AMERICAN SOCIETY OF HEATING REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC.

TC/TG/TRG NO: **TC 9.9** Date: **January 20, 2014** Location: **New York, NY USA**

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

VOTING MEMBERS	YEAR APPTD	PRESENT ABSENT	VOTING MEMBERS	YEAR APPTD	PRESENT ABSENT
John Bean	10	P	David Moss	11	P
Don Beaty , Publications/International Subcommittee Chair	10	P	Jason Matteson	13	P
Chris Kurkjian	11	P	David Quirk, Chair	09	P
Ecton English, Webmaster	10	P	Robin Steinbrecher-Vice	10	P
Joseph Gangemi , Programs Sub Chair	11	P	Herb Villa	10	P
Rhonda Johnson	10	P			
Greg Jeffers- Secretary	12	P			
Mukesh Khattar	10	P			
Madhu Iyengar	13	P			
All attendees-see appendix		See Appendix At end			

All Members of TC/TG/MTG/TRG plus the following:	
TAC Section Head:	Tom Lawrence
TAC Chair:	
All Committee Liaisons As Shown On TC/TG/MTG/TRG Rosters:	
Manager Of Standards	Stephanie Reiniche
Manager Of Research & Technical Services	Mike Vaughn

2:15 General Meeting on January 20, 2014 - Call to order

Chairman, David Quirk called the meeting to order at 2:15 p.m., but had technical difficulties using the ASHRAE simulcast which caused the schedule to be altered while problems were fixed. The quorum of voting members was met with 13 members present out of 14 required. Motion for approval of prior minutes by Don, seconded by Robin. The vote was unanimous at 13-0.

Introduction

David presented a general discussion on TC9.9 using a slide presentation. He expressed the importance of updating member's bios on the ASHRAE Website.

Website Update Ecton English

The website is averaging about 250 people visits per week with most being new visits. Out of the 4800 total hits, 2800 were unique hits. The new ASHRAE TC 9.9 Networking Thermal Guidelines received the most activity with 1050 downloads. The following general question was asked: "Can presentations be put on the website?" Response: Not normally since they can be resubmitted at a later date if not accepted currently.

2:30 p.m. Presentation – Air Separation Metrics Robert Tozer

Data center energy efficiency has become an important focus for the industry and it has led to many changes in the way facilities are designed and operated. Air management is a key enabler to save energy on the cooling systems and hence the way air is managed in the data hall is changing. By reducing bypass air flows it is possible to reduce CRAH fan speeds to save energy. Reducing recirculation of hot IT equipment exhaust air into the IT intake air path means the air supplied to servers is within a narrow range, close to the cooling unit supply temperature and allows temperature set points to be increased, reducing refrigeration energy, whilst maintaining appropriate conditions. Building upon air management metrics of bypass and recirculation, the authors have developed air performance metrics which describe how well the cold air stream is separated from the hot air stream and can be applied to any containment method. Furthermore, these metrics may be determined indirectly by taking a series of temperature measurements in various locations within the space. Measured performance can be represented graphically to compare with optimal / ideal performance and identify opportunities to improve air management performance. Practical examples are provided, including where contained systems perform worse than open systems.

Items discussed included how much cooling is delivered and bypassed, horizontal and vertical recirculation (see 2009 paper presented in Chicago for other background), air performance plots, and air segregation formula/metric.

3:00 p.m. Presentation - Emerging Technologies for Optimum Cooling of Data Centers—Opportunities and Challenges Michael M. Ohadi, Ph.D., Don Beaty, Roger Schmidt

The enormous energy and power demand in data centers continue to provide significant opportunity for savings of capital and operational resources through innovative solutions and technologies. Use of optimum cooling methods, utilization of emerging software and hardware for monitoring and control of energy/water consumption and risk/reliability assessment of emerging measures such as free air cooling and direct immersion cooling can contribute to major energy savings and environmental sustainability. The need for standards that establish relevant guidelines and best practices is another critical need in Data Centers. In this 30-minute presentation the panel members will collectively address these and other issues of current interest data centers/mission critical facilities.

