

Welcome to the ASHRAE TC 9.9 Virtual Meeting!

No need to say hello, we will begin
promptly at 6:00 pm EST

Agenda

- Introduction
- Programs
- Research
- Publications



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



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

ASHRAE Winter Conference 2025
Programs, Research, & Publication
Hybrid In-Person / Virtual

Virtual Meeting Etiquette

- Do not share your video due to the high number of virtual participants.
- Prior to speaking individuals should state their name so that others know who is speaking.
- Virtual participants should keep yourself muted unless giving permission to speak by the Host via chat.
- Please do not attempt to share your screen without being asked to do so by the Host or Co-Host.
- In-person participants are discouraged from joining the virtual meeting due to wireless bandwidth constraints.



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

ASHRAE TC 9.9 Attendance Record

ASHRAE Technical Committee 9.9 - Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment
2025 Winter Meeting

Programs, Research, & Publications

Hybrid Event Timing:

Sunday, February 9, 2025; 6:00-8:00 pm EST
Event Address: <https://www.microsoft.com/microsoft-teams/join-a-meeting>
Meeting ID: 252 046 633 687
Passcode: D5Hw6aM9
Physical Meeting Room:

Hilton Orlando Room: Lake Highland AB (Lobby Level)

Main Meeting

Hybrid Event Timing:

Monday, February 10, 2025; 2:30 - 7:00 pm EST
Event Address: <https://www.microsoft.com/microsoft-teams/join-a-meeting>
Meeting ID: 243 052 086 357
Passcode: ff2RX6eT
Physical Meeting Room:

Hilton Orlando Room: Orange D (Lower Level)

Contact us at tc99chair@gmail.com
Technical Committee Website: <http://tc0909.ashraetcs.org>

<https://forms.gle/Yzg85KnmqGRhbzo17>

Or use the QR Code below:



Virtual Host: Vice Chair - Mark Steinke

- Monitor the chat thread for questions and comments.
- Mute and Unmute Virtual Participants and Guests.
- Manage discussions and voting.
- Manage screen-sharing and in-person presentation

Virtual Co-Host: Secretary - John Gross

- Monitor time and keep the meeting on schedule.
- Record the event.
- Produce meeting minutes.
- Will repeat the attendance link multiple times during the meeting and upon chat request.
- Respond to audio problems.

- Video projector that displays the presentation being shared virtually.
- Be aware that chat comments sent to the Host may be seen by those in-person in addition to general chat comments.
- There are audio speakers in the room but unmuted virtual commentators may not be immediately connected. Please be patient.

Topic		Time	Presenter	In-Person or Virtual
Introduction	Welcome and Introductions	10	Matt Koukl	IP
Programs	2025 Orlando & 2025 Summer Phoenix	20	Eric Yang	IP
Handbook	Handbook Update	15	Robert McFarlane/ Jonell Watson	IP
Research	Research Committee Update	30	Brad Cochran	V
Research	Research Workshop - Topics Working Session	10	Brad Cochran	V
Total Time:		85	Minutes	



Programs Update

**ASHRAE 2025 Winter Meeting
February 8 - February 12, 2025**

Eric Yang, Program Chair

Conference Co-Sponsored by TC 9.9 (Sponsored by TC 4.10 Indoor Environmental Modeling)

**Seminar 52: The Evolution Continues! CFD Must Continue to Enhance and Improve Its Underlying Algorithms to Meet Data Center and Ventilation Demands-
Chair: Duncan Phyfe**

Time: Wednesday 8:00 AM – 9:30 AM EST

Program submitted by TC 9.9, but not accepted.

- 1. DOE Cool chip research update submission (part 1 and 2) –Eric Yang**
- 2. Liquid cooling water quality and filtration requirement –Tim Shed**
- 3. Thermal Energy Storage (TES) Requirements for Liquid-Cooled Data Centers -
Tom Davison**

Program considered by TC 9.9, not submitted to Orlando

- 1. Micro Data Centers; What Are They and How Do They Work?**

Overview of Conference Tracks:

•Tracks

- **Fundamentals and Applications**
- **HVAC&R Systems and Equipment**
- **Research Summit**
- **Workforce Development**
- **Industrial Ventilation, Refrigeration, Air-Conditioning and Energy Utilization**
- **Heat Pumps, Refrigerants, and Decarbonization**
- **Onsite Energy Storage**

- **Fundamentals and Applications**
 - Liquid Cooling Water Quality and Filtration Requirement – (Tim Shedd, resubmit)
 - A2L refrigerant (Mukul) –IN progress
- **HVAC&R Systems and Equipment**
 - Modular Electrical Room Design in Data Centers (seek speakers)
 - Single-phase and Two-phase Immersion Design for Ultra High-density Deployment (seek speakers)
 - TCS/FWS chilled water loop requirement (seek speakers)
 - Debate (90.1 scope requirement on TCS Loop: whether this should be exempted –(John Gross)
- **Research Summit**
 - DOE liquid cooling (cool chip) program updates (Eric Yang - resubmit)
- **Onsite Energy Storage**
 - Thermal Storage Requirement for Liquid Cooled Data Centers (Tom Davison, resubmit)

Important Dates

Monday, February 26, 2025 | Debate, Panel, Seminar, Forum, Workshop, and Debate Proposals Due

Monday, March 5, 2025 | Conference Papers and Extended Abstracts Due

- **Technical Papers**
- **Conference Papers**
 - Not required to be approved by TC's
 - Organized by either CEC or TC into Sessions
- **Extended Abstracts**
 - Available at Annual Conferences
- **Seminars, Workshops**
 - Organized by TCs
 - Require Learning Objectives
- **Panels, Debates, Forums**
 - Organized by TCs
 - Do not require Learning Objectives

Panel Discussion

- Feature a broad range of subjects and explore different perspectives on industry related topics.
- This session format includes a panel of 3-6 speakers each addressing a facet of the session topic, followed by an interactive discussion lead by the session chair.

