



# ASHRAE Chapter Meeting HVAC Noise & Vibration Control RTU Best Practices

Presented By

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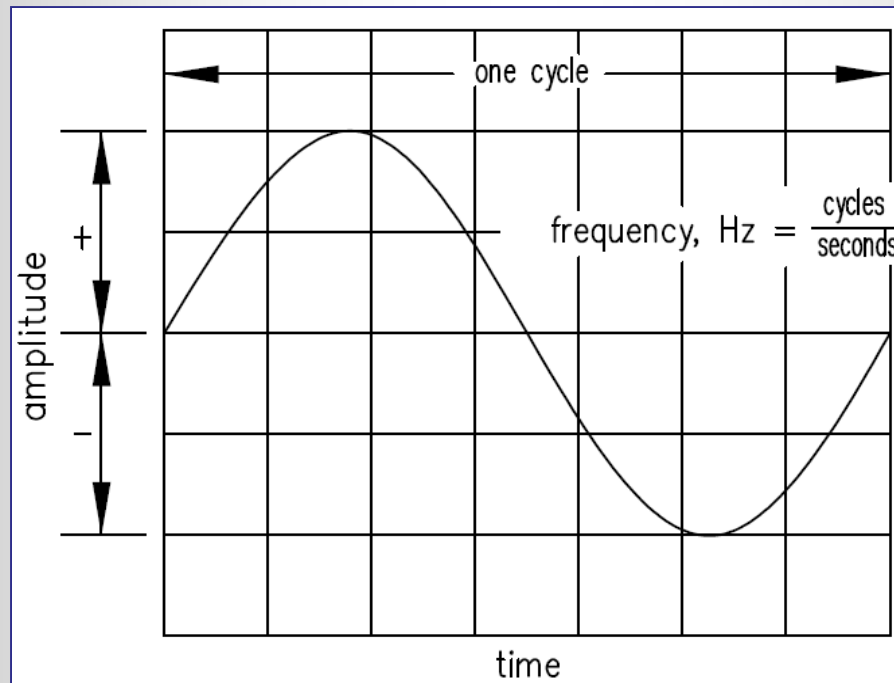
Noise & Vibration Control, Inc.  
610-863-6300

[www.brd-noise.com](http://www.brd-noise.com)



# Characteristics of Sound

- Quantity = Loudness (Intensity)
- Quality = Pitch (Tonal Content)
  - Character (Cyclical Ramping)

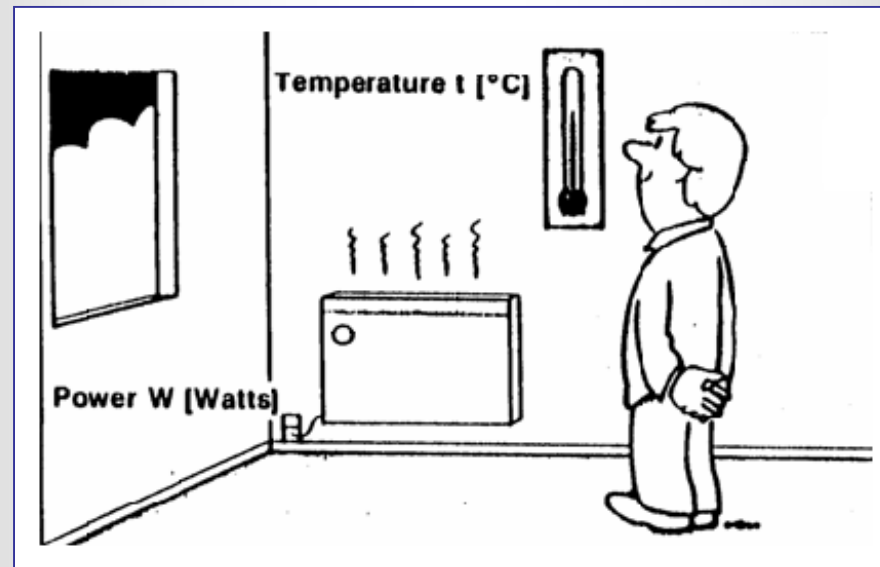




# Power vs. Pressure

## PWL vs. SPL

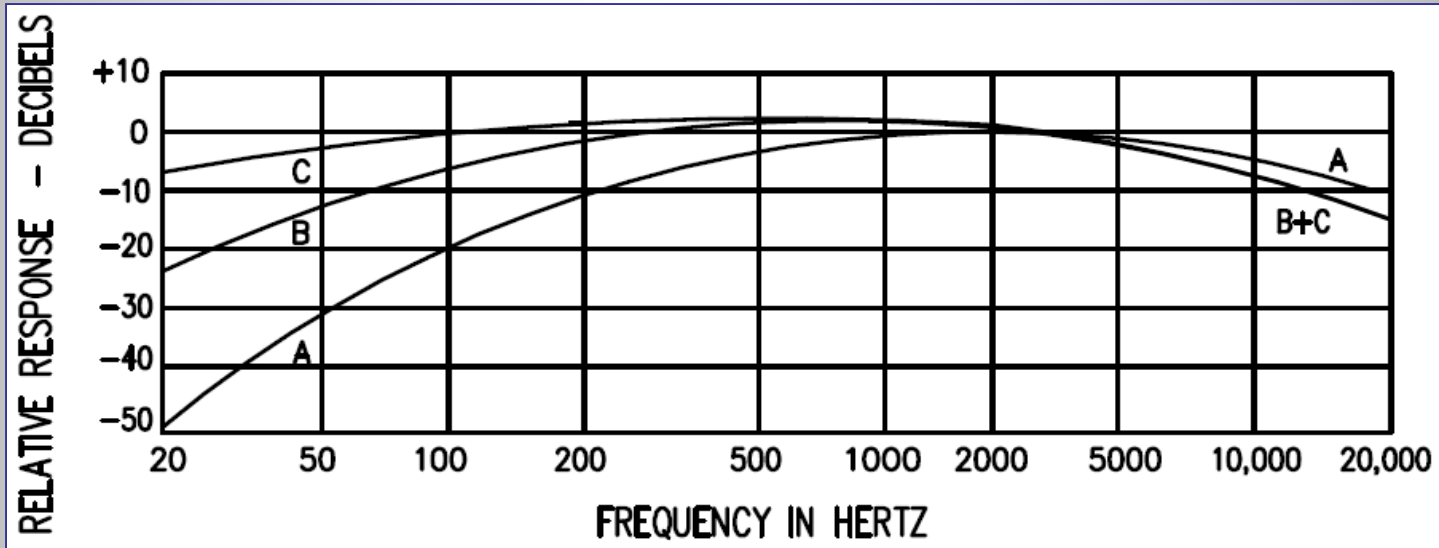
### Cause vs. Effect



Watts vs. Temperature



# “A” Weighting of Decibels



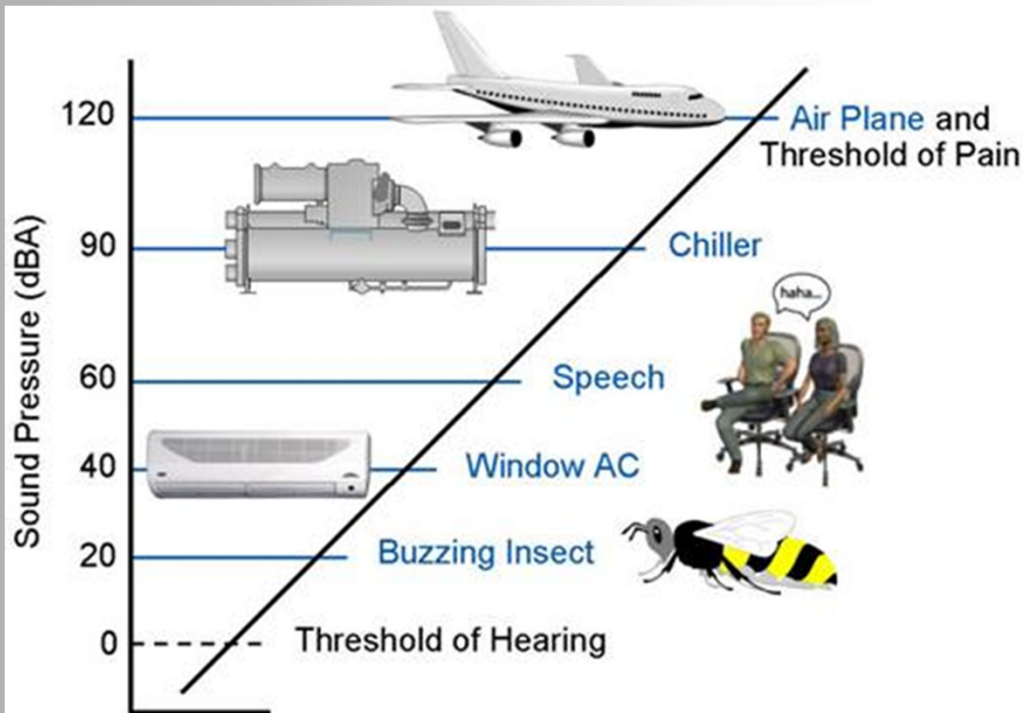
	Octave Band Center Frequency, Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
A-weighting	-39	-26	-16	-9	-3	0	+1	+1	-1

Correction factors that turn dB into dBA





## What Is The Decibel Scale?



The decibel (dB) is:

- a dimensionless unit, the ratio of a measured value (p) to a reference value (ref) on log scale.
- threshold of hearing to a level of extreme danger is 7 orders of magnitude (10,000,000 times that of the lower threshold)

dB	Actual SPL Reduction	Perceived Volume Reduction
3 dB	50.00%	18.77%
6 dB	75.00%	34.02%
9 dB	87.50%	46.41%
12 dB	93.75%	56.47%
15 dB	96.88%	64.64%
18 dB	98.44%	71.28%
21 dB	99.22%	76.67%
24 dB	99.61%	81.05%
27 dB	99.80%	84.61%
30 dB	99.90%	87.50%
33 dB	99.95%	89.85%
36 dB	99.98%	91.75%
39 dB	99.99%	93.30%
42 dB	99.99%	94.56%
45 dB	100.00%	95.58%
48 dB	100.00%	96.41%
51 dB	100.00%	97.08%
54 dB	100.00%	97.63%
57 dB	100.00%	98.08%
60 dB	100.00%	98.44%
63 dB	100.00%	98.73%
66 dB	100.00%	98.97%
69 dB	100.00%	99.16%
72 dB	100.00%	99.32%
75 dB	100.00%	99.45%
78 dB	100.00%	99.55%
81 dB	100.00%	99.64%



# Fundamentals of HVAC Acoustical Engineering



- Answer the 4 questions
- Use 3 to 5 dBA safety factor
- cursory review on every project; in depth review when warranted
- Assess site ambient noise levels
- Evaluate airborne and structure-borne transmission
- System problems require system solutions





# Just Right Acoustics

- Where are we now? Baseline data (standard)
- Where do we need to be? Acceptance Criteria (NC, RC, dB, dBA, etc...)
- What needs to be done to achieve compliance?
- How much will it cost?



