M I N U T E S

EXECUTIVE COMMITTEE MEETING

Caesars Palace Hotel
Las Vegas, Nevada
January 28, February 1 and 2, 2017

Note: These draft minutes have not been approved and are not the official, approved record until approved by the Executive Committee.

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Executive Committee Meeting
January 28 and February 1 and 2, 2017

PRINCIPAL MOTIONS

Executive Committee Meeting
January 28 and February 1 and 2, 2017

No. - Pg.	Motion
1 – 5	that the UNEP-ASHRAE Work Plan 2017-2018 be approved.
2 – 6	that the overhaul of the ASHRAE website begin immediately.
3 – 6	that ExCom recommends the AASA membership application of ABRAFAC - Associação Brasileira de Facilities be approved by the Board of Directors.
4 – 7	that the motion from the Southern Piedmont Chapter for ASHRAE to create an annual stipend of $100,000, paid monthly to the President of Society, be defeated.
5 – 7	that ExCom recommends that the Lawrence Berkeley National Laboratory (LBNL) /ASHRAE Memorandum of Understanding be approved by the Board of Directors.
6 – 7	that ExCom recommends that the United Nations Development Programme UNDP/ASHRAE Memorandum of Understanding be approved by the Board of Directors.
7 – 7	that ExCom recommends that VDI – GBG/ASHRAE Memorandum of Understanding be approved by the Board of Directors.
8 – 9	that ExCom recommends that ISHRAE/ASHRAE Memorandum of Understanding be approved by the Board of Directors.
9 – 9	that the Executive Committee initiate a revision of the *Refrigerants and their Responsible Use* position document (PD).
10 – 9	that the Executive Committee initiate a revision of the *Airborne Infectious Diseases* PD.
11 – 10	that the Executive Committee initiate a revision of the *Climate Change* PD.
12 – 10	that the Strategic Partnership Agreement between ASHRAE, CIBSE and REHVA be approved.

ACTION ITEMS
Executive Committee Meeting
January 28, February 1 and 2, 2017

Item	Responsible	Summary of Action	Status
1 – 2	Littleton	(Carryover) Contact the International District Energy Association regarding the approval of the ASHRAE/IDEA MOU. (Update: 5/2016: Coming to closure. 10/2016: Still Ongoing. **1/2017: Ongoing.**	_____
2 – 2	Littleton	(Carryover) Work with CAMEE to renew CAMEE/ASHRAE MOU which is expiring in the coming month and add item to Spring ExCom agenda. (Update: 5/2016: Ongoing but working with CAMEE. **1/2017: Ongoing.**	_____
3 – 2	Wentz/Littleton	(Carryover) Organize an ASHRAE/MCAA meeting after the June Annual Conference. Discuss the possibility of a joint publication on change orders and claims. (Update: 5/2016: Ongoing.**1/2017: Ongoing**.)	_____
4 – 2	Olesen	(Carryover) Work with Members Council on future participation in Solar Decathlons and for ways ASHRAE might increase participation. (Update: 10/2016: Ongoing. **1/2017: Ongoing**.)	_____
5 – 2	Olesen/Littleton	(Carryover) Investigate the cost for membership in INIVE which would include participation by all ASHRAE members. (Update: 10/2016 - $6,000 all ASHRAE members in N.A., $1500 for all U.S. members. **1/2017: Ongoing.)**	_____
6 – 2	Olesen/Chakroun	(Carryover) Work with PubEd and GGAC for the appropriate location to place the Guidelines for Professional Practice in the ASHRAE structure. (Update: 10/2016: Ongoing. **1/2017: Ongoing**.)	_____
7 – 2	Littleton	(Carryover) Investigate the Buildings XIII Conference and make a recommendation as to whether ASHRAE should consider taking over administration of the conference. (Update: 10/2016: Considering a workshop and waiting for DOE to make decision regarding financial contribution. **1/2017: Ongoing**.)	_____
8 – 2	Hayter	(Carryover) Discuss the Climate Knowledge Brokers Forum with GGAC, regarding a future strategy discussion. (Update: **1/2017 – Ongoing**.)	_____
9 – 2	Littleton	(Carryover) Reapply as a partner to CCAC, instead of as an actor. (Update: **1/2017 – Ongoing**.)	_____
10 – 2	Littleton	(Carryover) Collect the Board luncheon note cards and send results to the luncheon attendees. (Update: **1/2017 – Ongoing.)**	_____
11 – 4	Littleton	Explore the feasibility of an Expo show outside of the United States.	_____

Item	Responsible	Summary of Action	Status
12 – 4	Littleton	Add to Race to Zero student design competition and interface with DOE to the discussion list for the D.C. Leadership meetings this spring.	
13 – 5	Chakroun	Notify UNEP of ASHRAE's approval of the 2017-2018 Work Plan.	
14 – 5	Wentz/Olesen	Appoint a UNEP/ASHRAE Presidential Ad Hoc to establish an assessment program to develop an international guideline for the safe and sustainable operation and maintenance of air-conditioning and refrigeration plants, with special focus on developing markets, and that compliance to these practices can be verified through a point-based qualification or verification scheme.	
15 – 6	Littleton	Notify appropriate staff that the overhaul of the ASHRAE website can begin immediately.	
16 – 6	Littleton	Notify ABRAFAC - Associação Brasileira de Facilities of their AASA membership application approval.	
17 – 6	Littleton	Develop a new Society Annual Report format for this year's Annual Meeting in June 2017.	
18 – 7	Olesen	Notify Members Council that the Southern Piedmont Chapter motion to create an annual stipend of $100,000, paid monthly to the President of Society was defeated.	
19 – 7	Littleton	Contact Lawrence Berkeley National Laboratory (LBNL) regarding the approval of the memorandum of understanding with ASHRAE.	
20 – 7	Littleton	Contact the United Nations Development Programme (UNDP) regarding the approval of the memorandum of understanding with ASHRAE.	
21 – 7	Littleton	Contact VDI – GBG regarding the approval of the memorandum of understanding with ASHRAE.	
22 – 8	Littleton	Send the potential April 2017 D.C. meeting list to Jim Scarborough.	
23 – 8	Chakroun	Refer the ASHRAExCHANGE back to ECC regarding the continuation of the program.	
24 – 9	Hayter	Work with Technology Council on a more global approach to a path to Net Zero.	
25 – 9	Littleton	Contact ISHRAE regarding the approval of the memorandum of understanding with ASHRAE.	
26 – 9	Graef	Notify Technology Council that they may initiate the revision of the *Refrigerants and their Responsible Use* position document (PD).	

Item	Responsible	Summary of Action	Status
27 – 9	Graef	Notify Technology Council that they may initiate the revision of the *Airborne Infectious Diseases* PD.	
28 – 10	Graef	Notify Technology Council that they may initiate the revision of the *Climate Change* PD.	
29 – 10	Wentz	Notify CIBSE and REHVA that the Strategic Partnership Agreement has been approved by ASHRAE.	Complete
30 – 10	Olesen	Send SMACNA visit report to ExCom and have SMACNA added to the spring ExCom agenda.	

EXECUTIVE COMMITTEE MEETING

Caesars Palace Hotel
Orlando, Florida
January 28 and February 1 and 2, 2017

MEMBERS PRESENT:	Timothy G. Wentz, President Bjarne W. Olesen, President-Elect Sheila J. Hayter, Treasurer Walid Chakroun, Vice President Patricia T. Graef, Vice President M. Ginger Scoggins, Vice President Edward Ka Cheung Tsui, Vice President
MEMBER NOMINEES PRESENT:	Darryl K. Boyce, Treasurer Nominee Mick CA Schwedler, Vice President Nominee
STAFF PRESENT:	Jeff H. Littleton, Executive Vice President Mary D. Townsend, Executive Assistant

January 28, 2017	Guests: Annie Smith, Leadership U Kris Tan, Leadership U Enrica Galasso, Leadership U Rob Hoadley, Leadership U Rachel Romero, YRC Region IX Bill Simpson, Student Activities (SA) Michael Brandemuehl, (SA) Scott Wayland, Golden Gate Mbr. Dick Hayter, Presidential Mbr.	ASHRAE Staff: Steve Comstock Vanita Gupta Claire Ramspeck Craig Wright Stephanie Reiniche Lilas Pratt
February 1, 2017	Annie Smith, Leadership U Chonghui Lin, Leadership U Rob Hoadley, Leadership U Darryl Boyce, Development Scott Wayland, Golden Gate Mbr Mick Schwedler, Board Member Peter Simmonds, COF	Vanita Gupta Kim Mitchell Joyce Abrams Craig Wright Jim Scarborough Lilas Pratt
February 2, 2017	No guests.	

Call to Order

President Wentz called the first of three Executive Committee meetings to order on Saturday, January 28, 2017 at 8:30 a.m. ExCom members, staff, and guests attended as listed above.

Review of the Agenda

Items were added to the agenda during the three days of meetings and they have been included in the minutes.

- ASHRAE/ISHRAE Memorandum of Understanding
- European Conference
- Technology Council Report to Executive Committee

Approval of Minutes

Ms. Chakroun made the following consent motion:

that the minutes of the ExCom meetings noted below be approved:

- October 4 and 5, 2016
- November 4, 2016
- January 24, 2017

MOTION PASSED (Unanimous, CNV)

Review of Action Items

Action items 1-10 are ongoing and listed in the action item list at the beginning of the minutes. Updates are included where possible. AI 1-10

Report of the Treasurer Attachment A

2016-2017 Financial Update and ASHRAE Investment Overview

Ms. Hayter reported that the General Fund forecast for 2016-2017 shows that the deficit has decreased by roughly $42K. The budget was presented in June 2016 with a deficit of $283K and the current forecast is a deficit of $241K. Education and publication revenues are forecasted to decrease but are partially offset by higher than expected AHR Expo revenue from the Winter Meeting in Las Vegas. Forecasted decreased publishing/promotion, outside services and salaries are the major expense variations from budget but do not offset the decrease in revenues. The consolidated cumulative net assets saw an increase as of December 31, 2016 as compared to 12 months ago. This is due primarily to investment valuations increasing almost 10% as compared to December 31, 2015. Ms. Hayter also reported that business plans were received by Building EQ, HPB and Certification (programs operating with a deficit). The Chair and Vice Chair of their respective Committee will be invited to the Finance Committee meeting in Long Beach to deliver an update on how the programs are tracking toward their business plans. Additionally there are two Rule of the Board changes, included in the Finance Committee Report, which will be presented to the Board of Directors.

Reports of Bodies Reporting to ExCom

Foundation Trustees Attachment B

Ms. Mitchell reported that the trustees did not have any motions for the Executive Committee but had a few information items to share:

- Approved a funding request in support of ALI and e-Learning programs for $90,000.00. $40,000 will go to ALI to support ASHRAE's new Global Training Initiative and $50,000 will go toward e-Learning infrastructure improvements to accelerate course development.
- Several new endowed scholarships were approved by the trustees including, but not limited to:
    - Regina Canada Chapter Awarded Scholarship
    - Austin Texas Chapter Awarded Scholarship
    - Hampton Roads, Virginia Chapter Awarded Scholarship
- Officers for the 2017-2018 Society year were approved.

Scholarship Trustees Attachment C

Mr. Littleton reported that the trustees are investigating the possible creation of scholarships aimed at students from countries with developing economies and they will be revising and updating the Scholarship Manual of Procedures and Guidelines. In the Scholarship Trustee attachment, students selected to receive scholarships are listed with the name of the scholarship and the amount of the award.

College of Fellows Attachment D

Mr. Simmonds, Chair of the College of Fellows reported that they are setting up a mentoring program with YEA. This effort will be developed jointly and a web page forum will be set up to share advice and communicate. The ExCom terms were approved to be two years in length, from the original one year.

Life Member's Club Attachment E

Ms. Mitchell reported that the LMC is working on their manual of procedures, as well as approving changes to their reference manual. They also approved the funding for a third Grant-in-Aid.

Joint Expo Policy Committee Attachment F

Mr. Littleton reported on the final numbers from the 2017 AHR Expo in Las Vegas:

- An overall record 500,159 sq. ft. of exhibitor space was sold.
- 1964 exhibiting companies, including 583 international companies.
- IEC plans to add the South Hall at the next show in Las Vegas to accommodate the growth.

Mr. Littleton also reported on the status of the 2018 AHR Expo - Chicago – January 22-24, 2018.

- 530,000 sq. ft. of exhibitor space has been laid out with the potential for an additional 10,000 sq. ft.
- 447,000 sq. ft. of exhibitor space has been sold
- 1063 exhibiting companies to date.

The 2018 AHR Expo Mexico will be held in Mexico City on October 2-4, 2018 and as of this date 59, 730 square feet of exhibitor space is sold and the maximum layout is for 77,000 square feet.

Mr. Littleton will explore the feasibility of an Expo show outside of the United States. AI - 11

Unfinished Business

DOE Race to Zero Student Design Competition Attachment G

Ms. Romero presented an overview of the DOE Race to Zero Student Design Competition. The competition's vision is to inspire and develop the next generation of building professionals and advance and enhance building science curriculum in universities. Between 2014 and 2016, there were 92 teams representing 51 universities. The competition this year will be April 22-23, 2017 on the main campus of the National Renewable Energy Laboratory in Golden, CO. Teams may pick from four different categories in the competition. The major emphasis of the event is to provide job ready skills. The requirements for competitors are included in the presentation. Ms. Romero thanked ASHRAE for its continued sponsorship and support.

Mr. Littleton will add to Race to Zero student design competition and interfacing with DOE to the discussion list for the D.C. Leadership meetings this spring. AI - 12

Delivery of Handbook in Developing Economies Attachment H

Mr. Tsui presented the proposed changes to the delivery of the ASHRAE handbook to members in developing economies and the motions under consideration in PubEd Council. The major concerns currently are the non delivery of the handbook outside of North America and the added cost for the delivery of the handbook to these locations.

Middle East Education Center

Mr. Chakroun reported that there are two offers of space in the Middle East for locating an education center. There are offers from Dubai and Bahrain. The potential is good for both locations but no final decision has been made. This is an opportunity to expand training and other ASHRAE offerings with a center located in this area of the world.

Initiative #1A of Strategic Plan Employer Support

Ms. Scoggins reported that this issue has been resolved through the REACH program.

Alliance to Save Energy (ASE) Productivity Concept

Ms. Hayter presented the ASE Productivity Concept, which is to promote an increased amount of productivity results for governments and municipalities and determining how they are investing resources. They are looking for groups to support the effort and sign on. There is a lack of specifics and not sure there is value for ASHRAE at this time.

Women in HVAC&R

Ms. Scoggins reported all board members of Women in HVAC&R attended the Women in ASHRAE breakfast and were thrilled with the number of women attending. Work continues between ASHRAE and this group to develop new bridges and relationships.

Historic Building MTG

Ms. Graef reported that the proposed Historic Building MTG was presented to TAC. Presently they would like more specifics and thought the MTG was potentially too broad. There is also a search for a chair for this MTG.

New Business

New UNEP-ASHRAE Work Plan 2017-2018 Attachment I

Mr. Chakroun and the following representatives from UNEP presented the most current work plan between organizations:

- Shamila Nair-Bedouelle – Head of Branch, UNEP
- James S. Curlin – Network and Policy Manager, UNEP
- Ayman Eltalouny – Programme Officer, UNEP

ASHRAE and UNEP are finalizing the 2017-2018 Work Plan – Working Beyond High- GWP Refrigerants. This is a continuing collaborative effort of the two organizations. ASHRAE provides the technical knowledge and assistance for UNEP to build bridges between industry and policy makers on feasibility of alternative refrigerants and equipment efficiency including addressing specific needs of developing countries. The two main goals of the new work plan are Advocacy and Knowledge Sharing, as well as Training, Education and Practice.

Mr. Chakroun moved:

(1) that the UNEP-ASHRAE Work Plan 2017-2019 be approved.

AI - 13

MOTION 1 PASSED (Unanimous, CNV)

AI - 14

Mr. Wentz and Mr. Olesen will appoint an UNEP/ASHRAE Presidential Ad Hoc to establish an assessment program to develop an international guideline for the safe and sustainable operation and maintenance of air-conditioning and refrigeration plants, with special focus on developing markets, and that compliance to these practices can be verified through a point-based qualification or verification scheme.

Marketing Department Report Attachment J

Mrs. Gupta reported on the status of marketing effort on behalf of the Marketing Department in the first six months of the Society year. She highlighted the Winter Conference marketing efforts, the My ASHRAE Membership Retention program, standards marketing and social media updates. The extensive presentation is attached to the minutes.

ASHRAE Website Overhaul Attachment K

Mr. Littleton reported that in the 2016-2017 budget there are funds set aside for the website overhaul. They are available to use until July 1, 2017. This can be considered a capital expense which can be depreciated over several years and does not keep us from starting now. It will not be taken from this year's budget. This will not distrupt the current website because the work is done behind the scenes with a projected timeline of 12 months. We may be fortunate to have it ready to roll out at the Winter Meeting in Chicago. This information will be reported to the Board.

Mr. Chakroun moved:

(2) that the overhaul of the ASHRAE website begin immediately.

MOTION 2 PASSED (Unanimous, CNV) AI - 15

AASA Application for ABRAFAC Brazil Attachment L

Mr. Chakroun moved:

(3) that ExCom recommends the AASA membership application of ABRAFAC - Associação Brasileira de Facilities be approved by the Board of Directors.

MOTION 3 PASSED (Unanimous, CNV) AI - 16

2016-2017 Annual Society Snapshot Strategy Attachment M

Mr. Littleton reported that there has been interest in reformatting the Society Annual Report. The new format would be a one page over-sized document that would be handed out at the Plenary Meeting in June. This would also be posted online in an effort to have it be a synopsis and timely.

Mr. Littleton will develop a new Society Annual Report format for this year's Annual Meeting in June 2017. AI - 17

Stipend for ASHRAE President Attachment N

Mr. Olesen reported that the Southern Piedmont Chapter made a motion to create an annual stipend of $100,000, paid monthly to the President of Society. It was presented to Members Council and they have referred the motion to ExCom.

Ms. Hayter moved

(4) that the motion from the Southern Piedmont Chapter for ASHRAE to create an annual stipend of $100,000, paid monthly to the President of Society, be defeated.

Discussion included:

- A leader of a volunteer organization should be a volunteer without any pay.
- One possible solution is to add more Vice Presidents to the Executive Committee.

AI - 18

MOTION 4 PASSED (Unanimous, CNV)

ASHRAE/LBNL MOU Attachment O

Mr. Chakroun moved:

(5) that ExCom recommends that the Lawrence Berkeley National Laboratory (LBNL)/ASHRAE Memorandum of Understanding be approved by the Board of Directors.

AI - 19

MOTION 5 PASSED (Unanimous, CNV)

ASHRAE/UNDP MOU Attachment P

Mr. Chakroun moved:

(6) that ExCom recommends that the United Nations Development Programme UNDP/ASHRAE Memorandum of Understanding be approved by the Board of Directors.

AI - 20

MOTION 6 PASSED (Unanimous, CNV)

ASHRAE/VDI - GBG MOU Attachment Q

Mr. Chakroun moved:

(7) that ExCom recommends that VDI – GBG/ASHRAE Memorandum of Understanding be approved by the Board of Directors.

MOTION 7 PASSED (Unanimous, CNV) AI - 21

District Energy Publication Agreement with Empower Attachment R

Mr. Chakroun reported on the ASHRAE Guide for District Cooling: Revision and Companion Operations Manual. They acknowledge the offer of support from Empower Energy Solutions. This update is needed to incorporate new developments and findings, and a guide for operators is needed to enable the benefits of District Cooling to be fully realized and its technology promise met. ASHRAE will draft a funding agreement which will be based on ASHRAE requirements and also detail the process for development. These are all listed in the attachment.

Olesen Presidential Initiatives Attachment S

Mr. Olesen reported that he recently sent a summary cover letter for his Society themes for 2017-2018 to Staff Directors for their input. He also included a detailed list of initiatives that were enclosed in an excel file. This list is under development by PEAC and will include all three councils and several of their committees. Several of the initiatives are "business as usual" where the topic is focusing on the society theme.

AIA Collaboration Attachment T

Mr. Littleton reported that AIA and ASHRAE have been having quarterly conference calls and the current attachment shows the most recent agenda and minutes of the most recent meeting. There is a good list of initiatives that have come from the meetings. They are discussing an annual form that would include consulting engineers, contractors, architects and other engineers.

Budget Impact of Combined CRC Attachment U

Mr. Littleton reported that an MBO this year for Members Council was to look at joint CRCs and the process for holding them. The attachment details budget information collected. At the current time, any request for a joint CRC needs to be presented to Members Council.

EPA Meeting Planned for April 2017

Ms. Hayter reported that the original meeting was planned for November 2016 but has been postponed until this coming April 2017. The plan is to schedule a half day with the EPA.

DOE JUMP Program Outside of North America

Ms. Hayter reported that at this juncture, there was nothing to report except that they were workiing on locking down a meeting in D. C. with Tim Unruh.

Mr. Littleton will send the potential April 2017 D.C. meeting list to Jim Scarborough. AI - 22

Future of ASHRAExCHANGE Attachment V

Mr. Wentz reported that there were great hopes for the ASHRAExCHANGE, but that the exchange has not performed up to its expectations. It appears to be supplanted by other online social media, such as Linkedin and Facebook.

Mr. Chakroun will refer the ASHRAExCHANGE back to ECC regarding the continuation of the program. AI - 23

ASHRAE Gala Awards

Mr. Wentz reported that CIBSE has a very formal awards event each year. Mr. Littleton and Ms. Hayter are attending this year. Although it is a very formal event, there is potential because we are able to connect with people in the industry we don't normally connect with at other events.

Internship Program and Job Board

Mr. Littleton reported that the Internship program is up and running on the jobs.ashrae.org page.

Workforce Foundation Update

Mr. Littleton reported that the current Workforce Foundation doesn't work for ASHRAE.

Climate Change Impact on Standards

Mr. Wentz reported that Technology Council is already integrating incremental changes.

Discussion included:

- ASHRAE should own a Net Zero Standard.
- Does a new standard need to be developed.
- Do we work within the 189.1 or is that timeline too long.

Ms. Hayter will work with Technology Council on a more global approach to a path to Net Zero. AI - 24

ASHRAE/ISHRAE MOU Attachment W

Mr. Chakroun moved:

(8) that ExCom recommends that ISHRAE/ASHRAE Memorandum of Understanding be approved by the Board of Directors.

MOTION 8 PASSED (Unanimous, CNV) AI - 25

XVII European Conference

Mr. Olesen reported he will be attending the XVII European Conference in Milan, Italy in June. Mr. Chakroun also has accepted the invitation but will only be there a short time. The main topic is working together with the major experts on refrigeration technology and its future.

Technology Council Report to Executive Committee Attachment X

Mr. Olesen moved:

(9) that the Executive Committee initiate a revision of the *Refrigerants and their Responsible Use* position document (PD).

MOTION 9 PASSED (Unanimous, CNV) AI - 26

Mr. Olesen moved:

(10) that the Executive Committee initiate a revision of the *Airborne Infectious Diseases* PD.

MOTION 10 PASSED (Unanimous, CNV) AI - 27

Mr. Olesen moved:

(11) that the Executive Committee initiate a revision of the *Climate Change* PD.

AI - 28

MOTION 11 PASSED (Unanimous, CNV)

Strategic Partnership Agreement with ASHRAE, CIBSE and REHVA Attachment Y

Mr. Chakroun moved:

(12) that the Strategic Partnership Agreement between ASHRAE, CIBSE and REHVA be approved.

MOTION 12 PASSED (Unanimous, CNV)

AI- 29

Report of the President - Attachment Z

President Wentz reported that his attached travel report reflects visits made year to date and are submitted for officer review.

Reports of Officers' CRC and Intersociety Visits

Ms. Graef reported that she attended the Building XIII Conference. There continues to be discussion about who will run this conference in the future and if ASHRAE would be willing to take a more significant role in running the event. DOE has verbally committed $60,000 to the continued operation.

Mr. Olesen reported that he attended the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) meeting. He will send a report to ExCom highlighting his visit. He would like an opportunity to present his report at the next ExCom meeting.

AI- 30

Ms. Scoggins reported that she attended the National Institute of Building Sciences (NIBS) conference .

Ms. Hayter and Mr. Littleton attended the Air Conditioning, Heating, and Refrigeration Institute (AHRI). The networking done at this event is valuable and attendance should continue.

Reports of ASHRAE Representatives

National Council of Examiners for Engineering and Surveying (NCEES)

Mr. Hayter, ASHRAE Representative to NCEES reported that there is a renewed push for requiring a master's degree for future licensing. The significant effort is centered in the State of New Jersey by the American Society of Civil Engineers (ASCE). ASHRAE is contributing to a lobbying effort with other organizations that reject this requirement.

National Institute of Building Sciences (NIBS) Attachment 1

DOE Commercial Workforce Credentialing Council Attachment 2

North American Technician Excellence (NATE) Attachment 3

Advanced Energy Design Guides (AEDG) Steering Committee Attachment 4

Executive Session

The Executive Committee had several sessions during the three-day meeting and all discussions are covered in the Executive Session minutes.

