# Sound Control, Standards, & How to get what you expect!

**Presented By**

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**www.HUSHCORE.Net**

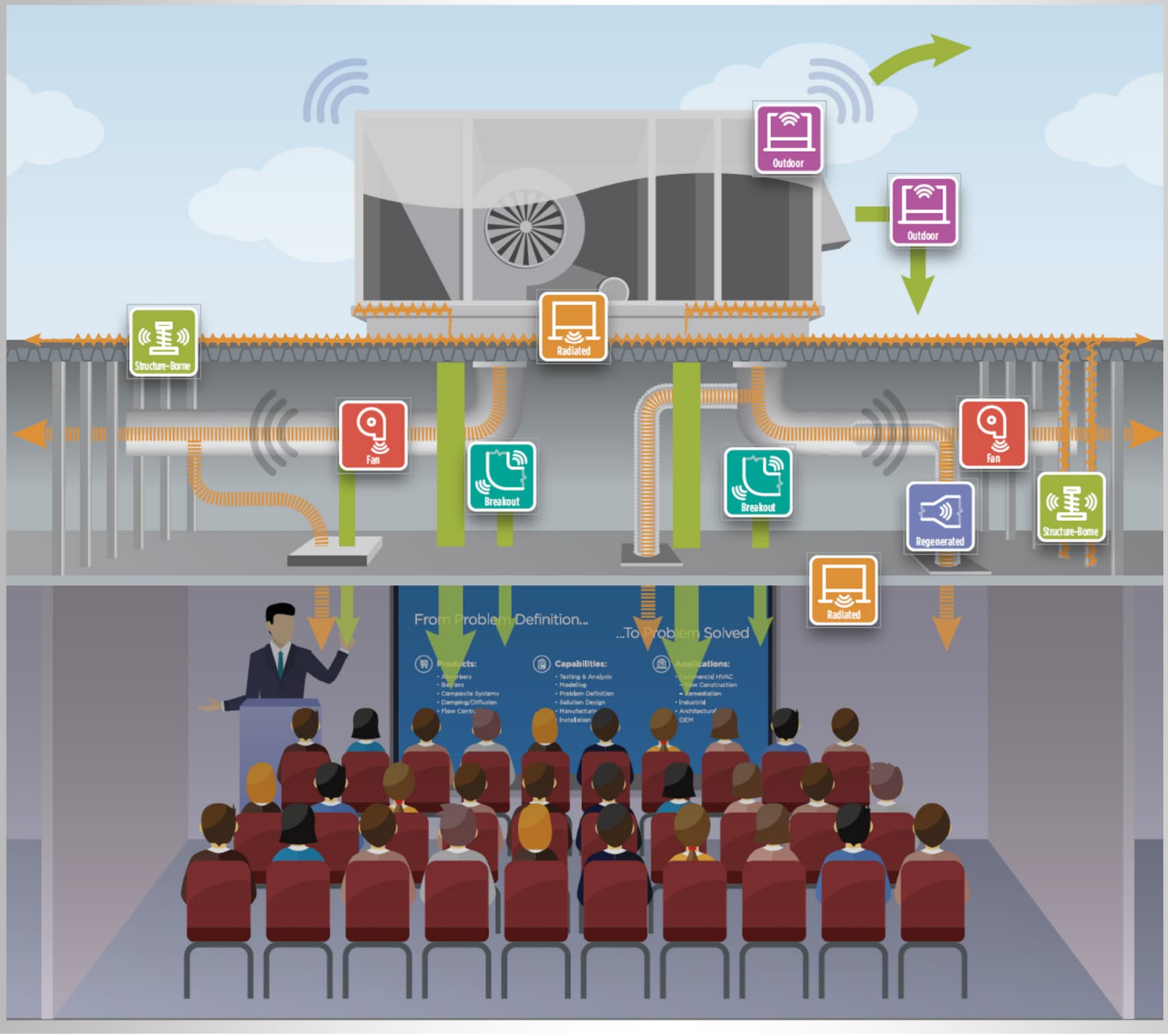
# Considerations

1. Design & responsibility
   - Early in project or an after thought
   - Architect, engineer, equipment supplier, acoustician
2. Sound target/goal
   - Objective
   - Subjective
3. Equipment/system compatibility
   - Operation/warranty
   - Servicing
   - Pressure drop
   - Etc…

# Sound Control

## Curb Mounted RTU’s

# Noise Transmission Paths



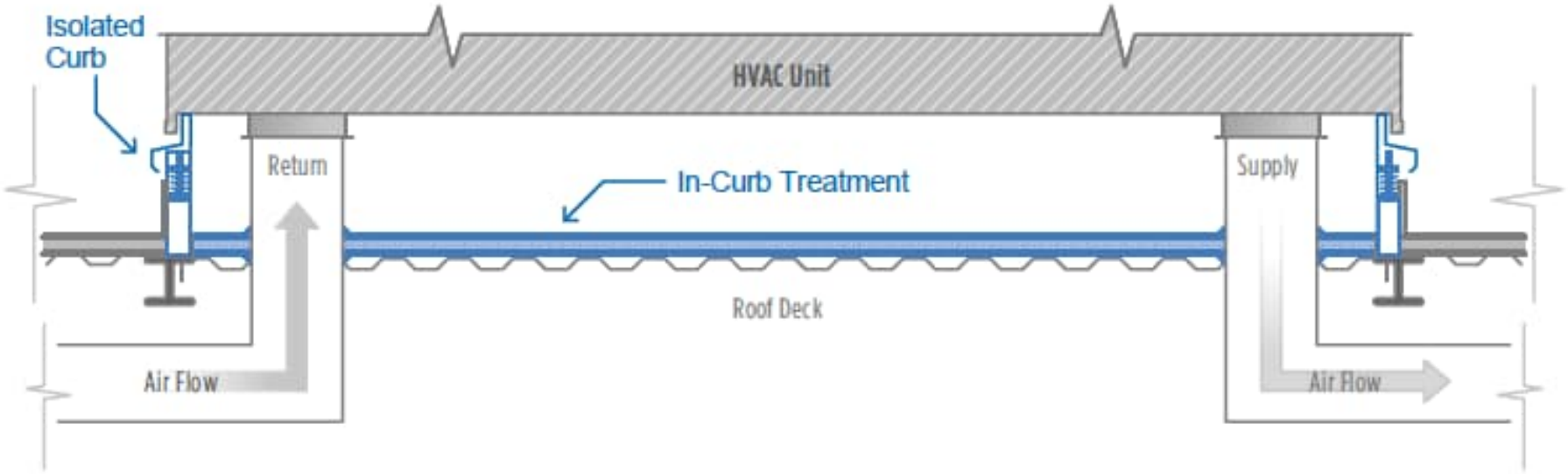

# RTU System Sound Control Best Practices - Traditional

- Internal unit isolation or vibration rails
- Built up gypsum board/insulation in-curb treatment
- Scheduled attenuators or lined duct
- Heavy gauge duct for first 15-20’ under units.


