



1791 Tullie Circle, N.E./Atlanta, GA 30329
404-636-8400

DRAFT

TC/TG/MTG/TRG MINUTES COVER SHEET

(Minutes of all Meetings are to be distributed to all persons listed below within 60 days following the meeting.)

TC/TG/MTG/TRG No. TC 9.9 DATE June 14, 2021

TC/TG/MTG/TRG TITLE Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment

DATE OF MEETING June 14, 2021 LOCATION Virtual

Note: These aft minutes have not been approved and not the official, approved record until approved by the TC.

MEMBERS PRESENT	MEMBERS ABSENT	EX-OFFICIO MEMBERS AND ADDITIONAL ATTENDANCE
VOTING MEMBERS	Lex Coors	Andy Soon
Gerardo Alfonso	Terry L Rodgers	Kris Crosby
John H Bean, Jr	Vali Sorell	Tim Persons
Donald L Beaty	Dave Meadows	Ramesh Navaratnam
Dustin Demetriou	John M Gross, III	
Ecton English	David F Kelley	
Matt Koukl		
David L Moss		
John Groenewold		
Roger R Schmidt		
CORRESPONDING MEMBERS		
Jim VanGilder	Raymond Abraham	
Mark Seymour	Antonio Aguayo	
Benjamin Petschke	Robert Akkerman	
Jason Matteson	Stuart Aldridge	
Steve Greenberg	Sajad Alimohammadi	
Shlomo Novotny	Husam Alissa	
Paul Finch	Mohammad Alkiswani	
Ahmed Abdel Salam	Shawn Andrews	
Christopher Muller	Serpil Ari	

Casey Winkel	Paul Artman	
Henry Amistadi	Jakki Artus	
Thomas Davidson	Sean Ashburn	
Ameya Soparkar	George Augustini	
Sang Lee	Robert Bader	
Nick Gangemi	William Bahnfleth	
Robert McFarlane	Andrew Baxter	
Gaurav Soni	William Beck	
Devdatta Kulkarni	Chad Beery	
Mark Steinke	Adenilson Belizario	
Matthew Archibald	Paul Bemis	
Robert Tozer	Satyam Bendapudi	
Alexandre Kontoyanis	James Benville	
Robert Hewitt	James Betts	
	Rakesh Bhatia	
	Erich Binder	
	Michael Bishop	
	Byron Blackmore	
	Alonzo Blalock	
	James Bogart	
	Holly Brink	
	Rolf Brink	
	Douglas Brown	
	Jerrod Buterbaugh	
	Wim Buters	
	Aldo Calvi	
	Nicholas Casale	
	Noe Casalino	
	John Castelvechi	
	Neil Chauhan	
	David Chialastri	
	Vijayakumar Chithambaram	
	Dale Cibene	
	Alan Claassen	
	Fabio Clavijo	
	Brad Cochran	
	Benjamin Coe	
	Michael Collarin	
	Dan Comperchio	
	Howard Cooper	
	Florin Corcoz	
	Bryce Cox	
	James Coyle	
	Bryan Coyne	
	Craig Crader	
	Greg Crumpton	
	Bob Culver	
	Christopher Daniel	
	Steve David	
	George Degroft	

	Dustin Demetriou	
	Charuchandra Dewasthale	
	Cuong Dinh	
	Bob Doherty	
	Benedict Dolcich	
	Daniel Donahoe	
	DAVID DONGES	
	Robert Druga	
	Aaron Duda	
	John Dumler	
	Dan Dyer	
	Jacqueline Eaton	
	David Edenburn	
	Michael Edie	
	Dennis Eisenbarth	
	Frank Erceg	
	Hamza Erden	
	Maxwell Evans	
	Huang Feng	
	Mark Fisher	
	Jon Fitch	
	Adam Fleming	
	Sophia Flucker	
	Clayton Foster	
	Kamran Fouladi	
	David Franczak	
	Michael Frank	
	Terry Frantzis	
	Charles Freda	
	F French	
	Paul Galloway	
	Hongwen Gao	
	Kevin Gebke	
	Rajat Ghosh	
	John Gideon	
	Arthur Giesler	
	Robin Gilbert	
	Kenneth Gill	
	Troy Goldschmidt	
	Nigel Gore	
	Scott Graf	
	David Grant	
	Shaun Green	
	Charles Gulledege	
	Dinesh Gupta	
	Edward Gutowski	
	Kamel Haddad	
	Stephen Halsted	
	Xu Han	
	John Haney	

	Andrew Harrison	
	Kyle Hasenkox	
	Michael Hathorne	
	Scot Heath	
	Mohamed Hegazy	
	Dennis Hellmer	
	Magnus Herrlin	
	Mathias Hery	
	Ali Heydari	
	Ted Hight	
	Elly Hiu	
	Chris Hsieh	
	Hugh Hudson	
	Kevin Hughes	
	Steven Hyde	
	Ming-Ren I	
	J C Ierschot	
	Hifumi Iguchi	
	Gwenn Ivester	
	Madhusudan Iyengar	
	Charles Johnson	
	Rhonda Johnson	
	Gary Johnson, Jr	
	Roger Jones	
	Alex Juncker	
	Alekhya Kaianathbhatta	
	George Kaler	
	Rajendera Kapoor	
	Md Masud Karim	
	Kailash Karki	
	Kanchan Kelkar	
	Daniel Kennedy	
	Gordon Keogh	
	Michael Kester	
	Rehan Khalid	
	Kishor Khankari	
	Richard Killian	
	William Kingrey	
	Marvin Kirshenbaum	
	Timothy Kittila	
	Erhard Klotz	
	Paul Knight	
	Srinivas Kodea	
	Michael Koerner	
	Jayavant Kumar	
	Pardeep Kumar	
	Sushil Kumar	
	Yuichi Kurihashi	
	Christopher Kurkjian	
	Osmo Kuusisto	

	Yiu Wa Kwan	
	Stephen Lahti	
	Colin Laisure-Pool	
	Yuk Kuen Lam	
	David Landsberg	
	Federico Lang	
	Elizabeth Langer	
	John Lanni	
	Jon Larry	
	Geoff Lawler	
	Matt Lawrence	
	Christian Le	
	Allan Lee	
	Bret Lehman	
	Frank Lembo	
	Guillermo Leon Orellana	
	Hsing-Sheng Liang	
	Mike Licitra	
	Nemat Lotfi	
	Francis Allen Lumabas	
	William Mak	
	Mark Malkin	
	William Maltz	
	Alessandro Mandelli	
	Noreshvarman Manisagar	
	Eugene Maritz	
	Lawrence Markel	
	Ted Marwitz	
	Caroline Mason	
	Carl Massey	
	Guillermo Massucco	
	James McAleer	
	Timothy McCann	
	Christopher McDermott	
	Jaakko McEvoy	
	Michael McKenna	
	Douglas McLellan	
	Michael McRee	
	Godwyn Mendes	
	Michael Miller	
	Francis Mills	
	DONALD Mitchell	
	Richie Mittal	
	Michael Monahan	
	Mark Monroe	
	Chad Moore	
	John Murgida	
	Ram Narayanamurthy	
	Philip Naughton	
	Pooya Navid	