Debates

- Highlight hot-button issues commonly faced by ASHRAE members. Industry experts, either on teams or as individuals, argue opposing sides of an issue, concluding with position summaries and audience feedback.

Forums (no recordings)

- “Off-the-record” discussed held to promote a free exchange of ideas.
- Allow individuals to speak confidently without concern of criticism.
- There are no papers attached to forums.

- These sessions present papers on current applications or procedures, as well as papers reporting on research in process.
- Less rigorous than Technical Papers
- Can highlight case studies or ongoing research
- Maximum eight pages in length, single spaced. Published in *ASHRAE Transactions* and indexed in Scopus – presentation at conference required
- Single blind review process; subject to commercialism review
- Shorter timeline for the Conference
 - Abstracts due about 6 months prior to meeting
 - If accepted, papers due about 4 months prior to meeting

<https://www.ashrae.org/technical-resources/authoring-tools/citation-and-abstract-indexes#transactions>

- These sessions present papers on current applications or procedures, as well as papers resulting from research on fundamental concepts and basic theory
- More involved papers usually detailing research or similar activities
- Maximum of 30 pages in length
- Rigorous double-blind review process; subject to commercialism review
- Longer timeline for development and approval
 - Final papers required about 9 months prior to a Conference to go through the review process
- Published in *ASHRAE Transactions* and indexed in Scopus – presentation at conference required

<https://www.ashrae.org/technical-resources/authoring-tools/citation-and-abstract-indexes#transactions>

- These sessions present extended abstracts on research in progress, applications, case studies, and other topics in HVAC&R technical areas. They are intended to be preliminary research results that will eventually be expanded into full papers.
- Extended abstracts may be presented in Conference Paper Sessions with papers on a similar topic.
- Available as part of the Annual Conference Research Summit
- Limited to Three Pages
- Included in ASHRAE Transactions and indexed in Scopus

<https://www.ashrae.org/technical-resources/authoring-tools/citation-and-abstract-indexes#transactions>

- Develop a detailed **program abstract** and identify speakers (contact Track Chair with questions)
- Upload the required information on the session and speakers to the Conference website
- Preview speaker presentations to check that they meet the ASHRAE Conference Presentation Policy (found at https://www.ashrae.org/file%20library/conferences/speaker%20resources/conference-presentation-policy_final_2019.07.10.pdf)
- Make sure speaker presentations are uploaded prior to the Conference
- Coordinate presentations to minimize overlap and make sure the timing is correct
- Introduce and monitor session at the Conference
- Assist authors in identifying learning objectives & completing Q&A

Panel, Debate, Forum Chair Responsibility

- Introduce and Moderate the session at the Conference
- Upload the required information to the Conference website
- Make sure are working to the required deadlines

- More visibility to ASHRAE members and ASHRAE society
- Add points to the service award
- Provide the lower registration fee

Next Step

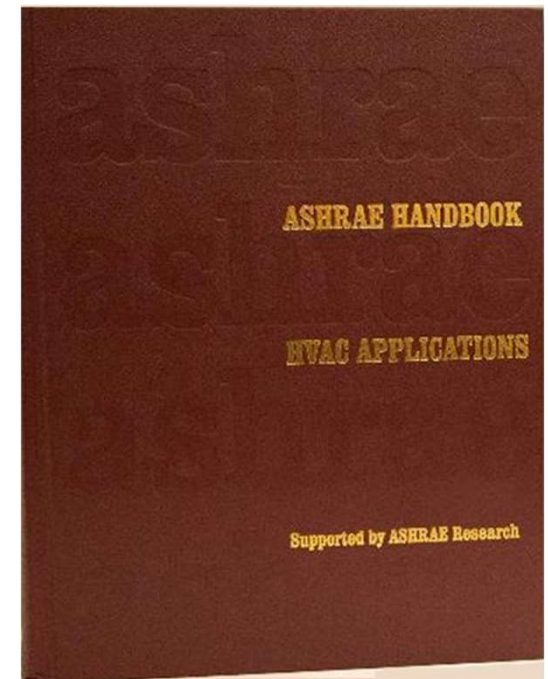
Contact Eric Yang (ericyangcem@gmail.com)

- If you need to co-sponsorship from other TCs or other help to submit a program.
- If you need an ASHRAE speaker submission template or understand the process of submitting a session
- If you need to help facilitate preparing the program

ASHRAE Handbook “Applications”

Chapter 20

“Data Centers & Telecommunication Facilities”