# In-curb Acoustic Treatment

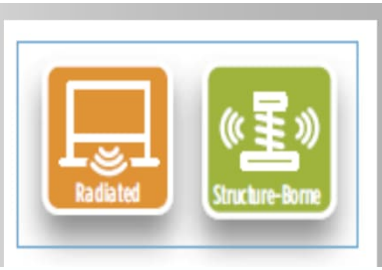
**Entry Level Systems - "BETTER"**

Direct ducted designs with fan attenuation addressed elsewhere



## Acoustical Treatment of RTU Radiated Noise

In-Curb acoustical systems provide designers/specifiers with due diligence and known performance that is not achievable with a traditional gyp and batt insulation.



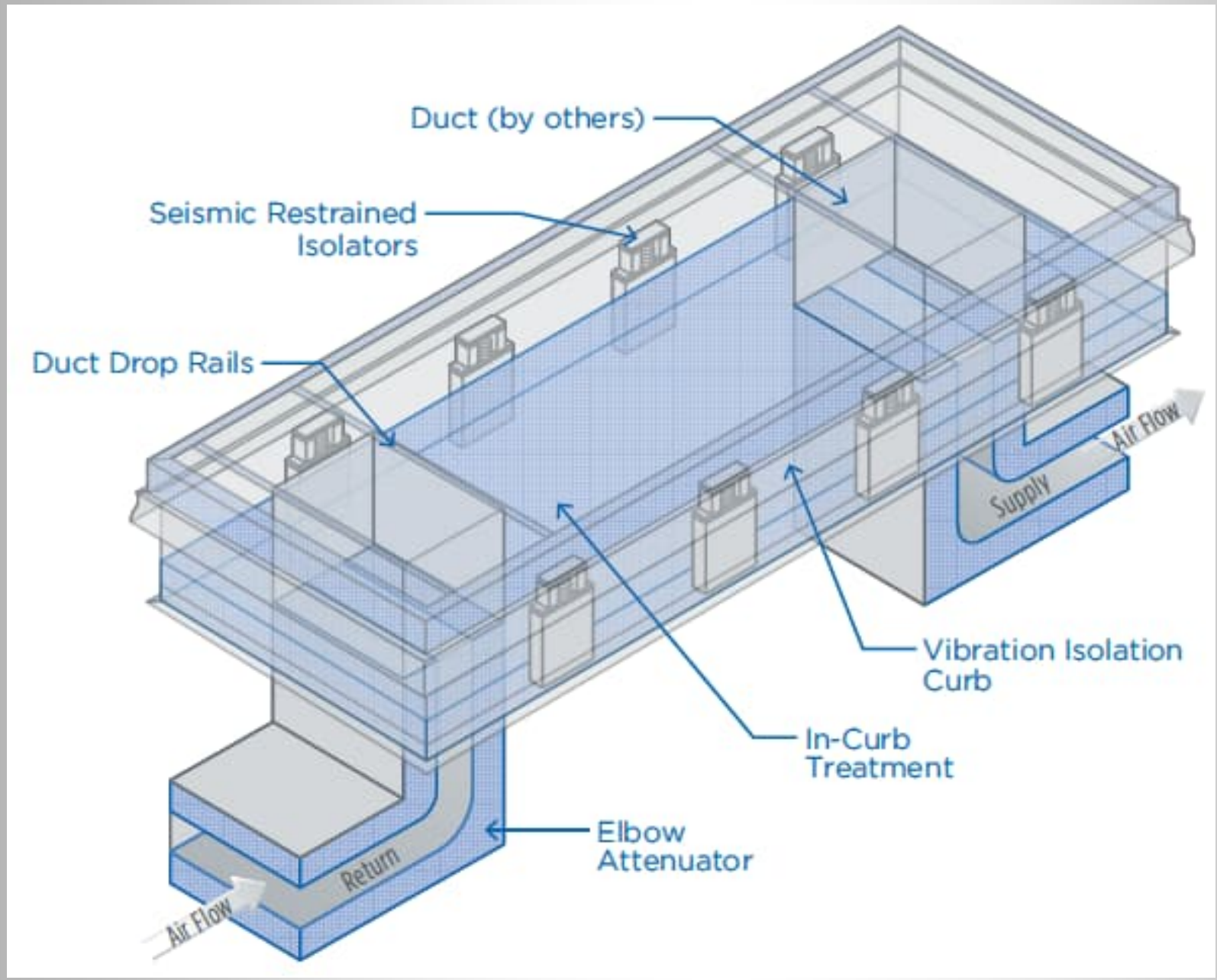

| | | |
|---|---|---|
| **Performance** | ■ Independently tested w/range of attenuation | ■ Unknown |
| **Commissioning** | ■ Submittal required per new specification with provision for site inspection/verification<br>■ 100% confidence provided | ■ No submittals<br>■ No site verification required/specified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

# GOOD / BETTER / BEST
# Design Model

- Integrated vibration/seismic pre-assembled curb (larger tonnage units)
- Engineered in-curb acoustical package (deck supported – all tonnage units)
- Elbow silencers at deck openings (Larger tonnage units)
- Deck openings flashed to ¼” and sealed with acoustic grade caulk

# Entry Level Systems - "BEST"

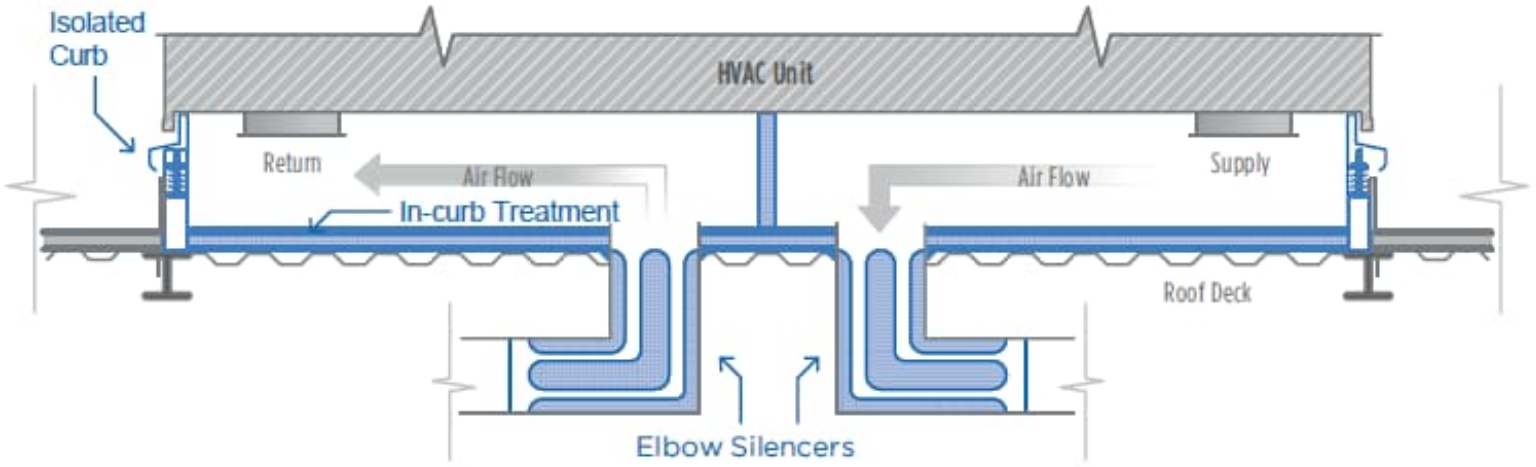
Direct ducted designs with integrated fan attenuation




