

ASHRAE TC 2.6 Sound and Vibration Control

Main Committee Meeting Agenda

2:15 PM – 4:15 PM Tuesday January 26, 2021

Summer Virtual Conference

NOTE: All Task Group Chairs and Subcommittee Chairs are asked to submit written report to the Secretary (Paul Bauch) before Friday January 29th, 2021

1. Call to order (Saenz-Acosta)

- 1.1. Read scope of TC 2.6: TC 2.6 is concerned with the fundamental scientific and engineering principles of sound and vibration, particularly as applied to the design and performance of the built environment.
- 1.2. ASHRAE Code of Ethics statement: "The ASHRAE Code of Ethics is to be adhered to by those doing ASHRAE business whether or not they are an ASHRAE member (www.ashrae.org/about-code-of-ethics)."
- 1.3. Additions and/or modifications to the agenda

2. Introduction of those present (Saenz-Acosta)

- 2.1. Welcome new members and visitors

3. Confirmation of current voting members

- 3.1. 11 members – 8 members present

4. Review and approval of the minutes (Saenz-Acosta)

Jason moved, Jeremy seconded. Unanimous approved.

5. Secretary's report (Bauch)

Strong attendance during monthly meetings averaging 20-25 participants.

6. TC Chair's meeting report (Saenz-Acosta)

- 6.1. New online Roster changes, if you are not a member of TC 2.6 please go to our website: <https://tc0206.ashraetcs.org/membership.php>

Changing status needs to be planned during ex com meeting. Elected positions and new roster is effective 1st of July or August. New members were asked to join at the ashrae website via the TC2.6 site.

7. Chair's announcements and correspondence (Saenz-Acosta)

- 7.1. Section Head
- 7.2. Research
- 7.3. Publications

8. Subcommittee reports (written reports to be provided to Secretary)

8.1. Research Subcommittee (Meeuwsen)

- 8.1.1. Research Chair's meeting report
- 8.1.2. Work Statements/RTAR's/URP's
 - 8.1.2.1. RP 1707 - Annoyance Thresholds of Tones in Noise as Related to Building Services Equipment – Still waiting for final report to be submitted. Dr. Davies is working on final edits before submitting.
ACTION: Need an update on submitting conference paper for Phoenix.
 - 8.1.2.2. RP 1852 - Develop performance metric, criteria, and process to measure and predict of speech privacy in High Performance Buildings – Erik Miller-Klein is PMS chair. Project awarded to Soft dB acoustical. Work is on hold due to pandemic lockdown.
 - 8.1.2.3. RTAR 1919 - The Effects of Duct Size and Aspect Ratio on Flow Noise in Elbows – Accepted and approved to move forward to work statement.

- 8.1.2.4. PTAR – update Application of Manufacturer’s Sound Data book – Not much movement. Still waiting for feedback from RAC. Appears to be on hold for other priorities.
- 8.1.2.5. WS-1754 Developing the Standard Test Method for Dynamic Characteristics of Large Vibration Isolators – Greg has possible revisions to revamp the work statement. Will update at the next research subcommittee meeting.

8.1.3. Topics for future research
NOTE: 1829 was withdrawn

8.2. **Programs Subcommittee** (Swan)

8.2.1. Program Chair’s meeting report - Met yesterday Jan 25 during the “Chicago” virtual meeting.

8.2.2. Programs this meeting

8.2.2.1. Streaming from Tuesday 9 February 2021
Seminar 50: Elevator Noise, Vibration and Energy Efficiency (Track 1)
(Swan: Miller-Klein, Boldt)

8.2.2.2. Streaming from Tuesday 9 February 2021
Seminar 73: Noise and Vibration Commissioning and Remediation (Track 5)
(Miller-Klein: Bauch, Miller Klein)

8.2.3. Programs at Phoenix 2021

Track 5 Seminar – Noise in Critical Environments (Marks: Miller-Klein, LaForgia, Bauch)
Track 1 Workshop – Upcoming changes to the vibration table in the applications handbook.

Proposals Due: Feb 18 or 22. Acceptance notification April 2.

