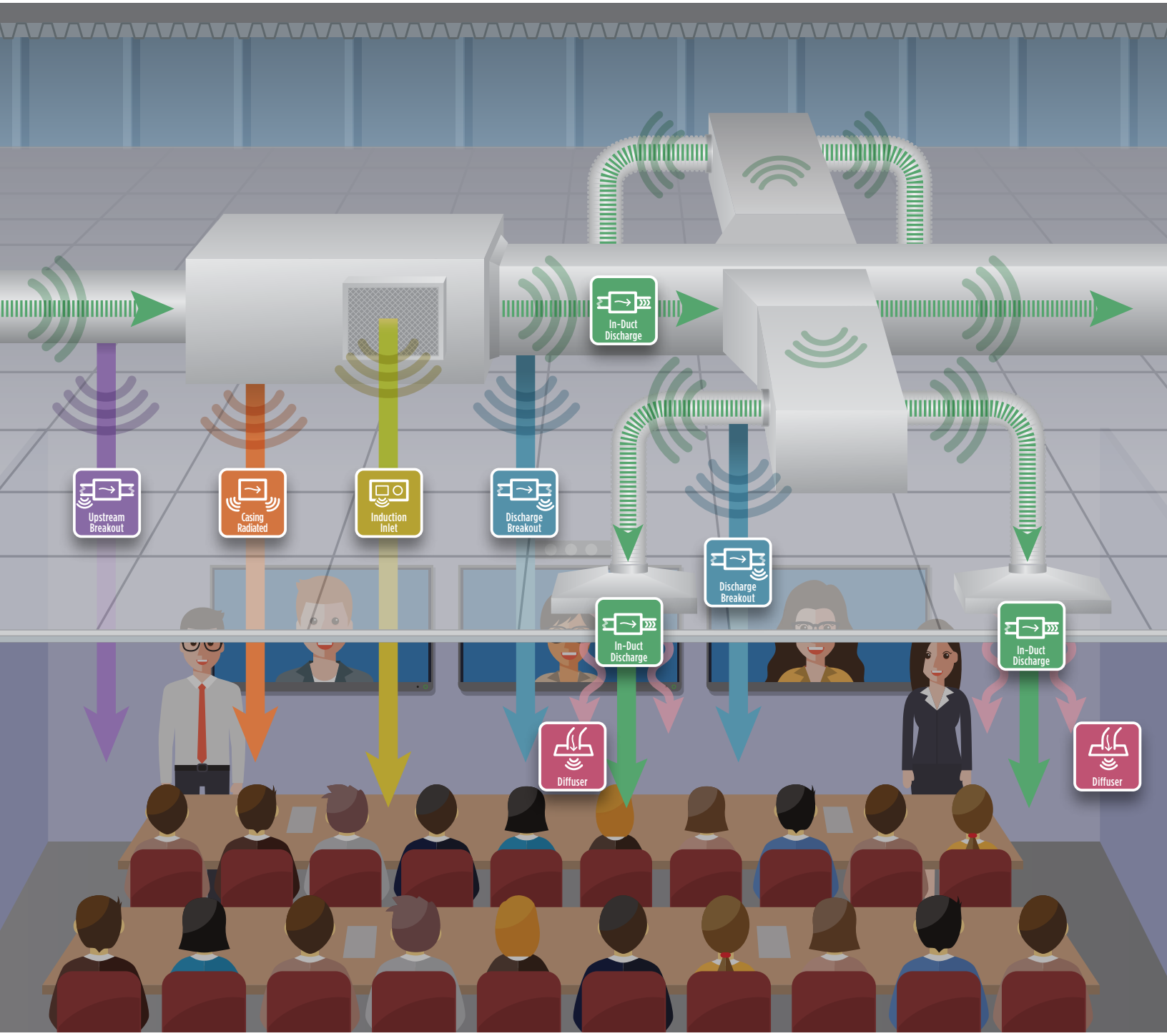
HUSHCORE® Systems for Air Terminal Unit (ATU) Applications

Comprehensive System Solutions for Duct Borne and Casing Radiated Sound Reduction

BRD Noise and Vibration Control, Inc. | HUSH CORE®

Air Terminal Unit (ATU) Problem Definition for Fan Powered Variable Air Volume (FPVAV) Acoustic Model



Multi-Path System Problems Require Comprehensive System Solutions

BRD HUSHCORE® Solutions have been helping keep Business, Education, Healthcare and Entertainment facilities quiet, inside and outside, since 1975.

ATU Noise Transmission Paths

Casing Radiated Noise
Radiated Noise from the ATU cabinet/casing is often a primary contributing source to the spaces directly below. Care should be taken to locate ATUs away from ceiling return air grilles for plenum return applications.

Induction Inlet Noise
Induction Inlet Noise is a primary contributing source for units with induction air openings. Drawing air directly from the ceiling plenum, they have only a thin particulate filter to deter noise radiation at the opening.

In-Duct Discharge Noise
ATU Discharge Noise travels downstream in the discharge ductwork. Discharge Noise is a product of air turbulence through the box valves regulating air volume based on room demand. Fan Powered units usually have a Forward Curved (FC) fan producing fan noise at the unit discharge.