# Acoustical Tutorial for Rooftop Curb Mounted AHU

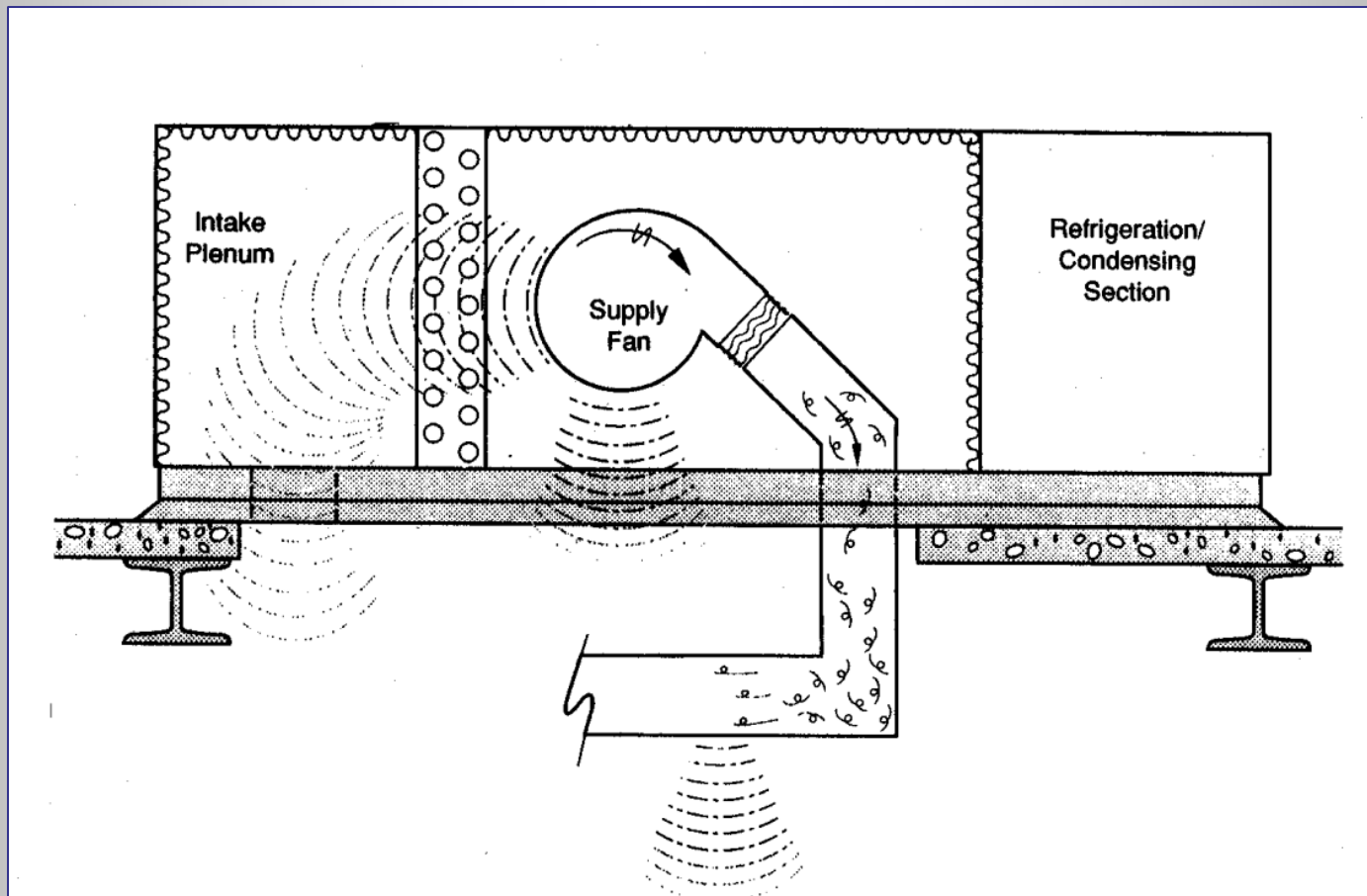


# *Construction Trends*

- Less mass in building
- Less space between floors
- Drop ceilings
- Premium for rentable/usable space
- Value Engineering
- Heightened sensitivity of owners/occupants
- ANSI S12.60
- *CURB MOUNTED RTUs*

