

**AMERICAN SOCIETY OF HEATING, REFRIGERATING AND  
AIR-CONDITIONING ENGINEERS, INC.**

1791 Tullie Circle, N.E./Atlanta, GA 30329  
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**TC/TG/MTG/TRG MINUTES COVER SHEET**

(Minutes of all Meetings are to be distributed to all persons listed below within 60 days following the meeting.)

TC/TG/MTG/TRG No.	<u>2.6</u>	DATE	<u>January 28, 2013</u>
TC/TG/MTG/TRG TITLE	<u>Sound and Vibration</u>		
DATE OF MEETING	<u>January 28, 2013</u>	LOCATION	<u>Dallas, TX</u>

MEMBERS PRESENT	YEAR APPTD	MEMBERS ABSENT	YEAR APPTD	EX-OFFICIO MEMBERS AND ADDITIONAL ATTENDANCE
<b>Voting Members:</b> Curt Eichelberger Robert Hassler Eddie Lau Jerry Lilly Dustin Meredith Erik Miller-Klein Patrick Oliver Kim Osborn Douglas Reynolds Robert Simmons Jason Swan Randal Zimmerman <b>Corresponding Members:</b> Danny Abbate Zvirimumwoyo Chinoda Nicole Cuff Radha Ganesh Ali Herfat Michael Keating Reginald Keith Dan LaForgia Patrick Marks Alexander Michaud Karl Peterman Raj Prime Michael Resetar Lauren Ronsse Kenneth Roy Mark Schaffer		<b>Voting Members:</b> Francis Babineau John Dunlap Robert Lilkendey Richard Peppin Terence Tyson <b>Corresponding Members:</b> Rami Alkhalil Jeffrey Babich Mark Bastasch Joseph Bridger Norm Broner Todd Busch David Carroll Erroll Eaton Ronald Eligator Mark Fly Vernon Frankwich Michael Froehlich Kevin Gaghan Jason George John Gierzak Lewis Goodfriend Brian Guenther Art Hallstrom Joseph Horesco Manoj Khati Jim Kline Marvin Kloostra Will Kowald		<b>Visitors:</b> Chris Auth Joe Brooks Franco Cincotti Victor Clemente Nathaniel Deibler Sami Elkhazin Keith Habecker David Herrin Jim Holtrop Matthew Hooti Larry Hopkins Chad Huggins Joshua Kading Ed Koop Tim Kuski Sally Anne McInerny Dave Meredith Emanuel Mouratidis John Murphy Steve Purdie Srivivasan Ramalingam Brian Reynolds Jackie Russo Jenny Samson Josh Thede S. Vasconi

MEMBERS PRESENT	YEAR APPTD	MEMBERS ABSENT	YEAR APPTD	EX-OFFICIO MEMBERS AND ADDITIONAL ATTENDANCE
Michael Schwob John Sofra Jack Wang Lily Wang Zhiping Wang Steve Wise		Kevin Lai Brian Landsberger Joshua Leasure Geoff Leventhall Charles Mattocks Paul Meisel Andrew Mitchell Ralph Muehleisen Matthew Murello Jose Nepomuceno Chris Papadimos John Pappas James Pooler William Rockwood Erica Ryherd Benjamin Sachwald Ken Shook Tim Simcoe Michael Spencer Matthew Stead William Stewart Nicholas Sylvestre-Williams Vijay Tripathi Jonathan Weinstein Roman Wowk		

**DISTRIBUTION**

<b>All Members of TC/TG/MTG/TRG plus the following:</b>	
TAC Section Head:	J Thomas Sobieski
TAC Chair:	William McQuade
All Committee Liaisons As Shown On TC/TG/MTG/TRG Rosters:	Donald Brandt Cecily Grzywacz Jean-Gabriel Joannette David John Francis Mills Jeff Traylor Chris Ahne
Manager Of Standards:	Stephanie Reiniche
Manager Of Research & Technical Services:	Michael Vaughn

ASHRAE TC 2.6 Sound and Vibration Control  
Meeting Minutes & Reports  
Monday, January 28, 2013  
Dallas, Texas

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## Main Committee Meeting Attendance List

### Voting Members:

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Douglas Reynolds	Univ Of Nevada Las Vegas	douglas.reynolds43@gmail.com
Robert Simmons	Petra Seismic Design	res@seismic-source.com
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### Corresponding Members:

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Jack Wang	Trane	jjwang@trane.com
Lily Wang	University Of Nebraska	lwang4@unl.edu
Zhiping Wang	Morrison Products Inc	zpwang@morrisonproducts.com
Steve Wise	Wise Associates	stevewise@att.net

ASHRAE TC 2.6 Sound and Vibration Control

Main Committee Meeting Minutes

Monday, January 28, 2013

Dallas, Texas

**Main Committee Meeting Attendance List Continued**

**Visitors:**

Chris Auth	Baltimore Aircoil	cauth@baltimoreaircoil.com
Joe Brooks	AMCA International, Inc.	jbrooks@amca.org
Franco Cincotti	Comefri USA	fcincotti@comefriusa.com
Victor Clemente	Industrial Acoustics	victor.clemente@iac-acoustics.com
Nathaniel Deibler	PVC Specialties	nated@pvcspecialties.com
Sami Elkhazin	Vibro-Acoustics	selkhazin@vibro-acoustics.com
Keith Habecker	SEMCO	keith.habecker@flaktwoods.com
David Herrin	University of Kentucky	dherin@engr.uky.edu
Jim Holtrop	AcoustiControl	jim@acousticcontrol.com
Matthew Hooti	Vibro-Acoustics	m.hooti@vibrao-acoustics.com
Larry Hopkins	Huntair Inc.	lhopkins@huntair.com
Chad Huggins	Krueger	chuggins@krueger-hvac.com
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S. Vasconi	Petra Seismic Design	svasconi@petraseismicdesign.com

## **ASHRAE TC 2.6 Main Committee Meeting Minutes**

2:15-4:15pm Monday, January 28, 2013

1. Call to order (Oliver)
  - Call to order by Patrick Oliver 2:17.
  - 1.1. Read scope of TC 2.6
    - The scope is posted on the TC website.
  - 1.2. Additions and/or modifications to the agenda
    - No additions or modifications.
2. Introduction of those present (All)
3. Confirmation of current voting members (Meredith)
  - 13 of 17 voting members present – constitutes a quorum
4. Review and approval of the minutes (Oliver)
  - Motion by Curt Eichelberger and seconded by Jason Swan: The San Antonio minutes were approved by unanimous vote.
5. Secretary's report (Schwob)
  - Please provide all subcommittee reports on or by Friday, February 8th.
6. TC Chair's meeting report (Oliver)
  - TC Chairs met Sunday morning.
  - Hightower technical achievement award nominations are due September 1st 2013. Anyone can nominate.
  - The TC Manual of Procedures was updated October of 2012. It is available on the ASHRAE website.
  - The research projects meeting were listed as closed for PMS members only. That is not correct. Those meeting are open.
  - Each TC member should review the code of ethics. See Oliver after meeting if you have questions.
  - The 50% draft of the Refrigeration Commissioning Design Guide is open for review and comment.
  - A new field has been added to the ASHRAE website for biographical data to classify member employment. TC members called to add this data to their profiles.
  - MTG formed by TAC for Cold Climate Design Guide. TC members urged to go to the MTG section of the ASHRAE website for more info. The contact is Mike Vaughn.
  - TC subcommittees have the option to meet via conference call provided by ASHRAE.
  - Encouraged guests to participate in subcommittee meetings and get more involved.
7. Chair's announcements and correspondence (Oliver)
  - Included above.
8. Subcommittee Reports (also see attached reports from subcommittee Chairs)

#### 8.1. Research Subcommittee (Eichelberger)

##### 8.1.1. Research Chair's meeting report

- David John is our new research liaison. He should be copied on all RTAR's and WS's for review.
- Upper limit of \$200k for RAC approval.
- RAC is serious about reducing effort in producing RTAR's and WS's. All forms revised, simplified and easy to use.
- Acceptance of an RTAR does not guarantee that the WS will be funded.
- If RAC doesn't receive more RTAR's in 2013, ASHRAE will run out of projects.
- RAC is looking for a new member. Contact Mike Vaughn if you are interested.

