Welcome!

Welcome to the ASHRAE TC 9.9 Virtual Meeting!

No need to say hello, we will begin promptly at 10:00 am EDT

Agenda

- Introduction
- Programs
- Handbook
- Research

Housekeeping

Audio

- Attendees are muted upon entry
- Do not un-mute your line
- If you are joining via computer and phone line, ensure both are muted

Video

- We encourage you to keep your video off
- If you do enable your video, be mindful that you are on display! Turn off your video when needed.

Q&A

- Use the chat function to ask questions
- Our moderator will share questions throughout the presentation with the speaker to answer.
- If you need to speak, please use the Raise Hand button and the moderator will enable your microphone.

Attendance

- Please complete the attendance form found at the URL at the bottom of this slide

Attendance: http://bit.ly/tc99-summer

Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment

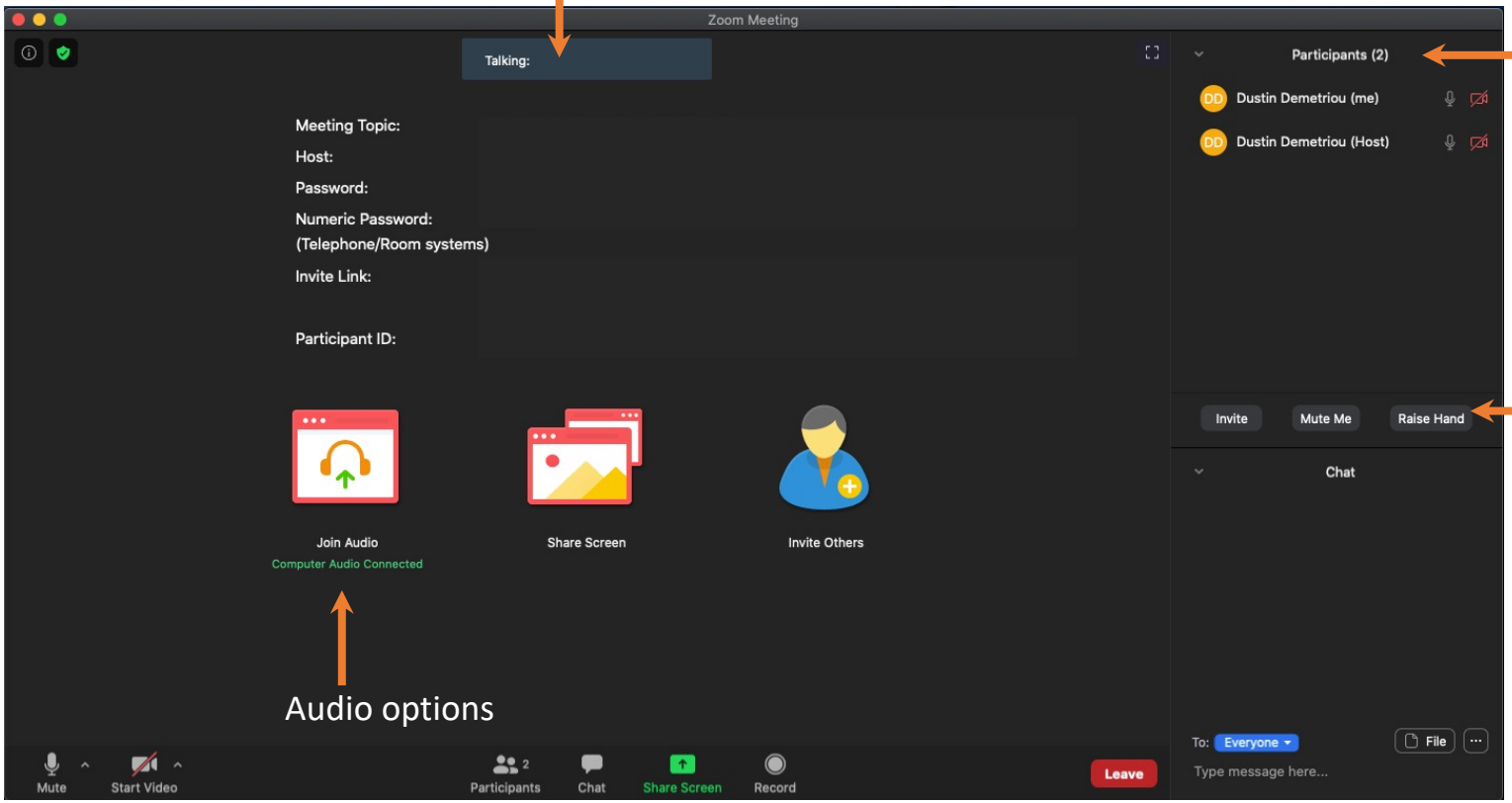
ASHRAE Annual Conference 2021

Virtual

Zoom Controls

Full Zoom Window

Speaker



Participant panel

Raise hand

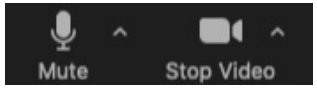
Chat panel

Audio options

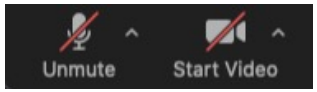
Toggle chat panel on/off

Turn video on / off

Mute / unmute audio



Audio and Video ON



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Attendance

ASHRAE TC 9.9 Attendance Record

ASHRAE Technical Committee 9.9 - Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment
2021 Winter Meeting
Virtual Event Timing: January 19, 2021
Event Address: https://ashrae-org.zoom.us/j/98449509730?pwd=Q2ZCNFhRQXFTY05CSTNYbElZTkdKQT09
Contact us at tc99chair@gmail.com
Technical Committee Website: http://tc0909.ashraetcs.org

* Required

Name *

Your answer

Email

Your answer

Attendance is being recorded using a Google Form. Please make sure you complete the form at:

http://bit.ly/tc99-summer

ASHRAE Code of Ethics

As members of ASHRAE or participants in ASHRAE committees, we pledge to act with honesty, fairness, courtesy, competence, integrity and respect for others in our conduct.

A. Efforts of the Society, its members, and its bodies shall be directed at all times to enhancing the public health, safety and welfare.

B. Members and organized bodies of the Society shall be good stewards of the world's resources including energy, natural, human and financial resources.

C. Our products and services shall be offered only in areas where our competence and expertise can satisfy the public need.

D. We shall act with care and competence in all activities, using and developing up-to-date knowledge and skills.

E. We shall avoid real or perceived conflicts of interest whenever possible and disclose them to affected parties when they do exist.

F. The confidentiality of business affairs, proprietary information, intellectual property, procedures, and restricted Society discussions and materials shall be respected.

G. Each member is expected and encouraged to be committed to the code of ethics of his or her own professional or trade association in their nation and area of work.

H. Activities crossing national and cultural boundaries shall respect the ethical codes of the seat of the principal activity.

Agenda

Monday, June 14, 2021
TC 9.9 Program, Handbook, and Research
10:00 AM – 12:00 PM EDT
Location: Virtual

Topic		Time	Presenter
Introduction	Welcome and Introductions	10	Dustin Demetriou
Programs	2021 Annual Virtual and 2022 Winter Conference	15	Nick Gangemi
Handbook	Chapter 20	10	Bob McFarlane
Research	1675-RP: Guidance for CFD Modeling of Data Centers	15	Mark Seymour
	Sea Salt Filtration RTAR and WS	15	Roger Schmidt
	Singapore TDC Collaboration	15	Demetriou/Schmidt/Seymour
	Wetted Materials Research	10	Mark Steinke

Total Time 90 minutes

Attendance: http://bit.ly/tc99-summer

Programs Update

ASHRAE Virtual Winter Meeting

Nick Gangemi, Program Chair

2021 ASHRAE Virtual Conference
Jun 28–30, 2021

Tuesday, June 29, 7:00 AM – 8:30 AM

Seminar 8 (Intermediate)

Energy Management Best Practices, Case Studies and Lessons Learned from Real-World Data Center

Track: Design, Control, and Operation of Critical Environments
Sponsor: 9.9 Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment, 7.6 Building Energy Performance, TC 7.3, TC 7.5
Chair: Eric Yang, P.E., Member, Energy Systems Group, Washington, D.C.