	C.D Nayak	
	Ian Nelson	
	David Nesheiwat	
	John Neubauer	
	Salah Nezar	
	Michael Nicolai	
	Zuokui Ning	
	Budy Notohardjono	
	John O'Brien	
	Mark Ogilvie	
	Michael Ohadi	
	Sean OHern	
	Lawrence Ollice	
	Shelley Ophir	
	Leslye Paniagua	
	Balakrishnan P Panicker	
	Farid Parsaei	
	Chandrakant Patel	
	Mark Pavol	
	Andrew Pearson	
	Tim Persoons	
	Craig Petersen	
	John Peterson	
	FLORIN POPA	
	Mani Prakash	
	Justin Prosser	
	Suhasini Pyarasani	
	David Quirk	
	Prakash Rapolu	
	David Redford	
	Stuart Redshaw	
	Charles Rego	
	William Reynolds	
	Steven Rosenstock	
	Joel Rutledge	
	Jeffrey Rutt	
	Hitoshi Sakamoto	
	Anders Saksager	
	Carine Saliba	
	Nestor Salinas	
	Michael Salvatore	
	Angela Sampaio	
	Michael Schwarz	
	Michael Schwedler	
	Clifford Scofield	
	Justin Seter	
	Darshit Shah	
	Jimil Shah	
	Anthony Sharp	
	Timothy Shedd	

	Mohit Shrivastava	
	Saurabh Shrivastava	
	Matt Shumway	
	Ruben Sidranski	
	Thursten Simonsen	
	Mark Simpson	
	Thomas Sin	
	Satwinder Singh	
	Annelise Smith	
	Grant Smith	
	Stuart Smith	
	John Song	
	Marc Soucy	
	Ronald Spangler	
	Jonathan Spreeman	
	Mark Sprenger	
	Jeffrey Stein	
	Robin Steinbrecher	
	Morgan Stevens	
	Charles Stewart	
	Michael Streich	
	Robert Sullivan	
	Kaiyu Sun	
	David Sundin	
	Jacob Svenkeson	
	Micah Sweeney	
	Inn Tang	
	SOON TATT	
	Edwin Teoh	
	Russell Tipton	
	David Tootle	
	Sengul Topuz	
	Chad Tramonte	
	Jeff Trower	
	William Tschudi	
	Edward Tsui	
	Saahil Tumber	
	William Ung	
	Marianna Vallejo	
	James Vallort	
	Richard Velten	
	Herb Villa	
	David Vranish	
	Darrin Watson	
	Jonell Watson	
	Ralph Webb	
	Aaron Wemhoff	
	Andrew Wengerd	
	Kurt Wetzal	
	Malcolm White	

	Katherine Whitenack	
	Robert Wichert	
	Christopher Wilson	
	Stephen Woollard	
	Stephen Wren	
	Lixia Wu	
	Eric Yang	
	Yang Zou	
	Wangda Zuo	
PROVISIONAL CORRESPONDING MEMBERS		
Mark R Mannex	Mina Abiedallah	
David McGlocklin	Sama Aghniaey	
Cibi Chakravarthy N	Rafael Aharoni	
Robert Curtis	Hassan Ali Younes	
Kyle Bergeron	Ramanathan Arumugasamy	
Norman Bourassa	Adenilson Belizario	
Ken Beach	Matthew Brazil	
Timothy Startt	Dustin Bremner	
Tozer Bandorawalla	Glenn Brenneke	
Michael Strouboulis	Cillian Brown	
ERIC TUNKS	Julia Call	
Jian Wen Chan	Chris Campbell	
	Byron Coetser	
	Kevin Connor	
	Anthony Cosenze	
	Brian Courtright	
	Biswajit De	
	Shivraj Dhaka	
	Terry Fletcher	
	Yangyang Fu	
	PIETRO FUMAGALLI	
	Leo Gabrek	
	Michael Geraghty	
	Michael Geraghty	
	Michael Gibbons	
	Mike Gilkerson	
	Kenneth Goodman	
	Rohit Gupta	
	Michael Hallstrom	
	John Han	
	Ariel Iantosca	
	Dennis Julian	
	Ali Akber Kazmi	
	Sadegh Khalili	
	Peter Koneck-Wilwerding	
	Steve Krupka	

	Cheng-Xian Lin	
	Bernie Malouin	
	Kapil Mehrotra	
	Giuliano Molon	
	Lucas Moreira	
	Kamal Mostafavi	
	Ramesh Navaratnam	
	Bjorn Oberg	
	Melissa Olson	
	RYAN REIMER	
	Oscar Rueda	
	Francisco Sanchez	
	Jeremy Smith	
	Antonio Tan III	
	Russell Taylor	
	Sharon Thomas	
	Greg Towsley	
	Alfred Uzokwe	
	Bruno Winge	
	David Yancosky	
	Philip Yu	
	Samual Zastrow	
	Jon Zubiaurre	

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Published Agenda

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

Call to Order: 6/14/21 10:00 AM EST Dustin Demetriou

- Procedural Items for Virtual Meeting
 - Zoom meeting overview
 - Use of meeting attendance form.
 - A few additional questions to capture info about members.
- Introductions and Welcome
 - Dustin Demetriou Current Chair, John Groenewold- Vice Chair
 - Agenda for Sunday and Monday meetings is posted on TC 9.9 website.
 - Overview of Meeting Agenda
- Programs –Nick Gangemi
 - Reviewed ASHRAE Virtual Summer Conference June 28-30 2021.
 - Reviewed the various conference tracks.
 - Live Sessions
 - Tuesday June 29 1:00AM - 8:30AM
 - Energy Management Best Practices, Case Studies and Lessons Learned from Real-World Data Center.
 - Wednesday June 30, 3:00PM – 4:00PM
 - Air Quality and Handling in Mission Critical Facilities
 - Pre-recorded Sessions
 - Seminar 39 Demand for Variable Speed Equipment in Data Centers
 - Seminar 65 Sound and Vibration Issues with Mission Critical Facilities
 - Seminar 71: The continuing Evolution of the ASHRAE Data Center Environmental Guidelines.
 - Upcoming 2022 Winter Conference
 - Las Vegas, NV| Jan. 29- Feb 3., 2022

- Review of tracks
 - Track 1: HVAC & R Systems and Equipment
 - Track 2: Fundamentals of Applications
 - Track 3: Refrigerants and Refrigeration
 - Track 4: Buildings at 360°
 - Track 5: Energy System Integration
 - Track 6: Environmental Health and IEQ in the International Arena
 - Track 7: HVAC for Industrial and Commercial Purposes- Challenges and Opportunities
 - Track 8: Refrigerants, Safety, Performances
- No Mission Critical Track
 - Likely Track 1,2,3 would be most applicable to Mission Critical and TC 9.9
- 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
- TC members are encouraged to work through Nick when working on ASHRAE presentation activities to help with acceptance success rate.
- Contact Nick Gangemi, Program Chair | 585-721-8795 | nick.gangemi@bureauveritas.com
- Comments:
 - Bob McFarlane- How do you Chair a session: When you start filling out the paperwork there's a line to place your name in the section.
 - Dustin D. – have there been any discussions about hybrid approach to the conference