##### 8.1.2. Ongoing research projects

###### 8.1.2.1. RP-1322 Performance, Perception and Criteria with PI Wang/UNL (Schaffer)

- Project final report was reviewed. Recommended that this report be approved. Motion to approve by Curt Eichelberger and seconded by Mark Schaffer. Accepted unanimously.

###### 8.1.2.2. RP-1408 Attenuation of Lined Ducts with PI Reynolds/UNLV (Lilly)

- The project was given an extension to June 2014 to facilitate RP-1529. Good progress being made.

###### 8.1.2.3. RP-1529 Numerical Modeling of Lined Ducts (Marks)

- Met with principle investigator Dr. David Herrin. The project is well underway.

##### 8.1.3. Work Statements/RTAR's/URP's

- Lily Wang circulated a draft RTAR titled Annoyance Thresholds of Tones in Noise as Related to Building Services Equipment. This draft was reviewed and edited during the Criteria Subcommittee meeting (1/27/13). The revised RTAR will be forwarded to the Research Liaison for review. If all goes well, the RTAR will be submitted to the TC for approval before May 15<sup>th</sup>.

###### 8.1.3.1. RTAR-1560 Installed Performance of Vibration Isolators (Simmons)

- RTAR 1560 has been pulled off the ASHRAE Docket for now and needs to be reintroduced with the new RTAR format. We have tabled the revision until we progress a little more on the SPC 197 Standard for Method of Test for Isolator Performance.

###### 8.1.3.2. RTAR-\*\*\* Effect of HVAC Noise in Hospitals (Babineau/Roy)

- Ken Roy and J.R. Babineau prepared a draft RTAR June 2010 that was returned by RAC. Consensus is that we need other TCs to either support or co-sponsor this RTAR. The next step is for Ken Roy to solicit support from TC2.1 (Physiology & Human Environment), and J.R. Babineau to solicit support from TC9.6 (Health Care Facilities).

##### 8.1.4. Topics for future research

- Tone Criteria: Lily Wang is finalizing an RTAR.
- Room Effect: Possible hot topic for meeting in Dallas to review what is already in the

literature. Doug Reynolds volunteered to present.

- Silencer System Effects: Patrick Oliver and Victor Clemente will work on an RTAR.
- Fluctuation Criteria: Objective would be to develop a metric for Criteria section of Handbook. Criteria subcommittee decided to work on tone criteria first.
- Piping Noise for Equipment: Mark Schaffer to report back on this topic next meeting.
- The Effect of HVAC Noise in Hospitals: Ken Roy and J. R. Babineau soliciting support from other TCs.
- Fan Elbow Effect: No champion for this topic.
- BIM: TC2.6 efforts are focused on ASHRAE Multidisciplinary Task Group and SPC 205.
- Flow Noise Generation in Ducts: No champion for this topic at this time.

#### 8.2. Programs Subcommittee (Miller-Klein)

##### 8.2.1. Program Chair's meeting report

- We are sponsoring a seminar about the Basics of HVAC Noise Control on Jan 29<sup>th</sup>. We would like to follow-up on the "Basics of HVAC Noise Control" theme at the Annual Conference in Denver. Hopefully this will be reoccurring.
- Programs for Denver Conference:  
Coordination in the New Design Environment (FTP login, daily design iterations, BIM) with Designers, Engineers, and Consultants (Mark Schaffer)  
Green Building Acoustics – LEED, IGCC, PMP Best Practices (Kenneth Roy, Lily Wang, Curt Eichelberger)  
Basics of HVAC Noise Control: Sound Power vs. Sound Pressure vs. Sones (Miller-Klein), Propagation of Sound (Rich Peppin), Vibration Isolation – The Basics (Reginald Keith)
- Programs for the New York Conference:  
Basics of HVAC Noise Control: Environmental Noise Codes: Current and Future (Miller-Klein), Objectionable: Tones & Fluctuations (Jerry Lilly), Outdoor Noise/Liability (Matt Murello)  
Green Buildings & Their Noise Issues  
Ongoing Equipment Series, Noise Source Characteristics (Jack Wang), Chilled Beam (Patrick Oliver)

##### 8.2.2. Programs this meeting

###### 8.2.2.1. Conference Paper Session 7: Numerical Methods for Noise and Vibration Simulation of HVAC&R Systems

###### 8.2.2.2. AHR Session 1: Basics of Noise Control

##### 8.2.3. Potential programs next meeting – Denver, June 2013

#### 8.3. Publications Subcommittee (Wise)

- Made TC aware of Standard 189 and PMP.
- Steve asked if anybody is aware or using the PMP. There was no response.
- Curt discussed the purpose of the PMP. IAQ has been given appropriate emphasis and balanced with other building requirements. This publication is for building owners and operators.

- ASHRAE's new scope has trickled down to the TC's. The TC's need decide what content needs to be added to the handbooks.

#### 8.3.1. Handbook chapters

##### 8.3.1.1. Handbook Applications 2015 (Wise/Peppin)

- We have two years remaining before this chapter is published. We will have to vote on any changes within a year. Revisions have not yet started. The last revision was substantial. There should be only minor changes this cycle. The chapter has been divided into ten sections for review and editing. We are looking for 2 or 3 people to review these sections. Steve will send out a list of ten sections. If you would like to volunteer please contact Steve or Rich.
- The new Publications Liaison, Chris Ahne, introduced himself in the Publications subcommittee meeting. He informed us that handbook will be online with multimedia content. The subscription will be \$49. We can add spreadsheets, sound files and other media. We need to incorporate this into our work on the handbook. We will not make wholesale changes to process at this time, will incorporate media content gradually.

##### 8.3.1.2. Handbook Fundamentals 2013 (Weinstein/Wise)

- The new handbook will be published this year. All paper work has been submitted. We have not received galley proofs yet. Steve Wise and Rich Peppin will review. Reggie Keith and Jason Swan also volunteered to review.

#### 8.3.2. Other publications

- There was nothing to discuss.

#### 8.3.3. Web page (Schwob)

- The meeting schedule and agenda for this conference have been posted.
- San Antonio programs have been posted.
- A new page was created to organize the content for meetings.
- A new page was created for the HVAC sound files. Some of the recordings are poor quality. If anybody has good HVAC noise recordings please send them to me to be posted.
- A new roster will be posted after this meeting.
- Tones Page: Do we want it active, updated or remain the same? It was decided to leave the page active.
- Let me know if we need to update the publications, research, and standards pages or if other subcommittees would like to post their activity.

#### 8.4. Standards Subcommittee (Ronsse)

##### 8.4.1. SPC 79 – Method of Test for Fan Coil Units (Oliver)

- Met Saturday morning. Discussed current draft. SPC 79 will be harmonized with AHRI standards (ducted and un-ducted). Testing will be in 1/3 octave down to 50Hz.