Discharge Breakout Noise
Duct Breakout Noise can take place anywhere in the ductwork upstream or downstream of the ATU. It is the sound passing through the walls of the ductwork radiating to building spaces below. Ductwork resistivity to Breakout Noise is a function of the wall mass, duct component shape, profile and size. Breakout Noise in ATU applications is greatest on the discharge/outlet side of the unit in the first 6′ to 8′ of ductwork.

Upstream Breakout Noise
Duct Breakout Noise upstream of the ATU is a secondary contributing source in most applications. The air valve modulating airflow at the ATU inlet can cause regenerated noise from turbulence that breaks out upstream of the unit. Residual RTU noise can also breakout in the upstream ductwork.

Diffuser Noise
Diffuser Noise comes from two sources. All residual noise traveling in-duct on the discharge side of the air terminal box will dump into the occupied space at supply diffuser locations. Return grilles are usually secondary contributors except where open to the plenum in close proximity to plenum mounted equipment. Regenerated noise is the second source emitting at diffusers caused by turbulence attributable to discontinuities through the typical flex duct runs attaching to the throat of the diffuser grille.

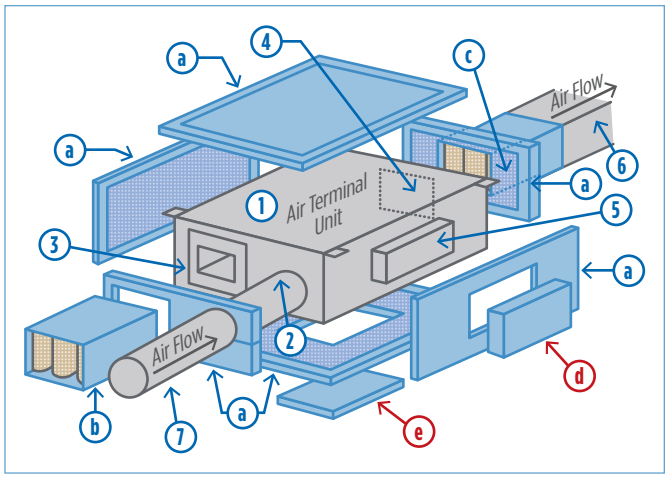
HUSHCORE® *Premium*™, *Supreme*™ or *Zenith*™ System Solutions can address several of these paths - *for more details see pages 4 - 5.*

From Problem Definition... to Problem Solved.

Learn more at www.hushcore.net or call 610-863-6300

Multi-Path HUSHCORE® System Solutions

HUSHCORE® Treatments for Air Terminal Units (ATU)



ATU Unit Manufacturer	
1	Air Terminal Unit
2	Primary Air Inlet
3	Induction Air Inlet
4	Unit Outlet (Discharge)
5	Air Valve Control Box
6	Discharge Ductwork
7	Inlet Ductwork from RTU

Acoustical Manufacturer	
a	HUSHCORE® Premium™ System Velcro® Removable Acoustical Enclosure
b	HUSHCORE® Inlet HUSH DUCT™ Silencer
c	HUSHCORE® Outlet/Discharge HUSH DUCT™ Silencer
d	HUSHCORE® Control Box Removable Access Enclosure *(optional)*
e	Localized Removable Access Panel *(optional)*

Please visit our website www.hushcore.net for more information about our acoustical treatments for Air Terminal Units. CAD details and guide specifications are available for project bid documents and drawings.

HUSHCORE® Air Terminal Unit (ATU) Acoustical Systems Selection Guidelines

The table below shows various HUSHCORE® System models with the transmission paths they address.

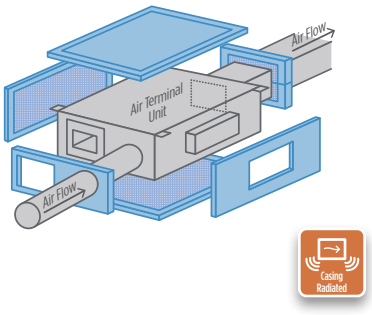
	Transmission Paths Addressed						Components				
HUSHCORE System	Casing Radiated	Induction Inlet	In-Duct Discharge	Discharge Breakout	Upstream Breakout	Diffuser	a	b	c	d	e
Premium™	✓						✓			*	*
Supreme™ "I"	✓	✓					✓	✓		*	*
Supreme™ "D"	✓		✓	✓			✓		✓	*	*
Zenith™	✓	✓	✓	✓			✓	✓	✓	*	*

* = not standard but available as an option

HUSHCORE® Premium™ System Baseline Treatment

All HUSHCORE® ATU Systems incorporate the Premium™ System Baseline Treatment with options outlined in the Product Matrix Table shown below.