This session includes energy management best practices, case studies and lessons learned from real-world data center operation. Presentations address how controls systems, smart building technologies and data analytics are helping data centers operate more efficiently and reliably via real world examples and case studies. Common pitfalls in the data center operation are also discussed.

1. Harnessing the Power of Data Analytics for Reliable and Efficient Data Center Operations at LBNL's High Performance Computing Center, Jingjing Liu, P.E., BEAP, Lawrence Berkeley National Laboratory, Berkeley, CA
2. Is Your Legacy Data Center Ready to Improve Energy Efficiency through the Use of Data Analytics, AI/ML and Intelligent Controls Optimization?, John Dumler, P.E., Member, Digital Realty, Atlanta, GA
3. Classic Pitfalls to Avoid in Data Center Operation Mark Seymour, P.E., Member, Future Facilities, London, United Kingdom

Wednesday, June 30, 3:00 PM – 4:00 PM

Conference Papers Session 3 (Intermediate)

Air Quality and Handling in Mission Critical Facilities

Track: Design, Control, and Operation of Critical Environments
Chair: Eric Yang, P.E., Member, Energy Systems Group, Washington, D.C.

Air quality and flow control are a key consideration in mission critical environments. such as data centers, healthcare facilities and clean rooms. This session begins with an introduction of latest air-mover technologies and the requirements for improved fan performance continue to grow with demand for higher HVACR energy efficiencies. This is followed by a discussion of temperature controlled air-flow in healthcare facilities, and the impact of exhaust grilles on the air quality and flow patterns. The last paper focuses on the development of digital twin of a data center to improve its design, control and operation.

1. Air Considerations in Imaging (X-Ray) Rooms (VC-21A-C014) Travis English, P.E., Member, Kaiser Permanente, Anaheim, CA
2. Development of Detailed Server Digital Twin Models for Enabling a Data Center Digital Twin for Design, Control and Operation (VC-21A-C015) Dustin Demetriou, Ph.D., Member, Yuanchen Hu, Ph.D. and John Madalengoitia, IBM, Poughkeepsie, NY
3. EC Fan Array Implementation – How to Capture the Energy Savings without Sacrificing Power Quality (VC-21AC016) Anthony Hoevenaars, P.Eng., Member and Joseph Landrette,
4. Effect of Exhaust Grille Position on Air Quality and Flow Patterns in Clean Rooms (VC-21A-C017) Essam Khalil, Ph.D., P.E., Fellow ASHRAE, Taher AbouDief, Dr.Eng, Ahmed Abou Zeid, Dr.Eng and Hesham Metwally, P.Eng., Cairo University, Cairo, Egypt
5. The Efficacy of Temperature-Controlled Air Flow in Maintaining Ultraclean Conditions throughout the Operating Room (VC-21A-C018) Clemens Bulitta, M.D.1, Kathy Warye, Associate Member2 and Peter Hojerback3, (1)Technical University of Applied Sciences Amberg-Weiden, Amberg-Weiden, Germany, (2)Infection Prevention Partners, Sonoma, CA, (3)A vidicare, Lund, Sweden

On Demand

Seminar 39 (Basic) Demand for Variable Speed Equipment in Data Center Applications

Track: HVAC&R Systems and Equipment
Sponsor: 1.11 Electric Motors and Motor Control, 5.1 Fans
Chair: Nicolas S. Rosner, P.E., Member, Eaton, City of Industry, CA

Data center is a fast-growing niche in the HVAC&R industry and Data Center mechanical equipment design requires both redundancy and energy efficiency. The purpose of this presentation is to identify the needs of a Data Center end-user, including critical equipment. ECM and VFD fan arrays will be presented. Speakers will also discuss Custom Air Handler system design with an emphasis on variable speed technology. Top industry experts will explain equipment considerations. Participants will understand equipment solutions in this critical segment of the industry.

1. Fan Array Technology: Efficiency, Basics, Inductions Motors with VFDs and ECMs Tom A. Bise, Associate Member, Johnson Controls, York, PA
2. Custom Air Handlers George Paich, Associate Member, Alliance Air Products, San Diego, CA
3. Data Center Mechanical Equipment Design, Redundancy and Variable Speed Applications Tim Chadwick, P.E., Member, AlfaTech, San Jose, CA

On Demand

Seminar 65 (Intermediate) Sound and Vibration Issues with Mission Critical Facilities

Track: Design, Control, and Operation of Critical Environments
Sponsor: 2.6 Sound and Vibration
Chair: Patrick Marks, P.E., Fellow ASHRAE, Johnson Controls, New Freedom, PA

Whether it is a hospital, a data center or another mission critical facility, these projects present their own unique sound and vibration control challenges. This seminar will highlight specific noise and vibration concerns unique to data centers and health care facilities and will review successful case studies of applications.

1. Data Center Sound and Vibration Control Issues Paul Bauch, Member1 and Patrick Marks, P.E., Fellow ASHRAE2 , (1) Johnson Controls, York, PA, (2)Johnson Controls, New Freedom, PA
2. Generator Noise Control Dan LaForgia, Member, Vibro-Acoustics, Huntington, NY
3. Noise Control That Focuses on Care and Safety in Healthcare Erik Miller-Klein, P.E., Member, Tenor Engineering Group LLC, Seattle, WA

On Demand

Seminar 71 (Intermediate) The Continuing Evolution of the ASHRAE Data Center Environmental Guidelines

Track: Design, Control, and Operation of Critical Environments
Sponsor: 9.9 Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment
Chair: Joseph Gangemi, Life Member, Data Aire, Orange, CA

To address the growing emphasis on energy efficiency of data centers, TC 9.9 has been evolving the Thermal Guidelines on a regular basis as data becomes available. A historical perspective is given including the latest change to the recommended envelope based on research of high humidity and gaseous pollutants as it affects the reliability of IT equipment. Another environmental envelope has been added to the existing 4 air-cooling classes to accommodate high density racks. With increasing high density racks the IT industry will be deploying more liquid cooling products. With these trends the water-cooling classes have been expanded and renamed.

1. History of the ASHRAE Thermal Guidelines and IT Equipment Power Trends Dustin Demetriou, Ph.D., Member, IBM, Poughkeepsie, NY
2. Research on High RH and Gaseous Pollutants Impact on IT Equipment Reliability Roger Schmidt, Ph.D., P.E., Member, IBM, Poughkeepsie, NY
3. Expanded Guidelines for Data Center and IT Air Cooling Paul Artman, Lenovo, Raleigh, NC
4. Liquid Cooling White Paper and Updates to the ASHRAE Water Cooling Classes Dave Moss, Dell Inc., Round Rock, TX

2022 ASHRAE Winter Conference
Las Vegas, NV
Jan. 29 – Feb. 3, 2022

Las Vegas Tracks

1. **HVAC&R Systems and Equipment:** HVAC&R systems and equipment are constantly evolving to address the changing requirements of the built environment. Papers and programs in this track focus on the development of new systems and equipment, improvements to existing systems and equipment and the proper application and operation of systems and equipment.

2. **Fundamentals and Applications:** Fundamentals are the foundation for understanding applications in engineering. Key components of ASHRAE fundamentals include thermodynamics, psychometrics, fluid and mass flow. This track provides opportunities for papers and presentations of varying levels across a large topic base. Concepts, design elements and shared experiences for theoretical and applied concepts of HVAC&R design are included.

3. **Refrigerants and Refrigeration:** Refrigeration systems generate and use cold for a range of processes, from food preparation and conservation, to vaccine preservation, to long-term protection of fragile ancient inks of historic documents and others. Differences in technologies and equipment, performances, refrigerants, etc., may hide synergies from which both industrial and commercial systems might benefit, also, but not only, from the points of view of reducing direct and indirect GHG emissions.

4. **Buildings at 360°:** Buildings use a large share of a country's final energy, in particular for heating, cooling and various services. Papers and presentations explaining methods, equipment, systems and solutions to satisfy occupants' needs, to guarantee buildings' performances and resilience, and to save resources (energy, water, etc.) will fit this track.