##### 8.4.2. SPC 130 – Method of Test for Rating Ducted Air Terminal Units (Zimmerman)

- Significant changes: Adding end reflection per AHRI 880. Also, adding test procedures for

- exhaust terminals and valves. Then will allow exhaust terminals to be included in AHRI certification program.
- 8.4.3. SPC 189 – Design for High Performance Green Buildings (Bridger/Schaffer)
- 189.1 TC 2.6 to review. Ken: addressed as a standard now but will probably become code. It will need to be written in code language. Performance based requirements will be used rather than prescriptive requirements. This should be supported by the handbooks. We anticipate this will have a major impact on the design of buildings. Procedure must be enforceable by code.
  - 189.2 planned for future.
  - 189.3 has little acoustical content.
- 8.4.4. SPC 197 – Method of Test for Passive Vibration Isolators (Peterman)
- Not much progress.
- 8.4.5. SPC 200 – Method of Test for Chilled Beams (Zimmerman)
- Nothing to report. It will go out for review soon.
- 8.4.6. GPC 10 – Interactions Affecting the Achievement of Acceptable Indoor Environments (Wang)
- Met on Sunday morning. Currently word-smithing. Hoping to raise the influence of this guideline. Has not been popular.
- 8.4.7. Performance Measurement Protocol (PMP) Best Practices document (Eichelberger)
- Nothing more to add to what was already discussed.
- 8.4.8. Updates from Other Standards Organizations
- 8.4.8.1. AHRI (Abbate)
- Nothing new published. Working on 5 standards: 250, 270, 300, 350, water cooled refrigerating and HVAC equipment is brand new
- 8.4.8.2. AMCA (Brooks)
- The new AMCA Standard 270, Laboratory Methods of Testing Fan Arrays for Rating, was approved for development by the AMCA Board of Directors.
- 8.4.8.3. ANSI (Ronsse)
- Maintaining a list of current working groups. Updates will be published in subcommittee meeting minutes.
- 8.4.8.3.1. Working Group on Sound Measurement in Rooms (Lilly)
- New draft with all sections included for review.
- 8.4.8.4. ASTM (Peppin); E33 (Lilly)
- E477 is up for ballot and will probably be passed. There are many changes.
  - E33 not discussed.
- 8.4.8.5. ISO (Reynolds); ISO TC205 (Roy)
- ANSI S2.71 is currently being revised. Update the references and modernize.
  - ISO TC205 Building Environment Design currently has 10 working groups. Working

Group 6 will be dealing with indoor acoustical environment.

#### 8.5. Standing Subcommittees

##### 8.5.1. Sound Criteria (Wang)

- Currently working on RTAR for annoyance thresholds of tones in noise produced by HVAC equipment. A work statement is also being drafted and will be presented at the meeting in Denver.

##### 8.5.2. Vibration Isolation (Simmons)

- There was a conflict between the scheduled subcommittee meeting and a seminar yesterday. The subcommittee meeting did not occur. Robert Simmons has resigned from Chair position. Carl Peterman accepted this Chair position. Other nominations/volunteers for this Chair were solicited. There were no other volunteers.

##### 8.5.3. BIM (Mitchell)

- Nothing to discuss.

#### 8.6. Operations Subcommittee (Meredith)

##### 8.6.1. Bylaws

- The bylaws are posted on the website.

##### 8.6.2. Honors and awards (Wang)

- Mark Fly became a fellow. Nominations for the next cycle are due in December.
- Nominations for distinguished service awards are due at the Denver meeting. The award is based on a point system. You can nominate yourself.

##### 8.6.3. Long range planning

- Not discussed in this meeting.

##### 8.6.4. Membership (Meredith)

- We currently have 63 corresponding members, 7 provisional members and 16 voting members, including 1 nonquorum member.
- Next year we will have 70 corresponding members, 17 voting members and 2 nonquorum members.
- Oliver nominated Dustin for TC chair. The position was opened to other nominations. No one responded. Dustin left room. The nomination was seconded by Doug Reynolds. Dustin was approved by unanimous election.
- Other than the chair for vibration isolation, subcommittee Chairs remain.
- Dan LaForgia will become the Secretary next cycle.

##### 8.6.5. Liaisons (Meredith)

###### 8.6.5.1. International Green Construction Code update

- Nobody to respond on this subject.

###### 8.6.5.2. ASHRAE TC 2.1 Physiology and Human Environment (Wang)

- There will be a meeting tomorrow. Lily Wang will be there and will ask to cosponsor them to cosponsor the RTAR for annoyance thresholds of tones in noise.

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#### 8.6.5.3. ASHRAE TC 2.7 Seismic and Wind Restraint Design

- Carl Peterman: TC 2.7 will meet tomorrow. There was a seminar this morning about seismic certification of equipment. There will be another session Wednesday about flooding and wind. TC 2.7 has submitted an RTAR on research for rooftop mounted equipment.
- Robert Simmons: SBC 171 is also being revised.

#### 8.6.5.4. ASHRAE TC 5.1 Fan Design and Application (Osborne)

- Kim: TC 5.1 is working with AMCA on a plenum fan systems effect research project. They had a seminar yesterday morning and will have a forum Wednesday regarding fan energy efficiency.

#### 8.6.5.5. ASHRAE TC 5.2 Duct Design (Gierzak)

- Nobody to respond.

#### 8.6.5.6. ASHRAE TC 5.3 Room Air Distribution (Zimmerman)

- Randy: TC 5.3 will now include air curtains. They have a seminar today which is an introduction to the ASHRAE Chilled Beam Design Guide.

#### 8.6.5.7. ASHRAE TC 6.10 Fuels and Combustion (Herrin)

- David: TC 6.10 meets tomorrow. They have a couple of papers ready to be presented at the Denver or New York conferences.

#### 8.6.5.8. ASA (Wang)

- The next meeting is in June at Montreal. There will be no sessions of particular interest to this TC.

#### 8.6.5.9. VISCMA (Peterman)

- There is nothing pertinent to discuss at this time.

#### 8.6.5.10. Others: CTI, INCE, NCAC, CIBSE etc.

- Nobody to respond.

### 9. New business/Old business

- Mark Schaffer urged all present to let their associates know about the change in ASHRAE's scope of activity.

### 10. Next meeting date and location – Denver

- The next conference will be held June 22 to 26 in Denver.

### 11. Adjournment

- Motion by Patrick Oliver and seconded by Doug Reynolds.

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## **ASHRAE TC 2.6 Research Subcommittee Report**

Submitted by: Curt Eichelberger ([curtis.eichelberger@jci.com](mailto:curtis.eichelberger@jci.com))

### **Highlights of the Research Chair's meeting:**

- David John ([RL2@ashrae.net](mailto:RL2@ashrae.net)) is our new liaison. Reminder that our Research Liaison should review all RTARs and WS. Please copy Curt Eichelberger ([curtis.eichelberger@jci.com](mailto:curtis.eichelberger@jci.com)) on all correspondence with the Research Liaison.
- RTARs due May 15, August 15 and December 15.
- Why do RTARS get returned:
  - Idea not appropriate for ASHRAE funding
  - Not adequate references for to past work or existing literature
  - Not clear how project will “advance” the state-of-the art
  - Budget does not seem in line with work to be performed.
- Upper limit of \$200k for RAC approval.
- RAC is serious about reducing the effort of TCs in preparing RTARs and WS. Working on revisions to both RTAR and WS format.
- Acceptance of RTAR is no guarantee the WS will be funded.
- If RAC doesn't receive enough RTARs during 2013, ASHRAE may run out of projects !
- Looking for nominations to RAC membership.

### **Ongoing Research Projects:**

RP-1322 Productivity and perception based evaluation of indoor noise criteria, Mark Schaffer, PMS chair. Lily Wang, University of Nebraska, principle investigator. Project final report was distributed last week. PMS recommend, and TC 2.6 voted to approve, the report at the main meeting 1/28/13.