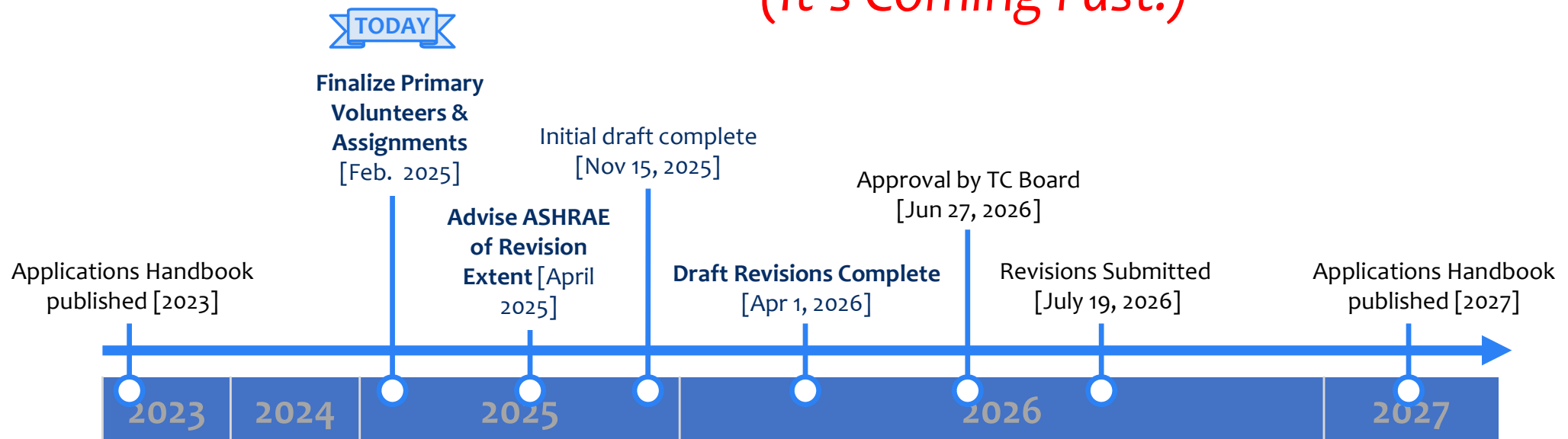
- Background
- Purpose of Chapter 20
- Timeline
- Current Status
- Volunteering
 - Who, Why, Roles & Commitment
- How To Volunteer
- Next Steps
- Contacts
- Q & A

- ASHRAE's Handbooks - Four Publications
 - Fundamentals
 - Refrigeration
 - **Applications**
 - HVAC Systems and Equipment
- Published on four-year cycle
- TC9.9's Responsibility: Chapter 20 of "Applications"
 - *"Data Centers and Communications Facilities"*
- All revisions by Volunteers through TC9.9

- Tutorial for New Engineers
- Reference for Experienced Engineers
- Design Guideline for Those New to Data Centers
- To Alert to “What You Don’t Know”
 - And Then Encourage Retaining Subject Matter Experts?
- To Push Manufacturers to Standardization

- The Applications Handbook last published 2023
- The Handbook revision cycle has already started!
- **Draft Revisions due April 1, 2026 for 2027 Edition**

(It's Coming Fast!)



- Chapter 20 Topic Cross-Check (*Requested by ASHRAE*)
 - Can't Get Search Access to All Volumes
 - Therefore, For Now, We're Ignoring
- 33 People Have Volunteered
 - Some for Too Many Topics
 - We're Generally Limiting to 5 Per Person
- We Still Need Topics Covered

Let's Complete The Sign-up Sheet TODAY!!

- Industry experts
 - New TC 9.9 Joiners
 - Less experienced, More experienced
 - Anyone with Expertise!
-
- Do not have to be a member of TC9.9
 - Do not have to be a Member ASHRAE

- Contribute to The Society and support your industry
- Be a role model for mentees and junior engineers
- Experience developing industry text
- Bragging rights
- Major Contributors* Receive
 - Personalized Handbook
 - Published Recognition

**For New Material or Significant Revisions*

Volunteer Roles

- Primary reviewers (**NOW**)
 - Subject matter experts
 - Have Been Notified
 - Not All Have Acknowledged!
- Secondary reviewers (**LATER**)
 - Support to Primary
 - 2nd & 3rd Sets of Eyes
 - Review for Clarity
 - Smooth Writing
 - Grammar & Spelling

Tasks

- Update Technical Information
- Review texts for consistency:
 - Within the chapter
 - Across ASHRAE's publications
 - Across industry standards and guidelines, etc.
- Sanity checks

- **All effort is volunteer**
- **Level of effort varies based on Topic:**
 - Primary reviewers 2-10 hrs. per topic
 - Secondary reviewers 5-10 hrs. per topic
- **Commitment term**
 - Today to Draft Completion (Nov. 2025)
 - Ad-hoc Support to Apr. 2026

1. Sign-Up on the Topic Spreadsheet in-person **TODAY!!**
2. If Necessary: Will Also be Accessible via <http://tc0909.ashraetcs.org/>
“TC 9.9 2025 Winter Meeting Presentations & Information”
1. Email us directly:
 - Select Review Topics **by Spreadsheet Line Number**
 - rmcfarlane@smwllc.com
 - Jonell.watson@accenture.com
 - **Include Name, Company, and Email Address**

- Determine Extent of Revisions
- Access to ASHRAE “Authoring Portal”
 - Used for All Review and Revisions
 - Now Works on ALL Browser Platforms Including MAC
 - Can Work Simultaneously on the Same File
 - Most Recent “Save” Will Be Seen by Others
- All Work Must Use “Track Changes”
- New or Revised Illustrations
 - **Require Written Permissions!!**
 - **Preference is “In Perpetuity”**

- Please advise Bob McFarlane or Jonell Watson
 - rmcfarlane@smwllc.com
 - Jonell.watson@accenture.com
- **IMPORTANT:**
 - **Make Us “Trusted Senders”**
 - **Reply ALL**
 - **Agree to “Read Receipt”**

QUESTIONS?



TC 9.9 Research Projects

Planned and Proposed

Brad Cochran has taken over as Research Chair from **Mark Seymour**

Connor Murray has taken over as Section 9 Research Liaison from **Roland Charneux**

Roland Charneux is now RPS Chair tasked with RTAR reviews

- Currently no RTAR under review by RAC across all TCs.
- So now is a good opportunity to submit RTARs, funding is available.

TRP-1913 - *Study of the Corrosion Impact on Information Technology Equipment in Data Centers Located in Coastal Regions with High Sea Salt Concentration*

- Bids currently being reviewed by PES.

