Engineering Data

ED 19018

Group: **WSHP**
Part Number: ED 19018
Date: **October 2013**

Sound Power Ratings for SmartSource™ 1 & 2-Stage Horizontal & Vertical Water Source Heat Pump Products

Introduction

An exceptional level of Indoor Environmental Quality (IEQ) and personal comfort should be goals for all HVAC designs. Sound quality and the associated sound levels are a few of the many key parameters in measuring personal comfort. To deliver this type of comfort, acoustic consultants may have to be involved for complex and acoustically sensitive applications such as performing arts centers, theaters, and large gathering spaces. However, it is the HVAC designer and the project architect working together who are most likely tasked with crating a comfortable acoustic environment. Given the potentially significant noise contributions from the HVAC system, the HVAC designer must be equipped with specialized tools to help facilitate important acoustic design decisions.

Daikin has developed several tools to assist the design team in evaluating the acoustic performance of HVAC systems. The Application Guide – HVAC Acoustic Fundamentals[1] is a detailed technical reference manual with comprehensive acoustic fundamentals combined with typical HVAC system acoustic analysis guidance. When used in conjunction with Daikin's Acoustic Analyzer™ software and published sound power data from the manufacturer, the design team can estimate the room sound levels. These tools can help to estimate the affect of the HVAC equipment sound levels both in the space and outside of the building. The information generated by the Acoustic Analyzer™ software can help determine if the resulting room sound levels can meet the specifications or if further acoustic attenuation, alternative HVAC equipment or building modifications are necessary.

[1] McQuay International Application Guide – HVAC Acoustic Fundamentals, catalog AG 31-010

System Analysis

Three types of acoustic analyses can be performed with Daikin's Acoustic Analyzer™ software. These include outdoor sound, zoned comfort systems and central systems. This Engineering Document focuses on the SmartSource Single and 2-Stage Horizontal and Vertical Water Source Heat Pump sound power data and the resulting indoor sound levels based on a zoned comfort system. However, the Acoustic Analyzer™ software can be used to evaluate the acoustic performance of the following other system types:

- Outdoor Sound – this is used to estimate sound levels at the property line or at an adjacent building. The sound source is typically an air-cooled chiller, rooftop unit or cooling tower.
- Zoned (Decentralized) Comfort Systems – this is used to estimate sound levels of indoor equipment that resides in or near the occupied space. These include systems that reside in the occupied space (i.e. console water source heat pumps) and units that are ducted away from or above the occupied space (i.e. horizontal and vertical water source heat pumps). The Acoustic Analyzer™ software takes the room effect, duct breakout, return and discharge air noise, and radiated sound pathways into consideration.
- Central Systems – this is used to estimate sound levels from HVAC equipment that serve multiple spaces such as a chilled water air handler with multiple VAV boxes in several zones. This analysis tends to be based on larger equipment with greater sound power levels. The Acoustic Analyzer™ divides central systems into two categories; "Large" for applications with open office spaces and "Defined" for all other

applications. The Acoustic Analyzer™ can perform several acoustic evaluations of a central system, including:

- Supply and return duct sound. A special feature allows the mechanical room to be included in the return air path. This is specifically meant for vertical self-contained systems that often use the mechanical room as the return air plenum.
- Diffuser sound.
- Terminal unit radiated sound.
- Sound transmitted through a wall.
- Sound breakout from any node on the supply or return duct.

The "Zoned (Decentralized) Comfort Systems" analysis should be the basis for evaluating the occupied space sound levels for a water source heat pump system.

Analysis Summary and Output Reports

To assist the design team in making decisions regarding the proposed system, the Acoustic Analyzer™ provides an easy to follow summary of the calculated results. The summary report provides the basic acoustic analysis information including the room effect calculations, attenuation guidance, and a plot of the resulting sound criteria.

The sound criteria can be determined based on Noise Criteria (NC), Room Criteria (RC) or Noise Rating (NR). An example of the NC evaluation and report is shown in Figure 1.

Figure 1: Examples of the NC Evaluation and Report

Acoustic Analysis Version 1.0

Job name	Vertical Stack WSHP Acoustic Analysis	**Run name**	Cooling High Speed
Customer name	Sample Job	**HVAC unit**	WHC-015
Operator	Daikin Application Engineering	**Analysis type**	Zoned comfort system
		Analysis subtype	In space

Summary

Requested NC level	35	**Estimated NR level**	32
Attenuation required	Yes	**Estimated RC level**	35 (R)
Estimated NC level	36	**Estimated dBA**	35

Room Data

Room Details			
Room length	20 ft	**Total surface area**	992 ft²
Room width	12 ft	**Receiver room equation**	Thompson
Room height	8 ft	**People**	1
Floor area	240 ft²	**Chairs**	1
Room volume	1920 ft³		

Wall, Floor and Ceiling Properties

Surface	Area	Type	Glass area	Closed curtains
Wall 1	80 ft²	Curtain wall	80 ft²	Yes
Wall 2	96 ft²	Drywall on brick wall	0 ft²	No
Wall 3	160 ft²	Drywall on brick wall	0 ft²	No
Wall 4	96 ft²	Drywall on brick wall	0 ft²	No
Floor	240 ft²	Carpet on foam rubber		
Ceiling	240 ft²	Textured concrete ceiling		

Wall Floor and Ceiling Sound Absorption Properties

Band (Hz)	16	31	63	125	250	500	1k	2k	4k	8k
Wall 1 sound absorption coef.	-	0.07	0.13	0.18	0.06	0.04	0.03	0.02	0.02	0.02
Wall 2 sound absorption coef.	-	0.00	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.04
Wall 3 sound absorption coef.	-	0.00	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.04
Wall 4 sound absorption coef.	-	0.00	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.04
Ceiling sound absorption coef.	-	0.00	0.00	0.01	0.02	0.02	0.06	0.08	0.10	0.08
Floor sound absorption coef.	-	0.03	0.06	0.08	0.27	0.39	0.34	0.48	0.63	0.50
Room constant	-	16	33	49	108	153	177	217	261	241

Important: Daikin disclaims any responsibility for actions based on this program. See Software License and Disclaimer.