5. **Energy System Integration:** Energy is the omnipresent reality of our daily lives (e.g., electricity for appliances and equipment, heat and cold for industrial processes and commercial purposes). Once used, part of the input the energy is wasted as heat/cold or as exhaust byproducts, thus contributing to the pollution of soil, water and air. The integration of various energy sources/grids with buildings, processes and transportation allows to better exploit the available energy (renewables, in particular) while reducing the said waste through a circular approach to energy usage. Papers on renewables, fossil fuels, grid integration, aggregation, demand-side flexibility, smart devices, IoT, synthetic hydrogen and synthetic fuels, CCUS, electrification would fit this track.

Attendance: http://bit.ly/tc99-summer

Las Vegas Tracks

6. **Environmental Health and IEQ in the International Arena:** We spend a large part of our days indoors to live, work, practice gym, etc. Indoor environment is essential for our comfort, well-being, health, productivity, but is often treated and regulated differently in various parts of the world due to local conditions, circumstances, history, traditions. Presentations that explain local norms and trends are welcome to increase the knowledge on such an important topic, with an eye also on energy usage.

7. **HVAC for Industrial and Commercial Purposes - Challenges and Opportunities:** How to guarantee a set point within the required tolerances in a large industrial facility? How to increase the overall energy efficiency of a commercial facility through HVAC systems? What are the lessons that can be learnt from in terms of equipment, installation, commissioning, etc. and that can be transferred to other types of facilities; and vice versa? This is the track where such topics can find suitable space.

8. **Refrigerants, Safety, Performances:** Be it for cooling and refrigeration, be it for heating, refrigerants are at the heart of vapor compression cycles. Space cooling and refrigeration for food cold chains and medical purposes are forecast to grow in the coming decades; the same can be envisaged for residential-, commercial- and industrial-grade heat pumps. The choice of refrigerant plays an important role, along with control and safety features of the equipment, both to maximize performances, and to minimize direct and indirect GHG emissions (the former are usually associated to runtime leakages and end-of-life incomplete recovery of the refrigerant, whereas the latter are associated to the consumed energy). Presentations in this track present advancements and developments about flammability of refrigerants (e.g., HFOs, naturals, etc.), that can reduce the direct emissions, but that may have safety, regulatory and performance issues when deployed on the field.

Important Dates for Las Vegas

Monday, April 12, 2021: Conference Paper Abstracts, Technical Papers Due
Friday, April 30, 2021: Conference Paper Abstract Accept/Reject Notifications
Friday, June 18, 2021: Website Opens for Program Proposals
Monday, July 12, 2021: Conference Papers Due
Monday, August 2, 2021: Debate, Panel, Seminar, Forum, Workshop and Debate Proposals Due
Friday, August 6, 2021: Revised Conference Papers/Final Technical Papers Due
Monday, August 23, 2021: Conference Paper Accept/Revise/Reject Notifications

Program Types

- **Technical Paper Sessions-**
  - These sessions present papers on current applications or procedures, as well as papers resulting from research on fundamental concepts and basic theory.

- **Conference Paper Sessions-**
  - Papers on current applications or procedures, as well as papers reporting on research in process.
  - These papers differ from technical papers in that they are shorter in length and undergo a much less stringent peer review.

Program Types

- **Panels-**
  - Panel discussions can feature a **broad range of subjects** and explore **different perspectives** on issues in the industry.
  - A panel **may feature discussions about integrated project delivery** among designers, builders and facility management professionals.

- **Forums-**
  - Forums are “off-the-record” discussions held to **promote a free exchange of ideas**.
  - Limited reporting to allow **individuals to speak confidentially** without concern of criticism.
  - There are **no papers** attached to these forums.

Program Types (cont.)

- **Debates-**
  - Debates highlight **hot-button issues**
  - Experts, either on **teams or as individuals**, present **different sides** of an issue in debate format.
  - Each participant **presents evidence for or against** a specific statement or question

- **Seminars-**
  - Seminars feature **presentations** on subjects of current interest.
  - **Papers are not available** from the Society; however, seminar PowerPoint presentations with audio descriptions of the **presentations are posted online**.

Program Types (cont.)

- **Workshops-**
  - Workshops enable technical committees and other **ASHRAE committees** to provide a **series of short presentations** on a topic requiring specific expertise.
  - These short presentations are provided with an increased **emphasis on audience participation and training** in a specific set of skills.

Technical Papers

Technical Papers:

- Technical Papers are presented by authors at ASHRAE **Winter and Annual Conferences**.
- Technical Papers submitted for review must be both technically accurate and clearly written.
- Technical Papers undergo a **rigorous double-blind review** and must be **approved by three reviewers** knowledgeable in the subject matter.
- Technical Papers can be **up to 30 double-spaced manuscript** pages in length, including tables and charts, and a maximum of 12 figures (not counted in the page count).
- Accepted Technical Papers are **available as hard-copy preprints** in the bookstore during the conference.
- The Technical Papers must be presented at the conference in order to be **published in *ASHRAE Transactions***, where they will be included with questions and answers (if any).

Conference Papers

Conference Papers:

- Conference Papers are **shorter than Technical Papers**, undergo a **less stringent review** and can be **prepared closer to the conferences**.
- Unlike Technical Papers, **abstracts** of Conference Papers are **submitted first** for review.
- Upon acceptance, papers are due three months after abstract acceptance, **undergo a single-blind review** (the author(s) names are included in the paper; however, reviewer's remain anonymous), and must be **approved by two reviewers**.
- Upon approval, papers are scheduled for oral presentation.
- Conference Papers can be **no more than 8 single-spaced pages** in length total (includes text, tables, figures, etc.).

Nick Gangemi, Program Chair

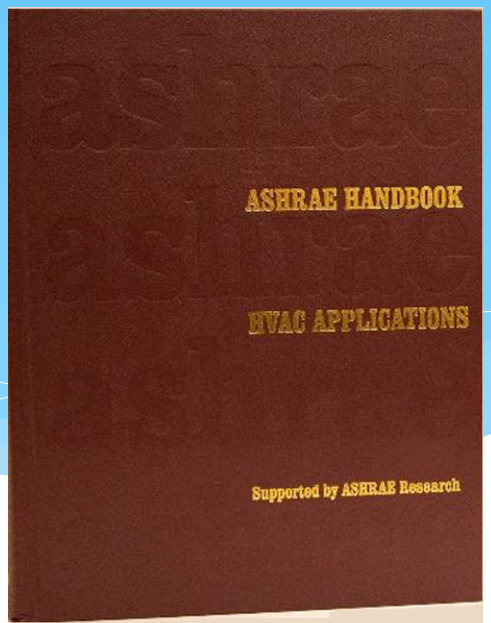
585-721-8795

Nick.GANGEMI@bureauveritas.com

ASHRAE HANDBOOK "Applications"

Moved to Chapter 20 in 2019 Publication

"Data Centers & Telecommunication Facilities"



NEXT UPDATE

* 2023 “Applications” Handbook

* Revision Due Date: June 2022 Summer Meeting
  * Approved at HQ

* Means Approved by TC Board At or Before Meeting

  Revision Submissions By March 1, 2022

REVIEWS TO DATE

* Benjamin Petschke
  * International References
  * Improvements & Additions to “Raised Floor” Paragraphs
  * Improvements & Additions to CRAH Paragraph
  * Improvement to Downflow CRAC/CRAH Paragraph
  * Correction to “Top Blow” CRAC/CRAH Sentence
  * Improvement to PUE Paragraph
  * Improvements & Additions to “Economizer” Section of Energy Efficiency Section

REVIEWS TO DATE

* Gerardo Alfonso
  * Add Latency Issues Re: IoT, IA, & Real Time Applications
  * Update 90.4 & BICSI 002 Date References
  * Include New BICSI 009-2019 Reference w/ Summary
  * Include TGG #79 Reference w/ Summary
  * Update Std. 127 Date Reference
  * Include Drawing for CFD
  * Reference TGG #68 White Paper In Addition to Mention of PI
  * Include TC 9.9 Book #14 – DCIM

REVIEWS TO DATE

* Dustin Demetriou
  * PoP (Point of Presence) Used in Fig. 1, but Not Defined.
  * Add DCIM Book & Update of Book & Standards Versions & Dates
  * Fig. 2 (from Datacom Books) Labels 4- Post Racks as "*Open*".
  * Sect. 2.3: Change "*Air Quality*" to "*Coolant Quality*"
  * Add Ref. to *Gaseous Contamination* Study to Environmental Guidelines for Air Cooled Equipment
  * Move High & Low RH Text and Static Study in *Power & Thermal Moisture Management: Don't Affect* IT Equip. Design.
  * Add Text Re: Sidewall Ventilation in Non-Raised Floor Designs.
  * Include Chilled Water Plants as Common WSE Applications.