# HIGH PERFORMANCE LEVEL
# PROJECT SPECIFIC

## High Performance Systems

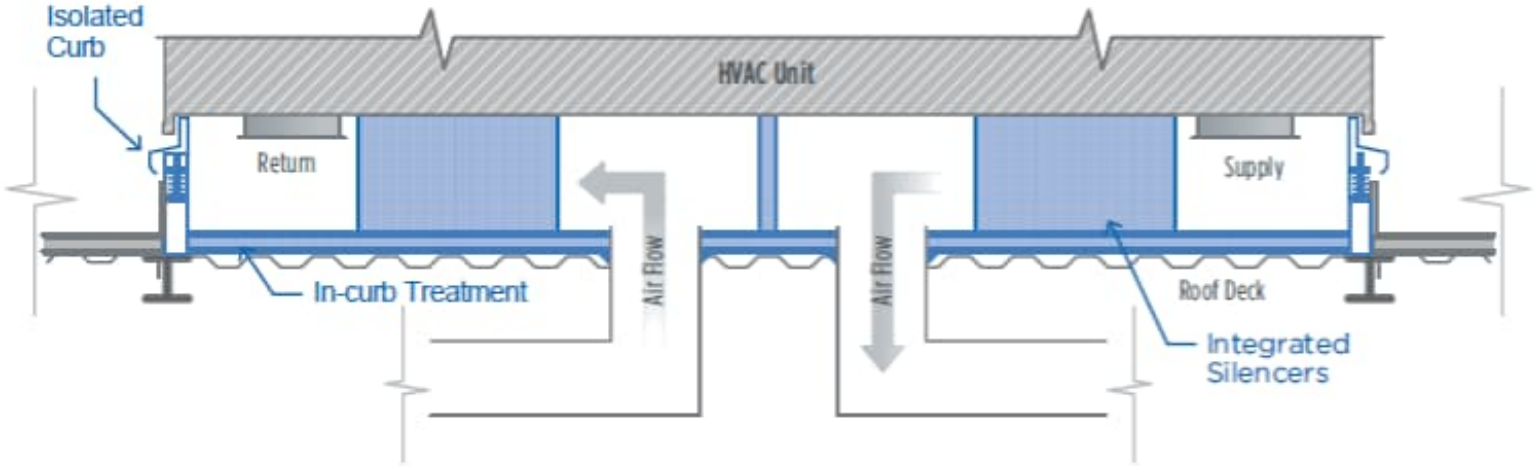
Plenum curbs with silencers at deck openings