RP-1408 The effect of lining length on the insertion loss of acoustical duct liner. Jerry Lilly PMS chair. Doug Reynolds, UNLV, principle investigator. The objective of this research is to show how the sound attenuation of lined ducts depends on duct length. This project has been in progress for over four years and a no-cost extension has been granted to June 2014. Testing has started on round ducts, which should be completed by May/June. Testing on rectangular ducts will then continue through December 2014, and elbows will then be tested through June 2014.

RP-1408 Extension. An extension to the 1408 Work Statement was approved January 2010. The purpose is to collect vibration and sound intensity test data on a small subset of duct configurations. This test data will then be used to validate the analytical models of breakout noise that will be developed in RP-1529.

RP-1529 Full frequency numerical modeling of sound transmission and radiation in lined ducts – Pat Marks, PMS Chair. Dr. David Herrin, University of Kentucky, principle investigator. This project will develop and validate full-frequency numerical modeling techniques for sound transmission through, and radiation from, HVAC ductwork. Project was awarded, July 2012, to SECAT/University of Kentucky. David Herrin provided an overview of the approach they expect to use for the project during the PMS meeting. Target completion date is mid-2014, but this may be delayed until completion of RP-1408 testing.

**RTARs:**

Lily Wang circulated a draft RTAR titled Annoyance Thresholds of Tones in Noise as Related to Building Services Equipment. This draft was reviewed and edited during the Criteria Subcommittee meeting 1/27/13. Others working with Lily Wang on this RTAR include Mark Schaffer, Steve Wise and Patrick Oliver. Next steps are to finalized edits and send to our Research Liaison for review and comment. If all goes well, we may submit to TC 2.6 voting members for approval via a letter ballot before the next RTAR deadline in May 15.

Effect of HVAC noise in hospitals – Ken Roy and J.R. Babineau prepared a draft RTAR June 2010 that was returned by RAC. Consensus is that we need other TCs to either support or co-sponsor this RTAR. The next step is for Ken Roy to solicit support from TC2.1 (Physiology & Human Environment), and J.R. Babineau to solicit support from TC9.6 (Health Care Facilities).

**Topics discussed and prioritized for future research:**

The top topics discussed during the research subcommittee meetings are listed below in order of priority.

1. **Tone criteria** – Lily Wang is finalizing an RTAR.
2. **Room effect** (include effect of single pass ceiling systems) – Possible hot topic for meeting in Dallas to review what is already in the literature. Doug Reynolds volunteered to present.
3. **Silencer system effects** – Patrick Oliver and Victor Clemente will work on an RTAR.
4. **Fluctuation criteria** – Objective would be to develop a metric for Criteria section of Handbook. Criteria subcommittee decided to work on tone criteria first.
5. **Piping noise for equipment** – Mark Schaffer to report back on this topic next meeting.
6. **Effect of HVAC noise in hospitals** – Ken Roy and J. R. Babineau soliciting support from other TCs.
7. **Fan elbow effect** – No champion for this topic at this time.
8. **BIM** – TC2.6 efforts are focused on ASHRAE Multidisciplinary Task Group and SPC 205.
9. **Flow noise generation in ducts** – No champion for this topic at this time.

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**ASHRAE TC 2.6 Programs Subcommittee Report**

Submitted by: Erik Miller-Klein

This Meeting – Dallas, TX – January 27 to January 30, 2013  
 Programs to Presented at Dallas 2013 sponsored by TC2.6

Type	Subject	Chair
Conf Paper Session 7 (Tuesday @ 11 AM in Lone Star A4)	Numerical Methods for Noise and Vibration Simulation of HVAC&R Systems <ul style="list-style-type: none"> <li>- Prediction of Insertion Loss of Plenums (Herrin)</li> <li>- Using Statistical Energy Analysis to Analyze Sound and Vibration in HVAC Ducts (Herrin)</li> <li>- Numerical Vibration Simulation Applied to the Design of Refrigeration Piping Systems (Wang)</li> </ul>	Curt Eichelberger
AHR Expo Seminar (Tuesday @ 2PM AHRI Expo)	Basics of Noise Control <ul style="list-style-type: none"> <li>- Fan Selection for Acoustics (Schaffer)</li> <li>- Physics of Silencers (LaForgia)</li> <li>- Ear Training – What does that sound like and mean?(Miller-Klein)</li> </ul>	Erik Miller-Klein

Upcoming Dates:

Denver 2013 (Summer Conference)

Upcoming Deadlines:

**February 11, 2013:** Proposals for seminars and forums due

**March 25, 2013:** Notification of conference paper, seminar, and forum *accept/reject*

**May 6, 2013:** Upload of presentations begin

**June 3, 2013:** PowerPoint presentations due

New York City 2014 (Winter Conference)

Upcoming Deadlines:

**March 15, 2013** – Conference Paper abstracts due (after approval 3 months to write)

**April 19, 2013** – Full Technical Papers due

**July 2, 2013** – Conference Papers due (for abstracts that were accepted)

Notes:

- The speakers will be charged \$95 for the conference. ASHRAE has reduced the cost for all other attendees by \$100 through this change.

**Program Topics – Future & For Consideration**

<b>Status</b>	<b>Subject</b>	<b>Type</b>	<b>Champion</b>
Denver 2013	<b>Coordination in the New Design Environment (FTP login, daily design iterations, BIM) with Designers, Engineers, and Consultants</b>	Forum	Mark Schaffer (with assistance from EMK)
Denver 2013	<b>Green Building Acoustics – LEED, IGCC, PMP Best Practices</b> <ul style="list-style-type: none"> <li>- Kenneth Roy</li> <li>- Lily Wang</li> <li>- Curt Eichelberger</li> </ul>	Seminar	Lily Wang
Denver 2013	<b>Basics of HVAC Noise Control (New Sub-Topics)</b> <ul style="list-style-type: none"> <li>- Sound Power vs. Sound Pressure vs. Sones (Miller-Klein)</li> <li>- Propagation of Sound (Rich Peppin)</li> <li>- Vibration Isolation – The Basics (Reginald “Reggie” Keith)</li> </ul>	Seminar	Erik Miller-Klein
New York 2014	<b>Basics of HVAC Noise Control (New Sub-Topics)</b> <ul style="list-style-type: none"> <li>- Environmental Noise Codes: Current and Future (Miller-Klein)</li> <li>- Objectionable: Tones &amp; Fluctuations (Jerry Lilly)</li> <li>- Outdoor Noise/Liability (Matt Murello)? Or Other?</li> </ul>	Seminar	Erik Miller-Klein
New York 2014	<b>Green Buildings &amp; Their Noise Issues</b> <ul style="list-style-type: none"> <li>- Roof or Building Mounted Wind Turbines (contacting someone in UK)</li> <li>- Operable Windows – Energy compared to Noise</li> <li>- Thermal storage in floors, exposed radiant systems &amp; footfall noise</li> </ul>	Seminar	Jason Swan & Patrick Oliver (European & Canadian Panelists)
New York 2014	<b>Ongoing Equipment Series (kick-off)</b>	Seminar	Pat Marks

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Status	Subject	Type	Champion
	<ul style="list-style-type: none"> <li>- Noise Source Characteristics (Jack Wang)</li> <li>- Chilled Beam (Patrick Oliver)</li> <li>-</li> </ul>		
Seattle 2014	<b>Basics of HVAC Noise Control</b> <i>(New Sub-Topics)</i> <ul style="list-style-type: none"> <li>- VRF the Advantages and Challenges (Schaffer)</li> <li>-</li> </ul>	Seminar	Mark Schaffer
Chicago 2015	<b>Basics of HVAC Noise Control</b> <i>(New Sub-Topics)</i> <ul style="list-style-type: none"> <li>- Duct Liner, Breakout &amp; Flanking (Doug Reynolds)</li> <li>-</li> </ul>		Jerry Lilly?
	Standard method of Test for vibration isolators		Chris Papadimos
	In-Situ sound testing methods and challenges for different types of mechanical equipment		Chris Papadimos
	RTU Noise		Sami Elkhazin
	Forum on next gen handbook		<i>Champion?</i>