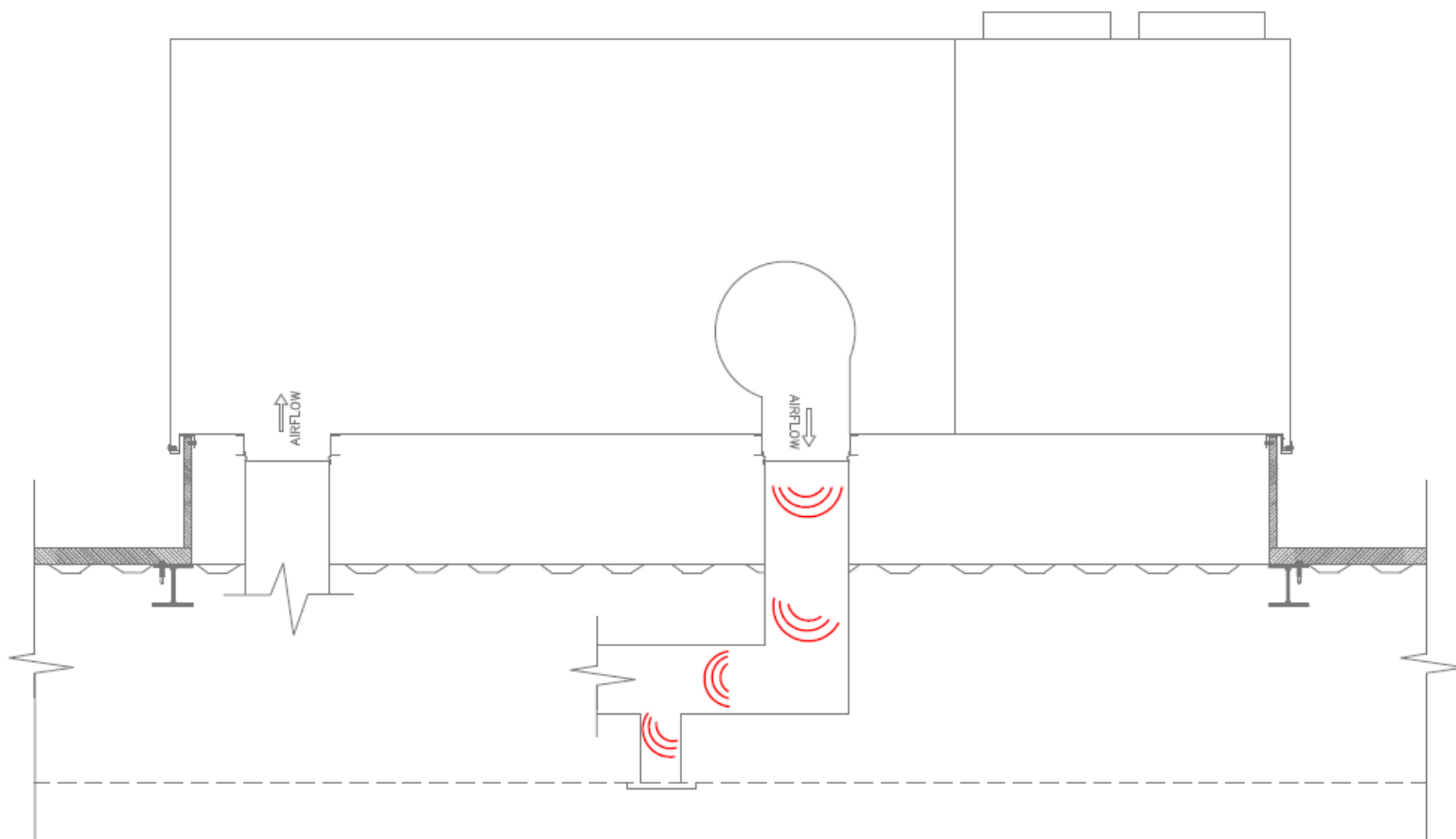


# Typical Rooftop Unit System Problems

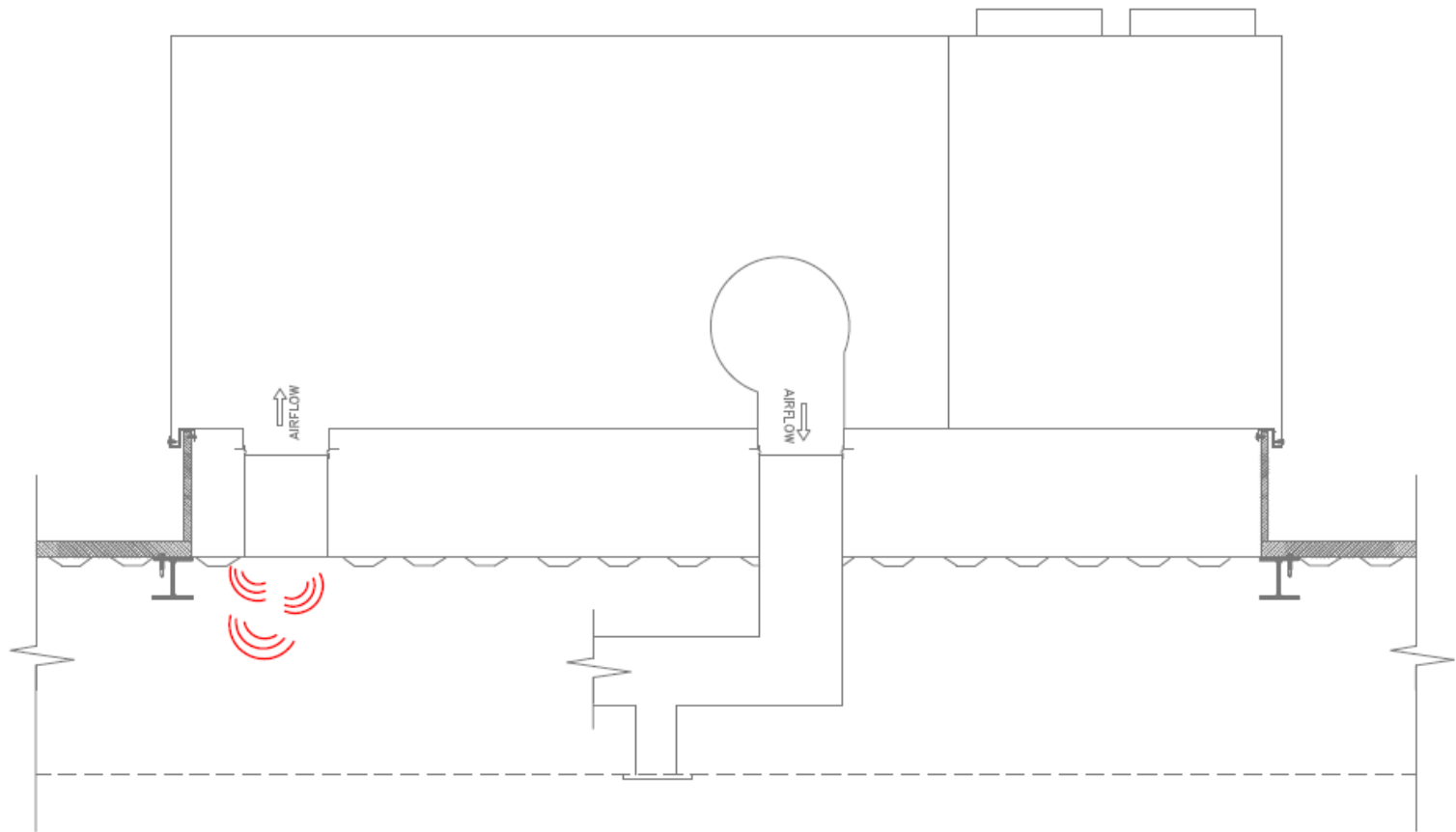




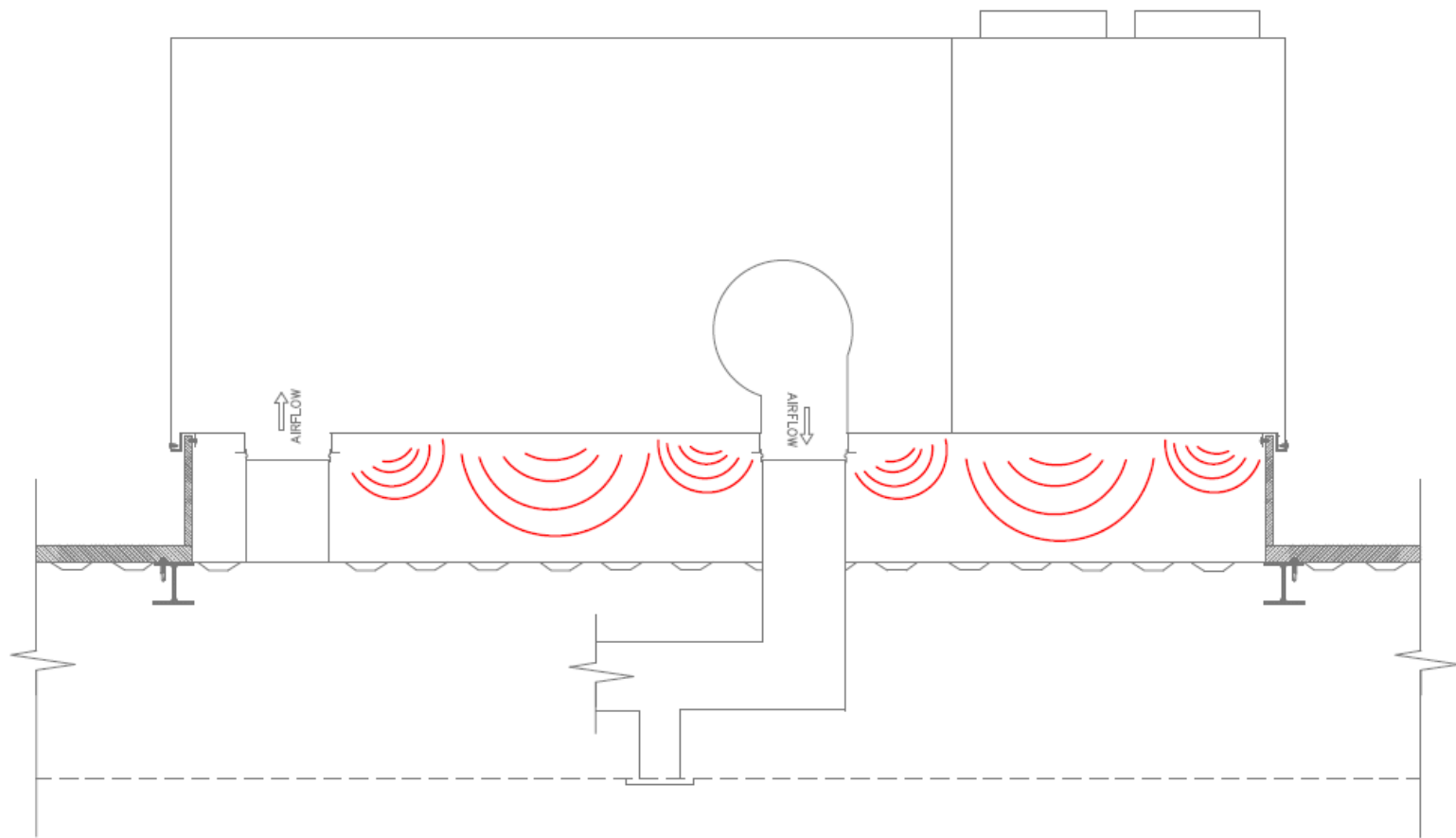
## In-Duct Supply Fan Noise



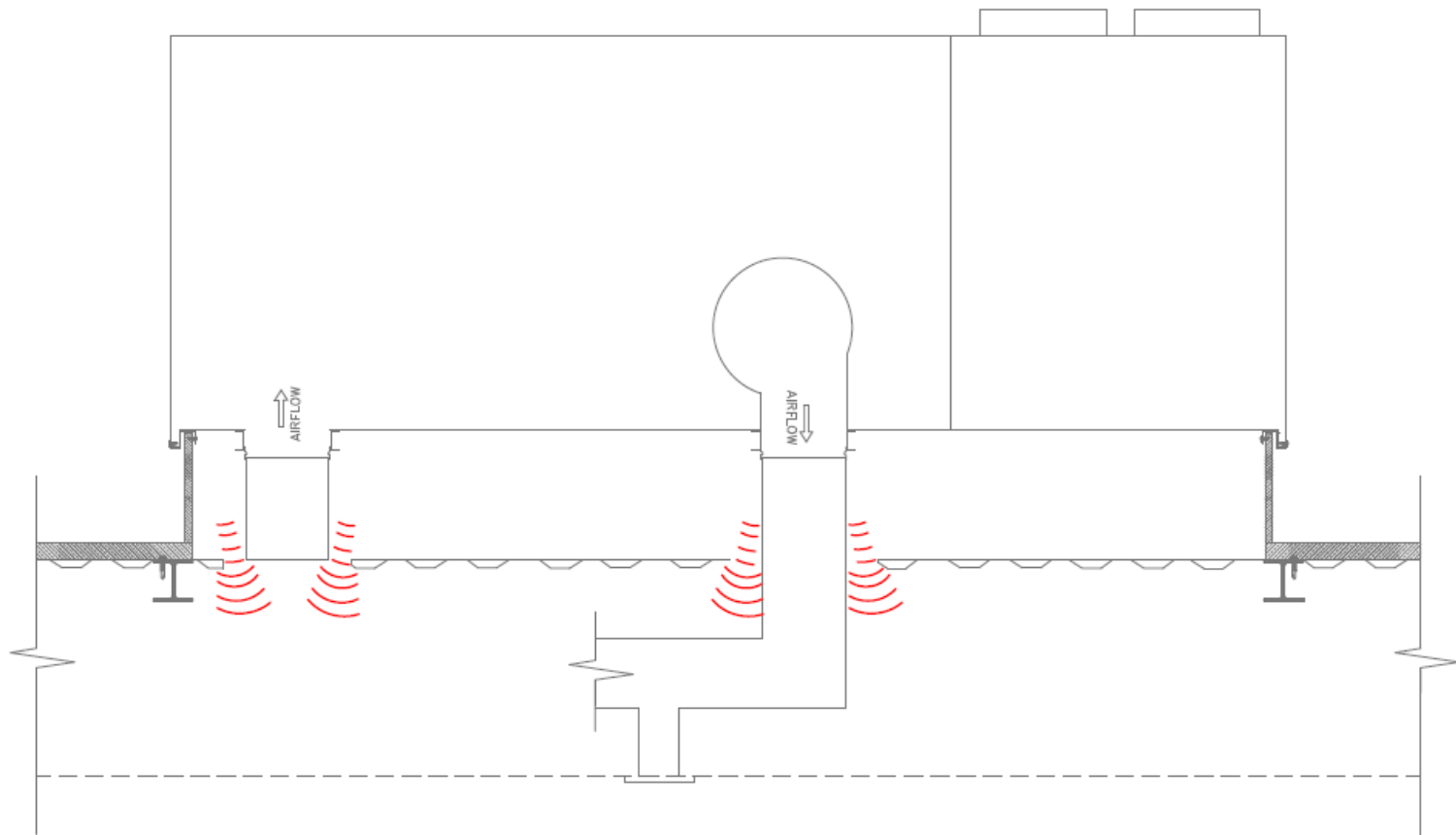
## Reverse Flow Fan Noise Into Return Ductwork/Plenum



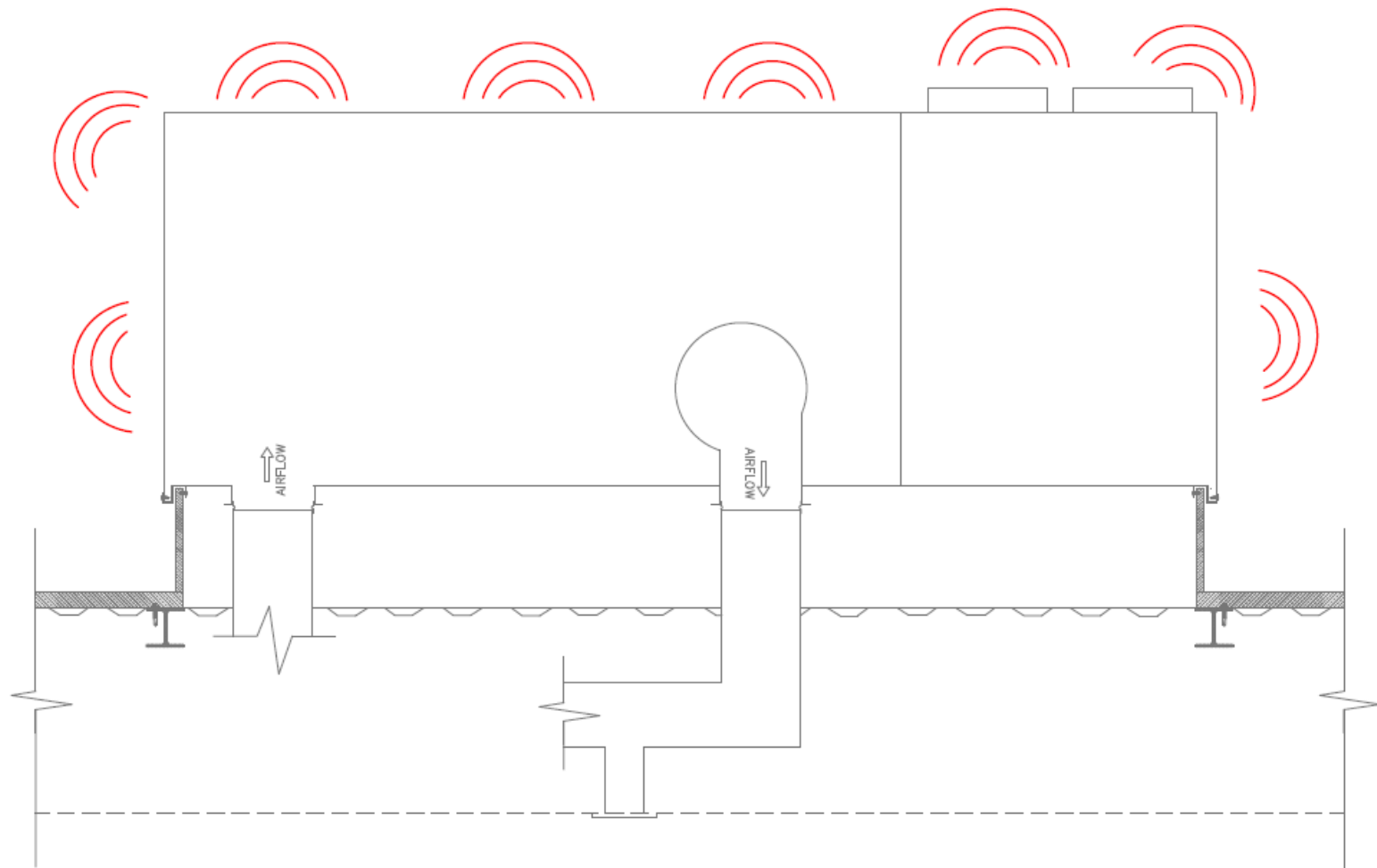
## RTU Base Pan Radiated Noise



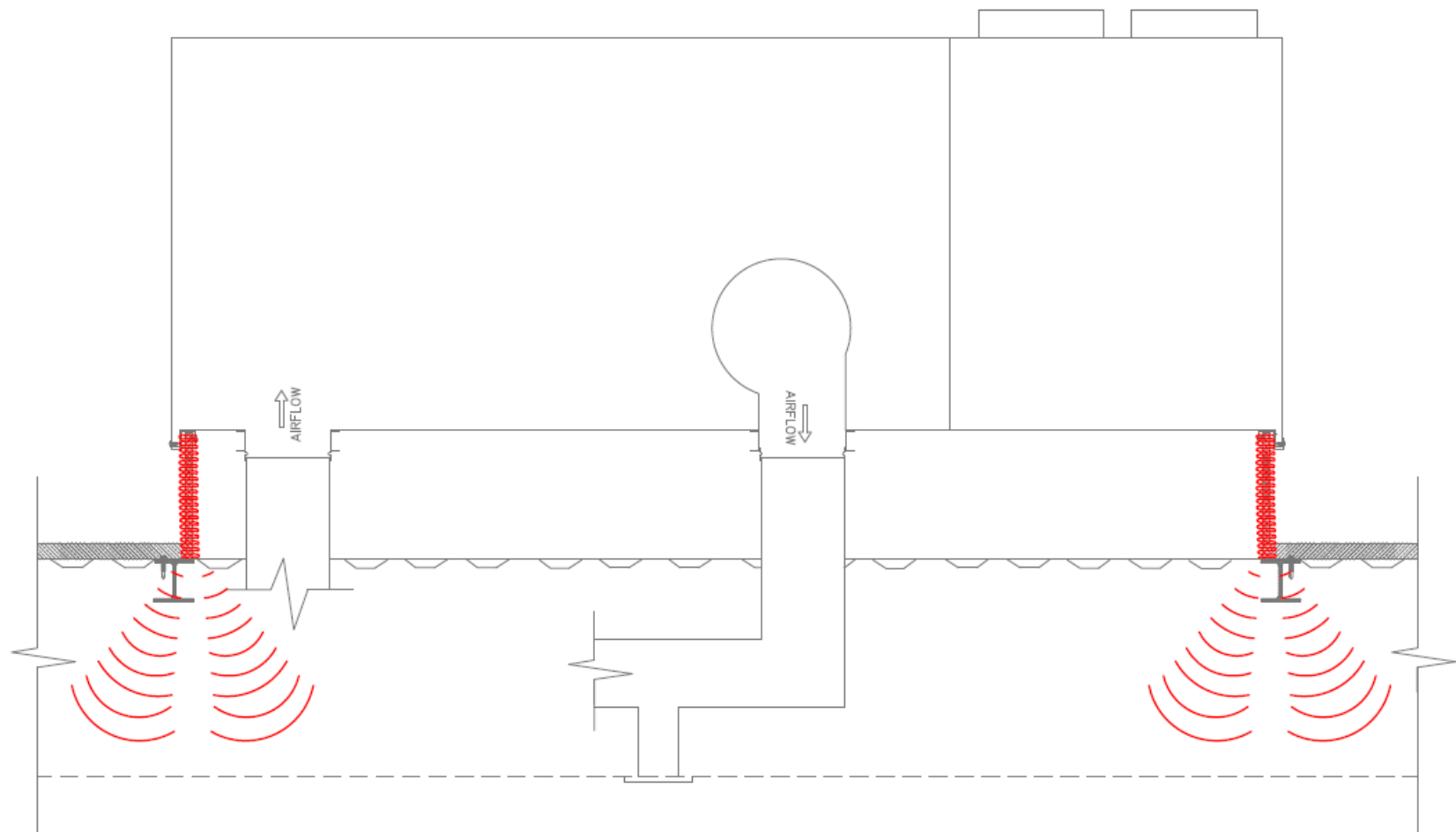
## Over Cut Deck Openings For Return & Supply Ductwork



