Welcome!

Welcome to the ASHRAE TC 9.9 Virtual Meeting!

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

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

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

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

ASHRAE Summer Conference 2024
Programs, Research, & Publication
Hybrid In-Person / Virtual

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

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: https://forms.gle/tD3sKPS83kAZpgwAA

Attendance

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

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

https://forms.gle/tD3sKPS83kAZpgwAA

Or use the QR Code below:

Virtual Meeting Housekeeping

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.

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

In Person Setup

- 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.

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Agenda

Topic		Time	Presenter	In-Person or Virtual
Introduction	Welcome and Introductions	10	Matt Koukl	IP
Programs	2024 Summer Indianapolis & 2025 Orlando	10	Eric Yang	IP
Handbook	Handbook Update	20	Robert McFarlane/ Jonell Watson	IP
Research	Research Committee Update	30	Mark Seymour	IP
Publications	Publications Update	10	Don Beaty	IP
Programs	Working session on Program Topics	10	Eric Yang/ Matt Koukl	IP
Research	Research Workshop - Topics Working Session	10	Mark Seymour	IP
Liaison Reports	Standard 90.4	5	Marcus Hassen	IP
	Total Time:	105	Minutes	

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Programs Update

ASHRAE 2024 Summer Meeting
June 22- June 26, 2024

Eric Yang, Program Chair

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

ASHRAE Summer Conference-Indianapolis

Panel 1: Liquid Cooling Data Center Deployments User Case: A Recipe for Success- Chair: John Groenewold
Time: Sunday 1:30 PM – 3:00 PM EST
Sponsored by TC 9.9

Seminar 32: Leveraging Airflow/IEQ Metrics in CFD for Building Design and Operation
Time: Tuesday 8:00 AM – 9:30 AM EST -Chair: Vincent Tang
Sponsored by 4.10, Co-Sponsored by TC 9.9, TC4.3, 4.7

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Program Options

- **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

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Technical Papers

- 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

Conference Papers

- 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

Extended Abstracts

- 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

Program Types -Do not require Learning Objectives, Q&A

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.

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

ASHRAE Winter Conference 2025-Orlando

Overview of Conference Tracks:

- **Tracks**
  - **Fundamentals and Applications**
  - **HVAC&R Systems and Equipment**
  - **Refrigeration & Refrigerant**
  - **Energy storage and Grid Resiliency**
  - **Pathways to Building Carbonization**
  - **Artificial Intelligence**
  - **Industrialized Construction: opportunities and challenges**
  - **Ventilation and Indoor Environmental Quality**
  - **Future-proofing the Built environment**

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Important Dates –Orlando

Friday, August 2, 2024| Debate, Panel, Seminar, Forum, Workshop, and Debate Proposals Due
Friday, October 4, 2024 | Conference Paper Accept/Revise/Reject Notifications

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Program Ideas – Winter Conference at Orlando

- **Fundamentals and Applications**
  - **Liquid Cooling Design Consideration and Challenges in Data Centers**
  - **Liquid Cooling Water Quality and Filtration Requirement – (in progress)**
  - **Case Study of Recent Life Cycle Assessment in Data Centers (in progress)**
- **HVAC&R Systems and Equipment**
  - **Modular Electrical Room Design in Data Centers**
  - **Thermal Storage Requirement for Liquid Cooled Data Centers**
  - **Single-phase and Two-phase Immersion Design for Ultra High-density Deployment**
- **Artificial Intelligence**
  - **Data Center Design Challenges**
- **Industrialized Construction: opportunities and challenges**
  - **Prefabricated construction in Data Center**

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Seminar & Workshop Chair Responsibility

- 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

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

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

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Conference Speaker or Session Chair Benefits

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

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Next Step

- **If you need to co-sponsorship from other TCs or other help to submit a program.**
- **If you need to help facilitate preparing the program**

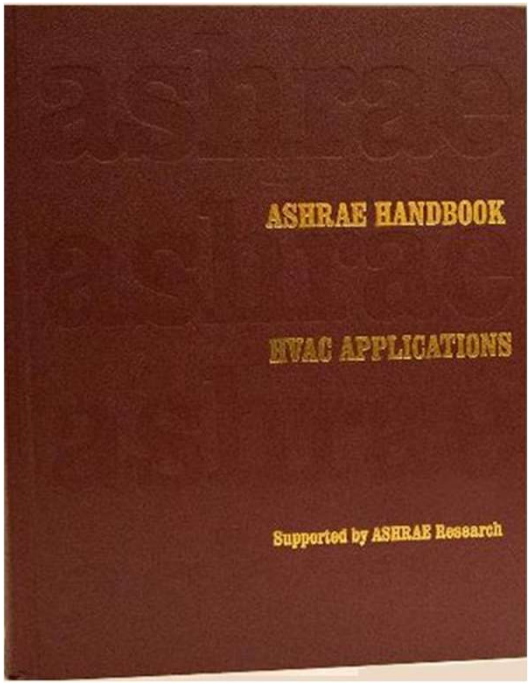
Contact Eric Yang (ericyangcem@gmail.com)

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

ASHRAE Handbook “Applications”

Chapter 20

“Data Centers & Telecommunication Facilities”



Agenda

- Background
- Purpose
- Current Status
- Today's Priorities
- Present Volunteer Status
- Call for Volunteers
- Review Plan
- Next Steps
- QA

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Background

- 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 on a volunteer basis through TC9.9

Purpose of Chapter 20

- 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

Current Status

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

(It Will Come Faster Than You Think!)

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Today's Priorities

- Chapter 20 Topic Cross-Check *(Mandated by ASHRAE)*
  - What is Covered in Other Handbook Volumes or Chapters?
  - If Similar, Who Should Cover?

- Get Primary Reviewers for All Chapter 20 Topics
  - Need to Know Extent of Probably Revisions

Present Volunteers

- 32 People have volunteered
- Some are covering too many topics
  - Schlomo Novotny has 32 !!
  - Ali Heydari has 16
  - Rohit Dhumane has 18
  - Matt Archibald has 13

- Need to spread the load!!
- No one should cover more than 5-8

Who Should Volunteer?

- Industry experts
- New joiners
- Less experienced, More experienced
- Anyone!

- Do not have to be a member of TC9.9
- Do not have to be a member ASHRAE

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Why Volunteer?

- 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*

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

How Can I Help?