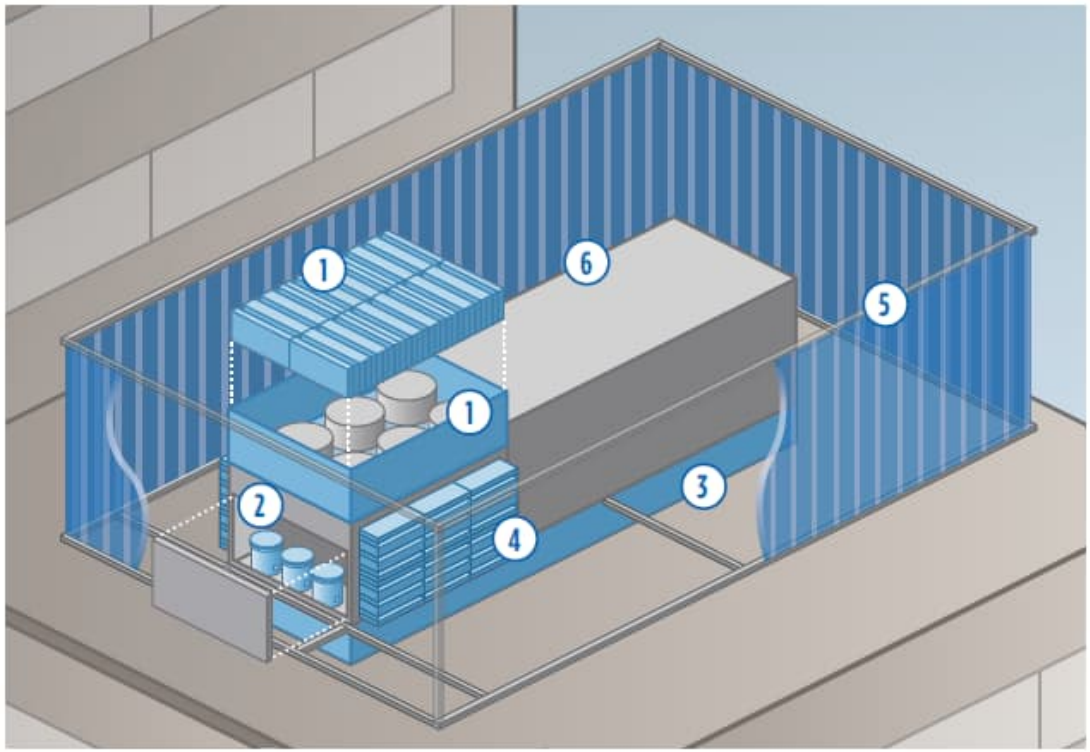


## Custom Systems

Complete plenum curb integrated designs




# Outdoor Solutions



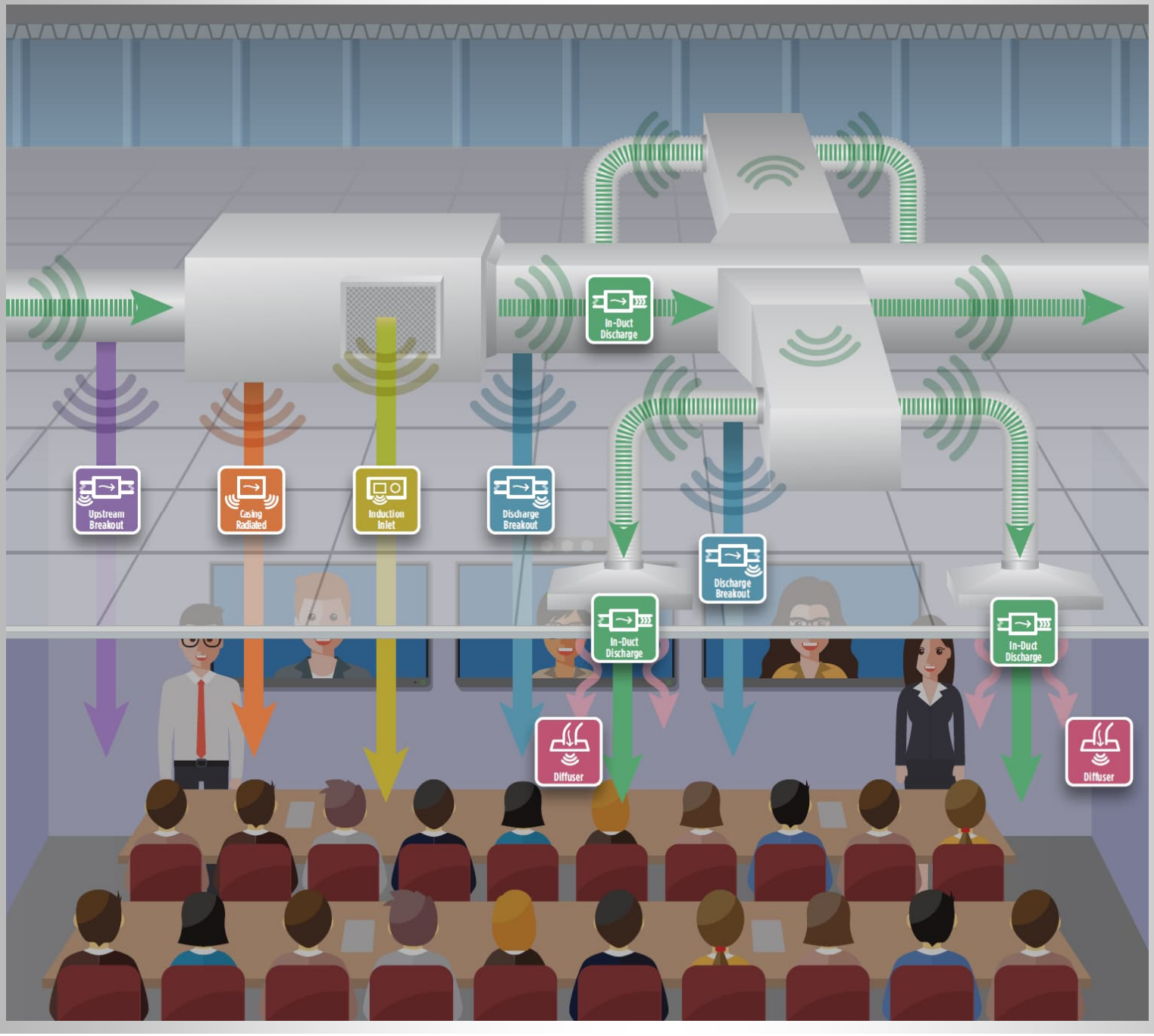

1. Acoustical condenser fan discharge stack (4-6+ dBA)
2. Acoustical covers for scroll compressors (2-4 dBA)
3. Vibration curb in-curb acoustical system (8-10+ dBA)
4. Acoustic condenser air intakes (4-8+ dBA)
5. Acoustical curb/unit supported screen (7-10 dBA)
6. Rooftop unit



# Sound Control

## Air Terminal Unit

# Noise Transmission Paths




Casing Radiated

Induction Inlet

In-Duct Discharge

Discharge Breakout

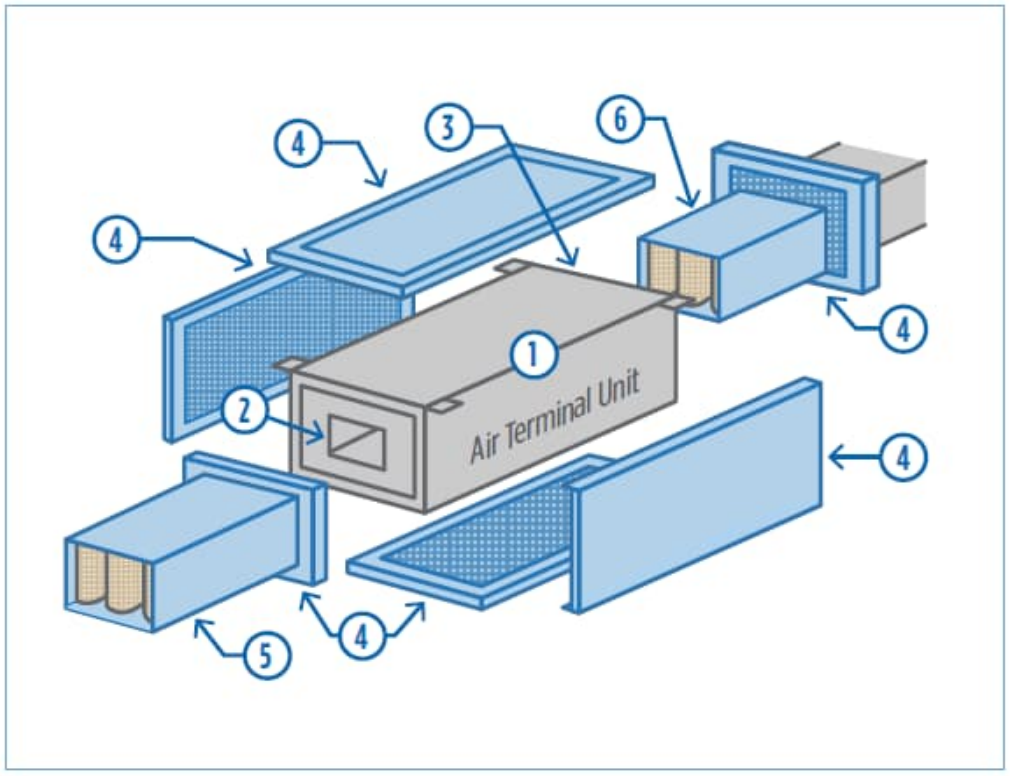
Upstream Breakout

Diffuser

# *Best Practices*
# VAV Boxes

- Lined discharge 10’ to 15’
- First take-off minimum 3’ from discharge
- Single duct VAV 1500 – 1700 CFM
- Fan powered VAV 1100 – 1200 CFM
- External wraps for casing radiated noise

# Air Terminal Units




ATU Manufacturer

1. Air Terminal Unit
2. Primary Air Inlet
3. Unit Outlet (Discharge)

Acoustical Manufacturer

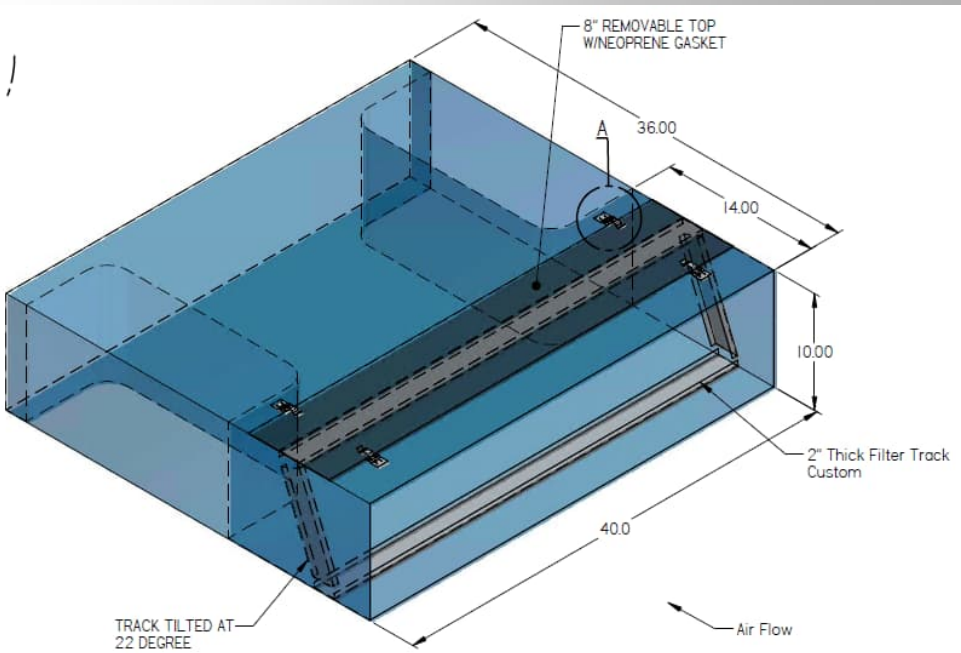
4. Removable Acoustic Enclosure (4-6 dBA)
5. Inlet/Return Silencer (4-10+ dBA)
6. Outlet/Discharge Silencer (4-10+ dBA)

Fan powered VAV box

Water-Source Heat Pump

# Removable Acoustic Enclosure System

- *Casing radiated noise attenuation*
- Velcro removable panels jacket system
  - Can be Class A rated
- Easy access to service fan, compressor, filters, etc.