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## **ASHRAE TC 2.6 Publications Subcommittee Report**

Submitted by: Steve Wise

Attendees: Rich Peppin, Patrick Oliver, Victor Clemente, Dan LaForgia, Mark Schaffer, Andrew Mitchell, Don Warick, John Iacobellis, Robert Hassler, Jack Wang, Michael Schwob, Karl Peterman, Mark Fly, Jerry Lilly, Kim Osborne, Dustin Meredith, Eddie Lau, Ken Roy, Erik Miller-Klein, Curt Eichelberger, Pat Marks, Jason Swan, Steve Vasconi, Matthew Hooti, Steve Purdie, Harris Sheinman, Reggie Keith

We have a new ASHRAE liaison – Chris Ahne

### **Applications Handbook, 2015 revision**

Schedule: we are to vote on new revisions at next Winter meeting, so we want to make substantial progress by June.

Two issues were discussed that may factor into future revisions in this chapter.

1. The chapter is now accessible via **ASHRAE HANDBOOK ON-LINE**, for people wishing to pay an extra \$49/yr. Right now, there are format issues: it is difficult to scroll through the text on a small mobile device, and certain graphics may be hard to view. We may also want to establish some keyword links so that readers can jump to particular issue of interest.
2. It was mentioned that with ASHRAE STD 189 “Green Buildings” and the Performance Measurement Protocol documents available at the bookstore, ASHRAE has expanded their scope beyond what might historically have been called “noise control for HVAC equipment” to include “guidelines for room acoustics”, which gets into things like reverb time and room-to-room transmission of voices and other non-HVAC. We need to decide if some of these issues should be mentioned in the Applications chapter.

Rich Peppin has volunteered to help “drive” the 2015 revisions.

### ***URGENT REQUEST FOR VOLUNTEERS AMONG TC2.6 CORRESPONDING MEMBERS:***

We have chopped up the chapter into 10 manageable sections. Any TC correspondent who would like to join revision teams for one or more sections is welcome. Please send an e-mail to [stevewise@att.net](mailto:stevewise@att.net) ASAP (February 18) identifying your area of interest, and Rich and I will send you word.doc sections. We intend to have team revisions drafted by June.

- 1 - Intro + CRITERIA
- 2 - Basic Source-Path-Receiver concepts + FANS + DUCT SOUND GENERATION
- 3 - More Sources – CHILLERS + GENERATORS
- 4 - Attenuating Paths – DUCTS + PLENUMS + SILENCERS
- 5 - ROOM EFFECT + ROOM MEASUREMENTS
- 6 - OUTDOOR NOISE + FUME HOODS
- 7 - MER NOISE + CEILING FACTORS
- 8 - Noise Reduction – SOURCE=PATH-RECEIVER EXAMPLES

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9 - VIBRATION

10 - REFERENCES

**TC Website <http://ashrae-tc26.org>**

Mike Schwob reported that all is well. More info is available in his report.

**Fundamentals Handbook, 2013 revision**

Rich Peppin, Reggie Keith and Steve Wise will review Galley Proofs, which are expected within a month.

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### **ASHRAE TC 2.6 Webmaster Report**

Submitted by: Michael Schwob

- The meeting schedule and agenda for this conference have been posted.
- San Antonio programs have been posted.
- A new page was created to organize the content for meetings.
- A new page was created for the HVAC sound files. Some of the recordings are poor quality. If anybody has good HVAC noise recordings please send them to me to be posted.
- A new roster will be posted prior to the next meeting.
- The web pages for publications, research, and standards should be reviewed by the appropriate subcommittee. Any updates should be forwarded to me.

## **ASHRAE TC 2.6 Standards Subcommittee Report**

Submitted by: Lauren Ronsse

This report provides a summary of the standards updates provided during the ASHRAE TC 2.6 main meeting.

1. The standards subcommittee is comprised of liaisons from TC 2.6 to SPCs and Working Groups to make sure that TC 2.6 has input on all ASHRAE standards with sound and vibration control content.
2. Updates from SPC and WG liaisons:
  - a. SPC 79: Method of Test for Fan Coil Units (Oliver)
    - i. Incorporating sound testing for fan coil units – mandate how they shall be tested (AHRI 260, AHRI 350 – harmonize SPC 79 with this standard)
    - ii. Has FCU data from 50 Hz up in 1/3-octave bands
  - b. SPC 130: Method of Test for Rating Ducted Air Terminal Units (Zimmerman)
    - i. Updating method of test for terminal units...update to include end reflection and more types of products (i.e. exhaust)
    - ii. Some significant acoustics changes – adding in end reflection corrections (currently in AHRI A80, will be removed from 130)
    - iii. Adding test procedures for exhaust to account for sound path from the exhaust back into the room. Add back into exhaust terminals.
  - c. SPC 189.1: Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential (Ronsse reporting for Bridger)
    - i. Standard 189.1 is under continuous maintenance, and the current status was discussed during the Hot Topics meeting on Sunday.
    - ii. Has designated reviewers from TC 2.6 who are providing feedback on acoustics proposals that are submitted for inclusion in the standard.
    - iii. Subcommittee from TC 2.6 currently developing suggested acoustics content for standard. Met on Saturday to discuss this:
      1. Combining Exterior to Interior Sound Isolation and Interior Background Sound Control sections (Miller-Klein / Peterman)
      2. Interior Sound Isolation (Lilly)
      3. Interior Room Acoustics and Reverberation Control (Roy)
      4. Speech Privacy/Security (Schaffer / Roy)
    - iv. Once initial draft is completed it will be submitted to TC 2.6 for review, comment, and vote. Then it will be submitted to Andy Persily for consideration for inclusion in Standard 189.1.
    - v. Standard 189.3 is a new standard for High Performance Health Care Facilities, which is currently available for public comment.
    - vi. Effort to create Standard 189.2 is underway for residential buildings.
  - d. SPC 197: Method of Test for Passive Vibration Isolators (Peterman)

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- i. Intent – determine method of test for vibration isolators
  - ii. Developed a draft based on an ISO standard
  - iii. Industry is currently lacking in a method for testing isolators (particularly at high frequencies)
- e. SPC 200: Method of test for chilled beams (Zimmerman)
  - i. New standard for testing active chilled beams: testing airflow and conduction rate of diffusers
  - ii. Nothing new of interest to report – will go out for review fairly soon
- f. GPC 10: Interactions Affecting the Achievement of Acceptable Indoor Environments (Wang)
  - i. Now a published document after 19 years of work. It is under continuous maintenance.
  - ii. Trying to increase the influence of this document – perhaps via addendum
- g. Best Practice for Evaluating and Improving the Performance of Commercial Buildings document (Eichelberger)
  - i. Follow-up to PMP document regarding how to get measurements done in high-performance buildings
  - ii. Main focus is energy and water conservation, but with consideration for maintaining proper lighting and acoustics
  - iii. Primarily intended for building owners and facility managers
- 3. Updates from other standards organizations
  - a. AHRI (Abbate)
    - i. New standard: water cooled refrigerating and HVAC equipment
  - b. AMCA (Brooks)
    - i. Air and sound performance for sound arrays – logarithmically add sound levels for enclosed modules...may need testing for open modules
    - ii. Test sound power output of air curtains...adds onto 300 a way to set it up
  - c. ANSI (Ronsse)
    - i. Compiled a list of active ASNSI working groups and standards that are related to this TC. These will be included in the meeting minutes.
    - ii. Ali Herfat volunteered to assume ANSI liaison position.
    - iii. Revising standard on human exposure to vibration in buildings...updating references (Reynolds)
    - iv. Working Group on Sound Measurement in rooms (Lilly)
      - 1. Still working on drafts
      - 2. Mailing list will get a draft that includes all sections
  - d. ASTM (Peppin)
    - i. E477 is submitted for ballot
    - ii. E33 (Lilly)
  - e. ISO (Reynolds)

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- f. ISO TC205 (Roy)
  - i. This was originally running through ASHRAE, now work has been transferred to ASTM at the ISO level
  - ii. Working Group 6: pertinent to acoustics – no longer meeting directly with TC205.