Future Meetings

2017-2018 CRC Schedule Attachment 5

Board Orientation and Committee Appointments – March 6-9, 2017

2017 Spring ExCom Meeting – March 23-26, 2017 – Kimpton Canary Hotel, Santa Barbara, CA

Adjournment

Mr. Wentz thanked everyone for coming. The meeting was adjourned on Thursday, February 2, 2017

Jeff H. Littleton, Secretary

mdt/2017-03-02

Distribution: Board of Directors
Staff Directors

Attachments:
A. Report of the Treasurer
B. Foundation Trustees Report
C. Scholarship Trustees Report
D. College of Fellows Report
E. Life Member's Club Report
F. Joint Expo Policy Committee Report
G. DOE Race to Zero Student Design Competition Presentation

H. Delivery of Handbook in Developing Economies Report
I. UNEP-ASHRAE Work Plan 2017-2018
J. Marketing Department Presentation
K. ASHRAE Website Overhaul
L. AASA Application for ABRAFAC Brazil
M. 2016-2017 Annual Society Snapshot Strategy
N. Members Council Motion to ExCom – Stipend for ASHRAE President
O. ASHRAE/LBNL Memorandum of Understanding
P. ASHRAE/UNDP Memorandum of Understanding
Q. ASHRAE/VDI-GBG Memorandum of Understanding
R. District Energy Publication Agreement with Empower
S. Olesen Presidential Initiatives
T. AIA Collaboration Report
U. Budget Impact of Combined CRCs
V. Future of ASHRAExCHANGE
W. ASHRAE/ISHRAE Memorandum of Understanding
X. Technology Council Report to the Executive Committee
Y. Strategic Partnership Agreement with ASHRAE, CIBSE and REHVA
Z. Report of the President
1. National Institute of Building Sciences Report
2. DOE Commercial Workforce Credentialing Council Report
3. North American Technician Excellence Report
4. AEDG Steering Committee Report
5. 2017-2018 CRC Schedule

ASHRAE
GENERAL, RESEARCH, COF AND LIFE MEMBERS FUNDS
STATEMENT OF FINANCIAL POSITION - COMPARATIVE
Saturday, December 31, 2016

	12/31/2016	One Year Ago 12/31/2015	Two Years Ago 12/31/2014	Three Years Ago 12/31/2013	Four Years Ago 12/31/2012	Five Years Ago 12/31/2011	Six Years Ago 12/31/2010
1 Cash	$2,221.2	$1,767.1	$1,383.7	$1,631.3	$1,508.7	$2,053.2	$1,550.8
2 Marketable Securities at Market Value	19,176.4	17,912.0	18,332.7	17,349.0	14,553.2	12,745.6	12,701.9
3 Accounts Receivable	966.2	1,161.4	1,010.8	947.7	1,258.0	1,272.9	1,054.2
4 Less: Allowance for Uncollectable Accounts	(162.2)	(274.9)	(185.2)	(90.1)	(151.0)	(126.6)	(119.7)
5 Miscellaneous Receivables & Deposits	21.4	27.1	10.6	10.7	14.2	13.6	16.2
6 Inventory	612.3	437.2	555.4	579.7	479.4	401.3	491.7
7 Prepaid Expense	484.3	684.0	438.0	562.4	525.8	382.4	783.7
8 Property and Equipment-Remaining Value	5,613.0	6,154.0	6,517.2	7,080.5	7,579.5	7,950.2	8,684.4
9 Due To (From) Other Funds				0.2			
10 TOTAL ASSETS	28,932.6	27,867.9	28,063.2	28,071.4	25,767.8	24,692.6	25,163.2
11 Accounts Payable & Accrued Expenses	4,976.6	6,119.5	5,362.0	5,571.9	5,708.0	5,512.0	5,800.5
12 Refundable Advances	11.5	7.7	9.9	1.0	1.7	10.8	3.6
13 Deferred Income	7,832.6	7,245.2	6,985.5	6,710.0	6,263.2	6,184.4	6,087.1
14 TOTAL LIABILITIES	12,820.7	13,372.4	12,357.4	12,282.9	11,972.9	11,707.2	11,891.2
15 Net Assets Beginning of Year	17,828.2	18,454.9	18,367.6	16,741.8	16,305.0	16,657.2	14,141.1
16 Net Assets -Surplus/(Deficit) for Current Yr	(1,716.3)	(3,959.4)	(2,661.8)	(953.3)	(2,510.1)	(3,671.8)	(869.1)
18 TOTAL LIABILITIES & NET ASSETS	28,932.6	27,867.9	28,063.2	28,071.4	25,767.8	24,692.6	25,163.2
19 NET ASSETS TO DATE	16,111.9	14,495.5	15,705.8	15,788.5	13,794.9	12,985.4	13,272.0

ASHRAE
ASHRAE CONSOLIDATED (excl Foundation)
For the Six Months Ending Saturday, December 31, 2016

Fiscal YTD Through Month of Dec					TWELVE MONTHS ENDING JUNE 30						DRAFT	DRAFT	DRAFT
Actual	Budget	Actual	Budget	roll up	Actual	Actual	Budget	Actual	Forecast	Budget	Budget	Budget	Budget
FY 2016	FY 2016	FY 2017	FY 2017	acct / Description	FY 2014	FY 2015	FY 2016	FY 2016	FY 2017	FY 2017	FY 2018	FY 2019	FY 2020
				REVENUES									
$3,776.5	$3,833.9	$3,796.8	$3,949.4	31 Membership Dues Earned Income	$7,325.3	$7,430.5	$7,750.2	$7,634.5	$7,806.4	$7,985.4	$7,989.0	$8,150.8	$8,301.3
1,652.9	1,750.0	1,513.5	1,770.3	32 Publication Sales Income	3,803.6	3,483.9	3,585.5	3,626.1	3,635.4	3,924.8	3,934.0	4,034.7	4,116.0
1,764.6	1,645.4	1,653.2	1,811.6	34 Advertising Income - Display	3,773.1	3,710.8	3,761.0	3,779.4	3,644.8	3,846.0	3,675.8	3,801.4	3,908.9
10.3	11.1	9.9	13.4	34 Advertising Income - Classified	26.5	32.0	25.0	19.3	18.0	25.0	25.0	25.5	25.7
322.2	325.4	394.7	329.5	34 Advertising Income - On-line	470.4	595.6	640.0	715.8	890.0	720.0	920.0	945.0	970.0
139.4	130.0	230.9	294.5	35.1 Meeting & Seminar Income	1,965.7	1,578.5	1,737.5	1,529.9	2,013.5	1,968.5	1,646.5	1,679.4	1,695.3
88.8	115.2	101.9	118.3	35.2 Certification Registration	148.5	183.3	220.0	187.6	210.0	250.0	250.0	270.0	280.0
681.8	647.9	579.7	762.7	35.3 Education Registration	1,301.6	1,504.5	1,585.0	1,844.8	1,815.0	2,060.0	2,028.0	2,296.4	2,381.9
3.2				37 Special Project Income	105.0	316.6		3.2	45.0				
494.8	446.6	521.3	496.6	38 Contribution Income	1,945.6	2,116.6	2,249.4	2,215.6	2,360.8	2,335.8	2,440.8	2,972.4	3,031.8
				41.1 AHR Exposition Income	3,973.0	5,146.6	4,757.6	5,168.0	5,500.0	5,168.0	5,702.5	4,700.0	5,041.0
10.0	(47.6)	90.0	90.0	41.2 Contributions and Matching Gifts	130.0	115.0	59.4	57.0	137.3	140.9	59.5	59.5	59.7
34.0	60.0	162.3	84.0	41.3 Exposition Income - Other Countries		145.9	60.0	34.0	162.3	84.0		50.0	
327.6	349.8	1,014.7	1,134.7	44 Reserve Transfers	1,025.5	885.7	641.4	655.3	1,747.3	2,269.4	2,014.0	948.4	976.8
99.3	123.2	103.5	149.5	46 Miscellaneous Income	340.7	534.4	299.1	322.7	355.9	352.9	334.5	340.1	350.3
9,405.4	**9,390.9**	**10,172.4**	**11,004.5**	**TOTAL REVENUES**	**26,334.5**	**27,779.9**	**27,371.1**	**27,793.2**	**30,341.7**	**31,130.7**	**31,019.6**	**30,273.6**	**31,138.7**
				EXPENSES:									
4,309.8	4,436.3	4,306.3	4,315.2	51 Salary Expense	7,523.6	7,910.9	8,403.1	8,780.7	8,809.2	8,891.9	9,233.5	9,406.5	9,688.7
1,324.1	1,242.7	1,283.4	1,328.2	52 Payroll Taxes, Benefits, Personnel Exp	2,271.7	2,536.2	2,392.2	2,738.8	2,599.6	2,654.7	2,736.4	2,795.4	3,009.5
1,731.8	1,504.8	1,462.7	1,915.1	61 Publishing and Promotion Expense	3,569.1	3,776.9	3,777.2	3,827.9	3,649.3	3,935.8	3,877.5	3,875.6	3,984.5
657.9	718.4	653.1	644.4	64 Meetings & Conferences Expense	2,293.1	2,199.2	2,279.1	2,362.8	2,854.1	2,786.2	2,468.5	2,395.7	2,465.2
691.3	1,141.0	908.4	1,119.8	66 Travel Expense	2,265.6	2,076.6	2,321.5	1,863.8	2,485.2	2,515.0	2,638.8	2,543.9	2,619.6
83.1	77.2	100.6	71.5	68 Awards, Certif, Logo Cost of Goods Sold	119.7	164.6	149.2	158.5	153.6	153.6	159.8	163.0	167.9
1,081.5	1,647.3	968.2	1,355.4	71 Research Projects & Grants Expense	2,649.6	2,469.6	2,678.0	2,321.1	3,606.3	3,953.6	3,177.7	2,658.3	2,670.6
50.0	55.0	122.1	112.0	73 Special Projects Expense	50.0	72.5	110.0	101.3	181.0	162.0	70.0		
46.8	25.5	44.3	31.8	76 Public Relations Expense	129.1	51.0	62.3	79.4	64.1	64.1	66.7	68.0	70.1
307.8	319.1	273.9	307.5	78 Occupancy & Insurance	563.4	559.2	575.9	588.6	595.7	595.7	619.5	631.9	650.8
906.9	800.0	763.3	892.9	82 Office Expense and Organizational Dues	1,746.9	1,840.2	1,892.7	1,862.7	2,014.6	2,002.1	2,156.6	2,125.4	2,178.4
732.5	986.7	875.5	1,268.8	84 Outside Services Expense	1,528.0	1,659.7	1,980.0	1,713.1	2,607.7	2,713.8	2,579.1	2,153.9	2,226.1
362.6	238.3	177.4	334.5	88 Other Expense	542.9	530.8	555.6	673.6	662.3	685.5	691.9	706.6	726.8
(532.2)		(375.9)	(237.5)	88.1 Prepaid Expense (contra acct)	(18.3)	33.8		(560.5)	(475.0)	(475.0)	(475.0)	(475.0)	(489.3)
	50.0	130.3	190.0	89 Opportunity Fund	35.0	35.5	100.0		240.0	240.0	240.0	100.0	100.0
292.8	292.7	267.4	276.5	90 Depreciation Expense	660.9	631.9	543.5	579.3	534.7	534.7	720.7	821.6	846.2
	2.3	0.3	73.1	91 Allocation of Overhead & BOD			0.0	0.0	0.0	0.0	0.0	0.0	33.0
12,046.7	**13,537.3**	**11,961.3**	**13,999.2**	**TOTAL EXPENSES**	**25,930.3**	**26,548.6**	**27,820.3**	**27,091.1**	**30,582.4**	**31,413.7**	**30,961.7**	**29,970.8**	**30,948.1**
(2,641.3)	(4,146.4)	(1,788.9)	(2,994.7)	SURPLUS (DEFICIT) before reserve income	404.2	1,231.3	(449.2)	702.1	(240.7)	(283.0)	57.9	302.8	190.6
				91.5 Headquarters Building Renewal Contributions	0.3								
				91.7 Gain on Merger		153.9							
281.3	210.5	53.8	222.5	92 Non-recurring Expenses	474.8	639.5	590.0	477.9	350.0	350.0			
				Reserve Investment Income:									
(709.4)	550.3	1,141.0	932.6	95 Investmt Income - Reserves (net of exp)	2,721.8	222.5	923.0	(186.1)	798.3	798.3	847.8	869.5	895.6
(327.6)	(349.9)	(1,014.7)	(1,134.7)	96 Transfer Reserves Portion Used Currently	(1,025.5)	(885.7)	(641.4)	(655.3)	(1,747.3)	(2,269.4)	(2,014.0)	(948.4)	(976.8)
(1,037.0)	200.4	126.3	(202.1)	Remaining Reserve Investment Income	1,696.3	(663.2)	281.6	(841.4)	(949.0)	(1,471.1)	(1,166.2)	(78.9)	(81.2)
(3,959.6)	**(4,156.5)**	**(1,716.4)**	**(3,419.3)**	**OVERALL SURPLUS (DEFICIT) after reserve incor**	**1,626.0**	**82.5**	**(757.6)**	**(617.2)**	**(1,539.7)**	**(2,104.1)**	**(1,108.3)**	**223.9**	**109.4**

ASHRAE
GENERAL (Fund 2)
For the Six Months Ending Saturday, December 31, 2016

Fiscal YTD Through Month of Dec					TWELVE MONTHS ENDING JUNE 30						DRAFT	DRAFT	DRAFT
Actual	Budget	Actual	Budget	roll up	Actual	Actual	Budget	Actual	Forecast	Budget	Budget	Budget	Budget
FY 2016	FY 2016	FY 2017	FY 2017	acct / Description	FY 2014	FY 2015	FY 2016	FY 2016	FY 2017	FY 2017	FY 2018	FY 2019	FY 2020
				REVENUES									
$3,700.9	$3,750.4	$3,720.9	$3,871.8	31 Membership Dues Earned Income	$7,178.7	$7,281.8	$7,595.7	$7,481.7	$7,649.6	$7,828.6	$7,832.0	$7,988.8	$8,136.3
1,652.9	1,750.0	1,513.5	1,770.3	32 Publication Sales Income	3,803.6	3,483.9	3,585.5	3,626.1	3,635.4	3,924.8	3,934.0	4,034.7	4,116.0
1,764.6	1,645.4	1,653.2	1,811.6	34 Advertising Income - Display	3,773.1	3,710.8	3,761.0	3,779.4	3,644.8	3,846.0	3,675.8	3,801.4	3,908.9
10.3	11.1	9.9	13.4	34 Advertising Income - Classified	26.5	32.0	25.0	19.3	18.0	25.0	25.0	25.5	25.7
322.2	325.4	394.7	329.5	34 Advertising Income - On-line	470.4	595.6	640.0	715.8	890.0	720.0	920.0	945.0	970.0
139.4	130.0	230.9	294.5	35.1 Meeting & Seminar Income	1,965.7	1,578.5	1,737.5	1,529.9	2,013.5	1,968.5	1,646.5	1,679.4	1,695.3
88.8	115.2	101.9	118.3	35.2 Certification Registration	148.5	183.3	220.0	187.6	210.0	250.0	250.0	270.0	280.0
681.8	647.9	579.7	762.7	35.3 Education Registration	1,301.6	1,504.5	1,585.0	1,844.8	1,815.0	2,060.0	2,028.0	2,296.4	2,381.9
3.2				37 Special Project Income	50.0	316.6		3.2	45.0				
11.2	6.3	19.1	12.6	38 Contribution Income	47.2	72.7	30.4	104.2	41.0	41.0	42.3	525.9	536.4
				41.1 AHR Exposition Income	3,973.0	5,146.6	4,757.6	5,168.0	5,500.0	5,168.0	5,702.5	4,700.0	5,041.0
10.0	(47.6)	90.0	90.0	41.2 Contributions and Matching Gifts	(1,859.2)	(1,699.5)	(1,839.0)	(1,841.4)	(1,862.7)	(1,859.3)	(1,940.5)	(1,769.4)	(1,824.0)
34.0	60.0	162.3	84.0	41.3 Exposition Income - Other Countries		145.9	60.0	34.0	162.3	84.0		50.0	
199.2	217.3	310.7	430.7	44 Reserve Transfers	489.2	314.5	398.4	398.4	726.4	861.4	1,329.0	733.4	755.4
99.3	121.5	103.5	147.8	46 Miscellaneous Income	341.9	534.4	295.9	322.7	352.5	349.5	331.0	336.5	346.6
8,717.8	**8,732.9**	**8,890.3**	**9,737.2**	**TOTAL REVENUES**	**21,710.2**	**23,201.6**	**22,853.0**	**23,373.7**	**24,840.8**	**25,267.5**	**25,775.6**	**25,617.6**	**26,369.5**
				EXPENSES:									
4,022.4	4,126.8	4,028.9	4,033.8	51 Salary Expense	6,988.0	7,357.2	7,832.3	8,205.5	8,245.8	8,328.5	8,643.3	8,805.2	9,046.3
1,239.8	1,161.7	1,206.6	1,244.9	52 Payroll Taxes, Benefits, Personnel Exp	2,119.3	2,375.3	2,241.5	2,581.5	2,437.8	2,493.0	2,571.5	2,627.1	2,829.6
1,697.5	1,451.8	1,437.4	1,895.7	61 Publishing and Promotion Expense	3,524.7	3,757.5	3,673.9	3,786.5	3,545.1	3,831.6	3,772.2	3,844.6	3,952.6
637.7	706.6	627.9	635.5	64 Meetings & Conferences Expense	2,286.6	2,178.5	2,262.2	2,335.7	2,832.7	2,768.8	2,450.4	2,377.3	2,446.2
645.3	1,054.6	842.7	1,044.2	66 Travel Expense	2,138.0	1,954.6	2,190.1	1,776.0	2,353.2	2,382.7	2,501.6	2,403.9	2,475.5
37.7	45.0	42.9	39.6	68 Awards, Certif, Logo Cost of Goods Sold	86.9	98.9	116.5	90.9	120.0	120.0	124.8	127.3	131.1
109.0	110.8	110.9	117.4	71 Research Projects & Grants Expense	106.5	100.9	127.5	121.7	131.3	131.3	136.6	139.3	143.5
50.0	55.0	122.1	112.0	73 Special Projects Expense	50.0	72.5	110.0	101.3	181.0	162.0	70.0		
46.8	25.4	44.3	31.7	76 Public Relations Expense	129.1	51.0	62.0	79.4	63.9	63.9	66.5	67.8	69.8
307.8	319.1	273.9	307.5	78 Occupancy & Insurance	563.4	559.2	575.9	588.6	595.7	595.7	619.5	631.9	650.8
877.1	771.2	740.3	858.1	82 Office Expense and Organizational Dues	1,704.0	1,788.1	1,835.4	1,815.0	1,957.9	1,944.1	2,096.2	2,064.0	2,115.0
727.5	986.7	875.5	1,268.8	84 Outside Services Expense	1,528.0	1,654.6	1,980.0	1,717.7	2,607.7	2,713.8	2,579.1	2,153.9	2,226.1
348.9	214.3	162.5	316.0	88 Other Expense	496.8	487.8	491.4	623.2	596.1	619.3	623.0	636.4	654.4
(532.2)		(375.9)	(237.5)	88.1 Prepaid Expense (contra acct)	(18.3)	33.8		(560.5)	(475.0)	(475.0)	(475.0)	(475.0)	(489.3)
	50.0	130.3	190.0	89 Opportunity Fund	35.0	35.5	100.0		240.0	240.0	240.0	100.0	100.0
292.8	292.7	267.4	276.5	90 Depreciation Expense	660.9	631.9	543.5	579.3	534.7	534.7	720.7	821.6	846.2
(357.4)	(438.9)	(391.6)	(363.5)	91 Allocation of Overhead & BOD	(730.0)	(808.5)	(840.0)	(750.3)	(886.5)	(903.9)	(1,022.7)	(1,010.3)	(1,019.1)
10,150.7	**10,932.8**	**10,146.1**	**11,770.7**	**TOTAL EXPENSES**	**21,668.9**	**22,328.8**	**23,302.2**	**23,091.5**	**25,081.4**	**25,550.5**	**25,717.7**	**25,315.0**	**26,178.7**
(1,432.9)	(2,199.9)	(1,255.8)	(2,033.5)	SURPLUS (DEFICIT) before reserve income	41.3	872.8	(449.2)	282.2	(240.6)	(283.0)	57.9	302.6	190.8
				91.5 Headquarters Building Renewal Contrib	0.3								
281.3	210.5	53.8	222.5	92 Non-recurring Expenses	474.8	639.5	590.0	477.9	350.0	350.0			
				Reserve Investment Income:									
(460.2)	370.9	792.1	623.7	95 Investmt Income - Reserves (net of exp)	1,778.1	146.5	603.0	(115.9)	566.1	566.1	614.7	634.0	653.1
(199.2)	(217.3)	(310.7)	(430.7)	96 Transfer Reserves Portion Used Currently	(489.2)	(314.5)	(398.4)	(398.4)	(726.4)	(861.4)	(1,329.0)	(733.4)	(755.4)
(659.4)	153.6	481.4	193.0	Remaining Reserve Investment Income	1,288.9	(168.0)	204.6	(514.3)	(160.3)	(295.3)	(714.3)	(99.4)	(102.3)
(2,373.6)	**(2,256.8)**	**(828.2)**	**(2,063.0)**	**OVERALL SURPLUS (DEFICIT) after reser**	**855.7**	**65.3**	**(834.6)**	**(710.0)**	**(750.9)**	**(928.3)**	**(656.4)**	**203.2**	**88.5**

ASHRAE
BOARD OF DIRECTORS 2-5nn
For the Six Months Ending Saturday, December 31, 2016

Fiscal YTD Through Month of Dec					TWELVE MONTHS ENDING JUNE 30						DRAFT	DRAFT	DRAFT
Actual	Budget	Actual	Budget	roll up	Actual	Actual	Budget	Actual	Forecast	Budget	Budget	Budget	Budget
FY 2016	FY 2016	FY 2017	FY 2017	acct / Description	FY 2014	FY 2015	FY 2016	FY 2016	FY 2017	FY 2017	FY 2018	FY 2019	FY 2020
				REVENUES									
	$3.1		$4.0	38 Contribution Income	$4.5	$23.5	$8.0		$8.0	$8.0	$8.3	$491.5	$501.3
	0.0	80.0	80.0	41.2 Contributions and Matching Gifts			0.0	0.0	22.0	22.0	(58.0)	(59.2)	(61.0)
			120.0	44 Reserve Transfers					105.0	240.0	610.0		
0.3			5.0	46 Miscellaneous Income	2.5	0.0		0.3	5.0	5.0	5.2	5.3	5.5
0.3	**3.1**	**80.0**	**209.0**	**TOTAL REVENUES**	**7.0**	**23.5**	**8.0**	**0.3**	**140.0**	**275.0**	**565.5**	**437.6**	**445.8**
				EXPENSES:									
407.6	592.9	415.1	438.4	51 Salary Expense	735.7	695.8	1,039.3	811.0	887.6	947.1	992.3	1,010.9	961.6
121.4	155.5	113.5	129.3	52 Payroll Taxes, Benefits, Personnel Exp	214.4	193.2	274.4	245.1	252.1	265.3	270.4	276.1	271.0
3.8	49.2	31.1	69.9	61 Publishing and Promotion Expense	69.4	10.0	107.3	26.9	120.7	141.7	222.2	217.4	223.9
19.0	23.5	28.3	12.9	64 Meetings & Conferences Expense	71.0	64.0	61.6	84.0	86.2	70.7	109.6	86.0	88.6
232.5	444.5	347.4	448.1	66 Travel Expense	1,017.9	873.1	1,036.8	782.6	1,055.1	1,067.6	1,164.6	1,090.4	1,123.1
1.1	0.8	2.4	0.9	68 Awards, Certif, Logo Cost of Goods Sold	9.1	14.9	3.7	9.9	3.8	3.8	3.9	4.0	4.1
				71 Research Projects & Grants Expense	7.1	7.2	7.8	7.3	8.1	8.1	8.4	8.6	8.8
				76 Public Relations Expense	1.2	0.1							
12.3	24.5	8.9	30.4	82 Office Expense and Organizational Dues	42.6	32.5	44.8	16.5	45.4	57.4	64.9	65.8	67.8
34.5	135.2	93.5	250.0	84 Outside Services Expense	69.2	50.9	191.6	73.2	543.7	578.7	458.3	193.8	199.6
	5.3		11.3	88 Other Expense	0.5	1.9	10.6	7.0	12.7	22.6	31.6	25.6	26.4
0.0		0.0	0.0	88.1 Prepaid Expense (contra acct)				0.0	0.0	0.0	0.0	0.0	0.0
	50.0		50.0	89 Opportunity Fund	35.0	35.5	100.0		100.0	100.0	100.0	100.0	100.0
0.2				90 Depreciation Expense	4.1	3.2		0.2					
(832.7)	(1,443.6)	(1,084.0)	(1,311.3)	91 Allocation of Overhead & BOD	(2,277.4)	(1,957.4)	(2,877.9)	(2,064.0)	(3,115.4)	(3,250.0)	(3,426.2)	(3,078.6)	(3,074.9)
(0.3)	**37.8**	**(43.8)**	**129.9**	**TOTAL EXPENSES**		**24.9**	**0.0**	**(0.3)**	**0.0**	**13.0**	**0.0**	**0.0**	**0.0**
0.6	(34.7)	123.8	79.1	SURPLUS (DEFICIT) before reserve income	7.0	(1.4)	8.0	0.6	140.0	262.0	565.5	437.6	445.8
				Reserve Investment Income:									
			(120.0)	96 Transfer Reserves Portion Used Currently					(105.0)	(240.0)	(610.0)		
			(120.0)	Remaining Reserve Investment Income					(105.0)	(240.0)	(610.0)		
0.6	**(34.7)**	**123.8**	**(40.9)**	**OVERALL SURPLUS (DEFICIT) after reser**	**7.0**	**(1.4)**	**8.0**	**0.6**	**35.0**	**22.0**	**(44.5)**	**437.6**	**445.8**

ASHRAE
OVERHEAD 2-9nn
For the Six Months Ending Saturday, December 31, 2016

Fiscal YTD Through Month of Dec					TWELVE MONTHS ENDING JUNE 30						DRAFT	DRAFT	DRAFT
Actual	Budget	Actual	Budget	roll up	Actual	Actual	Budget	Actual	Forecast	Budget	Budget	Budget	Budget
FY 2016	FY 2016	FY 2017	FY 2017	acct / Description	FY 2014	FY 2015	FY 2016	FY 2016	FY 2017	FY 2017	FY 2018	FY 2019	FY 2020
				REVENUES									
				41.1 AHR Exposition Income	$3,973.0	$5,146.6	$4,757.6	$5,168.0	$5,500.0	$5,168.0	$5,702.5	$4,700.0	$5,041.0
				41.2 Contributions and Matching Gifts	(1,989.2)	(1,814.5)	(1,898.4)	(1,898.4)	(2,000.0)	(2,000.2)	(2,000.0)	(1,828.9)	(1,883.8)
34.0	60.0	162.3	84.0	41.3 Exposition Income - Other Countries		145.9	60.0	34.0	162.3	84.0		50.0	
199.2	217.3	310.7	310.7	44 Reserve Transfers	489.2	314.5	398.4	398.4	621.4	621.4	719.0	733.4	755.4
(10.1)	17.9	12.9	14.0	46 Miscellaneous Income	24.0	(47.2)	31.7	5.0	32.0	32.0	33.2	33.9	34.9
223.1	**295.2**	**485.9**	**408.7**	**TOTAL REVENUES**	**2,497.0**	**3,745.3**	**3,349.3**	**3,707.0**	**4,315.7**	**3,905.2**	**4,454.7**	**3,688.4**	**3,947.5**
				EXPENSES:									
1,036.2	987.7	1,063.6	1,027.0	51 Salary Expense	1,784.0	1,862.3	2,062.2	2,155.0	2,156.9	2,156.9	2,259.7	2,302.1	2,402.8
336.6	324.6	330.2	332.7	52 Payroll Taxes, Benefits, Personnel Exp	548.2	746.4	669.0	724.4	634.3	664.9	736.9	751.9	924.1
3.5	2.4	7.8	29.2	61 Publishing and Promotion Expense	5.1	21.8	26.8	24.8	106.0	116.0	116.4	116.7	120.2
5.2	8.8	8.3	5.7	64 Meetings & Conferences Expense	7.8	10.7	13.3	13.5	13.7	13.7	14.2	14.5	15.0
53.0	49.9	68.2	43.1	66 Travel Expense	92.4	87.0	87.0	96.4	109.6	89.6	93.2	95.0	97.9
		21.7	13.0	68 Awards, Certif, Logo Cost of Goods Sold					26.0	26.0	27.1	27.6	28.4
46.8	24.2	44.3	30.4	76 Public Relations Expense	127.9	50.9	59.6	79.4	61.4	61.4	63.9	65.2	67.1
281.1	297.8	254.3	281.6	78 Occupancy & Insurance	527.1	523.2	535.8	548.0	554.4	554.4	576.6	588.1	605.7
189.3	188.6	188.3	172.9	82 Office Expense and Organizational Dues	328.2	374.5	352.4	342.1	378.2	368.2	385.7	395.2	407.0
252.3	269.6	274.5	304.1	84 Outside Services Expense	478.7	454.8	502.0	457.5	504.7	510.0	571.1	583.3	600.8
53.8	41.0	58.0	59.3	88 Other Expense	93.5	83.7	72.1	102.4	109.7	109.7	116.3	122.1	125.8
279.2	292.7	267.3	276.5	90 Depreciation Expense	568.8	556.0	543.5	559.9	534.7	534.7	720.7	821.6	846.2
(2,516.2)	(2,623.6)	(2,586.6)	(2,659.0)	91 Allocation of Overhead & BOD	(4,547.6)	(4,740.0)	(4,923.7)	(5,037.2)	(5,189.7)	(5,205.5)	(5,681.8)	(5,883.3)	(6,241.0)
20.8	**(136.3)**		**(83.5)**	**TOTAL EXPENSES**	**14.1**	**31.3**	**0.0**	**66.2**	**(0.1)**	**0.0**	**0.0**	**0.0**	**0.0**
202.3	431.5	485.9	492.2	SURPLUS (DEFICIT) before reserve income	2,482.9	3,714.0	3,349.3	3,640.8	4,315.8	3,905.2	4,454.7	3,688.4	3,947.5
				91.5 Headquarters Building Renewal Contributions	0.3								
77.9				92 Non-recurring Expenses		161.2	90.0	157.7					
				Reserve Investment Income:									
(460.2)	370.9	792.1	623.7	95 Investmt Income - Reserves (net of exp)	1,778.1	146.5	603.0	(115.9)	566.1	566.1	614.7	634.0	653.1
(199.2)	(217.3)	(310.7)	(310.7)	96 Transfer Reserves Portion Used Currently	(489.2)	(314.5)	(398.4)	(398.4)	(621.4)	(621.4)	(719.0)	(733.4)	(755.4)
(659.4)	153.6	481.4	313.0	Remaining Reserve Investment Income	1,288.9	(168.0)	204.6	(514.3)	(55.3)	(55.3)	(104.3)	(99.4)	(102.3)
(535.0)	**585.1**	**967.3**	**805.2**	**OVERALL SURPLUS (DEFICIT) after reserve incon**	**3,772.1**	**3,384.8**	**3,463.9**	**2,968.8**	**4,260.5**	**3,849.9**	**4,350.4**	**3,589.0**	**3,845.2**

