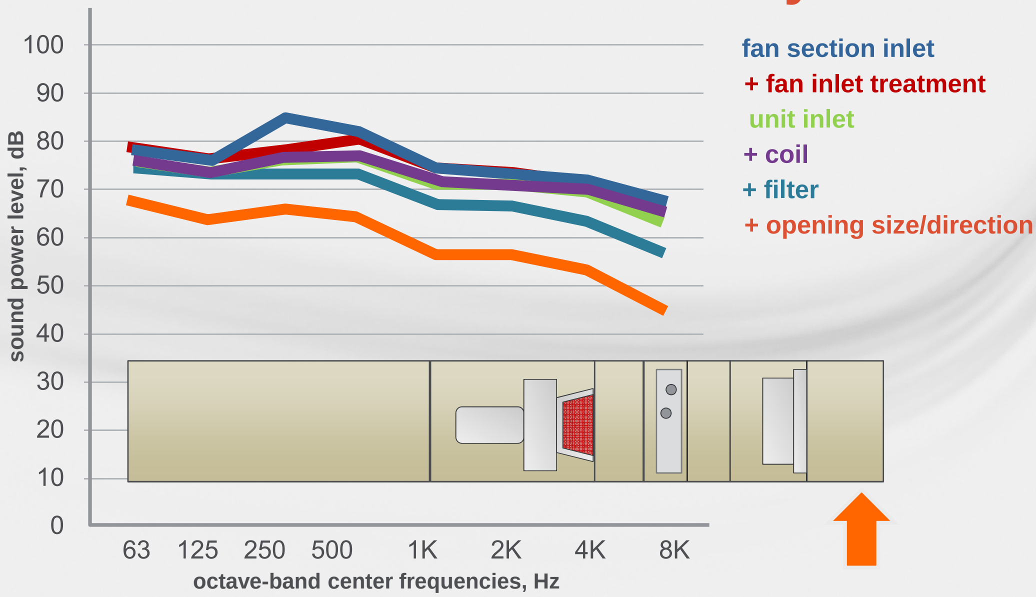
The building is overdesigned
($$ left in the job)

Plenum Calculation Validity

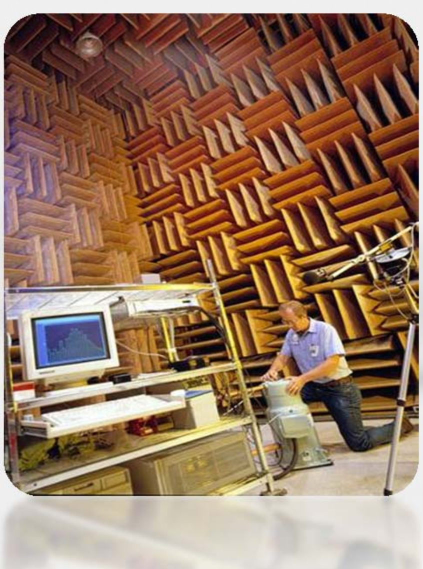


Unit (AHRI 260) *exceeds* bare fan (AMCA 300)

Plenum Calculation Validity



Inappropriate or Missing Standards



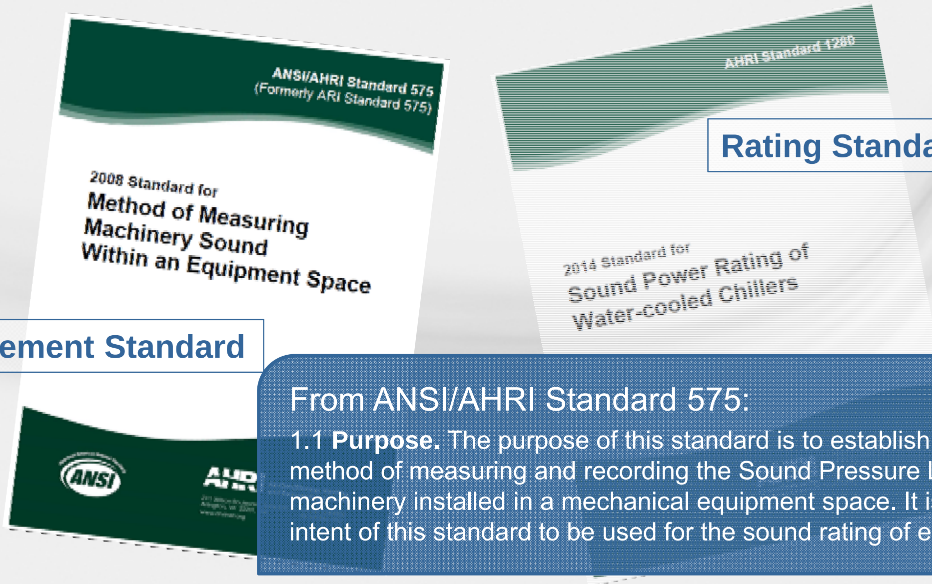
Common approaches:

- Source data + projections
- Equipment rating standard

Projection methods:

- Casing radiated component:
  - Transmission Loss (TL) Method
- Inlet or discharge components:
  - Plenum calculations

Misapplied Measurement Standard



Rating Standard

Measurement Standard

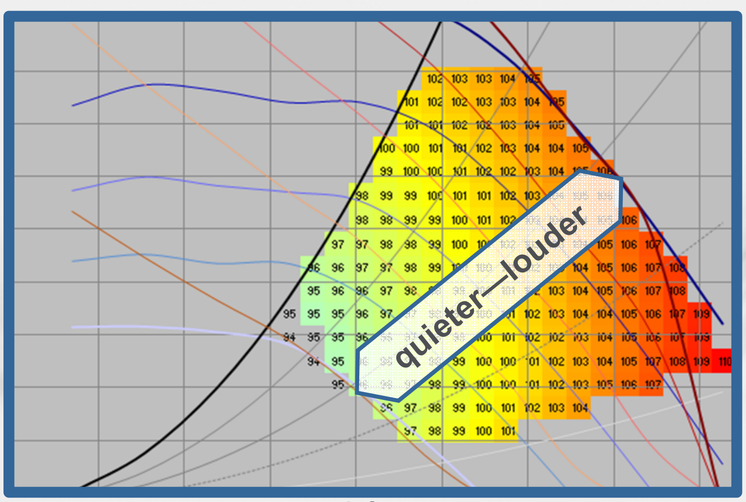
From ANSI/AHRI Standard 575:

1.1 **Purpose.** The purpose of this standard is to establish a uniform method of measuring and recording the Sound Pressure Level of machinery installed in a mechanical equipment space. It is not the intent of this standard to be used for the sound rating of equipment.

Different Operating Conditions

quieter—louder

pressure



airflow

quieter—louder

Different Operating Conditions

Be sure the operating conditions are the same:

- Same airflow
- Same pressure
  - Be sure all options are included

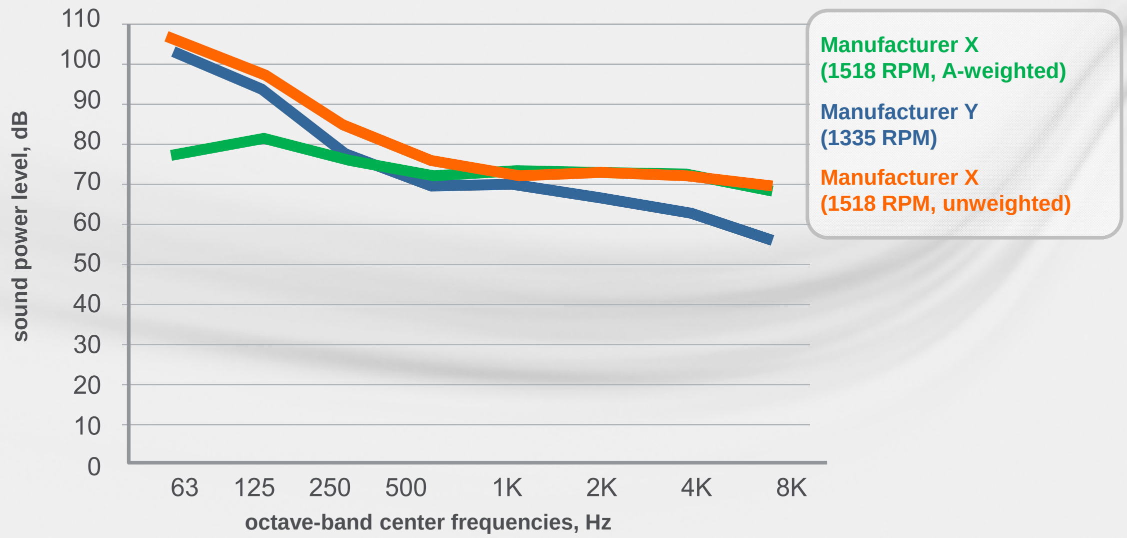
UNIT SIZE	FAN SPEED	SCFM	TOTAL SOUND POWER LEVEL OCTAVE BAND / CENTER FREQUENCY (HZ)						
			125	250	500	1000	2000	4000	8000
02	High	233	58	63	60	53	48	43	35
	Medium	190	48	52	46	43	34	25	26
	Low	149	42	45	31	28	20	23	26
03	High	321	57	60	55	52	47	41	34
	Medium	280	54	56	52	48	42	35	28
	Low	246	49	52	47	43	36	27	27