Volunteer Roles

- Primary reviewers
  - Subject matter experts
- Secondary reviewers
  - Support to Primary
  - 2nd & 3rd Sets of Eyes
  - Review of 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

Volunteer Commitment

- **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

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

How to Volunteer

1. Sign-Up on the Topic Spreadsheet in-person
2. Also Accessible via http://tc0909.ashraetcs.org/ under "*TC 9.9 2024 Summer Meeting Presentations & Information*"
3. Email us directly:
   - Select Review Topics **by Spreadsheet Line Number**
     - rmcfarlane@smwllc.com
     - Jonell.watson@accenture.com
   - Include Name, Company, and Email Address

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Review Plan

1) Sign-up Sheet #1:
   - **Cross-check Ch. 20 content with other Handbook chapters**
     - ASHRAE Wants To Reduce Duplication & Book Sizes
     - Coordinate With Other TC's to Ensure Proper Coverage

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Sample Sign-up Sheet #1: Cross-check Ch. 20 Against Handbooks

Ch20 content listed in chronological order

Section to write in which Handbook, Chapter, and governing TC are relevant

Describe how other Handbook Ch content is related

Include your name and contact to volunteer as a reviewer

APPLICATIONS HANDBOOK CH 20 HANDBOOK COMPARISON SIGN-UP SHEET

	OTHER LOCATIONS			REVIEWS	REVIEWERS	
TOPICS	BOOK	CHAPTER	TC	COMMENTS**	NAME	EMAIL
1. OVERVIEW & DEFINITIONS						
OVERVIEW						
DEFINITIONS						
2. DATACOM EQUIPMENT, POWER TRENDS, AND ENVIRONMENTAL GUIDELINES						
2.1 DATACOM EQUIPMENT WORKLOAD						
Load Characterization						
2.2 DATACOM EQUIPMENT RACKS						
2.3 DATACOM EQUIPMENT (HARDWARE)						
Server Classifications						
Datacom Equipment Airflow						
Liquid-Cooled Datacom Equipment						
Contamination						
Environmental Guidelines for Air-Cooled Equipment						
Controlling Temp. & Moisture in Datacom Environment for High Reliability						
Environmental Guidelines for Liquid-Cooled Equipment						
Datacom Equipment Nameplate Ratings and Manufacturers' Heat Release						
Power Trends						

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Review Plan

1) Sign-up Sheet #2:
   - **Need Primary Reviewers for Each Topic**
   - Each Topic in Each Chapter Section Has Been Listed
     - Topics Already Covered Have Been Greyed-out
     - Includes Figures, Tables, References, Definitions, and Bibliography
   - **Goal #1: Identify Extent of Probable Revisions**

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Sample Sign-up Sheet #2: Review Existing Ch.20 Content

Ch20 content listed in chronological order

Suggestions for updates to the content (if any)

Include your name and contact to volunteer as a primary (SME) or secondary (support) reviewer

APPLICATIONS HANDBOOK CH 20 CONTENT REVIEW SIGN-UP SHEET

ITEM NO.	TOPICS	v2027 Comments	VOLUNTEER REVISORS	
			PRIMARY	SECONDARY
1	**1. OVERVIEW & DEFINITIONS**			
2	**OVERVIEW**	Review		
3	**DEFINITIONS**	Review		
4	**2. DATACOM EQUIPMENT, POWER TRENDS, AND ENVIRONMENTAL GUIDELINES**			
5	**2.1 DATACOM EQUIPMENT WORKLOAD**	Review		
6	Load Characterization	Review		
7	**2.2 DATACOM EQUIPMENT RACKS**	Review: Change title to Racks & Cabinets?		
8	**2.3 DATACOM EQUIPMENT (HARDWARE)**	Review Intro		
9	Server Classifications	Update?		
10	Datacom Equipment Airflow	Add discussion wrt TOR Switch Extensions? (reverse installation of TOR switch for airflow configuration)		
11	Liquid-Cooled Datacom Equipment	Review		

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

NEXT STEPS

- You will get access to ASHRAE “Authoring Portal”
  - Requires Submitting Names & Emails and Confirming Access
  - 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”

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Who Are These Volunteers

- erkyanscem@gmail.com
- Michael@entropic.ie
- baron@greencomm-
- alkeshsolanki@icloud.com

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ADDITIONAL QUESTIONS?

- Please advise Bob McFarlane or Jonell Watson
  - rmcfarlane@smwllc.com
  - Jonell.watson@accenture.com

- QUESTIONS?

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

TC 9.9 Research Projects

Planned and Proposed

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

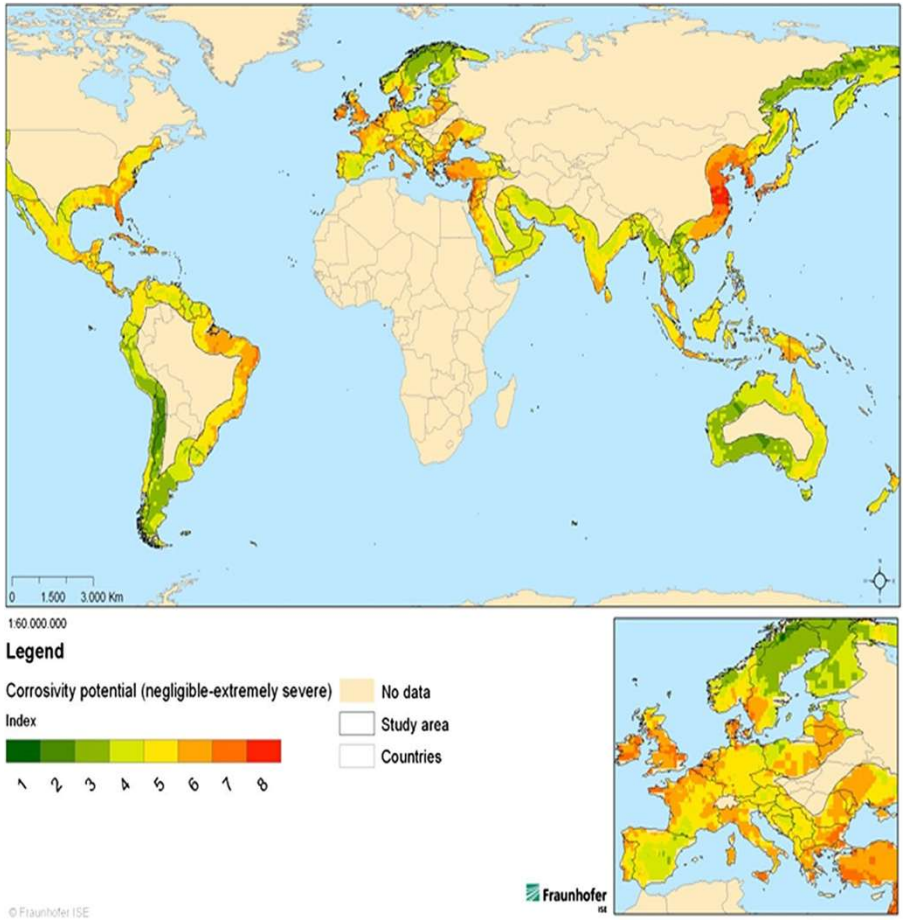
1913 - Study of the Corrosion Impact on Information Technology Equipment in Data Centers Located in Coastal Regions with High Sea Salt Concentration

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

1913-WS Motivation

- 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 Status

- WS-1913 was conditionally approved subject to updates / clarification of the work statement at the winter meeting of RAC
- Updates were made and submitted to the section 9 research liaison
- Research liaison believes that WS-1913 is ready for bid and will confirm at RAC meeting

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

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 SO_2. 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.