Michael Ohadai-

Academia data centers tend to have a relatively high PUE.
Thermal management efficiencies only consider two topics. Items studied include the following: Microgroove surface with ultra-low resistance to cooling, Embedded manifold micro-channel cooling, Two phase cooling, and Immersion based cooling. More information can be found at allied-control.com.
There are currently 13 projects funded by Defense Advanced Research Projects Agency (DARPA) including Georgia Tech (CEETHERM).

Roger Schmidt-

Roger's discussion included warm water cooling for 5 ASHRAE classes, rear door heat exchangers, and direct water cooling down to the processor level. Most of the industry included class W1, W2, and / or W5 IBM equipment in 2012. A 3.6 megawatt supercomputer requires 45°C cooling water (with 85-45°C boundary temperatures).

At Syracuse University a cooling tower cooled rear door heat exchanger was used with combined heat and power The University also used a heat recovery chiller or direct heat in the winter and integrated the use of Capstone Micro turbines.

Don Beaty-

In order to remain profitable, facilities need to anticipate and adapt without major changes. In the near future, 150 kW / rack with liquid cooling will be available. Don summarized his presentation and asked for more feedback and forum.

Responses:
Repackage modeling is not set up for data centers and there is a shortage of empirical data.
Modeling is important including the testing of 1U processors.
The option of a 2% speed fan with the change of standard perforated rear door does not differ much from the option of a rear door heat exchanger.

3:30 p.m. Liaison Reports

Standard 90.1 liaison ***Rick Pavlak***

In 2010, Standard 90.1 focused mostly on cooling efficiency and forces cooling towers to be oversized in cooler climates and requires a single selection point for waterside economizers. Miami is the only exception for economizers in 2010 Standard 90.1! LEED incorporated this version for their new standards but requires 10% mandatory plug loads which is very difficult to meet. The 2013 standard 90.1 has an alternative compliance path for PUE (chapter 6 of 90.1), one method involves kW values, another is kWh + bin calculations (AHJ approval). Standard 90.1-2016 is in development with zones added to the climate tables.

Standard 90.4 liaison ***David Quirk***

David discussed the importance of modeling. The initial public review of Standard 90.4 had 83 comments. There is still ample time to complete the new standard before January, 2016. This is the time required by IBC to be adopted.

Email Ron Jarnagin or Stephanie Reiniche for a copy of the Standard 90.4 draft.

SPC-127-2012R ***John Bean***

The SPC-127-2012R committee is being formulated. Two new member applications are due by April 19. PC Chair recommendation deadlines are due May 9. The work plan deadline is due June 13 2014. Forms are to be scanned and emailed to Denise Latham. The ARI, DOE, and 90.4 committees are recognizing the SPC-127-2012R standard. Contact John Bean or visit the ASHRAE website for more details.

ANSI EESCC ***Stephanie Reiniche***

Identifies coordination with other standards.

TC 9.9 International liaison ***Don Beaty***

ASHRAE Data center Handbooks have been translated into Chinese by IBM. Interactions with Scandinavia, Italy, Japan, China, India, and others. A total of six international members in the room today.

Took break at 4:15

4:40 p.m. DOE, DOD, HPC Working Group Updates Bill Tschudi

Activities update for the High Performance Computing Working –

Commissioning guidelines are being compiled for liquid cooled computers. EEHPC WG (Energy Efficient High Performance Computing Working Group) - This group consists of 400 members sharing best practices including for Liquid cooling, thermal guidelines, and commissioning. Demand response-grid integration issues and assembling lessons learned and roughing a guideline for commissioning
http://eehpcwg.lbl.gov/documents
Federal energy management center- to take up DC.

Activities for DOE –

Update of report to Congress, Data Center energy Challenge, and Measure and Manage initiatives- Update 2007 report. Update energy challenge in coordination with the Green Grid. Rollout through NRE.L Monitoring and metering is being pushed.