HUSHCORE® Premium™ System
HUSHCORE® Velcro® Removable Acoustical Jacket custom manufactured to fit cabinet envelope



HUSHCORE Product	Class A Rated Flammability[1]	Panel Colors	Edge Seal Colors	Cost Range
PWE-200[4]	No	B	B	$
PWE-210[2,4]	Yes	B	B	$ ½
PWN-250	No	B	G, B, T	$$
PWR-350[2]	Yes	G, B, T	G, B, T	$$ ½
PWA-500[2]	Yes	G, B, W, T	G, B, T	$$$
PWA-750[2]	Yes	G, B, W, T	G, B, T	$$$$
PHD-800[2,4]	Yes	*see note 3*	n/a	$$$$ ½

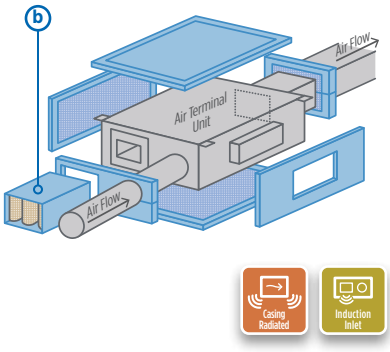
Notes:
1. Flammability testing for Class "A" is per ASTM E-84.
2. Products with Class "A" rating must be specified when installed in a plenum ceiling with open return to the RTU/ATU.
3. The PHD-800 is standardly galvanized steel but can be painted in a variety of standard colors.
4. New product

Color coding:
G = Gray
B = Black
W = White
T = Tan

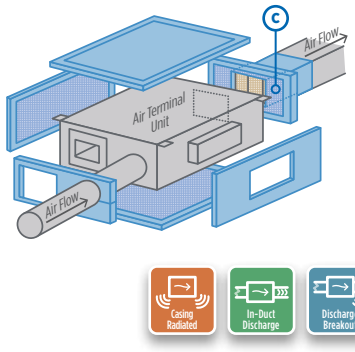
HUSHCORE® Supreme™ and Zenith™ Systems

The Supreme™ "I", Supreme™ "D", and Zenith™ Systems combine the Baseline Premium™ System for attenuation of the Casing Radiated sound transmission path with HUSH DUCT™ Silencers used to address duct borne and/or noise emanating from induction air openings.

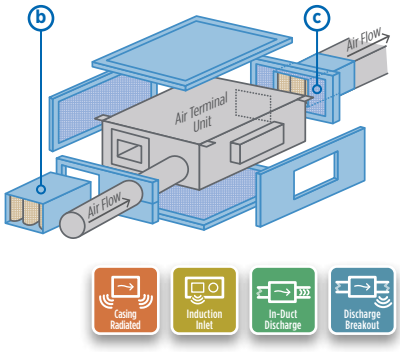
HUSHCORE® Supreme™ "I" System
HUSHCORE® Premium™ System *plus* Induction Inlet HUSH DUCT™ Silencer



HUSHCORE® Supreme™ "D" System
HUSHCORE® Premium™ System *plus* Discharge/Outlet HUSH DUCT™ Silencer



HUSHCORE® Zenith™ System
HUSHCORE® Premium™ System *plus* Induction Inlet HUSH DUCT™ Silencer *and* HUSH DUCT™ Discharge Silencer



HUSHCORE® Testing Program

Research and Development Performance Optimization Process

HUSHCORE® R&D efforts have assisted BRD Noise and Vibration Control, Inc. in optimizing material selection and construction for maximum performance. Testing was done in a NVLAP certified 3rd party laboratory for various HUSHCORE® Systems applied to a series flow fan powered Air Terminal Unit with 10" inlet. The laboratory method used in conducting these tests were in general accordance with Industry Standards AHRI 880-2017, *"Performance Rating of Air Terminals"* and ASHRAE 130-2016, *"Methods of Testing Air Terminal Units"*. The unit was operated with the fan operating at 0.25" w.g. external static pressure applied on the downstream duct, and with a primary air source applying 1.5" inlet static pressure at 100% of standard airflow. Some comparison testing was done with the Induction Inlet blanked off and a calibrated broadband noise source radiated through a speaker mounted in the cabinet.

For all HUSHCORE® testing, the terminal unit was mounted in accordance with paragraph 5.1.3.5 of AHRI Standard 880-2017 and Figure 2.0 of ASHRAE 130-2016 as shown in the figure and photo below.

AHRI 880: Mounting Detail for testing Casing Radiated Sound

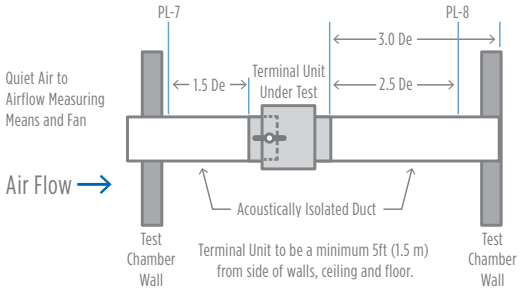


Figure 2.0 per ASHRAE 130

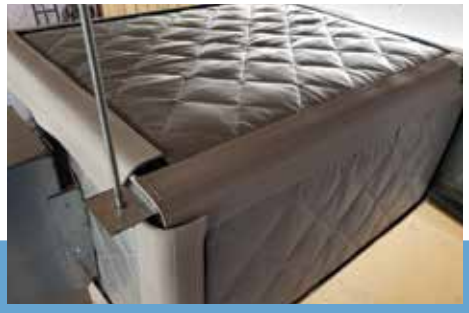
Test cell setup during testing

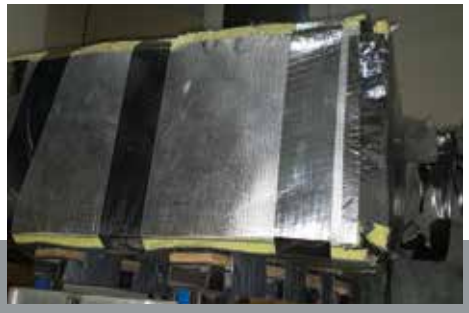
Testing Program Take-aways:

1. HUSHCORE® Premium™ System Custom Design Outperforms Field Fabricated Radiated treatments, which are 70% less effective *– see page 7 for data details.*
2. To achieve maximum reductions of the Casing Radiated Sound, reusable jackets must be used to cover the Air Valve Control Box *– see page 8 for data details.*
3. For Fan Powered VAV applications, the Induction Inlet and Casing Radiated Transmission Paths are equally weak links in the chain *– see page 9 for data details.*
4. Acoustical material testing per ASTM-E90 for Sound Transmission Loss (STC) is not an accurate indicator of ATU Casing Radiated performance. AHRI 880 testing produces performance data points that can be used for more accurate modeling.
5. Silencer Insertion Loss per industry standard ASTM-E477 overstates performance of duct silencers directly coupled to an ATU inlet or discharge because E477 has a minimum of 5 equivalent duct diameters straight flow into and out of the silencer.

Testing Program Take-away:

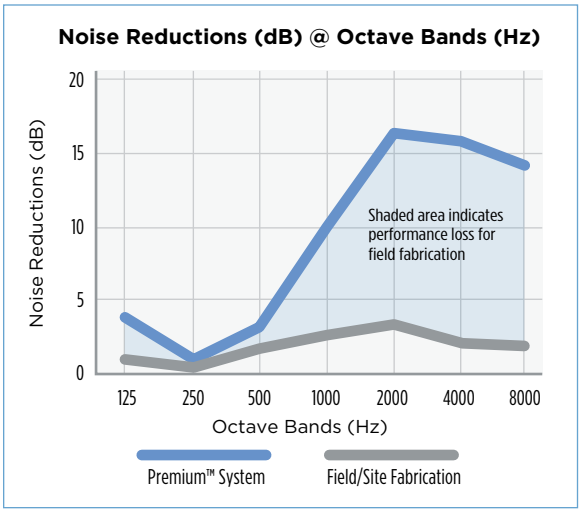
HUSHCORE® Premium™ System Custom Design Outperforms Field Fabrication, which is 70% less effective.





	HUSHCORE Premium™ System Custom/Factory Fabrication	Contractor Field/Site Fabrication
Description	Precision fit panels, cutouts and corner seals from tight tolerance factory fabrication on CAD programmable CNC cutting machine. Factory edges and Velcro® are sewn.	Imprecise field cutting of panels often from roll goods using utility knife. Edges are often un-sealed or finished with tape. Panels are affixed with glue, tape, or banding.
Fit & Removability	Precise fit for lowest percentage of gaps and leaks. Factory sewn custom panels with corner and edge seals result in easy Velcro® remov-ability through repeated service cycles.	Field cutting increases gaps/leaks at panel seams, around duct connection cutouts, and at corners. Removability is usually compromised due to method of attachment.
Acoustical Performance	Excellent overall and broadband reductions *- see plots at bottom of this page.*	Leaks and flanking noise from poor fit significantly reduce acoustical performance *- see plots at bottom of this page.*
Cost	Higher first material cost but lowest dollar cost per dB of reduction. Installation is less than 30 minutes per box yielding great labor savings.	Lower first material cost but labor intensive installation consumes savings when consider-ing final costs.

Graph & Table Results per ASHRAE 130 for HUSHCORE® Premium™ System Custom Factory Construction vs. Field/Site Fabricated



Noise Reductions (dB) @ Octave Band (Hz)	125	250	500	1000	2000	4000	8000
Premium™ System	3.7	1.0	3.1	9.1	16.4	15.7	14.0
Field/Site Fabrication	1.0	0.3	1.7	2.7	3.4	2.1	1.9

Notes:

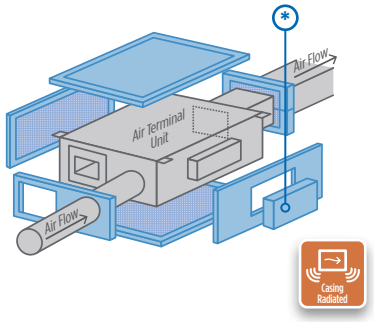
1) Testing is per ASHRAE 130 using 10" Series Box with blanked off Induction Inlet to isolate the radiated path.
2) Reductions are comparing Baseline Untreated and Treated Sound Power levels per ASHRAE 130.
3) Shaded area indicates the performance loss for field fabrication.
4) Test signal was using calibrated pink noise source.
5) HUSHCORE® Premium™ System included the optional Air Valve Control Box Jacket.

Testing Program Take-away:

Covering the ATU Air Valve Control Box Increases HUSHCORE® Premium™ System Performance by 1 to 2 dB.

The baseline treatment of all HUSHCORE® ATU Noise Reduction Systems is the Premium™ System. When considering the room/space directly below a plenum mounted ATU, the primary and dominant transmission source is the Casing Radiated Sound. This study was done to evaluate the added benefit of treating the Air Valve Control Box on the side of the unit which modulates the inlet air valve.

HUSHCORE® Premium™ System
HUSHCORE® Velcro® Removable Acoustical Jacket custom manufactured to fit cabinet envelope



HUSHCORE® Baseline Premium™ System

Premium™ System with optional cover for the Air Valve Control Box (see diagram at right)*

Test Methodology

Three styles of HUSHCORE® panels were evaluated for covering the Air Valve Control Box. One was to build a one-piece 5-sided enclosure. The second was a 5-piece shoe box design. The third was to engulf the control box with an extended casing/cabinet enclosure.

The 10" FPVAV unit was tested with a calibrated pink noise source generated from a speaker mounted inside. To isolate the Casing Radiated Path, the FPVAV induction inlet was blanked off with a sealed acoustical plug. The unit fan was not operating, and there was no airflow. Testing was otherwise done in general accordance with ASHRAE 130. Sound Power levels with the Premium™ System panels covering the entire unit cabinet were compared to test levels measured without the Air Valve Control Box Cover.

Data Results

To the right are the Sound Power reductions attributable to adding an Air Valve Control Box cover for the tested ATU. The results were similar for all three Control Box Cover types. Adding the cover should be conservatively estimated to provide an additional reduction of 1 to 2 dB across bands.

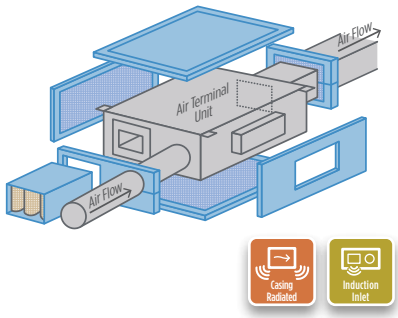
Noise Reductions (dB) @ Octave Band (Hz)							
Octave Band (Hz)	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Control Box Noise Reduction	1.5	1.2	2.2	3.5	3.9	2.6	2.0

Testing Program Take-away:

The Induction Inlet is as Critical as the Casing/Cabinet Radiated Path for Fan Powered Terminal Units.

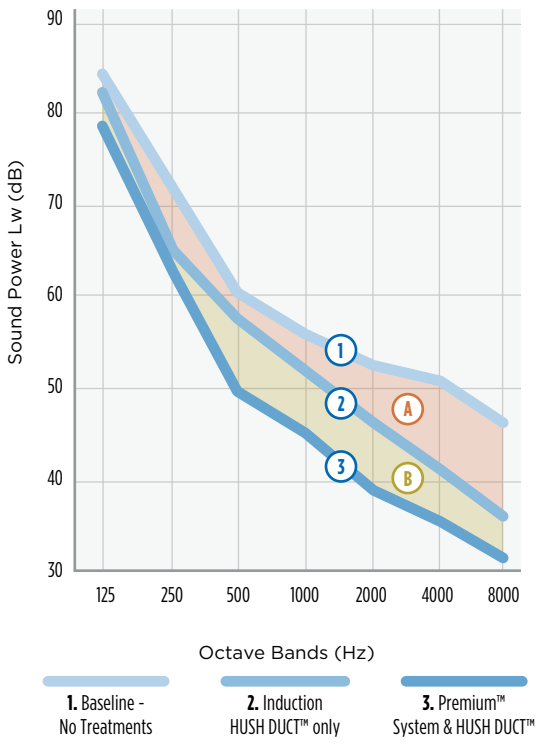
The Supreme™ "I" System diagrammed to the right is designed to attenuate the "Inlet Plus Casing Radiated" Noise associated with Fan Powered Variable Air Volume (FPVAV) Units, Water Source Heat Pumps (WSHP) and other equipment that radiates noise from BOTH an air inlet open to the ceiling plenum AND from the unit cabinet casing. Acoustically treating one source without treating the other compromises overall performance significantly.

HUSHCORE® Supreme™ "I" System
HUSHCORE® Premium™ System *plus* Induction Inlet HUSH DUCT™ Silencer



Test Methodology

The 10" FPVAV unit was tested while applying a 1.5" w.g. inlet static pressure at 100% of standard air flow. The unit fan was operating and adjusted as necessary for 0.25" w.g. external static pressure applied on the downstream duct. Testing of the bare untreated unit was done per ASHRAE 130 with resultant Sound Power Levels (see line 1 in table) compared to successive repeat tests where the HUSH DUCT™ Induction Silencer (see line 2 in table) was added and then with the Premium™ System added, (see line 3 in table).



Sound Power (Lw) w/ Unit Fan & PA in dB							
Hz	125	250	500	1000	2000	4000	8000
(1) Baseline - No Treatments	84.5	71.9	60.6	55.9	52.4	51.0	46.7
(2) Induction HUSH DUCT™ only	84.2	65.5	57.5	52.3	46.3	41.4	36.3
(3) Premium™ System & HUSH DUCT™	78.7	63.3	49.7	45.5	39.1	35.6	31.6

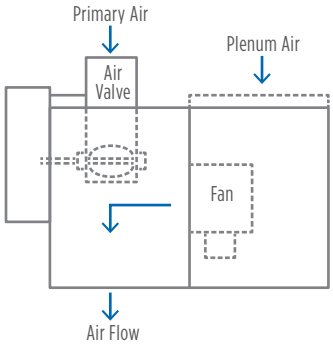
Noise Reductions (NR) in dB							
Hz	125	250	500	1000	2000	4000	8000
(A) HUSH DUCT™ NR	0.3	6.4	3.1	3.6	6.1	9.6	10.4
(B) Premium™ System NR	5.5	2.2	7.8	6.8	7.2	5.8	4.7
Total Inlet & Casing Reduction	5.8	8.6	10.9	10.4	13.3	15.4	15.1

ATU Types, Sizing, and Construction

Series vs. Parallel Fan Powered Units

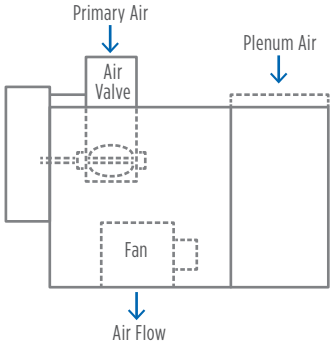
For noise sensitive applications, it is advantageous to optimize the ATU type, sizing and construction to yield the lowest baseline equipment sound levels. This will help minimize the need for specifying 3rd party acoustical treatments while still meeting the building design acoustical acceptance criteria. There are advantages for both unit configurations shown in the schematic diagrams below. The bullets below the diagrams list acoustical considerations for each.

Parallel Fan Powered Terminal Unit



- Quieter fans than series units because they are sized for about 30-60% of total unit flow and as such are smaller fans.
- Intermittent fan operation is a disadvantage as continuous noise sources are perceived as quieter. This impact can be minimized using an ECM with slow fan ramp-up speed.

Series Fan Powered Terminal Unit



- Continuous operating fan is less intrusive compared to parallel units where the fan operates intermittently. This translates to improved sound "quality".
- Series units have the disadvantage of requiring a larger, louder unit fan than parallel models in order to handle a larger CFM flow equal to the total room flow.

Unit Sizing

Overall lower fan velocities from oversizing the ATU box for a given application will result in improved acoustical performance. For fan powered models, lowering the fan RPM will also lower unit baseline sound output. Such a strategy could lower overall noise levels by 4 to 6 dB.

Operational Considerations

There are some operational dangers when oversizing an ATU with the goal of best managing the project acoustics. Oversizing a unit selection can adversely affect the ability of the air valve to modulate flow and thus to effectively control room temperatures. The loss of modulation capacity causes the unit to function more as a constant volume device with either low or full operational flow when the air valve flow sensing device operates below 400 FPM velocity. We recommend that an oversized unit operate above a minimum airflow velocity of 400 FPM.

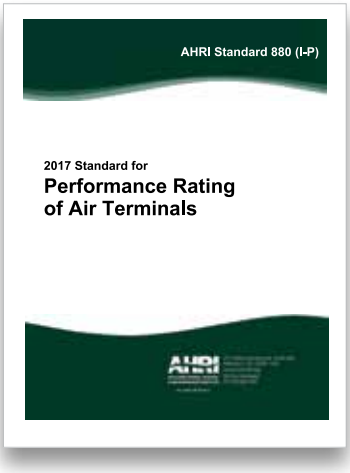
ATU Sound Rating Procedures and Certifications

In order to level the playing field on ATU published sound data when comparing manufacturers, it is important to understand the industry standard rating procedures, protocol, and reporting methodologies. The pertinent ASHRAE and AHRI Testing, Rating, and Estimating standards are summarized below.

Testing
ASHRAE 130

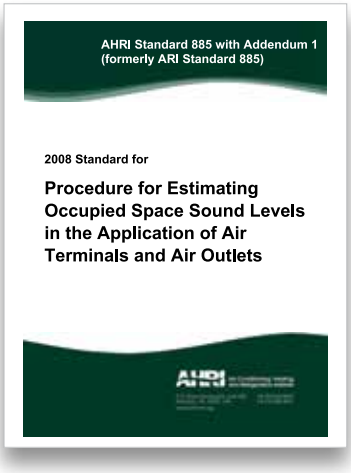
Laboratory Methods of Testing Air Terminal Units
Test methodology as used per AHRI 880 to test both radiated and discharge sound in a certified reverberation room. There are 2 different set-ups for separately evaluating the casing radiated and discharge components of an ATU. The mounting setup for testing the Casing Radiated Sound is shown on page 6.

Rating
AHRI 880



Performance Rating of Air Terminals
This is a Certified Performance Rating standard based on industry agreed operating conditions. The resultant data (tested per ASHRAE 130 methodologies) is expressed as ATU sound power across octave band center frequencies. AHRI data is in dB/dBA decibels. The standard now includes End Reflection Loss (ERL) corrections not captured in the ASHRAE 130 methodology.

Estimating
AHRI 885



Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets
AHRI 885 is a standardization of transfer functions used to estimate occupied space sound levels based on the ceiling plenum depth, the footprint of the room below and the ceiling type. The transfer functions are octave band reductions per Appendix "E" used as corrections to the AHRI 880 unit sound power to plot an expected room Noise Criteria (NC) value.

Please visit our website www.hushcore.net for more information about our acoustical treatments for Air Terminal Units. CAD details and guide specifications are available for project bid documents and drawings.

APPLICATION CONSIDERATION #3

ATU Ratings: Noise Criteria (NC) vs. Sound Power (dB)

ATU Manufacturer's Sound Ratings: *Responsible Engineering or Dubious Data*

	Responsible Engineering	Dubious Data
Baseline Data	Uses certified AHRI 880 baseline data to the latest revision.	Uses AHRI 880 baseline data from an outdated standard.
Transfer Functions	Project specific correction factors selected from AHRI 885 per building design.	AHRI 885 transfer functions selected without knowledge of built environment.
Transfer Function Documentation	Itemizes selected project specific attenuation values/transfer functions/corrections.	May not itemize corrections assumed with listed ATU NC data.
Other Contributions	Considers RTU upstream contribution and possible impact on room NC level.	Does NOT consider RTU upstream contribution to overall level.

Examples of Transfer Functions per AHRI 885 Selected From Appendix "E" Values

Octave Band (Hz)	125	250	500	1000	2000	4000	Note
Radiated dB	18	19	20	26	31	36	1
Discharge Attenuation dB	29	30	41	51	52	39	2

Notes:
1. Based on Environmental Effect and Ceiling/Space Effect.
2. Based on Environmental Effect, 5' of lined duct, end reflection, 5' of flex duct, space effect and sound power division.

ATU Sound Ratings Best Practices

- Always evaluate unit manufacturers based on the same criteria or standard.
- Use Just Right Acoustics™ path analysis modeling program by HUSHCORE® or other qualified acoustical engineering software to determine expected project noise levels and to evaluate needed acoustical treatments to meet building acceptance criteria.
- Where scheduling ATUs by NC rating, specify the exact transfer functions to be used by all equipment bidders as standardized in AHRI 885.
- Specify acoustical treatments performance per ASHRAE 130 as outlined in AHRI 880 test procedures to mimic actual ATU use.
- When scheduling Basis of Design ATU Manufacturer's NC rating, require clearly delineated transfer functions used and include those in notes with the equipment schedule.

Unit Location Guidelines

- Locate ATU equipment in plenum spaces above non critical areas such as corridors, bathrooms, storage, etc. Avoid placing units in plenum spaces where room target performance below is NC-35 or less.
- Avoid installing ATUs close to ceiling diffusers and Return Air grilles.
- Avoid ATUs installed in exposed ceiling spaces regardless of the target room NC.

Specification Strategies for Acoustical Treatments on ATUs

	HUSHCORE Engineered Design	Best Practices Specification & Detail
Application	Critical Spaces	Non Critical Spaces
Target NC	Recommended where acceptance criteria are NC-35 or below and for all applications with exposed/open ceiling.	Recommended where acceptance criteria are above NC-35.
Project Specific Design	YES. Design per project through multi-path analysis given baseline ATU noise values, duct designs, and project noise goal/criteria.	NO. Usually templated from previous acceptable installations.
Transmission Paths Addressed	An Engineered specification reflecting a multi-path analysis of radiated, inlet, discharge, and duct breakout sources.	Usually focuses on the ATU discharge sound but may show a radiated treatment. Almost never addresses breakout sound.
Modeling Software	Just Right Acoustics™ modeling by HUSHCORE®.	Modeling not usually done.

BRD Noise and Vibration Control, Inc. can support both specification strategies. Standard CAD Details and Guideline Specs are available from your Sales Engineer or at www.hushcore.net under the Air Terminal Unit tab. For the Engineered Design approach, we need about 3 weeks after receipt of layouts and baseline ATU sound levels to perform a full path analysis complete with a custom specification.

How To Specify HUSHCORE® Acoustical Systems for ATUs

Key Elements of Effective Specifications for ATU Acoustical Treatments

- Specify Performance per ASHRAE 130.
- Embed or schedule with ATU Equipment.
- Include performance accountability to meet space acceptance criteria.
- Specify factory custom panel fabrication.
- Include sealing and removability features compatible with ATU equipment.

Design Resources Available at www.hushcore.net in Word, PDF and CAD File Formats

- CAD Details
- Word Specifications in 3-part format
- Drawing Schedule Templates
- Short Form Notes
- Installation Guidelines
- Product Literature

Unit Support Guidelines

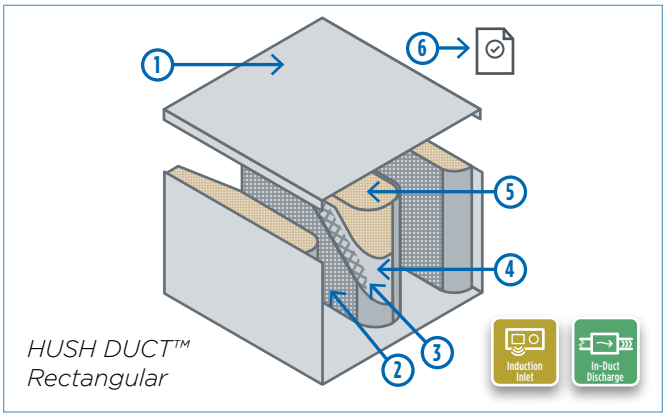
- Suspend using resilient vibration isolation hangers with 30° misalignment feature to prevent hanger rod "short circuit". Hangers should have neoprene isolation element.
- Duct to units with heavy weight fabric flexes of short length to limit noise leakage. Use HUSHCORE® removable jackets at flexes for critical applications.

HUSH DUCT™ Silencer Design Tutorial for ATU Applications

HUSH DUCT™ Silencers are used in the following HUSHCORE® ATU Treatment Systems

HUSHCORE System	Induction Silencer	Discharge Silencer	Recommended Velocity	Notes
Premium™				Baseline Treatment for Casing Radiated Path with no Silencers
Supreme™ "I" 	✓		500 FPM	
Supreme™ "D" 		✓	500 FPM	
Zenith™ 	✓	✓	500 FPM	

Typical HUSH DUCT™ Construction and Options for ATU Applications



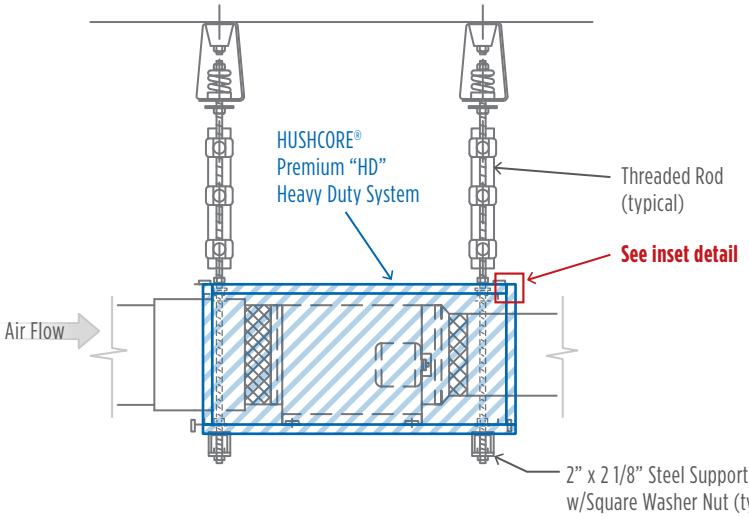
HUSH DUCT™ Rectangular

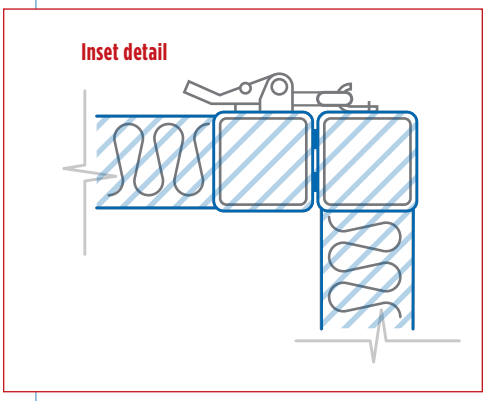
Key	
1	Exterior casing 24 ga. to 18 ga.
2	Acoustically transparent perforated steel retaining screen internals
3	Acoustic standoff spacer for media film
4	Media film (Fiberglass Cloth, Mylar, or Tedlar)
5	Acoustical media (Fiberglass or Natural Fiber)
6	Tested to latest revision of ASTM E477

Component	Description
Silencer Types	Rectangular, round, square tubular, and packless
Connections	Slip or flanged
Construction Materials	Galvanized steel, stainless steel, and aluminum
Length	Standardized 36" length but can be customized as required to meet job performance.
Internal Splitter Baffle Offset	Internal splitter baffles can be offset 12" in the silencer casing to reduce the turbulence when directly coupled to a FPVAV discharge.
Extended Casing Baffles	Splitter baffles can be an Extended Casing design to keep baffle heads out of the duct airflow for superior aerodynamic performance.
Noise Breakout Options	Exterior silencer casing can be Heavy Gauge HG-1 (16 ga.) or HG-2 (10 ga.) to control breakout transmission through the silencer shell.

New Product!

HUSHCORE® Premium™ "HD" Heavy Duty System, Model PHD-800, Using HUSH GUARD™ Galvanized Steel Acoustical Panels





Quick Release Easy Access Tension Latch Joiners

Premium™ "HD" Advantages

- Improved low frequency acoustical performance.
- Manufactured using HUSH GUARD™ galvanized steel panels.
- Side panels removable using quick release tension latches for service access.
- Galvanized finish blends in with ductwork in exposed ceiling applications.
- Can be powder coat painted in standard colors.
- Standard 2" thick, also available in 4" thick where space permits.

From Problem Definition... to Problem Solved.

Learn more at www.hushcore.net, call 610-863-6300, or e-mail us at hushcore@brd-nonoise.com

BRD Noise and Vibration Control, Inc. | HUSH CORE®

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