Weighted Octave Data

- Similar products
- Manufacturer Y is much louder than Manufacturer X
  - Especially at low frequency

Casing Lw	63	125	250	500	1K	2K	4K	8K
Manufacturer X	83	73	61	64	63	38	25	25
Manufacturer Y	97	92	63	87	76	66	56	57

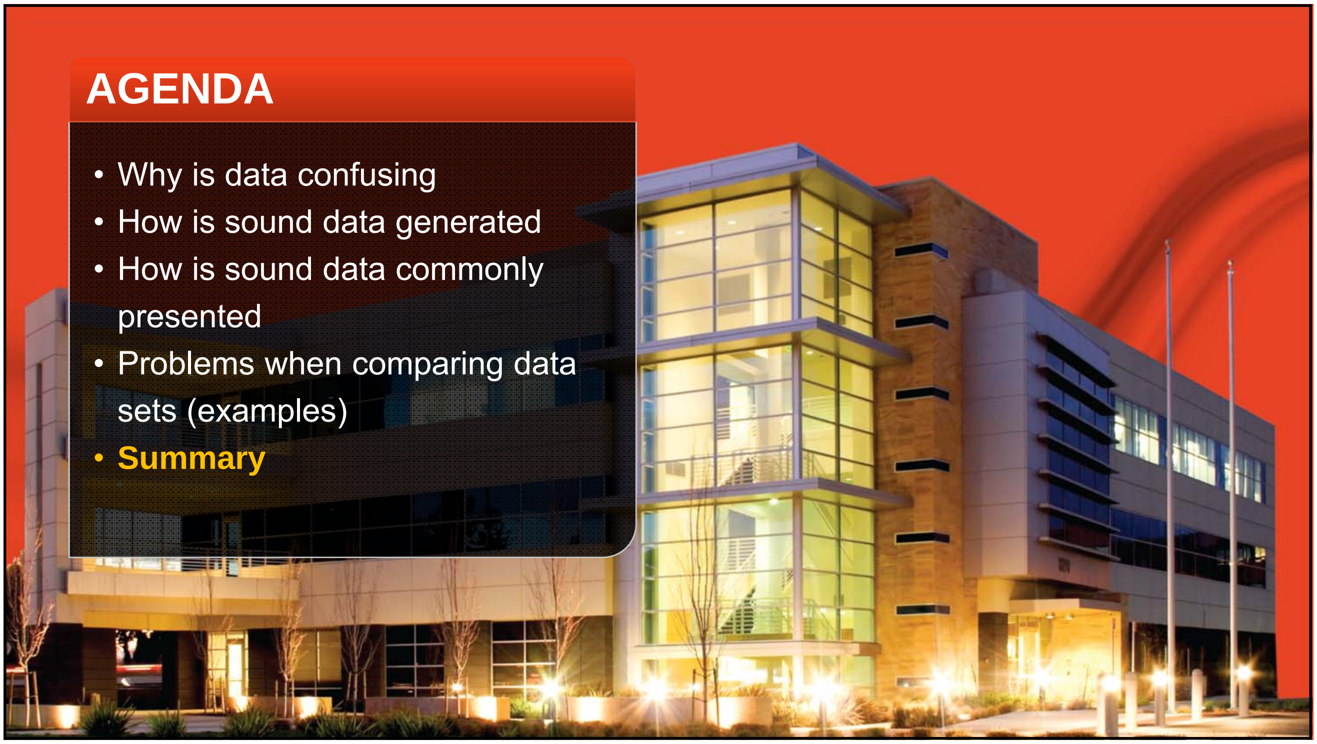
Weighted Octave Data



Problems Encountered - Summary

Know when you are evaluating:

- Sound power vs. sound pressure
- Sound data in-accordance with appropriate standards
- Different operating conditions
- Unweighted vs. weighted octave data



Substandard Data

- Has this data been generated using an industry-agreed-upon testing method?
- Is the data being presented in a way that meets or exceeds the minimum criteria presented within this standard?
- Are labels and footnotes used to explain data, identify and justify anomalies?

Summary

- Manufactures provide sound data in a lot of different formats (e.g. NC, dBA).
- The different formats are useful for different purposes.
- Always use sound power (L_w) when comparing units.
- And always check that the correct standard, including date, is used.

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Evaluating Sound Data

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Are there any other events/topics you would like Trane to offer to provide additional knowledge of their products and services?

Additional questions or comments:

Trane *Engineers Newsletter LIVE: Evaluating Sound Data*
APP-CMC055-EN QUIZ

1. Acoustic data in general are reliable. Issues only arise when they aren't labeled clearly "sound pressure" or "sound power."
   a. True
   b. False

2. Best Practices for acoustic data include:
   a. Standardized tests, reverberant rooms, trained personnel, and an RSS (Reference Sound Source)
   b. Standardized tests, quantified facilities, trained monkeys, and a blue plastic bugle
   c. Standardized tests, qualified facilities, trained personnel, and calibrated instruments
   d. Good Estimates, Ballpark Estimates, and Dubious Data

3. A footnote on your table says "sound pressure data collected in a free field over a reflecting plane, at a range of 10m from the broad side of unit" and has different sets of columns for stating the number of fans running, and the % of full load according to an industry standard that prescribes part-load operation. What is the best description of the quality of these data?