Activities for DOD –

Liquid Immersion Cooling Demonstration and the TROPEC program to evaluate computing equipment. 3M, SGI, INTEL, Schneider Electric, Navy Research Lab, Tropec evaluation of new technologies http://Tropec.net

5:00 p.m. Publications Subcommittee Report Don Beaty

A new PUE book was created by the Green Grid and is available at bookstores. The book on Liquid Cooling has been revised and others are being worked on. ASHRAE is changing PDF protection to allow the files to function on different machines and also to be downloadable.

5:05 p.m. Industry Coordination & Reports-Bahgat Sammakia SUNY, Al Ortega Villanova

Center for Energy- Smart Electronic systems ES2

NSF Funded, 4 universities- Villanova, University of Texas Arlington, Georgia Institute of Technology , Binghamton University of New York. A $50k dollar fee allows industry to access 10 research projects Currently there are 60 active research facilities. Each center works on different topics with the end goal of creating energy optimized data centers.

Topics include studies that indicate performance is not proportional to power, front end power, operations efficiency, energy recovery, coping with performance loss with short term load trends -3 minutes in the future (the time required to wake a server), and energy aware virtualization.

- Silicon Photonics-CMOS by Intel compact and more efficient than copper- 1+ Tbits per sec.
- New benchmarking metrics on a single fiber cable
- CFD models are being utilized that are verified for small models with unilateral solutions that could run in seconds in lieu of a time exhaustive CFD.
- Zeolite adsorption for energy systems
- Six sigma CFD software is being utilized.

5:15 p.m. IT Subcommittee Report Roger Schmidt, Dave Moss, Jing Zhang

- IT Delta T, CFM, pressure WP reviewed.
- Some server take aways
- Max exhaust temp from server is trending toward a max of 60 deg C to back of racks. This is a bulk air temperature. Vendors said there could be small localized spots of higher temperatures, though UL touch specs force them to limit these temperatures, depending on the materials that might be touched (e.g., plastic vs metal)."
- Many servers can handle 0.3 inches WG back pressure
- TC 9.9 Data Center books include a potential book aimed at diving deep on interactions between IT equipment and the facility. It will combine recent whitepapers on storage and networking along with recent subjects delta-T and pressure and borrow related content from the liquid book (Formal release summer annual 2014 meeting)
- The effects of moisture on hardware reliability; need to operate below deliquescence RH.
- Hardware should be cleaned by MERV 13 filters.
- Ammonium hydrogen sulfate hazardous to humans as well because of 40% deliquescent humidity.
- Filters have poor efficiency measuring PM 2.5 filter dust.
- Progress is also being made on ESD efforts and Thermal Guideline book Transient temperature requirement and RH/contamination and hardware failures.

6:40 p.m. Presentation – Evaporative Cooling in Data Centers Steve Slaysak

Novel cooling technologies are enabling data center PUEs below 1.1 by leveraging free/evaporative heat sinks that operate annually on only 5% of the energy consumed by the IT. Some approaches can achieve these ultra-high efficiencies, effective COPs around 20, without compromising operational comfort envelopes and while also delivering peak cooling demand reductions of 50%- 90%. Staged indirect evaporative coolers can be configured as either Air-Side Economizers or Indirect Air-Side Economizers depending on the local climate and application requirements. For a given operating envelope, the greatest savings in cooling and peak power infrastructure are achieved by delivering the lowest temperature during extreme weather. These savings can be equivalent to years of energy bill savings, and make advanced technologies the lowest first-cost option.

7:00 p.m. Group Discussion - Part I- IT liquid cooling implementations and transition to liquid cooling

What qualifies as "liquid Cooling"? General consensus is that it means different things to different items.
High performance vs. cost performance
It's limited to HPC because people don't need it.
Energy efficiency doesn't make up for high CAPEX.
Biggest battle is the perception that liquid cooling solutions will leak.
Single Threading is more likely to need liquid cooling; cram many cores onto a board; for financial transactions, number crunching, and big data. Multi-Threading has less need for liquid cooling; smaller chips but fewer on a board; for audio / video over IP; growing as a portion of total CPUs

7:20 p.m. Group Discussion - Part II- Energy Standards for Data Centers; 90.1, 90.4P, LEED for Data Centers, & Green Globes