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

1913-WS Project Monitoring Sub- Committee

- 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

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

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

RTAR-1972/1972-WS Update

- RTAR-1972 Data Center Direct-to-Chip Liquid Cooling Resiliency – Failure Modes and IT Throttling Impacts
- RTAR-1972 Status/ Timeline (written and vetted in Q4 2023, Q1 2024)
- TC9.9 Vote 12-0-0 Yes-12 No-0 Not Returned-0 (Main Sponsor)
- TC4.10 Indoor Air Modeling Yes-9 No-0 Not Returned-2 (Co-sponsor)
- TC7.6 Building Energy Performance Yes-8 No-0 Not Returned-0 (Co-sponsor)
- March 15, 2024 RTAR Submitted to MORTS (RAC)
- May 13, 2024 RTAR Accepted for further development into Work Statement, positive feedback provided

RTAR-1972/1972-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)

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

1972-WS

- Proposed Work Statement (WS) Timeline
  - Now to June 28: Continue review at author/ TC research subcommittee level
  - July 1 -3: Updates to WS
  - July 5 – 19: Review by TC9.9 RAC Research Liaison
  - July 22 – 25: Further Updates to WS
  - July 26 - Aug 9: Review & votes by TC9.9, TC4.10, TC7.6
  - Aug 10 – 14: Minor changes as needed to accommodate TC's
  - Aug 15: Submit to MORTS (RAC)
- Entirety of timeline: Solicit corporate co-sponsorship

Corporate co-sponsorship

Estimate cost of this research is $300,000 (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)

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

1972-WS Proposed Project Evaluation Sub-Committee (PES) & PMS

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

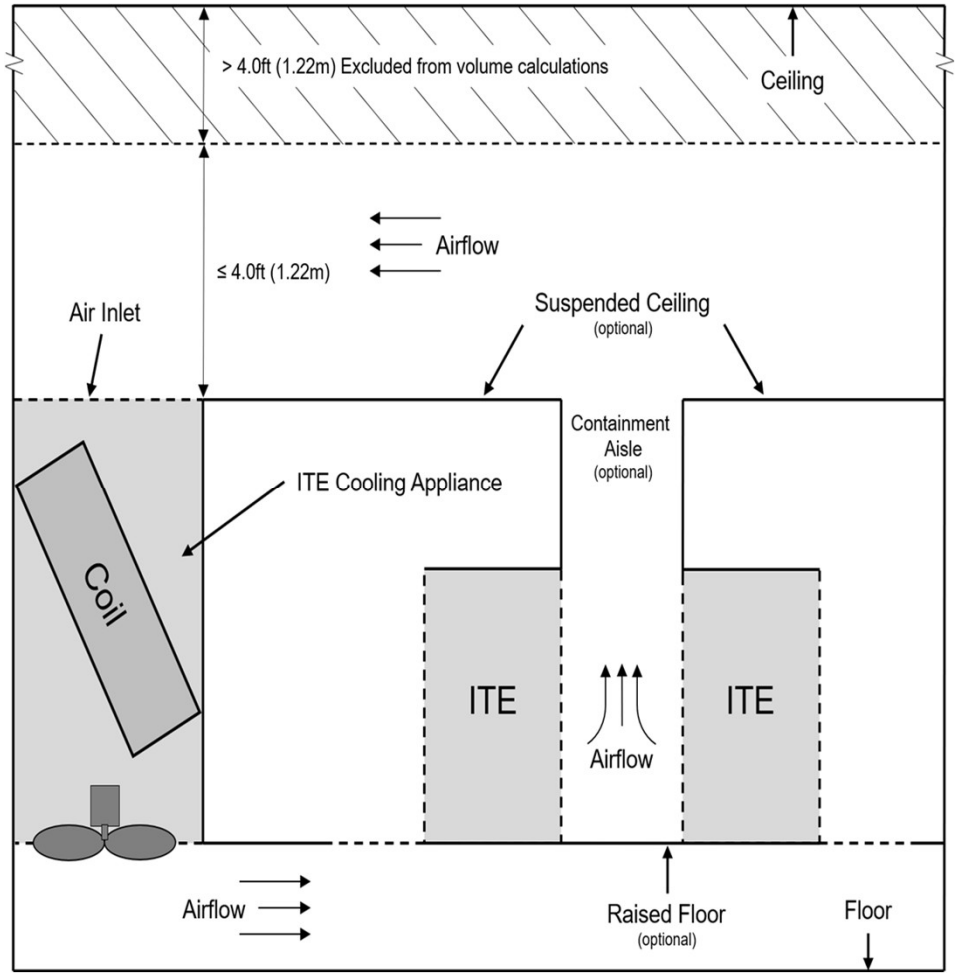
Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Volume Calculations for ITE Cooling Appliances Using ATLs

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Volume Calculations for ITE Cooling Appliances Using ATLs

- 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 inUL/CSA 60335-2-40 4th edition further limits refrigerant capacity



Objectives

- 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 in 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.

Proposed RTAR / WS Authors

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

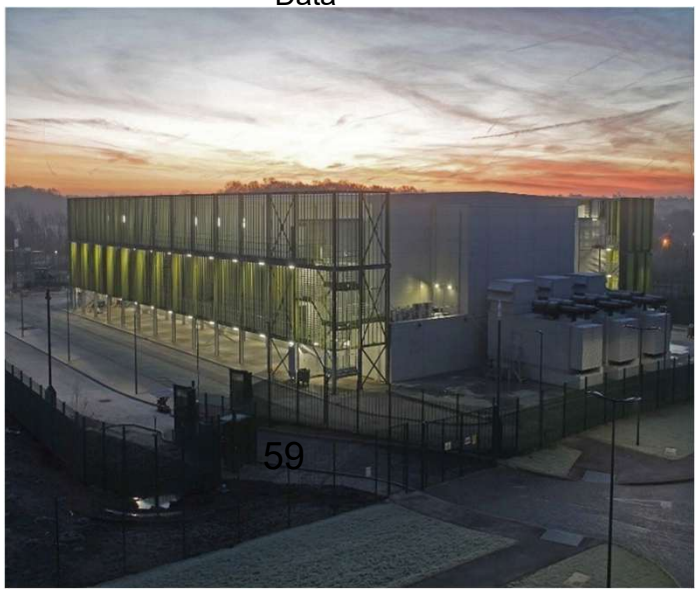
Guidelines for Data Center External Airflow CFD Modeling

