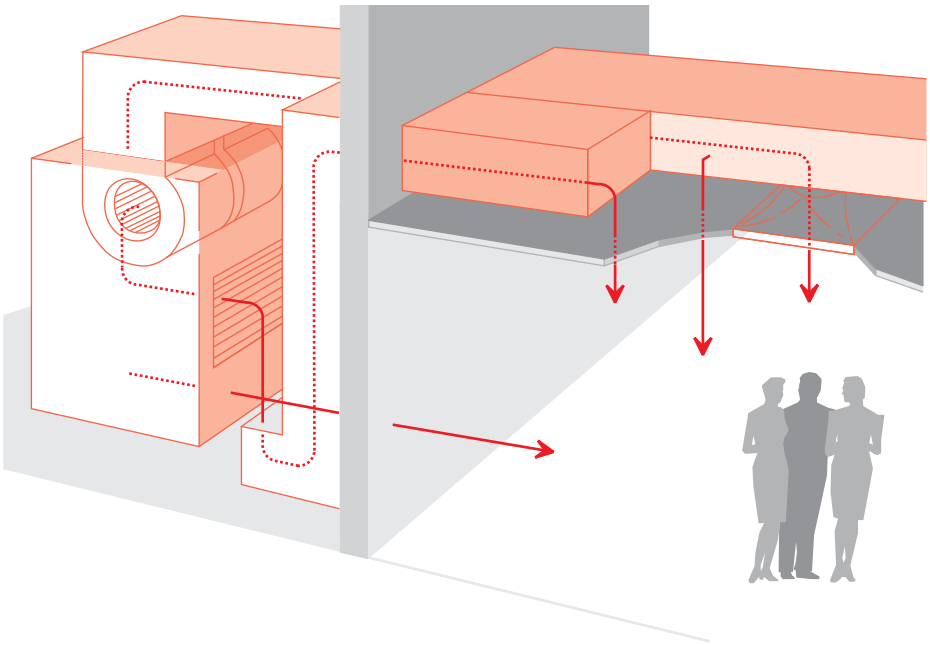
TRANE

# Trane Engineers Newsletter Live

## Specifying Quality Sound

*Presenters: Dave Guckelberger, Brian Reynolds, Art Hallstrom*



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# Agenda

Trane Engineers Newsletter Live Series

## Specifying Quality Sound

**Abstract**
After viewing this program you will understand how product sound data is developed and how to performance optimize an air-handling unit.

**Presenters:** Art Hallstrom, Dave Guckelberger and Brian Reynolds

**After attending you will be able to:**
- Understand how to set an acoustical target (code, standard considerations)
- Identify sound paths
- Summarize cost effective noise control opportunities in air-handlers
- Summarzie updates to ARI 260P

**Agenda**
Fundamentals of acoustical modeling
- a) Set an acoustical target
- b) Identify sound paths
- c) Predict path attenuation

ARI 260P update
Cost-effective noise control
Case history: an acoustically optimized job
Resources

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# Presenter biographies

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## Specifying Quality Sound (2000)

### *Art Hallstrom, PE | manager of airside applications | Trane*

Art has more than 35 years of industry experience working with innovative systems and products. Art has authored over 30 applications manuals and articles on subjects like electronic noise cancellation, building pressurization, and static regain duct design. Art is a PE, ASHRAE Fellow and is serves on the ASHRAE Technical Council. He is a former Director of ASHRAE and a Past President of the ASHRAE College of Fellows.

### *Dave Guckelberger | applications engineer | Trane*

Dave Guckelberger represents 31 years of engineering expertise with Trane. He is currently a member of the Applications Engineering Group and provides engineering support for TAP™, the Trane acoustics program. Mr. Guckelberger is a member of ASHRAE and an associate member of INCE. He is the author of several application manuals and trade-journal articles, as well as the two Engineers Newsletters used for this broadcast, "The Artful Science of Achieving Quality Sound" and "Sound Ratings and ARI 260P."

### *Rich Harmening | manager of Acoustics and Mechanics Technology | Trane*

Rich Harmening represents 31 years of experience in structural dynamics and acoustics, 26 of those years with Trane. He has been a member of the ARI Technical Committee on Sound since 1975, chairman of ARI 260 Subcommittee from its inception, and chairman of ARI Technical Committee on Sound since 1995. In addition, Mr. Harmening chairs the ISO working group for air-conditioning sound standards which has developed ISO 13261 Part 1 for outdoor equipment sound, Part 2 for indoor non-ducted equipment sound, and is currently developing Part 3 for ducted equipment sound.