WS-1972 - *Data Center Direct-to-Chip Liquid Cooling Resiliency – Failure Modes and IT Throttling Impacts*

- WS updated and resubmitted in December

WS-1956 - *Compact CFD Modeling Guidance for Thin Flow Resistances*

- WS returned from RAC with comments last summer.

New RTAR - *Data Center Direct-to-Chip Liquid Cooling Resiliency – Failure Modes and IT Throttling Impacts*

- RTAR to be voting on during main meeting.

Future RTAR – *Guidelines for Data Center External Dispersion Modeling*

Future RTAR – *Flow Velocity Limits for Erosion Control*

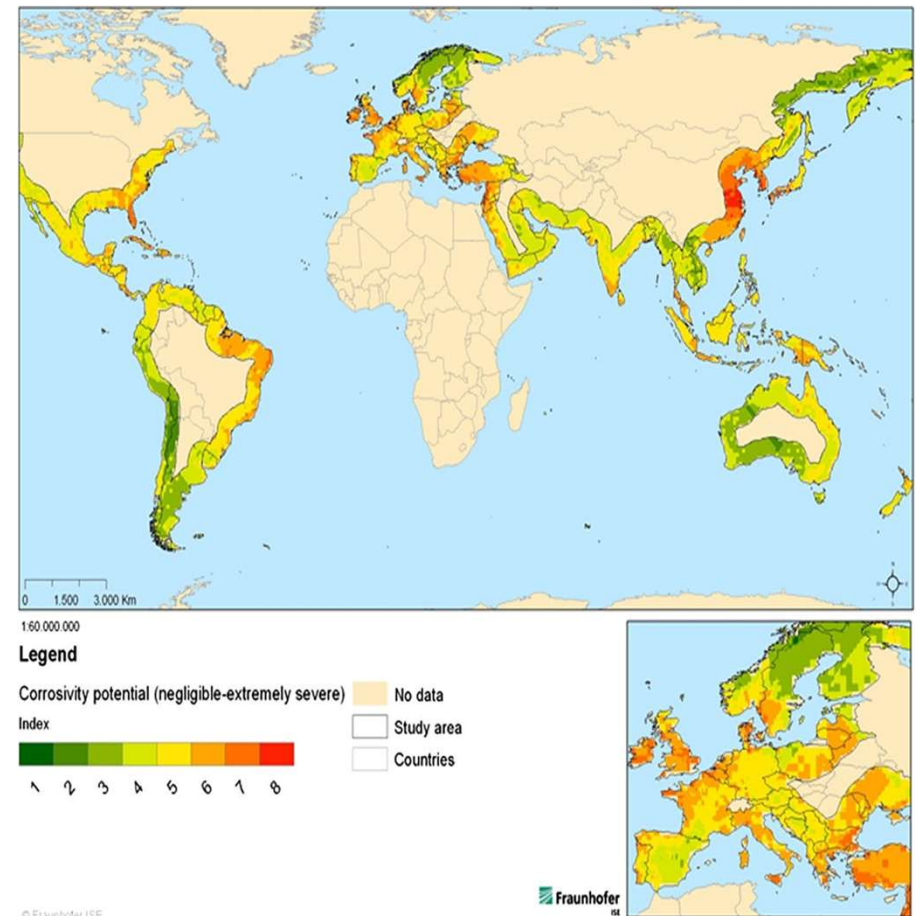
1913 - Study of the Corrosion Impact on Information Technology Equipment in Data Centers Located in Coastal Regions with High Sea Salt Concentration

- **Chris Muller**, Chair – AAF International, member of TC2.4
- **Rui Zhang** (Oakridge National Lab) – member of TC9.9
- **Kyung-Ju Choi**, PhD, LMS Technologies, ASHRAE TC2.3 Program subcommittee chair
- **Vali Sorell** – Oracle – member of TC9.9
- **Michael Corbat**, Rensa Filtration, TC2.3 voting member

1913-WS Status

- TRP-1913 went out for bid last fall
- Four bids have been received
- Bids currently being reviewed by PES

- Study of the Corrosion Impact on Information Technology Equipment in Data Centers Located in Coastal Regions with High Sea Salt Concentration
- Motivation
 - Electronic failures in marine environments occur – is sea salt important?
 - Can the data center environmental envelopes be expanded if we know?



1913-WS Objectives

- Conduct a literature survey to understand the importance of field variables. Variables include temperature, moisture content, wet/dry cycles, and salt concentration (fine particulates and airborne water droplets) and SO₂. Identify their impact on corrosion to design a set of experiments.
- Develop a draft test methodology and establish minimum specifications for the test facility and instrumentation.
- Based on literature survey and coastal environmental measurements, create a design of experiments that includes the key parameters and the parameter ranges to be tested.
- Develop a test facility (bearing in mind previous ITE contamination research) capable of monitoring and controlling the test parameters determined from the literature survey. The time it takes to cause corrosion of the IT equipment in marine environments is a key element of the testing.
- Document the results of the effect on corrosion of electronic equipment from the sea salts. Identify the tool/s for measuring corrosion of IT equipment in marine environments including recommendations on where the measurements should be.
- Develop new guidelines for operating data centers and other electronics in marine environments.