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

The Site

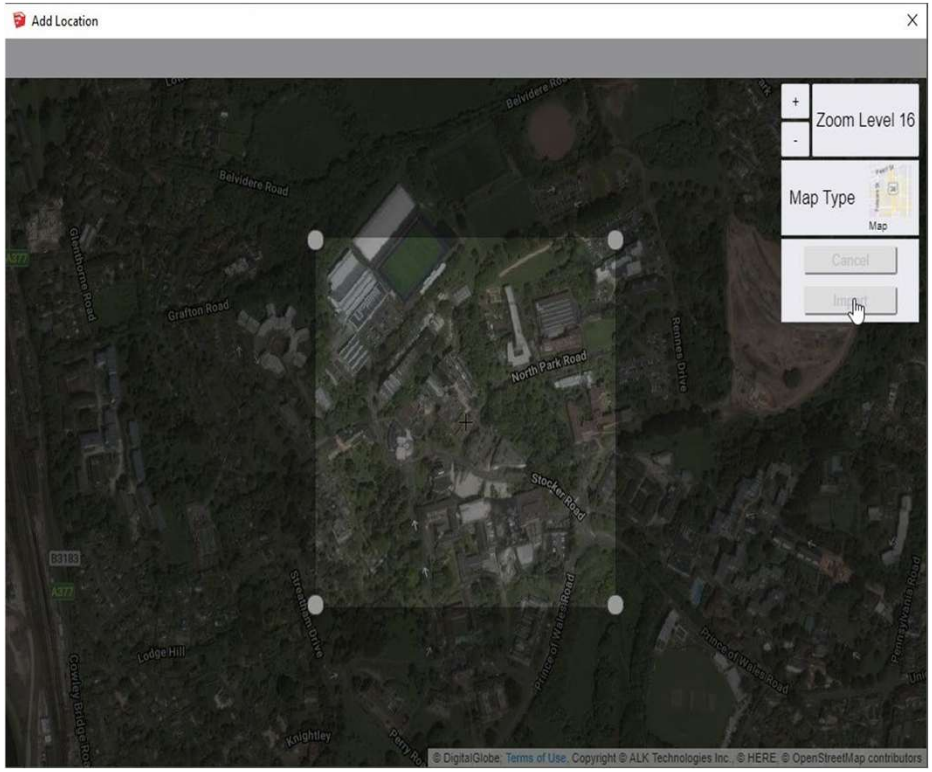
- Data Center Installations are complex and often built near existing facilities
- CFD study is important to help ensure the necessary resilience can be provide with systems that minimise environmental impact
- Al allowing for:
  - The ambient conditions
  - The surrounding environment
  - The cooling strategy
  - ITE power density

Images and data courtesy Kao Data



What Are The Challenges? - Terrain

- Digital mapping tools now can provide a 3-D representation of the terrain

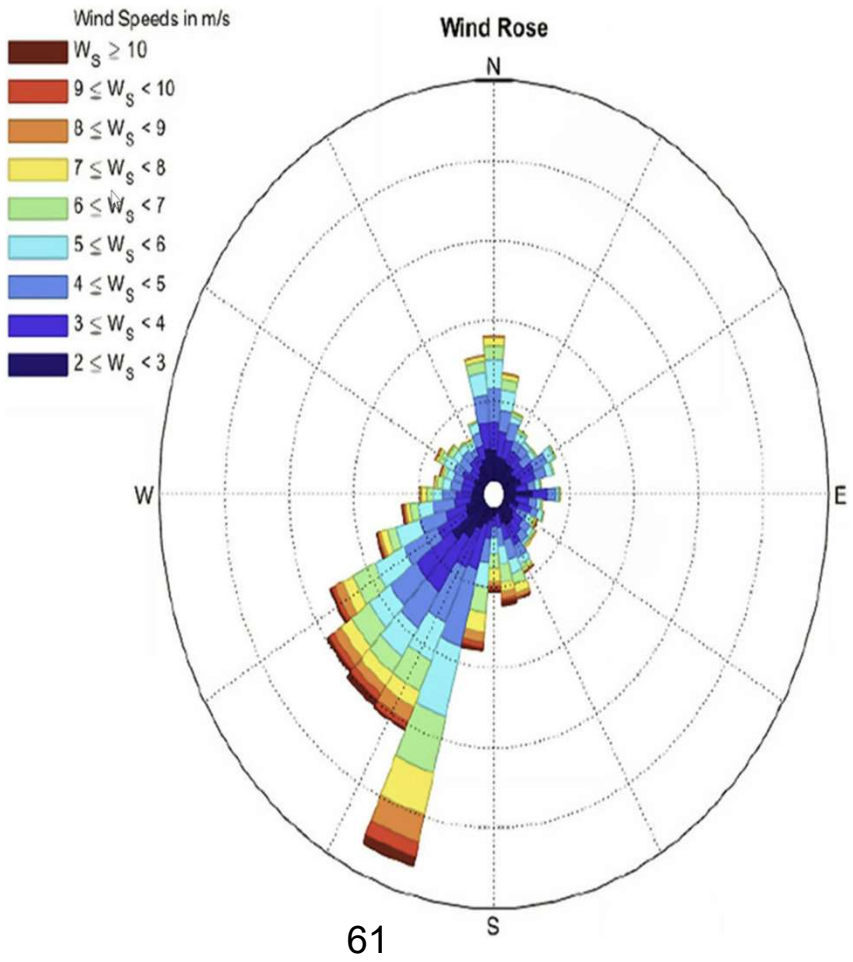


- This can be loaded into some CFD tools to create a good representation of the local vicinity
- Objects such as buildings may need to be replaced by simulation objects with appropriate behaviour

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

What Are The Challenges? – Variable External Environment

- What is the external environment?
  - Almost infinitely variable
  - Range of wind speed
  - All directions
- No simulation can be definitive as it is just a snapshot of one possible condition
- Must chose a variety of conditions to identify whether there are risks
- Use simulation to assess approaches to mitigate risks



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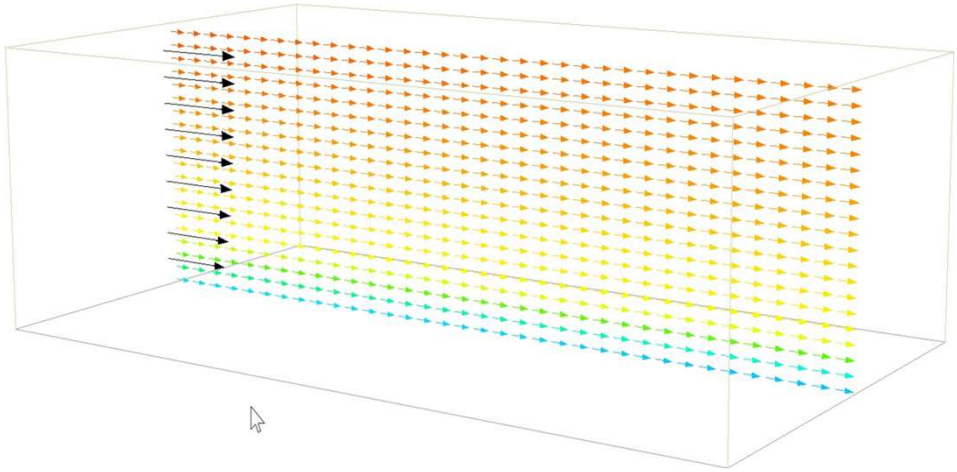
What Are The Challenges? – Variable External Environment

- Wind is normally represented by:
  - Speed at a reference height (typically 10m)
  - Wind direction
  - Terrain typical roughness height
- Solar
  - Be careful when including solar gain in steady state simulations to avoid excessive surface temperature
  - Consider setting appropriate ground temperatures.