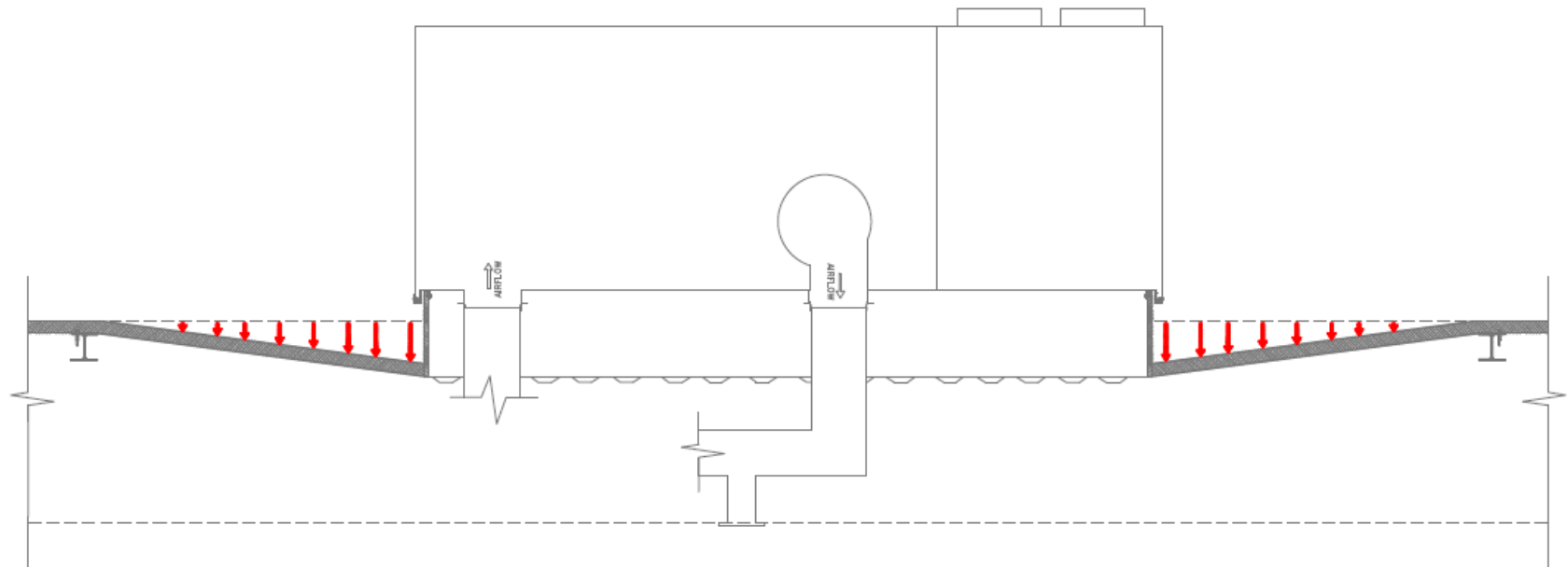
## Cabinet Radiated Outdoor Noise



## Structure-Borne Vibration Into Building Shell

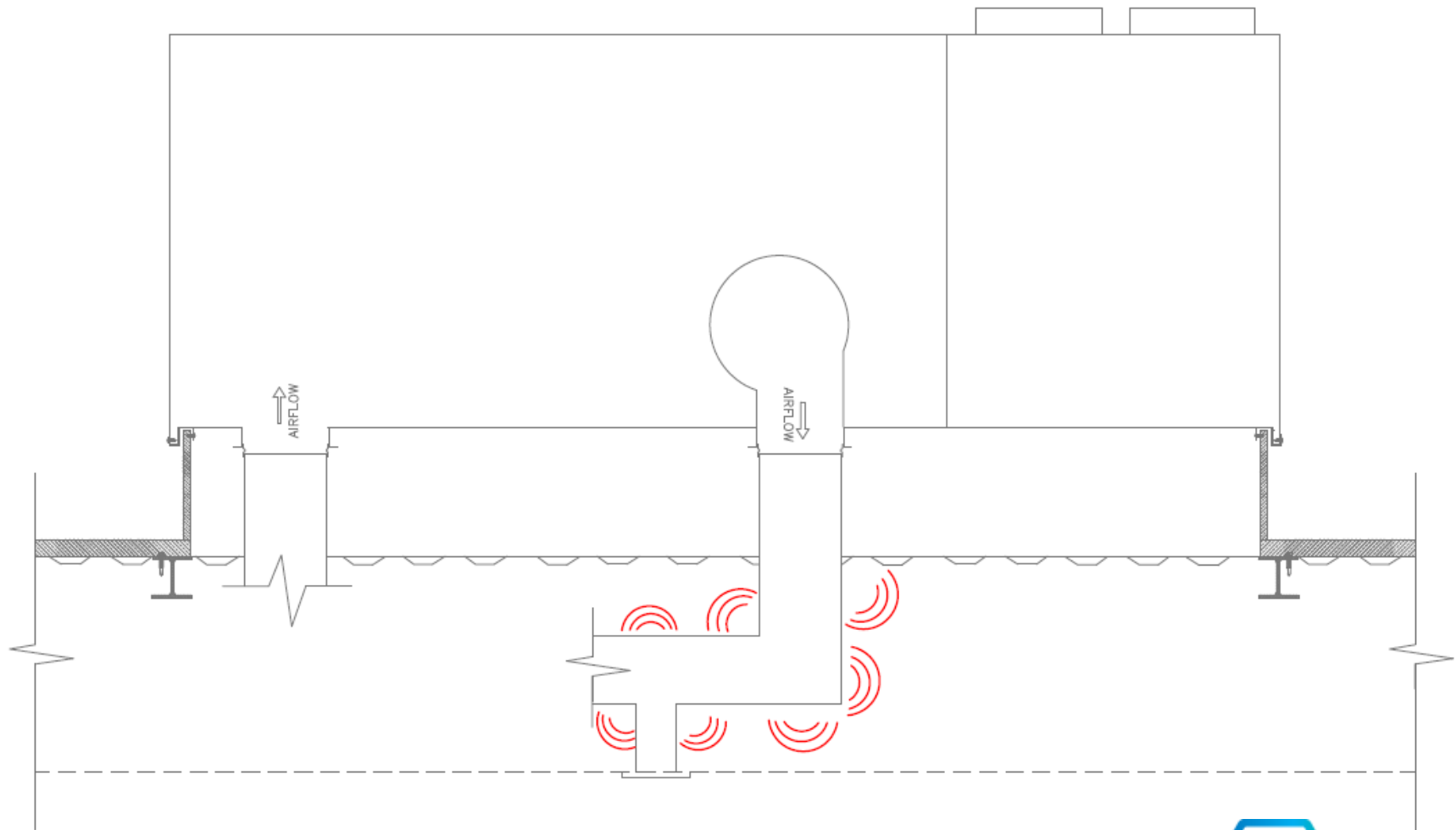


## Lightweight Roof Deflection

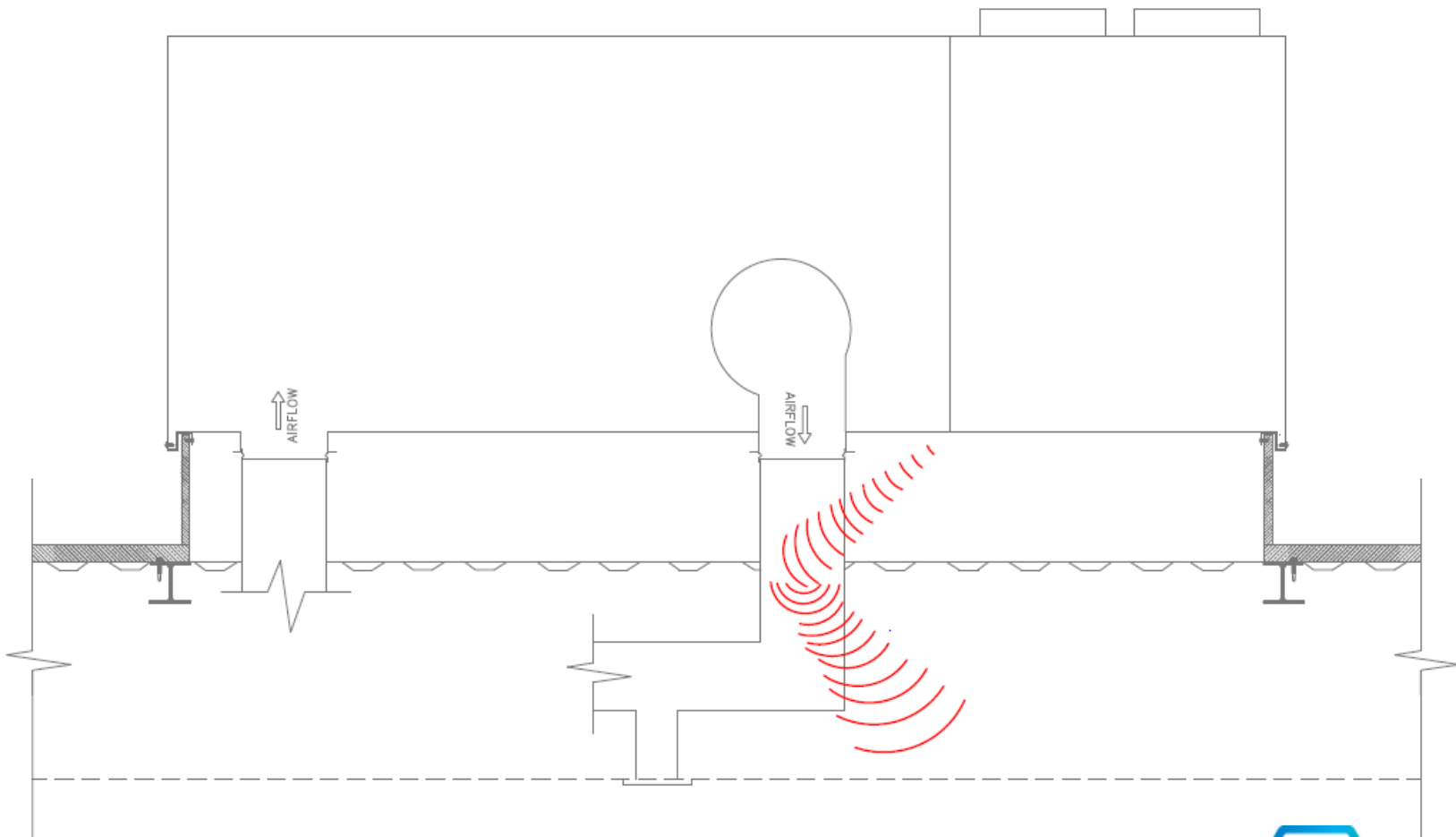




## Duct Breakout Noise



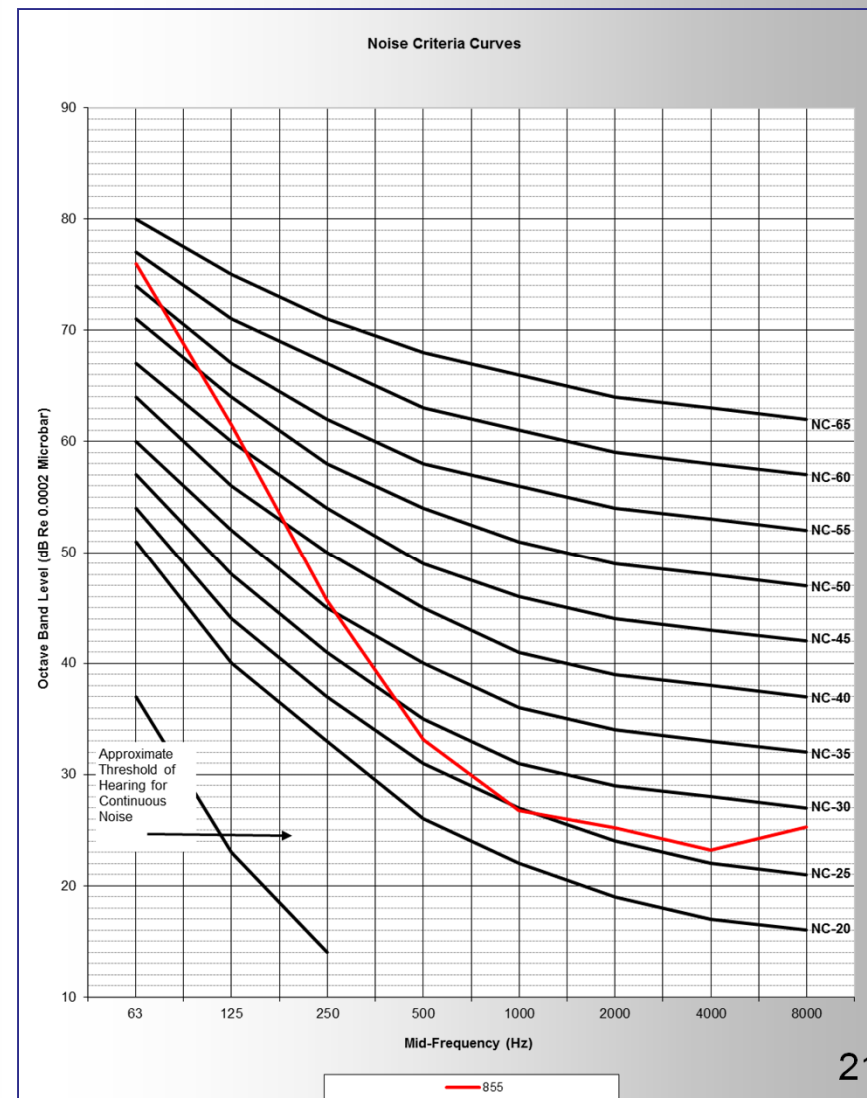
## Break In Noise Bypassing Through The Ductwork