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## **ASHRAE TC 2.6 Liaison Subcommittee Report**

Submitted by: Lauren Ronsse

### **Active Working Groups (Select)**

#### **S1/WG01 Standard Microphones and their Calibration**

Active

(Parallel to IEC/TC29/WG5 and IEC.TC 28/WG 8) – Revision of S1.10-1966(R 1986) Method for the Calibration of

Microphones and S1.12-1967 (W 2001) Specification for Laboratory Standard Microphones

**Chair, S1/WG01 V. Nedzelnitsky**

#### **S1/WG04 Measurement of Sound Pressure Levels in Air**

Active

To revise the current Annex A: Identification and evaluation of prominent discrete tones (Character of the sound) to bring it into consistency with the more up-to-date prominent tone procedures recently published in ECMA-74.

**Chair, S1/WG04 VACANT**

**Vice-Chair, S1/WG04 E. Dunens**

#### **S2/WG06 Vibration and Shock Actuators**

Active

This WG will monitor workings of ISO TC 108 SC 6, develop standards that relate to vibration generating systems including: electrodynamic, electropneumatic, mechanical generating systems (exciters), shock generating machines, and standards that provide guidance for use and selection of these systems.

**Chair, S2/WG06 G.B. Booth**

#### **S2/WG07 Acquisition of Mechanical Vibration and Shock Measurement Data**

Active

Development of standards for the acquisition of data related to mechanical vibration and shock measurements.

**Chair, S2/WG07 B.E. Douglas**

#### **S2/WG10 Measurement and Evaluation of Machinery for Acceptance and Condition**

Active

The development of standards and standardized terminology for the measurement, analysis, and evaluation of machinery for the purposes of acceptance and condition assessment. This measurement, analysis, and evaluation activity generally applies to the mechanical vibration, balance, structural integrity, and the electrical, thermal and tribology-related properties of machinery. The standardization includes the measurement instrumentation, evaluation procedures, and acceptance criteria related to the balancing, condition monitoring, acceptance testing, diagnostics, life usage, fault analysis, and prognosis of machinery.

**Chair, S 2/WG10 R.L. Eshleman**

**S2/WG39 Human Exposure to Mechanical Vibration and Shock**

Active

Standardization in the field of shock, vibration and related biodynamic environments with regard to health, safety, performance and comfort criteria and guidelines regarding the effects of occupational and non-occupational exposures on the human population (environments of primary interest are: vibration, rotational oscillations, shock and impact transmitted to the whole-body or parts thereof). Preparation of standard terminology and characterization of the biodynamic properties of humans with and without support and restraint devices by means of biodynamic models or analogues is also included as a basis for the description of the physical, behavioral and physiological effects of the mechanical environments under consideration.

**Chair, S2/WG39 D.D. Reynolds**

**S12/WG03 Measurement of Noise from Information Technology and Telecommunications Equipment**

Active

(parallel to ISO/TC 43/ SC1/WG23) - Development of procedures for measurement and evaluation of noise emitted from

Information Technology and Telecommunications Equipment and their component noise sources.

**Chair, S12/WG03 K.X.C. Man**

**S12/WG15 Measurement and Evaluation of Outdoor Community Noise**

Active

To produce a series of Standards for outdoor environmental noise that deal with: (1) definitions and nomenclature, (2)

measurements including both short-term measurements and long-term monitoring, etc., (3) modeling of environmental

noise, (4) quantitative evaluation of the effects of environmental noise such as annoyance, complaints, sleep disturbance,

disturbance by noise-induced vibration and rattles, and (5) compatible land use planning with respect to noise.

**Chair, S12/WG15 P.D. Schomer**

**S12/WG44 Speech Privacy**

Active

To develop standards and guidelines for the design and evaluation of speech privacy in health care facilities.

**Chair, S12/WG44 G.C. Tocci**

**Vice-Chair, S12/WG44 D.M. Sykes**

**S12/WG50 Information Technology (IT) Equipment in Classrooms**

Active

Develop new part to ANSI S12.60 to cover IT equipment with 1) recommended sound power criteria for IT equipment in classrooms, 2) recommendations for purchase specification format, and 3) recommendations for installation conditions of IT equipment.

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**Chair, S12/WG50 R.D. Hellweg**

**S12/WG51 Procedure for Measuring the Ambient Noise Level in a Room**

Active

Develop a new standard that will specify how to conduct ambient noise measurements in a room, including: instrumentation requirements, microphone placement, duration of each measurement, identification of specific noise sources (e.g., HVAC, lighting, electrical, exterior traffic and aircraft), and data reduction and analysis.

**Chair, S12/WG51 J.G. Lilly**

**S12/L5 ASTM E-33 on Environmental Acoustics**

Active

The development of standards on the characteristics and performance of materials, products, systems, and services relating to the acoustical environment and the promotion of related knowledge (to include the activities of ASTM E33.06 on Building Acoustics, parallel to ISO/TC 43/SC2 and ASTM E33.09 on Community Noise).

**Chair, S12/L5 K.P. Roy**

**S12/L8 ASME PTC 36 Measurement of Industrial Sound**

Active

The object of PTC 36 is to describe procedures for measuring and reporting airborne sound emission from stationary sound sources and equipment, or from facilities composed of multiple stationary sound sources. The scope includes procedures to determine compliance with specified acoustical criteria in a variety of acoustical environments, including outdoor settings influenced by ambient sound. Generally, sound pressure levels and/or sound power levels in prescribed frequency bands are used to quantify the sound emission of industrial equipment and facilities. Sound pressure level measurements or sound intensity measurements may be used to calculate sound power level.

**Chair, S12/L8 R.A. Putnam**

**Current ANSI Standards (Select)**

- **ANSI S1.13-2005 (R 2010)** American National Standard Measurement of Sound Pressure Levels in Air.
- **ANSI/ASA S1.18-2010** American National Standard Method for Determining the Acoustic Impedance of Ground Surfaces. (*Revision of ANSI S1.18-1999*).
- **ANSI S2.8-2007 (R2012)** American National Standard Technical Information Used for Resilient Mounting Applications.
- **ANSI/ASA S2.9-2008** American National Standard Parameters for Specifying Damping Properties of Materials and System Damping.
- **ANSI S2.71-1983 (R 2012)** American National Standard Guide to the Evaluation of Human Exposure to Vibration in Buildings (*Reaffirmation and redesignation of ANSI S3.29-1983*).
- **ANSI S12.1-1983 (R 2011)** American National Standard Guidelines for the Preparation of Standard Procedures to Determine the Noise Emission from Sources.
- **ANSI/ASA S12.2-2008** American National Standard Criteria for Evaluating Room Noise.