ASHRAE
MEMBERS COUNCIL (2-2nn & 2-8nn)
For the Six Months Ending Saturday, December 31, 2016

Fiscal YTD Through Month of Dec					TWELVE MONTHS ENDING JUNE 30						DRAFT	DRAFT	DRAFT
Actual	Budget	Actual	Budget	roll up	Actual	Actual	Budget	Actual	Forecast	Budget	Budget	Budget	Budget
FY 2016	FY 2016	FY 2017	FY 2017	acct / Description	FY 2014	FY 2015	FY 2016	FY 2016	FY 2017	FY 2017	FY 2018	FY 2019	FY 2020
				REVENUES									
$3,700.9	$3,750.4	$3,720.9	$3,871.8	31 Membership Dues Earned Income	$7,178.7	$7,281.8	$7,595.7	$7,481.7	$7,649.6	$7,828.6	$7,832.0	$7,988.8	$8,136.3
139.4	130.0	230.9	294.5	35.1 Meeting & Seminar Income	1,965.7	1,578.5	1,737.5	1,529.9	2,013.5	1,968.5	1,646.5	1,679.4	1,695.3
7.6		16.9	4.5	38 Contribution Income	25.6	38.4	8.4	92.1	18.7	18.7	19.0	19.2	19.6
10.0	10.4	10.0	10.0	41.2 Contributions and Matching Gifts	20.0	20.0	20.4	20.0	20.3	20.3	20.7	20.9	21.6
56.5	28.2	58.3	49.8	46 Miscellaneous Income	103.0	153.3	83.6	117.9	99.7	99.7	72.6	74.1	76.3
3,914.4	**3,919.0**	**4,037.0**	**4,230.6**	**TOTAL REVENUES**	**9,293.0**	**9,072.0**	**9,445.6**	**9,241.6**	**9,801.8**	**9,935.8**	**9,590.8**	**9,782.4**	**9,949.1**
				EXPENSES:									
648.5	670.9	659.4	673.0	51 Salary Expense	1,175.4	1,135.0	1,243.3	1,330.7	1,369.7	1,369.7	1,448.2	1,475.3	1,367.7
187.8	175.5	180.8	199.7	52 Payroll Taxes, Benefits, Personnel Exp	342.6	313.7	328.3	404.7	399.0	399.0	406.7	415.2	383.1
144.9	124.0	148.8	148.2	61 Publishing and Promotion Expense	339.3	422.2	404.5	398.0	313.6	313.6	327.7	337.9	348.0
426.2	491.4	338.2	374.6	64 Meetings & Conferences Expense	1,841.9	1,644.0	1,740.7	1,658.4	2,123.7	2,103.3	1,720.0	1,641.7	1,691.0
304.6	414.2	304.9	436.2	66 Travel Expense	667.6	668.7	731.9	625.0	835.7	843.6	849.3	817.5	842.0
37.0	43.0	18.7	24.5	68 Awards, Certif, Logo Cost of Goods Sold	76.6	82.8	108.8	80.0	86.0	86.0	89.4	91.2	94.0
109.0	110.8	110.9	117.4	71 Research Projects & Grants Expense	99.4	93.7	119.6	114.4	123.2	123.2	128.2	130.7	134.7
156.2	174.7	142.6	151.9	82 Office Expense and Organizational Dues	330.0	299.4	359.4	319.9	370.3	370.3	461.0	393.7	405.5
63.8	47.9	43.6	84.1	84 Outside Services Expense	178.1	175.2	178.4	195.6	278.5	278.5	295.2	194.0	199.8
134.6	128.7	147.5	140.0	88 Other Expense	259.2	294.1	246.1	285.9	316.2	323.2	317.7	324.2	334.0
(289.5)		(132.7)		88.1 Prepaid Expense (contra acct)	2.0	13.5		(8.8)					
		130.3	140.0	89 Opportunity Fund					140.0	140.0	140.0		
806.5	953.2	917.4	924.3	91 Allocation of Overhead & BOD	1,603.9	1,657.9	1,829.6	1,736.4	1,928.6	1,966.7	1,986.8	1,963.0	2,044.3
2,729.6	**3,334.3**	**3,010.4**	**3,413.9**	**TOTAL EXPENSES**	**6,916.0**	**6,800.2**	**7,290.6**	**7,140.2**	**8,284.5**	**8,317.1**	**8,170.2**	**7,784.4**	**7,844.1**
1,184.8	584.7	1,026.6	816.7	SURPLUS (DEFICIT) before reserve income	2,377.0	2,271.8	2,155.0	2,101.4	1,517.3	1,618.7	1,420.6	1,998.0	2,105.0
1,184.8	**584.7**	**1,026.6**	**816.7**	**OVERALL SURPLUS (DEFICIT) after reserve incon**	**2,377.0**	**2,271.8**	**2,155.0**	**2,101.4**	**1,517.3**	**1,618.7**	**1,420.6**	**1,998.0**	**2,105.0**

ASHRAE
PUBLISHING & EDUCATION COUNCIL (2-4nn & 5-5nn)
For the Six Months Ending Saturday, December 31, 2016

Fiscal YTD Through Month of Dec					TWELVE MONTHS ENDING JUNE 30						DRAFT	DRAFT	DRAFT
Actual	Budget	Actual	Budget	roll up	Actual	Actual	Budget	Actual	Forecast	Budget	Budget	Budget	Budget
FY 2016	FY 2016	FY 2017	FY 2017	acct / Description	FY 2014	FY 2015	FY 2016	FY 2016	FY 2017	FY 2017	FY 2018	FY 2019	FY 2020
				REVENUES									
$1,652.9	$1,750.0	$1,513.5	$1,770.3	32 Publication Sales Income	$3,803.6	$3,483.9	$3,585.5	$3,626.1	$3,635.4	$3,924.8	$3,934.0	$4,034.7	$4,116.0
1,764.6	1,645.4	1,653.2	1,811.6	34 Advertising Income - Display	3,773.1	3,710.8	3,761.0	3,779.4	3,644.8	3,846.0	3,675.8	3,801.4	3,908.9
10.3	11.1	9.9	13.4	34 Advertising Income - Classified	26.5	32.0	25.0	19.3	18.0	25.0	25.0	25.5	25.7
322.2	325.4	394.7	329.5	34 Advertising Income - On-line	470.4	595.6	640.0	715.8	890.0	720.0	920.0	945.0	970.0
88.8	115.2	101.9	118.3	35.2 Certification Registration	148.5	183.3	220.0	187.6	210.0	250.0	250.0	270.0	280.0
681.8	647.9	579.7	762.7	35.3 Education Registration	1,301.6	1,504.5	1,585.0	1,844.8	1,815.0	2,060.0	2,028.0	2,296.4	2,381.9
				37 Special Project Income	45.0	230.0							
3.6	3.2	2.2	4.1	38 Contribution Income	17.0	10.8	13.9	12.1	14.3	14.3	14.9	15.2	15.5
				41.2 Contributions and Matching Gifts	110.0	95.0	97.0	95.0	95.0	98.6	96.8	97.7	99.2
46.6	55.9	17.2	66.0	46 Miscellaneous Income	195.3	143.1	155.2	184.4	189.8	186.8	192.9	195.6	201.5
4,570.8	**4,554.1**	**4,272.3**	**4,875.9**	**TOTAL REVENUES**	**9,891.0**	**9,989.0**	**10,082.6**	**10,464.5**	**10,512.3**	**11,125.5**	**11,137.4**	**11,681.5**	**11,998.7**
				EXPENSES:									
1,189.1	1,275.4	1,128.3	1,197.4	51 Salary Expense	2,232.8	2,218.4	2,364.0	2,411.7	2,411.7	2,434.9	2,455.5	2,501.5	2,660.5
379.4	349.3	374.1	377.4	52 Payroll Taxes, Benefits, Personnel Exp	717.3	706.0	673.2	780.7	744.9	756.3	742.1	759.6	805.8
1,544.5	1,275.6	1,248.0	1,647.3	61 Publishing and Promotion Expense	3,105.4	3,302.7	3,133.0	3,331.8	3,002.6	3,258.1	3,103.5	3,170.3	3,258.0
181.9	170.3	239.2	235.2	64 Meetings & Conferences Expense	354.7	451.6	426.8	564.6	588.0	560.0	585.2	613.3	629.3
33.9	73.9	51.5	70.5	66 Travel Expense	196.9	178.4	187.1	137.8	176.7	205.7	212.9	216.3	222.2
(0.3)	1.2	0.1	1.3	68 Awards, Certif, Logo Cost of Goods Sold	0.8	1.0	2.5	0.8	2.6	2.6	2.7	2.7	2.8
26.7	21.4	19.5	25.9	78 Occupancy & Insurance	36.3	36.1	40.1	40.6	41.3	41.3	42.9	43.8	45.1
425.5	372.6	395.3	393.3	82 Office Expense and Organizational Dues	894.2	963.5	969.4	1,036.6	1,043.3	1,027.5	1,058.0	1,081.4	1,103.0
339.8	506.0	452.8	603.1	84 Outside Services Expense	744.5	817.2	1,054.3	938.3	1,225.6	1,291.3	1,197.0	1,124.2	1,165.5
160.4	39.3	(43.1)	105.4	88 Other Expense	143.7	108.1	162.5	227.7	157.3	163.6	157.3	164.3	168.1
				90 Depreciation Expense	61.0	45.8							
1,481.1	1,819.4	1,563.5	1,802.9	91 Allocation of Overhead & BOD	3,048.4	3,237.1	3,478.9	3,147.3	3,713.9	3,787.1	4,208.9	4,158.5	4,330.7
5,762.0	**5,904.4**	**5,429.2**	**6,459.7**	**TOTAL EXPENSES**	**11,536.0**	**12,065.9**	**12,491.8**	**12,617.9**	**13,107.9**	**13,528.4**	**13,766.0**	**13,835.9**	**14,391.0**
(1,191.2)	(1,350.3)	(1,156.9)	(1,583.8)	SURPLUS (DEFICIT) before reserve income	(1,645.0)	(2,076.9)	(2,409.2)	(2,153.4)	(2,595.6)	(2,402.9)	(2,628.6)	(2,154.4)	(2,392.3)
(1,191.2)	**(1,350.3)**	**(1,156.9)**	**(1,583.8)**	**OVERALL SURPLUS (DEFICIT) after reserve incon**	**(1,645.0)**	**(2,076.9)**	**(2,409.2)**	**(2,153.4)**	**(2,595.6)**	**(2,402.9)**	**(2,628.6)**	**(2,154.4)**	**(2,392.3)**

ASHRAE
TECHNOLOGY COUNCIL
For the Six Months Ending Saturday, December 31, 2016

Fiscal YTD Through Month of Dec					TWELVE MONTHS ENDING JUNE 30						DRAFT	DRAFT	DRAFT
Actual	Budget	Actual	Budget	roll up	Actual	Actual	Budget	Actual	Forecast	Budget	Budget	Budget	Budget
FY 2016	FY 2016	FY 2017	FY 2017	acct / Description	FY 2014	FY 2015	FY 2016	FY 2016	FY 2017	FY 2017	FY 2018	FY 2019	FY 2020
				REVENUES									
$3.2				37 Special Project Income	$5.0	$86.6		$3.2	$45.0				
6.0	19.5	15.1	13.0	46 Miscellaneous Income	17.0	12.2	25.3	15.0	26.0	26.0	27.1	27.6	28.4
9.2	**19.5**	**15.1**	**13.0**	**TOTAL REVENUES**	**22.0**	**98.8**	**25.3**	**18.2**	**71.0**	**26.0**	**27.1**	**27.6**	**28.4**
				EXPENSES:									
565.6	599.8	582.4	528.3	51 Salary Expense	1,060.1	1,108.7	1,123.5	1,125.8	1,060.9	1,060.9	1,111.5	1,132.3	1,264.3
164.5	156.8	158.6	156.1	52 Payroll Taxes, Benefits, Personnel Exp	296.7	322.2	296.6	322.8	304.6	304.6	310.5	317.0	345.6
(0.3)	0.7	0.1	1.0	61 Publishing and Promotion Expense	5.5	0.8	2.2	0.3	2.3	2.3	2.4	2.4	2.5
2.0	12.7	13.8	7.1	64 Meetings & Conferences Expense	11.3	8.2	19.8	8.8	21.2	21.2	21.5	21.8	22.4
16.9	72.1	65.5	46.1	66 Travel Expense	163.2	132.5	147.4	93.2	176.1	176.1	181.6	184.8	190.3
				68 Awards, Certif, Logo Cost of Goods Sold	0.4	0.3	1.6	0.3	1.6	1.6	1.7	1.7	1.8
50.0	55.0	122.1	112.0	73 Special Projects Expense	50.0	72.5	110.0	101.3	181.0	162.0	70.0		
	1.2		1.2	76 Public Relations Expense			2.4		2.5	2.5	2.6	2.6	2.7
87.4	10.8	0.7	109.6	82 Office Expense and Organizational Dues	109.0	90.1	109.5	88.9	120.7	120.7	126.5	127.9	131.7
34.8	28.1	8.9	27.5	84 Outside Services Expense	57.5	2.8	53.7	39.3	55.3	55.3	57.4	58.6	60.3
0.0	0.1		0.1	88 Other Expense			0.1	0.0	0.1	0.1	0.1	0.1	0.1
				88.1 Prepaid Expense (contra acct)	(20.3)	20.3							
13.5		0.0		90 Depreciation Expense	27.0	27.0		19.2					
704.0	855.7	798.1	879.6	91 Allocation of Overhead & BOD	1,442.7	1,621.0	1,653.2	1,467.2	1,763.0	1,797.8	1,867.8	1,845.4	1,921.8
1,638.4	**1,793.0**	**1,750.2**	**1,868.6**	**TOTAL EXPENSES**	**3,203.1**	**3,406.4**	**3,520.0**	**3,267.1**	**3,689.3**	**3,705.1**	**3,753.6**	**3,694.6**	**3,943.5**
(1,629.2)	(1,773.5)	(1,735.1)	(1,855.6)	SURPLUS (DEFICIT) before reserve income	(3,181.1)	(3,307.6)	(3,494.7)	(3,248.9)	(3,618.3)	(3,679.1)	(3,726.5)	(3,667.0)	(3,915.1)
203.5	210.5	53.8	222.5	92 Non-recurring Expenses	474.8	478.3	500.0	320.1	350.0	350.0			
(1,832.7)	**(1,984.0)**	**(1,788.9)**	**(2,078.1)**	**OVERALL SURPLUS (DEFICIT) after reser**	**(3,655.9)**	**(3,785.9)**	**(3,994.7)**	**(3,569.0)**	**(3,968.3)**	**(4,029.1)**	**(3,726.5)**	**(3,667.0)**	**(3,915.1)**

ASHRAE
RESEARCH (funds 3 & 4)
For the Six Months Ending Saturday, December 31, 2016

Fiscal YTD Through Month of Dec					TWELVE MONTHS ENDING JUNE 30						DRAFT	DRAFT	DRAFT
Actual	*Budget*	Actual	*Budget*	roll up	Actual	Actual	*Budget*	Actual	Forecast	*Budget*	Budget	Budget	Budget
FY 2016	*FY 2016*	FY 2017	*FY 2017*	acct / Description	FY 2014	FY 2015	*FY 2016*	FY 2016	FY 2017	*FY 2017*	FY 2018	FY 2019	FY 2020
				REVENUES									
$75.6	$83.5	$76.0	$77.6	31 Membership Dues Earned Income	$146.6	$148.7	$154.5	$152.7	$156.8	$156.8	$157.0	$162.0	$165.0
				37 Special Project Income	55.0								
435.9	440.3	448.8	484.0	38 Contribution Income	1,898.4	2,000.2	2,219.0	2,046.7	2,319.8	2,294.8	2,398.5	2,446.4	2,495.4
				41.2 Contributions and Matching Gifts	1,989.2	1,814.5	1,898.4	1,898.4	2,000.0	2,000.2	2,000.0	1,828.9	1,883.8
128.4	132.5	704.0	704.0	44 Reserve Transfers	536.3	571.2	243.0	256.9	1,020.9	1,408.0	685.0	215.0	221.5
0.0	1.6		1.7	46 Miscellaneous Income	(1.1)		3.3	0.0	3.4	3.4	3.5	3.6	3.7
639.9	**657.9**	**1,228.8**	**1,267.3**	**TOTAL REVENUES**	**4,624.4**	**4,534.6**	**4,518.2**	**4,354.7**	**5,500.9**	**5,863.2**	**5,244.0**	**4,655.9**	**4,769.4**
				EXPENSES:									
287.4	309.5	277.0	281.5	51 Salary Expense	535.7	553.8	570.8	575.2	563.3	563.3	590.2	601.2	642.4
84.3	81.0	76.7	83.3	52 Payroll Taxes, Benefits, Personnel Exp	152.4	160.9	150.7	157.3	161.8	161.8	164.9	168.4	179.9
34.3	53.0	25.4	19.4	61 Publishing and Promotion Expense	44.4	19.4	103.4	41.3	104.2	104.2	105.4	31.0	31.9
20.2	11.8	25.2	8.9	64 Meetings & Conferences Expense	6.5	20.7	16.9	27.0	21.4	17.4	18.1	18.4	19.0
45.9	86.4	65.6	75.6	66 Travel Expense	127.6	119.1	131.4	84.0	131.9	132.3	137.2	139.9	144.1
35.4	32.2	46.4	31.9	68 Awards, Certif, Logo Cost of Goods Sold	32.7	35.6	32.7	37.4	33.6	33.6	35.0	35.7	36.8
972.4	1,536.5	857.3	1,237.9	71 Research Projects & Grants Expense	2,543.0	2,368.7	2,550.5	2,199.4	3,475.0	3,822.3	3,041.2	2,519.0	2,527.1
	0.1		0.1	76 Public Relations Expense			0.2		0.2	0.2	0.3	0.3	0.3
27.9	28.8	23.0	34.8	82 Office Expense and Organizational Dues	42.9	52.1	57.3	45.7	56.7	58.0	60.3	61.5	63.4
4.8				84 Outside Services Expense		4.8		(4.8)					
13.7	24.0	15.0	18.5	88 Other Expense	46.1	43.0	64.3	50.4	66.2	66.2	68.9	70.2	72.3
357.4	441.2	391.9	436.6	91 Allocation of Overhead & BOD	730.0	808.5	840.0	750.3	886.5	903.9	1,022.7	1,010.3	1,052.1
1,883.7	**2,604.5**	**1,803.5**	**2,228.5**	**TOTAL EXPENSES**	**4,261.3**	**4,186.6**	**4,518.2**	**3,963.2**	**5,500.8**	**5,863.2**	**5,244.2**	**4,655.9**	**4,769.3**
(1,243.8)	(1,946.6)	(574.7)	(961.2)	SURPLUS (DEFICIT) before reserve income	363.1	348.0	0.0	391.5	0.1	0.0	(0.2)	0.0	0.1
				Reserve Investment Income:									
(244.1)	179.4	350.0	308.9	95 Investmt Income - Reserves (net of exp)	943.7	75.2	320.0	(70.1)	232.2	232.2	233.1	235.5	242.6
(128.4)	(132.5)	(704.0)	(704.0)	96 Transfer Reserves Portion Used Currentl	(536.3)	(571.2)	(243.0)	(256.9)	(1,020.9)	(1,408.0)	(685.0)	(215.0)	(221.5)
(372.5)	46.9	(354.0)	(395.1)	Remaining Reserve Investment Income	407.4	(496.0)	77.0	(327.0)	(788.7)	(1,175.8)	(451.9)	20.5	21.1
(1,616.3)	**(1,899.7)**	**(928.7)**	**(1,356.3)**	**OVERALL SURPLUS (DEFICIT) after reser**	**770.5**	**(148.0)**	**77.0**	**64.5**	**(788.6)**	**(1,175.8)**	**(452.1)**	**20.5**	**21.2**

ASHRAE
GENERAL (Fund 2) - Major Variations
For the Six Months Ending Saturday, December 31, 2016

Fiscal YTD Through Month of Dec					TWELVE MONTHS ENDING JUNE 30						Variance	
Actual	Budget	Actual	Budget	roll up	Actual	Actual	Budget	Actual	Forecast	Budget	Budget vs.	Comments
FY 2016	FY 2016	FY 2017	FY 2017	acct / Description	FY 2014	FY 2015	FY 2016	FY 2016	FY 2017	FY 2017	Forecast	
				REVENUES								
$3,700.9	$3,750.4	$3,720.9	$3,871.8	31 Membership Dues Earned Income	$7,178.7	$7,281.8	$7,595.7	$7,481.7	$7,649.6	$7,828.6	(179.0)	Monthly trend is consistently below budget.
1,652.9	1,750.0	1,513.5	1,770.3	32 Publication Sales Income	3,803.6	3,483.9	3,585.5	3,626.1	3,635.4	3,924.8	(289.4)	In general, income is down across all book and non-print publication categories. Pub/Ed will look at promotional opportunities.
1,764.6	1,645.4	1,653.2	1,811.6	34 Advertising Income - Display	3,773.1	3,710.8	3,761.0	3,779.4	3,644.8	3,846.0	(201.2)	Some shift to online advertising as print/digital package sales increase (as compared to print only)
10.3	11.1	9.9	13.4	34 Advertising Income - Classified	26.5	32.0	25.0	19.3	18.0	25.0	(7.0)	
322.2	325.4	394.7	329.5	34 Advertising Income - On-line	470.4	595.6	640.0	715.8	890.0	720.0	170.0	Additional digital offerings.
139.4	130.0	230.9	294.5	35.1 Meeting & Seminar Income	1,965.7	1,578.5	1,737.5	1,529.9	2,013.5	1,968.5	45.0	
88.8	115.2	101.9	118.3	35.2 Certification Registration	148.5	183.3	220.0	187.6	210.0	250.0	(40.0)	Budget set higher in anticipation of ANSI accreditation benefit and DOE recognition.
681.8	647.9	579.7	762.7	35.3 Education Registration	1,301.6	1,504.5	1,585.0	1,844.8	1,815.0	2,060.0	(245.0)	eLearning was offline for 3 months hurting its performance. Other areas had aggressive 16-17 budgets.
3.2				37 Special Project Income	50.0	316.6		3.2	45.0		45.0	
11.2	6.3	19.1	12.6	38 Contribution Income	47.2	72.7	30.4	104.2	41.0	41.0	-	
				41.1 AHR Exposition Income	3,973.0	5,146.6	4,757.6	5,168.0	5,500.0	5,168.0	332.0	Las Vegas AHR Expo expected to be one of the largest (500,000 net sq. ft.)
10.0	(47.6)	90.0	90.0	41.2 Contributions and Matching Gifts	(1,859.2)	(1,699.5)	(1,839.0)	(1,841.4)	(1,862.7)	(1,859.3)	(3.4)	
34.0	60.0	162.3	84.0	41.3 Exposition Income - Other Countries		145.9	60.0	34.0	162.3	84.0	78.3	Larger than anticipated Mexico AHR Show (Monterrey)
199.2	217.3	310.7	430.7	44 Reserve Transfers	489.2	314.5	398.4	398.4	726.4	861.4	(135.0)	Cap. Campaign won't need budgeted level of funding in 16-17.
99.3	121.5	103.5	147.8	46 Miscellaneous Income	341.9	534.4	295.9	322.7	352.5	349.5	3.0	
8,717.8	**8,732.9**	**8,890.3**	**9,737.2**	**TOTAL REVENUES**	**21,710.2**	**23,201.6**	**22,853.0**	**23,373.7**	**24,840.8**	**25,267.5**		
				EXPENSES:								
4,022.4	4,126.8	4,028.9	4,033.8	51 Salary Expense	6,988.0	7,357.2	7,832.3	8,205.5	8,245.8	8,328.5	(82.7)	Primarily related to staffing for Cap. Campaign put on hold.
1,239.8	1,161.7	1,206.6	1,244.9	52 Payroll Taxes, Benefits, Personnel Exp	2,119.3	2,375.3	2,241.5	2,581.5	2,437.8	2,493.0	(55.2)	
1,697.5	1,451.8	1,437.4	1,895.7	61 Publishing and Promotion Expense	3,524.7	3,757.5	3,673.9	3,786.5	3,545.1	3,831.6	(286.5)	Reduced product sales leads to decreased expenditures (printing, shipping, commissions, etc.)
637.7	706.6	627.9	635.5	64 Meetings & Conferences Expense	2,286.6	2,178.5	2,262.2	2,335.7	2,832.7	2,768.8	63.9	
645.3	1,054.6	842.7	1,044.2	66 Travel Expense	2,138.0	1,954.6	2,190.1	1,776.0	2,353.2	2,382.7	(29.5)	
37.7	45.0	42.9	39.6	68 Awards, Certif, Logo Cost of Goods Sold	86.9	98.9	116.5	90.9	120.0	120.0	-	
109.0	110.8	110.9	117.4	71 Research Projects & Grants Expense	106.5	100.9	127.5	121.7	131.3	131.3	-	
50.0	55.0	122.1	112.0	73 Special Projects Expense	50.0	72.5	110.0	101.3	181.0	162.0	19.0	
46.8	25.4	44.3	31.7	76 Public Relations Expense	129.1	51.0	62.0	79.4	63.9	63.9	-	
307.8	319.1	273.9	307.5	78 Occupancy & Insurance	563.4	559.2	575.9	588.6	595.7	595.7	-	
877.1	771.2	740.3	858.1	82 Office Expense and Organizational Dues	1,704.0	1,788.1	1,835.4	1,815.0	1,957.9	1,944.1	13.8	
727.5	986.7	875.5	1,268.8	84 Outside Services Expense	1,528.0	1,654.6	1,980.0	1,717.7	2,607.7	2,713.8	(106.1)	Advantageous contract negotiation for Research Journal and other expenses spread over number of programs. Reduced scope of campaign consultant for 16-17.
348.9	214.3	162.5	316.0	88 Other Expense	496.8	487.8	491.4	623.2	596.1	619.3	(23.2)	
(532.2)		(375.9)	(237.5)	88.1 Prepaid Expense (contra acct)	(18.3)	33.8		(560.5)	(475.0)	(475.0)	-	
	50.0	130.3	190.0	89 Opportunity Fund	35.0	35.5	100.0		240.0	240.0	-	
292.8	292.7	267.4	276.5	90 Depreciation Expense	660.9	631.9	543.5	579.3	534.7	534.7	-	
(357.4)	(438.9)	(391.6)	(363.5)	91 Allocation of Overhead & BOD	(730.0)	(808.5)	(840.0)	(750.3)	(886.5)	(903.9)	17.4	
10,150.7	**10,932.8**	**10,146.1**	**11,770.7**	**TOTAL EXPENSES**	**21,668.9**	**22,328.8**	**23,302.2**	**23,091.5**	**25,081.4**	**25,550.5**		
(1,432.9)	(2,199.9)	(1,255.8)	(2,033.5)	SURPLUS (DEFICIT) before reserve income	41.3	872.8	(449.2)	282.2	(240.6)	(283.0)		

ASHRAE
BOARD OF DIRECTORS - Major Variations
For the Six Months Ending Saturday, December 31, 2016