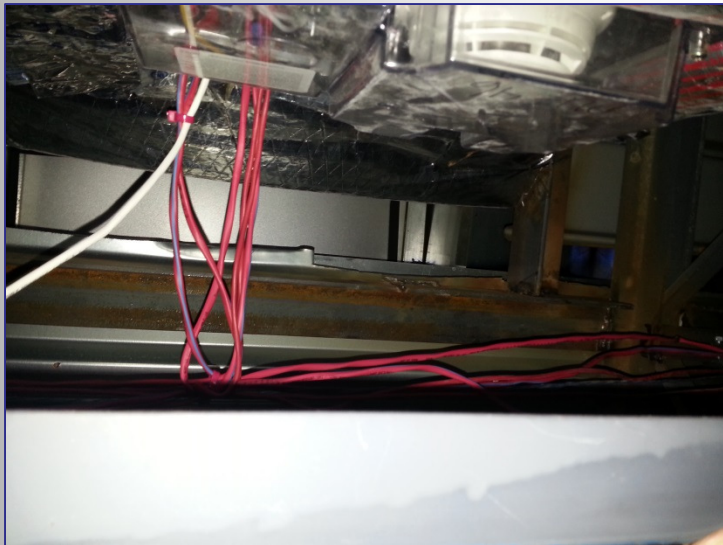
# RTU Case History #1

- Downstream Fan Attenuation
- Internal RTU Isolation
- Factory Non-Isolation Curb
- Deck openings over cut by 4" to 6"
- Ductwork supports tied into wall studs
- No In-curb acoustical treatment
- NC-59/50.1 dBA





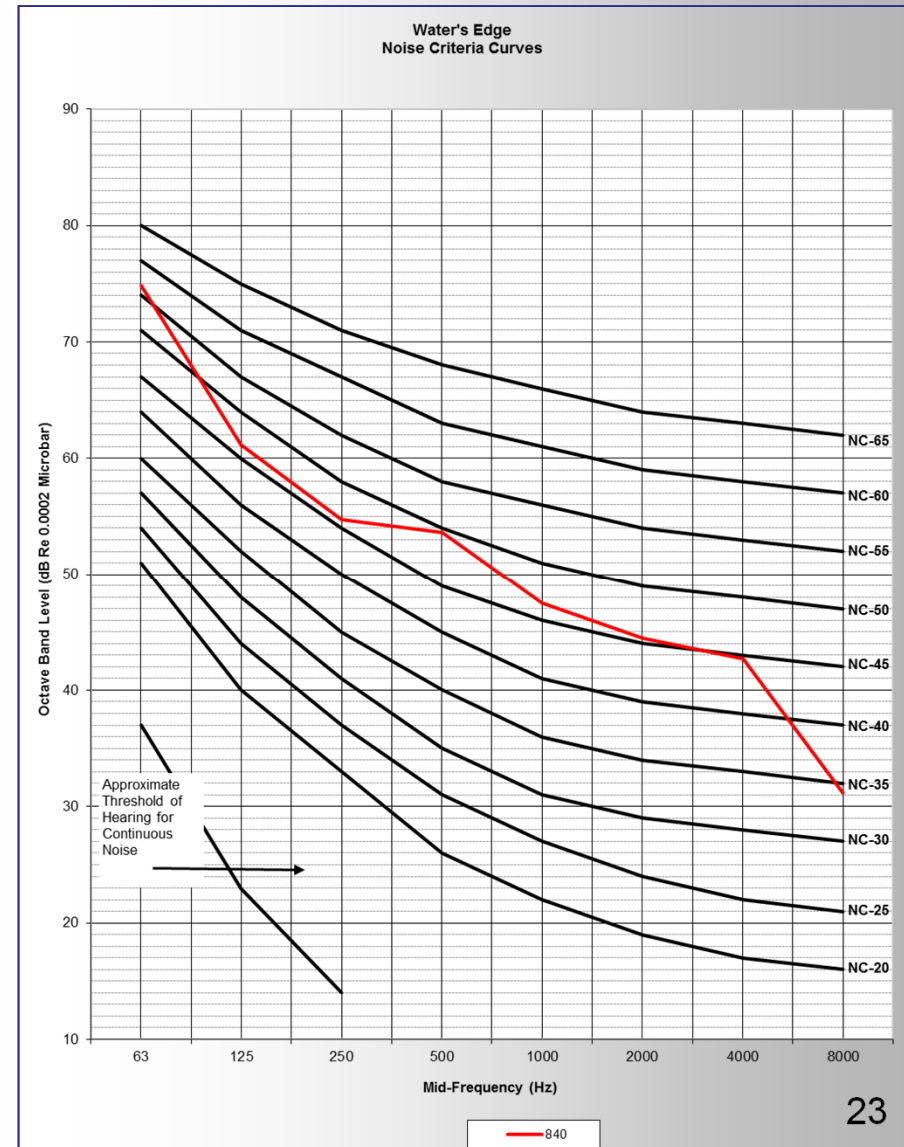
# RTU Case History #1





# RTU Case History #2

- Vibration Isolation Curb
- SA & RA Sound Attenuators
- External Duct Lagging
- Lightweight roof
- Duct drops sealed
- No- In-curb acoustical treatment
- NC 56/55.3 dBA







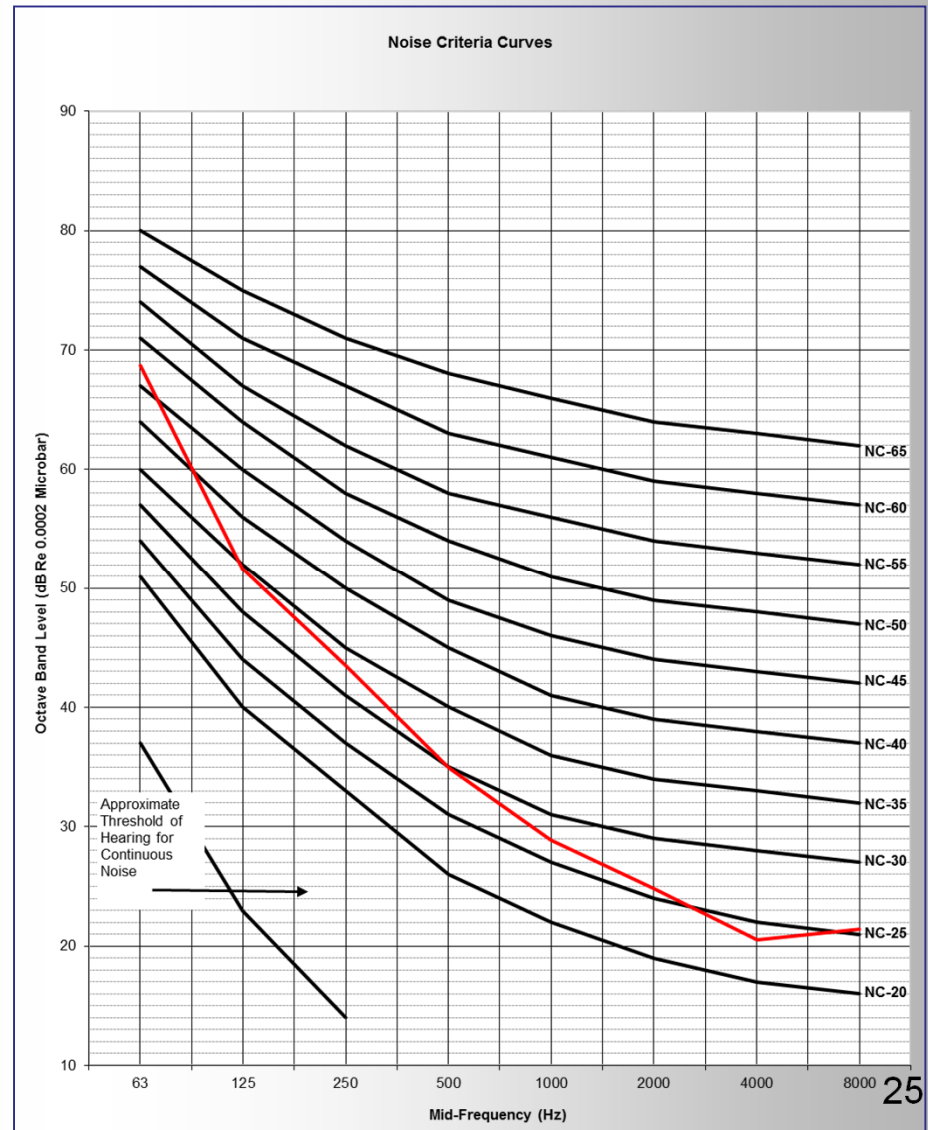
# RTU Case History #2





# RTU Case History #3

- Factory Curb
- Compressor Grommets
- Solid deck
- OA and horizontal discharge
- NC 47/ 43.8 dBA







# RTU Case History #3





# Specification Strategies



## Minimize Attenuation Needed

- Optimize RTU configurations to minimize baseline sound output
- Select RTU location over utility or other non-critical space
- Dialogue with architect regarding roof mass



# Transmission Paths to Address in the Specification

- In-Duct Fan Noise
- Radiated Noise
- Ductwork Breakout Noise
- Structure-borne Transmission
- Outdoor Noise

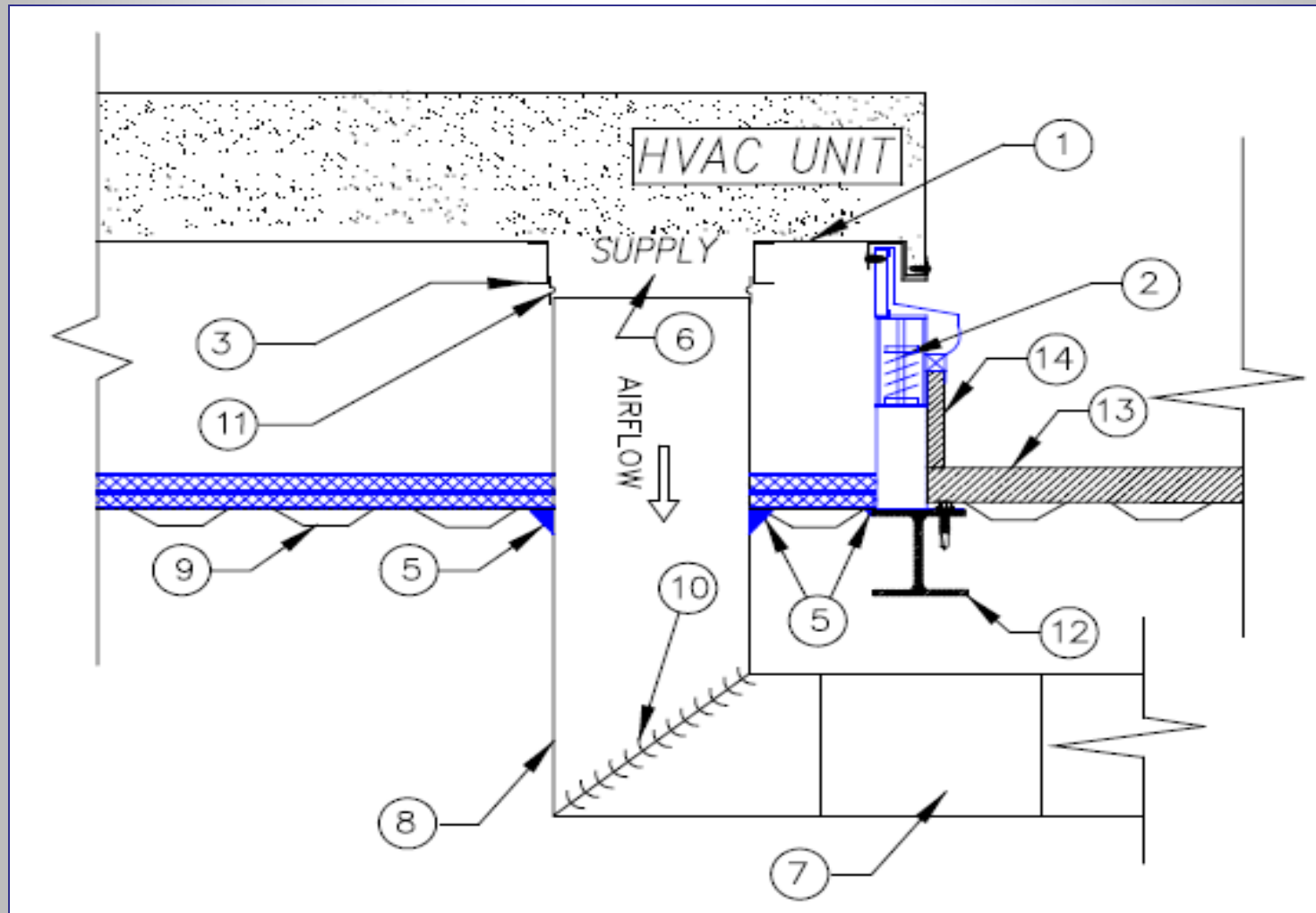


# RTU Specification Goal

- Predictable performance to meet objective criteria
- Measurable Performance Accountability
- Clear Installation Guidelines for the construction team
- Equipment/System Compatibility