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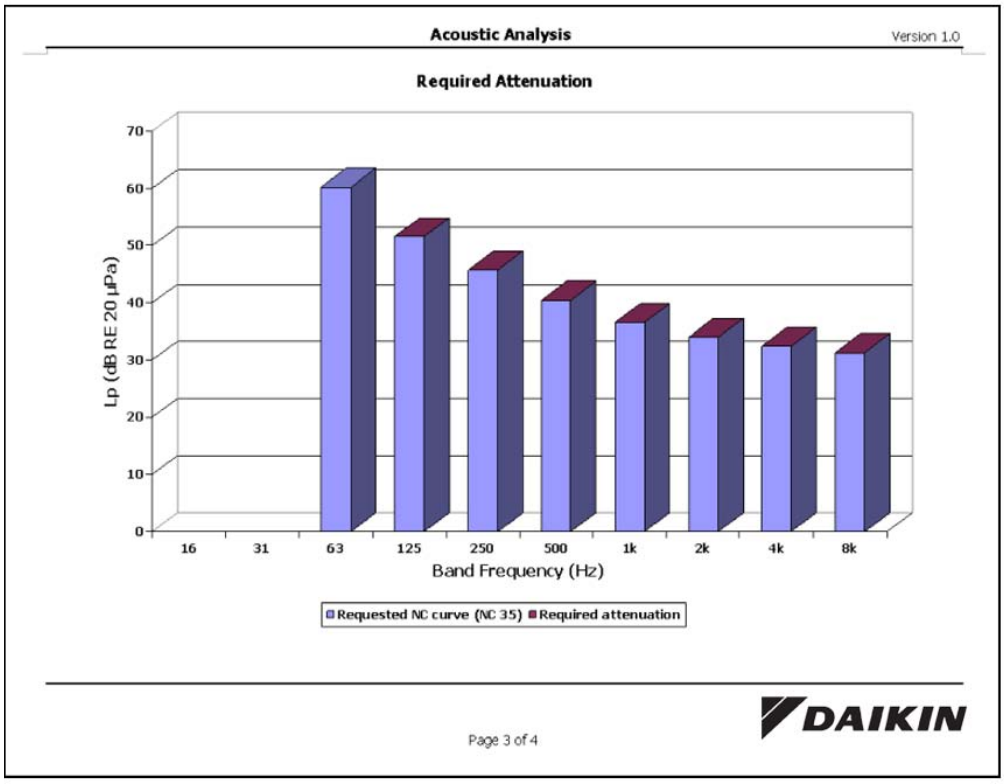
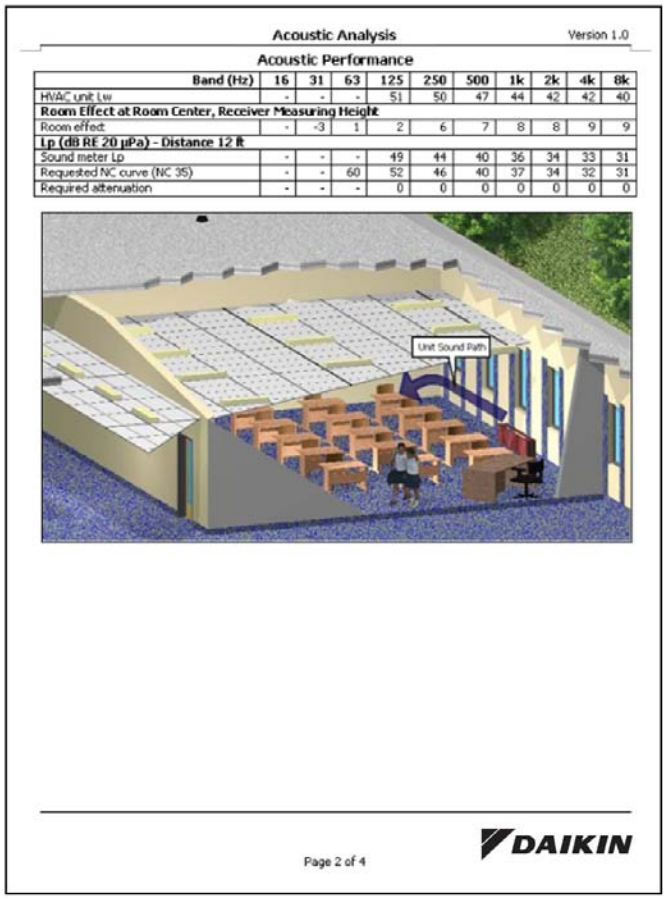


Getting a Copy

For a demo of the Acoustic Analyzer™ software, please visit www.DaikinApplied.com and follow these simple steps. Click on the Design Tools link from the left side bar. Click on the Software link from the drop down list. On the Software page, click on the Acoustic Analyzer™ Software Demo link.

To order a copy of the software, simply contact your local Daikin sales representative. Use the Sales Locator link on the Software page to find the closest Daikin sales Representative near you.



Acoustic Analysis — Version 1.0

Acoustic Performance

Band (Hz)	16	31	63	125	250	500	1k	2k	4k	8k
HVAC unit Lw	-	-	-	51	50	47	44	42	42	40
Room Effect at Room Center, Receiver Measuring Height										
Room effect	-	-3	1	2	6	7	8	8	9	9
Lp (dB RE 20 µPa) - Distance 12 ft										
Sound meter Lp	-	-	-	49	44	40	36	34	33	31
Requested NC curve (NC 35)	-	-	60	52	46	40	37	34	32	31
Required attenuation	-	-	-	0	0	0	0	0	0	0

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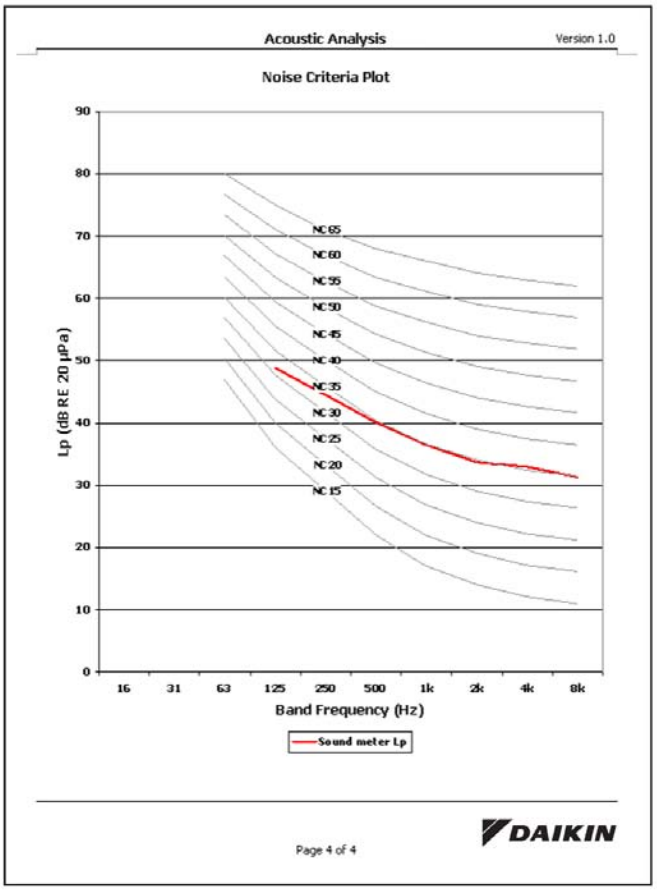

Acoustic Analysis — Version 1.0

Noise Criteria Plot

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Sound Power Fundamentals

What is the Difference between Sound and Noise?

Sound pressure is what causes our ear drums to vibrate and what is captured by a microphone to make an audio recording. “Noise” however, is what many people consider an annoyance, a distraction or even a painful reminder of excessive sound pressure. Noise, simply put, can cause an undesirable affect if not properly managed. However, this noise can create a subtle background sound level that can improve the indoor environmental quality if properly designed into the building.

In HVAC systems, noise can lead to uncomfortable indoor environmental quality. However, this same “noise” if properly controlled or attenuated can enhance the comfort of a building by creating subtle background noise. While other noises both inside and outside of the occupied space can affect the indoor noise levels, the HVAC system designer should strive to ensure that the noise levels produced by the HVAC system are appropriate for the space. To do so, the sound pressure must be determined.

What is Sound Pressure?

Sound pressure is a measure of the dynamic pressure that causes local pressure fluctuations in the air molecules. These fluctuations can be measured in Pascals (symbol is Pa) or when expressed in decibels (symbol is dB) the term is known as Sound Pressure Level. This pressure is what is measured by a microphone or perceived by our ear drums.

Sound pressure is very much dependent on the acoustic environment where it is measured or heard. As an example, a room with hard surfaces such as hardwood floors, gypsum wall boards and hard ceilings will have a significantly different measured sound pressure from a room with “soft” absorbent surfaces such as carpets, wall hangings and acoustic tile ceilings. Other factors include the effects of reflective surfaces, distance to the receiver or microphone, room surface treatments, the quantity and location of sound absorbing materials, physical barriers, and the influence of other sound sources in the space. All of these influences should be considered when assessing the acoustic performance of an HVAC system in a particular occupied space.

What is Sound Power?