UPDATE STATUS

* Revisions Made Via ASHRAE "*Authoring Portal*"
  * Now Works on ALL Browser Platforms Including MAC
    * Contributors Must Be Registered
    * Can Work Simultaneously
      * Most Recent "Save" Will Be Seen by Others
    * All Work Must Use "Track Changes"
    * New or Revised Illustrations are Submitted Separately
      * Written Permissions Are Mandatory!!

PLEASE SEND REQUESTS TO ME

* Please Ask Bob McFarlane for Edit Permission:
  * rmcfarlane@smwllc.com

* Requesting Assistance in Reviewing Suggestions
  * Subject Matter Experts on Specific Suggestions
  * Two Board Members to Expedite Board Approval
  * Asking Don Beatty for “Relevance” Review

A "SIGN-UP" WILL BE CREATED

* Subject Matter Experts
  * CRAC's & CRAHs
  * PUE
  * Economizers
  * BICSI
  * TGG
  * CFD
  * DataCom Books
  * Gaseous Contamination
  * Liquid Cooling

* Again, Please Ask Bob McFarlane for Edit Permission:
  * rmcfarlane@smwllc.com

PLEASE SEND REQUESTS TO ME

* AGAIN
* Please Advise Bob McFarlane
  * Edit Permission
  * Subject Matter Reviews
    * rmcfarlane@smwllc.com
  * QUESTIONS?

Research

Mark Seymour

ASHRAE TC 9.9

Project Update

1675-RP: Guidance for CFD Modeling of Data Centers

Cheng-Xian (Charlie) Lin and Beichao Hu

Florida International University

Yogendra Joshi and Dhaval Patel

Georgia Institute of Technology

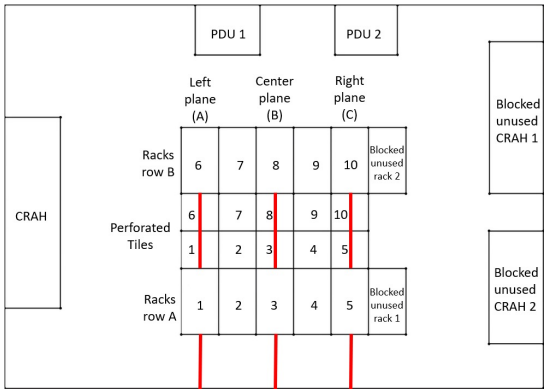
06/16/2021

Agenda

- Project Objectives
- Status of the Project
- Project Timeline
- Technical Progress Update (FIU)
- Plans for the Next Few Weeks

Project Objectives

- To develop general CFD modeling guidance for data center applications
- Experimental and CFD work
  - A data center with key features: CRAH, hot/cold aisle, perforated tile, underfloor plenum
  - Parameters varied in tests (~ 25 cases)
    - Server flow rates
    - Supply temperatures
    - Supply flow rates
    - Rack loading
    - Underfloor blockage
  - CFD model validation and sensitivity studies



Data Center Lab at Georgia Tech

Status of the Project

- Experimental work:
  - Testing data collected for all tasks
- CFD work:
  - Numerical simulations completed
- Project management:
  - Multiple technical consultations with some PMS members
  - FIU and GA Tech weekly online meetings
- Final Report
  - Draft in preparation

Project Timeline

	Tasks/Milestones	Deadline Month	Projected End Date	Status
1	Complete baseline CFD model of lab space (review model and assumptions with PMS in advance)	03/2019	03/09/2019	Complete
2	Create CFD models of design alternatives as specified in contract to identify/clearly define all scenarios which will be studies experimentally	03/2019	03/31/2019	Complete
3	Complete full characterization of second server simulator prototype	02/2019	02/15/2019	Complete
4	Receive balance of 40 server simulators	03/2019	03/31/2019	Received, 4/4/19
5	Install server simulators in lab and prepare for testing	03/2019	05/08/2019	Complete
6	Commence experimental testing	04/2019	05/31/2019	Started, 11/10/2019
7	Complete experimental measurements for baseline scenario	07/2020	11/30/2020	Complete
8	Complete experimental measurements for alternative scenarios	08/2020	12/31/2020	Complete
9	Present initial findings	06/2020	6/05/2020, Virtual	Complete
10	Present revised findings	01/2021	01/14/2021, virtual	Complete
11	Produce rough outline of CFD guidelines	03/2021	3/04/2021	Complete
11	**Present additional/final findings**	**06/2021**	**06/16/2021 virtual**	**In progress**
13	**Produce rough draft of full report of CFD guidelines**	**07/2021**	**07/15/2021**	**In progress**
14	**Produce final report of CFD guidelines**	**08/2021**	**08/31/2021**	
15	**Formally close project (currently aiming for Sept. 30, 2021)**	**09/2021**	**09/30/2021**	

Covid-19

Technical Progress Update

Beichao Hu

Table of Content

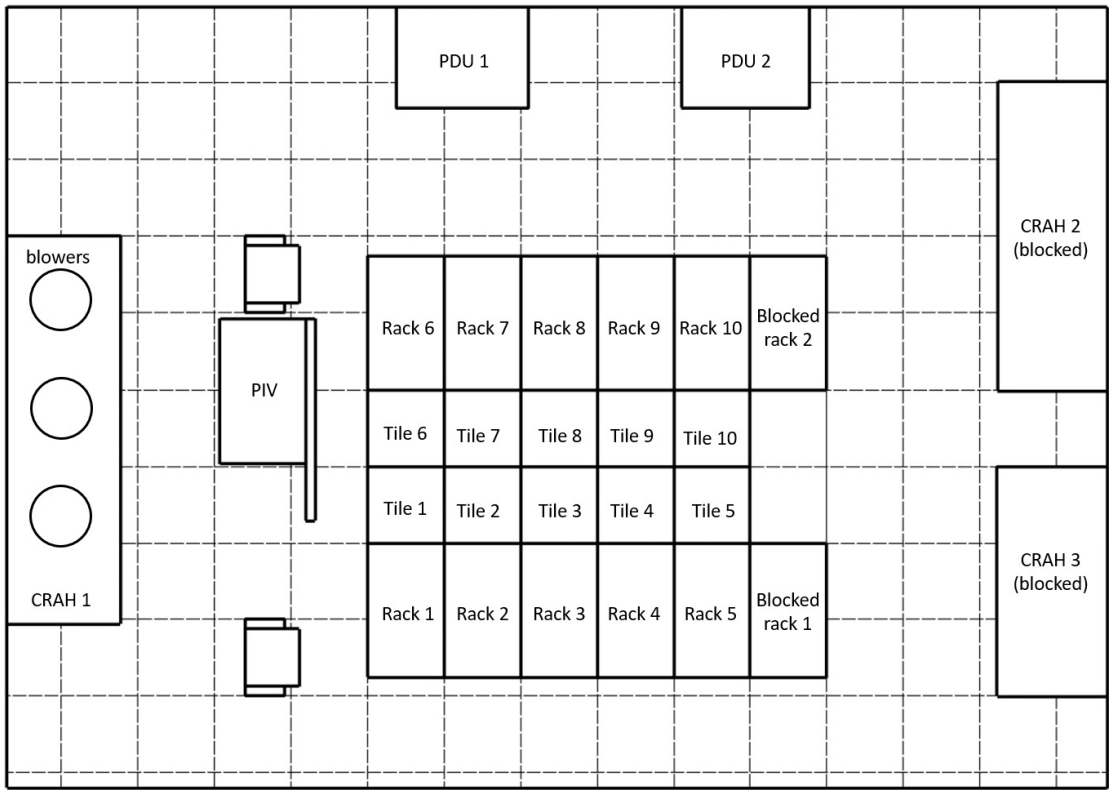
Overview of Progress

All experiments and baseline CFD cases were finished.

