# CONTROLLING ROOFTOP UNIT (RTU) NOISE

## PROBLEM DEFINITION

Noise problems associated with rooftop packaged air conditioning units are system related and require careful unit integration with today's typical building trends of curb mounting. Other building trends leading to system noise problems are lightweight long span roof systems, reduced floor to floor space for ductwork, and owner demands for increasing usable/rental space.

## NOISE SOURCES

System sound sources for curb mounted rooftop units are listed below:

- Supply, Return and Exhaust Fans
- Condenser Fans
- Compressors
- RTU Cabinet and Base
- Duct Fittings and Ductwork Design

## SOUND TRANSMISSION PATHS

Each of the system sound sources can transmit via structure-borne and airborne paths. Rotating RTU components generate structural vibration and airborne noise. The RTU cabinet surfaces designed to package components and contain noise become noise radiating sources themselves. This is particularly critical for the RTU cabinet base which many times is only protected from the noise sensitive space by the deck inside the curb perimeter and the acoustical drop ceiling. Ductwork and fittings along with airflow velocity determine aerodynamic noise caused by turbulent flow.

Aerodynamic turbulence excites duct wall surfaces (oil canning) which radiates airborne noise and transmits structurally wherever it comes in contact with structure through supports or wall/ floor penetrations. Breakout noise due to insufficient mass in duct walls must also be addressed.

Lastly, the building shell consisting of steel, concrete and drywall is a very efficient structure-borne transmitter of vibration and noise.

## HUSHCORE™ SOLUTIONS

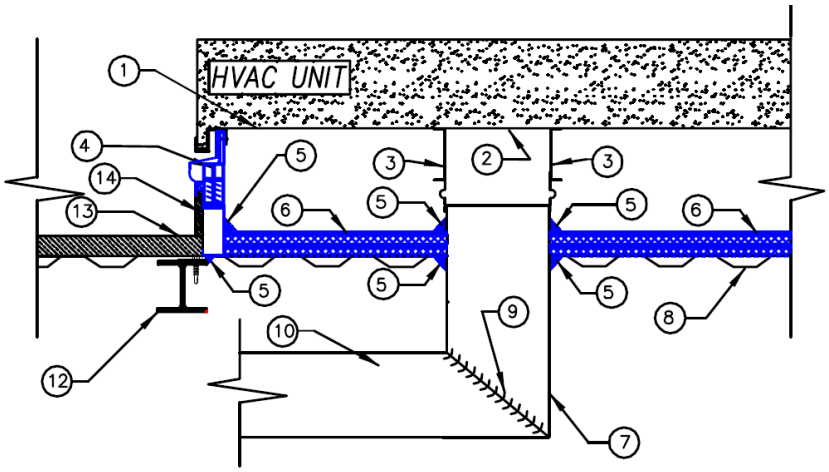
Multi-source system problems require system solutions. The HUSHCORE™ Systems illustrated on the following pages give an overview of a range of treatments which can be utilized. Customized solutions are required depending on project conditions, target NC goals, and selected RTU equipment. Contact your BRD Regional Manager or local representative for design assistance and support.

# ENTRY LEVEL SOLUTIONS

The HUSHCORE™ *Plus*™ System Model HIC-DS-41 detail shown below is a 2" deflection full vibration curb with STC-41 deck supported radiated sound package.

***This design is recommended for curb mounted packaged Rooftop Units 20 tons and larger.***

**HUSHCORE™ *Plus*™ Acoustical Curb System**




**BY RTU MANUFACTURER**

1. RTU Base
2. SA/RA Unit Openings

**BY HVAC CONTRACTOR**

7. Ductwork
8. Roof Deck Flashed to within ¼" of all Duct Drops but not in contact with Duct Wall
9. Turning Vane
10. Fan sound attenuation per schedule/specifications
11. Submit letter of Certification from Acoustical Supplier following inspection

**BY ACOUSTICAL MANUFACTURER**

3. Integral Curb Duct Supports
4. 2" Deflection Fully Assembled HUSH CURB™
5. HUSH SEALANT™ Acoustical Caulk at all Duct Drops & Curb Perimeter
6. HUSHCORE™ DS-41 *Deck*™ System In-Curb Acoustical Treatment

**BY GENERAL CONTRACTOR**

12. Building Steel
13. Built-Up Roof or Concrete
14. Insulation and Cant Strip
15. Curb Slope requirements where applicable