1913-WS Tasks & Deliverables

- Task 1. Perform and document a detailed literature review.
Deliverable: A report that summarizes the literature review.
- Task 2. Develop a test facility capable of monitoring and controlling dry bulb temperature, dew point, air flow velocity, sea salt concentration, and time of exposure that mimics the environmental conditions of data centers in marine environments.
Deliverable: A report that summarizes the test facility design and method to vary the various test parameters over the range of environmental parameters exhibited by data centers in coastal regions.
- Task 3. Experimentally characterize copper and silver corrosion of the test coupon samples using conditions appropriate to cover the ASHRAE thermal guidelines.
Deliverable: A report that summarizes corrosion test results over the range of environmental parameters experienced in coastal data centers. Highlight those parameters or group of parameters having the most destructive effect on IT equipment reliability. Include the effect of makeup air in your comments regarding the test results.
- Task 4. Understand and perform experiments to elucidate the relationship between the rate the change of humidity on the corrosion rates of copper and silver. For a direct air side economizer these changes can occur in minutes or hours depending on the weather patterns of the data center location and would impact the IT equipment housed within the data center.
Deliverable: A report of the effect that rate of change of humidity (wet/dry cycles) has on the corrosion of the IT materials.
- Task 5. Develop an updated set of thermal guidelines for coastal locations of data centers and specific guidelines that may focus on those data centers where resiliency may be the primary operational goal and not energy efficiency.
Deliverable: A report of the thermal guidelines for coastal data centers with those environmental conditions providing the highest reliability for IT equipment. In addition, a set of guidelines for coastal data center where resiliency is the primary operational goal should also be reported.
- Task 6. Provide guidance on what tool/s to use for quantifying corrosion in coastal data centers. In addition, provide recommendations on where those measurements should be made.
Deliverable: A report summarizing the tool/s for measuring corrosion in data centers and the optimum location for those measurements.

1972-WS Data Center Direct-to-Chip Liquid Cooling Resiliency – Failure Modes and IT Throttling Impacts

- David Quirk, **DLB**, Chair
- Jim VanGilder, **Schneider Electric**
- Eric Yang, **Vantage Data Centers**
- Tom Davidson, **DLB**
- Matthew Käufeler, **Cadence Design Systems**

1972-WS Status Update

- Minor changes to accommodate TC's
- Submitted to MORTS (RAC)
- WS Returned from MORTS w/ comments
- December: WS resubmitted to MORTS Changes include:
 - Increased cost estimate from \$300K to \$350K
 - Total estimated corporate support (cash + in-kind) \$51K
 - Up to three more potential sponsors
 - Added Letters of Support from:
 - IBM
 - J.M. Gross
 - Vantage Data Centers
 - DLB Associates
 - Strategic Thermal Labs

1972-WS Objectives

- Research failure system design for air/liquid hybrid and liquid cooled equipment using computer models and empirical data
- Examine ITE power and thermal capacitance impact on rate-of-rise and IT Throttling Time
- Look at impact of liquid cooling S-classes on IT throttling time
- Look at impact of secondary loop delta t on IT throttling time
- Look at impact of liquid cooling percentage on IT throttling time
- Look at impact of percentage of secondary loop failure on IT throttling time
- Conduct a comprehensive analysis (modeling + testing) of 30+ combinations
- Look at energy impact of specific liquid cooling systems and S-classes vs. air cooled baseline (metrics to include: MLC, ELC, PUE, and TUE)



Corporate co-sponsorship

Estimate cost of this research is \$350,000 (large by ASHRAE Standards, average is \$131,353 for 49 active projects). Corporate co-sponsorship greatly increases likelihood of project funding. (Just a pledge now, donations not accepted until project funded).

- In-kind or cash co-sponsorship available
- Corporate co-sponsors will be recognized in Work Statement and Final Report
- In-kind support may be of equipment (servers, CDU's, data acquisition, etc.)
- Field data support will aid in providing confidential failure and energy use data
- Cash donations directly to this research project must be at least \$1,000 per ASHRAE rules



If interested, contact Tom Davidson (tdavidson@dlbassociates.com), Mark Seymour (mseymour@cadence.com), or TC9.9 Chair Matt Koukl (mkoukl@aeieng.com)

1956-WS Compact CFD Modeling Guidance for Thin Flow Resistances

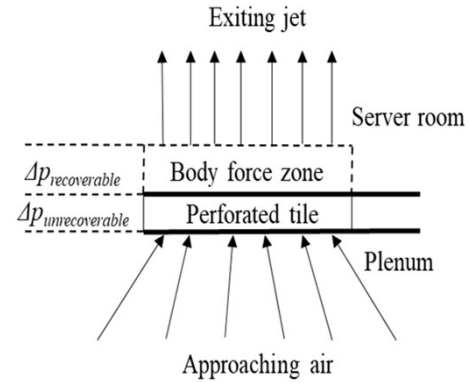
- Jim VanGilder
- Mark Seymour
- Duncan Phyfe
- Duncan Phillips
- One more representative from TC 9.9?