Fiscal YTD Through Month of Dec					TWELVE MONTHS ENDING JUNE 30						Variance	
Actual	Budget	Actual	Budget	roll up	Actual	Actual	Budget	Actual	Forecast	Budget	Budget vs.	Comments
FY 2016	FY 2016	FY 2017	FY 2017	acct / Description	FY 2014	FY 2015	FY 2016	FY 2016	FY 2017	FY 2017	Forecast	
				REVENUES								
	$3.1		$4.0	38 Contribution Income	$4.5	$23.5	$8.0		$8.0	$8.0	$0.0	
	0.0	80.0	80.0	41.2 Contributions and Matching Gifts			0.0	0.0	22.0	22.0	$0.0	
			120.0	44 Reserve Transfers					105.0	240.0	($135.0)	Cap. Campaign won't need budgeted level of funding in 16-17.
0.3			5.0	46 Miscellaneous Income	2.5	0.0		0.3	5.0	5.0	$0.0	
0.3	**3.1**	**80.0**	**209.0**	**TOTAL REVENUES**	**7.0**	**23.5**	**8.0**	**0.3**	**140.0**	**275.0**		
				EXPENSES:								
407.6	592.9	415.1	438.4	51 Salary Expense	735.7	695.8	1,039.3	811.0	887.6	947.1	($59.5)	Staffing for Cap. Campaign put on hold.
121.4	155.5	113.5	129.3	52 Payroll Taxes, Benefits, Personnel Exp	214.4	193.2	274.4	245.1	252.1	265.3	($13.2)	
3.8	49.2	31.1	69.9	61 Publishing and Promotion Expense	69.4	10.0	107.3	26.9	120.7	141.7	($21.0)	
19.0	23.5	28.3	12.9	64 Meetings & Conferences Expense	71.0	64.0	61.6	84.0	86.2	70.7	$15.5	
232.5	444.5	347.4	448.1	66 Travel Expense	1,017.9	873.1	1,036.8	782.6	1,055.1	1,067.6	($12.5)	
1.1	0.8	2.4	0.9	68 Awards, Certif, Logo Cost of Goods Sold	9.1	14.9	3.7	9.9	3.8	3.8	$0.0	
				71 Research Projects & Grants Expense	7.1	7.2	7.8	7.3	8.1	8.1	$0.0	
				76 Public Relations Expense	1.2	0.1					$0.0	
12.3	24.5	8.9	30.4	82 Office Expense and Organizational Dues	42.6	32.5	44.8	16.5	45.4	57.4	($12.0)	
34.5	135.2	93.5	250.0	84 Outside Services Expense	69.2	50.9	191.6	73.2	543.7	578.7	($35.0)	
	5.3		11.3	88 Other Expense	0.5	1.9	10.6	7.0	12.7	22.6	($9.9)	
0.0		0.0	0.0	88.1 Prepaid Expense (contra acct)				0.0	0.0	0.0	$0.0	
	50.0		50.0	89 Opportunity Fund	35.0	35.5	100.0		100.0	100.0	$0.0	
0.2				90 Depreciation Expense	4.1	3.2		0.2				
(832.7)	(1,443.6)	(1,084.0)	(1,311.3)	91 Allocation of Overhead & BOD	(2,277.4)	(1,957.4)	(2,877.9)	(2,064.0)	(3,115.4)	(3,250.0)		
(0.3)	**37.8**	**(43.8)**	**129.9**	**TOTAL EXPENSES**		**24.9**	**0.0**	**(0.3)**	**0.0**	**13.0**		
0.6	(34.7)	123.8	79.1	SURPLUS (DEFICIT) before reserve income	7.0	(1.4)	8.0	0.6	140.0	262.0		

ASHRAE
MEMBERS COUNCIL - Major Variations
For the Six Months Ending Saturday, December 31, 2016

Fiscal YTD Through Month of Dec					TWELVE MONTHS ENDING JUNE 30						Variance	
Actual	Budget	Actual	Budget	roll up	Actual	Actual	Budget	Actual	Forecast	Budget	Budget vs.	Comments
FY 2016	FY 2016	FY 2017	FY 2017	acct / Description	FY 2014	FY 2015	FY 2016	FY 2016	FY 2017	FY 2017	Forecast	
				REVENUES								
$3,700.9	$3,750.4	$3,720.9	$3,871.8	31 Membership Dues Earned Income	$7,178.7	$7,281.8	$7,595.7	$7,481.7	$7,649.6	$7,828.6	($179.0)	Monthly trend is consistently below budget.
139.4	130.0	230.9	294.5	35.1 Meeting & Seminar Income	1,965.7	1,578.5	1,737.5	1,529.9	2,013.5	1,968.5	$45.0	
7.6		16.9	4.5	38 Contribution Income	25.6	38.4	8.4	92.1	18.7	18.7	$0.0	
10.0	10.4	10.0	10.0	41.2 Contributions and Matching Gifts	20.0	20.0	20.4	20.0	20.3	20.3	$0.0	
56.5	28.2	58.3	49.8	46 Miscellaneous Income	103.0	153.3	83.6	117.9	99.7	99.7	$0.0	
3,914.4	**3,919.0**	**4,037.0**	**4,230.6**	**TOTAL REVENUES**	**9,293.0**	**9,072.0**	**9,445.6**	**9,241.6**	**9,801.8**	**9,935.8**		
				EXPENSES:								
648.5	670.9	659.4	673.0	51 Salary Expense	1,175.4	1,135.0	1,243.3	1,330.7	1,369.7	1,369.7	$0.0	
187.8	175.5	180.8	199.7	52 Payroll Taxes, Benefits, Personnel Exp	342.6	313.7	328.3	404.7	399.0	399.0	$0.0	
144.9	124.0	148.8	148.2	61 Publishing and Promotion Expense	339.3	422.2	404.5	398.0	313.6	313.6	$0.0	
426.2	491.4	338.2	374.6	64 Meetings & Conferences Expense	1,841.9	1,644.0	1,740.7	1,658.4	2,123.7	2,103.3	$20.4	
304.6	414.2	304.9	436.2	66 Travel Expense	667.6	668.7	731.9	625.0	835.7	843.6	($7.9)	
37.0	43.0	18.7	24.5	68 Awards, Certif, Logo Cost of Goods Sold	76.6	82.8	108.8	80.0	86.0	86.0	$0.0	
109.0	110.8	110.9	117.4	71 Research Projects & Grants Expense	99.4	93.7	119.6	114.4	123.2	123.2	$0.0	
156.2	174.7	142.6	151.9	82 Office Expense and Organizational Dues	330.0	299.4	359.4	319.9	370.3	370.3	$0.0	
63.8	47.9	43.6	84.1	84 Outside Services Expense	178.1	175.2	178.4	195.6	278.5	278.5	$0.0	
134.6	128.7	147.5	140.0	88 Other Expense	259.2	294.1	246.1	285.9	316.2	323.2	($7.0)	
(289.5)		(132.7)		88.1 Prepaid Expense (contra acct)	2.0	13.5		(8.8)			$0.0	
		130.3	140.0	89 Opportunity Fund					140.0	140.0	$0.0	
806.5	953.2	917.4	924.3	91 Allocation of Overhead & BOD	1,603.9	1,657.9	1,829.6	1,736.4	1,928.6	1,966.7		
2,729.6	**3,334.3**	**3,010.4**	**3,413.9**	**TOTAL EXPENSES**	**6,916.0**	**6,800.2**	**7,290.6**	**7,140.2**	**8,284.5**	**8,317.1**		
1,184.8	584.7	1,026.6	816.7	SURPLUS (DEFICIT) before reserve income	2,377.0	2,271.8	2,155.0	2,101.4	1,517.3	1,618.7		

ASHRAE
PUBLISHING & EDUCATION COUNCIL - Major Variations
For the Six Months Ending Saturday, December 31, 2016

Fiscal YTD Through Month of Dec					TWELVE MONTHS ENDING JUNE 30						Variance	
Actual	Budget	Actual	Budget	roll up	Actual	Actual	Budget	Actual	Forecast	Budget	Budget vs.	Comments
FY 2016	FY 2016	FY 2017	FY 2017	acct / Description	FY 2014	FY 2015	FY 2016	FY 2016	FY 2017	FY 2017	Forecast	
				REVENUES								
$1,652.9	$1,750.0	$1,513.5	$1,770.3	32 Publication Sales Income	$3,803.6	$3,483.9	$3,585.5	$3,626.1	$3,635.4	$3,924.8	(289.4)	In general, income is down across all book and non-print publication categories. Pub/Ed will look at promotional opportunties.
1,764.6	1,645.4	1,653.2	1,811.6	34 Advertising Income - Display	3,773.1	3,710.8	3,761.0	3,779.4	3,644.8	3,846.0	(201.2)	Some shift to online advertising as print/digital package sales increase (as compared to print only)
10.3	11.1	9.9	13.4	34 Advertising Income - Classified	26.5	32.0	25.0	19.3	18.0	25.0	(7.0)	
322.2	325.4	394.7	329.5	34 Advertising Income - On-line	470.4	595.6	640.0	715.8	890.0	720.0	170.0	Additional digital offerings.
88.8	115.2	101.9	118.3	35.2 Certification Registration	148.5	183.3	220.0	187.6	210.0	250.0	(40.0)	Budget set higher in anticipation of ANSI accredidation benefit and DOE recognition.
681.8	647.9	579.7	762.7	35.3 Education Registration	1,301.6	1,504.5	1,585.0	1,844.8	1,815.0	2,060.0	(245.0)	eLearning was offline for 3 months hurting its performance. Other areas had aggressive 16-17 budgets.
				37 Special Project Income	45.0	230.0					-	
3.6	3.2	2.2	4.1	38 Contribution Income	17.0	10.8	13.9	12.1	14.3	14.3	-	
				41.2 Contributions and Matching Gifts	110.0	95.0	97.0	95.0	95.0	98.6	(3.6)	
46.6	55.9	17.2	66.0	46 Miscellaneous Income	195.3	143.1	155.2	184.4	189.8	186.8	3.0	
4,570.8	**4,554.1**	**4,272.3**	**4,875.9**	**TOTAL REVENUES**	**9,891.0**	**9,989.0**	**10,082.6**	**10,464.5**	**10,512.3**	**11,125.5**		
				EXPENSES:							-	
1,189.1	1,275.4	1,128.3	1,197.4	51 Salary Expense	2,232.8	2,218.4	2,364.0	2,411.7	2,411.7	2,434.9	(23.2)	
379.4	349.3	374.1	377.4	52 Payroll Taxes, Benefits, Personnel Exp	717.3	706.0	673.2	780.7	744.9	756.3	(11.4)	
1,544.5	1,275.6	1,248.0	1,647.3	61 Publishing and Promotion Expense	3,105.4	3,302.7	3,133.0	3,331.8	3,002.6	3,258.1	(255.5)	Reduced product sales leads to decreased expenditures (printing, shipping, commissions, etc.)
181.9	170.3	239.2	235.2	64 Meetings & Conferences Expense	354.7	451.6	426.8	564.6	588.0	560.0		
33.9	73.9	51.5	70.5	66 Travel Expense	196.9	178.4	187.1	137.8	176.7	205.7		
(0.3)	1.2	0.1	1.3	68 Awards, Certif, Logo Cost of Goods Sold	0.8	1.0	2.5	0.8	2.6	2.6	-	
26.7	21.4	19.5	25.9	78 Occupancy & Insurance	36.3	36.1	40.1	40.6	41.3	41.3	-	
425.5	372.6	395.3	393.3	82 Office Expense and Organizational Dues	894.2	963.5	969.4	1,036.6	1,043.3	1,027.5	15.8	
339.8	506.0	452.8	603.1	84 Outside Services Expense	744.5	817.2	1,054.3	938.3	1,225.6	1,291.3	(65.7)	Advantageous contract negotiation for Research Journal and other expenses spread over number of programs.
160.4	39.3	(43.1)	105.4	88 Other Expense	143.7	108.1	162.5	227.7	157.3	163.6	(6.3)	
				90 Depreciation Expense	61.0	45.8						
1,481.1	1,819.4	1,563.5	1,802.9	91 Allocation of Overhead & BOD	3,048.4	3,237.1	3,478.9	3,147.3	3,713.9	3,787.1		
5,762.0	**5,904.4**	**5,429.2**	**6,459.7**	**TOTAL EXPENSES**	**11,536.0**	**12,065.9**	**12,491.8**	**12,617.9**	**13,107.9**	**13,528.4**		
(1,191.2)	(1,350.3)	(1,156.9)	(1,583.8)	SURPLUS (DEFICIT) before reserve income	(1,645.0)	(2,076.9)	(2,409.2)	(2,153.4)	(2,595.6)	(2,402.9)		

ASHRAE
TECHNOLOGY COUNCIL - Major Variations
For the Six Months Ending Saturday, December 31, 2016

Fiscal YTD Through Month of Dec					TWELVE MONTHS ENDING JUNE 30						Variance	Comments
Actual	Budget	Actual	Budget	roll up	Actual	Actual	Budget	Actual	Forecast	Budget	Budget vs.	
FY 2016	FY 2016	FY 2017	FY 2017	acct / Description	FY 2014	FY 2015	FY 2016	FY 2016	FY 2017	FY 2017	Forecast	
				REVENUES								
$3.2				37 Special Project Income	$5.0	$86.6		$3.2	$45.0		$45.0	
6.0	19.5	15.1	13.0	46 Miscellaneous Income	17.0	12.2	25.3	15.0	26.0	26.0	$0.0	
9.2	**19.5**	**15.1**	**13.0**	**TOTAL REVENUES**	**22.0**	**98.8**	**25.3**	**18.2**	**71.0**	**26.0**		
				EXPENSES:								
565.6	599.8	582.4	528.3	51 Salary Expense	1,060.1	1,108.7	1,123.5	1,125.8	1,060.9	1,060.9	$0.0	
164.5	156.8	158.6	156.1	52 Payroll Taxes, Benefits, Personnel Exp	296.7	322.2	296.6	322.8	304.6	304.6	$0.0	
(0.3)	0.7	0.1	1.0	61 Publishing and Promotion Expense	5.5	0.8	2.2	0.3	2.3	2.3	$0.0	
2.0	12.7	13.8	7.1	64 Meetings & Conferences Expense	11.3	8.2	19.8	8.8	21.2	21.2	$0.0	
16.9	72.1	65.5	46.1	66 Travel Expense	163.2	132.5	147.4	93.2	176.1	176.1	$0.0	
				68 Awards, Certif, Logo Cost of Goods Sold	0.4	0.3	1.6	0.3	1.6	1.6	$0.0	
50.0	55.0	122.1	112.0	73 Special Projects Expense	50.0	72.5	110.0	101.3	181.0	162.0	$19.0	
	1.2		1.2	76 Public Relations Expense			2.4		2.5	2.5	$0.0	
87.4	10.8	0.7	109.6	82 Office Expense and Organizational Dues	109.0	90.1	109.5	88.9	120.7	120.7	$0.0	
34.8	28.1	8.9	27.5	84 Outside Services Expense	57.5	2.8	53.7	39.3	55.3	55.3	$0.0	
0.0	0.1		0.1	88 Other Expense			0.1	0.0	0.1	0.1	$0.0	
				88.1 Prepaid Expense (contra acct)	(20.3)	20.3					$0.0	
13.5		0.0		90 Depreciation Expense	27.0	27.0		19.2			$0.0	
704.0	855.7	798.1	879.6	91 Allocation of Overhead & BOD	1,442.7	1,621.0	1,653.2	1,467.2	1,763.0	1,797.8		
1,638.4	**1,793.0**	**1,750.2**	**1,868.6**	**TOTAL EXPENSES**	**3,203.1**	**3,406.4**	**3,520.0**	**3,267.1**	**3,689.3**	**3,705.1**		
(1,629.2)	(1,773.5)	(1,735.1)	(1,855.6)	SURPLUS (DEFICIT) before reserve income	(3,181.1)	(3,307.6)	(3,494.7)	(3,248.9)	(3,618.3)	(3,679.1)		

ASHRAE
RESEARCH (funds 3 & 4) - Major Variations
For the Six Months Ending Saturday, December 31, 2016

Fiscal YTD Through Month of Dec					TWELVE MONTHS ENDING JUNE 30						Variance	
Actual	Budget	Actual	Budget	roll up	Actual	Actual	Budget	Actual	Forecast	Budget	Budget vs.	Comments
FY 2016	FY 2016	FY 2017	FY 2017	acct / Description	FY 2014	FY 2015	FY 2016	FY 2016	FY 2017	FY 2017	Forecast	
				REVENUES								
$75.6	$83.5	$76.0	$77.6	31 Membership Dues Earned Income	$146.6	$148.7	$154.5	$152.7	$156.8	$156.8	$0.0	
				37 Special Project Income	55.0						$0.0	
435.9	440.3	448.8	484.0	38 Contribution Income	1,898.4	2,000.2	2,219.0	2,046.7	2,319.8	2,294.8	$25.0	
				41.2 Contributions and Matching Gifts	1,989.2	1,814.5	1,898.4	1,898.4	2,000.0	2,000.2	($0.2)	
128.4	132.5	704.0	704.0	44 Reserve Transfers	536.3	571.2	243.0	256.9	1,020.9	1,408.0	($387.1)	Less funding needed in Research in 16-17. Primarily related to the change in timeline for the A2L refrigerant research.
0.0	1.6		1.7	46 Miscellaneous Income	(1.1)		3.3	0.0	3.4	3.4	$0.0	
639.9	**657.9**	**1,228.8**	**1,267.3**	**TOTAL REVENUES**	**4,624.4**	**4,534.6**	**4,518.2**	**4,354.7**	**5,500.9**	**5,863.2**		
				EXPENSES:								
287.4	309.5	277.0	281.5	51 Salary Expense	535.7	553.8	570.8	575.2	563.3	563.3	$0.0	
84.3	81.0	76.7	83.3	52 Payroll Taxes, Benefits, Personnel Exp	152.4	160.9	150.7	157.3	161.8	161.8	$0.0	
34.3	53.0	25.4	19.4	61 Publishing and Promotion Expense	44.4	19.4	103.4	41.3	104.2	104.2	$0.0	
20.2	11.8	25.2	8.9	64 Meetings & Conferences Expense	6.5	20.7	16.9	27.0	21.4	17.4	$4.0	
45.9	86.4	65.6	75.6	66 Travel Expense	127.6	119.1	131.4	84.0	131.9	132.3	($0.4)	
35.4	32.2	46.4	31.9	68 Awards, Certif, Logo Cost of Goods Sold	32.7	35.6	32.7	37.4	33.6	33.6	$0.0	
972.4	1,536.5	857.3	1,237.9	71 Research Projects & Grants Expense	2,543.0	2,368.7	2,550.5	2,199.4	3,475.0	3,822.3	($347.3)	Increase in expense estimates for certain projects; Shifting a portion of the A2L refrigerants research into 17-18.
	0.1		0.1	76 Public Relations Expense			0.2		0.2	0.2	$0.0	
27.9	28.8	23.0	34.8	82 Office Expense and Organizational Dues	42.9	52.1	57.3	45.7	56.7	58.0	($1.3)	
4.8				84 Outside Services Expense		4.8		(4.8)			$0.0	
13.7	24.0	15.0	18.5	88 Other Expense	46.1	43.0	64.3	50.4	66.2	66.2	$0.0	
357.4	441.2	391.9	436.6	91 Allocation of Overhead & BOD	730.0	808.5	840.0	750.3	886.5	903.9		
1,883.7	**2,604.5**	**1,803.5**	**2,228.5**	**TOTAL EXPENSES**	**4,261.3**	**4,186.6**	**4,518.2**	**3,963.2**	**5,500.8**	**5,863.2**		
(1,243.8)	(1,946.6)	(574.7)	(961.2)	SURPLUS (DEFICIT) before reserve income	363.1	348.0	0.0	391.5	0.1	0.0		

Portfolio Overview

Period Ending: 12/31/2016

Portfolio Inception Date: 2/26/2001

ASHRAE, Inc. GENERAL Fund

Asset Allocation

Category	Current Percentage	Current Value
Equity Mutual Funds & ETFs	60.2%	$7,670,537
Fixed Income Mutual Funds & ETFs	39.7%	$5,055,014
Cash Equivalents	0.2%	$22,058
Total Portfolio Value	**100.0%**	**$12,747,609**

Portfolio Analysis

	Fiscal 2nd Qtr	Fiscal YTD	Last 12mo	Last 2 Years	Inception
BEGINNING VALUE	**12,421,630.55**	**11,955,539.38**	**11,611,198.19**	**11,884,633.20**	**0.00**
Contributions	0.00	0.00	0.00	0.00	11,255,286.40
Withdrawals	0.00	0.00	0.00	0.00	(6,695,781.90)
Capital Appreciation	256,083.58	682,689.17	913,907.37	411,937.43	5,370,934.14
Income and Expenses	69,894.76	109,380.34	222,503.33	451,038.26	2,817,170.25
ENDING VALUE	**12,747,608.89**	**12,747,608.89**	**12,747,608.89**	**12,747,608.89**	**12,747,608.89**
INVESTMENT GAIN	**325,978.34**	**792,069.51**	**1,136,410.70**	**862,975.69**	**8,188,104.39**

Portfolio Returns

	Fiscal 2nd Qtr	Fiscal YTD	Last 12mo	Last 2 Years	Inception
Your Portfolio	**2.6%**	**6.6%**	**9.8%**	**3.6%**	**6.0%**
60/40 Benchmark	2.2%	5.9%	8.5%	3.6%	5.4%
S & P 500 Composite Total Return	3.8%	7.8%	12.0%	6.5%	5.8%
Russell 1000 Value	6.7%	10.4%	17.3%	6.2%	6.8%
Russell 2000 Index	8.8%	18.7%	21.3%	7.7%	8.3%
MSCI EAFE Index	(0.7%)	5.8%	1.5%	0.6%	4.3%
Citigroup 1-yr Treasury	0.1%	0.1%	0.8%	0.5%	2.0%
Barclays Aggregate Bond Index	(3.0%)	(2.5%)	2.6%	1.6%	4.7%

All returns are TWR, net of fees.
***Return date used is since inception date.**

Portfolio Overview

ASHRAE, Inc. RESEARCH Fund

Period Ending: 12/31/2016

Portfolio Inception Date: 2/26/2001

Asset Allocation

Category	Current Percentage	Current Value
Equity Mutual Funds & ETFs	60.2%	$3,309,891
Fixed Income Mutual Funds & ETFs	39.6%	$2,180,510
Cash Equivalents	0.2%	$11,468
Total Portfolio Value	**100.0%**	**$5,501,870**

Portfolio Analysis

	Fiscal 2nd Qtr	Fiscal YTD	Last 12mo	Last 2 Years	Inception
BEGINNING VALUE	**5,356,305.51**	**5,151,847.91**	**6,177,844.11**	**6,322,501.07**	**0.00**
Contributions	400,025.00	400,025.00	400,025.00	400,025.00	5,352,071.17
Withdrawals	(400,000.00)	(400,000.00)	(1,600,000.00)	(1,600,000.00)	(4,616,088.12)
Capital Appreciation	115,456.77	302,730.70	421,630.62	155,953.45	3,016,610.32
Income and Expenses	30,082.50	47,266.17	102,370.05	223,390.26	1,749,276.41
ENDING VALUE	**5,501,869.78**	**5,501,869.78**	**5,501,869.78**	**5,501,869.78**	**5,501,869.78**
INVESTMENT GAIN	**145,539.27**	**349,996.87**	**524,000.67**	**379,343.71**	**4,765,886.73**

Portfolio Returns

	Fiscal 2nd Qtr	Fiscal YTD	Last 12mo	Last 2 Years	Inception
Your Portfolio	**2.7%**	**6.8%**	**9.8%**	**3.6%**	**6.0%**
60/40 Benchmark	2.2%	5.9%	8.5%	3.6%	5.4%
S & P 500 Composite Total Return	3.8%	7.8%	12.0%	6.5%	5.8%
Russell 1000 Value	6.7%	10.4%	17.3%	6.2%	6.8%
Russell 2000 Index	8.8%	18.7%	21.3%	7.7%	8.3%
MSCI EAFE Index	(0.7%)	5.8%	1.5%	0.6%	4.3%
Citigroup 1-yr Treasury	0.1%	0.1%	0.8%	0.5%	2.0%
Barclays Aggregate Bond Index	(3.0%)	(2.5%)	2.6%	1.6%	4.7%

All returns are TWR, net of fees.
***Return date used is since inception date.**

REPORT TO THE BOARD OF DIRECTORS

From Finance Committee
Meeting of January 27, 2017

RECOMMENDATION FOR BOD APPROVAL:

1. Finance Committee recommends to the Board of Directors to revise the wording in the ROB, 1.201.027.4 A.2., in regards to member transportation/travel reimbursement as follows:

   Current ROB wording:
   The basic reimbursable expense limit is for the fourteen (14) day advance purchase (non-refundable) coach fare between the destination points and one checked bag only, or, if an automobile is used for travel, the United States of America Internal Revenue Service reimbursement rate for miles driven up to a maximum of 700 miles total. Cost of travel insurance, ground transportation, gratuities, and other similar out-of-pocket expenses are not reimbursable.

   Proposed Changes:
   The basic reimbursable expense limit is for the lesser of (a) the fourteen (14) day advance (no later than) purchase (non-refundable) coach fare between the destination points and one checked bag only, or (b) if an automobile is used for travel, based on the United States of America Internal Revenue Service reimbursement rate for total round trip direct miles driven ~~up to a maximum of 700 miles total~~. Cost of travel insurance, ground transportation (rental car, taxi, etc.), gratuities and other similar out-of-pocket expenses are not included (and therefore not reimbursable) in the basic reimbursable expense limit.

Background:
Last June, in reviewing the revised ROB it was the belief of staff and the Planning Subcommittee that the mileage limitation was a moot issue since the mileage expense is already capped by the 14 day advance airfare cost. This reference was removed while some other minor clarifications were added.

Fiscal Impact: Negligible or none.

Vote: Motion Passed 7-0-0 CNV

2. Finance Committee recommends to the Board of Directors to revise the wording in the ROB, 2.102.002.3, in regards to approval of ASHRAE disbursements as follows:

   Current ROB Wording:

   General and Research Fund Disbursement Approval
   General and Research Fund account disbursements (checks, wires, ACH) shall require at least one signature approval which shall include either the President, Treasurer, Executive Vice President or the Comptroller. The individual originating the disbursement cannot be the approver.

   Proposed addition to the end of the current ROB wording:

   Disbursements of $250,000.00 or higher shall require approval of two of the individuals listed herein.

Background: During the June 26, 2017 BOD Meeting at the 2016 Annual Meeting, the following action item was assigned to the President: *Request Finance Committee to evaluate the concept and merits of a two-tiered approval process for disbursements from the general and research funds based on the size or type of disbursement.* In reviewing the ROB, Finance Committee believed it may be prudent to have an additional level of review and approval on more significant expenditures of ASHRAE from a volunteer perspective. It is also a common practice among businesses and ASHRAE Chapters.

Fiscal Impact: None

Vote: Motion Passed 7-0-0 CNV

INFORMATION ITEMS

1. Finance Committee received a referral motion (Region X (Golden Gate Chapter) – Motion 4k (10/14/2016)) from Members Council that Society engage the services of a Certified Public Accountant or other professional to determine the requirements for regions to file or not file state taxes and non-profit status. This motion was defeated as guidance does exist for regions in the Manual for Region Operations which includes an Appendix F, Regional Financial Guidelines for Regional Treasurers. It was determined that the best course of action is that the local region should seek local legal or CPA advice as it relates to tax filing requirements.

2. Finance Committee received a referral motion (Region XII (Brasil Chapter) – Motion 4o (10/14/2016)) from Members Council that Society offer to members of the Brasil Chapter for the annual membership fees and benefits to be reduced to the same amount charged to members of the Developing Economy Program for a period of two years, effective July 1st 2017. This motion was defeated because this motion suggests special treatment be provided to one chapter due to local economic struggles. Although all committee members sympathize with these struggles, we find no better tool than the classification system used by the World Bank to define what is considered a Developing Economy country.

3. Finance Committee received a referral motion (Region XII (Florida West Coast Chapter) – Motion 4p (10/14/2016) from Members Council that Society approve an ad hoc committee be created to evaluate dues options to assist in changing world economies and payment options. Although all committee members sympathize with such local economic struggles, this motion was defeated as it suggests unique treatment be provided for some or several chapters based on yet undetermined criteria related to the economic status of a country. It further suggests that ASHRAE expend considerable resources to form an ad-hoc committee to study the matter further and to determine this criteria. In addition, it would impact current historical cash flow of ASHRAE revenue and result in other potential unintended consequences with respect to added administrative burdens on ASHRAE staff; likely increasing staff time and cost dealing with such a plan as currently no other member classification in ASHRAE has a payment plan.

4. Finance Committee discussed Programs Operating with a Deficit, specifically Certification, High Performing Buildings and bEQ Programs. As part of this discussion, recent financial statements were reviewed along with new business plans developed by each program committee. In addition, a representative was available to discuss questions and expectations . Representatives will be invited to the Finance Committee meeting in Long Beach to deliver an update on how the programs are tracking toward their business plans.

5. Finance Committee discussed impact of increasing numbers of Life Members (financial and non-financial) to Society. Finance Committee will look at different metrics to better evaluate financial impact.