# Sound Control

## Chiller

# Water-Cooled Chiller Treatments

## ***GOOD***
Acoustical Cover Systems

- Source control
- Removable Sound Blankets
- 3 to 6 dBA reduction
- Non-critical applications

## ***BETTER***
Acoustical Enclosure System

- Direct path control
- Acoustical curtain system
- Sliding panel perimeter walls and removable roof
- 12 to 15 dBA typical reduction
- Velcro panel joining
- Noise sensitive applications

## ***BEST***
Acoustical Enclosure System

- Direct Path Control
- Modular panel enclosure
- Access doors and removable service panels
- 15 to 20 dBA typical reduction
- Optional ventilation system
- Critical attenuation projects

# Air-Cooled Chiller Treatments

## ***GOOD***
### Acoustical Cover System

- Source control
- Removable Sound Blankets
- 3 to 8 dBA reduction
- Non-critical applications

## ***GOOD***
### Acoustical Intake System

- Source Control
- Acoustical louvers/silencers
- Direct mounting to lower and/or upper intake areas
- Typically galvanized steel construction
- Typical performance of 3 to 5 dBA for lower area and 5 to 7 dBA for upper and lower areas
- Typical pressure loss of 0.10” to 0.20” w.g.

## ***BETTER***
### Acoustical Discharge System

- Path Control at the source
- Modular acoustical panels
- Attenuates condenser fan noise
- 4 to 12 dBA reduction
- Outperforms Low Noise Fans
- Minimal pressure loss impact

# Air-Cooled Chiller Treatments

## ***BETTER***
Acoustical Barrier System

- Direct path control
- Designs for attachment to chain link, masonry walls, or other structures
- 10 to 12 dBA typical reduction
- Applications to attenuate compressor and condenser fan noise

## ***BETTER***
Acoustical Barrier System

- Direct path control
- Modular acoustical barrier wall
- Acoustical panels stacked between structural steel support columns
- 12 to 15 dBA typical reduction
- Noise Sensitive Installations
- Height of barrier wall depends on operating clearance around equipment and desired noise reduction.

## ***BEST***
Acoustical Enclosure System

- Direct Path Control
- Modular acoustical barrier wall
- Acoustical panels stacked between structural steel support columns
- Integrated acoustical air intake and parallel baffle exhaust plenum for aerodynamic performance
- 15 to 20+ dBA typical reduction
- Critical attenuation projects

# STANDARDS

# STANDARDS

- Provide certified Sound Levels for an equal comparison based on operating conditions (AHRI)
- Some provide calculations to estimate sound levels per specific conditions/application (for example AHRI 885
- AHRI standards are typically more stringent than AMCA standards
  - Comparing data between them is apples and orange

# Base Line Data (Standards)

- Per ASHRAE Handbook

  “When reviewing manufacturer’s sound data, obtain certification that the data have been obtained according to one or more of the relevant industry standards. If they have not, the equipment should be rejected in favor of equipment for which data have been obtained according to the relevant standard.”

# Rooftop Units

- Two primary standards are
  - AHRI 260 – applies to ducted portions of RTU
  - AHRI 370 – applies to condensing (outdoor) portion of RTU
- AMCA 300 or 303 is not comparable with ARHI 260 data.
  - AMCA is fan only and does not account for appurtenances (coils, cabinets, etc.)

- Different Standards AHRI & AMCA
  - Outdoor RTU Sound Levels

| Mnfr | Standard | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | dBA |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | AHRI 370 | 104 | 98 | 97 | 97 | 95 | 93 | 88 | 79 | 100 |
| 2 | AHRI 370 | NA | 99 | 97 | 96 | 96 | 94 | 89 | 89 | 104 |
| 3 | AMCA 303 | 88 | 91 | 89 | 86 | 82 | 80 | 77 | 73 | 88 |

# Air Terminal Units

- Start with certified sound power levels per AHRI 880-2011
- Use transfer functions in AHRI 885-2008 for power to pressure conversion. (Note that NC ratings are not part of AHRI 880).
- Separate transfer functions for radiate and discharge paths
- ATU catalog ratings are not likely to match actual NC in built environment.

| | 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 revision |
| **Transfer Functions** | Project specific correction factors selected 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 |

## Typical Transfer Functions per AHRI-885

| 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

# SPECIFICATIONS

## How to get what you expect

# Traditional Spec Strategies

- Specify sound data for lowest rated model as equipment basis of design
- Specify all available OEM equipment low noise options
- Specify the same treatment used on the last noise sensitive project
- Retain an acoustical consultant to write the specification
- Specify base equipment and address any noise problems at start-up

# Specification Minimum Criteria

1. *Meet objective criteria*
2. *Performance accountability*
3. *Maintain building & equipment compatibility.*

# Good Specification Bonuses

- Integrated and single source responsibility
- Clear guidelines for installing contractor
- Pre-assembled construction to reduce overall cost
- Submittal/Inspection/Certification
- Embed in the equipment schedule note
- Design due diligence

# RTU Traditional Sound Spec

## Mixed Results

### VIBRATION ISOLATOR SCHEDULE

| MANUFACTURER | MODEL # | ISOLATOR TYPE | EQUIPMENT SERVED | DEFLECTION | REMARKS |
|---|---|---|---|---|---|
| | | NEOPRENE AND SPRING HANGERS | ALL FAN COIL UNITS | 1.0" | 2 3 |
| | | VIBRATION RAIL CURB WITH SPRING ISOLATORS | ROOF-TOP AHU'S AH-1, AH-2, AND AH-3 | 2.0" | 1 2 3 4 5 |
| | | NEOPRENE MOUNTS | CHILLERS CH-1, CH-2 | 0.5" | 2 |
| | | NEOPRENE MOUNTS | OUTDOOR CONDENSING UNITS OU-1 THRU OU-7 | 0.35" | |

(1) 24" HIGH FULLY ASSEMBLED, ADJUSTABLE VIBRATION ISOLATION CURB.

(2) PROVIDE FLEXIBLE PIPE CONNECTORS ON ALL CHILLED WATER CONNECTIONS PER DETAIL SHEET M501 AND SPEC. SECTION 230519.

(3) PROVIDE FLEXIBLE DUCT CONNECTIONS AT ALL DUCTWORK CONNECTIONS.

(4) PROVIDE [illegible] IN-CURB ACOUSTICAL TREATMENT WITH ACOUSTICAL GRADE CAULK AT SEAMS, PERIMETER EDGES, AND DUCT DROPS.

(5) CURB WT. = 1,340 LBS FOR AH-1, 1,250 LBS FOR AH-2 AND 1,270 LBS FOR AH-3.

### SOUND ATTENUATOR SCHEDULE

SA

| SYMBOL | MANUF. & | SIZE W x H x L | CFM | FLOW | MAX. AIR PRESS. DROP | ROOM DESIGN NC(dB) | DYNAMIC INSERTION LOSS, DB | | | | | | | | WEIGHT (LBS.) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 | | |
| SA 1-1 | | 36"x48"x60" | 13,000 | FORWARD | 0.24" | 25 | 8 | 13 | 23 | 29 | 28 | 17 | 14 | 13 | 275 | 2 3 4 6 |
| SA 1-2 | | 72"x30"x84" | 12,500 | REVERSE | 0.26" | 30 | 11 | 21 | 36 | 51 | 53 | 53 | 43 | 25 | 490 | 2 3 5 6 |
| SA 2-1 | | 30"x48"x60" | 10,500 | FORWARD | 0.22" | 25 | 8 | 13 | 23 | 29 | 28 | 17 | 14 | 13 | 245 | 2 3 4 6 |
| SA 2-2 | | 72"x24"x84" | 10,000 | REVERSE | 0.25" | 35 | 11 | 21 | 36 | 51 | 53 | 53 | 43 | 25 | 490 | 2 3 5 6 |
| SA 3-1 | | 48"x30"x60" | 10,000 | FORWARD | 0.20" | 25 | 8 | 13 | 23 | 29 | 28 | 17 | 14 | 13 | 245 | 1 2 4 6 |
| SA 3-2 | | 48"x30"x120" | 9,500 | REVERSE | 0.40" | 35 | 13 | 33 | 44 | 51 | 51 | 53 | 48 | 26 | 690 | 1 2 5 6 |
| SA 4-1 | | 48"x24"x36" | 7,200 | FORWARD | 0.19" | 35 | 4 | 7 | 15 | 20 | 17 | 13 | 11 | 10 | 130 | 1 2 4 6 |
| SA 4-2 | | 48"x24"x60" | 6,700 | REVERSE | 0.25" | 35 | 11 | 21 | 36 | 51 | 53 | 53 | 43 | 25 | 240 | 1 2 5 6 |

(1) VERIFY SILENCER WIDTH & HEIGHT WITH STRUCTURE CLEARANCES PRIOR TO ORDERING.

(2) VERIFY ANY INCREASE IN WEIGHT WITH THE STRUCTURAL ENG. PRIOR TO ORDERING.

(3) INSTALLED OUTDOORS.

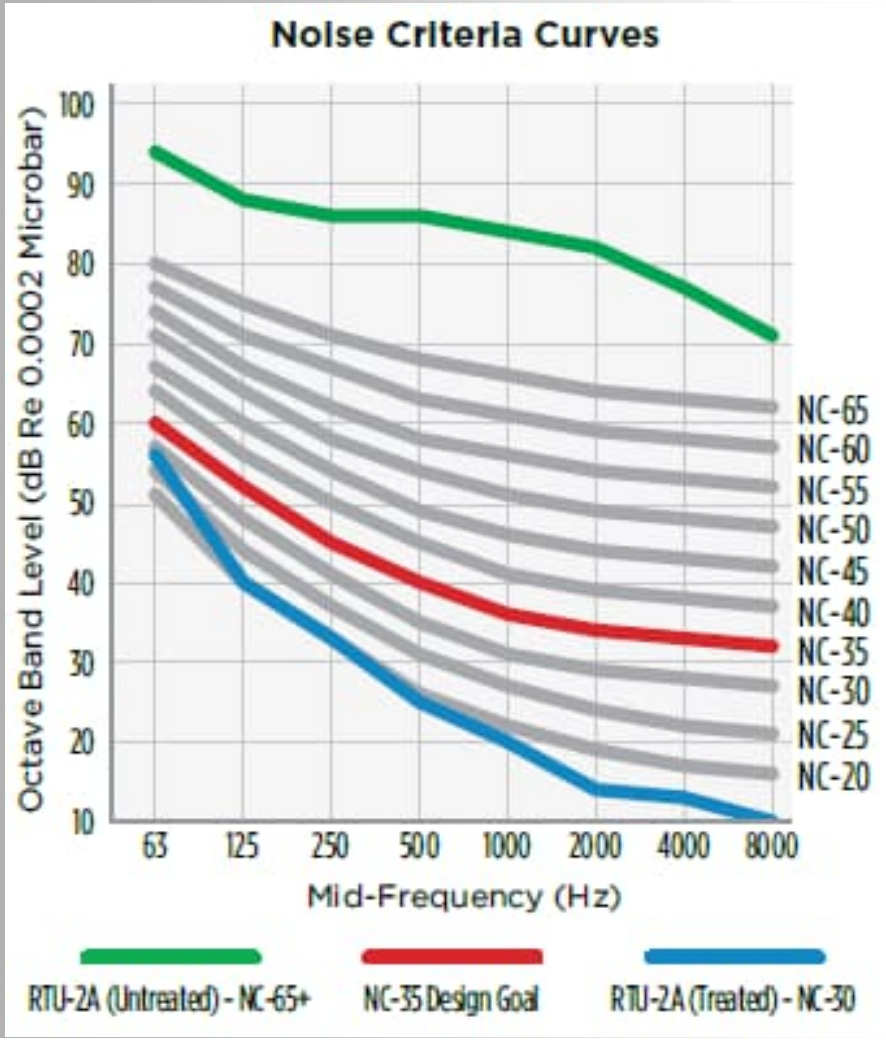
(4) SUPPLY DUCT.

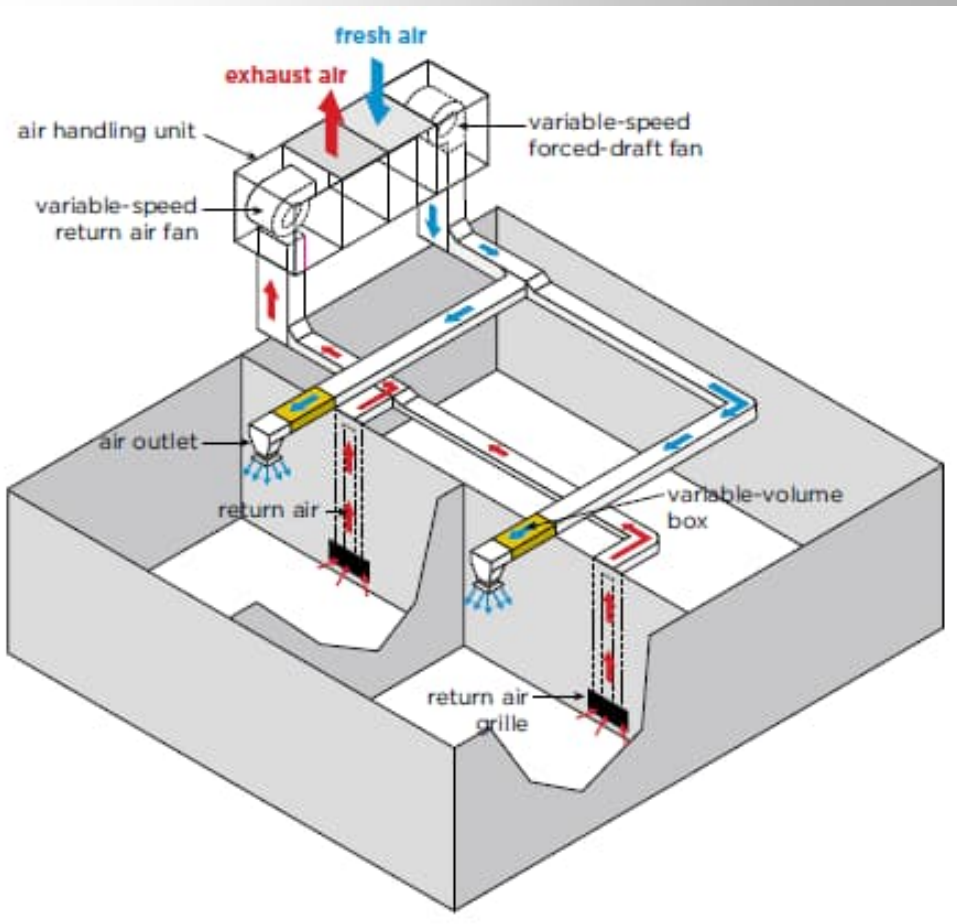
(5) RETURN DUCT.