1956 -WS Status Update

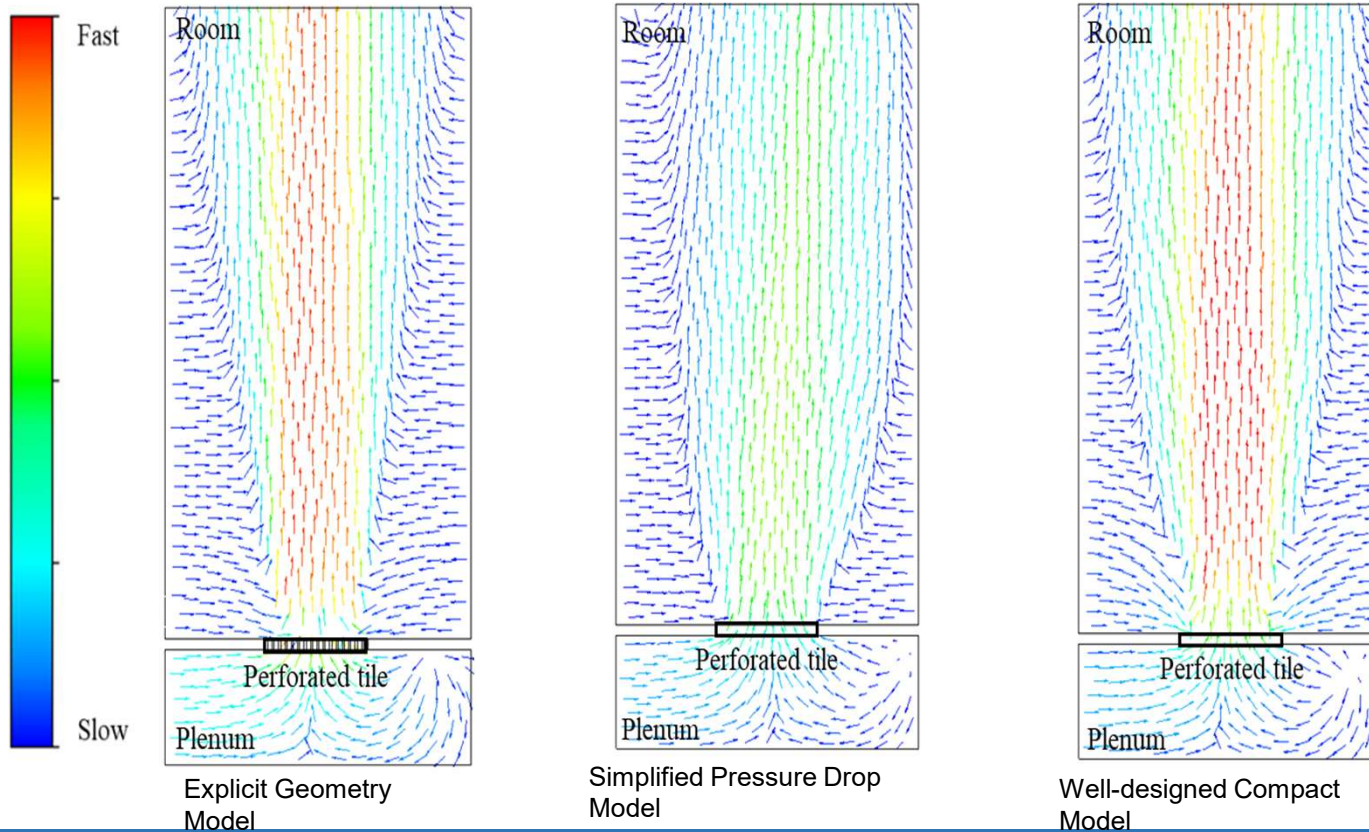
- WS returned to PES with comments
- WS has not been updated

- Resistances are common
 - Tiles, perf doors, louvres...
 - Previous research incomplete
 - Implementation varied
- Thickness of resistance often small c.f. domain size
- Compact model required – thin resistance used but can fail to capture:
 - Correct advected momentum – cross velocity
 - Consistent mass flow and momentum – hence pressure drop
 - Cannot capture detailed geometry efficiently
- Returned by RAC with comments

- Resistances are common
 - Tiles, perf doors, louvres...
 - Previous research incomplete
 - Implementation varied



Courtesy Hu, B
RP-1675



Determine thickness and strength distribution of the momentum source for a thin-resistance compact model to produce best agreement with reality (as benchmarked by detailed CFD and experimental validation).

Considerations:

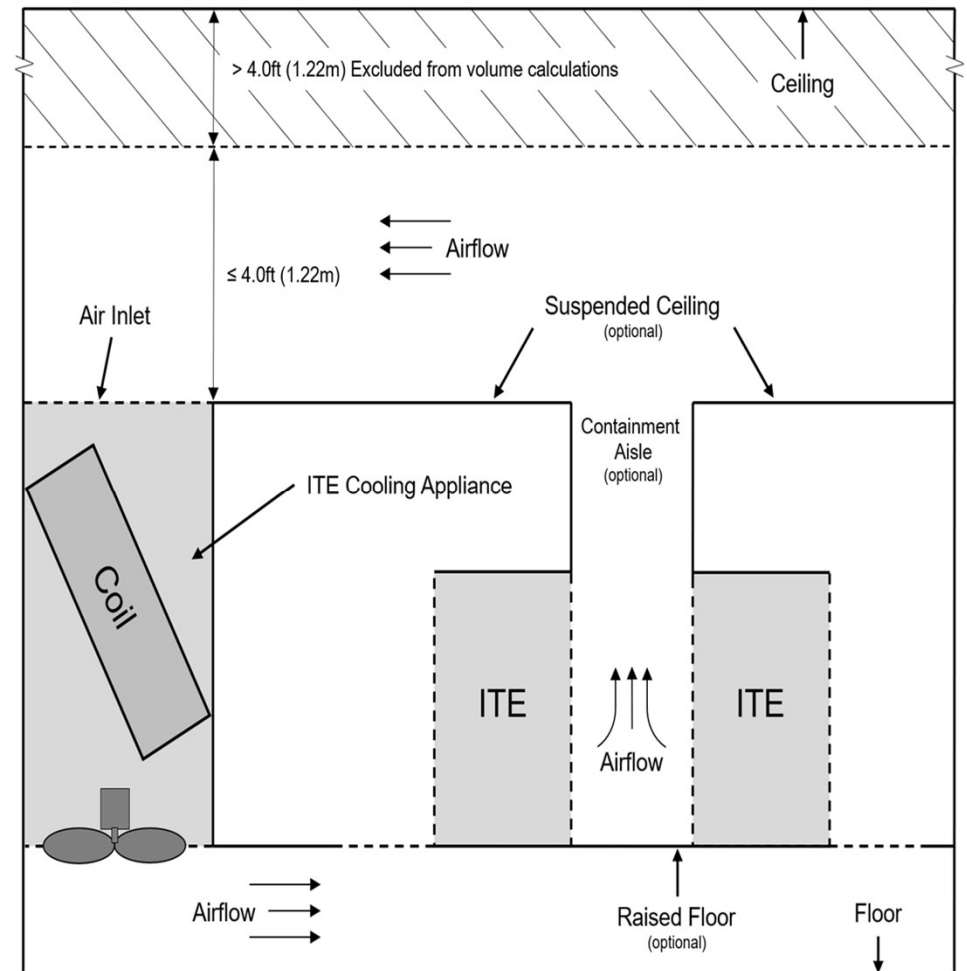
1. CFD issues like grid size and grid scheme (staggered vs. co-located) are to be investigated.
2. Simple thin resistances (e.g., porous plates with uniform hole distributions) with varying percentage open-areas should be considered.
3. At least one commercial HVAC-style grille and one data center perforated floor tile should be considered.
4. Multiple flow rates (supply velocities) should be considered, at least, for the simple thin resistance.