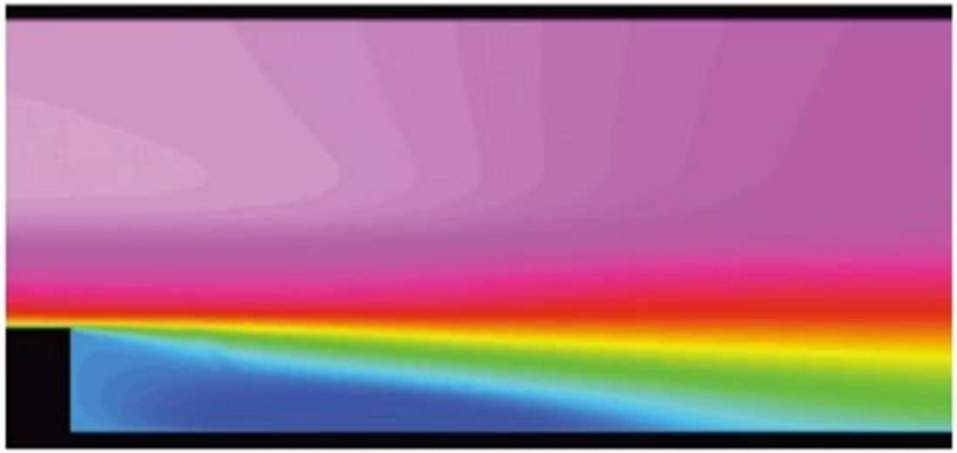
- Profile of incoming wind matches boundary
- No need to provide excessive space for boundary layer to develop upwind

What Are The Challenges?

- Turbulence

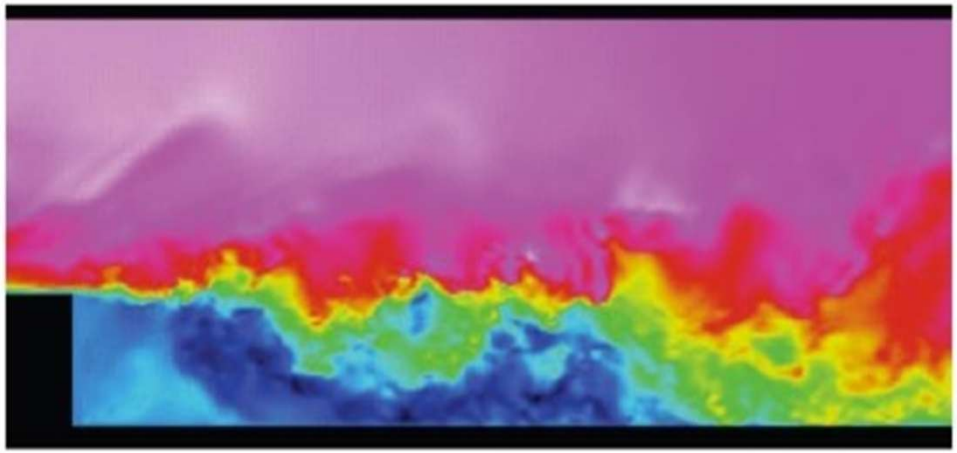
- The most common turbulence models calculate the impact of turbulence to predict time averaged mixing that results
- Atmospheric turbulence has large eddies that are transient in nature
- Modeling such transient behaviour is generally considered computationally prohibitive
- This must be considered during results interpretation
- RANS modeling is more than sufficient for thermal calculations because of the thermal inertia of the cooling systems…

Time Averaged - RANS



Source: Rémy Fransen, 3rd INCA colloquium, ONERA, Toulouse (2011)

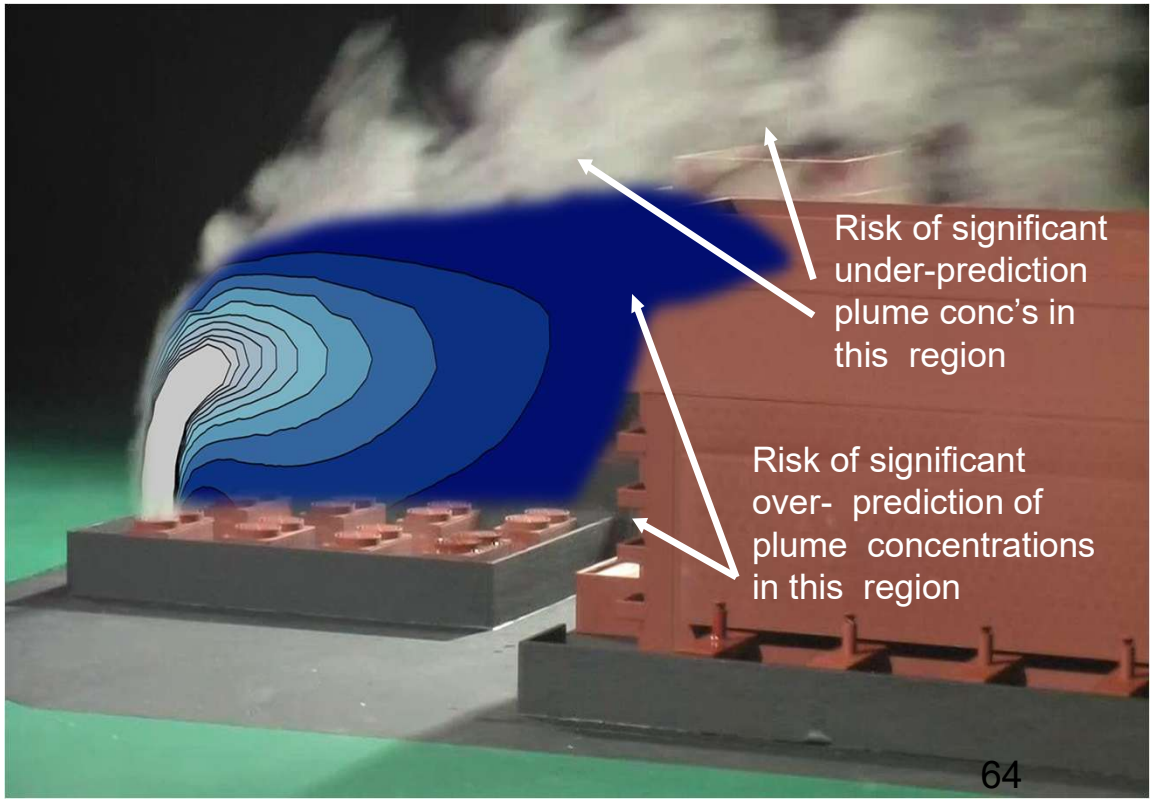
Large Scale Transitory - LES



Source: Rémy Fransen, 3rd INCA colloquium, ONERA, Toulouse (2011)