(6) THE SOUND ATTENUATOR SIZE, TYPE AND REQUIRED DIL ARE FOR BID PURPOSES ONLY. THE CONTRACTOR/SUPPLIER SHALL PROVIDE JOB SPECIFIC NOISE ANALYSIS CALCULATIONS DURING THE SUBMITTAL PROCESS FOR APPROVAL, AND MAKE NECESSARY CHANGES TO THE SOUND ATTENUATORS AS REQUIRED.

Sound Control, Standards, & How to get what you expect!

| | Path Summation with Attenuation | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Octave Band (Hz)** | **63** | **125** | **250** | **500** | **1000** | **2000** | **4000** | **8000** |
| **Radiated Path** | 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 |



# Schedule

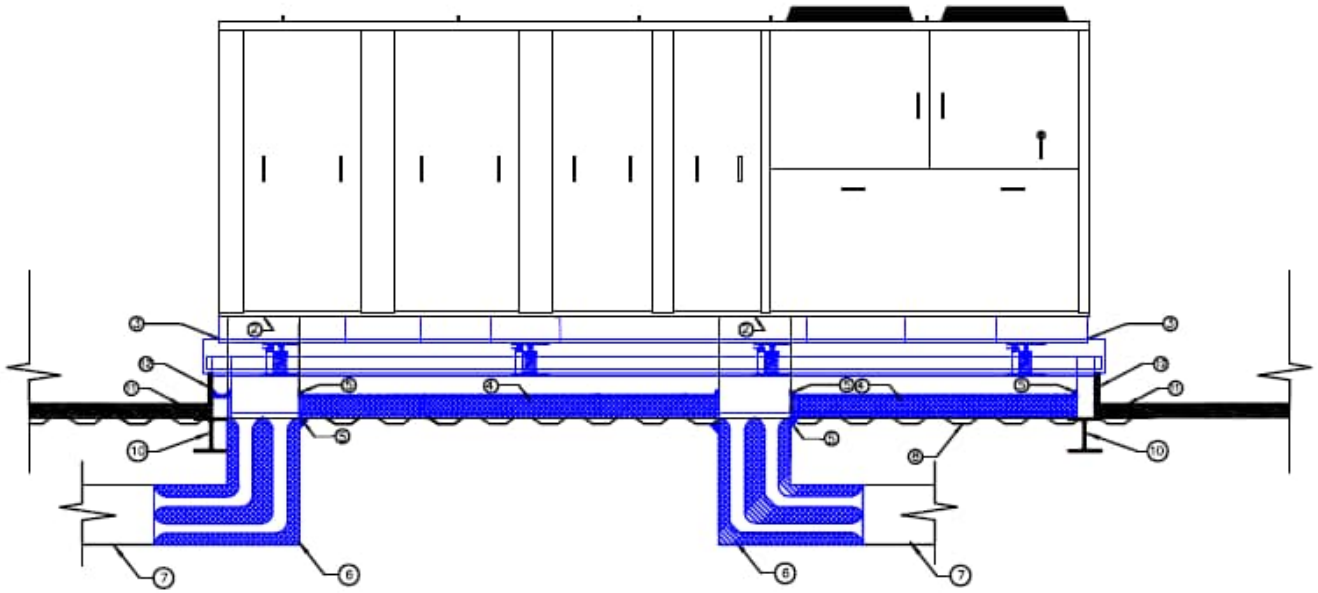
## RTU NOISE CONTROL SCHEDULE

| UNIT TAG | TYPE | CURB HEIGHT (IN) | IN-STREAM ATTENUATION | | | | | | MIN. DEFLECTION (IN) | NC LEVEL REQ'D | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | TAG | SA FLOW (CFM) | INSTALLED SA PD (IN WG) | TAG | RA FLOW (CFM) | INSTALLED RA PD (IN WG) | | | |
| AH-1 | | 24 | SA 1-1 | 13000 | 0.25 | SA 1-2 | 11500 | 0.25 | 2 | 20-30 | 1,2,3,4,5,6,7,8,9 |
| AH-2 | | 24 | SA 2-1 | 10500 | 0.22 | SA 2-2 | 10000 | 0.25 | 2 | 30-35 | 1,2,3,4,5,6,7,8,9 |
| AH-3 | | 24 | SA 3-1 | 10000 | 0.14 | SA 3-2 | 10000 | 0.37 | 2 | 30-35 | 1,2,3,4,5,6,7,8,9 |
| AH-4 | | 14 | SA 4-1 | 7200 | 0.10 | SA 4-2 | 7200 | 0.27 | 0 | 30-35 | 1,2,3,4,5,6,7,8,9 |

NOTES:

1. BASIS OF DESIGN . APPROVED AS OR EQUAL SHALL PROVIDE AS PART OF A QUALIFIED BID AND ACOUSTICAL REPORT DEMONSTRATING COMPLIANCE, NO EXCEPTIONS.
2. EQUIPMENT SCHEDULED SHALL BE MOUNTED ON FULLY ADJUSTABLE AND ASSEMBLED VIBRATION/ISOLATION CURB SYSTEM. CURB SHALL HAVE COMPLETELY ISOLATED TOP AND BOTTOM STEEL STRUCTURAL FRAMES WITH CONTINUOUS FLEXIBLE WEATHER SEAL. THE SYSTEM SHALL BE CAPABLE OF SERVING AS A BLOCKING DEVICE DURING INSTALLATION. SPRINGS SHALL HAVE BUILT IN LIMIT STOPS TO SNUB OUT WIND RESISTANCE. FACTORY CURBS WITH SECONDARY VIBRATION PAD KIT ARE NOT ACCEPTABLE.
3. THE CURB SYSTEM SHALL PROVIDE A SPACE NOISE CRITERIA (NC) AS SCHEDULED AND NOTED BELOW
   NC 20 – AUDITORIUM
   NC 30-35 – CLASSROOMS
   NC 40 – CORRIDORS
   SUBMIT COMBINED ACOUSTICAL CALCULATIONS TO DEMONSTRATE RESULTANT IN-DUCT, DUCT BREAK-OUT, & ROOF TRANSMISSION CONTRIBUTIONS TO A GIVEN SPACE WILL NOT EXCEED NC LEVELS SCHEDULED.
4. PRESSURE DROPS SCHEDULED TO INCLUDE SYSTEM EFFECTS.
5. CURB SYSTEM TO HAVE ACOUSTIC BOTTOM TO PREVENT ROOF TRANSMISSION INTO THE SPACE WITH TRANSMISSION LOSS VALUES AS SHOWN IN THE DETAIL AND IN COMPLIANCE WITH THE NC LEVEL SCHEDULED.
6. SYSTEM SILENCERS TO BE PROVIDED TO COMPLY WITH NC LEVELS SCHEDULED, INTERIOR SYSTEMS TO INCLUDE HIGH TRANSMISSION LOSS CASINGS (MIN. 18 GA) FOR BREAK-OUT NOISE, AND SIZE, & LOCATION SHALL BE PRE-COORDINATED BASED ON THE MECHANICAL PLANS REQUIRING MINOR FIELD COORDINATION.
7. CURB SYSTEM SHALL BE DESIGNED TO ACCOMMODATE ROOF SLOPE AND TO FIT THE EQUIPMENT SCHEDULED.
8. CONTRIBUTIONS FROM OTHER NOISE SOURCES SUCH AS DAMPERS, DUCT REGENERATED NOISE, DIFFUSERS, ETC... MUST BE AT LEAST 5 DB BELOW THE SCHEDULED NC LEVEL.