### *Brian Reynolds | manager of Acoustics and Mechanics Technology | Trane*

Brian Reynolds provides 20 years of experience with The Trane Company in the Acoustics and Mechanics Technology group. His primary responsibilities have included air-handler-unit sound testing, sound prediction programs, and development of the CLCHLW sound-power-level prediction program for Trane Modular Climate Changers and T-series Climate Changers. In addition to his experience with The Trane Company, Mr. Reynolds has been a member of the ARI Engineering Committee and the ASHRAE TC 2.6 Sound and Vibration Committee. He also chaired the AMCA Technical Advisory Committee on Sound and ASHRAE Special Project Committee 68-86R, "Laboratory Method of Testing to Determine the Sound Power in a Duct."

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engineers newsletter Live

# Specifying Quality Sound

The low cost path to quiet



## TransCanada PipeLines

Headquarters building (under construction)

Calgary, Canada

## Specifying Quality Sound

- Fundamentals of acoustical modeling
  - Set an acoustical target
  - Identify sound paths
  - Predict path attenuation
- ARI 260P update
- Cost-effective noise control

## Setting the Target

The designer's challenge:

- What does ASHRAE recommend?
- What do occupants expect?
- What laws or codes apply?
- What does the budget allow?

## Specifying Quality Sound

- Case history:
  an acoustically optimized job
- Question-and-answer session

## Setting the Target

- 1999 ASHRAE Handbook defines typical RC/NC levels
  - Classrooms 35 to 40 (max)
  - Office buildings 25 to 45
  - Courtrooms 25 to 35
  - Large gyms 40 to 55
  - Drama theaters 25 (max)

## Creating Quiet Comfort

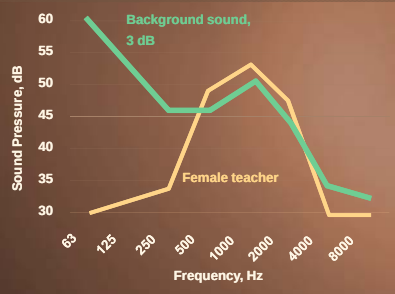
- Find the accepted NC target
- Read about the subject
- Verify owner or occupant requirements
- Check the budget
  - Use optimization ideas to reduce noise-control costs

## Path Identification

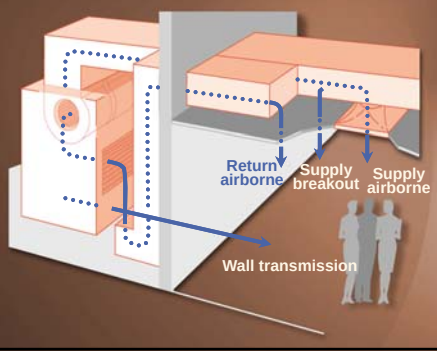
Source–path–receiver model

- Source … where sound originates
- Receiver … the "listening" location
- Path … everything in between

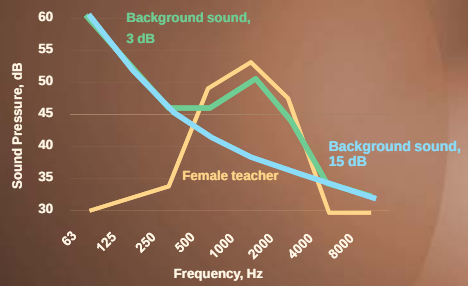
## Sound Target for a Classroom




## Indoor Source–Path–Receiver Model



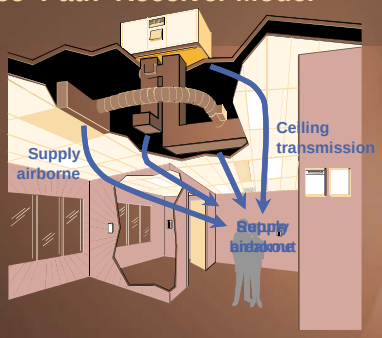

## Sound Target for a Classroom




## Types of Sound Paths

- Airborne
  - Sound travels with or against airflow
- Breakout
  - Sound travels through duct walls
- Transmission
  - Sound travels through walls, floors, and ceilings