Sound Power, Pac is a measure of the sonic energy over a unit of time for a given sound source emitted by the source in all directions. This represents the acoustic property of the sound source expressed in watts. Sound power expressed in decibels (dB) is known the Sound Power Level, L_w expressed in a very low base level of energy given as 0.000000000001 or 10^{-12} W.

Most important is that sound power is the acoustic “signature” of the particular sound source. This signature is totally independent of any affect that a room might have on the resulting sound pressure measured in that space.

Sound power is determined in a controlled acoustic environment under tightly controlled laboratory conditions. These laboratories can be reverberant or anechoic rooms with sophisticated sound intensity measurement instrumentation. Sound power can vary dramatically under different operating conditions such as fan speed, static pressure, compressor loading and thermal conditions under which the HVAC system is operating. For this reason, sound power is determined in accordance with ARI Sound Standards to ensure uniformity between different manufactures of similar equipment types. All reputable HVAC manufacturers should publish sound power data for their equipment to assist the system designer in assessing the resulting acoustic affect for a given application.

Table 1 provides a comparison between several different sound sources.

Table 1: Sound Power Sources

Situation and Sound Source	Sound Power P_{ac} watts	Sound Power Level L_w dB re 10^{-12} W
Rocket engine	1,000,000 W	180 dB
Turbojet engine	10,000 W	160 dB
Siren	1,000 W	150 dB
Heavy truck engine or loudspeaker rock concert	100 W	140 dB
Machine gun	10 W	130 dB
Jackhammer	1 W	120 dB
Excavator, trumpet	0.3 W	115 dB
Chain saw	0.1 W	110 dB
Helicopter	0.01 W	100 dB
Loud speech	0.001 W	90 dB
Usual talking	10^{-5} W	70 dB
Refrigerator	10^{-7} W	50 dB

What is the difference between Sound Pressure and Sound Power?

Understanding the difference between sound pressure and sound power is very important when assessing the acoustical performance of the HVAC system. As mentioned above, sound power is the acoustic signature of the equipment, while sound pressure is the resulting measure of what your ear will hear. From the sound power data provided by the manufacturer, an acoustic analysis can be performed using software tools such as the Acoustic Analyzer™. Sound power data is entered into the acoustic analysis tool along with the room properties to calculate the resulting room sound pressure level.

Noise Criteria (NC) and Room Criteria (RC)

In order to understand the potential effect of HVAC-related sound on the building occupants, several criteria have been established to rate or measure the sound to determine its acceptability. To do so, an estimate of both the perceived loudness and the sound quality of the noise should be understood. By using the calculated sound pressure level, the Noise Criteria (NC) or Room Criteria (RC) can be used to determine its acceptability depending on the nature of the application and the desired effect. In general, NC is a single-number rating that is somewhat sensitive to the relative loudness and speech interference properties of a given sound spectrum[2]. The RC method is a family of criterion curves and a rating procedure that assesses background noises in spaces, both on the basis of its effect on speech, and on subjective sound quality[3]. Both criteria have advantages and disadvantages when attempting to characterize HVAC system generated background noise. The HVAC designer should become fully knowledgeable of the assessment criteria and desired outcome before drawing conclusions regarding the suitability of any solution or a given application. In some cases, seeking the advice of a professional acoustical consultant may be necessary to achieve the desired acoustic performance for the application.

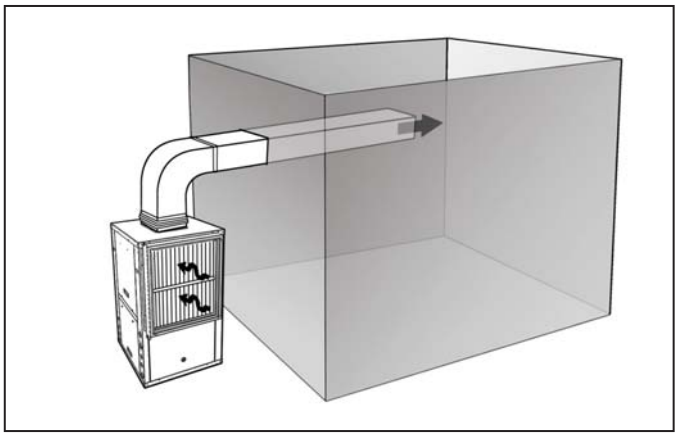
Sound Rating Standards

Standard AHRI 260-2001 - Sound Rating of Ducted Air Moving and Conditioning Equipment

Several AHRI standards have been developed to ensure that HVAC manufacturers, who choose to follow the standard, can provide sound power data in accordance documented requirements and recognized industry procedures. The purpose of Standard AHRI 260-2001 is to establish a method of sound rating the indoor portions of ducted air moving and conditioning equipment and to provide definitions; requirements for acquiring mapped sound data; Sound Power Level calculations and ratings; minimum data requirements for published sound ratings; and conformance conditions[4]. As a result, Daikin can provide industry recognized sound power levels to assist HVAC designers in assessing the acoustic performance of the HVAC system.

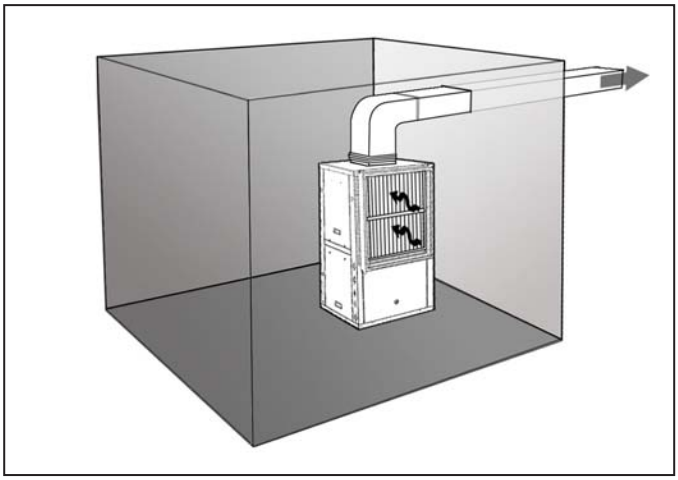
AHRI 260-2001 has been used to establish the radiated sound power levels for a horizontal or vertical water source heat pump for several different return and discharge air configurations. One of the most common configurations for water source heat pumps is known as the “ducted discharge”. This best represents a typical furred-in application similar to a residential condo, college dormitory or high-rise hotel installation with the return air register located in an adjoining space and where the supply air is ducted into the occupied space. The typical free inlet test setup for ducted discharge arrangements is shown in Figure 2.

Figure 2: Typical Free Inlet Test Set-up for “Ducted Discharge” Applications



Another common configuration has the water source heat pump unit located in a mechanical closet adjacent to the occupied space. A measure of the sound levels inside the mechanical space can be best determined using the free inlet combined with the casing radiated configuration. The test setup for this is shown in Figure 3.

Figure 3: Typical Free Inlet Combined with Casing Radiated Test Set-up



[2] 2007 ASHRAE Handbook – HVAC Applications, Sound and Vibration Control, “NC: Noise Criteria Method” page 47.31

[3] 2007 ASHRAE Handbook – HVAC Applications, Sound and Vibration Control, “RC: Room Criteria Method” page 47.31

[4] Standard AHRI 260-2001 - Sound Rating of Ducted Air Moving and Conditioning Equipment, Section 1.1 Purpose

Sound Performance - Paying Attention to the Details

Quiet HVAC equipment does not just happen. It's designed and built into every unit. Daikin's SmartSource Water Source Heat Pump quiet operation comes from decades of HVAC equipment expertise, rigorous attention to details and tenacious acoustic testing right from the start. The smallest of acoustic design details for each new product are painstakingly evaluated from an acoustic signature perspective. Acoustic evaluations take place in Daikin's reverberant sound lab to ensure the proper attention is given to the acoustic details of each new product.