# BEST – Example Spec Detail



BY RTU UNIT MANUFACTURER

1. RTU Base
2. SA/RA Unit Openings

BY ACOUSTICAL MANUFACTURER

3. 2" Deflection Full Perimeter Curb
4. In-Curb Acoustical Treatment
5. Acoustical Caulk at all Duct Drops & Curb Perimeter
6. Elbow Silencers for SA/RA

BY HVAC CONTRACTOR

7. Duct work
8. Roof Deck Flashed to within $\frac{1}{4}$" of all Duct Drops but not in contact with Duct Wall
9. Submit letter of certification from acoustical supplier following inspection.

BY GENERAL CONTRACTOR

10. Building Steel
11. Built-up Roof or Concrete
12. Insulation and Cant Strip
13. Curb Slope requirements where applicable

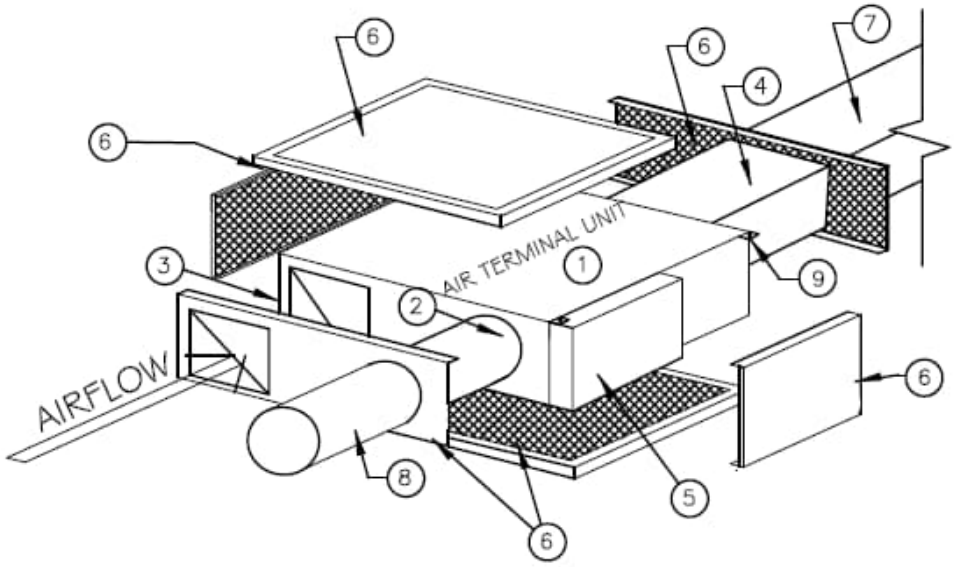
## RTU NOISE REDUCTION SYSTEM

1. Curbhall be a 2" deflection, fully adjustable and fully assembled curb system.
3. Curb shall be wind and seismic rated in accordance with latest IBC code and registered PE structural engineering stamp provided for the state of installation.
4. The completely isolated top and bottom steel frames have a continuous isolated weatherseal that does not diminish the isolation efficiency of min. 85%
5. The system shall be capable of serving as a blocking device during installation.
6. The springs shall have built-in limit stops to snub out resistance.
7. The curb shall have a field installed in-curb sound package for radiated noise with an installed thickness not to exceed 10"
8. Acoustical grade caulk shall be used around all curb perimeter edges and around all curb openings as detailed above after decking is flashed to within $\frac{1}{4}$" without contacting the duct wall.
7. In-curb sound package shall be suitable for a plenum curb where applicable.
8. The curb shall be shipped completely assembled. Silencers may ship loose for field installation.
9. The in-stream fan noise on the curb RA/SA shall be treated by silencers as per below in the performance section, RTU NOISE CONTROL SCHEDULE, and the specifications.
10. Factory curbs with secondary vibration rail kit is not acceptable.
11. A letter of certification shall be issued by the acoustical system supplier stating the complete system has been properly installed prior to setting the units. Photo verification is acceptable for review and approval.
12. Products and systems shall be by ABC company or approved equal.

## PERFORMANCE

1. To assure optimized aerodynamic and acoustic performance as well as proper integration and coordination of the final installation, the curb system shall be supplied by the rooftop unit manufacturer as part of a complete package.
2. The in-curb sound package shall be tested in accordance with procedure ASTM E-90-10. The assembly shall be rated at not less than the 1/3 octave performance values as listed below for sound radiation through the deck inside the curb.
3. Silencer attenuation shall be tested in accordance with ASTM E477-13 and have a flame spread classification <25 and smoke development rating <50 when tested in accordance with ASTM E84, UL723, and NFPA255. See RTU NOISE CONTROL SCHEDULE for acoustic and aerodynamic performance.

# NOISE CONTROL FOR DUCTED AIR TERMINAL UNITS




BY EQUIPMENT UNIT MANUFACTURER

1. Air Terminal Unit
2. Primary Air Inlet
3. Induction Air Inlet (If Present)
4. Unit Outlet (Discharge)
5. Control Box

BY ACOUSTICAL MANUFACTURER

6. Acoustical Enclosure

BY HVAC CONTRACTOR

7. Discharge Duct Work
8. Inlet Ductwork
9. Isolated Hanger Rods (Not Shown)
10. Flex Connections (Not Shown)

System consists of Velcro removable composite acoustical panels to form an enclosure to reduce the cabinet radiated noise levels of air terminal units. The panels shall be Class "A" flammability per ASTM E-84 when installed in a plenum rated ceiling. The system shall be designed using factory fabricated custom sized panels to be easily removable on all sides for periodic maintenance and service needs with side panel attachment and removal by Velcro only. Only the enclosure bottom panel shall be pinned to the cabinet in addition to Velcro support. Roll good materials cut in the field shall not be approved. Products and systems shall be by ABC company or approved equal.

PERFORMANCE

Acoustical Performance shall be tested per ASHRAE 130 with NR performance values as listed below for the cabinet/casing sound radiation path. The overall performance is based on previously tested installations with a typical casing dBA reduction in the 4 to 6 dBA range @ 3' from any point away from the system enclosure.

| System – (Noise Reduction) per ASHRAE 130 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Freq. (Hz) | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
| NR (dB) | 3 | 1 | 3 | 9 | 16 | 15 | 14 |

***Questions?***