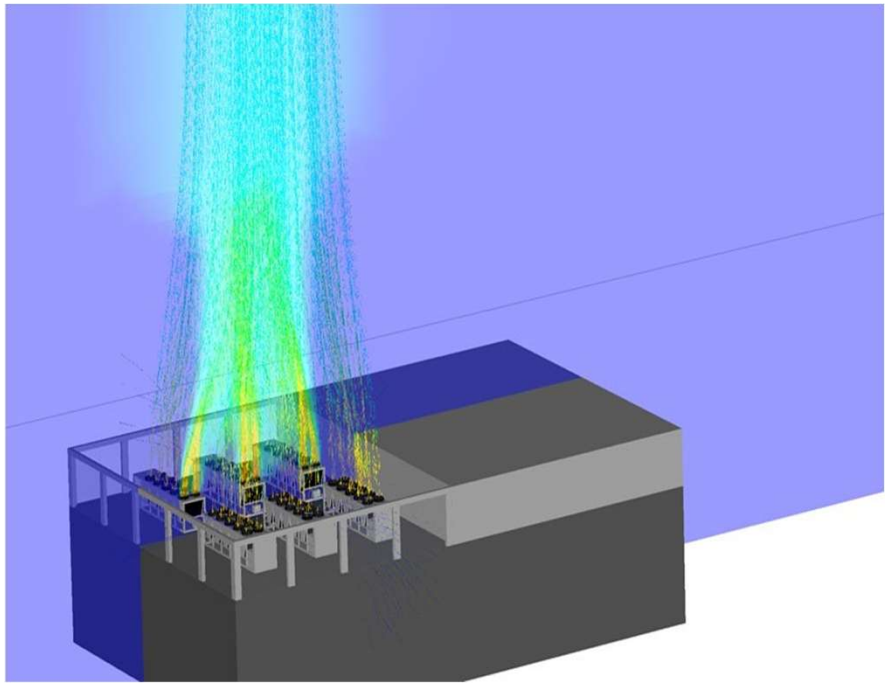
External Flow

- Common application of CFD for data centers
- Modeling quality and interpretation variable



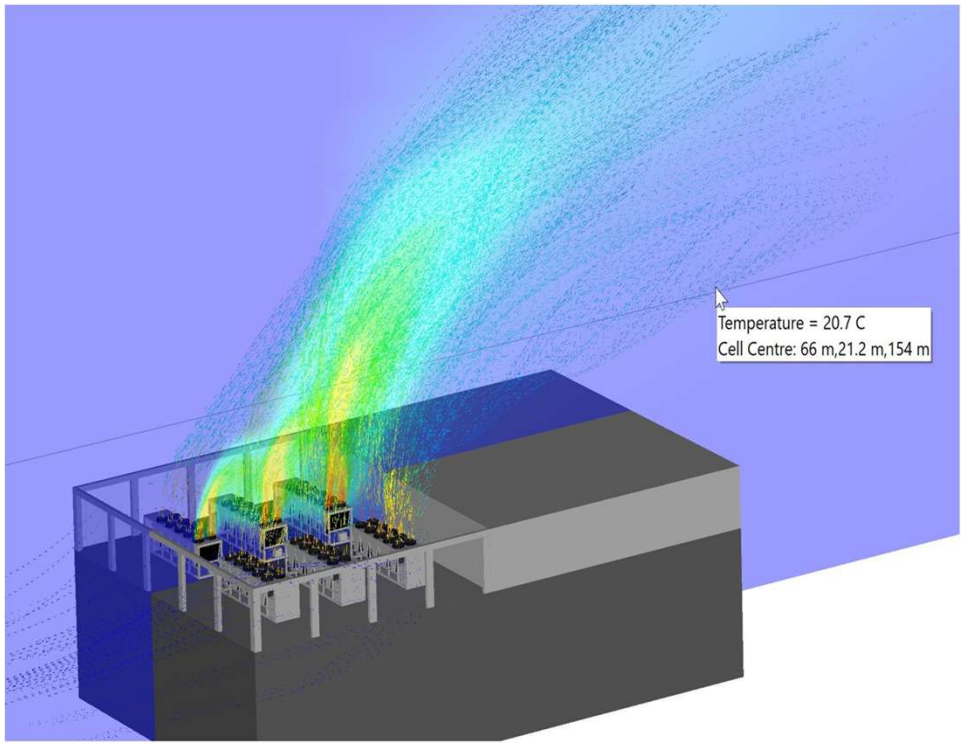
Modelling Detail - No Wind – Vertical Discharge

- Ambient:
- 20.0°C(68.0°F)
- Mean Temperature in: 20.2°C(68.4°F)
- Max temperature in:
  24.2°C (75.6°F)



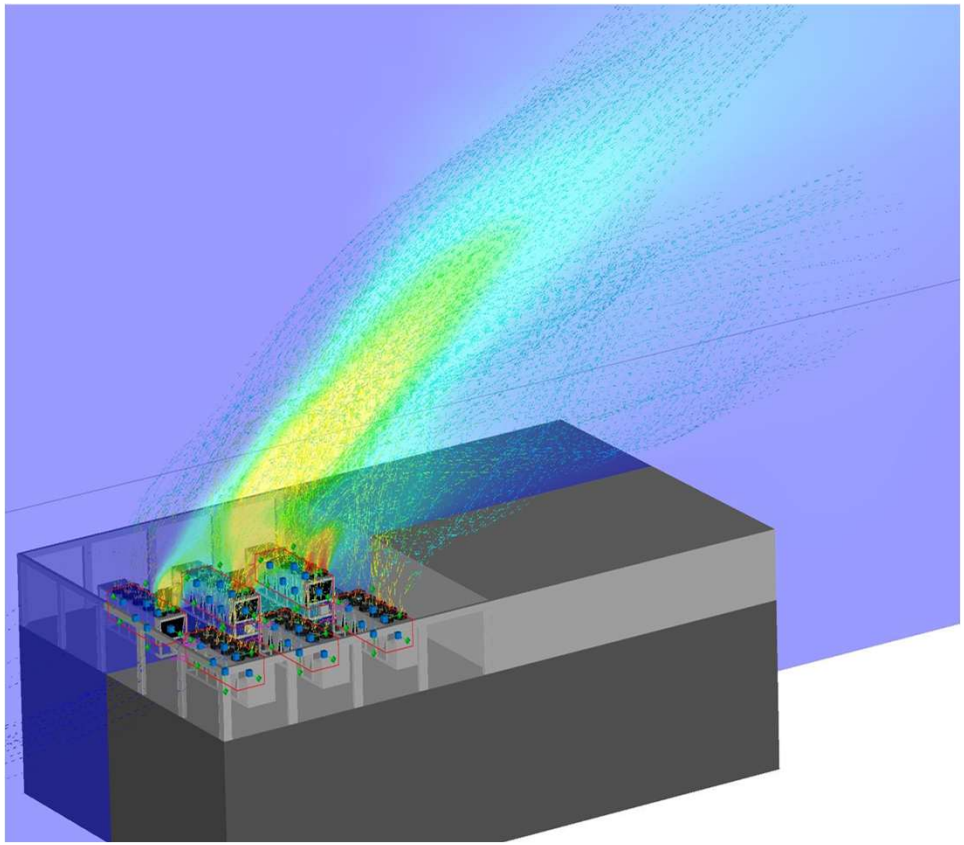
Modelling - Wind – Vertical Discharge

- Ambient:
- 20.0°C(68.0°F)
- Mean Temperature in: 20.8°C(69.4°F)
- Max temperature in:
  26.9°C (78.8°F)