Additional sensitivity studies were performed for the guideline. A few selected are

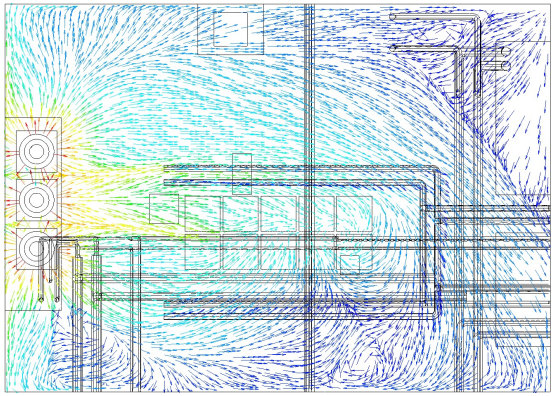
1. Effect of blower velocity angles.
2. Comparison of explicit stanchions and implicit stanchion models.
3. Multiple parametric studies of the body force model on perforated tiles.
4. Multiple parametric studies of the rack models and the effect of geometric details of racks.
5. Gap studies

In the progress of report writing.

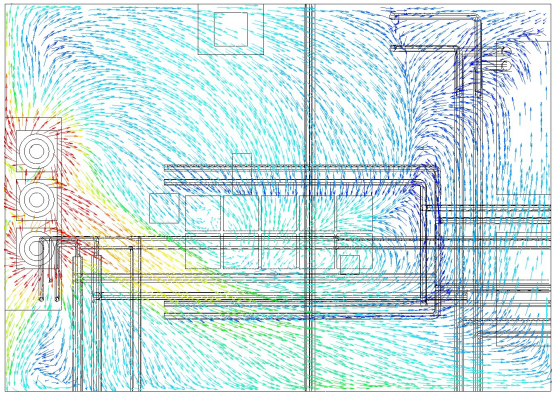


Plan view of the data center

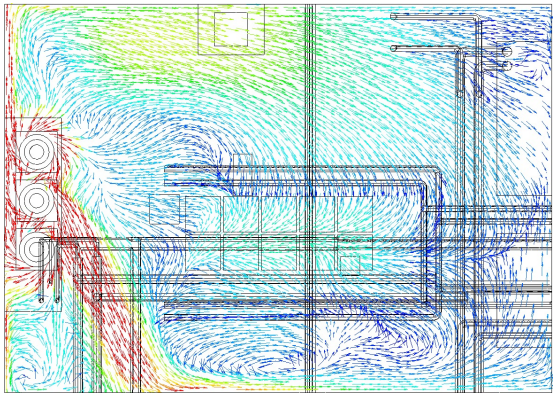
Blower Model Studies



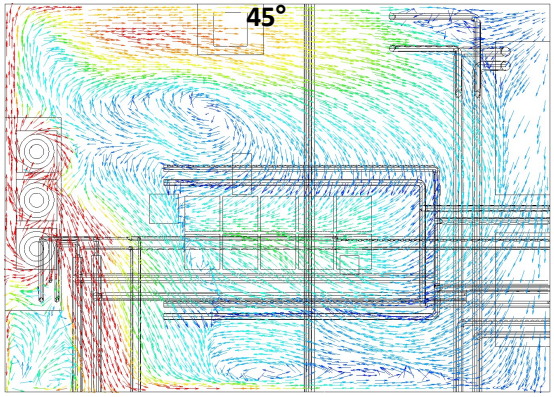
Velocity angle 90°



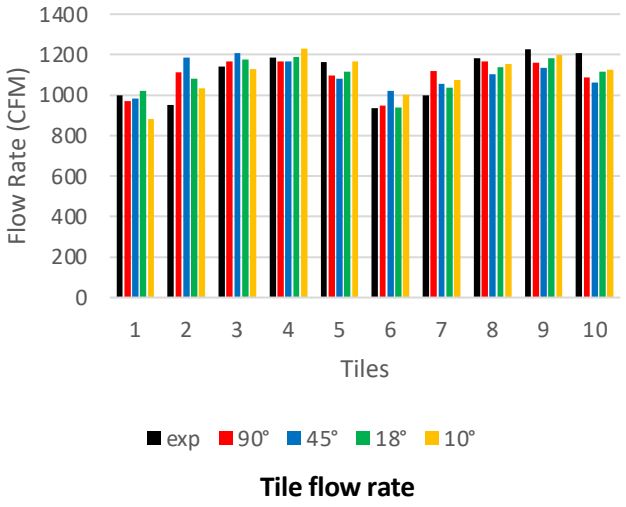
Velocity angle 45°



Velocity angle 18° (Calculated)



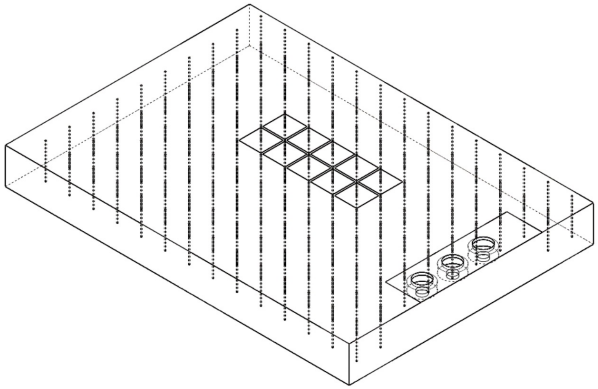
Velocity angle 10°



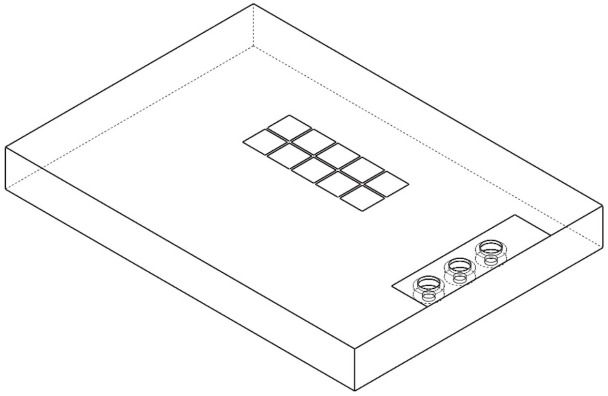
Tile flow rate

- The blower velocity angle has a measurable impact on the tile flow rate distribution.

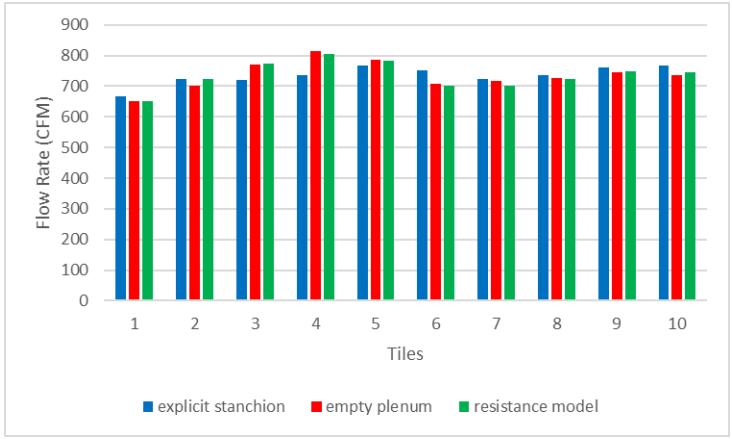
Stanchion Model Studies



Explicit stanchions



Empty plenum/resistance model



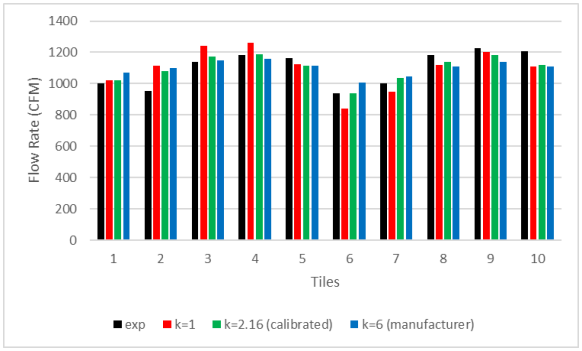
Tile flow rate

- The impact of the stanchion model is not significant in the small data center tested in this project.