## VARIATIONS AVAILABLE:

- Seismic construction
- Sloped construction
- 3" static deflection (27" high)
- Secondary vibration rails on factory KD curbs
- Higher STC ratings for radiated sound package
- Integrated HUSH DUCT™ silencers or Fiber-Free duct liner

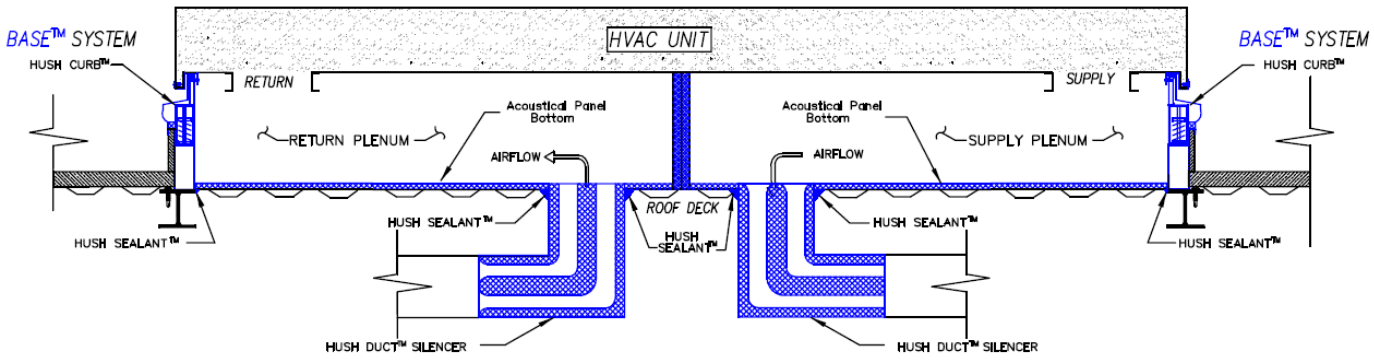
## HUSHCORE™ SPECIFICATION ADVANTAGES:

- Integrated design spec with embedded performance accountability
- Clear outline of scope and installation details for all construction trades
- Inspection accountability
- Turnkey solution from single source
- Equipment compatibility

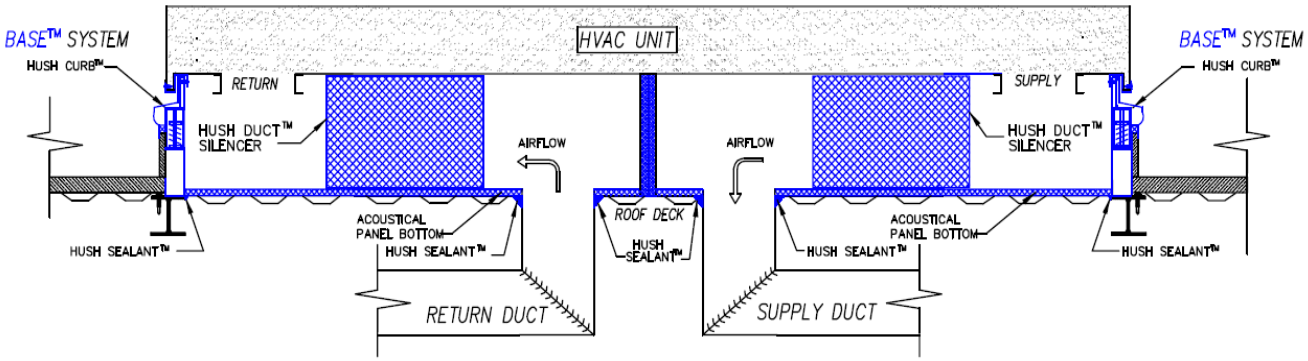
# HIGH PERFORMANCE SOLUTIONS

High performance solutions may be required for certain applications to service the higher sound sensitivities of the Healthcare, Educational and Entertainment markets. The performance limitations of Entry Level designs have to do with downflow ductwork for direct ducting to the unit openings in the bottom of the RTU cabinet. As the building ductwork size and aspect ratio can vary dramatically from that of the unit openings, the result is often a transition elbow fitting directly below the supply and return openings that may also incorporate multiple offsets to make up for misalignment of unit and building ductwork centerlines. HUSHCORE™ plenum curb construction allows for direct ducting, without offset or transition, to an opening (can be field cut) in the curb panelized bottom floor that is staggered from the actual unit opening. Fan sound attenuation for high performance designs is usually located closer to the curb/unit assembly and sometimes integrated inside the curb above deck. All of these design features reduce noise from turbulence, reduce duct breakout noise and reduce flanking or leakage because we are ducting to the curb and not the unit. Below are some examples of HUSHCORE™ *Whisper*™ "E" and *Ultra*™ High Performance Systems.