Modelling Detail - Wind – Swirling Discharge

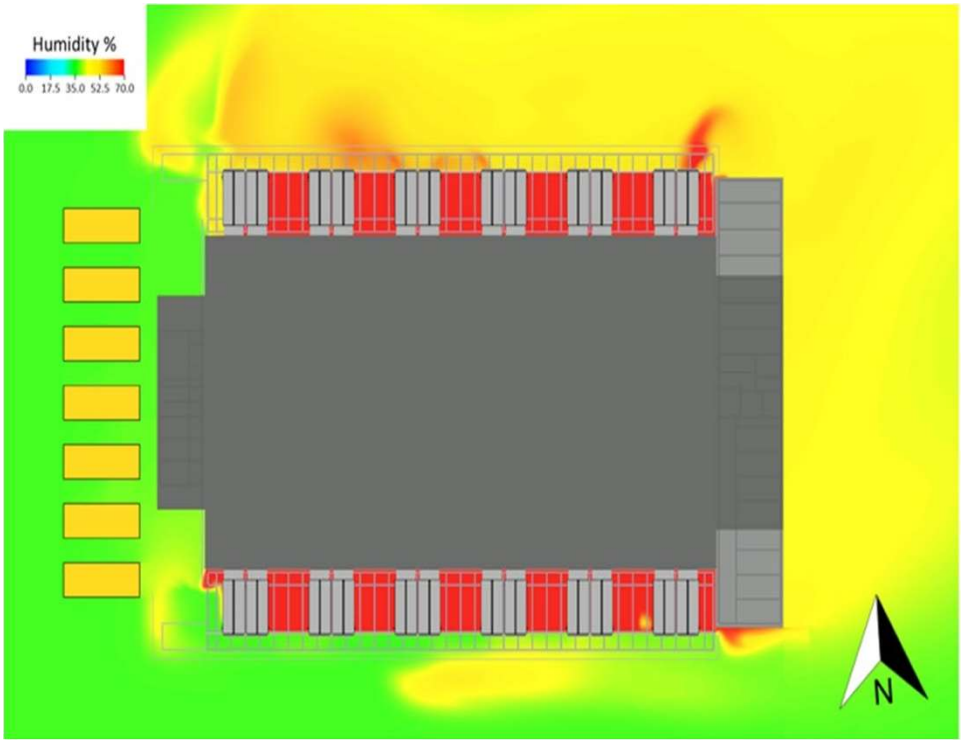
- Ambient:
- 20.0°C(68.0°F)
- Mean Temperature in: 21.4°C(70.5°F)
- Max temperature in: 29.9°C (85.8°F)

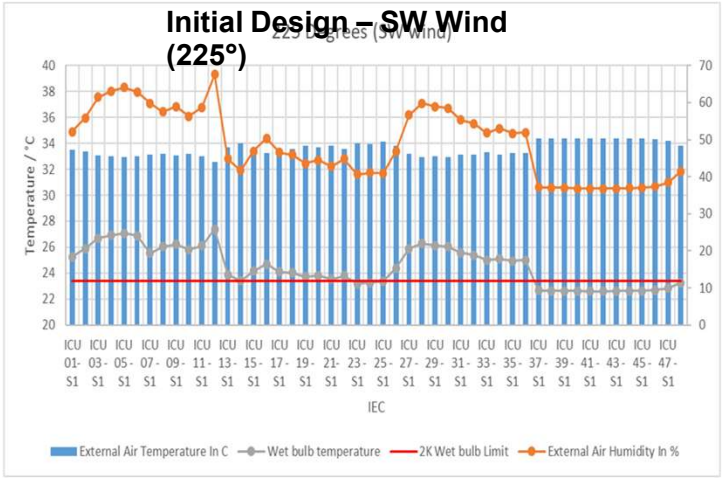


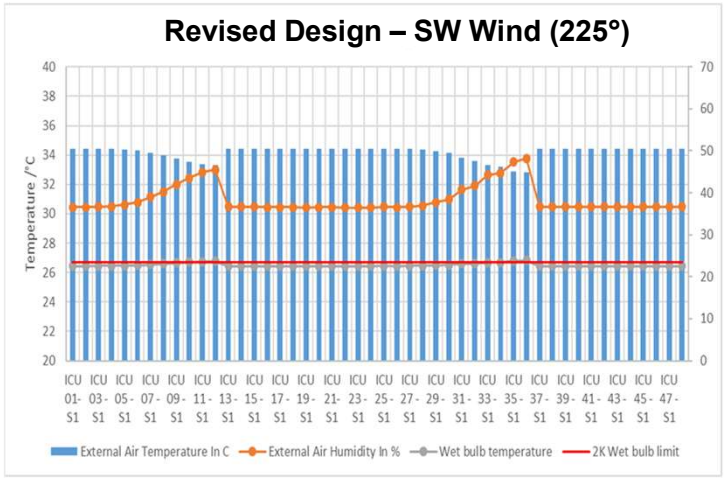
- In close proximity, the combination of factors affect chiller performance potentially derating them
- Simulation enables risk mitigation strategies to be developed

It's Not Just Temperature – Modeling Humidity

- At full load – in prevailing wind direction
- External ambient intake humidity raised, particularly for IECs on north elevation
  - Wet bulb temperature approx. 4°F (7.2°F) above design specification
- Simulations enabled designer to confidently develop an improved final design in order to meet design expectations







External Environment Modeling - Conclusions

- Modeling external environment is critical for modern data centers

- It is important toto:
  - Import and model terrain
  - Account for surrounding buildings…
  - Consider multiple wind directions and speeds
  - Predict impact on temperature and humidity

- Turbulence modelling must be considered when interpreting results
  - This is particularly so when considering contamination - Specific concentrations are normally not an outcome
  - A time averaged model should not be used to predict transient maxima created by transitory large- scale turbulence
  - A time averaged model is likely to be sufficient for thermal modeling