- ASHRAE is still reviewing how to handle a hybrid approach while trying to balance Expo and Venue financial requirements.
- Handbook Revision Update – Bob McFarlane
 - Next update is upon us.
 - Chapters are written by TCs
 - TC 9.9 is included in the Applications Handbook
 - We are in chapter 20, in 2019 it was moved from 19 to 20
 - 2023 “Applications” Handbook
 - Revision due Date: June 2022 Summer Meeting
 - Approved at HQ,
 - Revision need to be complete by March 1, 2022
 - Revisions have been proposed
 - (3) reviewers have provided comments.
 - Dustin Demetriou
 - Geraldo Alfonso
 - Benjamin Petschke
 - Need additional reviewers to provide a review of the chapter and offer updates.
 - If any other updates are requested, comments/ revisions need to be made immediately.
 - Update Status
 - Revisions Made Via ASHRAE “Authoring Portal”
 - Contributors must be registered
 - Can work Simultaneously; need to save to have comments seen by others
 - All work must use “Track Changes’
 - New or Revised illustrations are submitted separately
 - Written Permissions are Mandatory!!
 - Please send suggested changes to Handbook to Bob McFarlane
 - rmcfarlane@smwllc.com
 - Requesting Assistance in Reviewing suggestions
 - Subject matter experts on specific suggestions
 - Two Board Members to Expedite Board Approval
 - Asking Don Beaty for “Relevance” Review.
 - A” Sign-Up” will be Created
 - Subject Matter Experts
 - CRACs & CRAHs
 - PUE Economizers
 - BICSI

- TGG
 - CFD
 - DataCOM Books
 - Gaseous Contamination
 - Liquid Cooling
- Please send requests to Bob McFarlane
 - Edit Permission
 - Subject Matter Reviews
 - rmcfarlane@smcwllc.com
- Comments
 - Dustin D- Create a google form to have people sign-up for supporting the area of interest to review.
 - John Gross- Will help Review as a voting member.
- **Research Subcommittee – Mark Seymour**
 - Agenda
 - General ASHRAE Research Situation
 - 1675-RP: Guidance for Computational Fluid Dynamic (CFD) Modeling of Data Centers.
 - Sea Salt Filtration RTAR and WS
 - Wetted Materials Research
 - Open Discussion on Research Topics.
 - General ASHRAE Research Situation
 - Less revenue and funding for research.
 - Only 3 projects got approved during the last review. Not that many projects have been submitted.
 - (1) project has been submitted, (2) are proposals at this time.
 - General TC 9 has not meet yet and will be discussed Feb. 9-11.
 - **1675-RP: Guidance for CFD Modeling of Data Centers.**
 - Reviewed principal investigators performing work.
 - Cheng-Xian (Charlie) Lin and Beichao Hu- Florida International University
 - Yogendra Joshi and Dhaval Patel- Georgia Institute of technology.
 - Project Objectives
 - Develop a general CFD modeling guidance for data center applications.
 - Experimental and CFD work.
 - A Data center with key features: CRAH, hot/cold aisle, perforated tile.

- Status of the Project
 - Experimental work:
 - Testing data collected for all tasks
 - CFD work:
 - Numerical simulations completed
 - Project Management
 - -multiple
 - Final Report
- Project Timeline
 - Close in September 2021
- Technical Progress update
 - Overview of progress
 - Working on sensitivity analysis.
 - Blower Model studies, Floor Stanchion model studies, Perforated tile studies, rack model studies, gaps studies.
 - Blower Model studies
 - The Blower Velocity angle has a measurable impact on the tile flowrate distribution.
 - Likely in smaller data centers there's less impact of blower velocity.
 - Stanchion Model Studies
 - The impact of the stanchion model is not significant in the small data center tested in this project.
 - Perforated Tile Model
 - Modeled in Fluent and is a widely used general purpose tool.
 - Needed to create a floor tile model to accommodate a general purpose CFD tool.
 - Evaluated the volume of actual free area of the tile and found a slight different than the manufacturer noted free area.
 - Rack Model Studies
 - 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

- Racks were very well sealed to minimize any rack leakage to simplify the modeling.
 - Gap Studies.
 - 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.
 - Modeled using a Raised Access Floor, as there's more modeling characteristics that impact the airflow dynamics.
 - In progress of writing the report
 - Finalizing calculations
 - Deadline is September 2021.
 - Comments
 - Norm Bourassa- do we have details on the diffuser type and form Factor.
 - The model was using 10 Tate GrateAire. These were donated for this testing. And had high flow rates.
 - Bob McFarlane- Will any of this research translate to in-row or non-raised floor designs?
 - Yes. Fans racks, servers, similar items will be transferable to non-raised floor data centers.
 - Bob McFarlane- will you explain body force height.
 - Momentum of air coming from jets to suck in air. (Inches above the tile)
 - Henry Amistadi – Do you see these results turning in to minimum guidelines for CFD vendors?
 - Most of the CFD vendors are already for leveraging these results in their systems.
- **ASHRAE Sea Salt RTAR and WS – Roger Schmidt.**
 - Work Statement
 - Study of the Corrosion Impact on Information Technology Equipment in Data Center 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.

- No investigation on the corrosion in marine environments of materials used in constructing IT equipment, principally copper, silver, and PCB's (printed circuit boards).
- Research goal is to provide guidance for the required 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 December 15th, 2020.
 - 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
- Significant amounts of studies on Sodium Chloride 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.
- Work statement was rejected by ASHRAE with the following areas for suggested improvements
 - Split into 2 projects- filtration, corrosion
 - Focus only on corrosion
 - Follow sea salt established testing standards
 - Reviewing various testing standards and associated technical papers
 - Improve on design of testing apparatus
 - Modifying design to include synergistic effects of SO₂
 - SO₂ is a major catalyst to corrosion
 - Provide more data on the need of this research
 - Gathering data from data centers in marine environments
 - Expand on the testing conditions to mimic server environments
 - Enhancing writeup to better describe environment.
- Comments:
 - Mark Seymour- research Liaison wasn't very interested on the filtration and pushed toward corrosion. Liaison provided feedback that filtration is a known condition but there might be

actually more that should be studied.

- Bob McFarlane- on 4th bullet point.
 - There are proposals for the data center at sea. How about the implications of the sea.
 - Mark Seymour- What are the manufacturers doing to confirm if their equipment works at in these types of environments. RAC is expecting the research to be novel and the possible of joint funding strategies for this research.
- Geraldo Alfonso- are the maps going to be concentrated on just the US.
 - Any marine environment will be studied.
 - Send Roger a note about the marine environments in Columbia.

- **Singapore TDC Collaboration- Roger Schmidt, Mark Seymour, Jon Fitch, Chris Muller**

- Tropical Data Centre 2.0 (TDC2) Draft Proposal (To be funded by NRF Singapore)
 - Topic came to TC 9.9 at end of 2020 to collaborate on TDC2.
 - Funded by NTU and IMDA
 - Had several meetings with individuals.
 - Possible opportunity to collaborate on the Sea Salt RTAR.
 - Possible to share some initial research that was performed.
 - Performed work on corrosion and also fan and server airflow in hot humid environment.
- **Objective of TDC 2.0**
 - Develop operation regions for enhancing energy efficiency and having a high reliability.
 - Address the key technical challenges and concerns of deployment in commercial data centers
 - Develop industry guidelines/standards for TDC implementation
 - Catalyst commercial offering of TDC
- **Research Tasks**
 - Task 1: Quantify energy savings
 - Measurements of cooling energy, IT Energy
 - Task 2: Determine “Sweet-spot” temperature/humidity setpoints
 - Power profile of a representative IT equipment mix

- under different temperatures and humidity levels
 - Methods to determine the optimal setpoints for a given mix of IT equipment
 - Task 3: determine long-term impact on IT equipment reliability operating at higher-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 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
 - Partitioned space of 400sqft in a data hall
 - 10 42U racks w/ 8kW peak power /rack
 - Cold Aisle Containment
 - Subject to 99.95% reliability under SLA
 - Dedicated DX air conditions
 - Measuring cooling power usage
 - Controlling temperature from 24C to 32C and higher for short periods of time
 - Controlling relative humidity from 45% to 65% and other levels for short periods of time.
 - 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

- Revid chart detailing roles and responsibilities for the various groups participating in this research.
 - Team IMDA
 - Team NTU
 - Team TC 9.9, ASHRAE
- Just a few meetings.
- TC 9.9 team are working on the collaboration.
- Mark-Seymour- goal for the group is to look at expanding the thermal guidelines to expand the operating envelope to have a higher viability from a commercial environment.
- Sholomo- various groups are looking at pushing the environmental conditions further than what's listed in the ASHRAE thermal guidelines.
 - People should evaluate the tradeoffs to understand the boundary conditions for that specific organization.

- **Proposed Research (RTAR) on Wetted Materials – Mark Steinke**

- Background
 - Liquid cooling Guidelines book contains a listing of wetted materials for the Facility Water Supply (FWS) and Technology Cooling System (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 manufacturers.
 - Just an acknowledgement that the list is growing.
 - More liquid cooled solutions coming to the market
 - Heavily debated topic of the white paper.
 - Every ITE manufacturer should be investigating.
 - Every customer should be asking about wetted materials.
- Purpose
 - Every ITE manufacturer should be performing own studies and results are typically proprietary to that company.
 - Begin work on an 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.

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

- Comments
 - Mark R. Mannex- Does the scope of this effort include fluid combustibility (e.g., hydrocarbon based oils used in immersion systems)?
 - Generally, No, this is more focused on corrosion. Good topic
 - Jason Matteson – what type of learnings do we have with the FWS loop. Need to explore the idea of bringing the FWS loop directly to the servers. Is the wetted material list the same for TCS loop vs. micro channel loops.

- **Closing Comments**
 - Next Meeting June 15, 2021 10 - 3PM EDT
 - Reviewed topics and agenda for upcoming meeting
 - Requested Attendance be completed in the google form survey.
 - Slides will be made available on the [TC 9.9 website](#)

11:42 PM EDT Meeting Concluded

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Steve Greenberg	Sajad Alimohammadi	
Shlomo Novotny	Husam Alissa	
Paul Finch	Mohammad Alkiswani	
Ahmed Abdel Salam	Shawn Andrews	
Christopher Muller	Serpil Ari	
Casey Winkel	Paul Artman	
Henry Amistadi	Jakki Artus	
Thomas Davidson	Sean Ashburn	
Ameya Soparkar	George Augustini	
Sang Lee	Robert Bader	
Nick Gangemi	William Bahnfleth	
Robert McFarlane	Andrew Baxter	
Gaurav Soni	William Beck	
Benedict Dolcich	Chad Beery	
Mark Steinke	Adenilson Belizario	

Matthew Archibald	Paul Bemis	
Eric Yang	Satyam Bendapudi	
Jon Fitch	James Benville	
Mark Pavol	James Betts	
Nigel Gore	Rakesh Bhatia	
David Grant	Erich Binder	
Aaron Wemhoff	Michael Bishop	
Rick Pavlak	Byron Blackmore	
Micah Sweeney	Alonzo Blalock	
Robert Tozer	James Bogart	
Robert Hewitt	Holly Brink	
Jonell Watson	Rolf Brink	
	Douglas Brown	
	Jerrod Buterbaugh	
	Wim Buters	
	Aldo Calvi	
	Nicholas Casale	
	Noe Casalino	
	John Castelvechi	
	Neil Chauhan	
	David Chialastri	
	Vijayakumar Chithambaram	
	Dale Cibene	
	Alan Claassen	
	Fabio Clavijo	
	Brad Cochran	
	Benjamin Coe	
	Michael Collarin	
	Dan Comperchio	
	Howard Cooper	
	Florin Corcoz	
	Bryce Cox	
	James Coyle	
	Bryan Coyne	
	Craig Crader	
	Greg Crumpton	
	Bob Culver	
	Christopher Daniel	
	Steve David	
	George Degroft	
	Dustin Demetriou	
	Charuchandra Dewasthale	
	Cuong Dinh	
	Bob Doherty	
	Daniel Donahoe	
	DAVID DONGES	
	Robert Druga	
	Aaron Duda	
	John Dumler	
	Dan Dyer	

	Jacqueline Eaton	
	David Edenburn	
	Michael Edie	
	Dennis Eisenbarth	
	Frank Erceg	
	Hamza Erden	
	Maxwell Evans	
	Huang Feng	
	Mark Fisher	
	Adam Fleming	
	Sophia Flucker	
	Clayton Foster	
	Kamran Fouladi	
	David Franczak	
	Michael Frank	
	Terry Frantzis	
	Charles Freda	
	F French	
	Paul Galloway	
	Hongwen Gao	
	Kevin Gebke	
	Rajat Ghosh	
	John Gideon	
	Arthur Giesler	
	Robin Gilbert	
	Kenneth Gill	
	Troy Goldschmidt	
	Scott Graf	
	Shaun Green	
	Charles Gulledege	
	Dinesh Gupta	
	Edward Gutowski	
	Kamel Haddad	
	Stephen Halsted	
	Xu Han	
	John Haney	
	Andrew Harrison	
	Kyle Hasenkox	
	Michael Hathorne	
	Scot Heath	
	Mohamed Hegazy	
	Dennis Hellmer	
	Magnus Herrlin	
	Mathias Hery	
	Ali Heydari	
	Ted Hight	
	Elly Hiu	
	Chris Hsieh	
	Hugh Hudson	
	Kevin Hughes	

	Steven Hyde	
	Ming-Ren I	
	J C Ierschot	
	Hifumi Iguchi	
	Gwenn Ivester	
	Madhusudan Iyengar	
	Charles Johnson	
	Rhonda Johnson	
	Gary Johnson, Jr	
	Roger Jones	
	Alex Juncker	
	Alekhya Kaianathbhatta	
	George Kaler	
	Rajendera Kapoor	
	Md Masud Karim	
	Kailash Karki	
	Kanchan Kelkar	
	Daniel Kennedy	
	Gordon Keogh	
	Michael Kester	
	Rehan Khalid	
	Kishor Khankari	
	Richard Killian	
	William Kingrey	
	Marvin Kirshenbaum	
	Timothy Kittila	
	Erhard Klotz	
	Paul Knight	
	Srinivas Kodea	
	Michael Koerner	
	Jayavant Kumar	
	Pardeep Kumar	
	Sushil Kumar	
	Yuichi Kurihashi	
	Christopher Kurkjian	
	Osmo Kuusisto	
	Yiu Wa Kwan	
	Stephen Lahti	
	Colin Laisure-Pool	
	Yuk Kuen Lam	
	David Landsberg	
	Federico Lang	
	Elizabeth Langer	
	John Lanni	
	Jon Larry	
	Geoff Lawler	
	Matt Lawrence	
	Christian Le	
	Allan Lee	
	Bret Lehman	

	Frank Lembo	
	Guillermo Leon Orellana	
	Hsing-Sheng Liang	
	Nemat Lotfi	
	Francis Allen Lumabas	
	William Mak	
	Mark Malkin	
	William Maltz	
	Alessandro Mandelli	
	Noreshvarman Manisagar	
	Eugene Maritz	
	Lawrence Markel	
	Ted Marwitz	
	Caroline Mason	
	Carl Massey	
	Guillermo Massucco	
	James McAleer	
	Timothy McCann	
	Christopher McDermott	
	Jaakko McEvoy	
	Michael McKenna	
	Douglas McLellan	
	Michael McRee	
	Godwyn Mendes	
	Michael Miller	
	Francis Mills	
	DONALD Mitchell	
	Richie Mittal	
	Michael Monahan	
	Mark Monroe	
	Chad Moore	
	John Murgida	
	Ram Narayanamurthy	
	Philip Naughton	
	Pooya Navid	
	C.D Nayak	
	Ian Nelson	
	David Nesheiwat	
	John Neubauer	
	Salah Nezar	
	Michael Nicolai	
	Zuokui Ning	
	Budy Notohardjono	
	John O'Brien	
	Mark Ogilvie	
	Michael Ohadi	
	Sean OHern	
	Lawrence Ollice	
	Shelley Ophir	
	Leslye Paniagua	

	Balakrishnan P Panicker	
	Farid Parsaei	
	Chandrakant Patel	
	Andrew Pearson	
	Tim Persoons	
	Craig Petersen	
	John Peterson	
	FLORIN POPA	
	Mani Prakash	
	Justin Prosser	
	Suhasini Pyarasani	
	David Quirk	
	Prakash Rapolu	
	David Redford	
	Stuart Redshaw	
	Charles Rego	
	William Reynolds	
	Steven Rosenstock	
	Joel Rutledge	
	Jeffrey Rutt	
	Hitoshi Sakamoto	
	Anders Saksager	
	Carine Saliba	
	Nestor Salinas	
	Michael Salvatore	
	Angela Sampaio	
	Michael Schwarz	
	Michael Schwedler	
	Clifford Scofield	
	Justin Seter	
	Darshit Shah	
	Jimil Shah	
	Anthony Sharp	
	Timothy Shedd	
	Mohit Shrivastava	
	Saurabh Shrivastava	
	Matt Shumway	
	Ruben Sidranski	
	Thursten Simonsen	
	Mark Simpson	
	Thomas Sin	
	Satwinder Singh	
	Annelise Smith	
	Grant Smith	
	Stuart Smith	
	John Song	
	Marc Soucy	
	Ronald Spangler	
	Jonathan Spreeman	
	Mark Sprenger	

	Jeffrey Stein	
	Robin Steinbrecher	
	Morgan Stevens	
	Charles Stewart	
	Michael Streich	
	Robert Sullivan	
	Kaiyu Sun	
	David Sundin	
	Jacob Svenkeson	
	Inn Tang	
	SOON TATT	
	Edwin Teoh	
	Russell Tipton	
	David Tootle	
	Sengul Topuz	
	Chad Tramonte	
	Jeff Trower	
	William Tschudi	
	Edward Tsui	
	Saahil Tumber	
	William Ung	
	Marianna Vallejo	
	James Vallort	
	Richard Velten	
	Herb Villa	
	David Vranish	
	Darrin Watson	
	Ralph Webb	
	Andrew Wengerd	
	Kurt Wetzell	
	Malcolm White	
	Katherine Whitenack	
	Robert Wichert	
	Christopher Wilson	
	Stephen Woollard	
	Stephen Wren	
	Lixia Wu	
	Yang Zou	
	Wangda Zuo	
	Alexandre Kontoyanis	
	Mark Seymour	
	Devdatta Kulkarni	
PROVISIONAL CORRESPONDING MEMBERS		
Mark R Mannex	Mina Abiedallah	
David McGlocklin	Sama Aghniaey	
Cibi Chakravarthy N	Rafael Aharoni	
Robert Curtis	Hassan Ali Younes	

Kyle Bergeron	Ramanathan Arumugasamy	
Norman Bourassa	Adenilson Belizario	
Ken Beach	Matthew Brazil	
Timothy Startt	Dustin Bremner	
Tozer Bandorawalla	Cillian Brown	
Michael Strouboulis	Julia Call	
ERIC TUNKS	Chris Campbell	
Glenn Brenneke	Byron Coetser	
Ali Akber Kazmi	Kevin Connor	
	Anthony Cosenze	
	Brian Courtright	
	Biswajit De	
	Shivraj Dhaka	
	Terry Fletcher	
	Yangyang Fu	
	PIETRO FUMAGALLI	
	Leo Gabrek	
	Michael Geraghty	
	Michael Geraghty	
	Michael Gibbons	
	Mike Gilkerson	
	Kenneth Goodman	
	Rohit Gupta	
	Michael Hallstrom	
	John Han	
	Ariel Iantosca	
	Dennis Julian	
	Sadegh Khalili	
	Peter Koneck-Wilwerding	
	Steve Krupka	
	Cheng-Xian Lin	
	Bernie Malouin	
	Kapil Mehrotra	
	Giuliano Molon	
	Lucas Moreira	
	Kamal Mostafavi	
	Ramesh Navaratnam	
	Bjorn Oberg	
	Melissa Olson	
	RYAN REIMER	
	Oscar Rueda	
	Francisco Sanchez	
	Jeremy Smith	
	Antonio Tan III	
	Russell Taylor	
	Sharon Thomas	
	Greg Towsley	
	Alfred Uzokwe	
	Bruno Winge	

	David Yancosky	
	Philip Yu	
	Samual Zastrow	
	Jon Zubiaurre	
	Jian Wen Chan	

Published 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
	Publication Statistics	10	Ecton English
Publications	Thermal Guidelines 5 th Edition	15	Roger Schmidt
	Design Considerations 3 rd Edition	10	John Gross
	Emergence & Expansion of Liquid Cooling	10	Dave Moss
	Liquid Cooling Datacom Book	15	Roger Schmidt
IT Subcommittee	Liquid Cooling Pressure Testing	10	Roger Schmidt
	IEC Connector Harmonization	10	Roger Schmidt

Total Time 4 hours 15 minutes

Call to Order: 06/15/21 10:03 AM EST Dustin Demetriou

1. Introductions
 - a. Reviewed registering for meeting attendance

- b. Reviewed ASHRAE code of Ethics
- c. Overview of Meeting Agenda
- d. Noted ASHRAE TC 9.9 website
 - i. Noted that presentation will be uploaded to website.
- e. 9 Voting Members in attendance and quorum met.
- f. What is TC 9.9
 - i. Reviewed TC 9.9 Title, Purpose, and Scope
 - ii. Reviewed participants and roster. TC 9.9 is the largest and most active TC with over 400 members.
 - iii. Reviewed the Contributions of ASHRAE TC 9.9
 - iv. Reviewed the timeline of ASHRAE TC 9.9 publications.
 - 1. Typically, white papers result in a Datacom Book
 - v. Overview provided of TC 9.9 Datacom Book Series
 - 1. Most current Book, Book 14 DCIM.
 - a. Books are available in the Bookstore/ Library.
 - vi. New whitepapers and updates to the Thermal Guidelines 5th Edition
 - vii. ASHRAE Handbook Updates Chapter 20 ongoing and anticipated in 2022 update.
 - viii. Reviewed TC 9.9 current work Activities.
 - 1. Activities Listed on TC 9.9 website
 - 2. Datacom book series
 - 3. Research activities
 - 4. White Papers/Technical Briefs
 - ix. Noted LinkedIn page.
 - <https://www.linkedin.com/company/18665978>
- g. Officers and Membership.
 - i. This will be Dustin's Last meeting at Chair on June 20, 2021
 - ii. New membership will run through July 1, 2021 June 30, 2022
 - iii. Reviewed Roster and Chairs.
 - iv. Reviewed New Officers (as of Jul 1, 2022)

Position	Name
Chair	John Groenewold
Vice Chair	Matt Koukl
Secretary	Mark Steinke
Program Subcommittee Chair	Nick Gangemi
IT Subcommittee Chair	Roger Schmidt
Handbook Subcommittee Chair	Robert McFarlane
Standards Subcommittee Chair	Richard Pavlak
Membership Subcommittee Chair	Jack Glass

Research Subcommittee Chair	Mark Seymour
Webmaster	Ecton English
Marketing Subcommittee Chair	Paul Finch

v. TC 9.9 Liaisons

1. Standard 90.1: Rick Pavlak
2. Standard 90.4: Dave Kelley
3. Standard 127: John Bean
4. Standard 300, Guideline 1.6: Terry Rodgers
5. International: Don Beaty
6. MTG.CYB: Ecton English

vi. Voting Members

1. 15 are full voting members.
2. Consists of an average of 12, minimum of 6 and a maximum of 18.
3. Currently 15 voting members
 - a. Gerardo Alfonso
 - b. John Bean
 - c. Don Beaty
 - d. Lex Coors
 - e. David Kelley
 - f. Ecton English
 - g. John Groenewald
 - h. John Gross
 - i. Matt Koukl
 - j. David Meadows
 - k. David Moss
 - l. Joe Prisco
 - m. Terry Rodgers
 - n. Roger Schmidt
 - o. Vali Sorell
4. July 1, 2021

vii. Voting Members Rolling off in 2021

1. Dustin Demetriou- rolling off as chair and voting member.
2. John Groenewald will be the new chair after July 1, 2021
3. Joe Prisco new person as a voting member.

h. 2021 Votes

- i. Reviewed items the Voting members voted on
- ii. All votes were approved by the voting members.

i. Membership Information

- i. 89 Provisional Corresponding Members as of 6/2021

1. 2 years, Chair make decision to move to a Corresponding member
 2. Can participate in activities but can't become a voting member.
 - ii. 348 Corresponding Members as of 6/2021
 1. Can be voting members
 2. Can be nominated/ elected as an officer
 - iii. Make sure that you keep your ASHRAE profile updated! (email is used for committee updates)
 1. Keep profile up-to-date.
 2. Track membership via email bounce
 - iv. Can join TC 9.9 via website.
 - j. Awards
 - i. 2021-2022 Hightower Award Nominations by Wednesday, September 1st.
 - ii. Recognizes technical leadership in the TC.
 - iii. Looks at the activity over 4 years of activity within the TC.
 - iv. Reach out to Dustin for the awards.
 - k. Additional Announcements:
 - i. CEC Standing Request for Future Society Meeting Program Track suggestions. Please reach out to conference committee with new suggestions.
 - ii. Professional Development Committee PDC is seeking ideas for new ASHRAE Learning Institute (ALI) courses.
 1. Reach out with any suggestions.
 - l. Decarbonization Task Force
 - i. Seeking participation in task force and how to decarbonize infrastructure.
 1. Review decarbonization PPIB
 - m. Revised Strategic Plan issued in 2019 and has been extended through 2025.
 - n. Reviewed the need to sign-up to participate in handbook update.
 - i. Use the following link to sign-up to help on handbook [TC 9.9 Handbook Sign Up](#)
2. Program
- a. Reviewed programs for Virtual Annual Conference 6/28- 6/30, 2021
 - i. Conference Paper Presentations
 - ii. On Demand
 - b. 2022 ASHRAE Annual Conference Las Vegas, NV Jan 29- Feb. 3, 2022

- c. There's a bit of push and pull between Virtual and in-person presentations.
 - i. Reach out to Nick regarding presentations and if you want to be in-person vs. virtual.
- d. Reviewed Las Vegas Tracks
 - i. Need to find appropriate track to fit within one of the existing tracks. Look at possible 4,5,6,7 tracks for potential higher acceptance for the tracks.
 - ii. No track dedicated for TC 9.9/ Mission Critical.
- e. Reviewed dates that were presented in the meeting on 6/16/2021 for the Las Vegas program.
- f. Contact Nick Gangemi 585-721-8795 with any questions or comments nick.gangemi@bureauveritas.com
- g. Provide ID of submission to Nick to help lobby to the various track chairs.

3. Webmaster

- a. Reviewed website link.
 - i. <http://tc0909.ashraetcs.org>
- b. Reviewed analytics for the website and anticipate having more data for tracking purposes.
- c. Invites and other documents are stored on the website.
- d. Meeting minutes are provided on the website.
- e. Document section has current white papers and old presentations.

4. Liaison Reports

- a. Standard 90.1 -Rick Pavlak
 - i. Only 1 of 3 90.1 meetings have occurred before the ASHRAE TC 9.9
 - ii. New alternative compliance path- Credit based
 - iii. 90.4 is recognized in 2019 standard.
 - 1. Encourage local jurisdiction to adapt 90.4
 - iv. Addendum P. for piping insulation.
 - 1. Negative comments and is requiring revisions and updates due to commentary on
 - v. Efficiency updates on all systems across the board
 - 1. Addendums on chillers, packaged equipment, data com equipment efficiencies.
 - vi. Track through the ASHRAE website and get into the standard section and get updates through notifications pushed out by the various committees.
 - vii. Comment: 90.1 and 90.2 can be viewed for free on the

ASHRAE website, but not 90.4

- b. 90.4 Liaison Report – Rick Pavlak (Standing in for Dave Kelly)
 - i. Had 1 meeting for this conference and another to follow.
 - ii. Since publication of 90.4 2019 there have been 4 Addendums: A, B,C, D
 - 1. Fairly minor updates to 2019 standard.
 - 2. On the ASHRAE website and can be view for free.
 - iii. Electrical Subcommittee.
 - 1. Working on incoming power calculations for ELC.
 - 2. Evaluating UPS minimum efficiency chart
 - iv. Mechanical subcommittee
 - 1. Working on creating example calculations
 - 2. Examples are going to be published on the website. Hoping to be able to adjust from the code based calculation to an excel based calculator
 - 3. Building envelop compliance may or may not hurt overall energy efficiency. Anticipate using modeling for compliance vs. just doing prescriptive requirements- currently being evaluated.
 - 4. MLC calculation when rear door heat exchangers are used on racks/ cabinets.
 - a. Looking at passive vs. active rear door heat exchangers. Book 13 covers some specific items.
 - b. Addendum will be coming out for how this might impact MLC calculations.
- c. SSPC 127- John Bean
 - i. SPC 127 was published in 2020 and is closed out based upon the publication.
 - ii. Roster has been submitted and tentatively approved by ASHRAE.
 - iii. Would like to have people that are Users and or General Interest to apply to be on the committee. Please consider joining if you are not a producer
 - iv. Becomes active and live in July, 2021
 - v. There are several comments from the public review period and need to be addressed as part of an addendum.
 - vi. Existing method of test has method of test to perform calculation of rear door heat exchangers equipment without fans.
 - vii. Addendums can be created to new equipment being rated.

- viii. Comments from Jake Rede- What are, or where are, the definitions of 'User' or 'General Interest'? User= end user, general interest could be a consulting engineer or Commissioning agent. If the company isn't a manufacturer of equipment can be on the either general interest or user.
 - d. AHRI 1360 Liaison Report- Dave McGlocklin
 - i. 1360 members have completed the revisions.
 - ii. Standard is out for review and is out for review by AHRI standards department and then will group working group and expected to have the review complete in the next few months.
 - iii. Monthly meetings occur to be reviewing the net COP metric and including in the next issuance.
 - iv. Looking to be more agile with addendums.
 - v. Looking for new people to join the committee.
 - e. SSPC 300, guideline 1.6 – Terry Rodgers
 - i. Ongoing work between EEHPC and TC 9.9 on Commissioning of HPC facilities.
 - ii. Reach out to Terry regarding interest.
 - f. MTG.CYB – Ecton English
 - i. Multidisciplinary Task Group.
 - ii. Spin off from TC 1.5 cybersecurity sub-committee.
 - iii. ASHRAE has approved bi-monthly in the ASHRAE journal on cybersecurity. Has dedicated section
 - 1. Min of 800 word count with maximum word count of 2,000.
 - 2. Reach out to the MTG members or Ecton directly.
 - 3. Looking to get a years' worth of articles before this starts.
 - 4.
5. Datacenter Dynamics – Dustin Demetriou
- a. Jon Fitch - Working on getting out the message regarding new publications and other articles getting published.
 - b. DCD has been publishing various virtual broadcasts.
 - c. Working on getting ASHRAE speaking engagements with DCD.
 - i. Have had various presentations in 2020 and 2021
 - 1. Keeping IT Cool, Virginia, Building the Edge, Keeping IT Cool
 - ii. Events are free.
 - iii.
 - d. Questions:

- 6. Open Compute Project Update – Nigel Gore
 - a. What is Open Compute Project (OCP)
 - i. Industry non-profit focuses on establishing an open source HW ecosystem for the Data Center market. (brick and mortar and prefabricated data centers)
 - ii. Founded in 2011 by Facebook, Rackspace, Intel- now 200+ members and growing.
 - iii. Broad range of summits, global summit in NAM, 4000+ attendees. November 2021.
 - b. Open Compute Project - Structure
 - i. Reviewed the various groups
 - ii. Advanced Cooling Facilities
 - iii. Advanced Cooling Solutions.
 - 1. Enable global adoption of liquid cooling for data center equipment.
 - c. Immersion Sub-Project Overview
 - i. Led by 3M and Shell
 - ii. Community based program to facilitate the progression of immersion cooling
 - iii. Harmonization efforts across other ACS & ACF workstreams
 - iv. Current Active projects:
 - 1. Material & liquid compatibility: whitepaper/database
 - 2. Immersion Requirements revision 2
 - 3. Reach out to Nigel, John Gross, John Bean for additional information.
 - v. Door HX Sub-Project Overview
 - 1. Looking at hybrid Air to liquid to liquid rear door solutions.
 - 2. Operating conditions and Quality/Reliability.
 - vi. Cold Plate Sub-Project Overview
 - 1. Generate an open specification and supporting documents focusing on standardization and definitions of cold plate liquid cooled solutions.
 - vii. Advanced cooling facilities
 - 1. The Advanced Cooling- Facilities sub-project collaborates on integration of Advanced Cooling Solutions (ACS) into data center facilities via liquid distribution.
 - 2. Participants develop solutions, guidance and reference designs that enable ACS deployment in both new and

existing data centers.

- viii. David Meadows- will presentation be available on the website. Yes, will get posted.

7. UL 603335-2 A2L Refrigerants – Jake Rede, Ben Dolcich, Bill Kinas

- a. New Low GWP Refrigerant Requirements affecting CRAC Unit Design and Application Regulations Needing TC 9.9 Attention
 - i. Problem Statement and Action Needed.
 - ii. History of Refrigerant phase downs, Ozone Depleting and GWP
 - iii. HFO's- Mildly flammable refrigerants
 - iv. Recent Regulations- California and Federal
 - v. Comfort Cooling Standard and ITEF (Information Technology Equipment Facilities)
 - vi. What to do? Need is now. Give ITEF input of UL/CSA 60335-2-40
- b. Problem statement and Action needed
 - i. ITEF looking for others to provide input to UL/CSA 60335-2-40 WG 14 subcommittee
 - ii. Discussed Climate Change Refrigerant GWP history
 - 1. Montreal Protocol, Kyoto, Protocol, and Kigali Agreement
 - iii. Beginning in 2025 new refrigerants that will have less than 750 GWP. New refrigerants will have slight flammability
 - iv. Global HFC Refrigerant phase down Plan- becoming prescriptive.
 - v. Refrigerant landscape
 - 1. Discussed chart of various refrigerants
 - vi. Low GWP HFC Regulations- California Activity
 - 1. CARB- (California Air Resource Board)
 - 2. Effective Jan 1, 2025 for all new equipment sold into CA.
 - vii. Many new proposals to Federal EPA echoing California rules
- c. Typical ITEF and CRAC design and applications
 - i. Discussed typical data center physical design and CRAC units and refrigeration implications
 - ii. Discussed considerations for UL/CSA standard regarding implications on the standard based upon design of data centers.
- d. Looking for a broad of group of people to join the group.
- e. AHRI has put in a significant of work researching the A2L refrigerants.

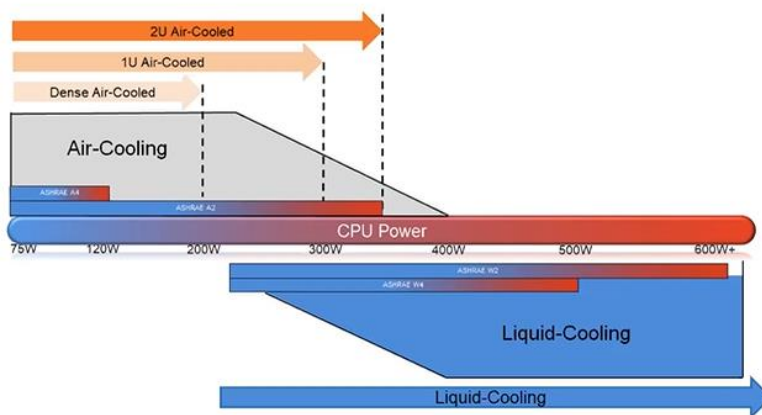
- i. Burning velocity- flame propagation speed.
 - ii. Industry is working on and learning more about these A2L refrigerants.
 - f. June 17th First meeting. UL/CSA 60335-2-40.
 - g. Contact Gregory Relue-Chari-UL/CSA 60335-2-40 Committee, Gregory.Relue@emerson.com
- 8. Data Center Cooling Resiliency – Mark Mannex
 - a. Examples of sudden loss of cooling
 - i. Contractors working at facilities
 - ii. Result can be catastrophic.
 - iii. Temp rise up to 1F /minute.
 - 1. Resulting in equipment failure or fire suppression activation.
 - b. Set of guidelines
 - i. Education of the facility Owner
 - ii. Result if this occurred at the facility and the outcome
 - 1. Study of what happens to facility and data streams
 - iii. How long does it take the facility to heat-up and what's the time to heal.
 - 1. Contingency planning
 - iv. Controls with predictive capabilities
 - 1. Practiced orderly manner shutdown and contingency planning
 - c. Possibly a good topic for the committee to consider a white paper.
 - d. Comments
 - i. Norm Bourassa- NERSC is going though the planning and contingency.
 - ii. Robert McFarlane- Contingency planning can be fairly complex and challenging to sometime get decisions from the owner on what should occur.
 - iii. John Gross- Clients are scaling back component redundancy for system redundancy but are not testing the system redundancy for failing over to their other systems.
- 9. Publication Statistics -Ecton English
 - a. Book Sales As of April 8th, 2021
 - b. Thermal Guidelines Book Sales
 - i. 1st edition – Sold 3,566
 - ii. 2nd edition – Sold 1,004
 - iii. 3rd Edition – Sold 590
 - iv. 4th Edition – Sold 357