## Outdoor Source–Path–Receiver Model




## Analysis Tools Can Help

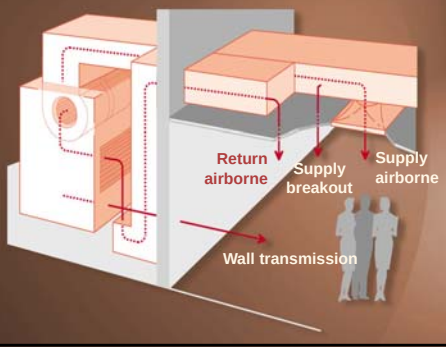
- Forecast sound-pressure levels during design … after-the-fact for problem jobs
- Start with accurate data
- Advantage?
  Predict expected attenuation by path

## Path Identification

Important points:

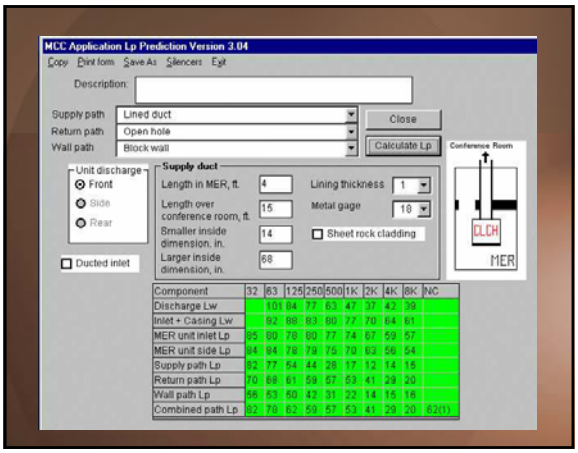
- One piece of equipment may contain multiple sound sources
- Sound may travel along multiple paths
- Total sound at the receiver is the sum of all paths

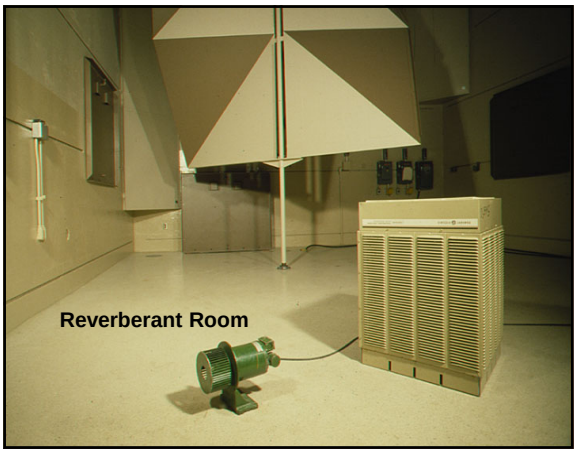
## Indoor Source–Path–Receiver Model




## Acoustical Prediction Modeling

- Break down each path into elements
- Calculate the acoustical effect of each element
- Add up sound for all paths
- Compare the sum to the target NC level
- If high, attenuate the loudest paths




## Air-Handler Sound Power

- What is the “pedigree” of the source sound data?
  - Generic projections
    - Least accurate
  - Fan plus plenum or casing
  - AMCA 300–96
  - ARI 260P
    - Most accurate

## Cost-Effective Noise Control

- Optimize the location of the air handler
  - Sound decreases with distance
  - Route supply ducts over storage areas or bathrooms
  - Include the architect on the design team

## Air-Handler Sound

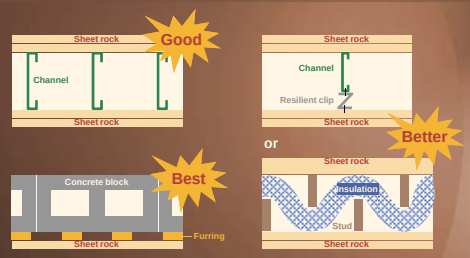
| | Poor | Good | Better | Best |
|---|---|---|---|---|
| Fan | ASHRAE fan algorithm | AMCA 300 test data | AMCA 300 test data | **ARI 260** test data |
| Air handler | ASHRAE casing algorithm | ASHRAE casing algorithm | AMCA 300 test data | **ARI 260** test data |
| Path projection | ASHRAE path algorithms | ASHRAE path algorithms | ASHRAE path algorithms | **mockup** -based Lp prediction |

## Cost-Effective Noise Control

- Optimize the wall transmission path
  - Add mass or special drywall configurations
  - Seal all openings, caulk cracks
  - Provide proper vibration isolation

cost-effective noise control

## Wall Options




## Cost-Effective Noise Control

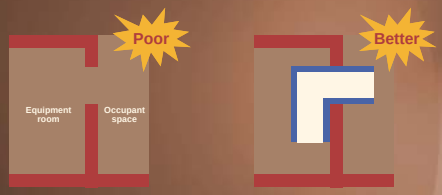
- Optimize the return airborne path
  - Open hole
    - Least expensive, worst performance
  - 90° elbow
  - 90° elbow with tee connection
  - Lined chase wall
    - Most expensive, best performance