Data Center Direct-to-Chip Liquid Cooling Resiliency – Failure Modes and IT Throttling Impacts

- Richard Pavlak
- Ben Dolcich, Vertiv (ret)
- Bill Kinas

- RTAR has been reviewed by Research Chair (Mark)
- Distributed to TC9.9 Voting Members for Review
- Will hold vote to accept during Main Meeting
- If RTAR is approved, will need to be forwarded to SSPC 15 for possible Co-Sponsoring

- Existing standards - Standard 15-2022 and UL/CSA are not designed for data centers
- Studies on 2L refrigerants are based on comfort cooling with low airflow rates
- There are inconsistent practices with regard to airflow volume – Only 4ft in height above drop/false ceiling is included in UL/CSA 60335-2-40 4th edition further limits refrigerant capacity



- Build a CFD geometric model based on the parameters in U101.DVN.8.1.
- Evaluate the effectiveness of the dilution of the refrigerant charge specified in ASHRAE Standard 15-2022, the air flow pattern into the return air, comparing these results to the safety metrics established in Standard 15-2022.
- If the base model identifies the effective volume is well mixed at the prescribed 4-foot limit, raise the height. (The authors believe the 4' limit is too low).
- If the base model shows a dead air space below 4-foot limit lower the height to determine and verify whether there is a height with all acceptable circulation.
- The expectation is that the 4' limit is too low and that increasing the limit height above the return air opening is viable. Thus, the objective is to run successive models increasing the height limit until the total volume does not mix and a boundary layer of room air appears in the CFD model.

Guidelines for Data Center External Airflow Modeling

- Brad Cochran
- Mark Seymour

The Concern

- Data Center installations are complex and often built near existing facilities or within tight confines.
- Thermally sensitive intakes are surrounded by significant sources of heat rejection (cooling towers, chillers, DGs, hot aisle exhaust etc.)
- With server loads increasing significantly, understanding the level of re-entrainment of the hot exhaust is critical for defining cooling capacity.
- A plume dispersion study is important to help ensure that the necessary resilience is available to avoid insufficient cooling capacity.



Images and data courtesy Kao Data



ANALYTICAL

- ASHRAE Dilution Equations

Pro's

- Calculations can be performed in a simple spreadsheet
- Can quickly evaluate a full range of wind speeds

Con's

- Designed for evaluating a single emission source at multiple receptor locations
 - Assumes wind is always from emission source to receptor. Doesn't calculate off-axis concentrations. So, cannot combined exhausts.
- Assumes fully developed flow at the exhaust exit (may not be valid for cooling towers, chillers)
- Doesn't directly address building wake effects/increased turbulence

ANALYTICAL

- EPA's AERMOD Dispersion Program (Used primarily for air permitting applications)

Pro's

- Free software from EPA (GUI interface available from private vendor)
- Dispersion calculations can be conducted on an hourly basis using validated meteorological databases. (Doesn't assume design ambient temperature occurs for all hours)
- Can combine impacts from multiple emission sources.

Con's

- Dispersion model "tuned" to obtain fence line concentrations
- Does not calculate on-building concentrations
- Building wake model can create spurious results, particularly for a data center campus.

NUMERICAL MODELING

- Computational Fluid Dynamics

Pro's

- Can evaluate the entire campus in a single simulation with combined impacts from multiple sources
- Graphics can show the thermal distributions across the campus
- Commercial software programs available

Con's

- Steady-State “RANS” simulations do not resolve the full spectra of turbulence, the driving factor in plume dispersion, so accuracy of results can be a concern
- Unsteady “LES” simulations resolve the larger turbulent eddies, and thus can be more accurate, but are significantly more expensive to conduct
- Each combination of wind speed, wind direction, and ambient temperature is a separate simulation. So, the number of simulations is typically limited.
- No guidance documentation available for how to properly conduct a CFD dispersion modeling assessment. (ASHRAE recommends against using CFD for plume dispersion.)

PHYSICAL MODELING

- Atmospheric Boundary Layer Wind Tunnels

Pro's

- Properly designed ABL wind tunnel can provide the most accurate dispersion modeling results.
- A full range of wind speeds and wind directions can be readily evaluated.
- Probability distributions of intake temperatures can be obtained for each intake.