# RTU Specification Examples



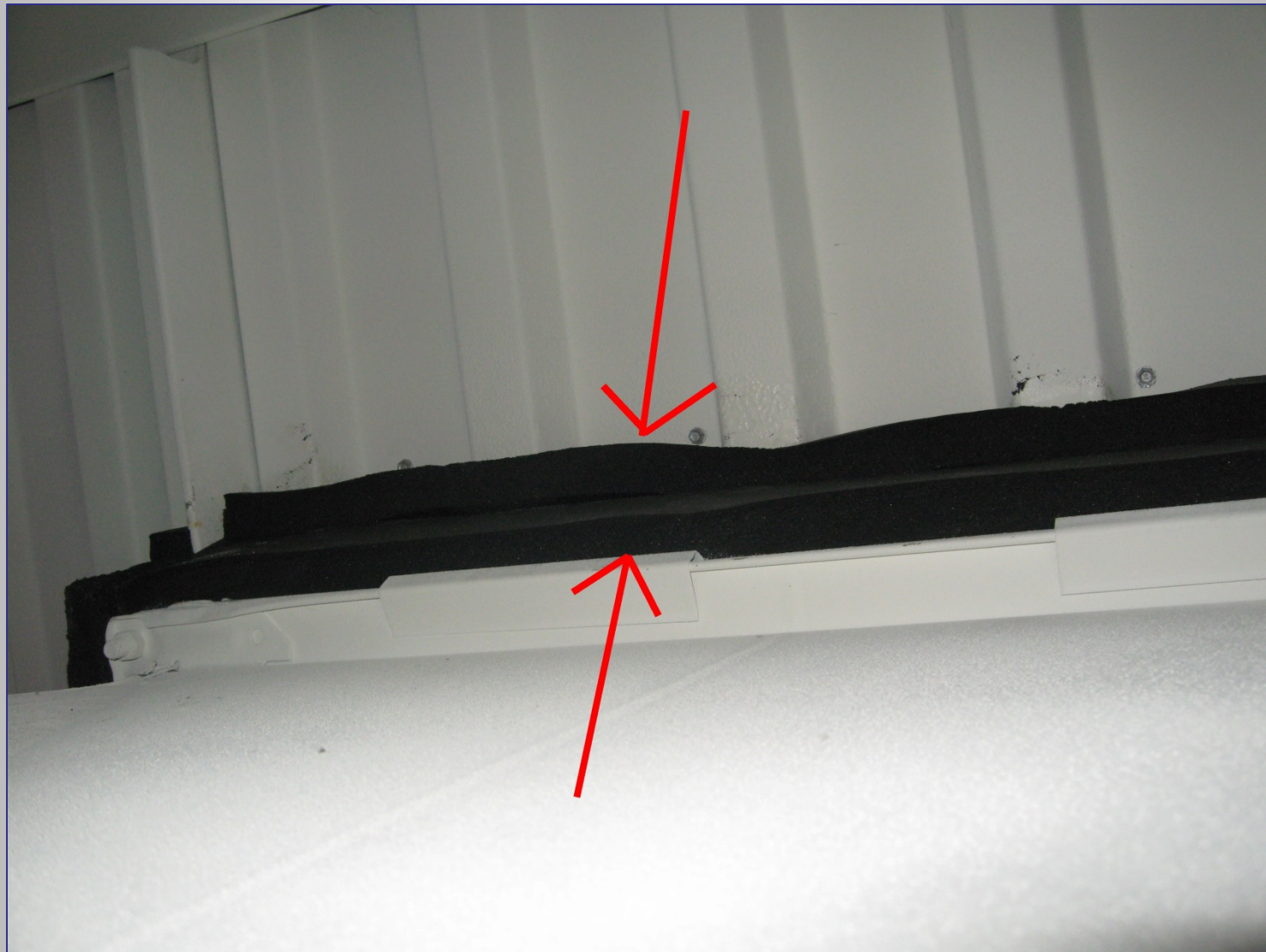


# RTU Specification Features

- Design specification with embedded acoustical performance
- Single source supply of Acoustical materials
- Specify procedure for the HVAC contractor to cut and seal deck openings for SA and RA inside the curb
- Require acoustical material supplier to inspect & certify
- Embed acoustical specification with RTU equipment
- Pre-Assembled construction