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- **ANSI S12.3-1985 (R 2011)** American National Standard Statistical Methods for Determining and Verifying Stated Noise Emission Values of Machinery and Equipment.
- **ANSI S12.7-1986 (R 2006)** American National Standard Methods for Measurements of Impulse Noise.
- **ANSI/ASA S12.8-1998 (R 2008)** American National Standard Methods for Determining the Insertion Loss of Outdoor Noise Barriers.
- **ANSI S12.9/Part 1-1988 (R 2003)** American National Standard Quantities and Procedures for Description and Measurement of Environmental Sound, Part 1.
- **ANSI/ASA S12.10-2010/Part 1** American National Standard Acoustics - Measurement of Airborne Noise Emitted by Information Technology and Telecommunications Equipment - Part 1: Determination of Sound Power Level and Emission Sound Pressure Level
- **ANSI/ASA S12.11/Part 1-2003 (R 2008) / ISO 10302:1996 (MOD)** American National Standard Acoustics – Measurement of noise and vibration of small air-moving devices – Part 1: Airborne noise emission. (Modified Nationally Adopted International Standard).
- **ANSI/ASA S12.11/Part 2 – 2003 (R 2008)** American National Standard Acoustics – Measurement of Noise and Vibration of Small Air-Moving Devices – Part 2: Structure-Borne Vibration.
- **ANSI/ASA S12.16-1992 (R 2007)** American National Standard Guidelines for the Specification of Noise of New Machinery.
- **ANSI S12.23-1989 (R 2011)** American National Standard Method for the Designation of Sound Power Emitted by Machinery and Equipment.
- **ANSI/ASA S12.60/1-2010** American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 1: Permanent Schools.
- **ANSI/ASA S12.60/2-2009** American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 2: Relocatable Classroom Factors.
- **ANSI S12.65-2006 (R 2011)** American National Standard for Rating Noise with Respect to Speech Interference.

## ASHRAE TC 2.6 Criteria Subcommittee Report

Lily Wang

Attendees: F. Cincotti, V. Clemente, C. Eichelberger, R. Hassler, A. T. Herfat, R. Keith, D. LaForgia, S.K. Lau, J. Lilly, P. Marks, D. Meredith, E. Miller-Klein, A. Michaud, A. Mitchell, R. Muehleisen, P. Oliver, R. Peppin, K. Peterman, S. Purdie, D. Reynolds, K. Roy, M. Schaffer, M. Schwob, L. Ronsse, J. Swan, S. Vasconi, J. Wang, L. Wang, S. Wise

- I. Scope/purpose of the criteria committee: “To define and promote measurement protocols and benchmarks/guidelines/criteria to evaluate building acoustics, as related to building mechanical systems”
- II. Development of an RTAR/Work Statement on Tones:
  - A. A summary of the committee’s discussion from San Antonio was presented, to review what the committee’s consensus is so far on this RTAR.
    1. Definition of the research question: “At what point is a tone in noise rated as ‘annoying’ by 80% (and 90%) of the general population?”
    2. WHO: Definition of ‘general population’... Normal hearing adults, ages 19 to 65?; investigators should consider subjects’ noise sensitivities and compare against any published normal distributions
    3. WHAT (Signals):
      - a. Tones: 7 fundamentals (29.5, 60, 125, 250, 500, 750, 1000 Hz) alone, and also all of the above with pertinent harmonic structures (e.g. 29.5Hz + 177 Hz, etc.) = 14 tonal signals
      - b. Level of the tones: varying levels
      - c. Background level and/or spectrum:
        - i. Should determine if the base absolute level of the background noise impacts the perceived annoyance of a tone ...so is 18 dB PR above a 50 dBA noise less annoying than 18 dB PR above 30 dBA noise? (S. Wise’s hypothesis is that a smaller PR is required at higher levels, and a larger PR at low levels.)
        - ii. More discussion needed on spectrum
      - d. Multiple (non-harmonic) tones will not be covered in this RTAR, but may be a topic for future research
    4. HOW (Methodology):
      - a. Test a ‘worst case’ scenario where participants do not have control over the tone
      - b. For this research, consensus is that it’s best to use narrow band data and possibly apply the psychoacoustically developed metrics of PR and TNR (already used in standard ANSI S1.13)
      - c. Researcher will be asked to use high quality equipment and specify what FFT procedures

will be applied (window, number of lines, etc), and also perhaps to determine what the variability of metrics would be based on FFT settings.

B. Other comments made during the above summary are as follows:

1. What bandwidths shall the tones have? Consider further when refining work statement.
2. Harmonic versions of test signals may not necessarily mean including only the first harmonic ... should consider probable harmonic structure of building services equipment.
3. Will the project consider fluctuating tones? Probably not, but keep as possible future topic.
4. The background noise (level and spectrum) depends heavily on the space under consideration (that is, is the in the mechanical equipment room or in the occupied space)?
5. J. Lilly commented that he felt the spectrum of the background noise should match an RC contour, as that is common in occupied spaces.
6. J. Swan asked if there would be interest in testing more frequencies, such as those commonly found in the EU, i.e. 50 Hz? Maybe annoyance caused by a 50Hz tone would not be that different from 60 Hz, though.
7. S. Wise commented that we should not constrain the project to use already developed metrics such as PR or TNR as they may not be the best metric for quantifying the annoyance of tones.
8. J. Lilly noted that he discussed this project with Matt Nobile who conducted the previous study cited in ANSI S1.13; Nobile himself is currently leaning away from PR and towards TNR. Also the ISO standard has selected TNR as the metric of choice. It would be good to include Nobile as this work statement progresses.
9. M. Schaffer discussed that it would be great to eventually have an addendum to equipment ratings that indicates tonality, perhaps an indicator of the strongest tonal frequency and its strength (e.g. 234 Hz – 10 dB). S. Wise concurred and felt that the research should cover methodology, metric, and the acceptable quantity. R. Muehleisen countered that as long as the test signals are measured in narrow band, they could be run through any number of proposed metric calculations. The focus of this RTAR should be on gathering answers to the research question of defining the thresholds of annoyance. Development of metrics or ratings can be done subsequent to that.

C. A draft of the RTAR, renamed “Annoyance Thresholds of Tones in Noise as Related to Building Services Equipment” was reviewed in detail (attached). A number of changes were suggested and will be incorporated in the next revision.

D. Ongoing Tasks

1. RTAR team to review revisions further (L. Wang, P. Oliver, M. Schaffer, S. Wise)
2. Submit to RAC Liaison for his review
3. Aim to complete TC 2.6 email ballot vote so that we can submit prior to RAC’s next RTAR deadline of 5/15
4. Continue to work on details for eventual Work Statement at next meeting in Denver (request

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1.5 hours)

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## **RTAR Form: Annoyance Thresholds of Tones in Noise as Produced by HVAC&R Equipment**

Unique Tracking Number Assigned by MORTS \_\_\_\_\_  
**RESEARCH TOPIC ACCEPTANCE REQUEST (RTAR) FORM**  
(Generally 2 to 6 pages, with 10 pt Times New Roman font)  
Sponsoring TC/TG/MTG/SSPC/EHC/REF: \_\_\_\_\_ TC 2.6 Sound and Vibration Control

**Title:**

Annoyance Thresholds of Tones in Noise as Produced by HVAC&R Equipment

**Applicability to ASHRAE Research Strategic Plan:**

This project is directly applicable to Goal 4 of the ASHRAE Research Strategic Plan 2010-2015 (Navigation for a Sustainable Future) “Significantly advance our understanding of the impact of indoor environmental quality (IEQ) on work performance, health symptoms and perceived environmental quality in offices, providing a basis for improvements in ASHRAE standards, guidelines, HVAC&R designs and operation practices.” Tones in noise as produced by common HVAC&R equipment are one of the most common complaints presented by building occupants and neighboring residential communities. This research project seeks to quantify the threshold at which the degree of tonalness in noise cause a vast majority (e.g. 80%) of the general public to consider it annoying. Such knowledge will advance our understanding of how acoustic conditions impact the perceived environmental quality, and eventually assist our society in setting design criteria to limit the impact of tonal noise.

**Research Classification:**

Basic/Applied Research

**TC/TG/MTG/SSPC Vote:**

(For –Against-Abstentions-Absent-Total)

**Reasons for Negative Votes and Abstentions:**

(Negative Votes)

(Abstentions)

**Estimated Cost:**

\$180,000

**Estimated Duration:**

24 months

**RTAR Lead Author:**

Lily Wang, [LWang4@UNL.edu](mailto:LWang4@UNL.edu)

**Expected Work Statement Lead Author:**

Lily Wang, [LWang4@UNL.edu](mailto:LWang4@UNL.edu)

**Co-sponsoring TC/TG/MTG/SSPCs and votes:**

??

**Possible Co-funding Organizations:**

(List only those organizations (name, contact information) that have reviewed this RTAR and expressed support)

AHRI??

**Application of Results:**

(Handbook chapters, special publications etc. to be affected by results of this project)

Results will be included in Chapter 47 on “Sound and Vibration Control” of the ASHRAE HVAC Applications

Handbook.

**State-of-the-Art (Background):**

(Briefly describe the amount and quality of past research, and quantify existing gaps)

HVAC system designers can use the table of noise criteria guidelines in Chapter 47 of the ASHRAE HVAC Applications Handbook (2011) to help them design building HVAC systems that will meet acceptable noise conditions for assorted types of spaces. However, these criteria do not apply well if the noise contains perceptible tones, as commonly produced by HVAC&R equipment with rotating parts (fans, motors, impellers, etc.). TC 2.6 does not find that sufficient data exists to be able to provide guidelines for noise with tones at this time; the annoyance thresholds experienced by the general population with regards to the degree of tones in noise is a significant piece of knowledge that is currently unknown.

The topic of noise with tones has generated much interest over the years, as many other types of equipment (aircraft, industrial machinery, and other office equipment) generate such spectra as well (Kryter and Pearsons 1965, Hellman 1982, 1984). A number of methods have been developed for quantifying the prominence of the tone in the noise or its 'tonalness', including Tone-to-Noise Ratio (ANSI S1.13-2005), Prominence Ratio (ANSI S1.13-2005), and Aures' Tonalness metric (1985). A round robin test was conducted to compare the two metrics discussed in ANSI S1.13, Tone-to-Noise Ratio and Prominence Ratio (Balant et al. 1999, Hellweg and Nobile 2002). They found that for broadband noise with a single prominent tone, the two metrics correlate well with each other and also with the degree of tonalness perception, but further issues need to be clarified regarding more complex tones (e.g. multiple tones in the same critical band, harmonic series of tones, or time-varying tones). Some work has been directed towards dealing with these more complex cases (Hellman 1985; Hastings et al. 2003, Lee et al. 2004, 2005). Many of these previous investigations have focused on how the tonal additions affect the perceived loudness of the acoustic signal, but none has directly sought to determine the human thresholds of annoyance for tones in noise.

The recent revision of ANSI S1.13 in 2005 includes the work of Hellweg and Nobile (2002), updating the prominence ratios at frequencies less than 1000 Hz from the previously listed value of 7 dB to range between 9 dB (at 1000 Hz) and 19 dB (at 100 Hz). Hellweg and Nobile's study, though, was limited in that they extrapolated their findings based on testing only two tonal frequencies (250 Hz and 1000 Hz). Furthermore, their subjective questionnaires focused on the perception of 'prominence' rather than annoyance.

ASHRAE TC 2.6 committee has determined that there is consequently a significant gap in knowledge that must be filled with regards to tones in noise. At what point is a tone in noise rated as 'annoying' (not just prominent) by the vast majority (e.g. 80%) of the general population? If we know that our HVAC equipment is producing a certain tonalness, do we have to design acoustic attenuation into the system? We are currently unable to base such decisions on solid experimental evidence, but rather the issue is left unaddressed (which can result in a large number of complaints) or is over-designed to compensate for our lack of knowledge.

Ventilation-like noise spectra that specifically include tones have been utilized in a few investigations involving perception or performance, but all of these studies have been limited to testing across six or less signals each. The results sometimes show that the presence of tones can impact perception or performance (Landström et al. 1991, 1993, 1994; Holmberg et al. 1993; Ryherd and Wang 2010), but again none has been able to comprehensively provide guidelines for what the threshold of annoyance for tones in noise should be across a wide range of tonal frequencies. In particular, the study by Ryherd and Wang (2010), sponsored by ASHRAE, tested three frequencies

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(120 Hz, 235 Hz, or 595 Hz) at two prominence ratios (5 and 9). These two prominence ratios were selected based on the previous version of ANSI S1.13-2005 which listed the prominence ratio as 7 across all frequencies; but the gathered results confirmed Hellweg and Nobile's finding that such prominence ratios are not high enough to cause significant annoyance at the frequencies tested. Future work is required to link the perception of much higher tonalness levels to human annoyance thresholds.

#### **Advancement to the State-of-the-Art:**

(Provide an estimate – as quantitative as possible – of the improvement expected from this research [i.e. x% energy reduction in product y or building type z, x% increase in heat transfer coefficient between y and z, or x% reduction in design time to do y, etc.] )

This research will provide quantitative data on the levels of tones in noise that cause certain percentages (a majority, or 80% or 90%, etc.) of the human population to be annoyed, which is not currently available. This informative data will lead to better designs with regards to the amount of acoustic attenuation to apply to tonal equipment installations so that the tone level is acceptable, reducing the number of complaints, and conversely improving human quality of life in the built environment.

#### Justification and Value to ASHRAE:

(Identify by number, profession, or industry the ASHRAE members affected. State the likelihood and how the improvement would be adopted by industry. Estimate the timeframe over which x% of society in total would be affected. Indicate the likelihood of ASHRAE's obtaining any intellectual property rights from this project.)

As noise can impact all ASHRAE members, this research has great value to our entire society. We estimate that 100% of the society in total will be affected within 10 years, as the data gathered in this project are embedded into the ASHRAE Handbook and eventually into design criteria, regarding noise from HVAC&R equipment in the built environment. We do not foresee any intellectual property rights resulting from this project.

#### **Objectives:**

(List the project goals and succinctly state how this project will accomplish its intended advancement to the state-of-the-art [i.e. a computer simulation will be used to do x, a computer simulation will be developed for x and verified using laboratory data from tests y and z, field test data will be obtained from x and used to do y])

The project goals are to:

- Determine what the human annoyance thresholds are of tones in noise, across the most common tonal frequencies found in HVAC&R equipment (i.e. 29.5, 60, 125, 250, 500, 750, and 1000 Hz)
- Determine if those thresholds vary, depending on whether there is a single fundamental tone (e.g. only 60 Hz) or multiple harmonics (e.g. 60 Hz + 120 Hz)
- Determine if those thresholds vary, depending on the absolute level of the ambient background noise; that is, does a certain tonalness (15 dB) above a background noise level of 35 dBA demonstrate the same annoyance as that same tonalness (15 dB) above a higher background noise level of 55 dBA?

A subjective study will be conducted by exposing test subjects to the simulated tonal noise signals and asking them to adjust the magnitude of the tone until it is found to be at the threshold of annoyance. Statistical analyses of the gathered data will result in an anticipated table of the annoyance thresholds across tonal frequencies.

#### **Key References:**

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