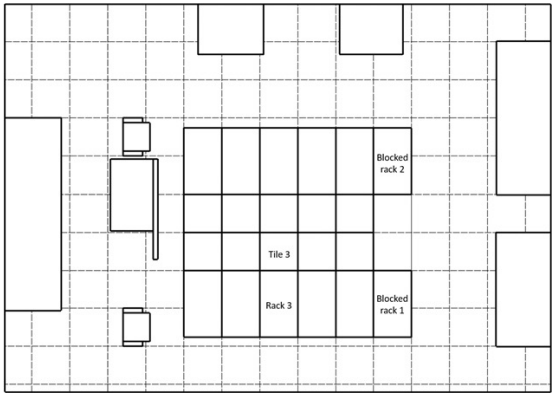
Perforated Tile Model Studies

$$\Delta p = \frac{1}{2} k \rho v^2$$

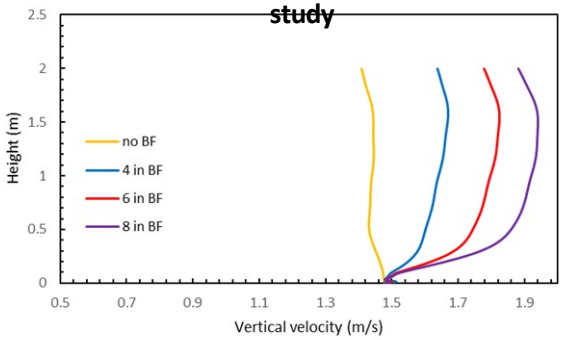
Δp: Pressure drop across perforated tiles (Pa)
k: Tile pressure drop coefficient (resistance)
v: Nominal air velocity across tiles



Effect of tile resistance on tile flow rate distribution

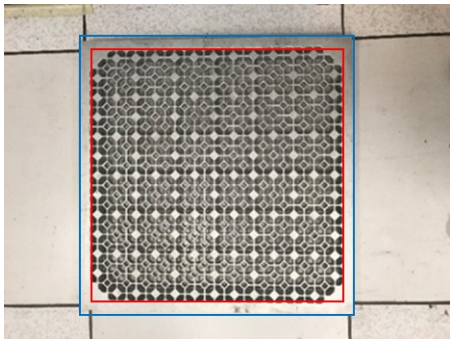


Single tile test for body force model study



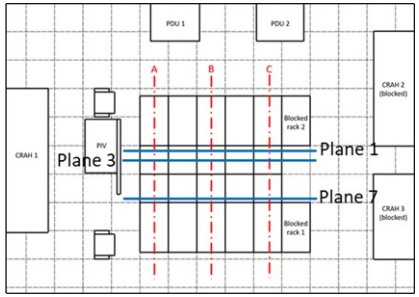
Effect of body force height on velocity profile along height direction in cold aisle

- Body force height has a big impact on velocity profile. The larger the height, the stronger the momentum enhancement.
- Tile resistance has a big impact on tile flow rate distribution. It is important to calibrate the tile resistance.

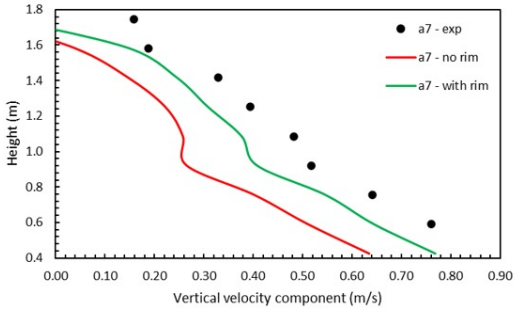


Tile rim

Porosity of the tile:
56% excluding rims (manufacturer's quote)
48% including rims



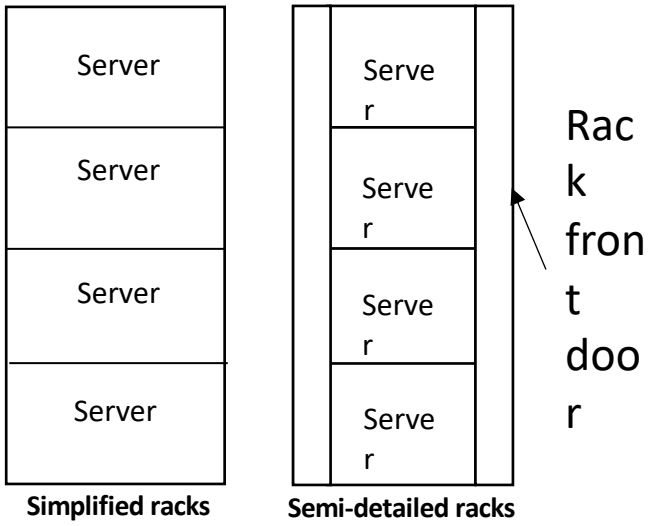
Layout



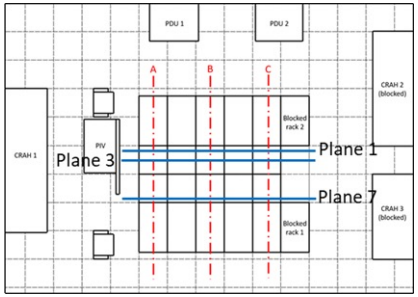
Effect of the tile rim on the velocity profile in the cold aisle

- It is important to model tile rims and calibrate the actual porosity of the tile.

Rack Model Studies

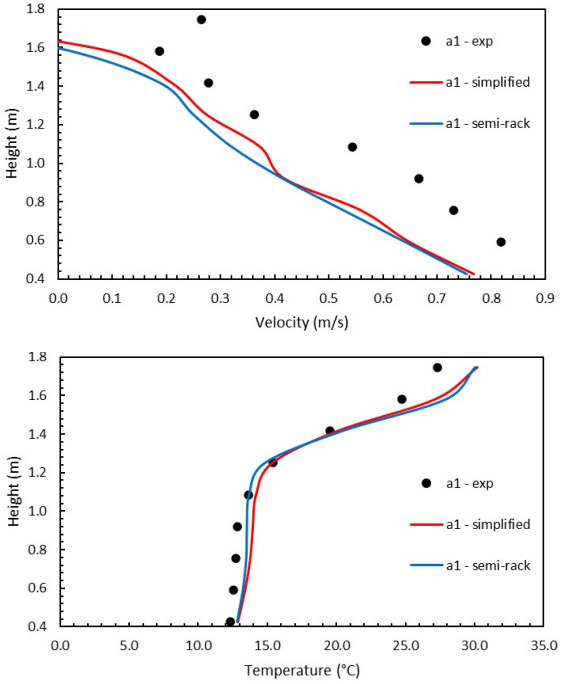


Schematic of black box model

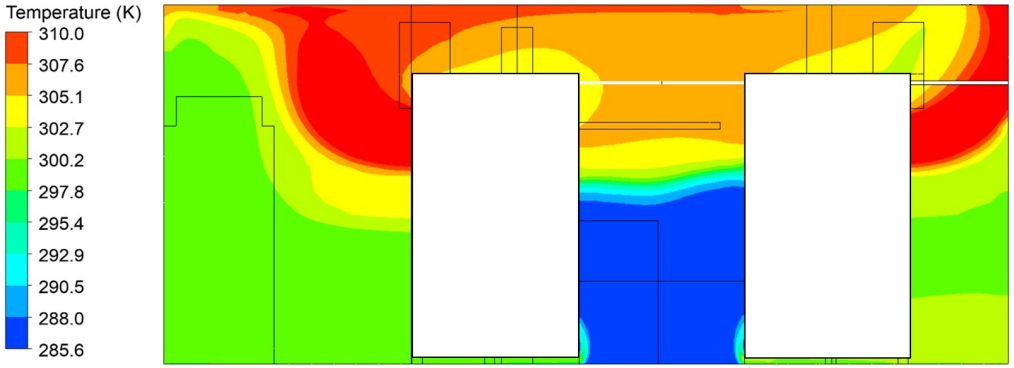


Layout

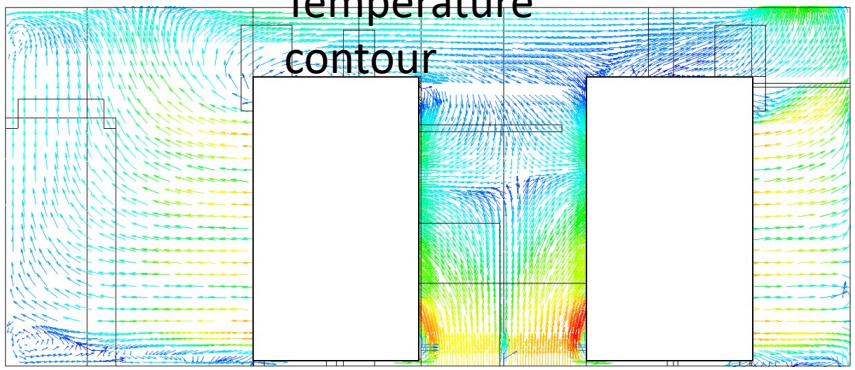
- Geometric details of black box rack models such as the location of the rack and front door do not have much impact on the profile in the cold aisle.