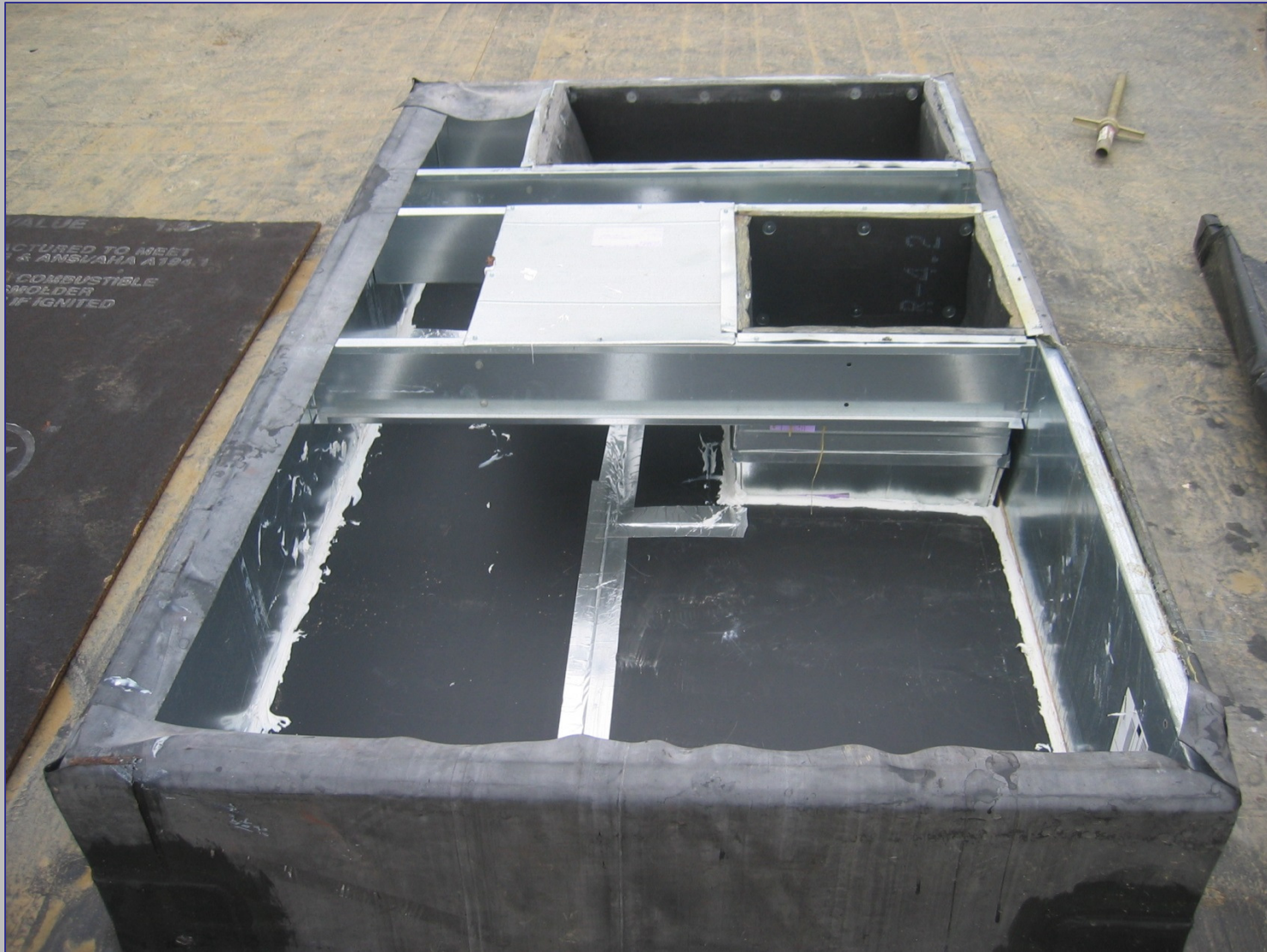


















# In-Curb System

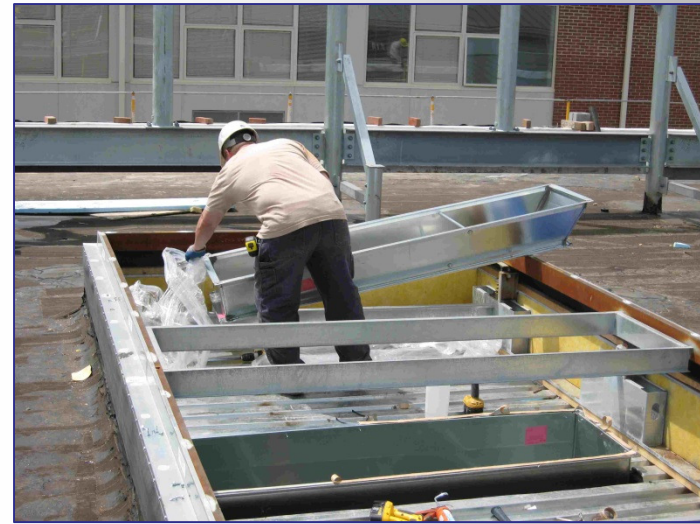








# Isolation Curb Kit Assembly







# Pre-assembled Construction





# The Results

- Performance Improvement of 5 to 10 NC/dBA
- No uptick in cost points



# Higher Performance RTU Acoustical Systems are Rarely Needed



# Higher Performance Applications

- Entertainment/Theatre Venues
- Libraries/Museums
- K-12/Higher Education

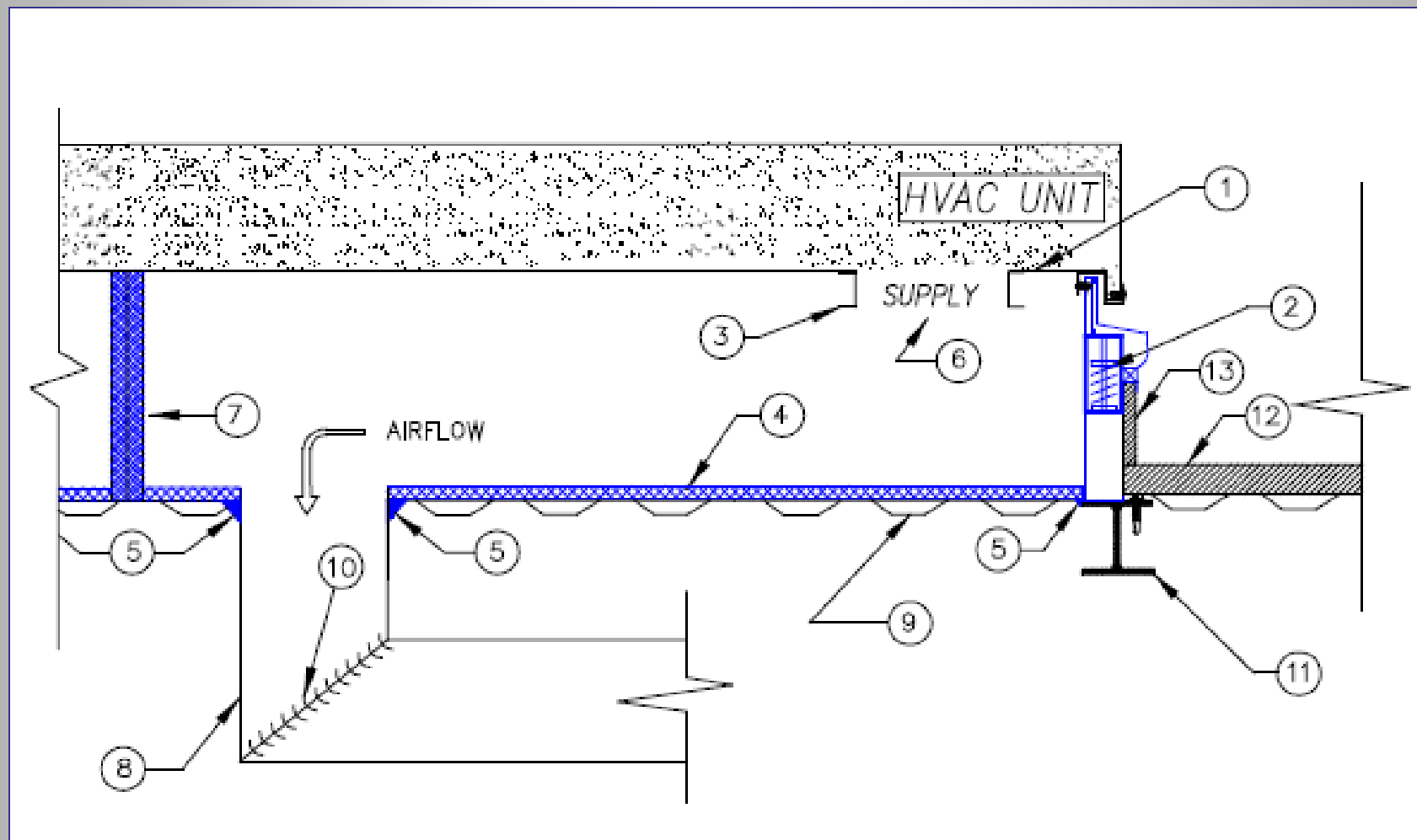


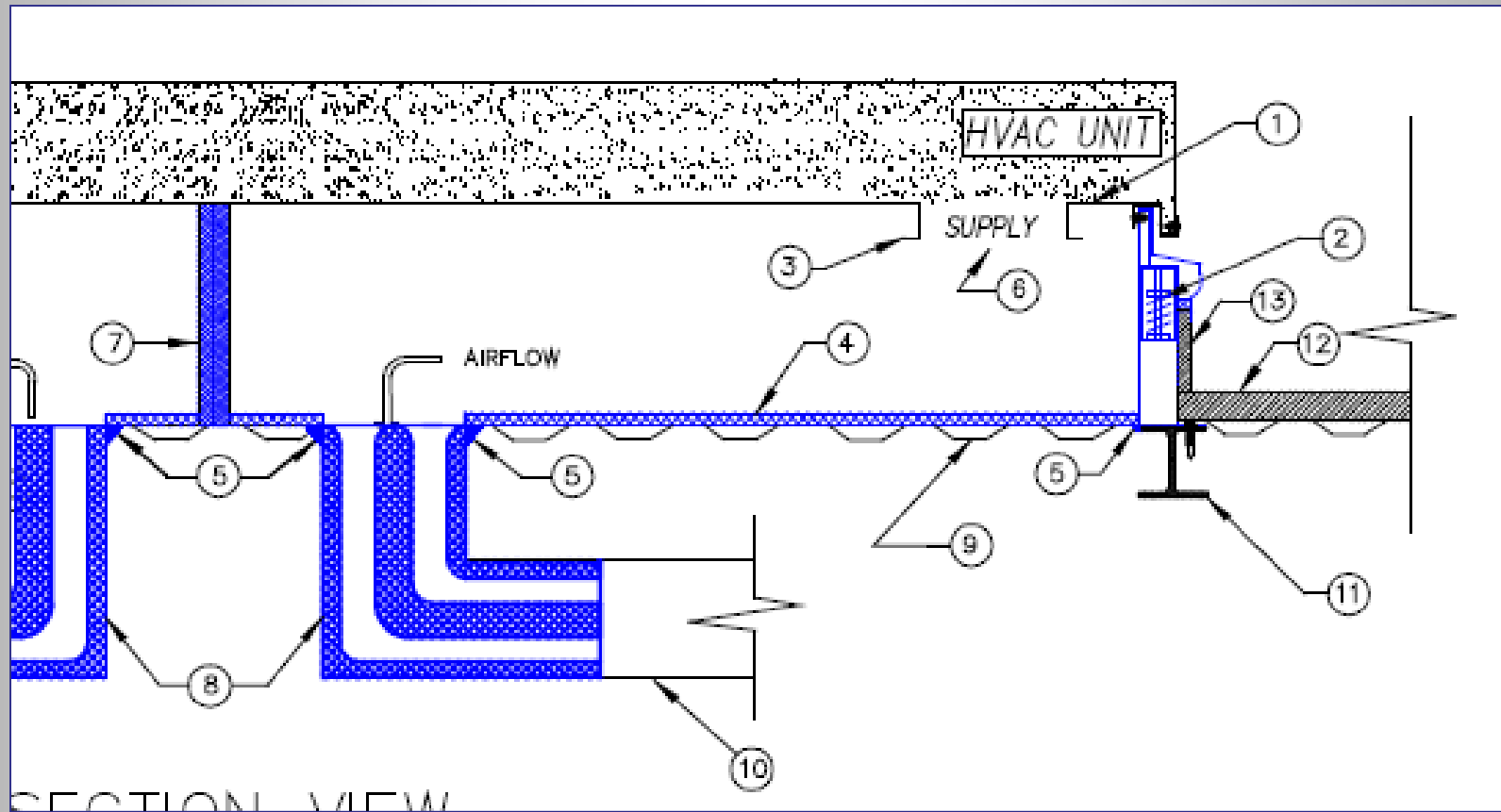
# High Performance Design Features

- Plenumized Curbs
- Acoustical panel curb bottom with SA/RA openings offset from the unit opening
- Silencers closer to unit or recessed in the curb
- Eliminates the elbow/transition/offset duct connection to the unit opening

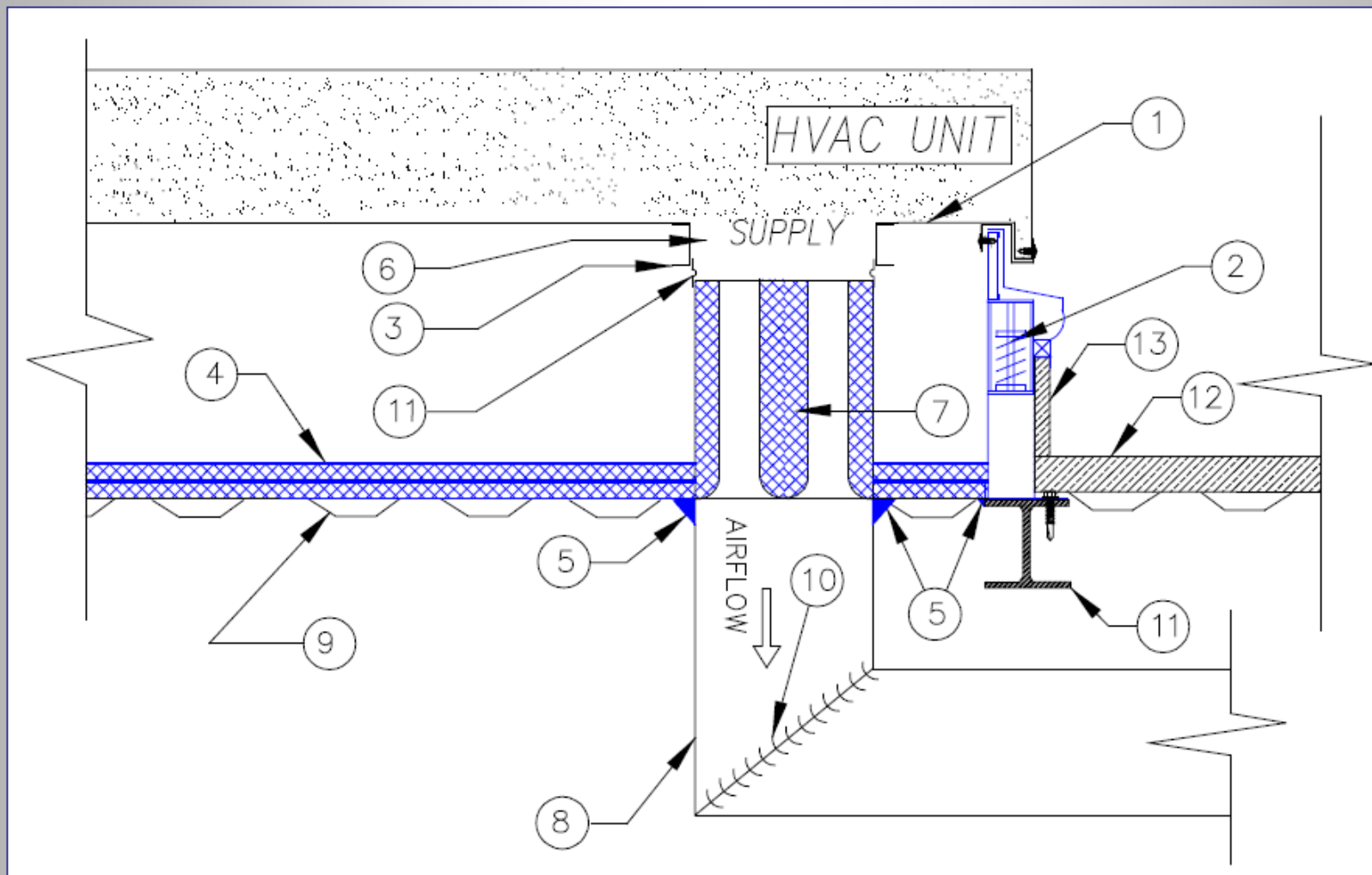


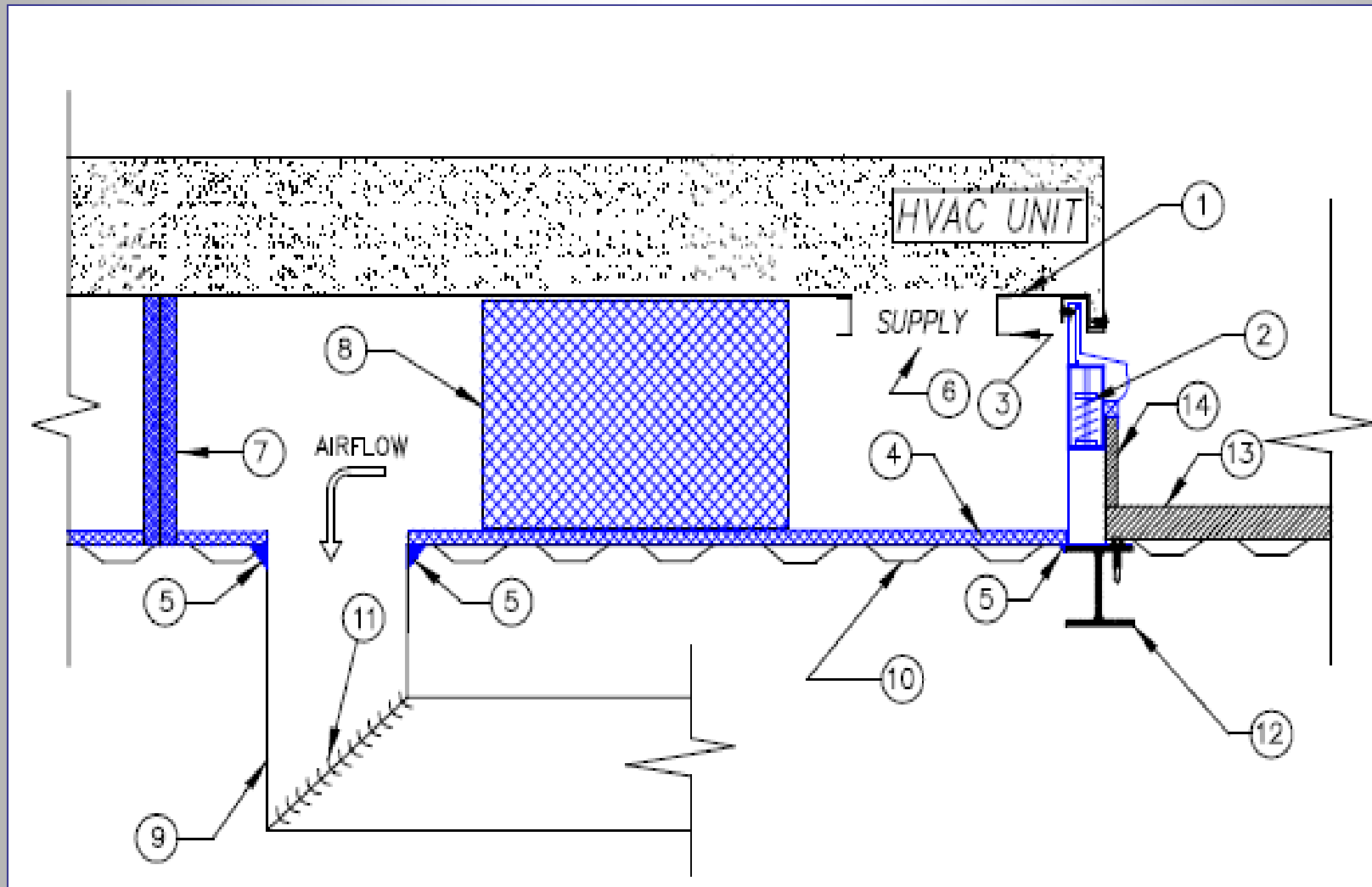
# Higher Performance Detail Illustrations