6. The General Reserve Fund as of December 31, 2016 had total assets of $12,747,609. The General Reserve Fund represents 56% of the average of the General Fund total expenses for the last three years (2013-2014 through 2015-2016). The ROB targets a General Reserve Fund balance that is between 1/3 to 2/3 of typical annual General Fund total expense.

7. The Research Reserve Fund as of December 31, 2016 had total assets of $5,501,870. There is no ROB target established for the Research Reserve Fund. Finance Committee discussed a possible minimum target level for the Research Reserve Fund and determined that the rules that currently exist in Finance, BOD and RAC are sufficient for the prudent investment and disbursement of research funds. Therefore no changes were recommended.

8. The Audited Financial Statements for FY 2016-17 were presented to the Finance Committee. They were previously approved by the Audit Committee in October meeting.

9. MBOs for FY 2016-2017 status is as follows:
   #1: Finance/Budget Presentation to BOD - Improvements to make more concise and easier to understand. In progress - target completion is Annual Meeting 2017.
   #2: Proposed European Region - Determine costs involved - Start-Up and Ongoing. In progress - Scope may be expanded to include a modular tool to assist in future ASHRAE structure additions and subtractions – target completion is Annual Meeting 2017.
   #3: Modernize Volunteer Member Reimbursement Process (migrate to paperless) – In progress – will provide update on Spring Finance Committee conference call.
   #4: Reimbursement Policies for Members Outside of the U.S. (alternatives to mitigate issues experienced by those members) – In progress. Additional discussions needed with international members to determine best alternatives – target completion is Annual Meeting 2017.
   #5: Evaluate Concept & Merits of a two-tiered Approval Process for disbursements from the General and Research Funds based on size or Type of Disbursement – Complete. (Relates to Motion #2 above)

January 27, 2017
Date

Chair

Financial Update

Board of Directors

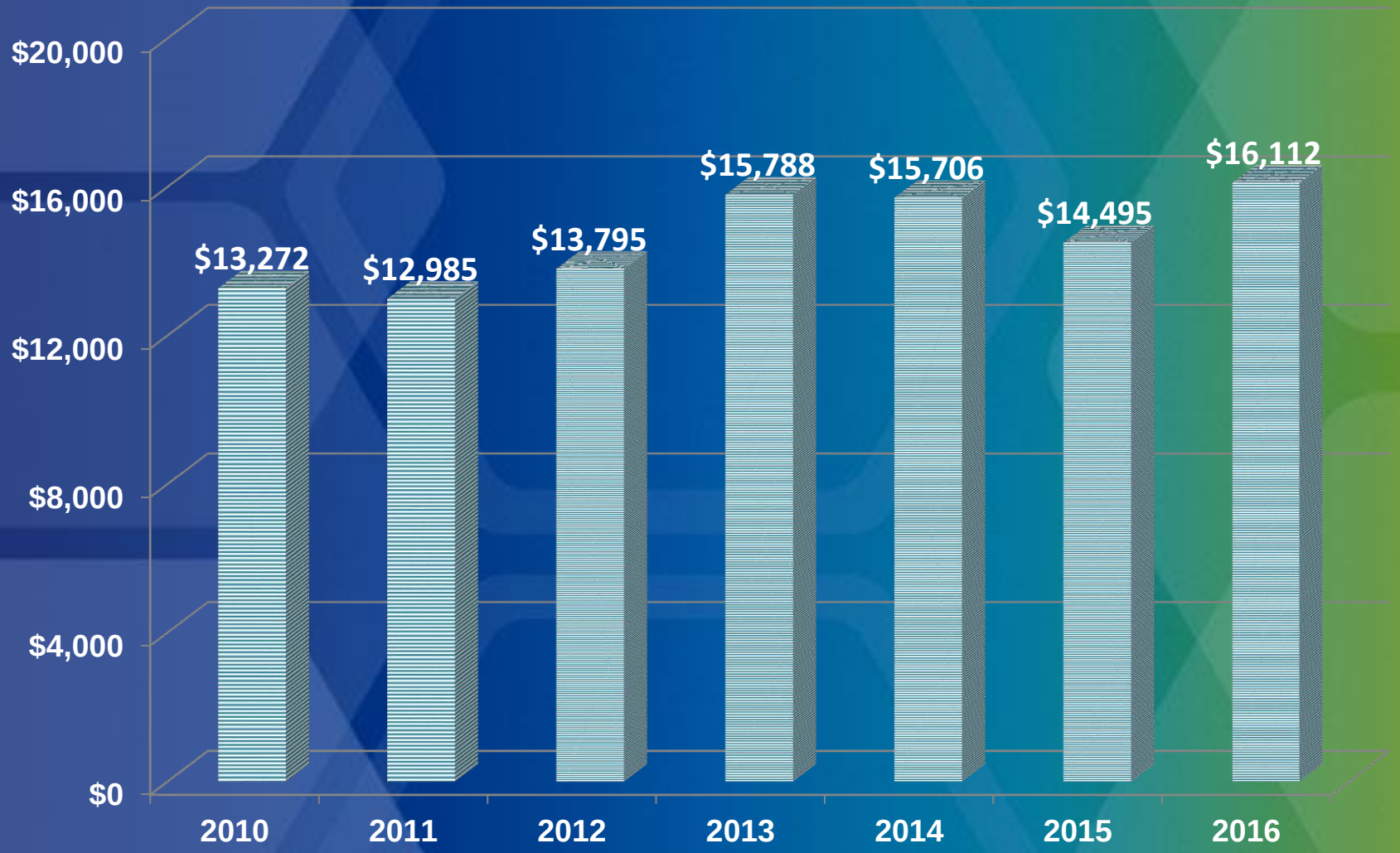
Winter Meeting

January 29, 2017

Financial Status

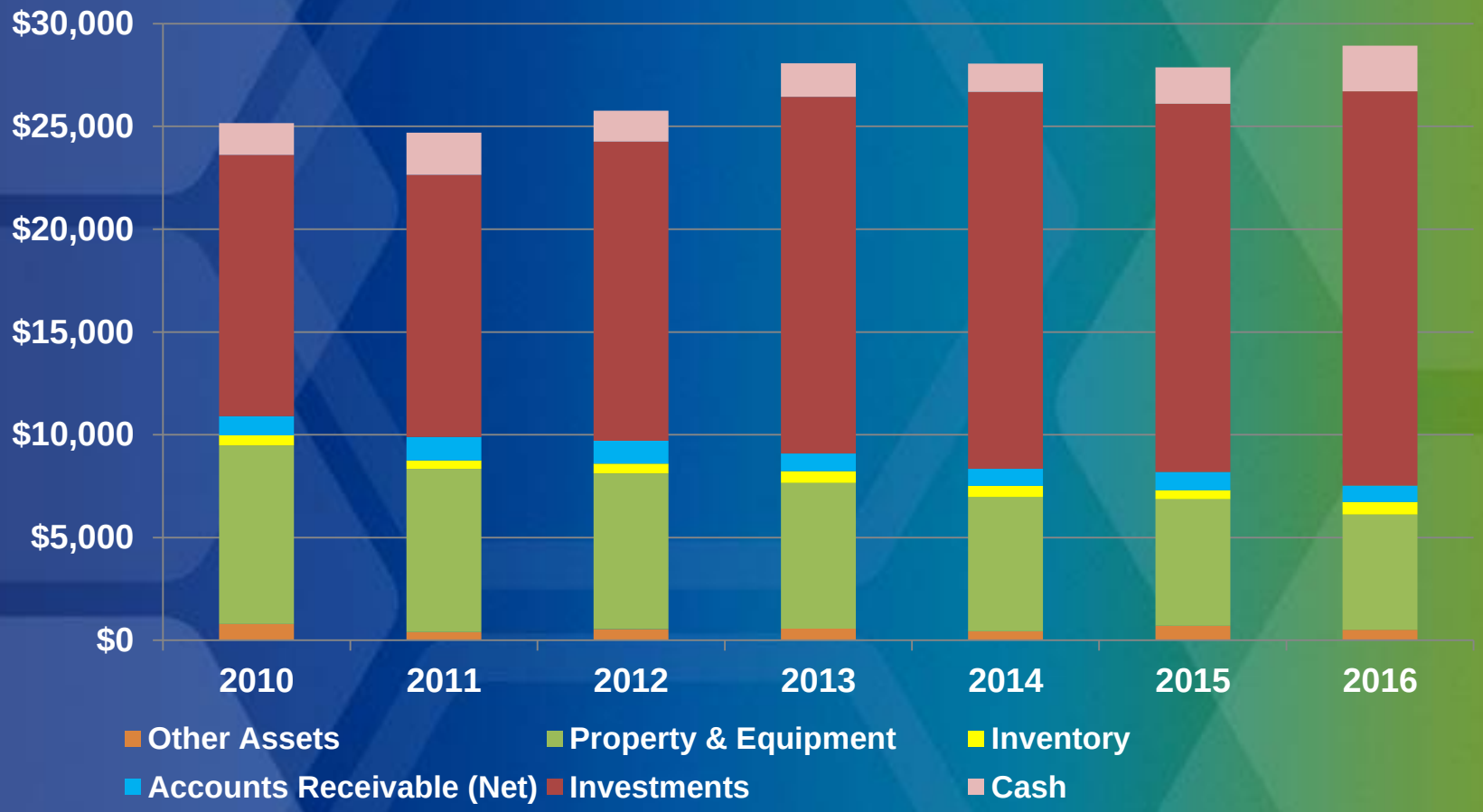
Consolidated Cumulative Net Assets

(As of December 31)



Composition of Assets

As of December 31



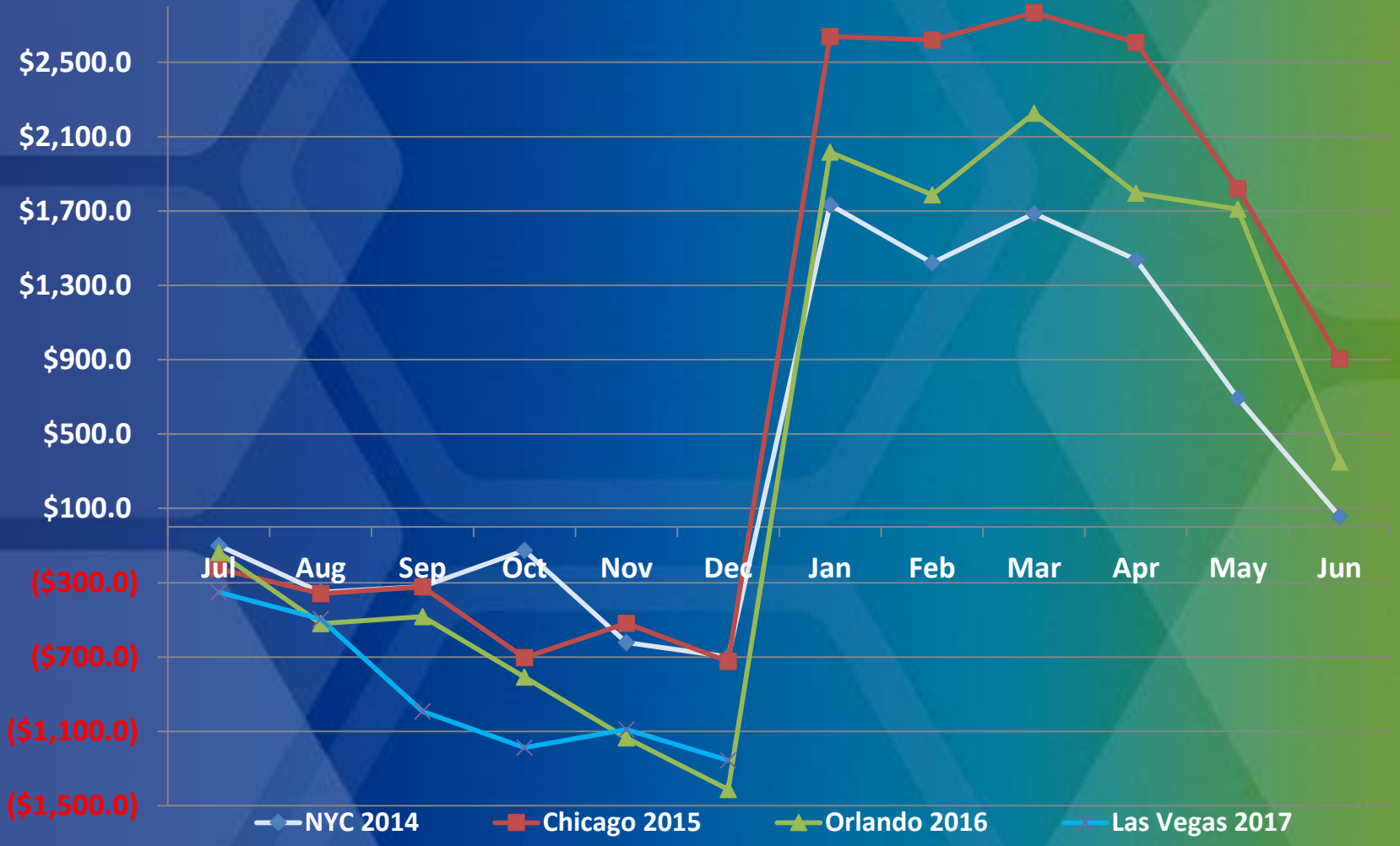
General Fund

16-17 Budget to 16-17 Forecast as of Dec 31

	16-17 Budget	16-17 Forecast
Revenues	$31,131	$30,341
Expenses	31,414	30,582
Surplus/(Deficit)	$ (283)	$ (241)

General Fund Cumulative Net Revenue and Expense

December 31, 2016



Major Variations (Forecast vs. Budget)

For the Six Months Ended December 31, 2016

Revenues	**Variation**
• AHR Expo	$332K
– Las Vegas will be one of the largest AHR Expos in history (approx. 500,000 net square feet).	
• Education	($245K)
– eLearning - offline for 3 months.	
• Publications	($187K)
– In general, sales are down across all book and non-print categories. Pub/Ed will look at promotional opportunities.	

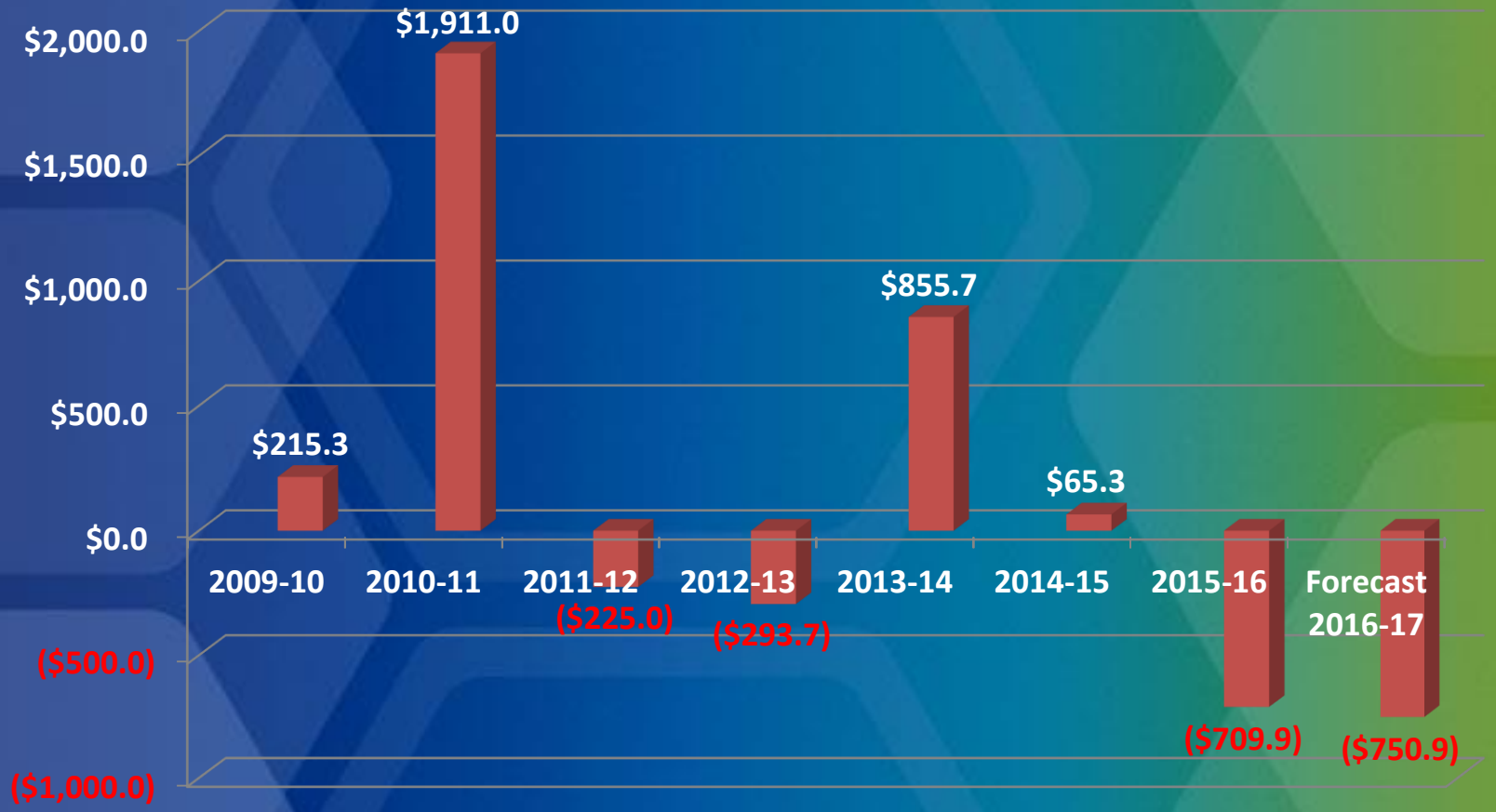
Major Variations (Forecast vs. Budget)

For the Six Months Ended December 31, 2016

Expenses	Variation
• Publishing/Promo	($307K)
– Forecasted lower book and non-print sales translates into lower related expenses (printing, shipping, commissions, etc.)	
• Outside Services	($106K)
– Pub/Ed negotiated certain benefits for Research Journal at a lower cost than projected. Reduced scope for campaign consultant.	
• Salaries	($83K)
– Pushed out timing of hiring staff in support of capital campaign	

General Fund Surplus (Deficit)
Before Nonrecurring Expenses and Investment Income/Loss
(As of December 31 - Exclusive of Foundation)

General Fund Surplus (Deficit)
After Nonrecurring Expenses, Investment Income/Loss and Reserve Transfers
(As of December 31 - Exclusive of Foundation)



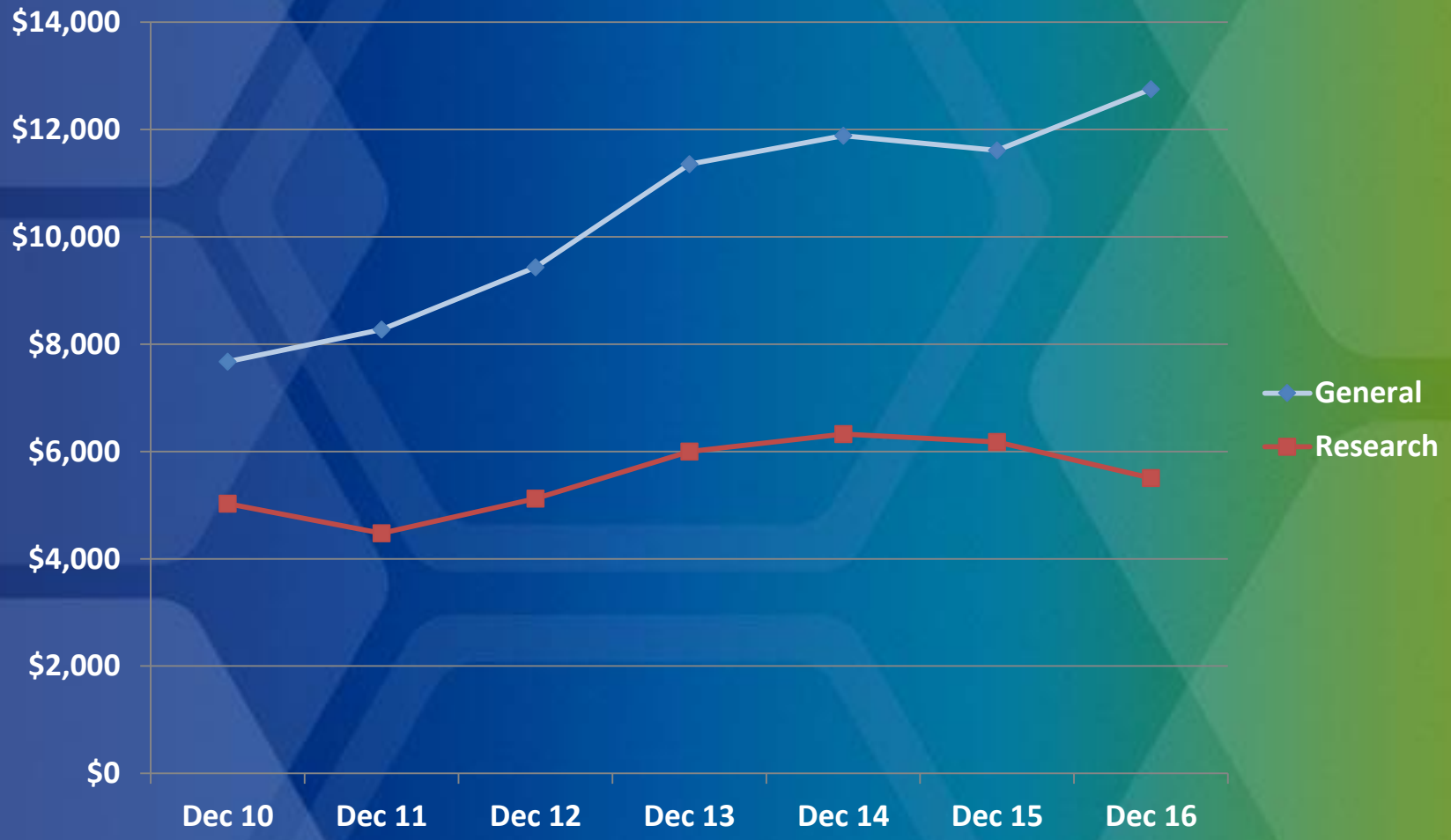
Research Fund

16-17 Budget to 16-17 Forecast as of December 31

	16-17 Budget	16-17 Forecast
Revenues	$5,863	$5,501
Expenses	5,863	5,501
Surplus/(Deficit)	$ 0	$ 0

Investment Reserves

Investment Reserves
(YTD through December exclusive of Foundation)



Questions?

REPORT TO THE EXECUTIVE COMMITTEE
From Foundation Board of Trustees
As of 01/30/2017

Recommendations for ExCom Approval:

1. None.

Information Items:

1. The Foundation Board of Trustees approved funding requests in support of ALI and e-Learning programs, contingent upon the request being reviewed and resubmitted by Publishing and Education Council. The $40,000 for ALI will support ASHRAE's new Global Training Initiative. The $50,000 for e-Learning will support infrastructure improvements to accelerate course development. Fiscal Impact $90,000.

2. The Foundation Board of Trustees approved the creation of the following new endowed scholarships.
    a. Regina Canada Chapter Awarded Scholarship
    b. Ottawa Valley Canada Chapter Society Scholarship
    c. Austin Texas Chapter Awarded Scholarship
    d. Columbus, Ohio Chapter Awarded Scholarship
    e. Hampton Roads, Virginia Chapter Awarded Scholarship

3. The Foundation Board of Trustees approved the following officers for the Society Year 2017-2018.

    Chair – Bill Harrison
    First Vice Chair – Jim Fields
    Second Vice Chair – Tom Watson
    Foundation Treasurer – Damon Gowan

January 30, 2017

Date

Chair

REPORT TO THE EXECUTIVE COMMITTEE
From the Scholarship Trustees
January 31, 2017

INFORMATION ITEMS:

1. The trustees are investigating the possible creation of scholarships aimed at students from countries with developing economies.

2. The trustees are working to revise and update the Scholarship MOP and Guidelines.

3. The trustees rescinded the following motion passed at the June 28th 2016 meeting:

   Motion 4A: to require student membership in ASHRAE for all post high school scholarship applicants, effective January 1, 2017

   Background: The trustees have decided to strongly encourage membership instead of requiring it. A link to the ASHRAE membership application will be added to the scholarship webpage.

4. The trustees selected students to receive the Society's Undergraduate Engineering, Regional/Chapter, and University Specific Scholarships for the 2017-2018 academic year as listed below. The Society's Freshman, High School Senior, and Engineering Technology Scholarships will be awarded at the 2017ASHRAE Annual Conference in Long Beach, CA.

   $10,000 Willis H. Carrier Scholarship
   Elena Gowdy, Pennsylvania State University, Architectural Engineering
   Sarah Drummey, University of Nebraska, Architectural Engineering

   $10,000 Reuben Trane Scholarship (awarded over a two-year period at $5,000 per year):
   Claire Feind, Texas A&M University, Mechanical Engineering
   Mark Jirak, Minnesota State University, Mechanical Engineering
   Karan Kedia, Purdue University, Mechanical Engineering

   $5,000 Frank M. Coda Scholarship
   Timothy Grider, University of Tennessee, Mechanical Engineering

   $5,000 Lynn G. Bellenger Scholarship
   Briana Basile, Pennsylvania State University, Architectural Engineering

   $5,000 Gordon V. R. Holness Scholarship
   Karolina Czerwinski, City College of New York, Mechanical Engineering

   $5,000 Alwin B. Newton Scholarship
   Michelle Ragan, Kansas State University, Architectural Engineering

   $5,000 C. J. Peters Scholarship
   Mary Taylor, Pennsylvania State University, Architectural Engineering

   $5,000 Duane Hanson Scholarship
   Callie Clark, University of California, Civil & Environmental Engineering

   $5,000 Legacy Scholarship

Paul McNeely, North Carolina State University, Mechanical Engineering

$5,000 ASHRAE Region IV Benny Bootle Scholarship
Kristin O'Brien, Clemson University, Mechanical Engineering

$5,000 James R. Bullock Scholarship
Brandon Hines, North Carolina State University, Mechanical Engineering

$5,000 General Scholarship
Casey Bertelsman, Kansas State University, Architectural Engineering

$3,000 Henry Adams Scholarship
Michael Akinseloyin, University of Lagos, Mechanical Engineering

$3,000 Region I Setty Family Foundation Scholarship
Jerod Sutcliffe, University of Hartford, Mechanical Engineering

$3,000 Region III Setty Family Foundation Scholarship
Jonathan Shoup, Grove City College, Mechanical Engineering

$3,000 Region VIII Scholarship
Darin Epperson, University of Texas, Mechanical Engineering

$3,000 ASHRAE Minnesota Chapter Peter Potvin Scholarship
Subhan Khalid, Minnesota State University, Pre-Engineering

$3,000 Central New York King-Traugott Scholarship
Mohammad Farooq, City College of New York, Mechanical Engineering

$3,000 Donald E. Nichols Scholarship
Hayden Rhymer, Tennessee Technological University, Mechanical Engineering

$3,000 J. Richard Mehalick Scholarship
Jordan Myers, University of Pittsburgh, Mechanical Engineering

$3,000 New Jersey Chapter Scholarship
The New Jersey Chapter Scholarship was not awarded during the meeting because there was no candidate from the geographic boundaries of the chapter. It was later realized that when there is no viable candidate from the geographic boundaries of the New Jersey chapter, a recipient may be selected from applicants who attend a school within the boundaries of ASHRAE Region I. An applicant from Region I has been identified and will be considered by the trustees via a conference call after the meeting.

1-31-2017	Chuck Curlin
Date	Scholarship Chair

REPORT TO THE EXECUTIVE COMMITTEE
From __College of Fellows____
As of January 29, 2017

Recommendations for ExCom Approval:

Information Items:

1. The College of Fellows is pleased to announce they have set up mentoring opportunities with YEA to start with. Mentoring questions and/or advice will be communicated via web page forum. This opportunity was developed by the College of Fellows and YEA, together.

   Background: There have been several attempts to develop a link between the COF and YEA. This has finally been developed into a very clear platform of mentoring opportunities between the two parties. At this stage only YEA are being considered, but the COF feel this should not be limited to only YEA members at a later stage. Mentoring and the dissemination of knowledge is part of the purpose of the COF as prescribed in the MOP. A COF Subcommittee has been set up to facilitate this.

2. The College of Fellows approved increasing the ExCom position terms from one year to two years. The MOP change will be approved by the College and submitted for approval during the Long Beach Annual Meeting.

   The Fellows would like to see more consistency in the leadership of their Executive Committee as new initiatives and objectives arise that align with their Scope and Purpose.

3. The College of Fellows will begin their Spring solicitation schedule in February. The Fellows solicit gifts in the Spring so the ask will not interfere with the Life Member's Club Fall solicitations. The first solicitation is hand signed to add an extra layer of stewardship.

4. The Fellows were excited to have guests from Honors & Awards share a proposed presentation promoting the grade of Fellows. This is a reflection of an ongoing relationship between the groups. If approved, the Fellows will add the presentation to their website.

   In an attempt to increase the number of new Fellows, the COF are working closely with Honors and Awards to assist with the nomination process and to identify possible Fellow nominees. A COF Subcommittee has been set up to facilitate this.

1-29-2017
Date

President, Peter Simmonds

REPORT TO THE EXECUTIVE COMMITTEE
From __Life Member's Club____
As of January 31, 2017

Recommendations for ExCom Approval:

1. The Life Member's Club approved the Manual of Procedures and recommends approval by the Board of Directors ExCom.

Background:
The changes are to correct some errors that are minor and are on the recommendation of Pat Graef.

Information Items:

1. The Life Member's Club approved funding for a 3rd Grant-in-Aid.

2. The Life Member's Club approved changes to their Reference Manual. The changes are mostly minor to reflect the current practice. There is a change to the nominating procedure to reflect the need to nominate members of ExCom as well as officers.

3. A certificate and check were presented to Dr. Thomas Kuehn, the 2016-17 E.K. Campbell Award recipient, at the Life Member's Luncheon.

   The LMC has decided on the 2017-18 E.K. Campbell Award recipient and will submit the nomination to Honors and Awards for official approval. The recipient will be notified in July 2017 and recognized during the 2018 Winter Conference in Chicago.

1-31-2017
Date

Chair, Richard Hayter

Manual of Procedures (MOP)

Life Members Club (LMC)

Effective 06/28/2016

Forward

The Life Members Club is a General Standing Committee of the Society and operates under the direction of the Board of Directors. The Rules of the Board (ROB) are the constitution of the committee. Proposed changes to the ROB and their appendices must be approved by the Board of Directors.

This Manual of Procedures (MOP) describes the methods and procedures by which the committee accomplishes the duties and responsibilities assigned to it. The MOP is an internal document of the committee for its own guidance. The MOP and revision thereto, shall be submitted to the Board of Directors for approval.

Proposed MOP and ROB changes shall normally only be presented to the Board of Directors for approval once a year for consideration.

1. Life Members Club (LMC) – General
   1.1. Scope and Purpose
      1.1.1. The LMC shall perform services to enhance the continued relationship with Society of long-time members, to recognize the contributions of outstanding HVAC&R educators, to encourage the academic and professional growth of HVAC&R graduate students and to support younger members.
      1.1.2. The LMC shall also provide fellowship within its membership
   1.2. The Life Members Club Reference manual provides detailed operating procedures
2. Membership
      2.1.1. Membership in the LMC is as described in Rule of the Board 2.105.010.2
      2.1.2. ~~No member of the club shall be required to pay dues.~~There shall be no additional financial requirement to be a member of the club.
3. Meetings of Members
   3.1. Regular LMC meetings shall be scheduled during the Society's Annual Meeting [summer] and Winter Conference as luncheon meetings.
   3.2. ASHRAE Standing Committee meetings are conducted using Robert's Rules of Order.
4. Quorum
   4.1. The Chair shall establish the quorum for a meeting of the LMC members as those members who are present but not less than 10. For an electronic or written ballot, the Chair shall establish the quorum as the total of those returning ballots but not less than 10.
   4.2. In all matters that call for the vote of LMC members, each member shall have one vote. Each member shall be entitled to vote in the election of directors and in any other matter that requires the vote of members.
5. Officers
   5.1. The officers of the LMC shall consist of a Chair, a Vice Chair and a Secretary/Treasurer who serve two-year terms.
      5.1.1. A person may hold only one office.
      5.1.2. The term of each officer shall commence on the first day of the ASHRAE fiscal year following election to office.
   5.2. Any LMC officer (regardless of how elected or appointed) may be removed with cause by the ASHRAE Board of Directors.
   5.3. Chair
      5.3.1. The Chair shall preside at and serve as Chair of LMC meetings and shall perform other duties and have other authority as may from time to time be delegated by ASHRAE's Board of Directors. The Chair has the authority to appoint LMC committees as needed.
   5.4. Vice Chair
      5.4.1. The Vice Chair shall, in the absence or disability of the Chair, or at the direction of Society's Board of Directors, perform the duties and exercise the powers of the Chair. The Vice Chair shall perform any other duties and have any other authority as from time to time may be delegated by the Chair or LMC ExCom.
   5.5. Secretary/Treasurer
      5.5.1. Shall be responsible for preparing and distributing agendas, in conjunction with the staff liaison, for LMC meetings and LMC ExCom meetings.
      5.5.2. Shall be responsible for recording and distributing, in conjunction with the staff liaison, minutes of LMC ExCom meetings.
      5.5.3. Shall perform any other duties and have any other authority as from time to time may be delegated by the Chair of LMC ExCom.
      5.5.4. Shall be responsible for overseeing of all funds and securities belonging to the Life Members Club and for the receipt, deposit, or disbursement of these funds and securities under the direction of the LMC ExCom unless otherwise provided by the LMC ExCom, in conjunction with the Society's financial officer.
6. Executive Committee (LMC ExCom)

6.1. The affairs of the Life Members Club shall be administered by an Executive Committee (LMC - ExCom) consisting of the Chair, Vice Chair, Secretary/Treasurer and not less than four (4) additional LMC members (ROB 2.105.010.3).

6.1.1. LMC ExCom members must be members of the ASHRAE Life Members Club in good standing.

6.1.2. The additional members of the ExCom shall have 3-year staggered terms.

6.2. Vacancies

6.2.1. A vacancy occurring in the LMC ExCom may be filled for the un-expired term, unless the members have elected a successor, by the affirmative vote of a majority of the remaining LMC ExCom members, whether or not the remaining LMC ExCom members constitute a quorum.

6.3. Regular Meetings

6.3.1. A regular meeting of LMC ExCom shall be held in conjunction with each meeting of members.

6.4. Special Meetings

6.4.1. Special meetings of LMC ExCom may be called by or at the request of the Chair or any LMC ExCom member in office at that time.

~~6.5. Place of Meetings~~

~~6.6.~~6.5. ~~LMC ExCom may hold their meetings in conjunction with Society Annual and Winter Conferences~~ExCom Voting

~~6.6.1.~~6.5.1. A majority of the LMC ExCom members then in office shall constitute a quorum for the transaction of business.

~~6.6.2.~~6.5.2. ~~ASHRAE Standing Committee meetings are conducted using Robert's Rules of Order~~All matters shall be decided by a majority of those voting, with fiscal matters requiring a two thirds majority. Letter ballots require a majority of the LMC ExCom voting membership to cast an affirmative vote. Letter ballots for fiscal matters must be approved by at least 2/3 of the voting membership of the Committee.

~~6.6.3.~~6.5.3. Motions involving Society policy (Found in ROB Volume 1) shall be approved by a 2/3 vote of the LMC ExCom members present in accordance with the quorum requirements and shall be submitted to the BOD for final approval.

7. Subcommittees and Liaisons

7.1. The LMC ExCom Chair shall appoint subcommittees and liaisons as required.

7.2. ~~The Chair shall appoint a member of the LMC ExCom to be the liaison to the ASHRAE Development Committee.~~As required, the Chair shall recommend to the ASHRAE president-elect a member of the LMC to serve a 3 year term on the Development Committee and represent LMC.

~~7.1.1.~~7.2.1. The LMC representative shall report Development Committee actions to the LMC ExCom at their regular meetings.

8. Awards

8.1. Details of current awards and procedures are found in the LMC Reference Manual.

8.2. E. K. Campbell Award of Merit

8.2.1. The Club shall sponsor an annual award, known as the "E.K. Campbell Award of Merit", to a deserving educator, who is an ASHRAE Member in good standing, and who is associated with a recognized institution of learning; to offer encouragement to teach the subjects covered by the profession and industry as related to the American Society of Heating, Refrigerating and Air Conditioning Engineers.

8.3. Other Potential Awards

8.3.1. Consider other special awards, which from time to time have been established by the LMC ExCom or may be established in the future for such worthy causes as the LMC ExCom may select.

9. Fiscal

9.1. Approval of expenditures of Life Member Club funds

9.1.1. By majority vote of the LMC Executive Committee (LMC ExCom) as prescribed in section ~~3~~6.

9.1.1.9.1.2. By majority vote of the ExCom members present at a regular meeting, provided that there are at least 5 voting members physically present at the time of the vote.

9.2. Disbursements of up to $1,000.00 may be approved by the Secretary/Treasurer (or in his absence, any other LMC officer) in writing or by E-mail. Disbursements exceeding this amount shall require the additional approval of the Chair or another LMC officer.

9.3. All funds of The Club are donations and shall not be used for any purpose except as outlineddescribed in the LMC Reference Manual approved by the LMC ExCom.

10. Staff Liaison

10.1 Shall be the ASHRAE LMC Staff Liaison acting as secretary at LMC meetings, submitting meeting minutes for approval to the Chair prior to distribution, and distributing meeting minutes within 60 days after committee meetings.

10.2 Mailing agendas and supporting papers to LMC members in a timely fashion Eensuring that LMC reports to the Board of Directors are prepared and submitted in a timely manner.

10.3 Welcoming new ExCom Members, sending them copies of the committee roster, Resource Manual, Manual of Procedures, minutes of the past two meetings, and other pertinent information.

11. Revisions

11.1. Revisions to the Manual of Procedures or Rules of the Board (ROB) may be initiated by any three (3) members of LMC ExCom or by six (6) members of the LMC and must be submitted in writing to LMC ExCom with signatures.

11.2. All such revisions, if approved by three (3) or more members of LMC ExCom, shall be submitted for vote by the LMC members at the next LMC meeting.

11.3. Revisions shall be forwarded to the approving body if they receive a majority vote at a regular meeting of The Club, provided that there are not less than ten [10] affirmative votes.

REPORT TO THE EXECUTIVE COMMITTEE
From ASHRAE/AHRI Joint Exposition Policy Committee
As of January 29, 2017

Information Items:

1. Final Report on 2017 AHR Expo – Las Vegas
   - An overall record 500,159 sq. ft. of exhibitor space sold
   - 1964 exhibiting companies, including 583 international companies
   - IEC plan to add the South Hall at the next Show in Las Vegas to accommodate the growth

2. Report on 2018 AHR Expo – Chicago – January 22-24
   - 530,000 sq. ft. of exhibitor space has been laid out with the potential for an additional 10,000 sq. ft.
   - 447,000 sq. ft. of exhibitor space has been sold
   - 1063 exhibiting companies

3. Report on 2025 AHR Expo
   IEC is negotiating with Las Vegas to secure dates. Dates of February 24-26 offered previously are not available.

4. List of Future AHR Dates/Locations
   - 2018 Chicago, January 22-24
   - 2019 Atlanta, January 14-16
   - 2020 Orlando, February 3-5
   - 2021 Chicago, January 25-27
   - 2022 Las Vegas, January 31 – February 2
   - 2023 Atlanta, February 6-8
   - 2024 Chicago, January 22-24
   - 2025 Las Vegas, ?
   - 2026 New York or Atlanta

5. Final Report on 2016 AHR Expo Mexico – Monterrey - Attached

6. Report on 2018 AHR Expo Mexico – Mexico City – Oct 2-4, 2018
   - The committee ratified an e-ballot approving an exhibitor space rate of $39.90 per sq. ft. for the 2018 AHR Expo Mexico
   - IEC has a sales booth at the 2017 AHR Expo in Las Vegas
   - 59,730 sq. ft. of exhibitor space sold
   - 77,000 sq. ft. has been laid out

7. ASHRAE plans to run two parallel sessions at the 2018 AHR Expo on the following subjects: Residential and Refrigerants

01/29/2017

Date

Chair

AHR EXPO MÉXICO

ASHRAE AHRI

September 20th-22nd, 2016

CINTERMEX • Monterrey, N.L. MEXICO

ATTENDANCE REPORT

GENERAL STATISTICS

10,879 Total attendance

Total visitors **7,424**

Total exhibitors **3,455**

Total attendance 10,879

Geographic

Local (Nuevo Leon state) **5,396**

Other Mexican States ..... **4,072** *

Outside Mexico **1,411**

Number of Countries Represented ..... 36 *

* **AHR Expo Mexico Show record**

362 Companies participated as exhibitors

Total Exhibiting Companies ..... **362** *

Net Sq.Ft. Sold ..... 75,475 *

Countries Represented by Exhibitors ..... **14 countries**

Mexico, USA, Belgium, Brasil, China, Colombia, Canada, Germany, Finland, France, Italy, Japan, Spain, United Kingdom.

* **AHR Expo Mexico Show record**

90% Of visitors have a role in purchasing

JOB FUNCTION

Directors, President, Owners **29%**

Sales **17%**

Specialized technicians **15%**

Product Manager **12%**

Purchasing **8%**

Operation and maintenance **7%**

Not given/Others **12%**

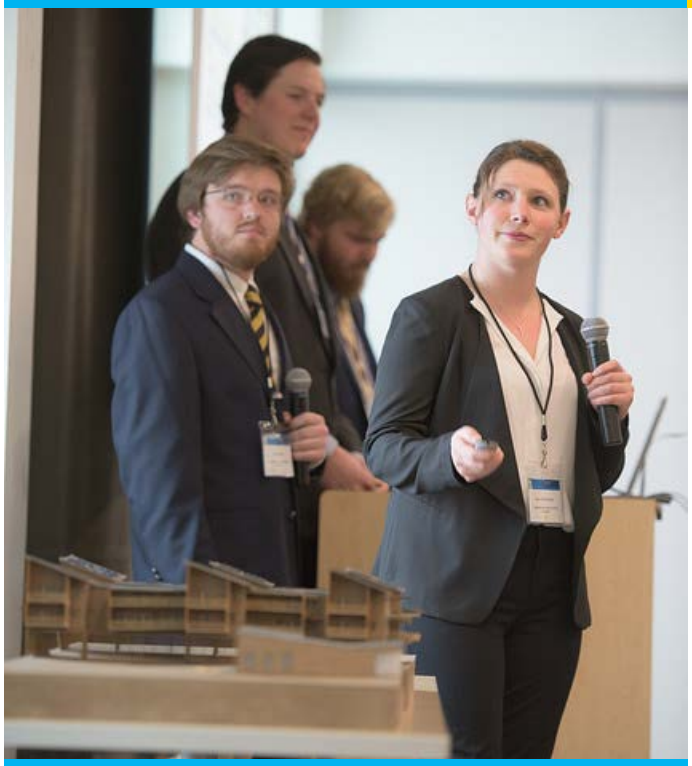
TYPE OF BUSINESS

- Contractors/Dealers
- Engineering, Design & Construction
- Distribution
- Manufacturers of HVACR and Allied Equipment & Components
- Facility/Building/Plant Mgt. & Operations
- Public Utilities
- Education
- Publishing/Press
- Allied to the Field/Other

36 Countries attendance

ARGENTINA	FRANCE	PANAMA
BRAZIL	GERMANY	PERU
BELGIUM	GUATEMALA	PUERTO RICO
CANADA	ITALY	SPAIN
CHILE	HONDURAS	TAIWAN
CHINA	HONG KONG	THAILAND
COLOMBIA	INDIA	TURKEY
COSTA RICA	ICELAND	UKRAINE
CUBA	ISRAEL	UNITED ARAB EMIRATES
DOMINICAN REPUBLIC	ITALY	UNITED KINGDOM
ECUADOR	JAMAICA	UNITED STATES OF AMERICA
EL SALVADOR	MEXICO	VENEZUELA
FINLAND	NICARAGUA	

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy



RACE TO ZERO
U.S. DEPARTMENT OF ENERGY
STUDENT DESIGN COMPETITION

2017 Race to Zero Student Design Competition

For ASHRAE ExCom

January 28, 2017

Rachel Romero– National Renewable Energy Laboratory

Client: Sam Rashkin, DOE

Colleagues: Sara Farrar, Joe Simon, Linh Truong, Pam Gray-Hann, NREL

Race to Zero Student Design Competition Vision

- ✓ **Inspire** and develop the next generation of building professionals
- ✓ **Advance** and enhance building science curriculum in universities

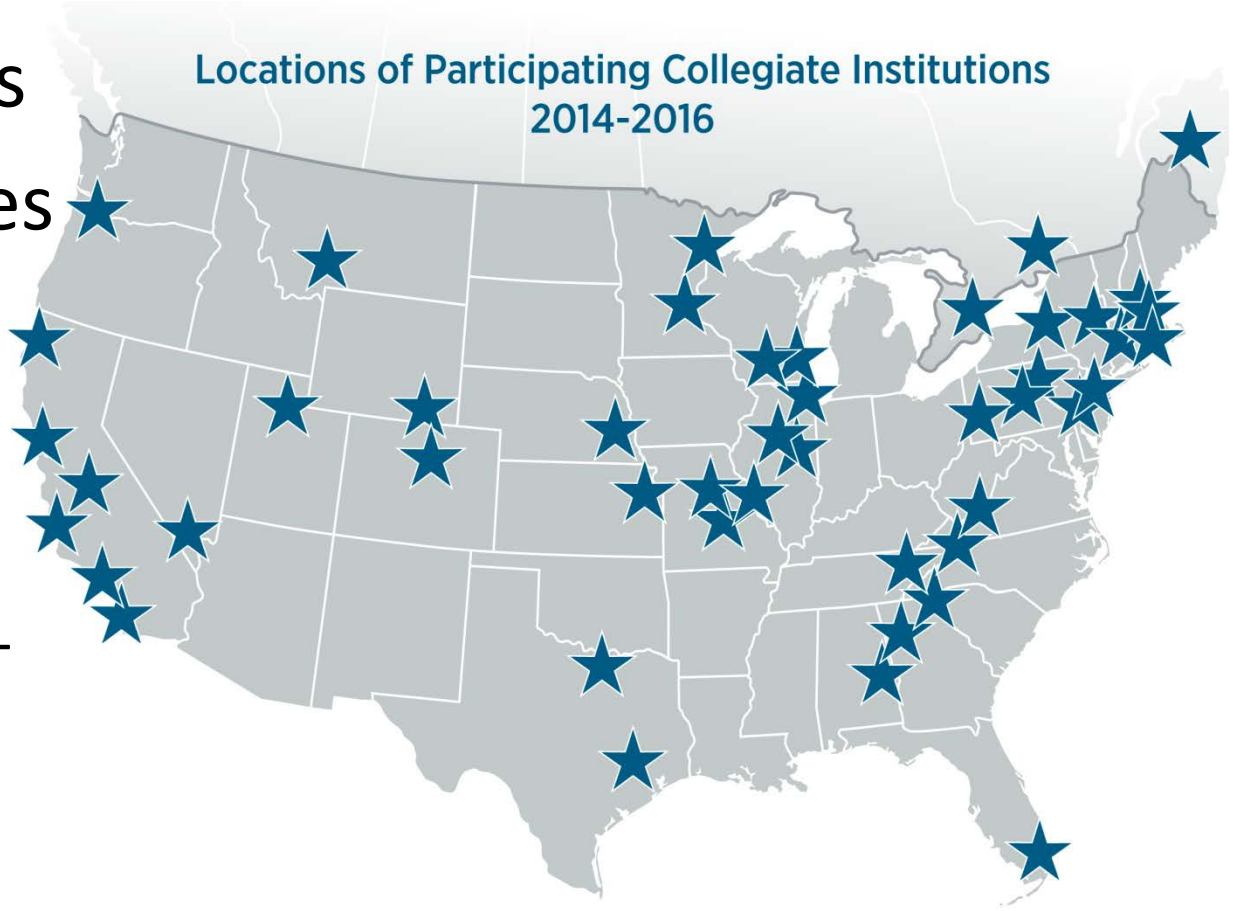
Participating Collegiate Institutions

2014-2016 stars

- 51 Universities
- 92 Teams

Team=

3 or more students + faculty lead



2017 Competition Event

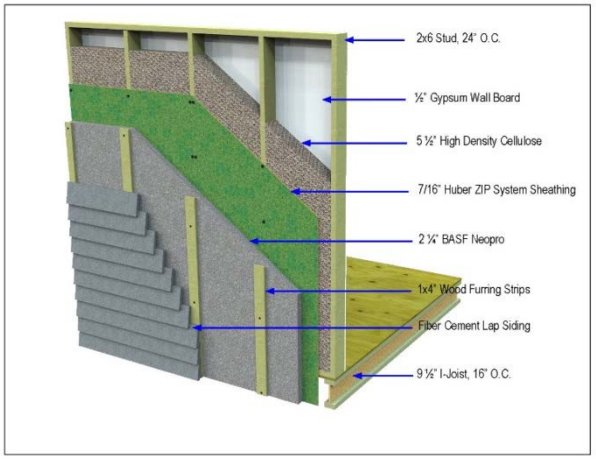
- April 22-23, 2017
- Main Campus of National Renewable Energy Laboratory in Golden, CO
- 4th edition of the annual competition

The Job-Ready Skills

Figure 37. Thermal Barrier

Figure 38. Vapor Barrier

Figure 39. Water Barrier



"I am going to be looking for a job in building science/high performance building. I found out that this is exactly what I want to do because of the Race to Zero."

-2016 Race to Zero Participant

Choose One of Four Contests:

1. Suburban Single-Family Detached House
2. Urban Single-Family Detached House
3. Attached Housing
4. Small Multifamily

Project Requirements

ZERO ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY

- Achieve DOE Zero Energy Ready Home requirements
- Effectively integrate building science principles and best practices
- Demonstrate marketplace relevance

2016 Winning Design: **Prairie View A&M University**

Urban Single-Family Contest

An affordable zero ready home for a historically significant, low income neighborhood

Began with the PHIUS+ 2015, used BEopt to optimized design criteria for the climate, and then adjustments based on industry partners recommendations

2016 Race to Zero Experience

"I had almost zero knowledge in everything I had to do for this project. Learning the material in class then getting to apply it in a real world application was amazingly helpful…"

-2016 Race to Zero Participant

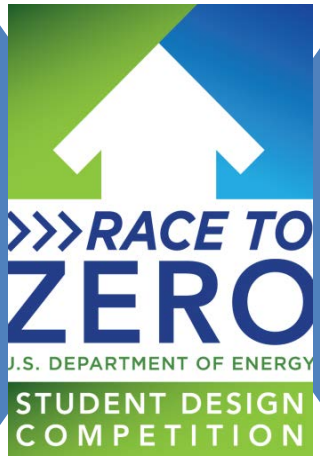
Thank you to our 2017 Sponsors!

- Attendance at closed event
- Provide juror
- Participation in a Career Connections activity
- Offering existing technical resources
- Presentation to teams on webinar
- Sponsor recognition in the event program and on the Race to Zero website
- Placement of your company's logo on event signage and at the awards banquet

Opportunities for Further Collaboration

Collaborate with US Department of Energy

- Use ZERH standard
- Be a partner in residential work



Collaborate with Race to Zero Competition

- Climate data beyond US
- Chapter involvement with teams

Questions?

http://energy.gov/eere/buildings/us-department-energy-race-zero-student-design-competition

OR

racetozero@ee.doe.gov

Propose change in:
1. method of Handbook PDF file delivery, &
2. member's benefit in Handbook

To: ExCom

From: PEC -
Study of Handbook Benefit with Global Membership Ad-Hoc committee

Date: 2016/12/28

Background and charge of the Ad-Hoc committee

As ASHRAE's membership has increased globally, delivery of the ASHRAE Handbook in its print form has posed increasing challenges. This includes members varying degrees of delivery success in different countries and wide variations in delivery cost. Also, since the Handbook benefit was established by ASHRAE decades ago, access to the Handbook in digital form has been introduced with differing delivery, functionality and membership benefits – both pro and con.

Motion:

1. Propose to eliminate Handbook CD format starting from 2018-19.
2. Propose to change the members' benefit in Handbook as follows, from 2018-19,
   - Regular member:
     a) Receive a 12 month complimentary subscription to the Handbook Online, with PDF files download; or
     b) Receive a printed Handbook, (without CD); or
     c) Pay extra to receive both (a) & (b)
   - Developing economies member:
     - Receive Handbook PDF cloud based file (with stamp)
3. Propose members (assume members outside US/Canada/Europe) to pay mailing surcharge (based on the country of delivery) if they choose Handbook Print copy, from 2019-20. And ASHRAE will send them the printed Handbook by FedEx.

Fiscal Impact(1):

		COST	SAVING
	Motion 1 & 2:		
a.	Saving from NOT producing and mailing CD (per year)		$125,374
b.	Cost increase for add PDF download to Handbook Online Year 1: Year 2 onward (per year):	 $40,000.00 $30,000.00	
c.	Cost increase for developing economies members PDF Cloud base delivery platform (one time cost)	$5,000.00	
	Motion 3:		
a.	Cost increase if ASHRAE send print Handbook to members (outside US/Canada/Europe) by **FedEx** (per year)	$76,273.00	

Fiscal Impact (2): potential saving

	2018-19	2019-20 onwards (per year)
If motion 1/2/3 pass and ASHRAE deliver the print handbook to members as usual in 2018-19.	$80,374.00	$90,374.00
If motion 1/2/3 pass and ASHRAE will deliver the print handbook to members by FedEx in 2018-19 without surcharge	$4,101.00	$90,374.00
If motion 1&2 pass, and ASHRAE will deliver the print handbook as usual.	$80,374.00	$90,374.00
If motion 1&2 pass and ASHRAE will deliver the print handbook to members by FedEx without surcharge (from 2017-18 onward)	$4,101.00	$14,101.00

Background info:
what's format of Handbook members are choosing ….

Print	CD	online	No of mbr chose for 2016		No of mbr got handbook of:		
							
 +			32,251*	mbrs chose print handbook with CD	32,251	32,251	
			6,949	mbrs chose CD only and developing economies mbrs		6,947	6,949***
			5,717	mbrs chose Handbook Online (HOL) only			5,717
 +	 +		3,226	mbrs chose print handbook with CD & Online for $33 additional	3,226	3,226	3,226
				No of Handbook copies ASHRAE have to prepare	35,477	42,424	

Note: information are extracted from handbook June 2016 delivery data

(*): Total no of full year members is 32251 + 3226 = 35477

(***): This was never approved BUT members (including developing economies mbrs) chose CD also got HOL by unknown reason

Background info:
Cost of manufacturing and distribute the CD

Manufacturing cost

- $36,000 for each year's CD development
- $0.75* each CD manufactured
- Total cost estimated for 2016 is:
- **$67,818.00**
  - ($36,000 + $0.75x42424 copies)

(*): The unit cost for CD manufacturing varied based on petroleum price. $1.44/CD @ 2014 & $1.24/CD @ 2015

Mailing cost

- $57,556.00

	Initial mailing cost	Followup mailing cost (est)
US	32,310	4,770
Canada	3,970	448
ROW	14,308	1,750
Total	50,588	6,968

ROW: Rest of the World

Total cost: $125,374.00

Note: information are extracted from handbook June 2016 delivery data

Disadvantage of Handbook CD:

- We periodically receive complaints regarding non-delivery of printed Handbooks and/or CD;
- CD is a mean of transferring PDF file and there are other technologies to transfer files nowadays;
- ASHRAE is phasing out CD technology because of disappearance of CD drives;
- ASHRDAE CDs do not work in Mac environments. Files are sent on request to such users. Spend extra staff working hours;
- Expensive mailing cost;

Propose alternative to Handbook CD

Transfer the Handbook PDF files through download

What is it?

- Regular Members can download the handbook chapter PDF files through Handbook Online;
- Developing Countries reduced fee members can download the PDF through a Cloud based delivery platform;
- Files can be accessed when offline;
- Files can be read in computers (PC/Mac) or tablet and files are responsive;

COST to ASHRAE

PDF archiving capability to Handbook online

(for regular members who choose HOL)

- One-time setup cost: $10,000
- Annual cost: $30,000
- Mailing cost: $0

PDF Cloud based delivery platform

(for developing economies members)

- One-time setup cost: $5,000
- Annual cost: $0
- Mailing cost: $0

Benefit in using PDF archiving capability to Handbook online

Benefit to ASHRAE

- Improve member satisfactions;
- Promote members to select Online product;
- Less complaint on non-delivery;
- Reduce extra staff time to manage complaint and send files to Mac users;
- Cost saving: (including cost to develop separate Cloud based delivery platform for developing economies members)
  - 1st year: est $80,374.00
  - 2nd year on: est $90,374.00
- No incremental cost for additional online users;
- Can help to analysis mbrs handbook usage behavior (only for members using HOL);

Benefit to members

- No delivery problem;
- Instant access to Handbook PDF, no need to wait for the CD delivery;
- Can access when offline through downloaded PDFs;
- Content searchable within the handbook chapter;
- Permanent archiving of Handbook content for lapsed members providing they download content while still members ;

Background info:
Cost of manufacturing and distribute printed Handbook

Copies of printed Handbook distributed

Country	IP	SI	Total
US	22956 1797*	1030 170*	23986 1967*
Canada	2080 149*	1110 78*	3190 227*
Europe	-	-	1197 89*
Special delivery countries (**)	-	-	383 38*
ROW	-	-	2597 283*

ROW: Rest of the World

Cost to distribute the printed Handbook (USD)

Country	Mailing cost	Ave mailing cost per mbr
US	61,164 11,802*	2.55 6.00*
Canada	40,736 4,767*	12.77 21.00*
Europe	19,236 1,869*	16.07 35.54*
Special delivery countries (**)	13,609 1,350	35.54 21.00*
ROW	51,521 5,943	19.84
Total	**211,997**	

Note: Information are extracted from handbook June 2016 delivery data ;
(*): Those are subsequent mailings after large initial mailing; mailing cost does not include $6.00/unit for pull/pack/ship and $10 per book mailing fee fro FedEx;
(**): sent by FedEx;

Current problem in printed Handbook delivery:

- We periodically receive complaints regarding non-delivery of handbooks;
- Create member unhappiness to the society and chapters, due to non-delivery handbooks problem;
- Most of the complaints came from countries outside US/Canada/Europe;
- Situation was solved for countries historically with most complaint (Argentina, Mexico, India, Pakistan, Sri Lanka) by using FedEx to deliver printed Handbook to South America members, but very costly;
- Extra staff time and higher mailing cost to resend the Handbook when complaint received;

Propose alternative to printed Handbook delivery

Promote Handbook Online as regular member's benefit

- Encourage members using Handbook Online to control mailing cost;
- Add PDF download to Handbook Online platform

Send the printed Handbook by FedEx to regular members in countries outside US/Canada and Europe, who choose to receive printed handbook

- Point-to-point delivery, reduce non-delivery cases/complaints;
- Members pay the surcharge for the mailing cost if they choose printed Handbook; (or use the saving from eliminating CD to cover the additional mailing cost)

Propose Timeline of change in Member's benefit

Current up to 2017-18	Handbook print	Handbook CD	Handbook Online	Handbook PDF download through Cloud platform	Handbook Online + PDF download
Regular member - standard benefit (opt 1)	Y	Y			
Regular member - standard benefit (opt 2)			Y		
Regular member benefit for $33 additional	Y	Y	Y		
Developing economies mbr benefit		Y			

Mbrs benefit in 2018-19					
Regular member - standard benefit (opt 1)	Y				
Regular member - standard benefit (opt 2)					Y
Regular member benefit for $33 additional	Y				Y
Developing economies mbr benefit				Y	

Mbrs benefit in 2019-20 and onwards (subject to further changes)					
Regular member - standard benefit (opt 1)					Y
Regular member - standard benefit (opt 2) (mbrs pay surcharge for mailing)	Y				
Regular member benefit with additional cost of handbook print and surcharge for mailing	Y				Y
Developing economies mbr benefit				Y	

2017-2018
ASHRAE-UNEP Joint Work Plan

Suggested Main theme

Working Beyond High-GWP Refrigerants

Goals of the 2015-2016 Work Plan

Goal 1: Emissions Reduction, long-term Refrigerants and Energy Efficiency	Goal 2: Expertise and Technological Information Exchange
Action 1 Building bridges between industry and policy-makers on feasibility of alternative refrigerants and equipment efficiency including addressing specific needs of the developing countries	**Action 1** Use the Distinguished Lecturer (DL) program at collaborative activities between UNEP and ASHRAE chapters/sections
Action 2 Compile research findings, resulted from ASHRAE Research Program, about Zero ODP & Low GWP alternatives and disseminate it to research centers, institutions and researchers in the developing countries	**Action 2** Explore the possibility of building list of experts categorized according to their specialties in the refrigeration and HVAC sectors, to assist developing countries
Action 3 Explore opportunities to promote responsible and sound management of refrigerants	**Action 3** Consider launching special Initiative to support the establishment and/or strengthening of local refrigeration and/or HVAC societies in developing countries
Action 4 Cooperate and coordinate efforts related to energy efficiency in the buildings sector	Action 4 Consider building an online tool/page to ensure outreaching the outcomes of the cooperation between ASHRAE and UNEP and facilitate communication with different stakeholders in relation to the cooperation

Suggestions for the 2017-2018 Work Plan

ASHRAE-UNEP 2017-2018 Work Plan

Working Beyond High-GWP Refrigerants

What's different in the new work plan?

- Thematically oriented to one main goal to offer more focus in delivery
- Product based work plan i.e. no broad goals or action items
- Covers wide spectrum of beneficiaries within the main goal of the work plan
- Offer products and services that are not available in the field
- Include appropriate visibility for ASHRAE-UNEP cooperation through incorporating the outreach dimension in all goals and activities
- Ensure involvement and engagement of governments and ASHRAE teams around the globe

Suggested Main theme

Working Beyond High-GWP Refrigerants

Main Goals	Actions
Advocacy and Knowledge Sharing	• Global Conferences and Events • Refrigerants Awareness Package • Low- GWP Innovation Award Program • Issues related to Buildings Sector
Training, Education and Practice	• Online Training Program on Refrigerants • Contemporary Learning Tools for Universities • Assessment Program for RAC Plants

Goal 1: Advocacy and Knowledge Sharing

Goal 1/Action 1: Global Conferences and Events

UNEP & ASHRAE will work together organizing joint global events for advocating, mainly amongst stakeholders in developing countries, latest technological development in relation to moving away from high-GWP alternatives in different refrigeration and air-conditioning sectors.

Activity #1:

International Conference on Sustainable Refrigeration Technologies for Marine and Off-Shore Fisheries Sectors

- Date/Venue: Bangkok, Thailand 6-8 April 2017
- Action items: Technical and Organizing committees established and managing the event

Activity #2:

Side events at 2017 MOP/OEWGs & ASHRAE events

- Date/Venue: OEWG-39 in Bangkok 11-14 July 2017 & MOP-29 in Montreal 20-24 Nov
- Action items: Liaison Committee to suggest themes and speakers

Activity #3:

International Conference on Feasible Low-GWP Alternatives for Developing Economies *(Tentative title)*

- Date/Venue: Spring 2018 Dubai, UAE *(To be confirmed)*
- Action items: Establish Technical Team to manage the event

Goal 1: Advocacy and Knowledge Sharing

Goal 1/Action 2: Refrigerants Awareness Package

UNEP & ASHRAE will develop an Awareness Package for advocating knowledge and development associated with the alternative refrigerants and their policies and standardization.

Activity #1:

Design a Series of seminars for the use by ASHRAE chapters and UNEP regional networks about refrigerants designation, classifications, safety, selection, policies and responsible use.

- Action items: Liaison Committee to develop the package content, suggested list of speakers and outline of the technical materials to be offered at the seminars

Activity #2:

Design a Series of dedicated Webinars about latest update of refrigerants designation and flammability standards.

- Action items: Liaison Committee to suggest a program for the Webinars including topic of each session, suggested speakers as well as dates/timing

Activity #3:

Develop and update joint Factsheets and Technical Briefs for policy makers and technical stakeholders

- Action items: Update regularly the “Refrigerants Classification and Designation” factsheet, develop new technical factsheets as well as develop briefing papers for policy-makers about technological and standards update. The Liaison Committee to discuss and conclude on the topics of the factsheets and briefing papers.

Goal 1: Advocacy and Knowledge Sharing

Goal 1/Action 3: Low-GWP Innovation Award Program

UNEP & ASHRAE to cooperate in establishing an international Award Program for promoting the innovation designs, research and practices of low-GWP alternatives and technologies.

Activity #1:

Establish Joint Committee to manage the Award Program

- Action items: The Liaison Committee to establish the Joint Award Committee with tasks of:
  A. Developing terms of reference for three award categories:
     1. Low-GWP Innovative Design Award
     2. Students Research Award
     3. Field Practice Award
  B. Suggest the Awards and number of awarded individuals for each category
  C. Manage the applications and act as Jury for the Award Program

Activity #2:

Outreach campaign for ASHRAE-UNEP Low-GWP Innovation Award Program

- Action items:
  A. Develop campaign to promote for the Joint Award Program including leaflets, web-Ads, Webinars and brief sessions at major events.
  B. Organize high-level Awarding Ceremonial Sessions at margins of Montreal Protocol Meeting of Parties.

Goal 1: Advocacy and Knowledge Sharing

Goal 1/Action 4: Issues Related to Buildings Sector

UNEP & ASHRAE to cooperate in exploring joint activities and programs related to the Buildings Sector in conjunction with the theme of the work plan and with focus on the following areas:

A. Energy Efficiency in Buildings
B. Indoor Environmental Quality (IEQ)
C. Buildings Codes and Standards

- Action items:
  A. The Liaison Committee will suggest products and activities that address the above three areas benefiting of ASHRAE and UNEP existing relevant programs
  B. Present the proposal to the ASHRAE-UNEP Annual Coordination Meeting (April-2017) for concluding on the specific action items and fiscal impacts

Goal 2: Training, Education and Practice

Goal 2/Action 1: Online Training Program on Refrigerants

ASHRAE and UNEP to cooperate in developing and outreaching an **Online Training Courses on Refrigerants** and make it accessible to different stakeholders around the globe

Activity #1:

Development of two (2) online courses:

- **Course-A (Refrigerant Literacy)**: For basic understanding of policy makers, facility managers and non-specialists on refrigerants main characteristics, uses and basic sound management needs.
- **Course-B (Sound Management of Refrigerants)**: For detailed training for RSS specialists on the sound and safe practices of handling and managing refrigerants during installation, servicing and disposing of refrigeration and air-conditioning applications.

- Action items:

- UNEP and ASHRAE to engage in contracting arrangements for the development of the two (2) courses including establishing joint working team, consultancy contracts for the development of the courses, review of the courses content during the development and finalize the online platform and make ready for the launch
- UNEP and ASHRAE to Launch the courses at margins of ASHRAE and UNEP international events

Activity #2:

Management and outreach the online courses

- Action items: UNEP and ASHRAE to design an outreach campaign to promote the use of the courses by different stakeholders around the globe and in particular in developing countries. This will include the management of the online platform during 2017-2018 as well as compiling feedback on the courses.

Goal 2: Training, Education and Practice

Goal 2/Action 2: Contemporary Learning for Universities

ASHRAE and UNEP to cooperate in promoting the research and education activities related to Low-GWP alternatives and technologies at universities and institutes

Activity #1:

Promote the research activities related to low-GWP alternatives and technologies through ASHRAE chapters and sections at Universities and Institutes

- Action items:
  - Liaison Committee to develop a Generic Seminar on research opportunities and priorities related to low-GWP alternatives and technologies to be used by ASHRAE branches and sections at Universities and Institutes.
  - Liaison Committee to organize remote orientation sessions on the use of the Generic Seminar

Activity #2:

Promote the introduction and use of UNEP Engineering Under-graduates Course on Refrigerants Management through ASHRAE Students branches

- Action items:
  - Liaison Committee to develop a Quick Guide for the use of UNEP Course by engineering colleges and universities.
  - Liaison Committee to organize orientation sessions, remotely and in margins of relevant ASHRAE or UNEP functions, on the use of the Quick Guide
  - UNEP to follow-up on the introduction of the course and link interested universities with the respective National Ozone units (NOUs)

Goal 2: Training, Education and Practice

Goal 2/Action 3: RAC Plants Assessment Program

ASHRAE and UNEP to cooperate in developing an Assessment Program on the Responsible Use of Refrigerants by RAC Plants

Activity #1:

Development of the Responsible Use of Refrigerant Assessment program which should include:

A. Refrigerant Containment Practices
B. Energy Saving Practices
C. Management and Operation Practices (labeling, record keeping, etc.)

- Action items:
  - Establish working team of experts for the development of the assessment program including the Assessment requirements, checklists and resources to be used by practitioners
  - Review and finalize the assessment program including testing and piloting the program

Activity #2:

Manage and outreach the use of the Certification Program

- Action items:
  - Suggest an operational model for managing the Assessment Program
  - Liaison Committee to develop short support tools about the Assessment Program including leaflets, Web-Ads and through means of mass-communication
  - Liaison Committee to organize orientation Webinars and Seminars, in margins of relevant ASHRAE or UNEP functions, on the use of the Assessment Program

ASHRAE.org Redesign – Brief and Teams

ASHRAE will engage with Bridgeline Digital Spring 2017 to redesign ASHRAE.org. The redesigned site will be mobile responsive, include a top-of-the-line search engine, and will have mechanisms in place to serve content relative to selected user's locations.

The expected start date of the project is currently March 2017.

The anticipated end date ultimately depends on the start date and project progression but is estimated at this time to be 12 months after start date.

As soon as the project kicks off ASHRAE staff will work with Bridgeline Digital on a Master Calendar for the project, including a complete project plan. The dates agreed on in the project plan will become the final working dates for the project, and meetings with staff and members in regards to the project will be scheduled around those dates.

Regular check-ins with and updates to ExCom will be planned as part of the project Master Calendar.

Member Involvement

Distinct working groups will be an important part of the foundation of the project. These groups will meet regularly throughout the duration of the project and will be responsible for project quality and execution. Each group consists of specially appointed staff, members, or vendor positions and each group will play a specific role as part of the common goals identified in the project plan.

- The **member group** will be put in place to ensure the redesign progresses smoothly and that the end result best meets the short and long-term needs of ASHRAE. That group has been carefully suggested from input from ASHRAE staff directors to select members from representing ASHRAE across the wide and global spectrum of Society. Their various viewpoints will ensure that the redesign meets the needs of the Society at many different levels.
- A **staff group** will manage execution and the day-to-day aspects of the project.
- A **vendor group** contains industry experts who will code the site, perform industry research, interview specially selected members and oversee all implementation and distribution of all project deliverables.

Suggested Member Group	Staff Group	Bridgeline (Vendor) Group*[i]
Karine Leblanc Tom Watson Joseph Firrantello Tom Phoenix Spencer Morasch Jeff Littleton Walid Chakroun Mick Schwedler * Heather Schopplein as liaison to ECC	Emily Sigman Kimberly Gates Donna Daniel Daniel Gurley Joslyn Ratcliff Brian Unrein Mary Townsend Tanisha Meyers-Lisle Tewana Parris Tara Thomas *Others from ASHRAE Marketing Department	 Project Manager Technical Lead & Solution Architect UX Architect / UX Designer UI Developer Application Engineer
Oversee Project Vision	Execution of Project | Direction	Industry Experts

ASHRAE.org Redesign – Brief and Teams

Market Research as a First Step

A first step in the project is Market Research to be performed by Bridgeline. Specifically, Bridgeline will provide to ASHRAE as a project deliverable a baseline research findings presentation via conference call

- Findings from up to three (3) member interviews via conference call
- Findings from up to two (2) potential and/or current users via conference call
- Findings from up to three (3) competitor, peer or aspiration websites.

The information architecture, navigation, strategy, design, and ultimately end result of the redesign will be based on the initial market research.

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[i] Project Manager - The Project Manager ("PM") is responsible for creation and management of the project plan and monitors the overall health of the project; including managing parallel initiatives, project financials, and proactively identifying issues in order to mitigate and avoid risks. PM will act as the main interface to ASHRAE's Project Lead and/or Executives to ensure project decisions are aligned with business requirements.

Technical Lead & Solution Architect - The Technical Lead & Solution Architect is responsible for the overall architecture and technical specifications for a project.

UX Architect / UX Designer - A UX Architect / UX Designer is heavily involved in the discovery and design phases of a project with the initial research, site map and wireframes used to create the site, as well as the initial design concepts.

UI Developer - A UI Developer will take the design concepts and create the HTML/CSS.

Application Engineer - An Application Engineer is responsible for building the templates in the iAPPS framework as well as any custom development for a project.

ASHRAE ASSOCIATE SOCIETY ALLIANCE APPLICATION REQUEST FORM

GENERAL INFORMATION

Society Name: ABRAFAC - Associação Brasileira de Facilities
Address Line 1: Rua Silvio Dante Bertachi, 287 - Vila Sônia - São Paulo / SP - Brazil
Address Line 2: CEP: 05625-000
Address Line 3:
Country: Brazil
Telephone: (+55 11) 4872-2895
Facsimile: -
Email: diretor.secretario@abrafac.org.br
Web Address: www.abrafac.org.br

SOCIETY OFFICIALS (Please list elected officials on a separate page)

CHIEF STAFF OFFICER (Please list person responsible for correspondence with ASHRAE – include formal title)

Name: Alexandre Marcelo Fontes Lara Title: Secretary Director
Email: diretor.secretario@abrafac.org.br
ASHRAE Member? Yes (●) Membership Number: 8139037
No ( )

SOCIETY PRESIDENT

Name: Luciano Brunherotto
Email: presidente@abrafac.org.br
Term of Office: From: January, 2015 To: December, 2018
ASHRAE Member? Yes ( ) Membership Number:
No (●)

ASSOCIATE SOCIETY ALLIANCE REPRESENTATIVE

Name: Luciano Brunherotto
Address Line 1: Rua Silvio Dante Bertachi, 287 - Vila Sônia - São Paulo / SP - Brazil
Address Line 2: CEP: 05625-000
Address Line 3:
Country: Brazil
Telephone: (+55 11) 4872-2895
Facsimile: -
Email: presidente@abrafac.org.br
ASHRAE Member? Yes ( ) Membership Number:
No (●)

PUBLICATIONS

Publication Name	Publication Frequency
Electronic Mailing	2 per week (in average)
Monthly Webinar Invitation	Several times a month
FM Debate Invitation (panel discussion)	Several times - bimonthly
FM Tactics Invitation (web conference)	Monthly
FM Congress & FM Best Practices Award	Annually - Several times during months prior to the event

MEMBERSHIP

Total Membership: 748

Membership Grades	Approximate Number of Members
Individual Members	600
Corporate Members	53
Student Members	70
Honorable Members	25

SOCIETY MEETINGS (include 5 year listing)

Dates	Location
Governing Board Meetings	Different locations along the year (Members)
Directors Board Meetings	Brunch Meeting
Association General Meeting	Different locations along the year (Members)
FM Congress	São Paulo
FM Best Practices Award	São Paulo

OTHER SOCIETY INFORMATION

Native Language: Portuguese

Objectives:

Founded in 2004, ABRAFAC is a non-profit professional organization with a main objective of developing the FM industry in Brazil by promoting an effective interaction between ABRAFAC members, the FM industry, correlated industries, the universities and technical / vocational schools and different correlated organizations around the world. As our core values, we consider the connectivity, the objectivity, the innovation, the integrity and sustainability.

Submitted by:

Name: Alexandre Marcelo Fontes Lara

Title: Secretary Director

Email: diretor.secretario@abrafac.org.br

Date: November, 24th 2016

Return Completed Application form and a copy of your Society Bylaws to:

Vickie Grant
ASHRAE
1791 Tullie Circle NE • Atlanta, GA 30329
Fax: 678-539-2156
Email: vgrant@ashrae.org

SOCIETY SNAPSHOT 2016—2017*

*Forecast Numbers: Actual numbers will be posted by 12/31/17

TECHNOLOGY

XX,XXX
STANDARDS & GUIDELINES PUBLISHED

XX,XXX
RESEARCH PROJECTS AWARDED

XX,XXX
TOTAL TECHNICAL INQUIRIES

MEMBER SERVICES

ASHRAE conferences around the world

XXX SPECIALITY

XXX SOCIETY

XX,XXX ▲ XX%
TOTAL SOCIETY MEMBERS

XXX ▲ XX%
TOTAL CHAPTERS

TOP COUNTRIES

XXX DL VISITS

XXX TOPICS PRESENTED

PUBLICATIONS/EDUCATION

XXX NEW PUBLICATIONS

XXX TOTAL EDUCATION COURSES PRESENTED

X,XXX STUDENTS TAUGHT

TOP 5 BESTSELLERS

ASHRAE Learning Institute

COURSE INVENTORY: **XXX**

XXX HOURS OF TRAINING ON ELEARNING PORTAL

MARKETING

X,XXX VISITS TO ASHRAE.ORG

TRADE SHOWS EXHIBITED

SOCIAL MEDIA FOLLOWERS

X,XXX ▲ XX%

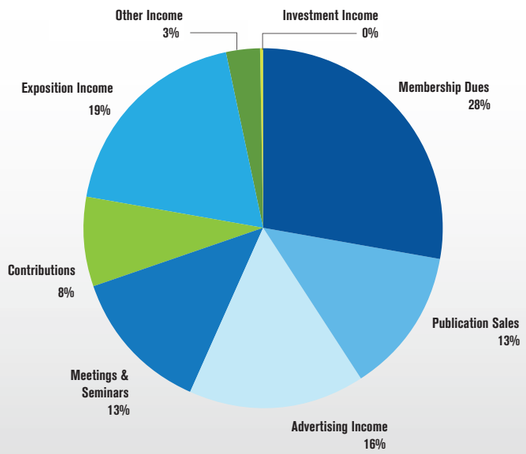
X,XXX ▲ XX%

X,XXX ▲ XX%

X,XXX ▲ XX%

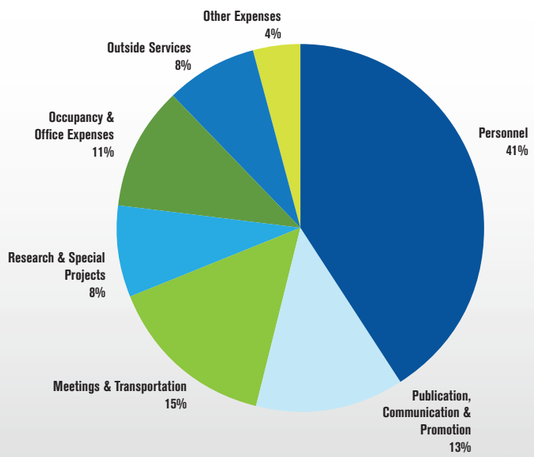
FINANCIAL

ASHRAE Source of Funds
Fiscal Year Ended June 30, 2016



$X,XXX REVENUE ▲

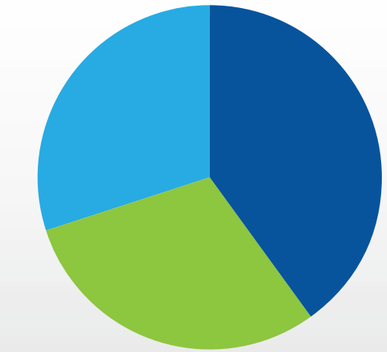
ASHRAE Application of Funds
Fiscal Year Ended June 30, 2016



$X,XXX EXPENSE ▲

DEVELOPMENT

$X,XXX
TOTAL RAISED



- OTHER: $XXX
- ENDOWED FUNDS: $XXX
- RP CAMPAIGN: $XXX

$X,XXX FOR **XXX** SCHOLARSHIPS AWARDED

GOAL: **$X,XXX**

CURRENT: **$X,XXX**

GOVERNMENT AFFAIRS

XXX
ASHRAE-RELATED BILLS TRACKED OR PASSED

XXX
CHAPTER OUTREACH EFFORTS

Shaping Tomorrow's
Built Environment Today

1791 Tullie Circle NE ▪ Atlanta, Georgia 30329-2305 ▪ Tel 678.539.1104 ▪ http://www.ashrae.org

Joyce Abrams
Director
Member Services

jabrams@ashrae.org

TO: Tim Wentz, Society Executive Committee Chair
Jeff Littleton, Society Executive Vice-President
Mary Townsend, Society Executive Committee Staff Liaison

FROM: Joyce Abrams

DATE: November 11, 2016

SUBJECT: Members Council Referral – Annual Stipend

During the Members Council October 2016 meeting in Atlanta, the council referred the motion below to the Society Executive Committee. I appreciate your keeping me advised of your actions. Let me know if you have any questions. Thank you.

Southern Piedmont Chapter – Motion 4c (10/14/2016):
That ASHRAE create an annual stipend of $100,000, paid monthly to the President of Society.

Background: Currently, ASHRAE society presidents only receive reimbursement for their travel expenses during their tenure. Due to the demands of the position they are effectively removed from working during the term. This places a burden on the individual and their employers. These financial demands are a potential deterrent to some individuals who are qualified and may aspire to serve in the role of ASHRAE Society President. This motion will also require an amendment to the bylaws.

Fiscal Impact: $100,000 Annually.

Memorandum of Understanding

between

The Regents of the University of California, as Management and Operating Contractor for Lawrence Berkeley National Laboratory

and

ASHRAE

On collaboration in the field of Energy Technologies, Energy Efficiency, Urban Systems and Monetization of Efficiency and Resiliency

This Memorandum of Understanding (MOU) is between The Regents of the University of California, manager and operator of the Lawrence Berkeley National Laboratory (LBNL) and ASHRAE, collectively referred to as "Participants" or separately as "Participant." LBNL is a U.S. Department of Energy National Laboratory managed and operated by The Regents of the University of California pursuant to Contract No. DE-AC02-05CH11231 (Contract 31). ASHRAE advances the arts and sciences of heating, ventilating, air-conditioning and refrigeration to serve humanity and promote a sustainable world.

1. Purpose

The purpose of this MOU is to explore potential future collaboration between the Participants in the fields of energy efficiency; energy technologies and policy; monetization and financing of sustainable buildings, energy analytics necessary for asset valuation and new growth capital on worldwide basis; and other topics determined to be of mutual interest. To accelerate the attainment of US and international future energy use goals, LBNL is engaged in creating the Global Partnership Alliance (GPA) – a public private partnership, which would be the vehicle for this collaboration.

The Participants understand that this MOU is not intended to, and does not, create legally binding obligations but serves only as a record of their intention to identify areas of potential future joint interest and possible future collaborations. Any activities by LBNL under this MOU, or any subsequent agreements, should comply with the terms and conditions of Contract 31.

2. Proposed Areas of Cooperation

The Participants express their intention to collaborate in one or more of the following areas:

a) Development of co-marketing plans in regards to ASHRAE sponsored conferences, meetings, working groups and other online channels as they relate to fields of mutual interest and furthering development of GPA.
b) Research, development and dissemination relating to the GPA strategic initiatives of

Guaranteed Performance, Integrated Systems, and Internet Buildings Operating System, including the development of best practices and tools and the furtherance of their adoption by means of standards and best practice guidelines, education and training and other such activities of mutual interest to the Participants. The Participants would jointly develop scopes of work (SOW) for these activities in the context of ASHRAE Multidisciplinary Task Groups, comprised of ASHRAE members, GPA representatives and other acceptable interested persons. The resulting projects would be co-funded by the Participants and by other organizations acceptable to the Participants. An open Request for Proposals would be issued and managed by ASHRAE. Sole source proposals from GPA that meet jointly agreed criteria would be considered. ASHRAE would co-fund selected projects from its normal research budget.

c) Exploration of organizational opportunities within ASHRAE for the purpose of maximizing the success of strategic initiatives, including fast market adoption of relevant outcomes of GPA strategic initiatives.

The scope of above activities and cooperation may be changed or extended to other areas by separate, mutual written agreement of the Participants.