- v. 5th Edition – Sold 4
- c. IT Equipment power trends
 - i. 1st edition – Sold 2,582
 - ii. 2nd Edition – Sold 300
 - iii. 3rd Edition – Sold 50
- d. Design Considerations
 - i. 1st Edition – Sold 2000
 - ii. 2nd Edition – Sold 787
- e. Have information on Std. 127 and 90.4 sales.
- f. Comments
 - i. Bob McFarlane- It would be great to see if there's a possibility to get ASHRAE to offer a reduced cost update.
 - ii. Don Beatty – The numbers of copies sold fail in comparison to the number of people involved in the industry.
 - iii. Bob McFarlane – Interested to know how the publications compare in sales to the other books.
 - iv. Updates don't seem to be selling as well as the first edition.
 - v. Books do not account for any Asian translation. Book sales do account for the Spanish translation.
- 10. International/ Publications – Don Beatty
 - a. International
 - i. No Major update
 - b. Publications
 - i. Rather than referring to a document as a “White Paper” these should be referred to as a “Technical Bulletin”.
- 11. Thermal Guidelines for Data Processing Environments, 5th Edition – Roger Schmidt
 - a. Major Changes to the guidelines
 - i. Change to the recommended envelop as a result of research of the effect of RH and gaseous pollutants.
 - ii. Addition of new high density air-cooled environmental envelope
 - iii. Change in Nomenclature of liquid cooling classes.
 - b. Change to the recommended envelop as a result of research of the effect of RH and gaseous pollutants
 - i. Primary reason for the update is due to ASHRAE funded research project (1755-RP) on effects of high relative humidity (RH) and gaseous pollutants on corrosion of IT equipment.
 - ii. Reviewed the background and motivation for the research and reviewed the results of the testing.

- iii. The results showed that if the 30-day corrosion thickness is below 300A and 200A for copper and silver, respectively, datacom equipment would not have premature failure within its service life.
 - iv. Cl₂ is not good for copper and H₂S is not good for silver.
 - v. Copper and silver coupon testing strongly recommended twice yearly. Environmental conditions to be adjusted based upon testing of coupons.
 - c. Addition of new high density air-cooled environmental envelope
 - i. High density components such as CPUs, GPU's, and memory are requiring increased cooling. However server volume doesn't permit these peak performances.
 - ii. New air cooling class specific to high density servers is being added to accommodate components temperature limit and the associated impacts to the ambient conditions.
 - iii. New H1 envelope is added to the environmental charts. All other conditions stay the same.
 - iv. Push in processor powers, and adding in H1 for high density air-cooled class (H1). Recommended upper temp limit of 25°C
 - d. Change in Nomenclature of liquid cooling classes.
 - i. Changed the liquid Cooling Class to correspond to the facility water temperatures.
 - e. Acknowledgements
- 12. Design Considerations 3rd Edition- John Gross
 - a. Have performed a great deal of edits on the book
 - b. Aligning content prior to submitting to ASHRAE
 - c. Need some volunteer help to align references and content between chapters.
- 13. Emergence & Expansion of Liquid Cooling – Dave Moss
 - a. Server “Compliance” Strengthened
 - i. Previously, the verbiage describing IT equipment operation relative to a particular class was” requires full operation of the equipment within the class specified”
 - ii. New Verbiage: “Operating within a particular environmental class requires full performance of the equipment over the entire environmental range of the specified class, based on nonfailure conditions.”
 - b. Reviewed the new white paper (Technical Bulletin): “Emergence and Expansion of Liquid Cooling in Mainstream Data Centers”
 - i. Data center temperature regression due to case temperature decreases with increased power.

- ii. Almost a decade long period of time without increases of power; just increase in core count and increase in case surface area.
- iii. CPU, GPU, Memory, etc. are going up and are becoming more difficult.
- c. Difficult -to-Cool Metric
 - i. New metric to show trend of chip cooling difficulty
- d. Impacts to Air-Cooled Data Centers
 - i. No room inside server to grow heat sinks
 - ii. Volume of airflow and fan power is expected to rise by 2% likely to grow by 25%
 - iii. Acoustics have been an issue for some time now, especially with hard disk drives; increased airflow will exacerbate that issue.
- e. Approximate Transitions to Liquid Cooling

Soft Limits & Temperature Regression of Air and Water



- i. Transition water around the 300-400W chips. Eventually could require the use of W27 water temperature.
 - ii. Economizing hours will come down.
 - iii. Chiller-less facilities will face the fact that they might need to add chilling capability.
 - iv. Businesses will come to decisions of performance need versus operating costs or performance versus heat reuse effectiveness.
14. IT Subcommittee
- a. Plans to update 2nd Edition of Liquid Cooling Guidelines
 - i. Anticipated for a 3rd book
 - 1. Six ASHRAE publications on Liquid Cooling to consider integrating into new book.
 - ii. Will breaker into 3 parts, facilities, technology and cooling

- systems, technology trends.
- iii. 3 groups formed to support the writing activities.
 1. Part 1 Technology led by Dave Moss (David.Moss@dell.com)
 2. Part 2 Facilities led by Dustin Demetriou (dwdemetr@us.ibm.com)
 3. Part 3 : Technology and Cooling System led by Mark Steinke (Mark.Steinke@amd.com)
 - b. Pressure Testing Requirements for IT Liquid Components – The Problem
 - i. Pressure of components between CDU and Cold Plate
 - ii. Pressure capability of the cold plates and ability to handle pressures.
 - iii. TC9.9 provided comments to IEC to consider updates to their documents to change from 5x to 3x. and now a 4th edition of IEC 62368-1 has updated guidance to a hydrostatic test for 2 minutes at 1.5x the maximum rate work pressure of the LFC or LFC Assembly.
 - iv. This guidance needs to be put into the upcoming revisions of the liquid cooling book.
 - v. Consider being inclusive of all types of systems negative pressure systems too.
 - c. Harmonization of cable/connectors/appliance coupler temperature standard w/ server operation environments.
 - i. Challenge for NEMA and IEC test requirements for connectors are not in concert with anticipated discharge/ back of rack temperatures.
 - ii. Requests were made for them to update their connectors.
 1. 40-60C ambient is common in the back of the racks.
 2. NEMA and IEC consider the ambient as the room temperature.
 - iii. NEMA Standards Publication WD-10, High Ambient Temperature test procedure for Wiring Devices.
 1. Consider derating components due to high temperatures in the back of the rack. Possibly derate the current on the higher ambient conditions.

Closing Comments

- Reminder to fill out the attendance through the google form.

Meeting Ended 1:27 PM EST

DRAFT