Velocity and temperature profile



Temperature contour



Velocity vectors

- Gaps under racks drain hot air from the hot aisle. Hot spots will also appear at the bottom of the rack due to the recirculation from the bottom.

Plan for the Next Few Weeks

- Finish the complete draft of the final report for review
- Submit the final report to ASHRAE

Thank You !

Sea Salt Filtration Research

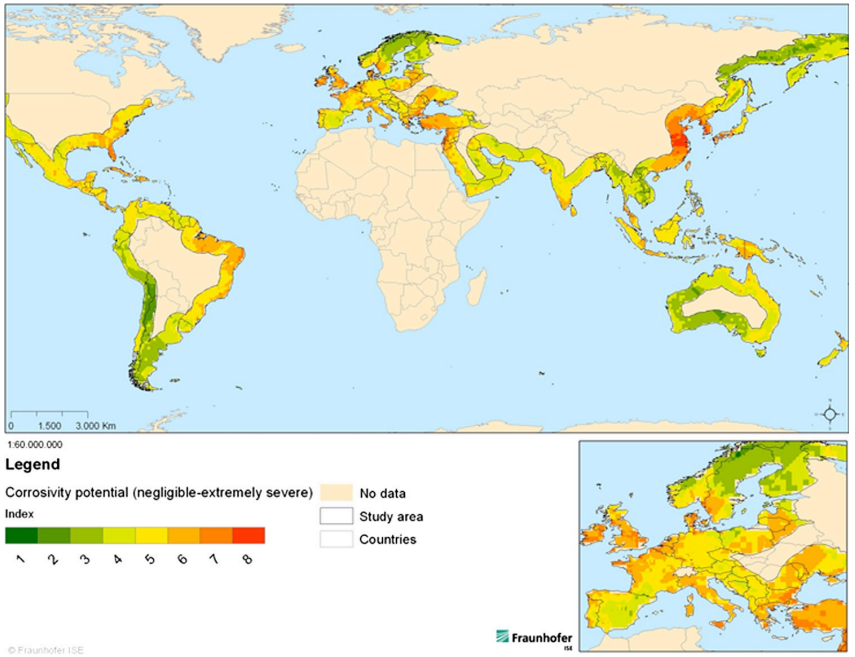
Roger Schmidt

ASHRAE Research Work Statement Proposal

Study of the Corrosion Impact on Information Technology Equipment in Data Centers Located in Coastal Regions with High Sea Salt Concentrations and the Level of Filtration Required to Maintain Reliable Operation of this Equipment

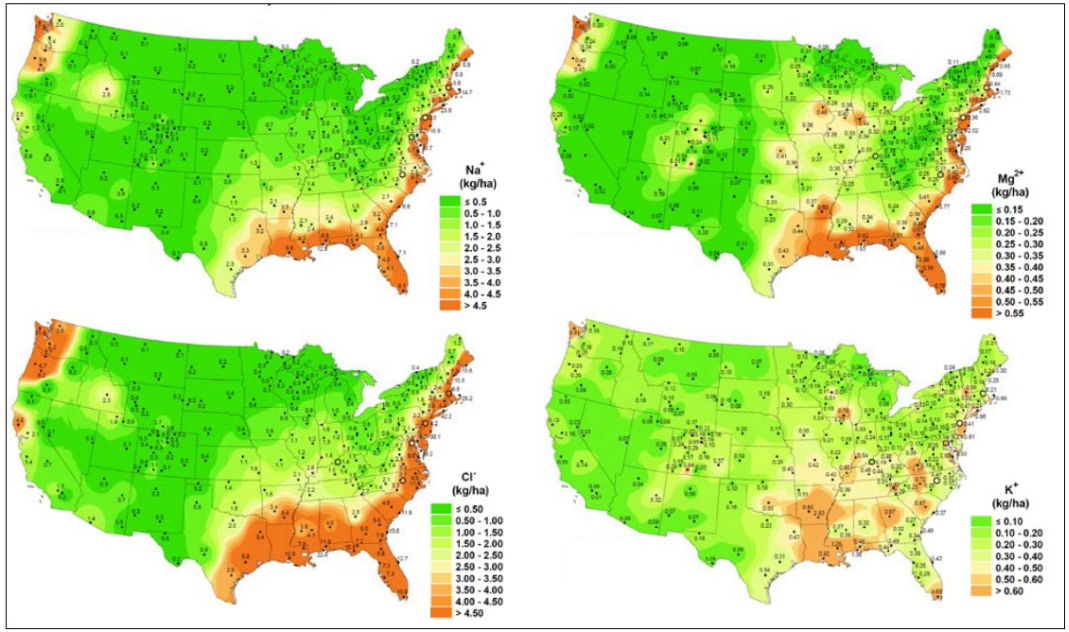
- No investigations have focused on the filtration required of sea salts such that corrosion or degradation of electronic equipment located in these coastal regions can be minimized.
- In addition, there is no investigation on the corrosion in marine environments of materials used in constructing IT equipment, principally copper, silver, and PCB's (printed circuit boards)
- This research aims to provide the proper filtration and to verify the current environmental guidelines for information technology equipment (ITE) in marine environments to maintain or expand the opportunity for increased free-cooling hours and improve data center energy efficiency globally.
- Draft Work Statement submitted Dec 15th

World's Coastal Regions rated by level of Corrosivity



Sponsor: TC 9.9 Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment
Coordinated with: TC 2.3 Gaseous Air Contaminants and Gas Contaminant Removal Equipment

Sea salt aerosols are characterized by high concentrations of Na, Mg, and Cl as shown in the figure



Despite the enormous amount of studies on NaCl particle-induced corrosion, **no investigations have focused on the filtration required of sea salts such that corrosion or degradation of electronic equipment located in these coastal regions can be minimized**. **Neither has there been an investigation on corrosion of materials used to construct IT equipment, principally copper, silver, and PCB's (printed circuit boards)**

Work statement was rejected by ASHRAE with the following areas for suggested for improvements

- Split into 2 projects – one filtration and one corrosion
  - Focus only on corrosion
- Follow sea salt established testing stds
  - Reviewing various testing stds and associated technical papers
- Improve on design of testing apparatus
  - Modifying design to include synergistic effects of SO2
- Provide more data on the need of this research
  - Gathering data from data centers in marine environments
- Expand on testing conditions to mimic server environments
  - Enhancing writeup to better describe environment

Singapore TDC Collaboration

Dustin Demetriou, Roger Schmidt, Mark Seymour, Jon Fitch, Chris Muller

Tropical Data Centre 2.0 (TDC2)
Draft Proposal

(to be funded by NRF Singapore)

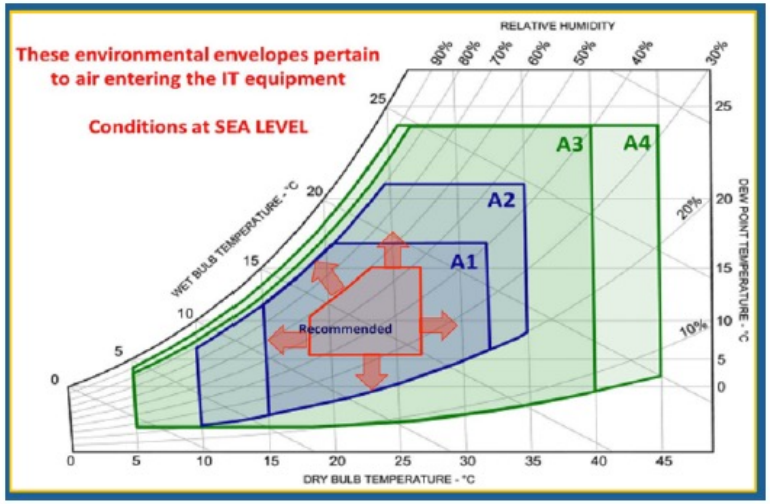
NTU (Asst Prof. TAN Rui, Assoc Prof. DUAN Fei, Prof. Dusit Niyato)
IMDA (Dr. Lek Heng NGOH)