- Independent guidance is required

1956-WS Compact CFD Modeling Guidance for Thin Flow Resistances

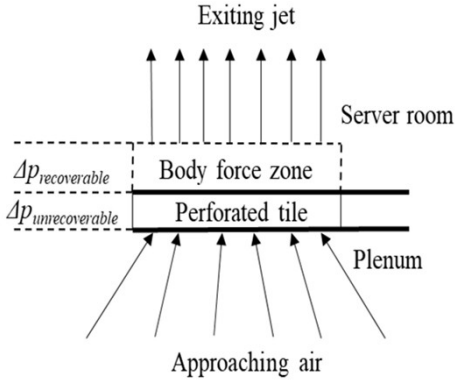
Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

TC 4.10 CFD Modeling Guidance For Flow Resistance

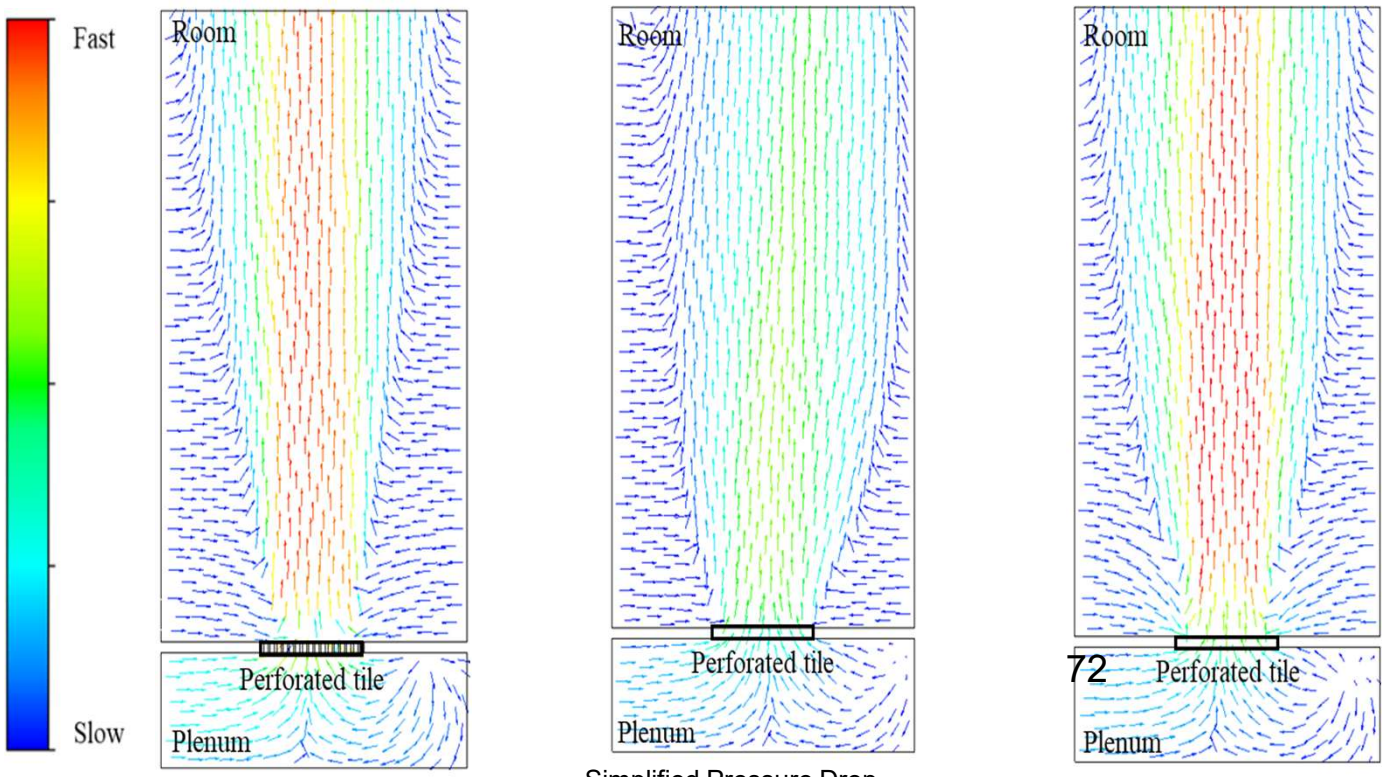
- Resistances are common
  - Tiles, perf doors, louvres…
  - Previous research incomplete
  - Implementation varied
- Thickness of resistance often small c.f. domain size
- Compact model required – thin resistance used but can fail to capture:
  - Correct advected momentum – cross velocity
  - Consistent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

CFD Modeling Guidance For Flow Resistance

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



Courtesy Hu, B RP-1675



Explicit Geometry Model

Simplified Pressure Drop Model

Well-designed Compact Model

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Objectives

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.

Contacts - CFD Modeling Guidance For Flow

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

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Flow Velocity Limits for Erosion Control

Flow Velocity Limits for Erosion Control

- ASHRAE Handbook
  - Does call out a 1.5 m/s as a velocity limit to keep pumping power minimized.
  - Does call out a 3.0 m/s limit on erosion with normal operation of 6,000 hr/yr. This is originally 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 consideration 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 the table appears to confirm that, but this is more pointing towards pumping power. However, it does not clearly state that.
- ASHRAE TC9.9 Liquid Cooling guidelines – Online encyclopedia
  - FWS section does have the callout for 1.2 m/s for energy consideration 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 corrosion
  - Some industry hose suppliers have references that call out 6.1 m/s
  - Should we consider an RTAR to provide a recommendation?

- Mark Steinke – msteinke@nvidia.com

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).

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

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Other Discussions

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Other Discussion at IT Sub-Committee

- Monday June 24, 2024 9:00 am – 11:10 am EDT
- Location: JW Marriott, 303 (3)
- Web Meeting: Microsoft Teams
- Meeting ID: 237 453 767 572 Passcode: 9NMpXL

Topic	Presenter
Liquid cooling resiliency research	Dave Quirk
Liquid cooling resiliency testing	Ali Heydari
Liquid cooling server thermal template	Dustin Demetriou
Expanding S-classes	Paul Artman
Wetted materials research	Tim Shedd
Erosion research project	Mark Steinke
External CFD modeling research	Mark Seymour
Sea salt corrosion research	Roger Schmidt
EU ecodesign regulation update	Paul Finch
Heterogeneous computing	Madhu Iyengar

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Publications Committee Update

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Program Topics Working Session

- Break into groups of 3-4 people
- Write down 1-2 ideas for Program Topics
  - **Spend 10 minutes discussing in groups**
- Convene to note Program topics from groups
- Topics will be noted for further follow-up

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Other Research Ideas

- Other ideas?

90.4 Liaison Report

Marcus Hassen

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Thank You

TC 9.9 Website:
tc0909.ashraetcs.org

Attendance: https://forms.gle/tD3sKPS83kAZpgwAA

Attendance

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

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

https://forms.gle/tD3sKPS83kAZpgwAA

Or use the QR Code below: