## HUSHCORE<sup>®</sup> RTU Acoustical Curb Systems





### **Curb Mounted Rooftop Unit (RTU) Problem Definition**



**Multi-Path System Problems Require Comprehensive System Solutions** BRD HUSHCORE<sup>®</sup> Solutions have been helping keep Business, Education, Healthcare and Entertainment facilities quiet, inside and outside, since 1975.

## **RTU Noise Transmission Paths**



#### Fan Noise

Some fan types generate higher sound levels than others, but all supply and return air fans will generate sound that travels in duct to diffusers servicing occupied building spaces. Fan noise is often the primary transmission path except when RTUs are located directly above the space they service where the radiated path may dominate. Pay attention to frequency octave band data to address fan blade passage tones.



#### **Radiated Noise**

Radiated noise is the sound radiating from the unit cabinet through the roof deck inside the RTU curb confines. Radiated noise is most significant in RTUs with DX cooling having a condensing section with compressors and cooling fans. In-curb acoustical treatments addressing the radiated path should include provisions for sealing around duct drops.



#### Structure-Borne Noise

Any structure that vibrates radiates airborne sound. Structure-borne vibration if not isolated at the unit by the RTU curb can excite building structural components. Roof steel, metal decking and gypsum board partitions are very efficient transmitters of vibration. Ductwork inside the building must also be isolated from structure.



#### **Duct Breakout Noise**

Breakout noise is sound passing through the walls of ductwork and silencer casings. It is a function of the component shape and size. Breakout noise is the reason to place sound attenuators as close to the unit as possible. Breakout noise is usually greatest in the first elbow and 10' to 12' of ductwork directly below the RTU in a downflow Supply Air (SA)/Return Air (RA) configuration.



#### **Regenerated Noise**

Regenerated noise is noise attributable to obstructions and discontinuities that create turbulence in the otherwise smooth flow of air in duct systems. Probability for turbulence and regenerated noise is greatest at the first duct drop elbows. Regenerated noise transmits in duct downstream and also radiates through the breakout path.

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#### **Outdoor Noise**

Outdoor noise is the radiated sound path to nearby community receptor locations. The sound pressure level at a given property line location is a function of the decay rate for a given distance and site influence of nearby grade, roof and/or building wall reflecting planes. Outdoor noise is of greatest concern for RTUs with DX cooling that incorporate a condensing unit section containing scroll compressors and condenser cooling fans.

#### From Problem Definition... to Problem Solved.

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

## **Multi-Path HUSHCORE® System Solutions**

#### **HUSHCORE®** Acoustical Vibration Curb Overview



#### **HUSHCORE® RTU Acoustical Curb Systems Selection Guidelines**

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

HUSHCORE <sup>®</sup> Acoustical Curb System	Fan	Radiated	《王》 Structure-Borne	Breakout	Regenerated	Comments
<ul> <li>Standard<sup>™</sup> System</li> <li>Plus<sup>™</sup> System</li> <li>Whisper<sup>™</sup> P System</li> </ul>		✓	✓			Excellent strategy for speci- fying repeatable Entry Level "Best Practices"
■ Standard <sup>™</sup> E System	~	✓	~	✓	~	All these Systems have HDES HUSH DUCT <sup>™</sup> fan attenuation silencers at the roof deck sup- ply and return air openings
<ul> <li>Plus V System</li> <li>Ultra<sup>™</sup> System</li> <li>Whisper<sup>™</sup> E System</li> <li>Custom System</li> </ul>	✓	✓	~	✓	~	These designs require curb heights of 36" to 60" to allow for integrated HUSH DUCTS™ inside the curb. Service platforms can be integrated into the taller curbs

**Please visit our website** <u>www.hushcore.net</u> for more information about our HUSHCORE Acoustical Curb Systems. CAD details and guide specifications are available for project bid documents and drawings.

## Three Levels of HUSHCORE® Technology







### **HUSHCORE® Entry Level Systems**



## Advantages of Using HUSHCORE<sup>®</sup> Deck<sup>™</sup> Systems for In-Curb Acoustical Treatment of RTU Radiated Noise



HUSHCORE<sup>®</sup> Deck<sup>™</sup> Systems provide designers/specifiers with due diligence and known performance that is not achievable with a traditional gypsum board and batt insulation.

	HUSHCORE® Deck™ Systems Proven Solutions	Gypsum Board & Batt Insulation Strategy
Performance	Independently tested w/range of attenuation	Unknown
Commissioning	<ul><li>Submittal required per new specification with provision for site inspection/verification</li><li>100% confidence provided</li></ul>	<ul> <li>No submittals</li> <li>No site verification required/specified 50/50 chance it made it in the curb</li> </ul>
Weight	<ul> <li>Weighs less but performs better due to lab testing optimization and research</li> </ul>	Weighs more but performs less
Cost	<ul> <li>Provides the best value considering installed cost and greatest dBA reductions per dollar spent</li> </ul>	<ul> <li>Lower first cost of materials but no cost advantage considering proper installation labor required</li> </ul>
Installation	<ul> <li>Details specified, including sealing</li> <li>Flexible materials allow tighter fit and filling of tight spaces</li> <li>Commissioning site verification ensures consistent quality</li> <li>No special tools required</li> </ul>	<ul> <li>No specification direction regarding sealing (#1 issue for sound control loss)</li> <li>Rigid materials create challenges for tight spaces and increase the potential for resonance</li> <li>No special tools required</li> </ul>

# HUSHCORE<sup>®</sup> Deck<sup>™</sup> System In-Curb Research & Development Performance Optimization Process

Radiated

HUSHCORE® R&D efforts have assisted BRD Noise and Vibration Control Inc. in optimizing material selection and construction for maximum performance. Mock-up testing is done in a NAVLAP certified 3rd party vertical test chamber to the ASTM E90 test procedure. The picture below is from our latest round of R&D testing. The preferred method for determining the STC rating of a product (ASTM E90) is officially called the "Standard Method for Laboratory Measurement of Airborne Sound Transmission". During an ASTM E90 test, a test specimen with material seams and layering representing actual field/ factory installed conditions is mounted between a room containing an isolated source of noise and a receiving room. Sound transmission loss, the difference between the sound level in the source room and the receiving room, is measured at specific sound frequencies and used to arrive at the STC rating. The higher the STC rating measured, the quieter it is in the receiving room.

#### ASTM E90 – "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission"

#### Results of multiple R&D efforts teach us the following:

- In-curb performance is often counter-intuitive and difficult to predict or calculate.
- Flexible insulations and mass barriers outperform rigid materials of comparable mass.
- 2. More is not always better so filling up the RTU curb is an inefficient solution and may yield lower performance.
- 4. In-curb acoustical treatments adhere to the law of diminishing return above 8" thick.

The table below summarizes a sampling of the most cost-effective Deck™ System Octave Band Transmission Loss per the ASTM E90 test standard. We are showing full octave performance from 125 Hz to 4000 Hz.

Deck™				Transmission Loss Octave Bands (Hz)					
System STC Model Rating	Class A Fire Rated	Estimated Cost	125	250	500	1000	2000	4000	
DS-30	30	Yes	\$	12	17	28	39	45	53
DS-38	38	Yes	\$	18	26	41	54	62	70
DS-40	40	No	\$	22	29	38	47	54	65
DS-41	41	No	\$\$	18	40	56	58	61	69
DS-45	45	No	\$\$	26	34	43	51	57	62
DS-49	49	Yes	\$\$	25	39	51	59	62	67
DS-53	53	Yes	\$\$\$	30	41	55	61	65	72
DS-55	55	No	\$\$\$	31	44	57	62	66	73
DS-57	57	No	\$\$\$	34	45	57	62	66	74
DS-60	60	No	\$\$\$\$	39	49	58	65	70	75

Contact BRD at hushcore@brd-nonoise.com to obtain full data results at all 1/3 octave frequencies

### **HUSHCORE® High Performance Systems**



#### Advantages of Using HUSH DUCT<sup>™</sup> Multi-Path Elbow Silencers to Increase Attenuation of Fan Noise and Duct Breakout Noise While Controlling Turbulence



**HUSH DUCT<sup>™</sup> Elbows at Deck Openings** 

Supply

Air Flow

**HVAC Unit** 

Roof Deck

HUSH DUCT Attenuator

HUSH SEALANT





	<b>Acoustical Performance</b>	Breakout Performance	Regenerated Aerodynamic Performance
HUSH DUCT™ Elbows at Deck Openings	Can provide greater overall and low frequency acoustical performance per foot of centerline length	Addresses breakout path at duct drop elbows under RTU	Radiused internal geometry reduces turbulence and regenerated noise
Downstream Straight Silencers	Performance limited by straight duct lengths available. Less Insertion Loss per foot	Does not attenuate break- out noise in first duct drop elbows	Downstream location does not address self noise (regenerated) of first elbow

## **Typical HUSH DUCT<sup>™</sup> Construction & Options**





#### Key

1	Exterior casing 24 ga. to 10 ga. for high TL
2	Acoustically transparent perforated steel retaining screen internals
3	Acoustic standoff spacer for media film
4	Media film (Fiberglass Cloth, or Mylar)
5	Acoustical media (Fiberglass or Natural Fiber)
6	Tested to latest revision of ASTM E477

#### Specialty HUSH DUCT™ Designs & Options

- Transition Silencers
- Packless/Fiber-Free Silencers
- Hospital Grade Silencers
- Industrial Silencers
- Tuned Silencers
- Silencers with Accessible Acoustical Media
- Galvanized, Stainless Steel and Aluminum Construction

## Advantages of Using HUSHCORE<sup>®</sup> Integrated and Pre-Assembled Vibration Curbs Instead of Traditional Field Assembled Rail Kits.



	Ship & Pick	Ship & Assemble
Construction	Welded/Fully Assembled	Mechanically bolted (Erector Set)
Quality Control	Factory Quality Controlled	Subject to human assembly error
Factory Curb	No factory curb required	Requires additional factory curb
Wind/Seismic	CAN be designed to meet code wind and seismic loads for all size RTUs	CANNOT meet all code wind and seismic loads for all size RTUs
Value	Eliminates field assembly labor	First cost savings spent on assembly

## How To Specify HUSHCORE<sup>®</sup> Acoustical/Vibration Curb Systems

## Key Elements of Effective Acoustical Specifications

- Acoustical/Aerodynamic Performance
- Acceptance Criteria in dBA or NC
- Design Prescription to meet above
- Performance Accountability
- Installation Guidelines
- RTU/Equipment Compatibility

#### Design Resources Available at www.hushcore.net

- CAD Details
- Specifications in 3-part format
- Contact a BRD sales person for recommended ductwork velocity guidelines.
- Short Form Notes
- Installation Guidelines
- Product Literature



#### CAD Detail Example HUSHCORE<sup>®</sup> Plus<sup>™</sup> E System Model HIC-DS-41-E

#### **Specification Tips:**

- RTU/Equipment specification
- Use 2 to 3 dB Safety Factor Tolerance when modeling performance
- Require single source responsibility

#### RTU Unit Manufacturer

- 1 RTU Base
- 2 SA/RA Unit Openings

	Acoustical Manufacturer
3	Integral Curb Duct Supports
4	2" Deflection Fully Assembled HUSH CURB™ Model HIC-2
5	HUSH SEALANT™ Acoustical Caulk at all Duct Drops & Curb Perimeter
6	HUSHCORE® DS-41 Deck™ System In-Curb Acoustical Treatment (rated at STC-41)
7	HUSH DUCT <sup>™</sup> Model HDES Elbow Silencer

HVAC Contractor				
8	Ductwork			
9	Roof Deck Flashed to within 0.25" of all Duct Drops but not in contact with Duct Wall			
10	Submit Letter of Certification from Acoustical Supplier following inspection			
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General Contractor				
11	Building Steel			
12	Built-Up Roof or Concrete			
13	Insulation and Cant Strip			
14	Curb Slope requirements where applicable			

## **Evaluating RTU Equipment Sound Ratings: Sound Power vs. Sound Pressure**

	Sound Power (Lw) CAUSE	Sound Pressure (Lp) EFFECT
dB	Decibel referenced to 10 <sup>-12</sup> Watts	Decibel referenced to $2 \times 10^{-5}$ Pascals
Consistency	Accurate Reportable and Verifiable Testing Standards	Can vary based on modeling or measurement methodology
Location	Data at the acoustic center of the equipment	Data for a location in the built environment
Environmental Factor	Data is independent of environmental influence	Project specific levels in the built environment
Equipment Comparisons	Allows comparisons among equipment manufacturers	Complicates equipment comparisons due to modeling variability
Data Uses	Used to define equipment baseline	Used to define space levels

#### Recommended AHRI Noise Standards for Rooftop Units

Rooftop Units are one of the few pieces of HVAC equipment to be rated by two separate noise standards published by the Air-Conditioning, Heating and Refrigeration Institute (AHRI). Both standards are expressed as baseline sound power values. AHRI Standard 260 pertains to RTUs and all HVAC Units that have duct connections. The condensing section part of many Rooftop Units is rated per AHRI Standard 370. These standards produce accurate and verifiable data specific to the equipment configuration.



#### How Do AMCA Noise Standards Compare to AHRI?

Although AMCA 300 and AHRI-260 are both rated in decibels per octave bands, that is where the similarities stop. AMCA 300 is a test procedure prescribed by the Air Movement and Control Association for bare fans while AHRI-260 rates the unit performance inclusive of appurtenances such as coils, filters, mix boxes and cabinet influences. Comparisons of unit sound levels tested to AMCA vs AHRI standards are not valid or reliable. AMCA "fan only" data does not consider the impact of the RTU cabinet as more turbulent airflow patterns in and out of the fan can produce higher sound levels. When equipment manufacturers offer AMCA data for their unit performance, it is often because they are a custom manufacturer where standardized AHRI testing of the equipment is not practical/ feasible. AHRI data considers supply fan contribution as well as secondary sources such as return/ exhaust fans and compressors.

"When reviewing manufacturer's sound data, obtain certification that the data has been obtained according to one or more of the relevant industry standards."

## Just Right Acoustics<sup>™</sup> Acoustical Modeling and Lay-In Service

#### Information Needed for Multi-Path Analysis

		Transmission Path to be Modeled						
Information Needed	Fan	Radiated	(کی) (یریدرییند-Borne	Breakout	Regenerated	Outdoor		
AHRI Baseline Sound Power	$\checkmark$	$\checkmark$		$\checkmark$		$\checkmark$		
NC Target in Receiver Space	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			
RTU CFM	$\checkmark$			$\checkmark$	$\checkmark$			
Fan RPM			$\checkmark$					
Ductwork Layouts & Elevations	$\checkmark$			$\checkmark$	$\checkmark$			
Ductwork Gauges				$\checkmark$	$\checkmark$			
Size of Receiver Space	$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$			
Distance to the Property Line						$\checkmark$		

#### Notes:

- 1. Regenerated noise levels cannot be modeled where duct design deviates from ASHRAE/SMACNA industry guidelines
- 2. Diffusers should be selected for NC rating 10 points below NC target
- 3. See recommended ductwork velocity guidelines at <u>hushcore.net</u>

#### Deliverable Example: K-12 Education RTU-2A with Target NC-35



	Path Summation with Attenuation							
Octave Band (Hz)	63	125	250	500	1000	2000	4000	8000
<b>Radiated Path</b>	45	38	29	18	11	1	3	0
Breakout Path	52	24	20	13	9	7	5	5
Supply Path	45	25	23	18	15	9	7	3
Return Path	52	34	29	23	16	11	9	5
Path Summation	56	40	33	25	20	14	13	10

## **HUSHCORE®** Rooftop Systems

#### Remedial vs. New Construction - which is better?

While new construction presents the advantage of easier coordination, not all jobs have this luxury. For remedial work, our HUSHCORE® Systems integration can be independently supported or cantilevered to avoid building penetrations when needed.



#### Concerns about unit airflow

Air-Flow recommendations with regard for unit spacing and unit enclosures, as per OEM Catalog: "When it is desirable to surround the unit(s), it is recommended that the screening be able to pass the required unit CFM without exceeding 0.1" of water external static pressure." – can be addressed through integration of our Hush Duct<sup>™</sup> Silencer intakes and discharge allowing for acoustic performance while still maintaining airflow.

#### Concerns about fan-discharge air-recirculation

Added system features can be incorporated to remediate air-recirculation spilling out from above the unit as well. Hush Guard panels can be mounted to the unit directly around the discharge fans (see images below).



#### **Concerns about unit clearances and OEM spacing recommendations**

RTU spacing clearances as per OEM Catalog: "Recommended clearances include side to wall: 6 ft (1.8 m), rear to wall: 6 ft (1.8 m), control panel end to wall: 4 ft (1.2 m), and finally, the distance between adjacent units: 10 ft (3 m)." – are often not feasible and are evaluated with any HUSHCORE® system design to ensure proper airflow and operation.

## HUSH SCREEN<sup>™</sup> Versatile Acoustical/Visual Equipment Screening Options



- Equipment concealment without roof penetration
- RTU curb mounted support good up to 90 MPH wind load
- RTU direct cabinet mounted support good up to 225 MPH wind load
- Clearances up to 38" from RTU cabinet

- Heights up to 108" depending on cabinet height and design wind load
- Acoustical Performance up to STC-35
- Sliding panel easy access
- Pedestal mounting options (Requires roof penetration) for equipment clearances greater than 38"

#### Available in Both Curb Supported (see below) and Unit Supported Designs



HUSHCORE<sup>®</sup> wind rated curb with bracketry, out riggers, twin track rails and vertical columns with racking braces. This methodology does not require approval by the RTU manufacturer.



Finished HUSH SCREEN<sup>™</sup> with single tier modular sliding access acoustical panels. This system is wind load rated without roof penetrations.

#### **HUSH COVER™ Compressor Sound Covers**



- Reduces compressor radiated noise (whine)
- Removable Replaceable Construction
- HUSH COVER<sup>™</sup> HC-500S-1 rated at STC-29
- Outdoor UV compatible construction with Silicone Impregnated Fiberglass Cloth exterior jacket
- Also available for use with Air Cooled Chillers, valves and other equipment
- Tested per ASTM E-1222 "Standard Test Method for Laboratory Measurement of the Insertion Loss of Pipe Lagging Systems"

1/3 Octave Band (Hz) Insertion Loss Acoustical Performance per ASTM E-1222												
315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
4	4	9	15	12	19	22	23	26	28	27	30	30

## HUSHCORE Summit System Reduces Rooftop Unit Condenser Noise an Average of 10.6 dBA at 3' around the Unit

#### **Office Building - Case Study**





#### OUTCOME

BRD Noise & Vibration Control, Inc. designed and manufactured a Summit Model HDE-2IOE Noise Reduction System for a Lennox model LCH300M4M Rooftop Unit condensing section. The Summit System source applied solution allowed for overall reductions around the unit ranging from 8 dBA to 17 dBA (10.6 dBA average reduction). Without using a free-standing barrier. All materials were unit mounted so no foundation work was required. The Summit System met the reductions calculated by the acoustical Consultant.

#### PROBLEM

A dunnage platform mounted package rooftop air conditioning unit (RTU) was transmitting noise which exceeded the ordinance mandated maximum allowable sound level. Traditional freestanding sound barriers or screens were not feasible given existing interferences near the RTU and the owner's desire to avoid roof penetration.

#### **CHALLENGES & SOLUTIONS**

As this was a retrofit project, there were concerns for added weight. Lightweight aluminum construction kept overall weights of the treatment to tolerable levels so that roof steel did not need to be altered. Additionally, the high target noise reductions required custom designed HUSH DUCT elements to treat the air intake and exhaust paths of the condensing section while minimizing back pressure.



## **Quiet Buildings Help Make Quiet Communities**

With HUSHCORE® Systems, quiet RTUs keep neighbors happy and building owners ordinance compliant.



Кеу	
1	Unitary™ SM-SB System acoustical condenser fan discharge stack
2	Standard <sup>™</sup> SL System HUSH COVERS <sup>™</sup> for scroll compressors
3	Plus™ System vibration curb with Deck™ System DS-53 acoustical package
4	Louver™ System condenser air intake HDAL HUSH DUCTS™
5	HUSH SCREEN™ curb/unit supported acoustical screen
6	Rooftop unit with condenser section



Louver<sup>™</sup> System RTU condenser intake, HUSH DUCT<sup>™</sup> fan discharge stack and compressor HUSH COVERS<sup>™</sup>



Unitary™ TMSB top view HUSH DUCTS™



RTU curb mounted two-tiered sliding panel HUSH SCREEN™

#### 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



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