Hot topics: Outdoor noise control (Lilly) Calcs, pitfalls of noise ordinance compliance, intensity, use of manufacturer’s data.

Technical/Conference Paper – TP: Tones and Background Noise (RP-1707)

ACTION

- Jason Swan to distribute poll to rank program topics
- Presenters for Phoenix to prepare proposals by Feb 22 (Marks, Miller-Klein, LaForgia, Bauch, Boldt)
 - o Abstract for session, presentations, objectives, bios, and 10 questions answered by the sessions.

8.3. **Publications Subcommittee** (Wise)

8.3.1. Handbook chapters

8.3.1.1. Handbook Applications 2019 (Wise)

8.3.1.2. Handbook Fundamentals 2021 (Wise)

8.3.2. Other publications

Fundamentals Ch9 - 2021

Galley Proofs on the way for review – Karina, Jeremy and Steve (added Jason and Jerry) will proof read the chapter.

Applications 2023

Focus on vibration isolation section. Changes to the tables and merging the “types” wording in CH56.

Steven Wise reviewed proposed changes to notes in the vibration isolation table of Ch48. Discussion pointed toward a need to reference seismic restraint guideline. “Practical Guide to Seismic Restraint, 2nd edition” 2012

In depth discussion around content which was tabled for next vibration isolation subcommittee meeting.

8.4. **Web page** (Saenz-Acosta)

Has been updated recently.

8.5. **Standards Subcommittee** (Bridger)

8.5.1. Updates from Other Standards Organizations

- 8.5.1.1. AHRI (Marks) – Delayed start up of TCoS due to staff changes at AHRI. Looking to incorporate recent RP on Tones to sound quality standard. Working groups will be open to all interested parties in the future. More details to come as they are available.
- 8.5.1.2. AMCA (Brooks/Osbom) – AMCA ordered the revision of AMCA 301 (ratings based on 300 test data). Sent out a call for membership to revise AMCA 300. AMCA 320 (sound intensity) revision was initiated last Fall.
- 8.5.1.3. ANSI (Reuter/Lilly) – Jerry Lilly reported on new standard of classroom acoustics including additions for gyms, auditoriums, and exercise facilities. Looking to revise S12.70 speech privacy for healthcare.
- 8.5.1.4. ASTM E33 (Lilly/Shafer) – Ben reported out on efforts to transfer C919 acoustic sealants to E33, remains in C24. Editing will be ongoing.
Vibration standard for ship bulkhead is coming up.
Other comments on rounding. When do you round? STC and IOTC calculations?
Exploring inclusion of impulse response to speed up testing.
- 8.5.1.5. ISO (Golden) – General revisions. Standard for music practice spaces. Indoor acoustic environment meeting coming up (design standard). ISO wants to look at structural testing of suspended ceilings.

8.6. **Standing Subcommittees** [10 minutes]

8.6.1. Vibration Isolation (Miller-Klein)

Reviewed potential changes in the approach to vibration isolation. More of a risk analysis approach in addition to a revised prescriptive approach. Also updates to Notes 20 and 21.

8.7. **Operations Subcommittee** (Saenz-Acosta) [15 minutes]

8.7.1. Honors and awards

8.7.2. Long range planning

8.7.3. Membership – Do not need to be an ASHRAE member to join as corresponding member. In person meetings are free to the public. Voting members and officers need to be ASHRAE members.

8.7.4. Liaisons (Saenz-Acosta)

8.7.4.1. ASHRAE TC 2.1 Physiology and Human Environment (Eichelberger)

One active research project – effect of ventilation on sleep. We pushed for noise intrusion to be included, but it did not make the final cut of the project scope. The committee is interested in looking at all of the IEQ parameters and how they interact.
ACTION: Open invitation to committee members to share insights or research regarding IEQ parameter interactions. Contact Curt for more information.

8.7.4.2. ASHRAE TC 2.7 Seismic, Wind and Flood Resistant Design (Waters)

Meeting Feb 2 and 3. M. Hooti can report more at next meeting.

8.7.4.3. ASHRAE TC 5.1 Fan Design and Application (Osborn)

One research project for system efficiency at part load.