Modeling tools are important. Should IT equipment be included in energy efficiency calculations and unrated HVAC equipment? You can't rate it if you don't have a metric for it.
Systems vs. equipment for standards and the equipment benefits from standards.
Lawrence Berkley performed tests comparing different systems which need to be documented.
Only 8 states have picked up the 2010- 90.1 Standard.
What should be the industry baseline comparison? Delta T's, Entering Air Temp, etc.
It is necessary to support development of 90.4 and enable building planners to demonstrate compliance
ASHRAE Research Proposal as of 1/17/2014:

- 23 pages (a lot of work!)
- $235,000 project, To be completed 2015, 54 man-months
- Future Facilities to donate 2-year license for CFD
- Prefer EnergyPlus
- Include handshake between CFD and Energy Tool
- GUI work was excluded; leave this to the commercial software vendors
- It was stated that a lot of people in TC9.9 use EnergyPlus. Historically it didn't have good GUI's, but better GUI's are being developed (NREL, etc.). So not a lot of data center people know what's in EnergyPlus for data centers. Energy Plus is considered as the most commonly used modeling software in the future.
- TC4.7 would not agree to co-sponsor this research. TC4.7 ("Energy Calculations") thinks the proposal is biting off too big of a chunk of work.
- TC9.9 is considering asking the DOE to co-fund the research and leverage Villanova's VTAS / Matlab, and if its best to start out with a smaller "spreadsheet" based calculator.

8:00 p.m. Presentation – Compact Server/rack models Ez Khalifa, Roger Schmidt, Jim VanGilder

This presentation covered a compact server/rack model to enable the practical transient CFD modeling of data centers for scenarios such as a loss of primary power and subsequent disruption in data center cooling.

- A review took place of the current work efforts to date along with future plans of action.
- Development of a compact Transient Server Model Update TC 9.9.
- What is response time for a data center to rack? Almost no response from server.
- Need to look at capacitance of building and racks for thermal mass and capacitance and effectiveness.
- Server mfg need to report thermal mass properties so a single model can be adopted.

- Potential changes to rate of change in IT thermal guidelines.
- Temp rate of change discussion is focused on Hard drive.
- Temp rating was not meant to be an absolute rate of change from the current guidelines and it is not meant to be instantaneous-(About 50% thought it was instantaneous in a poll of the room.)
- 5 degree C range over any 10 minute period and not exceed absolute changeover a 20 C period per hour, Should recommend to TIA.
- Will also need similar statement for tape drive vs. Hard drive.. A storage whitepaper will be fourth coming
- A request was made for a University of Minnesota Student to do research
- Controls student looking to do intelligence controls.

8:25 p.m. Discussion Part III David Quirk

- This discussion involved the NFPA requirements for aisle containment & high airflow smoke detection.
- NFPA came in late and has still not been adopted in many states.
- Obstructions are discussed in the containment.
- No thermal mechanical means is allowed to be used to remove containment.
- It can't impede egress.
- Still research required for detection in high airflow environments.

8:30 p.m. Presentation – RP-1499, ESD Research Results David Pommerenke

This planned presentation was cancelled due to scheduling conflicts with the presenter.

8:48 p.m. Adjourned-

Summary of Programs, Handbook and Research Meeting - Held 1/19/2014

- Attendance not taken, no votes taken. This was a working meeting to track the status of work in progress.

Programs – Nick Gangemi

- NYC – Nick reviewed the sessions that were held earlier in the day along with the upcoming ones. 70/85 people in the first two sessions.
- Nick reviewed the types of papers and their requirements. Technical and conference papers are the types. 65 to 70% approval rate on the seminars and conference papers. 6 were not accepted.
- Seattle – conference tracks were shown. Research will take precedence over other types of papers/seminars. Many key dates have passed. Seminar, forum and workshop proposals due February 13th. Nick will let people know who they can partner with.
- Keep Nick in the loop on submissions so that he can submit papers in a block.
- Chicago – tracks have just come out. Main theme is mission critical facilities. Submit everything that hasn't been accepted before.