Con's

- Requires the construction of a physical model
- Limited number of ABL wind tunnels available for commercial work
- The most expensive option (if not taking into account the number of wind speeds and wind directions simulated).
- Most time consuming (again, if not taking into account the number of wind speeds and wind directions simulated)

- Any dispersion model will have uncertainties (margin of errors) associated with their ability to predict intake concentrations/temperatures.
- The objective of this proposed research is to:
 - Evaluate the ability of each type of dispersion model to accurately predict intake concentrations by comparing results to on-site measured data
 - Define techniques that can improve the accuracy or at least provide conservative results.
 - Evaluate the potential uncertainty (margin of error) in predicting maximum intake temperatures over the lifetime (or basis of design period) of the data center.
 - Variables may include:
 1. How many wind speeds (and what wind speeds) are modeled
 2. How many wind directions (and what wind directions) are modeled
 3. How many grid points should be used and what type of mesh (CFD simulations)
 4. Do you apply the same design ambient temperature for all wind speeds and wind directions.
- Results will include guidance for the owner/engineer on not only which dispersion model, but how that modeling effort should be conducted to provide estimated design temperatures that are within an acceptable margin of error for that project.

Flow Velocity Limits for Erosion Control

- Mark Steinke

Flow Velocity Limits for Erosion Control

- ASHRAE Handbook
 - Does call out a 1.5 m/s as a velocity limit to keep pumping power low
 - Does call out a 3.0 m/s limit on erosion with normal operation sourced from a Carrier study in 1960.
- ASHRAE TC9.9 Liquid Cooling guidelines – 3rd Edition
 - FWS section does have the callout for 1.5 m/s for energy conservation but states 3.0 m/s for >6,000 hr/yr (back to ASHRAE Handbook reference)
 - TCS section does call out a 1.5 m/s for any flexible hose and this is more pointing towards pumping power. However, it does not have a callout for 3.0 m/s
- ASHRAE TC9.9 Liquid Cooling guidelines – Online
 - FWS section does have the callout for 1.2 m/s for energy conservation but states 3.0 m/s for >6,000 hr/yr (back to ASHRAE Handbook reference).
 - TCS section has this guidance removed.
- Therefore...
 - There is not a current guideline for flow velocity limits to prevent erosion
 - Some industry hose suppliers have references that call out 6 m/s
 - Should we consider an RTAR to provide a recommendation?

Table 23 Maximum Water Velocity to Minimize Erosion

Normal Operation, h/yr	Water Velocity, fps
1500	15
2000	14
3000	13
4000	12
6000	10

Source: Carrier (1960).

consideration but states 3.0 m/s for

the table appears to confirm that but
5.1.2.3. Velocity Considerations. The velocity of the water in the FWS loop piping must be controlled to ensure mechanical integrity is maintained over the life of the system. Excessive water velocity can lead to erosion, sound/vibration, water hammer, and air entrainment. Particulate-free water will impart less damage to the tubes and associated hardware. Table 5.2 provides guidance on maximum velocities in piping systems that operate over 8,000 hours per year. Flexible tubing velocities should be maintained below 1.5 m/s (5 ft/s). Excessive water velocity in piping systems also increases the pressure drop and energy usage of the system.

5.1.2.4. Liquid Quality/Composition. Table 5.3 identifies the water quality requirements that are necessary to operate the liquid-cooled system. The reader is encouraged to refer to Chapter 49 of the 2011 *ASHRAE Handbook—HVAC Applications*. This chapter, titled “Water Treatment,” provides a more in-depth discussion about the mechanisms and chemistries involved.

Table 5.2 Maximum Velocity Requirements

Pipe Size	Maximum Velocity (fps)	Maximum Velocity (m/s)
>3 in. (7.6 cm)	7	2.1
1.5 to 3 in. (3.8 cm to 7.6 cm)	6	1.8
<1 in. (<2.5 cm)	5	1.5
All flexible tubing	5	1.5

Other Ideas for Research?

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Other Discussions

Other Discussion at IT Sub-Committee

- Monday February 10, 2025 9:00 am – 11:30 am EST
- Location: Hilton Orlando, Key Largo B (Lower Level)
- Web Meeting: Microsoft Teams
 - Meeting ID: 210 631 366 130
 - Passcode: tP6tt9j8

Agenda:

Topic	Presenter	Duration (minutes)
Sea salt corrosion research	Roger Schmidt	5
Datacom encyclopedia updates <ul style="list-style-type: none"> • Liquid cooling resiliency technical brief • Liquid cooling server thermal template 	Dustin Demetriou	10
Liquid cooling resiliency research	Dave Quirk Tom Davidson Ali Heydari	10
Fluid velocity erosion studies	Sean Sivapalan	15
S-Class update (S20, S25)	Paul Artman	15
CDU Guidance <ul style="list-style-type: none"> • SSPC 127 CDU Testing • Tech Brief 	Pradeep Shahi Tim Shedd	20
Liquid cooling deployment questions	John Gross	15

Thank You

TC 9.9 Website:
tc0909.ashraetcs.org



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

ASHRAE TC 9.9 Attendance Record

ASHRAE Technical Committee 9.9 - Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment
2024 Summer Meeting

Programs, Research, & Publications

Hybrid Event Timing: Sunday June 23, 2024; 6:00-8:00 pm EDT
Event Address: <https://www.microsoft.com/microsoft-teams/join-a-meeting>
Meeting ID: 282 351 545 380
Passcode: h7fwVb
Physical Meeting Room: Indianapolis Marriott, Indiana E (1)

Main Meeting

Hybrid Event Timing: Monday June 24, 2024 ; 2:30 - 7:00 pm EDT
Event Address: <https://www.microsoft.com/microsoft-teams/join-a-meeting>
Meeting ID: 279 454 711 503
Passcode: DqcYw7
Physical Meeting Room: Indianapolis Marriott, Indiana ABC (1)

Contact us at tc99chair@gmail.com

Technical Committee Website: <http://tc0909.ashraetcs.org>

<https://forms.gle/tD3sKPS83kAZpgwAA>

Or use the QR Code below:

