

ASHRAE TC 2.6 Sound and Vibration Control

Main Committee Meeting Agenda

2:15-4:15 PM Monday, June 24th 2019

KCCC 2210, Kansas City, MO

NOTE: All Task Group Chairs and Subcommittee Chairs are asked to submit written report to the Secretary (Karina Saenz-Acosta) before Friday June 28th, 2019

1. **Call to order** (Miller-Klein) [2 minutes]
 - 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** (Miller-Klein) [5 minutes]
 - 2.1. Welcome new members and visitors.
3. **Confirmation of current voting members** (Miller-Klein) [3 minutes]
 - 3.1. 10 members, 7 members present
4. **Review and approval of the minutes** (Saenz-Acosta) [3 minutes]
 - 4.1. Robert Hassler (1st), Greg Meeuwsen (2nd), 7-0-0-0
5. **Secretary's report** (Saenz-Acosta) [3 minutes]
6. **TC Chair's meeting report** (Miller-Klein) [5 minutes]
 - 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>
7. **Chair's announcements and correspondence** (Miller-Klein) [3 minutes]
 - 7.1. 2019-2020 Chair, Erik Miller-Klein
 - 7.2. 2019-2020 Vice Chair, Karina Saenz-Acosta
8. **Subcommittee reports (written reports to be provided to Secretary)**
 - 8.1. **Research Subcommittee** (Meeuwsen) [20 minutes]
 - 8.1.1. Research Chair's meeting report
 - 8.1.1.1. RAC considered 7 RTAR's, 1 accepted, 2 accepted with comments, 3 rejected. 13 work statements considered, 1 accepted, 5 conditionally accepted, 7 returned to TC.
 - 8.1.1.2. The RAC proposal for a new process for funding publications was presented.
 - 8.1.1.3. Awarded grants-in-aid to 19 recipients (up to \$11.5k). Selected recipient of the New Investigator Award (\$125k).
 - 8.1.1.4. The active ASHRAE research portfolio is \$11.2M. Average new project granted per year is \$1.5M.
 - 8.1.1.5. Next due date for RTAR's and WS's to RAC is August 15.
 - 8.1.2. Work Statements/RTAR's/URP's
 - 8.1.2.1. TRP-1707 Annoyance Thresholds of Tones in Noise as Related to Building Services Equipment. Project started in September 2018 and is slightly behind schedule. PMS (Osborne) holding conference calls with investigators weekly.
 - 8.1.2.2. RTAR-1852 - Develop performance metric, criteria, and process to measure and predict of speech privacy in High Performance Buildings. Erik Miller-Klein submitted a work statement to ASHRAE by the May 15 deadline. RAC reviewed and approved with comments to be addressed.

- 8.1.2.3. RTAR-1754 – Developing the Standard Test Method for Dynamic Characteristics of Large Vibration Isolators. A new lead author and a significant support from vibration isolator manufacturer are needed.
- 8.1.3. Topics for future research
 - 8.1.3.1. Follow up project to extend the work of 1529, considering 1408 – Dave Herrin UK. RAC liaison recommends a URP is the best way to go. Dave Herrin is working on the URP work statement.
 - 8.1.3.2. Update publication “Application of Manufacturers Acoustical Data”. There is a new process for funding publications through research funds, involving both RAC and Publications. RAC is going to use this project as the first test case for the process. Curt Eichelberger will draft the PTAR.
 - 8.1.3.3. Impedance approach to vibration isolation. Develop and validate tools for this approach specific to building structures. This uses impedance of the receiving structure (building), impedance characteristics of the isolator (the subject of RTAR-1754) and the velocity and impedance of the isolated object (mechanical equipment). Greg Meeuwssen will champion.
- 8.2. **Programs Subcommittee** (Swan) [15 minutes]
 - 8.2.1. Program Chair’s meeting report
 - 8.2.2. Programs this meeting
 - 8.2.2.1. Seminar 17: Next Level Challenges in Commissioning
 - 8.2.2.2. Seminar 31: Chilled Beams
 - 8.2.2.3. Hot Topic: Blocked Impedance (Meeuwssen)
 - 8.2.3. Programs at Orlando 2020
 - 8.2.3.1. Looking at 4 possible tracks:
 - 8.2.3.1.1. Track 2: Maglev chillers/compressors
 - 8.2.3.1.2. Track 3: Refrigerated processes/storage
 - 8.2.3.1.3. Track 4: “Cutting Edge” Vibration Isolation
 - 8.2.3.1.4. Track 7: Tunnel/underground ventilation
 - 8.2.3.2. Hot Topic: Acoustic sections from S12.60 and FGI
- 8.3. **Publications Subcommittee** (Wise) [10 minutes]
 - 8.3.1. Handbook chapters
 - 8.3.1.1. Handbook Applications 2019 (Wise)
 - 8.3.1.1.1. It has been on-line and in print for a couple weeks.
 - 8.3.1.1.2. On-line version also has access to these spreadsheets: Duct attenuation calculator and Table 47.
 - 8.3.1.2. Handbook Fundamentals 2021 (Wise)
 - 8.3.1.2.1. Looking for volunteers to take a look and decide if it needs any tweaking.
 - 8.3.2. Other publications
 - 8.3.2.1. Duct attenuation calculator will be put on basecamp for people to download.
 - 8.3.2.2. Application of Manufacturers’ Sound Data
 - 8.3.2.2.1. Looking at an RTAR for this application.
- 8.4. **Web page** (Saenz-Acosta)
 - 8.4.1. Currently posting Agenda, Schedule and Minutes.
 - 8.4.2. Check if topics for monthly calls can be posted in the web page, so people who are not members can contact the chair if they want to join.
- 8.5. **Standards Subcommittee** (Bridger) [20 minutes]
 - 8.5.1. SPC 189.1 – Design for High Performance Green Buildings (Miller-Klein)
 - 8.5.1.1. Currently accepting proposals for a user’s manual.
 - 8.5.1.2. SPC 189.1 cannot be bought. It is embedded in the International Green Construction Code from 2018.
 - 8.5.2. Updates from Other Standards Organizations
 - 8.5.2.1. AHRI (Cesar)

- 8.5.2.1.1. TCoS is updating the following standards; AHRI 220, AHRI 230, AHRI 250, AHRI 370, AHRI 530, AHRI 1120.
 - 8.5.2.1.2. TCoS is developing the following new sound standards; AHRI 1150P, Declaration and Verification of Noise Emission Values of HVAC Machinery and Equipment Using Published Sound Rating Values and AHRI 375P, Application of Sound Rating Levels of Large Air-cooled Outdoor Refrigerating and Air-conditioning Equipment.
 - 8.5.2.2. AMCA (Brooks)
 - 8.5.2.2.1. Just completed a basic sound seminar.
 - 8.5.2.2.2. AMCA may develop an advance sound seminar.
 - 8.5.2.2.3. Putting together a task for the certification of in duct testing. Meeting by the end of July. It used to be ASHRAE 68, AMCA 330, but it was dropped.
 - 8.5.2.2.4. Starting certification revision for acoustics silencers.
 - 8.5.2.3. ANSI (Brooks)
 - 8.5.2.3.1. Looking at a method of test for jet fans
 - 8.5.2.4. ASTM (Miller-Klein)
 - 8.5.2.4.1. Round robin test went well for E477. There has not been a ballot created to incorporate the results into the standard.
 - 8.5.2.5. ISO (Brooks)
 - 8.5.2.5.1. Revising S1.4 Part 2, not major changes.
 - 8.5.2.5.2. ISO 19488 went out for a final vote and did not pass.
- 8.6. **Standing Subcommittees** [10 minutes]
- 8.6.1. Vibration Isolation (M Hooti)
 - 8.6.1.1. Michael provided a presentation on recycled rubber isolation pads. They provide good isolation efficiency, but there is no reference in ASHRAE.
 - 8.6.1.2. Check if new products can be incorporated and referenced in ASHRAE, so they can be used.
- 8.7. **Operations Subcommittee** (Miller-Klein) [15 minutes]
- 8.7.1. Honors and awards (Miller-Klein)
 - 8.7.2. Long range planning (Miller-Klein)
 - 8.7.3. Membership (Miller-Klein)
 - 8.7.3.1. Rolling off: Robert Hassler
 - 8.7.3.2. Rolling on: Dan LaForgia, Joseph Bridger, Ben Shafer, Jason Swan.
 - 8.7.4. Liaisons (Miller-Klein)
 - 8.7.4.1. ASHRAE TC 2.1 Physiology and Human Environment (Eichelberger)
 - 8.7.4.1.1. WS 1852 was conditionally approved.
 - 8.7.4.1.2. There is a new research that may interest TC 2.6, The Effects of Ventilation in Sleeping Environments.
 - 8.7.4.2. ASHRAE TC 2.7 Seismic and Wind Resistant Design (Marks)
 - 8.7.4.2.1. Main meeting tomorrow at 3:30pm.
 - 8.7.4.3. ASHRAE TC 5.1 Fan Design and Application (Osborn)
 - 8.7.4.3.1. Main meeting today at 4:15pm.
 - 8.7.4.3.2. WS 1829 has been returned with a lot of comments. There is a new draft to be submitted.
 - 8.7.4.4. ASHRAE TC 5.2 Duct Design (Hassler)
 - 8.7.4.4.1. Doing duct design on kitchen intakes instead of exhaust.
 - 8.7.4.5. ASHRAE TC 5.3 Room Air Distribution (Zimmerman)
 - 8.7.4.5.1. Open for revisions ASHRAE Standard 79. The main task is trying to align it better with AHRI 260 and 350.
 - 8.7.4.5.2. Open ASHRAE 130 to clean it up.
 - 8.7.4.6. ASA (Miller-Klein)
 - 8.7.4.6.1. Meeting in San Diego the first week of December. Abstracts are due July 8th.
 - 8.7.4.7. VISCMA (Waters)
 - 8.7.4.7.1. Webinars were successful. Trying to do a webinar every April and November.

8.7.4.8. Others: INCE (Herrin) Next Noise-Con meeting is in San Diego in August 2019. Meeting in 2020 will be in New Orleans. Meeting in 2021 is going to be in DC. Next year, 2020, is the international year of sound. EGSA (Simmons) Working group was put together to do what they consider the best practices for measuring sound pressure in an enclosure.

9. New business/Old business [5 minutes]

9.1. ASHRAE Learning Institute Course is due for major update

10. Next meeting date and location – Orlando, Florida February 1-5, 2020

11. Adjournment

11.1. Curt Eichelberger (1st), Jason Swan (2nd)

1.1. Research Subcommittee (Meeuwsen)

1.1.1. Research Chair's meeting report

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1.1.2. Work Statements/RTAR's/URP's

- 1.1.2.1. TRP-1707 - Annoyance Thresholds of Tones in Noise as Related to Building Services Equipment. Project started in September of 2018, and is slightly behind schedule. PMS (Osborne) holding conference calls with investigators weekly. Two PMS members visited Purdue to review work and test set up on May 3.
- 1.1.2.2. RTAR-1852 - Develop performance metric, criteria, and process to measure and predict of speech privacy in High Performance Buildings. Erik Miller-Klein submitted a work statement to ASHRAE by the May 15 deadline. RAC reviewed and approved with comments to be addressed.
- 1.1.2.3. RTAR-1754 - Developing the Standard Test Method for Dynamic Characteristics of Large Vibration Isolators. This is now dropped, but we come around to it again.
- 1.1.2.4. WS-1829 Co-sponsor go TC 5.1 Inlet and Outlet System Effects on Multiple Plenum Fans in a Parallel Arrangement (Fan Arrays) for Air and Sound Performance. Our members voted to approve the WS by email, but with comments that were addressed. RAC returned the WS with significant comments to address.
- 1.1.2.5. RTAR-1882- Procedure for Estimating Occupied Space Sound Levels in the Application of UFAD Air Terminals and Air Outlets. Co-sponsor, led by TC 5.3. RAC approved with comment, next step is to develop the WS, which needs to address the comments.

1.1.3. Topics for future research

- 1.1.3.1. Follow up project to extend 1529, considering 1408 – Dave Herrin UK. RAC liaison recommends a URP is the best way to go. Dave Herrin is working on the URP work statement.
- 1.1.3.2. Update publication "Application of Manufacturers Acoustical Data". There is a new process for funding publications through research funds, involving both RAC and Publications. RAC is going to use this project as the first test case for the process. Curt Eichelberger will draft the PTAR.
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ASHRAE TC 2.6 Sound and Vibration
PROGRAMS SUBCOMMITTEE – 2019 Annual Meeting, Kansas City, Missouri

DEFINITIONS

Technical Papers

Submitted directly by author
More involved papers, usually detailing research or similar activities
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 2017 for Jan 2018)

Conference Papers

Submitted directly by author
Less rigorous than technical papers
May highlight case studies or ongoing research
Maximum of 8 pages
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.

Seminars/Workshops/Forums/Debates

Session chairs and speakers selected by TCs
Program submitted by session chair
Includes speakers, bios, abstract, learning objectives, Q&A
Speakers submit final presentations 1 month prior to meeting for commercialism review

Seminars

60 minutes: 1 – 2 presentations
90 minutes: 3 – 4 presentations

Workshops (new in Summer 2014)

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

Forums/Panels

One moderator
60-minute length
No presentations

Debates

Expert teams/individuals present both sides

Hot Topic

Subcommittee Presentation
Invite outside special topic speaker to meetings
Listed in the ASHRAE schedule
Available to both TC 2.6 and larger organization
Speakers can be video-conferenced for this special session

**** Encouraged to use an ASHRAE approved PowerPoint template for presentations; available on their website ****

THIS MEETING:
Kansas City, 22-26 June 2019

Tracks

- 1: Systems/Equipment in Built Environ
- 2: Fundamentals/Applications
- 3: Optimization in HVAC&R
- 4: Commissioning New/Existing Buildings
- 5: Occupant Health & Safety
- 6: Modelling Throughout Building Life Cycle
- 7: Professional Development
- 8: Research Summit
- 9: Radiant Heating/Cooling

Seminar 17: Next Level Challenges

- Sunday 13:30-15:00, KCCC 2101 (Track 4)
High rise hotel, hybrid water supply (Nelson)
Replacement AHUs/Common Relief (Wiedner)
ASHRAE 189.1 (Miller-Klein)
International commissioning (Swan)

Seminar 31: Chilled Beams

- Monday 09:45-10:45, KCCC 2103C (Track 1)
Active Chilled Beam Basics (Searle)
New ASHRAE 200 Acoustic Testing (Peterman)
Sound Case Study (Miller-Klein)

Hot Topics:

- Sunday 11:00, KCCC 2210
Blocked Impedance (Meeuwssen)

Not submitted:

- Track 5: Hearing protection: TWA, Hospitals,
Escape / S/N / STI, WHO

NEXT MEETING:
Orlando, 1-5 February 2020

Tracks:

- 1: HVAC&R Fundamentals/Applications
- 2: Systems/Equipment
- 3: Refrigeration/Refrigerants
- 4: Cutting Edge Approaches
- 5: High Efficiency Design/Operation
- 6: Big Data & Smart Controls
- 7: Ventilation, IAQ and Air Distribution Systems
- 8: Standards, Guidelines & Codes

Seminars/Workshops/Forums:

Proposals due: 2 August 2019

- Track 2: Maglev chillers/ compressors (Marks)
TC 8.2
- Track 3: Refrigerated processes/Storage
(Swan to contact TC10.5, offer Keith's talk?)
- Track 4: 'Cutting Edge' Vib Iso (Miller-Klein)
- Track 7: Tunnel/ Underground ventilation
(Laforge)

Hot topics:

- Acoustic sections from S12.60 and FGI (Miller-Klein)

Technical/Conference Papers:

- Abstracts due: 18 March 2019
Final papers due: 8 July 2019

FOLLOWING MEETINGS:
Austin, 27 June-1 July 2020

Tracks:

- 1: Fundamentals/Applications
- 2: HVAC&R Systems/Equipment
- 3: Research summit
- 4: Professional Development
- 5: Grid-interactive Efficient Built Environment
- 6: Multi-family & Residential Buildings
- 7: Resilient Buildings & Communities
- 8: Zero Energy Buildings & Communities
- 9: Building Myths

Seminars/ Workshops/Forums:

Proposals due: 10 February 2020

- Track 6: New impact metrics, Fitness noise,
Plumbing noise (Rawlins: Golden, Wowk)
- Track ?: Plumbing noise
- Track ?: Elevators (Marks) Otis?

Technical/Conference Papers:

Abstracts due: 12 August 2019
Final papers due: 2 December 2019

- Track 6: New impact metrics, Fitness noise,
Plumbing noise (Rawlins: Golden, Wowk)

Hot topics:

- Chicago, 23-27 January 2021**
Phoenix, 26-30 June 2021
Las Vegas, 29 Jan – 2 Feb 2022
Toronto, 25-29 June 2022

TOPICS FOR FUTURE PROGRAMS

Series: Equipment Noise

Air Distribution Systems (Zimmerman)
Boilers (Marks)
Compressors: Frequency Characteristics (Rockwood)
Duct Breakout Noise (Reynolds)
Ductless Systems: PTACs, WSHP (Weinstein)
Electrical: Xfmrs, Elec Motors (Papadimos)
Elevators (Lilly)
Exhaust Noise (____)
Fan Boxes above/below (Zimmerman)
Fan Selection for Acoustics (Schaffer)
Fume hood
Generators (Laforgia)
Industrial Ventilation (____)
dust collection, garages, LNG
Maglev chillers
Pumps (____)
Plumbing noise (Wowk) TC 6.1/6.6?
Refrigeration: Commercial/Transport (Marks)
Silencers: Performance v Design (Papadimos)
Silencers: When? E477 Round Robin (Lilly)
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)
Outdoor Noise Control (Murillo/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 Background Noise (Wowk)
Tones and Fluctuations (Lilly)
Vibration Isolation (Keith)

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)
Vibration: Upper Level Installations (Simmons)
Industrial noise (Keith)

[Contact other TCs that may want to team up]

PAST PROGRAMS

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)

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 System Acoustics (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 in Acoustics for Healthcare
Facilities (Papadimos)
Acoustic Codes, Standards, Design
Guidelines: A Primer (Muehleisen)
HT: Classroom Physical Environment Effects
on Learning (Reynolds)

Efficiency/Performance of Fan Arrays
(Raychaudhuri)
Forum: Incorporating Acoustics into BIM
(Peterman/Mitchell)

2010 Orlando/Albuquerque

Acoustics in High Performance Building
(Peterman)
Noise & Mechanical 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)
HVAC System Noise Control for Classrooms
(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

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