   a. Best Practice (there is an industry standard involved, and the position is noted)
   b. Good Estimate (it does not comply with a standard, but the position, environment, and operation are described well-enough that they can be compared to similar data)
   c. Ballpark Estimate (handbook calculations were used along with standard data to produce the results)
   d. Dubious Data (since it is a measurement using sound pressure it may have been done with a sound level meter…and the unit is clearly installed somewhere)

4. A footnote on your table says "sound pressure data estimated from AHRI 370 sound power assuming spherical spreading in a free field over a reflecting plane and a range of 10m from the center of the unit" and has different sets of columns for stating the number of fans running, and the % of full load according to an industry standard that prescribes part-load operation. What is the best description of the quality of these data?
   a. Best Practice (there is an industry standard involved, and the position is noted)
   b. Good Estimate (it does not comply with a standard, but the position, environment, and operation are described well-enough that they can be compared to similar data)
   c. Ballpark Estimate (handbook calculations were used along with standard data to produce the results)
   d. Dubious Data (since it is a measurement using sound pressure it may have been done with a sound level meter…and the unit is clearly installed somewhere)

5. NC and dBA ratings can easily be converted to octave band sound data. (False)
   a. True
   b. False

6. Octave band sound power data taken in accordance with the appropriate rating standard should be used for comparing sound data from different manufacturers.
   a. True
   b. False

7. The A-weighting procedure can be applied to both sound power and sound pressure.
   a. True
   b. False

8. The source-path-receiver model analyzes the source of sound, the various paths sound takes to reach the receiver, and the environment of the receiver to determine sound pressure at the receiver.
   a. True
   b. False

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May 2015

Evaluating Sound Data

Industry Standards and Handbooks

available to purchase from < www.ashrae.org/bookstore > or <www.ahrinet.org>

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