8.7.4.4. ASHRAE TC 5.2 Duct Design (Hassler)

Met Jan 12. Working on an endowment fund for scholarship for YEA committee members. Working on duct design guide and fittings guide.

8.7.4.5. ASHRAE TC 5.3 Room Air Distribution (Zimmerman)

8.7.4.6. ASHRAE TC 9.6 Healthcare (Koukounian)

Met today Jan 26. Considering a section on acoustics in their handbook.

8.7.4.7. ASHRAE TC 9.7 Educational Facilities

Jeremy Stockman – No discussion other than NC curve discussion with Steve Wise.

8.7.4.8. ASHRAE TC 9.8 Indoor Agriculture

8.7.4.9. ASA (Reuter) – Next meeting is virtual. In person in Seattle.

8.7.4.10. VISCMA (Waters)

8.7.4.11. Others: INCE/InterNoise (Golden), NCAC (Bridger), EGSA (Simmons), etc...

InterNoise is going to be completely virtual. Board Cert will require some consideration.
NCAC is planned for the August 2021. Portsmouth NH.

9. **New business/Old business [5 minutes]**
Recognize Curt being awarded status of Fellow
Next TC meeting will be March.
10. **Next meeting date and location – Phoenix, AZ June 26-30 2021**
11. **Adjournment**
Curt motioned
Jason seconded.

Research Subcommittee Report – 2021 Winter Virtual Conference – January 25, 2021

Research project status:

RP-1707 - Annoyance Thresholds of Tones in Noise as Related to Building Services Equipment

- Project is complete, Patricia Davies principal investigator
- PMS chaired by Kim Osborne.
- There was a presentation from the investigators at the Orlando meeting.
- Waiting on submission of final report. Update from Kim?

RP-1852 - Develop performance metric, criteria, and process to measure and predict of speech privacy in High Performance Buildings

- Contract awarded to Soft dB Acoustical Consulting.
- Work has largely been on hold, due to inability to make measurements in occupied spaces under COVID-19.
- PMS chair is Erik Miller-Klein, brief summary from Erik.

RTAR-1919 - The Effects of Duct Size and Aspect Ratio on Flow Noise in Elbows

- Liaison indicates that RAC has approved the RTAR and development of the WS can commence.
- Brandon Cudequest is lead author.

WS-1829 - Inlet and Outlet System Effects on Multiple Plenum Fans in a Parallel Arrangement (Fan Arrays) for Air and Sound Performance

- Co-sponsor, lead is TC 5.1, lead author Kim Osborn.
- We voted to approve the WS with several comments.
- Status from Kim Osborn

PTAR – update Application of Manufacturer’s Sound Data book – Eichelberger

- Status from Curt Eichelberger

WS-1754 - Developing the Standard Test Method for Dynamic Characteristics of Large Vibration Isolators

- RTAR is expired
- Suggest we need a unified approach to modeling vibration isolation of equipment in buildings, and then decide what is needed to characterize isolators.

The Research “Breakfast Meeting” is scheduled for Feb. 8

TYPES OF PROGRAM SESSIONS

Technical Paper

Submitted directly by author
Papers are more involved, detailing research
Maximum of 30 pages
Rigorous double-blind review process; subject to commercialism review
Longer timeline for development and approval
Published in Transactions
Once paper reviewed/approved, submit presentation for review ~11 months before conference. (eg, March 2020 for Jan 2021)

Conference Paper/Extended Abstract

Submitted directly by author
Less rigorous than technical papers
May highlight case studies or ongoing research
Maximum of 8 pages (3 pages for EAs)
Single blind review process; subject to commercialism review
Shorter timeline for development and approval
Abstract due just after conference year before, Approval/rejection within 1 month,
Full paper due in 6 months,
Present 1 year from current conference.

ASHRAE asks for reviewers periodically

Seminar/Workshop/Forum

Session chairs and speakers selected by TCs
Program submitted by session chair/speakers
Include bios, abstracts, learning objectives, example questions/answers
Speakers submit final presentations 1 month prior to meeting for commercialism review

Seminar

60 minutes: 1 – 3 presentations
90 minutes: 3 – 4 presentations

Workshop

One chair and two presenters (maximum)
30 minutes for presentations
30 minutes for discussion

Debates

Experts (team/individual) present 2 sides
Hot button issues

Forum/Panel

One moderator
60-minute length
No presentations
Not recorded, ‘off the record’

Hot Topic

Internal subcommittee presentation
Can be invited from outside TC 2.6
Listed in the ASHRAE schedule
Available to both TC 2.6 and larger organization
Speakers can be video-conferenced (ie, no registration fee)

** ASHRAE encourages use of their approved PowerPoint template for presentations; available on their website **

THIS MEETING:
“Chicago” Virtual, 9-11 February 2021

Tracks:

- 1: HVAC&R Fundamentals/Applications
- 2: Systems and Equipment
- 3: Refrigeration and Refrigerants
- 4: Environmental Health Through IEQ
- 5: Building Performance and Commissioning for Operation & Management
- 6: Energy Conservation
- 7: International Design
- 8: Standards, Guidelines & Codes

Seminars:

Streaming from Tuesday 9 February 2021
Seminar 50: Elevator Noise, Vibration and Energy Efficiency (Track 1)
(Swan: Miller-Klein, Boldt)

Streaming from Tuesday 9 February 2021
Seminar 73: Noise and Vibration Commissioning and Remediation (Track 5)
(Miller-Klein: Bauch, Miller Klein)

Items to progress in next four weeks:

- Jason to distribute poll to rank the program topics on the following page
- Pat, Erik, Dan and Paul to submit their seminar to ASHRAE by 18 February 2021
- Greg, Erik, Steve, Matthew and Roman to do the same for their workshop (by 18 Feb 21)
- Jerry to organise the TC2.6 internal panel on outdoor noise.
- Jason will contact the above folks to provide direction.

NEXT MEETING:
“Phoenix”, 26-30 June 2021

Tracks:

- 1: Fundamentals and Applications
- 2: HVAC&R Systems and Equipment
- 3: Research Summit
- 4: Professional Development
- 5: Critical Environments: Design/Control/Operation
- 6: HVAC&R for Indoor Plants & Animals
- 7: Future Proof: Renewable/Regenerative/Resilient
- 8: Hot, Hot, Hot (warmer climates)

Seminars/ Workshops/Forums:

Proposals due: Thursday 18 (or Monday 22) Feb 2021

Accept/reject notifications: Friday 2 April 2021

Track 5: Seminar: Critical environments noise effects: Healthcare, Data Centers (Marks: Miller-Klein, LaForgia, Bauch)
with TC 2.1/9.6/9.9 - Changes due to H&S increase noise/vibration?

Track 1: Workshop: Upcoming changes to the Vibration Table (Meeuwssen, Miller-Klein, Wise, Golden, Wowk) Why changing. The theoretical, the practical, metrics.

Hot topics:

Outdoor Noise Control (Lilly) Calcs,
Pitfalls of noise ordinance compliance, Intensity,
Use of manufacturers' data

Technical/Conference Papers:

Conference/Technical Paper accept/reject: 18 Feb 2021

TP: Tones and Background Noise (RP-1707)

FOLLOWING MEETINGS:
Las Vegas, 29 Jan – 2 Feb 2022

Tracks:

1: [not yet known]

Seminars/ Workshops/Forums:

Proposals due: February 2021
Bring up in monthly calls

Track X: Tunnel/ Underground ventilation (LaForgia) with TC 5.1

Track X: What acoustics things will get you sued? QA is important – How consultants help during design. An attorney? (Boldt: Lilly)

Track X: Subject (Champion/Chair)

Technical/Conference Papers:

Abstracts/Session requests due: *March 2021*
Final Papers due: *July 2021*
Accept/reject notifications: *November 2021*

Toronto, 25-29 June 2022
Atlanta, 4-8 February 2023
Tampa, 24-28 June 2023

TOPICS FOR FUTURE PROGRAMS

Series: Equipment Noise

Air Distribution Systems (Zimmerman)
Boilers (Marks)
Compressors: Frequency Characteristics ()
DOAS units (Peterman)
Duct Breakout Noise (Lilly/Peterman)
Ductless Systems: PTACs, WSHP (Weinstein)
Electrical: Xfmrs, Elec Motors (Papadimos)
Exhaust Noise (____)
Fan Boxes: above/below floor (Zimmerman)
Fan Selection for Acoustics (Schaffer)
Fume hoods
Generators (LaForgia)
Industrial Ventilation (____)
 dust collection, garages, LNG
Pumps (____)
Plumbing noise (Wowk) TC 6.1/6.6?
Refrigeration: Commercial/Transport (Marks)
Rooftop systems (Peterman)
Silencers: Performance v Design (Papadimos)
Small Fan Coils (____)
Tankless water heaters
Under-floor Air Systems (Reynolds)
Variable Capacity Compressors (____)
VAV, CAV, VFD (w/5.1) (Gierzak)
 Insulation of

Format:

1. What it is, types, how works, why noisy
2. Standards, specification, lab data, mitigation methods
3. Field issues, case studies, testing

Series: Basics of HVAC Noise

Applications Chapter Review (____)
Commissioning (____)
Effects of 'over-design' (Lilly)
How Noise Affects Design Process (Lilkendy)
Noise and Productivity (Wang)
Noise Calculations How To (CD?) (Peterman)
Noise Flanking Paths (Peppin)
Predicted vs Actual Noise (Papadimos)
Prediction vs Lab vs Field (Papadimos/Marks)
Room Msmt: Test Method (Rockwood)
Speech Privacy in Low Noise Offices (____)
Tones and Fluctuations (Lilly)

Workshop

Vibration Handbook Table: Debate on where to take in future? Get feedback

Hot Topics

How to apply the results of RP-1707 on Tones? Indoors/Outdoors? To products?

Other Topics:

Classrooms: ICC adopts S12.60 (Bridger)
Design of Healthcare Facilities (Miller-Klein)
 Alarm fatigue, FGI Guidelines, Privacy
 Team up with healthcare TCs?
Labs internal: Air Valves/Fume Hoods (Wouk)
Labs external: Stacks, ventilation, nozzles
Mission Critical Facilities (____)
Noise Fluctuations (Lilly)
Passive vs Active (Wise)
Performance Rated Buildings (Roy)
Standard Test: Seismic Devices (w/2.7)
Tunnel Ventilation (LaForgia)
Industrial noise (Keith)
Noisy kit near to occupied?
Shell & Core vs Tenant Fit-Out/Improvement

Past Items:

Track ? : Hearing protection: TWA, Hospitals, Escape / S/N / STI, WHO

Track 3: Refrigerated processes/Storage
(Swan offered Keith's talk to TC10.5)

Track X: Plenum array fans

[Contact other TCs that may want to team up]

PAST PROGRAMS

2020 Orlando/"Austin"

Vibration Isolation Advances (Golden, Scarlett, Meeuwssen)

Beware These Common Concerns in Multi-Family Buildings (Miller-Klein, Dong/Rawlins, Golden)

When Is "Quiet" Quiet Enough (Hunt: Marks, Kollevoll)

HT: ANSI S12:60 / FGI vs 189.1 (Miller-Klein)

HT: Speech Privacy (Koukounian)

HT: Pandemic effects on acoustics

2019 Atlanta/Kansas City

RP-1408 Ductwork research (Herrin, Schwob)

VRF Systems (Lilly, Miller-Klein, Wowk)

Noise/Vib Equipment Selection (Boldt, Eichelberger, Wowk)

HT: IBC updates (Schmeida)

HT: Basecamp (Miller-Klein)

Commissioning (Miller-Klein, Swan)

Chilled Beams (Searle, Peterman, M-K)

Blocked Impedance (Meeuwssen)

2018 Chicago/Houston

Impacts of Safeguarding Buildings/HVAC Systems (Miller Klein)

HT: User Manual 189.1 Acoustic Control, Next Steps

HT: LNG Facilities (R Keith)

2017 Las Vegas/Long Beach

Acoustic Performance Standards for Residential Buildings (Miller-Klein)

HT: Mech Equipment Vibration & Structural Interaction (Wowk)

2016 Orlando/St Louis

TP: Simulating Noise Attenuation in Ducts (Kuehn)
Acoustics in Multi-Family Residential Environments (Papadimos)

Avoiding Pitfalls Integrating Seismic and Sound Control (w/2.07)

HT: Algorithms for HVAC Acoustics

2015 Chicago/Atlanta

System Effects from Inlet of Centrifugal/Plenum Fans (w/5.1,5.9)

Acoustic Mitigation for Lightweight Roof Assemblies (Miller-Klein)

Green Building Acoustics (Miller-Klein)

HT: Condensing Units on Lightweight Roof (Lilly)

HT: Sound measurement in rooms (Lilly)

2014 New York/Seattle

Equipment: Hydronic Systems (Miller-Klein)

Basics: Environmental Noise Impact & Mitigation (Wang)

2013 Dallas/Denver

Basics of HVAC Noise Control (Miller-Klein)

Numerical Methods for Noise/Vibration Simulation (Eichelberger)

HT: ASHRAE 189.1

2012 Chicago/San Antonio

Vibration Induced Noise & Mech Equipment Isolation (Marks)

HT: BIM and Acoustics

Impacts of Poor Aerodynamic HVAC Conditions (Schaffer)

New Acoustical Criteria and Measuring Methods (Peterman)

Review of Updated AHRI Standards (Papadimos)

2011 Las Vegas/Montreal

Recent Research: Healthcare Facility Acoustics (Papadimos)

Acoustic Codes/Standards/Guidelines (Muehleisen)

HT: Classroom Physical Environment Effects on Learning (Reynolds)

Fan Array Efficiency/Performance (Raychaudhuri)

Forum: Incorporating Acoustics into BIM (Peterman/Mitchell)

2010 Orlando/Albuquerque

Acoustics in High Performance Building (Peterman)

Noise & Mech System Design Process (Lilkendey)

Multiple Plenum Fans in an Array (Ganesh)

HT: Criteria (Paige) / Lined Duct End Reflection (Lilly)

HT: Int'l GBC (Marks) / Terminal Unit Tests/ASHRAE 130 (Peterman)

Classroom HVAC Noise Control (Lilkendey)

Unique Case Studies (Papadimos)

TP: Effects of Mech System Noise on Human Perf./Perception (Roy)

Sustainability and Our Environment (Ronsse)

2009 Chicago/Louisville

Staff Performance/Patient Welfare in Healthcare Facilities (Wang)

2008 New York/Salt Lake City

TP: End Reflection (RP-1314) (Eichelberger)

TP: Fan System Effects (RP-1219) (Eichelberger)

2007 Dallas/Long Beach

Acoustics for Green Buildings (Roy)

Acoustic vs Seismic (Lama/Marks/Blazier)

Lab Noise Control (Johnson/Moiseev)

ASHRAE TECHNICAL COMMITTEES

1.0-FUNDAMENTALS AND GENERAL

- 1.1 Thermodynamics and Psychrometrics
- 1.2 Instruments and Measurements
- 1.3 Heat Transfer and Fluid Flow
- 1.4 Control Theory and Application
- 1.5 Computer Applications
- 1.6 Terminology
- 1.7 Business, Management & General Legal Education
- 1.8 Mechanical Systems Insulation
- 1.9 Electrical Systems
- 1.10 Electric Motors and Motor Control
- 1.11 Moisture Management in Buildings
- 1.13 Optimization

2.0-ENVIRONMENTAL QUALITY

- 2.1 Physiology and Human Environment
- 2.2 Plant and Animal Environment
- 2.3 Gaseous Air Contaminants and Gas Contaminant Removal Equipment
- 2.4 Particulate Air Contaminants and Particulate Contaminant Removal Equipment
- 2.5 Global Climate Change
- 2.6 Sound and Vibration
- 2.7 Seismic, Wind and Flood Resistant Design
- 2.8 Building Environmental Impacts and Sustainability
- 2.9 Ultraviolet Air and Surface Treatment
- 2.10 Resilience and Security
- TG2 HVAC Security

3.0-MATERIALS AND PROCESSES

- 3.1 Refrigerants and Secondary Coolants
- 3.2 Refrigerant System Chemistry
- 3.3 Refrigerant Contaminant Control
- 3.4 Lubrication
- 3.6 Water Treatment
- 3.8 Refrigerant Containment

4.0-LOAD CALCULATION, ENERGY REQUIREMENTS

- 4.1 Load Calculation Data and Procedures
- 4.2 Climatic Information
- 4.3 Ventilation Requirements and Infiltration

- 4.4 Building Materials and Building Envelope Performance
- 4.5 Fenestration
- 4.7 Energy Calculations
- 4.10 Indoor Environmental Modeling
- TRG4 Indoor Air Quality Procedure Development

5.0-VENTILATION AND AIR DISTRIBUTION

- 5.1 Fans
- 5.2 Duct Design
- 5.3 Room Air Distribution
- 5.4 Industrial Process Air Cleaning (Air Pollution Ctrl)
- 5.5 Air-to-Air Energy Recovery
- 5.6 Control of Fire and Smoke
- 5.7 Evaporative Cooling
- 5.9 Enclosed Vehicular Facilities
- 5.10 Kitchen Ventilation
- 5.11 Humidifying Equipment

6.0-HEATING EQUIPMENT, HEATING AND COOLING SYSTEMS AND APPLICATIONS

- 6.1 Hydronic and Steam Equipment and Systems
- 6.2 District Energy
- 6.3 Central Forced Air Heating and Cooling Systems
- 6.5 Radiant Heating and Cooling
- 6.6 Service Water Heating Systems
- 6.7 Solar and Other Renewable Energies
- 6.8 Geothermal Heat Pump and Energy Recovery Applications
- 6.9 Thermal Storage
- 6.10 Fuels and Combustion

7.0-BUILDING PERFORMANCE

- 7.1 Integrated Building Design
- 7.2 HVAC&R Construction & Design Build Technologies
- 7.3 Operation and Maintenance Management
- 7.4 Exergy Analysis for Sustainable Buildings (EXER)
- 7.5 Smart Building Systems
- 7.6 Building Energy Performance
- 7.7 Testing and Balancing
- 7.8 Owning and Operating Costs
- 7.9 Building Commissioning

8.0-AIR-CONDITIONING AND REFRIGERATION SYSTEM COMPONENTS

- 8.1 Positive Displacement Compressors
- 8.2 Centrifugal Machines
- 8.3 Absorption and Heat Operated Machines
- 8.4 Air-to-Refrigerant Heat Transfer Equipment
- 8.5 Liquid-to-Refrigerant Heat Exchangers
- 8.6 Cooling Towers and Evaporative Condensers
- 8.7 Variable Refrigerant Flow (VRF)
- 8.8 Refrigerant System Controls and Accessories
- 8.9 Residential Refrigerators and Food Freezers
- 8.10 Mechanical Dehumidification Equipment and Heat Pipes
- 8.11 Unitary and Room Air Conditioners & Heat Pumps
- 8.12 Desiccant Dehumidification Equipment and Components

9.0-BUILDING APPLICATIONS

- 9.1 Large Building Air-Conditioning Systems
- 9.2 Industrial Air Conditioning and Ventilation
- 9.3 Transportation Air Conditioning
- 9.4 Justice Facilities
- 9.6 Healthcare Facilities
- 9.7 Educational Facilities
- 9.8 Large Building Air-Conditioning Applications
- 9.9 Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment
- 9.10 Laboratory Systems
- 9.11 Clean Spaces
- 9.12 Tall Buildings

10.0-REFRIGERATION SYSTEMS

- 10.1 Custom Engineered Refrigeration Systems
- 10.2 Automatic Icemaking Plants and Skating Rinks
- 10.3 Refrigerant Piping, Controls and Accessories
- 10.5 Refrigerated Processing and Storage
- 10.6 Transport Refrigeration
- 10.7 Commercial Food and Beverage Refrigeration Equipment
- 10.8 Refrigeration Load Calculations

Email Programs' chair: TCXXxx.PRO@ashrae.net