## HUSHCORE™ *WHISPER™ Type "E"* Acoustical Curb System




## HUSHCORE™ *ULTRA™* Acoustical Curb System



# DUCTWORK CONSIDERATIONS

Duct type and sizing needs to be consistent with NC target criteria. Duct layouts should follow the recommendations of SMACNA and ASHRAE design handbooks. The table at right shows target velocities for rectangular and circular duct shapes based on the project NC goals. In addition to controlling duct velocities, care must be taken during duct design to avoid abrupt take-offs, turns or changes in cross sectional area and aspect ratio. Contact BRD for more duct design guidelines.

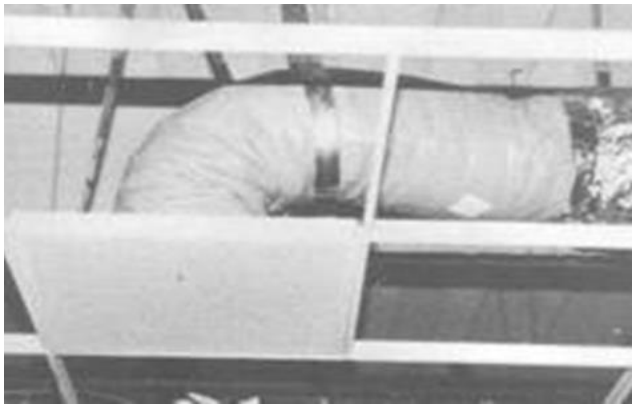
| Duct Location | RC or NC Rating in Adjacent Occupancy | Max. Airflow Velocity in Feet Per Minute | |
|---|---|---|---|
| | | Rectangular | Circular |
| In shaft or above solid drywall ceiling | 45 | 3500 | 5000 |
| | 35 | 2500 | 4500 |
| | 25 | 1700 | 3000 |
| Above suspended acoustical ceiling | 45 | 2500 | 4500 |
| | 35 | 1800 | 3000 |
| | 25 | 1200 | 2000 |

# CONTROLLING DUCT BREAKOUT NOISE

Duct breakout noise in the first 20' of ductwork connected to the unit is most effectively handled using HUSH GUARD™ acoustical panel plenums with horizontal round or flat oval duct taps. Externally applied acoustical composite sound insulation lagging is not quite as effective in the 63 to 250 Hz octave bands, but it is much more cost-effective. The HUSHCORE™ *Barricade*™ System (LVQ-210-LAG) is one such cost-effective lagging material.

# ROOM DIFFUSERS

The use of flex ducts for take-offs to room diffusers should be done with long radius 90° elbows. "Kinked" or "snaked" flex duct can increase NC levels by 7 to 9 points (see picture at right). Even ideal flex duct configurations will increase room NC values beyond the diffuser ratings as all diffusers NC ratings are reflective of ASHRAE Standard 70 inlet conditions of three equivalent straight duct diameters. It is recommended that diffusers be selected at 6 to 8 NC points below the room target NC.



# RTU OUTDOOR NOISE CONTROL TREATMENTS

The outdoor radiated noise of packaged rooftop units is mostly attributable to the condenser section where DX cooling is incorporated. The scroll compressors and condenser fans of the condenser section can be treated like an air-cooled chiller. Please refer to our detailed tutorial for Controlling Chiller Noise. Below we have shown some HUSHCORE™ RTU Source and Path type treatments.

## SOURCE TREATMENTS

- ***Reduces outdoor radiated noise associated with condenser section fans and compressors***

- ***Unitary***™ System top mounted discharge stack for condenser fan exhaust noise
- ***Standard***™ **"SL"** System HUSH COVER™ removable wraps for all scroll compressors
- ***Louver***™ System HDAL acoustical louvers for coil air intakes

## PATH TREATMENTS

- ***Reduces radiated noise from all RTU cabinet sources***

- ***Screen***™ System perimeter screen is RTU or curb supported
- Acts as visual and acoustic screen
- Service access facilitated with sliding HUSH GUARD™ panels
- ***Supreme***™ System roof barriers supported by roof steel are available for increased performance (STC-42) and where wind resistivity dictates.

*Unitary™ System discharge plenum*

*HUSH SCREEN™ STC-35 rated Barrier*

*Scroll compressor HUSH COVERS™*

*Supreme™ System RTU Sound Barrier*