Handbook- Bob McFarlane

- Bob is lead editor for an update to Ch. 19 of the ASHRAE Handbok. It is to be nearly a total rewrite of the chapter. The chapter is now 75 pages. Bob has been asked to reduce this to 65 pages. Existing figures can be reused (anything in present publications). New figures must be vetted including copyrights. Most of it is complete and edited sections have been sent out to authors.
- Some subtopics are still unassigned, volunteers are needed:
    - Ventilation and infiltration
    - Human comfort
    - Absorption chillers – he has a writer for this
- Some assigned sections have not been received and Bob will follow up on those.
- Outstanding tasks were reviewed. Target voting by TC 9.9 at the Seattle meeting. Bob has requested that everything be back in his hands by end of February.
- Due date is July 15th, 2014 for submittal of the chapter update.

Research – Madhu Iyengar, David Quirk, Tom Davidson, Mark Seymour

- Research Topic 1499 – Effect of Humidity on Static Electricity Induced Reliability Issues of ICT Equipment in Data Centers – The researcher will not be available for the Monday TC 9.9 main meeting.
    - The research is testing additional points at very low humidity. Final report should be available at the Seattle conference. These results would be used for updating the thermal guidelines. There is a high sensitivity at low humidity. Researchers got additional funding for low end testing of the humidity range based on earlier testing sensitivity. Extrapolation was not adequate.
- Work statement on development of improved and integrated energy modeling software for data centers –Tom
    - The WS was rejected by TC 4.7. They thought there was too much work to be covered by $200k. They suggested it might cost $2M.
    - Tom is looking for ideas from the TC on how to proceed. Perhaps collaboration with another group such as DOE or the utilities industry will be investigated..
- RTAR 1675 (TC 9.9 is co-sponsoring. TC 4.10 is the sponsor) – Experimental Benchmark Data for Data Center Numerical Modeling – Mark Seymour
    - Rejected by RAC – They see this as CFD validation which they believe has been done. Mark has been attempting to educate them on why this is not CFD validation. Don Beaty suggested this could be put in terms of ROI – qualitative or quantitative. Mark will consider this suggestion.
- Future projects – if you have suggestions send them to the TC 9.9 email address tc0909@ashrae.net

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Gerardo	Alfonso	x			C	
Sami	Alkharabsheh	x			Y	
Jim	Bailey				A	
Andrew	Baxter	x			C	
John	Bean	x			V	
Don	Beaty	x			V	
Eric	Carter				P	
Herman	Chu				G	
David	Claridge				A	
Benjamin	Cohen				A	
Ben	Cohen	x			Y	
Lex	Coors				C	
David	Copeland	x			C	
James	Cople	x			C	
Craig	Crader				C	
Charlie	Culp				A	

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Donal	Curtin	x			G	
Stew	Czarneck	x			G	
Milnes	David	x			Y	
Tom	Davidson	x			C	
Dustin	Demetria	x			C	
Nick	DesChamps	x			A	
Gene	Dimond				A	
Eugene	Dimond	x			G	
Dave	Dorste	x			G	
Keith	Dunnavant				A	
Dan	Dyer	x			G	
Rick	Eiland				A	
Derek	Elliott				A	
Michael	Ellsworth	x			G	
Ecton	English	x			V	
Hamza S.	Erden	x				

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Bert	Etherege				A	
Jeffrey	Ewin	x			P	
H	Ezzat	x			G	
Paul	Finch	x			A	
Mark	Fisher				A	
Jon	Fitch	x			C	
Mary	Foutz				A	
Michael	Frank	x			C	
Joseph (Nick)	Gangemi				V	
Tift	Gannon				A	
David	Garcia				A	
Don	George				A	
Mark	Germagian				C	
Reza	Ghias				C	
Kanad	Ghove				G	
Art	Giesler				C	

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Ken	Gill				A	
Jack	Glass	x			C	
Hiroyuki	Hmurayama				A	
Marc	Hourican	x				
Dave	Hoyt				A	
Kevin	Huges				P	
Toshi	Ikeda	x			Y	
Madhu	Iyengar	x			V	
Ted	Jacquay	x			Y	
Ted	Jagusztyn				P	
Greg	Jeffers	x			V	
Randi	Johnson				A	
Rhonda	Johnson	x			V	
Fitch	Jon				A	
Mike	Kaler				P	
Raj	Kapoor	x			C	

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Dave	Kelley	x			P	
Daniel	Kennedy	x			A	
H. Ezzat	Khalifa				G	
Kishor	Khankari	x			C	
Mukesh	Khattar	x			V	
Matt	Kouki	x			P, YEA	
Paul	Kozlov				A	
Eric	Kumar	x			C	
Chris	Kurkjian	x			V	
Geoff	Lawler	x			C	
Stuart	Lawrence	x			C	
Sang	Lee				C	
Tim	Lehotsky	x			Y	
Rick	Lewis	x				
Mike	Licitra	x			C	
Nemaj	Lotfi				C	

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Jay	Madden	x			G	
Richie	Mahan				G	
Ted	Marwitz	x			C	
Carol	Marriott				A	
Caroline	Mason	x			A	
Jason	Matteson				A	
Bob	McFarlane	x			C	
Michael	McGuinness	x			Y	
Jacque	McIlrath				A	
Michael	McKenna				A	
Doug	McLellan				C	
Bill	McQuade				A	
David	Meadows	x			C	
Brian	Medina	x			G	
Frank	Mills				V	
Richie	Mohan	x			G	

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Mark	Monroe	x			A	
Kosu	Morishima				A	
David	Moss				V	
Chris	Muller	x			C	
Al	Nichols				A	
Shlomo	Novotny	x			C	
Izuh	Obinelo	x			C	
Mike	Ohadi	x			C	
Andrea	Palmeri	x			G	
Christian	Pastrana	x			G	
Mike	Patterson				C	
Rick	Pavlak	x			C	
Gabriel	Peters				A	
John	Peterson				C	
David	Quirk	x			V	
Nirmal	Ram				A	

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Nathan	Redmann				A	
Stephanie	Reniche				A	
Terry	Rodgers				V	
Eddie	Rodrigues				A	
Edgar	Rovillos				A	
Joel	Rutledge				P	
Jeff	Rutt				V	
Shiro	Sakoo				A	
Roger	Schmidt	x			C	
David	Schowalter				G	
Mike	Scofield				C	
Ian	Seaton				C	
Justin	Seter	x			G	
Mark	Seymour	x			C	
PJ	Singh				C	
Steve	Slayzar	x			G	

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Jeff	Sloan	x			G	
Bahgat	Sommakia				G	
John	Song	x			P,Y	
Dornsak	Songnakul	x				
Vali	Sorell	x			C	
Row	Spangler				G	
Tom	Squillo	x			G	
Robin	Steinbrecher	x			V	
Peter	Strapp				A	
Dave	Swenson				G	
Geri	Swenson				G	
Makoto	Takahashi	x			G	
Yuichi	Takemasa				G	
Ryuji	Tanagihara				G	
David	Tootle	x				
Robert	Tozer	x			P	

ASHRAE TC 9.9
Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment
Meeting Attendance Roster

First Name (see sheet 4 and 5 for blank if your name is not indicated)	**Last Name** (see sheet 1-3 For your name -check off	Attendance- Check if	**Comp. or Group**	Notes: Send your –email address via ASHRAE TC.9.9 to tc0909@ashrae.net for information Visit our Website at http://tc99.ashraetcs.org/	**Member** Status-(V)oting (C)orresponding (P)rovisonal Member, Young Engineers Associate (Y), (A)SHRAE ,(G)uest, (O)ther-State	
Jeff	Trower	x			C	
Bill	Tschudi	x			C	
Edward	Tsui				A	
Marianna	Vallego				G	
Jim	VanGilder	x			C	
Herb	Villa	x			V	
Marlin	Vogel				G	
David	Wang	x			C	
Bob	Weidner	x			G	
Andrew	Wengerd	x			P	
Scott	Wilson	x			G	
Michael	Woodford				G	
Susumu	Yoneoka				G	
Lang	Yuan	x			C	
Jing	Zhang	x			Y	