Objective

1) Address the key technical challenges and concerns of deployment in commercial DCs

2) Develop industry guidelines/standards for TDC implementation

3) Catalyst commercial offering of TDC



- **Optimal operating region in tropics?**
  - **Energy efficiency**
  - **Equipment reliability**

Research Tasks

- Task 1: Quantify energy savings
  - Measurements of cooling energy, IT energy
  - Generalizable energy models
- Task 2: Determine "Sweet-spot" temperature/humanity setpoints
  - Power profile of a representative IT equipment mix under different temperatures & humidity levels
  - Method to determine the optimal setpoints for an given mix of IT equipment
- Task 3: Determine long-term impact on IT equipment reliability operating at high-temperature ambient conditions
  - Measure reliability of IT equipment based on data collected and reliability data from vendors and industry
  - Reproduce ASHRAE's X-factor with ASHRAE's field data so that we can apply the same method to generate the absolute reliability data and X-factor from our deployment
  - Reconcile ASHRAE's X-factor with our results
- Task 4: Cost and benefit analysis
  - Quantify & analyze the TCO of TDC by jointly considering additional Opex to replace failed equipment, costs of extra fittings, costs of energy, etc

A Planned Set Up at Commercial DC

- **Facility**
  - A partitioned space of 400sqft in a data hall
    - 10 42U racks with 8kW peak power/rack
    - Cold air containment
    - Subject to 99.95% reliability under SLA
  - Dedicated DX air conditioners that allow
    - Measuring cooling power usage
    - Controlling temperature from 24°C to 32°C, and higher for short time periods
    - Controlling relative humidity from 45% to 65%, and other levels for short time periods

- **IT equipment**
  - 400 used servers in different models of a single brand
  - TOR switches, 2 aggregation switches, 2 routers

- **Sensing**
  - Real-time power usage of each IT equipment
  - Real-time total IT power usage
  - Real-time power usage of DX air conditioners
  - Room air temperatures and relative humidity
  - Air quality survey of NO2, SO2, airborne chlorides (sea salt) by wet candle chloride apparatus

PROPOSED ROLES AND AGREEMENTS FOR JOINT PUBLICATIONS

Publication Type (publication agreement)	Role/Contribution/Acknowledgement		
	Team IMDA	Team NTU	Team TC9.9, ASHRAE
Academic Conference/Journal Research Paper on TDC2.0 (ACM/IEEE)	Co-authors affiliated to IMDA	Lead Authors affiliated to NTU	Co-authors affiliated to TC9.9, ASHRAE
ASHRAE research paper On Impact of air-pollutant on IT equipment (ASHRAE)	Co-authors affiliated to IMDA	Co-authors affiliated to NTU	Lead Authors affiliated to TC9.9, ASHRAE
Singapore Standard for Tropical Data Centre (Enterprise Singapore (ESG))	Co-chair of standard working group. IMDA acknowledged as an organisation whose experts are involved in the working group	Members of standard working group. NTU acknowledged as an organisation whose experts are involved in the working group	Reviewers. ASHRAE acknowledged as an organisation whose experts are involved as reviewers

Proposed Research on Wetted Materials

Mark Steinke

RTAR – Wetted Materials Research

Background

- Liquid Cooling Guidelines book contains a listing of wetted materials for the FWS and TCS loops
- Latest water-cooling white paper “Water-Cooled Servers - Common Designs, Components, and Processes” identified the growing list of wetted materials being used by ITE manufactures
  - Not an endorsement of these materials just an acknowledgement that the list is growing
  - More liquid cooled solutions coming to market
  - This was most debated topic of the WP
- Every ITE manufacturer should be investigating
- Every customer should be asking

Excerpt from Water-Cooling White Paper

Table 2: Common Wetted Materials Found in Water-cooled Servers.

Material	FWS	TCS
Acrylonitrile Butadiene Rubber (NBR)	X	
Aluminum & Alloys	X [a]	X [a]
Brass; with < 15% Zinc	X	X
Brass; Chrome Plated	X	X
Brass; Nickel Plated	X	X
Carbon Steels [b]	X	
Copper [c]	X	X
Copper Alloys: < 15% Zinc and Lead Free [c]	X	X
Polyoxymethylene (POM)	X	
Ethylene propylene diene monomer (EPDM)	X	X
Fluoroelastomer (FKM)	X	
Fluorinated Ethylene Polypropylene (FEP)		X
Polyamide (PA)	X	
Polychloroprene (CR)	X	
Polyethylene		X
Polyoxymethylene (POM)	X	
Polyphenylene Sulfide (PPS)		X
Polytetrafluoroethylene (PTFE)	X	
Polypropylene (PP)	X	
Polysulfone or Polyphenylsulfone (PSU,PPSU)	X	X
Silicone	X	
Stainless Steel; Solution Treated and Passivated [d]	X	X
Thread Sealant [e]	X	X
Teflon Tape [e]	X	X

Materials in **bold** font were originally listed in the Liquid Cooling guideline book [1].

RTAR – Wetted Materials Research

Purpose

- Every ITE manufacturer should be performing own studies and results are typically propriety to that company.
- Begin work on a RTAR to study wetted materials in liquid cooled systems
- Provide validation of a basic set of wetted materials for use
- Develop testing roadmap to validate other or emerging wetted materials
- Provide a common set of recommended wetted materials that can be expanded over time using this process

RTAR – Wetted Materials Research

Action

- Form small group interested in research topic
- Begin to RTAR work statement
- Goal of having RTAR work statement ready by winter meeting
- Contact if interested in participating
  - Mark Steinke Mark.Steinke@amd.com
  - Dustin Demetriou
  - Roger Schmidt
  - Mark Seymour

Agenda

Tuesday, June 15, 2021
TC 9.9 Main Meeting
10:00 AM – 3:00 PM EDT
Location: Virtual

Topic		Time	Presenter
Introduction	Welcome and Introductions	5	
	What is TC 9.9 Presentation	15	Dustin Demetriou
	TC 9.9 Officers and Membership	10	
Program		10	Nick Gangemi
Webmaster		5	Ecton English
Liaison Reports	Standard 90.1	10	Rick Pavlak
	Standard 90.4	10	Rick Pavlak
	SPC-127	10	John Bean
	AHRI 1360	10	David McGlocklin
	SSPC 300, Guideline 1.6	10	Terry Rodgers
	MTG.CYB	10	Ecton English
External Engagement	Datacenter Dynamics	5	Dustin Demetriou
	Open Compute Project	15	Nigel Gore
	UL 60335-2 A2L Refrigerants	15	B. Dolcich, B. Kinas, J. Rede
	Data Center Cooling Resiliency	10	Mark Mannex
Break		15	
International	International Update	10	Don Beaty
Publications	Publication Statistics	10	Ecton English
	Thermal Guidelines 5th Edition	15	Roger Schmidt
	Design Considerations 3rd Edition	10	John Gross
	Emergence & Expansion of Liquid Cooling	10	Dave Moss
IT Subcommittee	Liquid Cooling Datacom Book	15	Roger Schmidt
	Liquid Cooling Pressure Testing	10	Roger Schmidt
	IEC Connector Harmonization	10	Roger Schmidt

Total Time 4 hours 15 minutes

Attendance: http://bit.ly/tc99-summer

Attendance

ASHRAE TC 9.9 Attendance Record

ASHRAE Technical Committee 9.9 - Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment
2021 Winter Meeting
Virtual Event Timing: January 19, 2021
Event Address: https://ashrae-org.zoom.us/j/98449509730?pwd=Q2ZCNFhRQXFTY05CSTNYbElZTkdKQT09
Contact us at tc99chair@gmail.com
Technical Committee Website: http://tc0909.ashraetcs.org

* Required

Name *

Your answer

Email

Your answer

Attendance is being recorded using a Google Form. Please make sure you complete the form at:

http://bit.ly/tc99-summer

Thank You

TC 9.9 Website:

tc0909.ashraetcs.org