Daikin's SmartSource Water Source Heat Pumps include many acoustic enhancements to minimize sound levels where it is needed the most.

Double Vibration Isolation

Provided as standard, the compressor mount has a unique dual-level vibration isolation system. The compressor is mounted on vibration isolation grommets resting on a heavy gauge mounting plate, and then isolated from the cabinet base with rubber grommets to minimize vibration transfer. The compressor is equipped with thermal overload protection and is located in a well-insulated compartment away from the air stream to minimize sound transmission.

Figure 10: Dual-Level Vibration Isolation System

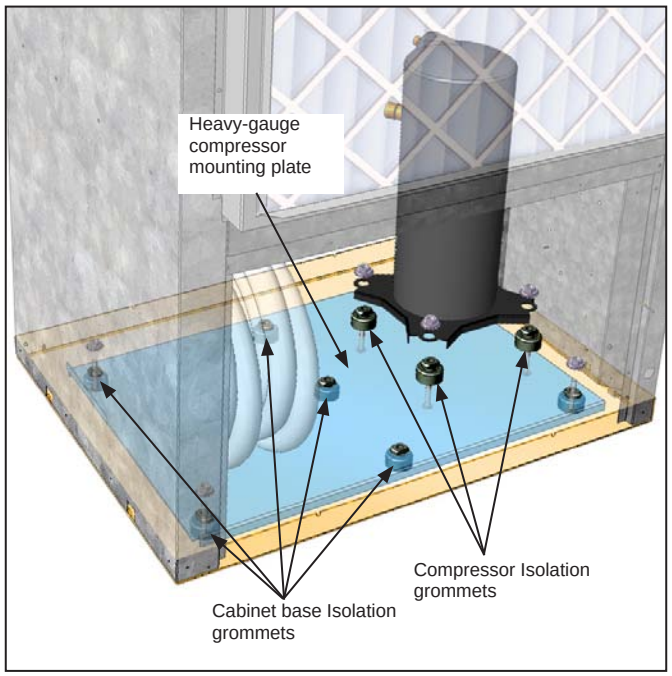


Figure 11: MicroTech III SmartSource Unit Controller & I/O Expansion Module

Smart Airflow Control

Since most of the operating hours are under part load conditions, the SmartSource unit will remain quieter, longer due to its Smart Airflow Control. Using the MicroTech III SmartSource controls combined with an intelligent ECM fan motor, the SmartSource units will reduce the air flow as the room temperature approaches setpoint conditions. Lower air flow means lower sound levels for most operating hours.

ECM Fans for Low Static Applications

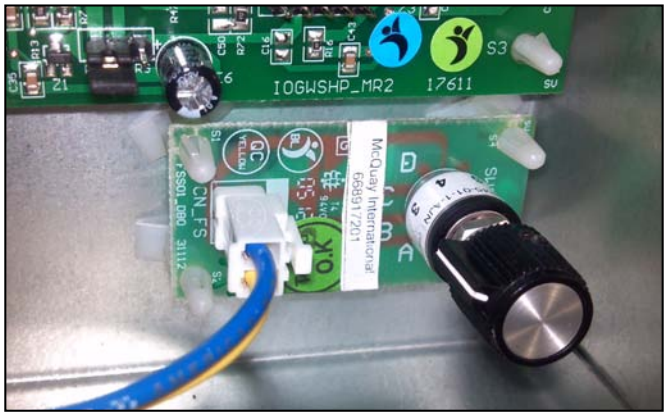
Fan systems using PSC motors will get louder under low static conditions due to increased motor speeds. However, the SmartSource units with ECM fan motors will get quieter in low static applications. The ECM used on the SmartSource units size 015 and larger are smart enough to know their current draw and RPM to ensure that a constant air flow is delivered regardless of the static pressure. As the static pressure is reduced, so is the fan speed. When the fan speed is reduced, so are the sound levels. To ensure quiet system operation for low static applications, smart ECM fan motors are used on all SmartSource units.

Figure 12: ECM Motor

Field Adjustable ECM Fan Motors

If noise levels are too high, simply turning a 4-position knob located in the unit will allow the user to select a lower air flow setting. Lower air flow means lower sound levels. Each SmartSource unit is equipped with field adjustable air flow settings as standard.

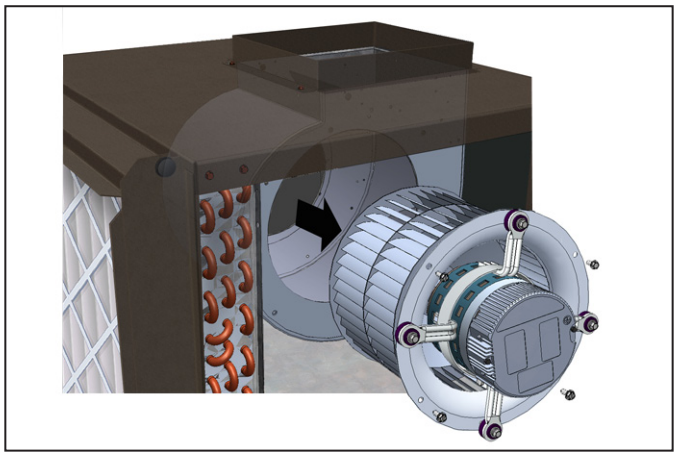
Figure 13: Adjustable fan speed rotary switch



4-Legged Fan Mount

Rigorous laboratory test revealed an opportunity to reduce the fan sound levels. A special 4-legged fan mount, provided on some SmartSource units, reduces vibrations between the fan motor and blower housing. This further reduces fan born sound levels.

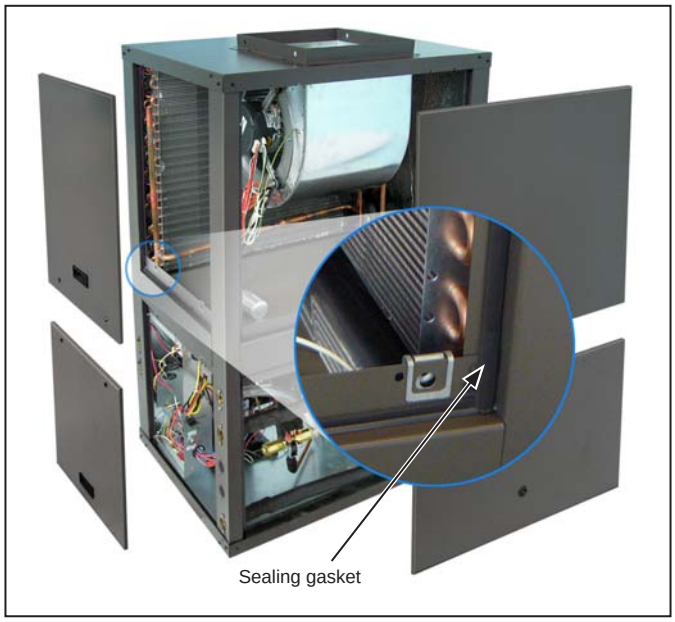
Figure 14: 4-Legged Motor Mount



Acoustically Sealed Access Panels

Heavy gauge sheet metal panels with a durable baked-on powder coating are isolated from the fan and compressor compartments with a sealing gasket. Providing a near water tight seal ensures that noise levels are contained within the unit and not allowed to escape to the surroundings.

Figure 15: Acoustically Sealed Panels



Premium Sound Package

An optional sound reduction kit adds a 3/4” thick acoustic foam panel of insulation to the fan section and a compressor blanket to help further reduce operating sound levels.

Figure 16: Sound Package

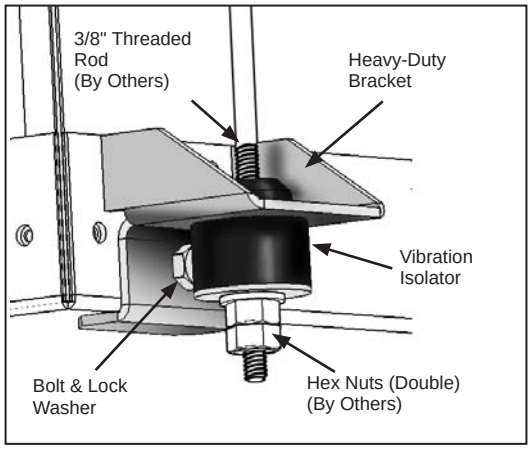
Field Installation Guidelines

It is always important to ensure that each unit is installed with the utmost attention to detail. Most importantly, follow the manufacturer's installation instructions! These installation guidelines should be followed to minimum vibration transmission to the building structure and to minimize discharge air and casing radiated sound levels.

Vibration Isolation Hanger Kits

Each horizontal unit is furnished with a mounting kit that includes heavy metal hanger brackets for hanging the unit from field-supplied hanger rods. Rubber isolators are included for sound and vibration attenuation, as are mounting washers, bolts and lock washers. The hangers are attached to fasteners at each corner of the unit, which are an integral part of the cabinet.

Figure 4: Hanger Brackets



Ductwork Attenuation

Suggested duct layout for multiple diffuser application

- All ductwork should conform to industry standards of good practice as described in ASHRAE Systems Guide.
- Ductwork is normally applied to ceiling, closet or floor mounted heat pumps on the discharge of the unit.
- A discharge collar is provided on all models to facilitate ductwork connection. The inclusion of a canvas connector is recommended between the discharge collar and duct transformation (enlargement). The preferred configuration for ceiling models, a horizontal transformation, typically requires a duct depth similar to the vertical dimension of the unit collar.
- The heat pump location must allow the incorporation of an elbow, without turning vanes, after the transformation from discharge collar to full trunk duct to interrupt line-of-sight propagation of sound rays. One inch (25mm) acoustic duct lining should extend in both directions for a distance of at least two equivalent duct diameters.
- For maximum attenuation, the last five equivalent duct diameters before each air outlet (register) should be lined with one inch (25mm) acoustic duct liner.
- Elbows, tees or dampers create turbulence and distortion in the airflow. A straight length of 5 to 10 equivalent duct diameters is recommended to smooth out flow before the next fitting or terminal. Take-off of diffuser necks directly from the bottom of a trunk duct produces noise. If utilizing volume control dampers, locate them several equivalent duct diameters upstream from the air outlet.
- For a hotel, motel, dormitory or nursing home application, using a single duct register discharge from one machine, a maximum velocity of 500 to 600 fpm (2.54 to 3.048 m/s) is suggested. These applications involve system static pressures as low as 0.05 inches of water (0.012 kPa) and relatively short duct lengths. Discharge duct must include full lining and a square elbow without turning vanes. Return air for these applications should enter through a low side wall filter-grille and route up the stud space to ceiling plenum. Return air ceiling grilles are not recommended.
- For horizontal type heat pumps mounted in a suspended ceiling, an acoustic attenuator can be placed at the air inlet to attenuate line-of-sight sound transmission through return openings, see Figure 7.
- For closet mounted heat pumps with return air through louvered doors, avoid line-of-sight connection between rear of louvers and air inlet to heat pump for maximum sound attenuation. Louver section should be boxed in and lined with one inch (25mm) acoustic material if louver space does not permit a break in line-of-sight transmission.
- Unit must be located on top of a vibration absorbing material such as a rubber (Isolation pad) that is the same size as the base of the unit, to minimize vibration and noise (Figure 6).

Alternatively, the unit can have a ducted return air with the opening facing the door and the major access panels facing 90° to the door.

Figure 5: Typical Vertical Unit Closet Installation

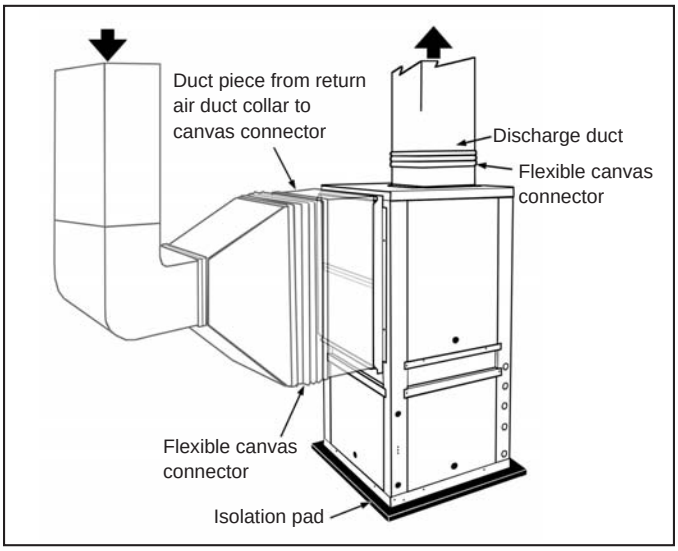
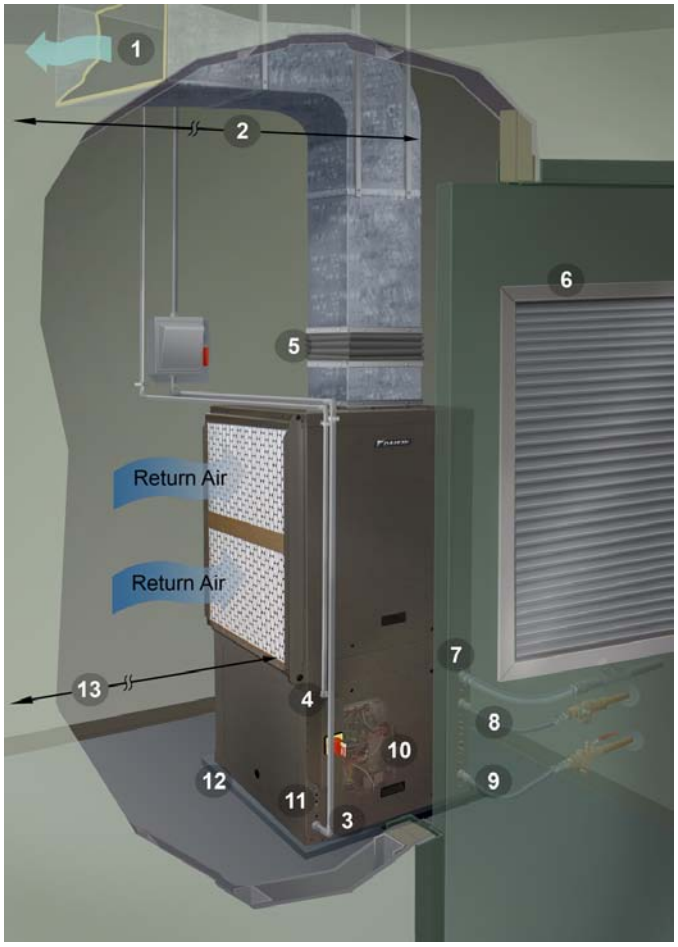
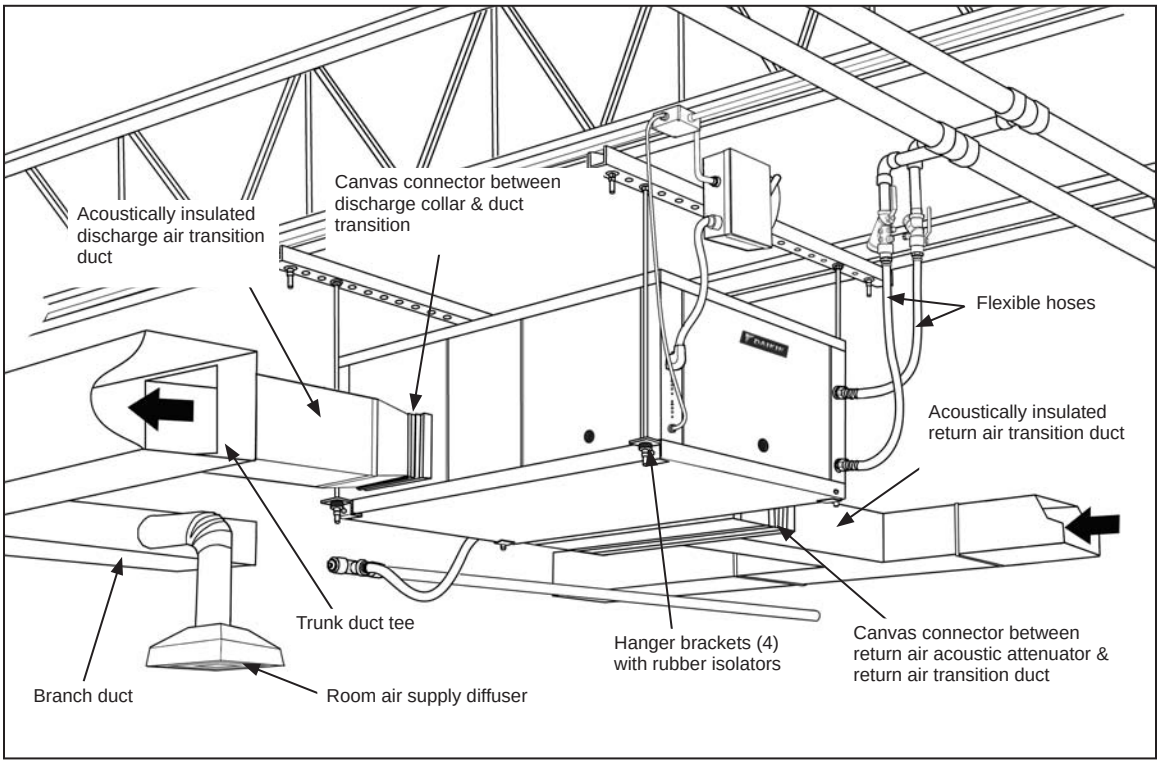


Figure 6: Vertical Unit - Typical Installation in Small Mechanical Room or Closet



1 - Supply Air Ducting
2 - Acoustical Thermal Lining (10 ft.)
3 - Line Voltage - 7/8" (22 mm) Hole
4 - Low Voltage - 7/8" (22 mm) Hole
5 - Flexible Duct Collar
6 - Louvered Door for Return Air
7 - Condensate Drain Connection
8 - Flexible Return Hose with Flow Controller/Ball Valve (3/4" FPT)
9 - Flexible Supply Hose with Y-Strainer/Ball Valve (3/4" FPT)
10 - Access Panel to Controller
11 - LED Annunciator Status Lights
12 - Vibration Isolation Pad

Figure 7: Typical Ceiling Unit Installation



Hoses & Hose Kits

Daikin sells a variety of flexible supply, return and condensate hoses and hose assemblies for connecting its water source heat pumps to a building's hard piping system.

Piping systems should include supply and return shutoff valves in the design to allow removal of a unit without the need to shut down the entire heat pump system.

Figure 8: Supply and Return Hoses

Supply and return hoses have a swivel fitting at one end to facilitate removal of the unit for replacement or service.

Standard supply and return fire-rated hoses have either a thermoplastic rubber or synthetic polymer core with a braided covering of stainless steel. Fittings are either plated steel or brass.

Figure 9: Flexible, Steel Braided Supply and Return Hose

For condensate piping, Daikin offers flexible vinyl hose, steel braided hose or a long, clear, plastic hose with the necessary clamps for connection to the field piping. In most cases the use of plastic hose eliminates the need for insulation to be wrapped around the pipe to prevent sweating.

A threaded, factory-supplied condensate fitting allows the connection of PVC, flexible vinyl hose or steel braided hose. The condensate piping must be trapped at the unit and pitched away from the unit not less than 1/4" per foot.

Model GSH, GSV with ECM Motor(3)

Table 2: Sound Power Data – SmartSource Single Stage Horizontal and Vertical Water Source Heat Pump

Unit Size	Operating Mode[2] (High Speed)	ARI-260 Sound Data, Sound Power (dB) re 1 pW															
		Ducted Discharge[3] Octave Band Frequency, Hz								Free Inlet & Case Radiated[4] Octave Band Frequency, Hz							
		125	250	500	1000	2000	4000	8000	dB "A" 1 pu	125	250	500	1000	2000	4000	8000	dB "A" 1 pu
007	Fan Only	50	45	50	50	48	44	44	54.6	52	49	48	48	45	42	43	52.4
	Cooling	54	49	50	50	48	44	44	54.6	66	56	51	48	44	42	42	55.1
	Heating	53	49	50	50	47	43	43	54.3	65	58	49	48	45	42	43	55.3
009	Fan Only	52	47	54	52	50	46	47	57.3	53	50	52	50	47	44	45	54.8
	Cooling	56	50	52	52	50	46	47	57.1	66	57	52	49	47	44	44	56.2
	Heating	54	50	55	52	50	46	46	57.5	65	58	54	50	47	45	45	56.9
012	Fan Only	54	48	54	55	53	49	49	59.3	60	52	51	51	49	47	47	56.4
	Cooling	57	50	54	55	52	49	49	59.2	66	57	52	51	49	46	46	57.4
	Heating	55	50	54	55	52	49	49	59.2	65	58	52	52	49	47	47	57.7
015	Fan Only	43	43	44	42	35	30	34	45.7	46	46	45	44	32	26	33	47.0
	Cooling	57	48	44	42	38	34	35	47.8	68	57	47	47	38	32	35	54.5
	Heating	66	53	49	46	40	34	34	52.9	68	61	54	57	45	36	35	60.7
019	Fan Only	43	43	45	43	36	30	33	46.4	45	46	45	44	36	29	33	47.4
	Cooling	57	50	48	47	43	37	35	51.7	68	56	50	49	43	36	36	55.8
	Heating	65	55	52	51	45	39	34	55.9	67	60	55	58	49	41	37	60.9
024	Fan Only	47	45	40	43	38	31	29	46.0	46	45	46	43	37	27	28	47.2
	Cooling	57	53	51	53	50	44	36	56.5	59	52	54	52	48	42	35	56.4
	Heating	58	53	49	52	50	45	36	56.1	66	54	56	53	50	44	37	58.2
030	Fan Only	52	50	46	49	47	42	34	53.2	54	50	52	50	46	40	36	54.3
	Cooling	64	58	54	58	58	55	46	63.1	68	57	59	57	56	51	42	62.4
	Heating	62	58	53	58	57	54	46	62.5	69	57	59	57	56	52	43	62.9
036	Fan Only	54	50	48	52	46	42	32	54.4	55	49	50	48	43	38	32	51.9
	Cooling	64	57	57	59	57	54	46	63.5	64	57	58	56	53	50	42	60.8
	Heating	63	59	57	59	56	53	44	63.1	69	57	58	56	54	51	44	61.7
042	Fan Only	51	48	46	50	44	38	30	52.3	58	51	50	51	46	38	30	54.1
	Cooling	60	55	54	57	55	52	45	61.3	68	59	58	57	57	51	42	62.5
	Heating	64	57	55	57	56	52	45	61.9	72	61	59	58	58	52	44	63.9
048	Fan Only	54	49	49	51	47	43	35	54.4	59	52	51	51	48	41	32	55.2
	Cooling	63	58	57	59	59	57	50	64.7	69	61	59	58	59	53	44	63.9
	Heating	66	61	58	60	59	56	50	65.0	71	62	60	59	59	54	47	65.0
060	Fan Only	53	48	50	51	45	41	34	53.6	61	54	51	51	47	43	36	55.2
	Cooling	67	60	60	61	59	56	49	65.5	72	66	61	61	60	57	51	66.6
	Heating	68	59	61	62	58	55	47	65.4	79	68	63	62	61	58	53	68.5
070	Fan Only	59	53	54	55	51	48	41	58.6	66	59	55	54	53	49	42	59.8
	Cooling	73	66	65	66	64	62	56	70.5	77	71	65	65	65	62	57	71.4
	Heating	72	64	66	66	62	60	54	70.1	78	70	64	65	64	63	58	71.1

Notes: *1. Cooling and heating conditions per ISO Standard 13256-1 water-loop rating conditions for 2-inch filter.*

2. Data based on sound measurements made in a reverberant room on representative units, 0.1" static pressure.

3. ECM motors are programmed for soft starts and stops to reduce sound levels. For WGSH,V 007-012 units, torque is automatically maintained over a wide range of external static pressure for quiet operation. For WGSH,V 015-070 units, speed and torque is automatically adjusted to deliver constant airflow over a wide range of external static pressure for quiet operation.

Table References:

[2] Data is based on fan setting 2.

[3] In accordance with ARI 260-2001, Section 4.5.5 "Free Inlet or Free Discharge".

[4] In accordance with ARI 260-2001, Section 4.5.3 "Free Inlet (or Free Discharge) Combined with Casing Radiated Test".

Model WGTH, WGTV with ECM Motor(3)

Table 3: Sound Power Data – SmartSource Two Stage Horizontal and Vertical Water Source Heat Pump

Unit Size	Operating Mode[2]		ARI-260 Sound Data, Sound Power (dB) re 1 pW															
			Ducted Discharge[3] Octave Band Frequency, Hz								Free Inlet & Case Radiated[4] Octave Band Frequency, Hz							
			125	250	500	1000	2000	4000	8000	dB "A" 1 pu	125	250	500	1000	2000	4000	8000	dB "A" 1 pu
026	Fan Only		47	45	40	43	38	31	29	46.0	46	45	46	43	37	27	28	47.2
	Cooling	Part Load	53	51	48	50	46	39	32	52.9	56	52	53	50	45	38	34	54.3
		Full Load	57	53	51	53	50	44	36	56.5	59	52	54	52	48	42	35	56.4
	Heating	Part Load	53	50	46	49	46	40	32	52.5	58	51	59	51	46	39	34	57.1
		Full Load	58	53	49	52	50	45	36	56.1	66	54	56	53	50	44	37	58.2
032	Fan Only		52	50	46	49	47	42	34	53.2	54	50	52	50	46	40	36	54.3
	Cooling	Part Load	58	54	51	55	54	51	42	59.7	64	56	56	55	52	47	38	59.6
		Full Load	64	58	54	58	58	55	46	63.1	68	57	59	57	56	51	42	62.4
	Heating	Part Load	58	55	50	55	54	50	41	59.4	63	55	60	55	53	48	40	60.6
		Full Load	62	58	53	58	57	54	46	62.5	69	57	59	57	56	52	43	62.9
038	Fan Only		54	50	48	52	46	42	32	54.4	55	49	50	48	43	38	32	51.9
	Cooling	Part Load	58	52	51	54	50	47	39	57.6	58	54	59	53	48	43	37	57.9
		Full Load	64	57	57	59	57	54	46	63.5	64	57	58	56	53	50	42	60.8
	Heating	Part Load	58	54	52	55	51	46	37	57.9	61	54	56	53	49	44	38	57.7
		Full Load	63	59	57	59	56	53	44	63.1	69	57	58	56	54	51	44	61.7
044	Fan Only		51	48	46	50	44	38	30	52.3	58	51	50	51	46	38	30	54.1
	Cooling	Part Load	58	53	51	54	51	48	40	57.8	68	60	57	55	53	47	38	60.4
		Full Load	60	55	54	57	55	52	45	61.3	68	59	58	57	57	51	42	62.5
	Heating	Part Load	61	54	52	54	52	47	39	58.4	74	59	61	55	55	48	40	63.2
		Full Load	64	57	55	57	56	52	45	61.9	72	61	59	58	58	52	44	63.9
049	Fan Only		54	49	49	51	47	43	35	54.4	59	52	51	51	48	41	32	55.2
	Cooling	Part Load	64	58	56	58	55	52	45	62.0	66	59	58	55	55	49	40	61.2
		Full Load	63	58	57	59	59	57	50	64.7	69	61	59	58	59	53	44	63.9
	Heating	Part Load	63	57	56	57	55	52	45	61.5	75	61	60	56	56	50	42	63.9
		Full Load	66	61	58	60	59	56	50	65.0	71	62	60	59	59	54	47	65.0
064	Fan Only		53	48	50	51	45	41	34	53.6	61	54	51	51	47	43	36	55.2
	Cooling	Part Load	62	56	56	57	54	51	44	61.3	69	62	58	57	56	52	46	62.8
		Full Load	67	60	60	61	59	56	49	65.5	72	66	61	61	60	57	51	66.6
	Heating	Part Load	65	55	58	58	54	51	42	61.7	80	64	60	58	57	54	48	66.5
		Full Load	68	59	61	62	58	55	47	65.4	79	68	63	62	61	58	53	68.5
072	Fan Only		59	53	54	55	51	48	41	58.6	66	59	55	54	53	49	42	59.8
	Cooling	Part Load	69	61	61	62	59	57	51	66.3	74	67	62	61	61	57	52	67.4
		Full Load	73	66	65	66	64	62	56	70.5	77	71	65	65	65	62	57	71.4
	Heating	Part Load	70	60	62	62	59	56	50	66.2	78	68	62	61	61	58	54	68.5
		Full Load	72	64	66	66	62	60	54	70.1	78	70	64	65	64	63	58	71.1

Notes: *1. Cooling and heating conditions per ISO Standard 13256-1 water-loop rating conditions for 2-inch filter.*

2. Data based on sound measurements made in a reverberant room on representative units, 0.1" static pressure.

3. ECM motors are programmed for soft starts and stops to reduce sound levels. For WGTH,V units, speed and torque is automatically adjusted to deliver constant airflow over a wide range of external static pressure for quiet operation.

Table References:

[2] Data is based on fan setting 2.

[3] In accordance with ARI 260-2001, Section 4.5.5 "Free Inlet or Free Discharge".

[4] In accordance with ARI 260-2001, Section 4.5.3 "Free Inlet (or Free Discharge) Combined with Casing Radiated Test".

Model GSH, GSV with ECM Motor(3) Premium Sound Package(4)

Table 4: Sound Power Data – SmartSource Single Stage Horizontal and Vertical Water Source Heat Pump

Unit Size	Operating Mode[2] (High Speed)	ARI-260 Sound Data, Sound Power (dB) re 1 pW															
		Ducted Discharge[3] Octave Band Frequency, Hz								Free Inlet & Case Radiated[4] Octave Band Frequency, Hz							
		125	250	500	1000	2000	4000	8000	dB "A"	125	250	500	1000	2000	4000	8000	dB "A"
024	Fan Only	49	45	40	44	38	30	29	46	46	45	45	42	34	26	29	46
	Cooling	58	54	51	54	49	42	34	57	59	52	53	51	45	40	35	55
	Heating	61	54	49	53	48	44	34	56	65	53	55	51	47	42	36	57
030	Fan Only	53	51	45	50	46	41	34	53	55	50	51	49	44	38	37	53
	Cooling	66	59	54	58	56	53	45	62	66	57	57	56	53	49	41	61
	Heating	64	59	53	58	55	52	44	62	68	57	58	56	53	50	43	61
036	Fan Only	55	51	48	52	46	42	32	55	56	49	50	47	40	37	33	51
	Cooling	66	58	57	60	56	52	44	63	63	57	57	54	50	48	41	59
	Heating	65	59	56	59	55	51	43	63	68	57	56	55	51	49	44	60
042	Fan Only	52	48	45	50	43	37	30	52	58	52	50	50	43	37	31	53
	Cooling	62	56	54	58	53	50	43	61	67	59	56	55	54	49	41	61
	Heating	65	57	55	58	55	50	43	62	71	61	57	56	55	50	43	62
048	Fan Only	56	50	48	51	46	43	36	54	59	52	50	50	45	40	33	54
	Cooling	65	59	57	59	58	55	49	64	69	61	57	56	56	52	44	62
	Heating	68	61	58	60	58	55	48	65	70	62	58	57	57	53	46	63
060	Fan Only	54	49	50	51	44	41	34	54	62	54	50	50	44	42	37	55
	Cooling	68	61	60	61	57	54	48	65	71	66	60	59	58	55	50	65
	Heating	71	59	61	62	56	53	45	65	78	68	61	60	58	57	53	68
070	Fan Only	60	53	53	56	51	47	41	59	67	59	54	53	50	48	44	59
	Cooling	75	67	65	67	62	60	54	70	77	71	64	63	62	61	56	70
	Heating	74	65	65	67	61	59	52	70	77	70	62	63	61	61	57	70

Notes: *1. Cooling and heating conditions per ISO Standard 13256-1 water-loop rating conditions for 2-inch filter.*

2. Data based on sound measurements made in a reverberant room on representative units, 0.1" static pressure.

3. ECM motors are programmed for soft starts and stops to reduce sound levels. For WGSH,V 024-070 units, speed and torque is automatically adjusted to deliver constant airflow over a wide range of external static pressure for quiet operation.

4. Sound package includes sound attenuating compressor blanket.

Table References:

[2] Data is based on fan setting 2.

[3] In accordance with ARI 260-2001, Section 4.5.5 "Free Inlet or Free Discharge".

[4] In accordance with ARI 260-2001, Section 4.5.3 "Free Inlet (or Free Discharge) Combined with Casing Radiated Test".

Model WGTH, WGTV with ECM Motor(3) Premium Sound Package(4)

Table 5: Sound Power Data – SmartSource Two Stage Horizontal and Vertical Water Source Heat Pump

Unit Size	Operating Mode[2]		ARI-260 Sound Data, Sound Power (dB) re 1 pW															
			Ducted Discharge[3] Octave Band Frequency, Hz								Free Inlet & Case Radiated[4] Octave Band Frequency, Hz							
			125	250	500	1000	2000	4000	8000	dB "A"	125	250	500	1000	2000	4000	8000	dB "A"
026	Fan Only		49	46	39	44	38	31	30	46	47	45	45	42	34	26	29	46
	Cooling	Part Load	54	51	48	50	45	38	32	53	56	52	52	49	42	37	35	53
		Full Load	59	54	51	53	48	42	34	56	58	53	53	50	45	40	35	55
	Heating	Part Load	54	50	45	49	45	40	32	52	57	52	58	49	43	38	35	57
		Full Load	61	53	48	52	48	44	34	56	65	54	55	51	47	42	36	57
032	Fan Only		53	51	45	50	47	41	34	53	54	50	51	49	44	38	37	53
	Cooling	Part Load	59	55	51	56	53	50	42	60	63	56	56	54	50	46	39	58
		Full Load	65	59	54	58	56	53	44	62	67	57	57	55	53	49	41	61
	Heating	Part Load	60	56	50	55	53	50	42	59	63	55	60	54	50	47	41	60
		Full Load	65	59	53	58	56	52	44	62	68	58	57	56	53	50	42	61
038	Fan Only		55	51	47	52	45	41	33	54	55	49	50	47	40	37	34	51
	Cooling	Part Load	60	53	51	55	49	46	39	58	59	54	58	52	45	41	39	57
		Full Load	66	58	57	59	56	52	44	63	63	58	57	55	50	48	41	59
	Heating	Part Load	59	55	51	55	50	46	38	58	62	53	56	52	46	43	39	57
		Full Load	65	59	57	59	55	51	43	63	68	57	56	55	52	50	44	60
044	Fan Only		52	49	45	50	44	38	30	52	58	52	50	50	43	37	31	53
	Cooling	Part Load	59	54	50	54	51	47	41	58	68	60	56	54	51	45	39	60
		Full Load	62	56	54	57	54	50	42	61	67	60	56	55	54	49	41	61
	Heating	Part Load	62	55	52	55	51	47	39	59	73	59	61	54	52	47	42	62
		Full Load	66	58	55	58	54	50	43	61	71	61	57	56	55	50	44	62
049	Fan Only		55	50	48	52	47	42	36	55	59	52	51	50	45	40	34	54
	Cooling	Part Load	65	58	55	58	55	52	45	62	66	59	58	54	52	47	42	60
		Full Load	65	60	57	59	57	55	49	64	68	60	57	56	56	52	43	62
	Heating	Part Load	65	57	55	57	54	52	46	61	76	62	59	56	53	49	43	64
		Full Load	68	62	58	60	57	54	47	65	70	62	58	57	56	53	45	63
064	Fan Only		54	48	49	51	44	41	35	54	62	54	51	50	44	42	38	55
	Cooling	Part Load	64	56	55	57	54	51	44	61	70	62	57	56	53	51	47	62
		Full Load	69	61	60	61	57	54	47	65	71	66	59	59	57	55	51	65
	Heating	Part Load	67	55	57	58	53	50	43	62	81	63	59	57	54	52	50	67
		Full Load	70	59	61	62	56	53	46	65	78	68	61	60	58	56	53	67
072	Fan Only		61	53	53	55	50	47	41	59	66	59	54	53	50	48	44	59
	Cooling	Part Load	70	62	60	62	59	57	51	66	73	67	61	61	58	56	54	67
		Full Load	75	67	64	67	62	60	54	70	77	72	63	64	62	61	57	70
	Heating	Part Load	71	60	61	63	58	56	50	67	78	67	62	60	58	57	54	68
		Full Load	75	65	65	67	61	59	51	70	78	71	62	63	61	61	57	70

Notes: *1. Cooling and heating conditions per ISO Standard 13256-1 water-loop rating conditions for 2-inch filter.*

2. Data based on sound measurements made in a reverberant room on representative units, 0.1" static pressure.

3. ECM motors are programmed for soft starts and stops to reduce sound levels. For WGTH,V units, speed and torque is automatically adjusted to deliver constant airflow over a wide range of external static pressure for quiet operation.

4. Sound package includes sound attenuating compressor blanket.

Table References:

[2] Data is based on fan setting 2.

[3] In accordance with ARI 260-2001, Section 4.5.5 "Free Inlet or Free Discharge".

[4] In accordance with ARI 260-2001, Section 4.5.3 "Free Inlet (or Free Discharge) Combined with Casing Radiated Test".

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