# Ductwork Design

- Duct type and sizing need to be consistent with NC target criteria



# Ductwork Design

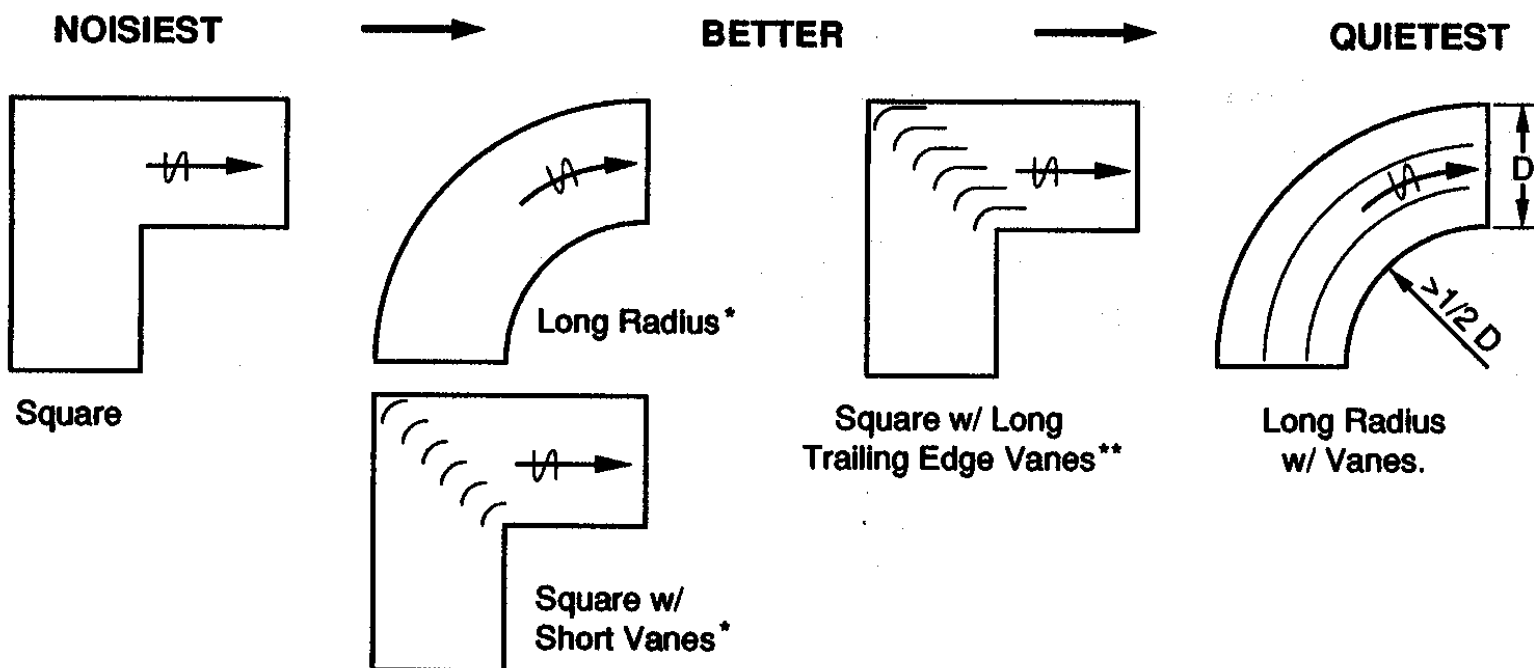
- Duct layout and configuration needs to follow SMACNA and ASHRAE design guidelines



# Good/Better/Best Acoustical Design Ductwork Configurations



# Guidelines for Minimizing Regenerated Noise In Elbows

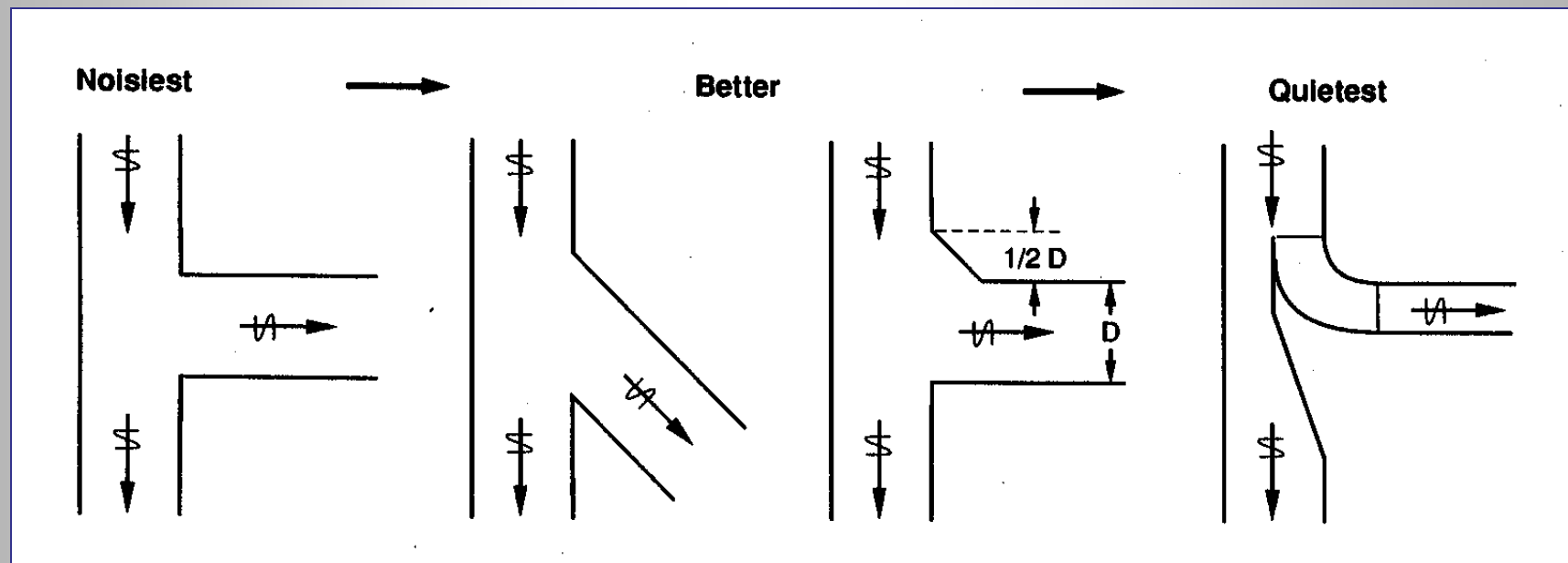


\* Airflow velocity and proximity of upstream and downstream fittings and fans determine which type is preferable.

\*\* Trailing edge length should be at least 3 times the vane spacing.

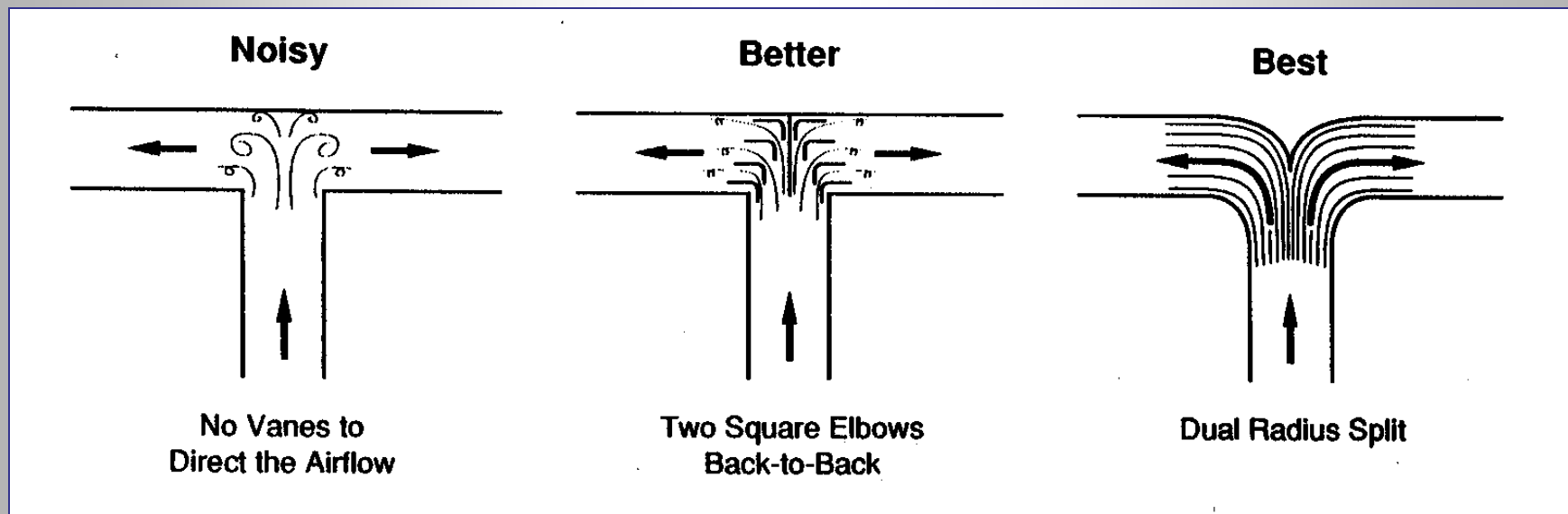


# Guidelines for Minimizing Regenerated Noise In Takeoffs





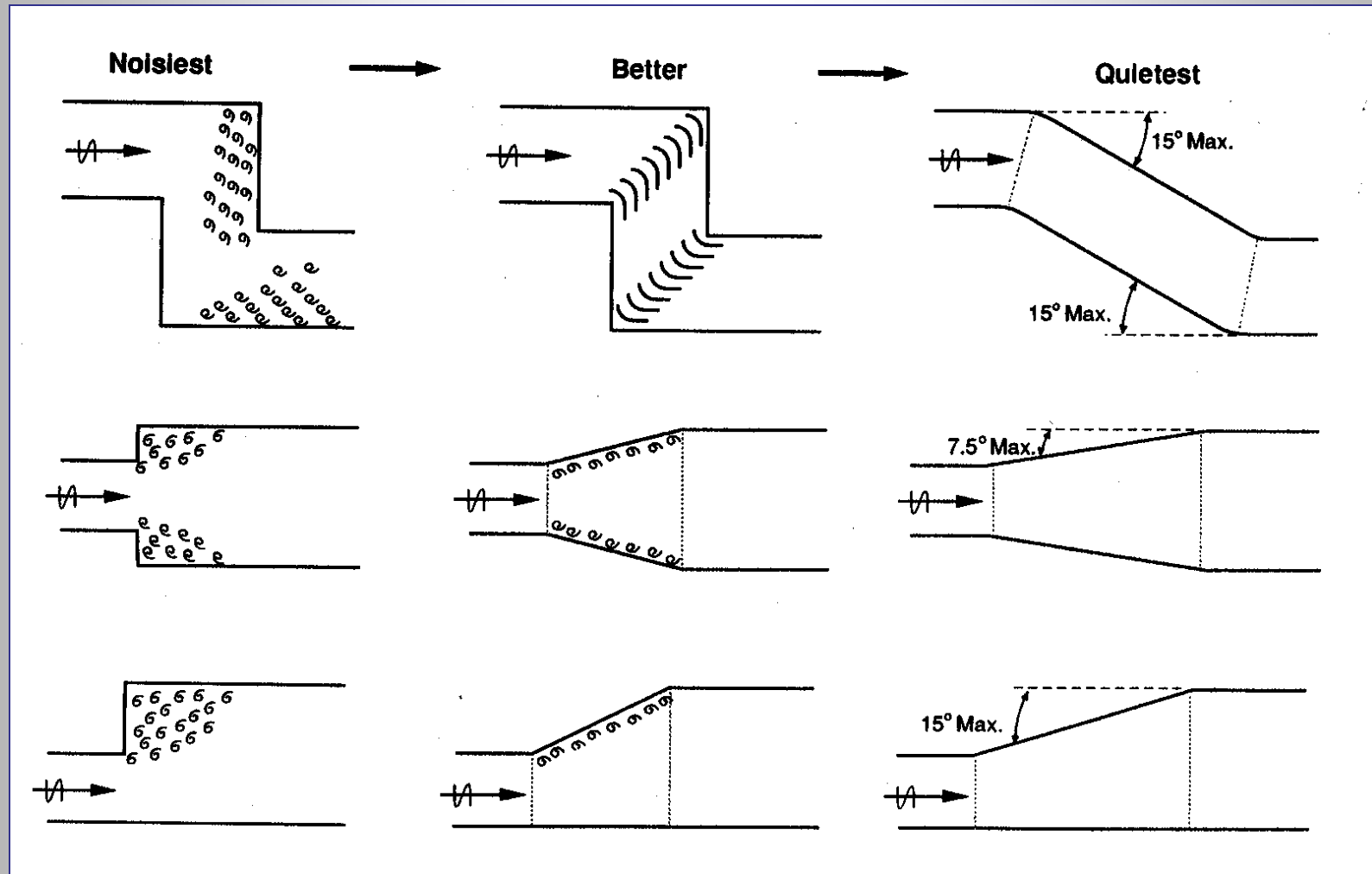
# Guidelines for Minimizing Regenerated Noise in Duct Tees







# Guidelines for Minimizing Regenerated Noise in Transitions and Offsets





# Outdoor Noise Treatments



# Scroll Compressor Sound Blankets





# Coil Intake Acoustical Louvers







# Condenser Fan Discharge Stacks





# Acoustical Barriers and Screens







# Condenser Section Enclosures





**Have a  
noise-free  
day!**