## Cost-Effective Noise Control

- Optimize the supply airborne paths
  - Unit-mounted discharge plenum
    - Effective for low and high frequencies
  - Lined ductwork
  - Duct silencer
    - Raises static pressure and sound of fan
    - Effective for mid and upper frequencies

cost-effective noise control

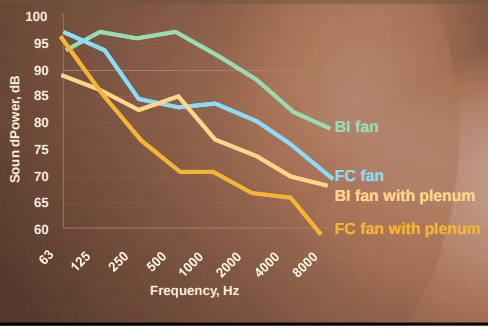
## Return Air Options




Open hole One elbow

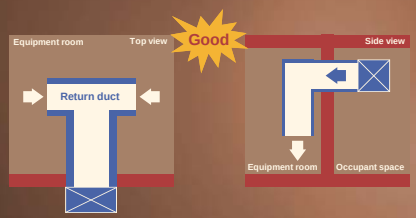
cost-effective noise control

## Supply Fan/Unit Optimization




cost-effective noise control

## Return Air Options




Two elbows in series

cost-effective noise control

## Return Air–Wall Option


Lined chase walls

cost-effective noise control

## Fan Type

- Double-wheel, double-inlet
  - Forward-curved
  - Backward-inclined
  - Airfoil
- Plug or “plenum”
  - 8, 9, 11, or 12 blades?

cost-effective noise control

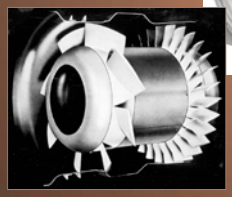
## Lined Return Air Chase Wall

Lining the walls of the return-air chase has little effect on rentable floor space

cost-effective noise control

## Fan Type

- Hybrid vaneaxial
  - Premium acoustical performance



cost-effective noise control

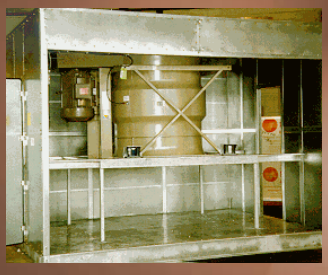
## Optimization Ideas

- Quiet the source
  - Fan type
  - Air-handler configuration
  - Casing construction

cost-effective noise control

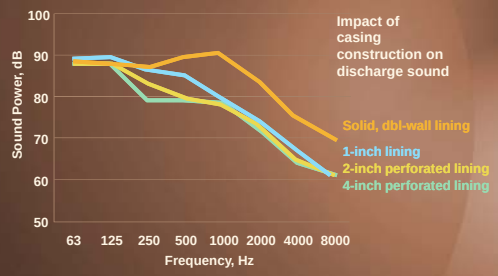
## Air-Handler Configuration

- Vertical air handler with vaneaxial fan



cost-effective noise control

## Casing Construction




review of today's broadcast

## Specifying Quality Sound

- Review acoustical effects when cost-cutting
- Adhere to design details during installation
- Confirm design
  - Incorporate success into the next job

summary

## Cost-Effective Noise Control

- The earlier you start, the more options you have
- Model the low-cost design first
- Locate the critical paths
- Model alternatives
  - Optimize the path, the source, or both to the achieve target

## Want to Learn More?

- Acoustics in Air Conditioning
  Trane, FND-AM-5
- Practical Guide to Noise and Vibration Control for HVAC Systems
  ASHRAE, ISBN 0-910110-76-X
- ASHRAE Handbook—1999 HVAC Applications
  ASHRAE, ISBN 1-883413-71-0

review of today's broadcast

## Specifying Quality Sound

- Set the acoustical goal
  - Entire team must agree at the outset
  - Verify the budget and schedule
- Perform an acoustical analysis
  - Engage an acoustical consultant for complex or sound-critical jobs
- Optimize path and source attenuation

## Want to Learn More?

- TAP™ Trane Acoustics Program
  - C.D.S.™ training course
- Web sites
  - www.lexashrae.org/TC26_Start/index.htm
    ASHRAE Technical Committee 2.6, Sound and Vibration Control
  - www.ncac.com
    National Council of Acoustical Consultants