3. Designated Representatives

A. To administer the implementation of this MOU, each Participant should designate one principal coordinator in charge of the collaboration, through whom all requests and plans of that Participant should be made.

B. The principal coordinators may hold meetings when necessary to discuss matters related to cooperation under this MOU.

C. The principal coordinators, and other senior representatives of each Participant should meet annually in order to:

- Ensure ongoing advancement of collaborative projects.
- Keep each respective organization informed of major initiatives.
- Discuss new opportunities for collaboration.

D. For purposes of this MOU, the designated representative for LBNL is intended to be the Energy Technologies Area (ETA) Associate Laboratory Director, or LBNL designated principal coordinator. The designated representative for ASHRAE is intended to be a member of the Executive Committee or other ASHRAE designee.

LBNL shall take responsibility for initiating the first annual liaison meeting. Action items with assigned responsibilities shall be recorded at each meeting. The parties responsible for ensuring this MOU is actively pursued through the term of the agreement are:

For: LBNL

Name: _____

For: ASHRAE

Name: _____

Title: _____ Title: _____

4. Commencement, Modification and Discontinuation

A. Cooperative activities under this MOU may commence upon signature of all Participants and continue for a three (3) year period, unless discontinued in accordance with Paragraph B of this Section 4.

B. The Participants may discontinue this MOU at any time in writing. A Participant that wishes to discontinue its participation in this MOU should endeavor to provide at least thirty (30) days written notice to the other Participant.

C. This MOU may be modified in writing by mutual consent of the Participants, and may be extended for additional periods.

5. General Terms

A. Each Participant should conduct the activities contemplated by this MOU in accordance with all applicable laws, regulations and other requirements to which it is subject, including, without limitation, export control laws and environment, health and safety laws and regulations.

B. This MOU does not create any legally binding obligations.

C. The conduct of cooperative activities contemplated by this MOU is subject to the availability of funding, personnel, and other resources.

D. Each Participant is responsible for the costs it incurs in participating in cooperative activities under this MOU.

Signed in duplicate.

THE REGENTS OF THE UNIVERSITY OF CALIFORNIA, LAWRENCE BERKELEY NATIONAL LABORATORY	ASHRAE
By: _____	By: _____
Name: Dr. A. Paul Alivisatos	Name: _____
Title: Laboratory Director	Title: President
Date _____	Date _____

MEMORANDUM OF UNDERSTANDING
BETWEEN
THE UNITED NATIONS DEVELOPMENT PROGRAMME
AND
[*Name of Civil society organization/ Foundation/ Private sector entity*]

[Please remove all the footnotes and guidance notes prior to sharing the draft MOU with the Party]

This Memorandum of Understanding ("MOU") is entered into by the United Nations Development Programme ("UNDP"), a subsidiary organ of the United Nations, an intergovernmental organization established by its Member States with its headquarters in New York, NY (USA), and ASHRAE, Inc. (hereinafter "ASHRAE"), headquartered in Atlanta, GA, USA. UNDP and ASHRAE are hereinafter referred to individually as a "Party" and jointly as the "Parties";

WHEREAS, UNDP serves in many respects as the operational arm of the United Nations at the country level and works with partners in numerous countries to promote among other things sustainable development, eradication of poverty, advancement of women, good governance and the rule of law;

WHEREAS, UNDP represented by [*Country Office or Bureau Name*] is interested in enhancing its development activities in [*Insert specific interests, such as strengthen countries electoral systems and improve access to justice and public administration; promote public dialogue*];

WHEREAS, ASHRAE is an organization duly organized under the not-for-profit laws of the U.S. and committed to advancing the arts and sciences of heating, ventilating, air-conditioning, and refrigeration to serve humanity and promote a more sustainable world.

WHEREAS, the Parties share similar missions and wish to cooperate in areas of mutual concern to enhance the effectiveness of their development efforts;

NOW, THEREFORE, the Parties wish to express their intention to cooperate as follows:

Article I
Purpose and Scope

The purpose of this MOU is to provide a framework of cooperation and facilitate and strengthen collaboration between the Parties, on a non-exclusive basis, in areas of common interest.

[*This section should describe the purpose, objective and expected outcomes of the MOU. It should answer the questions: What are the overall purposes of the MOU and the objectives of the collaboration?*]

Article II
Areas of Cooperation

The Parties agree to cooperate in the following areas of activity:

i) [*Description of coordinated activities, such as share analysis and information for identifying complementary programs to cure HIV/ AIDS*];

ii) [*Description of coordinated activities, such as harmonizing policy approaches in the areas of governance, conflict prevention and post-conflict reconstruction*]; and

iii) [*Description of coordinated activities, if there are more to add*].

[*Activities: this Article should list any specific activities outlined within the overall scope of the MOU that will serve to accomplish the objectives stated under Article I.*]

Article III
Consultation and Exchange of Information

3.1 The Parties shall, on a regular basis, keep each other informed of and consult on matters of common interest, which in their opinion are likely to lead to mutual collaboration.

3.2 Consultation and exchange of information and documents under this MOU shall be without prejudice to arrangements, which may be required to safeguard the confidential and restricted character of certain information and documents. Such arrangements will survive the termination of this MOU and of any agreements signed by the Parties within the scope of this collaboration.

3.3 The Parties shall, at such intervals as deemed appropriate, convene meetings to review the progress of activities being carried out under the present MOU and to plan future activities.

3.4 The Parties may invite each other to send observers to meetings or conferences convened by them or under their auspices in which, in the opinion of either party, the other may have an interest. Invitations shall be subject to the procedures applicable to such meetings or conferences.

Article IV
Implementation of the MOU

4.1 All of UNDP activities envisaged hereunder are subject to the availability of funding. To this end, in order to implement the specific activities envisioned hereunder, the Parties shall conclude cost-sharing agreements in accordance with the Parties' respective regulations, rules and procedures, which shall specify the costs or expenses relating to the activity and how they are to be borne by the Parties. Any funds so received by UNDP shall be used in accordance with its regulations, rules, policies and procedures. The cost-sharing agreements shall also include a provision incorporating by reference the MOU, which is applicable to the cost-sharing agreements and the projects/ programmes financed there from.

4.2 It is understood that all activities will be carried out on the basis of project documents agreed between UNDP and the concerned governments, and in accordance with the applicable UNDP regulations, rules, policies and procedures.

4.3 The costs of public relations activities relating to the partnership, that are not otherwise addressed by a specific cost-sharing agreement concluded hereunder, will be shared equally between the Parties.

4.4 Neither Party shall be an agent, representative or joint partner of the other Party. Neither Party shall enter into any contract or commitment on behalf of the other Party and shall be solely responsible for making all payments to and on behalf of its own account, as provided under this MOU and under cost-sharing agreements concluded hereunder.

4.5 Each Party shall be responsible for its acts and omissions in connection with this MOU and its implementation.

Article V
Use of Name and Emblem

5.1 Neither Party shall use the name, emblem or trademarks of the other party, or any its subsidiaries, and/ or affiliates, or any abbreviation thereof, without the express prior written approval of the other Party in each case. In no event will authorization to use the UNDP name or emblem, or any abbreviation thereof, be granted for commercial purposes, or for use in any manner that suggests an endorsement by UNDP of the Party services.

5.2 The Party acknowledges that it is familiar with UNDP's ideals and objectives and recognizes that its name and emblem may not be associated with any political or sectarian cause or otherwise used in a manner inconsistent with the status, reputation and neutrality of UNDP.

5.3 Nothing in this MOU grants to the Party the right to create a hyperlink to the UNDP website. Such link may be created only with UNDP's written authorization.

5.4 The Parties agree to recognize and acknowledge this partnership, as appropriate. To this end, the Parties shall consult with each other concerning the manner and form of such recognition and acknowledgement.

Article VI
Term, Termination, Renewal and Amendment

6.1 The proposed cooperation under this MOU is non-exclusive and shall have an initial term of two years from the Effective Date, as defined in Article XII unless terminated earlier by either Party upon two months' notice in writing to the other Party. The Parties may agree to extend this MOU in writing for subsequent periods of 2 years.

6.2 In the event of termination of the MOU, any cost-sharing or project cooperation agreements, and any project documents concluded pursuant to this MOU, may also be terminated in accordance with the termination provision contained in such agreements. In such case, the Parties shall take the necessary steps to ensure that the activities carried out under the MOU, the cost-sharing agreements, and project documents are brought to a prompt and orderly conclusion.

6.3 This MOU may be amended only by mutual written agreement of the Parties.

Article VII
Notices and Addresses

Any notice or request required or permitted to be given or made under this MOU shall be in writing. Such notice or request shall be deemed to have been duly given or made when it shall have been delivered by hand, certified mail, overnight courier, telex, or cable to the Party to which it is required to be given or made at the address specified below or such other address as shall be hereafter notified.

For UNDP:
[*Name*]
[*Address*]
[*Address*]
[*Address*]
[*Address*]

For ASHRAE:
Jeff Littleton
Executive Vice President
1791 Tullie Circle NE
Atlanta, GA 30319
Tel: 404-636-8400

Email: jlittleton@ashrae.org
]

Article VIII
Representations

ASHRAE represents that it is an organization in good standing duly organized under the not-for-profit laws of the U.S. ASHRAE shall promptly notify UNDP of any legal investigation or fiscal audit that it may be subject to from time to time.

Article IX
Settlement of Disputes

9.1 The Parties shall use good faith efforts to settle amicably any dispute, controversy or claim arising out of this MOU. Where the Parties wish to seek such an amicable settlement through conciliation, the conciliation shall take place in accordance with the UNCITRAL Conciliation Rules then obtaining, or according to such other procedure as may be agreed between the Parties.

9.2 Any dispute, controversy or claim between the Parties arising out of this MOU which is not settled amicably in accordance with the foregoing paragraph shall be referred to arbitration under the United Nations Commission on International Trade Law (UNCITRAL) Arbitration Rules then in force. The arbitral tribunal shall have no authority to award punitive damages. The Parties shall be bound by any arbitration award rendered as a result of such arbitration as the final adjudication of any such controversy, claim or dispute.

Article X
Miscellaneous

11.1 This MOU and any related co-financing agreements and project document comprise the complete understanding of the Parties in respect of the subject matter in this MOU and supersede all prior agreements relating to the same subject matter. Failure by either Party to enforce a provision of this MOU shall not constitute a waiver of that or any other provision of this MOU. The invalidity or unenforceability of any provision of this MOU shall not affect the validity or enforceability of any other provision of the MOU.

11.2 Nothing in this MOU shall be construed as creating a joint venture or any other form of legally binding commitment.

Article XI
Privileges and Immunities

Nothing in or relating to this MOU shall be deemed a waiver, express, or implied, of any of the privileges and immunities of the United Nations, including its subsidiary organs.

Article XII
Effectiveness

This MOU may be signed in counterparts, each of which shall be deemed an original and both of which duly executed shall constitute one entire document, and shall enter into effect on the date in which it is duly signed by both Parties ("Effective Date").

IN WITNESS WHEREOF, the duly authorized representatives of the Parties affix their signatures below.

FOR UNDP:	***FOR ASHRAE:***
_____	_____
Name	Tim Wentz
_____	_____
Title	President
_____	_____
Date	Date
_____	_____
Name	Jeff Littleton
_____	_____
Title	Executive Vice President
_____	_____
Date	Date

MEMORANDUM OF UNDERSTANDING
BETWEEN
THE UNITED NATIONS DEVELOPMENT PROGRAMME
AND
ASHRAE, Inc

This Memorandum of Understanding ("MOU") is entered into by the United Nations Development Programme ("UNDP"), a subsidiary organ of the United Nations, an intergovernmental organization established by its Member States with its headquarters in New York, NY (USA), and ASHRAE, Inc. (hereinafter "ASHRAE"), headquartered in Atlanta, GA, USA. UNDP and ASHRAE are hereinafter referred to individually as a "Party" and jointly as the "Parties";

WHEREAS, UNDP serves in many respects as the operational arm of the United Nations at the country level and works with partners in numerous countries to promote among other things sustainable development, eradication of poverty, advancement of women, good governance and the rule of law;

WHEREAS, UNDP represented by UNDP Bahrain and through the Sustainable Energy Project (Project ID 00079213) is interested in enhancing its development activities in sustainable energy and environmental conservation and protection;

WHEREAS, ASHRAE is an organization duly organized under the not-for-profit laws of the U.S. and committed to advancing the arts and sciences of heating, ventilating, air-conditioning, and refrigeration to serve humanity and promote a more sustainable world.

WHEREAS, the Parties share similar missions and wish to cooperate in areas of mutual concern to enhance the effectiveness of their development efforts;

NOW, THEREFORE, the Parties wish to express their intention to cooperate as follows:

Article I
Purpose and Scope

The purpose of this MOU is to provide a framework of cooperation and facilitate and strengthen collaboration between the Parties, on a non-exclusive basis, in areas of common interest.

The parties will use their mutual strengths and global networks to accelerate the transition to a more sustainable built environment, with particular focus on education, health, environmental stewardship.

Article II
Areas of Cooperation

The Parties agree to cooperate in the following areas of activity:

i) **Indoor Air Quality** – Promote systems, tools and education that support healthy indoor air quality and reduce the negative impacts of pollutants on building occupants, particularly those caused by indoor combustion cooking devices.
ii) **Sustainable Advocacy** – Support the development and implementation of government building codes, policies, standards and regulations that minimize environmental impacts of buildings and promote occupant health and safety.
iii) **Energy Efficiency** – Provide education and support to design and construction communities on tools and techniques that promote energy efficiency for building infrastructures.
iv) **Resilience** – Deploy and provide education on the principles of building and mechanical systems resilience.

In order to accomplish these four overarching objectives, the Parties agree to explore opportunities for:

i) Jointly administered **conferences** that educate and support community leaders, government officials, and design communities.

ii) Engagement of ASHRAE Chapter representatives and other ASHRAE **technical experts** to support existing UNDP initiatives in Bahrain.

iii) In-person and electronic **educational initiatives** to drive developing economies towards more sustainable built environments.

iv) **Research** collaboration to drive the development and deployment of low-cost sustainable tools and systems.

v) Development of **publications** and other technical literature that support joint ASHRAE/ UNDP initiatives.

Article III
Consultation and Exchange of Information

3.1 The Parties shall, on a regular basis, keep each other informed of and consult on matters of common interest, which in their opinion are likely to lead to mutual collaboration.

3.2 Consultation and exchange of information and documents under this MOU shall be without prejudice to arrangements, which may be required to safeguard the confidential and restricted character of certain information and documents. Such arrangements will survive the termination of this MOU and of any agreements signed by the Parties within the scope of this collaboration.

3.3 The Parties shall, at such intervals as deemed appropriate, convene meetings to review the progress of activities being carried out under the present MOU and to plan future activities.

3.4 The Parties may invite each other to send observers to meetings or conferences convened by them or under their auspices in which, in the opinion of either party, the other may have an interest. Invitations shall be subject to the procedures applicable to such meetings or conferences.

Article IV
Implementation of the MOU

4.1 All of UNDP activities envisaged hereunder are subject to the availability of funding. To this end, in order to implement the specific activities envisioned hereunder, the Parties shall conclude cost-sharing agreements in accordance with the Parties' respective regulations, rules and procedures, which shall specify the costs or expenses relating to the activity and how they are to be borne by the Parties. Any funds so received by UNDP shall be used in accordance with its regulations, rules, policies and procedures. The cost-sharing agreements shall also include a provision incorporating by reference the MOU, which is applicable to the cost-sharing agreements and the projects/ programmes financed there from.

4.2 It is understood that all activities will be carried out on the basis of project documents agreed between UNDP and the concerned governments, and in accordance with the applicable UNDP regulations, rules, policies and procedures.

4.3 The costs of public relations activities relating to the partnership, that are not otherwise addressed by a specific cost-sharing agreement concluded hereunder, will be agreed separately on a case-to-case basis.

4.4 Neither Party shall be an agent, representative or joint partner of the other Party. Neither Party shall enter into any contract or commitment on behalf of the other Party and shall be solely responsible for making all payments to and on behalf of its own account, as provided under this MOU and under cost-sharing agreements concluded hereunder.

4.5 Each Party shall be responsible for its acts and omissions in connection with this MOU and its implementation.

Article V
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5.1 Neither Party shall use the name, emblem or trademarks of the other party, or any its subsidiaries, and/ or affiliates, or any abbreviation thereof, without the express prior written approval of the other Party in each case. In no event will authorization to use the UNDP name or emblem, or any abbreviation thereof, be granted for commercial purposes, or for use in any manner that suggests an endorsement by UNDP of the Party services.

5.2 The Party acknowledges that it is familiar with UNDP's ideals and objectives and recognizes that its name and emblem may not be associated with any political or sectarian cause or otherwise used in a manner inconsistent with the status, reputation and neutrality of UNDP.

5.3 Nothing in this MOU grants to the Party the right to create a hyperlink to the UNDP website. Such link may be created only with UNDP's written authorization.

5.4 The Parties agree to recognize and acknowledge this partnership, as appropriate. To this end, the Parties shall consult with each other concerning the manner and form of such recognition and acknowledgement.

Article VI
Term, Termination, Renewal and Amendment

6.1 The proposed cooperation under this MOU is non-exclusive and shall have an initial term of two years from the Effective Date, as defined in Article XII unless

terminated earlier by either Party upon two months' notice in writing to the other Party. The Parties may agree to extend this MOU in writing for subsequent periods of 2 years.

6.2 In the event of termination of the MOU, any cost-sharing or project cooperation agreements, and any project documents concluded pursuant to this MOU, may also be terminated in accordance with the termination provision contained in such agreements. In such case, the Parties shall take the necessary steps to ensure that the activities carried out under the MOU, the cost-sharing agreements, and project documents are brought to a prompt and orderly conclusion.

6.3 This MOU may be amended only by mutual written agreement of the Parties.

Article VII
Notices and Addresses

Any notice or request required or permitted to be given or made under this MOU shall be in writing. Such notice or request shall be deemed to have been duly given or made when it shall have been delivered by hand, certified mail, overnight courier, telex, or cable to the Party to which it is required to be given or made at the address specified below or such other address as shall be hereafter notified.

For UNDP:	Jehan AlMurbati UNDP Portfolio Manager for Sustainable Growth, Energy and Environment/ SEU Executive Director P.O. Box 26814 Hoora, Kingdom of Bahrain
For ASHRAE:	Jeff Littleton Executive Vice President 1791 Tullie Circle NE Atlanta, GA 30319 Tel: 404-636-8400 Email: jlittleton@ashrae.org

Article VIII
Representations

ASHRAE represents that it is an organization in good standing duly organized under the not-for-profit laws of the U.S. ASHRAE shall promptly notify UNDP of any legal investigation or fiscal audit that it may be subject to from time to time.

Article IX
Settlement of Disputes

9.1 The Parties shall use good faith efforts to settle amicably any dispute, controversy or claim arising out of this MOU. Where the Parties wish to seek such an amicable settlement through conciliation, the conciliation shall take place in accordance with the UNCITRAL Conciliation Rules then obtaining, or according to such other procedure as may be agreed between the Parties.

9.2 Any dispute, controversy or claim between the Parties arising out of this MOU which is not settled amicably in accordance with the foregoing paragraph shall be referred to arbitration under the United Nations Commission on International Trade Law (UNCITRAL) Arbitration Rules then in force. The arbitral tribunal shall have no authority to award punitive damages. The Parties shall be bound by any arbitration award rendered as a result of such arbitration as the final adjudication of any such controversy, claim or dispute.

Article X
Miscellaneous

11.1 This MOU and any related co-financing agreements and project document comprise the complete understanding of the Parties in respect of the subject matter in this MOU and supersede all prior agreements relating to the same subject matter. Failure by either Party to enforce a provision of this MOU shall not constitute a waiver of that or any other provision of this MOU. The invalidity or unenforceability of any provision of this MOU shall not affect the validity or enforceability of any other provision of the MOU.

11.2 Nothing in this MOU shall be construed as creating a joint venture or any other form of legally binding commitment.

Article XI
Privileges and Immunities

Nothing in or relating to this MOU shall be deemed a waiver, express, or implied, of any of the privileges and immunities of the United Nations, including its subsidiary organs.

Article XII
Effectiveness

This MOU may be signed in counterparts, each of which shall be deemed an original and both of which duly executed shall constitute one entire document, and shall enter into effect on the date in which it is duly signed by both Parties ("Effective Date").

IN WITNESS WHEREOF, the duly authorized representatives of the Parties affix their signatures below.

FOR UNDP:	***FOR ASHRAE:***
Amin El Sharkawi	Tim Wentz
Name	Name
UN Resident Coordinator; UNDP Resident Representative	President
Title	Title
29 January 2017	29 January 2017
Date	Date

In witness:

Jehan AlMurbati	Jeff Littleton
Name	Name
UNDP Portfolio Manager for Sustainable Growth, Energy and Environment/ SEU Executive Director	Executive Vice President
Title	Title
29 January 2017	29 January 2017
Date	Date

Memorandum of Understanding
ASHRAE and VDI-GBG

Founded in 1894, ASHRAE, Atlanta, Georgia advances the arts and sciences of heating ventilating, air-conditioning and refrigeration to serve humanity and promote a sustainable world.

Founded in 1856, VDI is the society of German engineers. After the latest restructuring in 2009 VDI-GBG was founded within VDI, bringing together the engineers for all disciplines of the built environment, i.e. architecture, building services, civil engineering and facility management with the aim to create healthy and sustainable buildings and communities.

ASHRAE and VDI agree to support the Memorandum of Understanding to advance and promote the mutual interests of their respective members in building services. We are committed to working together toward on the following activities and goals:

CONSISTENT LEADERSHIP COMMUNICATION

Recognizing the importance of communication in organizational collaboration, both organizations commit to hold a liaison meeting annually (either in person or via conference call) of designated ASHRAE/VDI-GBG senior representatives to:

- Ensure ongoing advancement of collaborative projects.
- Keep each respective organization informed of major initiatives.
- Discuss new opportunities for collaboration.

VDI-GBG shall take responsibility for initiating the first annual liaison meeting. Action items with assigned responsibilities shall be recorded at each meeting. The parties responsible for ensuring this MOU is actively pursued through the term of the agreement are:

For ASHRAE:
Jeff Littleton
Executive Vice President
ASHRAE
1791 Tullie Circle, NE
Atlanta, GA 30329
Phone: 404-636-8400
Email: jlittleton@ashrae.org

For VDI-GBG:
Dipl.-Ing. (FH) Thomas Terhorst
Secretary
VDI-GBG
Verein Deutscher Ingenieure e.V.
VDI-Platz 1
40468 Dusseldorf
Phone: +49 211 6214-466
Email: terhorst@vdi.de

CONFERENCES AND MEETINGS

Each organization agrees to provide the other with a meeting invitation and two complimentary VIP registrations to the primary annual meeting.

ASHRAE and VDI-GBG agree to explore opportunities to provide speakers at the other organization's meetings to help provide updates and perspectives on technologies and trends of mutual interest.

Where mutually beneficial, each organization shall help publicize the other organization's meetings and promote attendance.

ADVOCACY

Where mutually beneficial and to the extent allowed by laws and corporate policies, ASHRAE and VDI-GBG agree to work together on common public affairs goals and ideologies. During annual liaison meetings, public affairs strategies will be discussed and common goals identified. Collaborative opportunities to be considered include:

- Joint promotion of codes and standards.
- Promoting mutually beneficial positions. Education of lawmakers on issues important to the members of each organization.

PUBLICATIONS

Recognizing that electronic and print publications are a primary means of disseminating new technologies, trends and practices, ASHRAE and VDI-GBG agree to:

- Provide at least one complimentary subscription the primary membership periodical to be received at the headquarters location of the other organization.
- Explore opportunities to jointly produce publications of mutual benefit.
- Cross-market each organization's publications where appropriate and with industry standard distributor discounts.
- Use periodicals to promote the other organization's events, publications and other activities.
- Explore mutually beneficial ways to translate publications for member benefit.

EDUCATION

As leading providers of conventional and online educational services and in recognition of the vital role professional development has for our respective members, ASHRAE and VDI-GBG agree to:

- Cross-market educational offerings and the regional, national and international levels.
- Explore opportunities to co-develop new courses or other training programs that take advantage of overlapping and complimentary expertise between ASHRAE and VDI-GBG.
- Discuss ways that certifications programs can be jointly developed or promoted.

TECHNICAL ACTIVITIES COORDINATION

ASHRAE and VDI-GBG agree to foster technical cooperation in areas of common interest by:

- Encourage members in each organization to participate on technical committees and task forces.
- Provide opportunities to participate in and comment on proposed standards, guidelines, policies, and position statements developed on technical subjects as they relate to buildings and community developments.
- Establish liaison representatives to key technical committees where mutually beneficial to do so.

RESEARCH

Recognizing the importance research plays in accelerating the transformation to a more sustainable built environment, ASHRAE and VDI-GBG agree to:

- Promote joint research in areas where research results will add to the body of knowledge beneficial to members;
- Disseminate research results quickly, focusing on high-impact findings.
- Identify opportunities for research funding from other sources.

TERMINATION

Either party may terminate this MOU, with or without stated cause, upon providing the other party with thirty (30) days written notice of intent to terminate.

TERM

The term of this Memorandum of Understanding shall begin when signed by both parties and shall terminate at the end of three (3) years unless extended at that time by written agreement.

LEGAL STANDING

This MOU reflects a commitment by ASHRAE and VDI-GBG to continue and enhance their working relationship and individual efforts toward achieving mutual objectives described above. It does not create a binding obligation or agreement between the two organizations, and neither organization has an obligation to negotiate toward or enter into a binding written agreement. In addition, this MOU does not create a partnership, joint venture, fiduciary relationship or similar relationship between ASHRAE and VDI-GBG. Furthermore, it is understood that this Memorandum of Understanding is conceived as a dynamic document, meant to change as circumstances and priorities warrant. It may be modified or amended by written agreement between both organizations.

FOR ASHRAE

Timothy G. Wentz
ASHRAE President

_____
Signature

_____
Date

Jeff Littleton
ASHRAE Executive Vice President

_____
Signature

_____
Date

FOR VDI-GBG

Dipl.-Ing. Andreas Wokittel
VDI-GBG President

_____
Signature

_____
Date

Dipl.-Wirt.-Ing. Ralph Appel
VDI-GBG Director

_____
Signature

_____
Date

ASHRAE Guide for District Cooling: Revision and Companion Operations Manual

ASHRAE welcomes the offer of support from Empower Energy Solutions on a revision of the ASHRAE Design Manual for District Cooling and a companion operations manual. The District Cooling industry has been growing exponentially since the manual's publication. An update is needed to incorporate new developments and findings, and a guide for operators is needed to enable the benefits of District Cooling to be fully realized and its technology promise met.

For the effort to move forward, ASHRAE will draft a Funding Agreement. The Agreement will be based on the following ASHRAE Requirements:

1. The resulting publications shall be named "ASHRAE Guides" or "ASHRAE Manuals."
2. ASHRAE shall retain exclusive copyright and exclusive rights to print the publications and to distribute the publications in both print and digital form.
3. ASHRAE shall be solely responsible for the approval of content appearing in the publications, editorial decisions, page layout, and publication format.
4. Empower shall be identified in the foreword or other suitable front matter of the publications as contributing funding to support development.
5. Empower shall be given a designated number of complimentary copies of the publications.
6. Empower shall be offered reduced pricing for purchase of additional copies of the publications.
7. Empower shall be offered reduced pricing for special editions of the publications that include the name and logo of Empower on the covers of the publications with the wording "Distributed with Compliments of" for Empower promotional use.
8. Empower shall be entitled to reprint portions of publications for Empower publications providing no such reprint in a single publication or single use constitutes more than 10% of the entire ASHRAE Guide or ASHRAE Manual from which it is drawn.
9. Empower publicity and other public references to the funding made available to ASHRAE for the publications shall be subject to the approval of ASHRAE. Such wording must be consistent with the wording of references made in the publications to the funding.
10. Each organization's name and trademarks shall remain the exclusive property of each respective organization.

Further, the Funding Agreement will lay out this process for development:

1. ASHRAE shall be solely responsible for determining the scope of each publications.
2. Empower shall be invited to comment on the scope of the publications before ASHRAE finalization of scope.
3. ASHRAE shall be solely responsible for the total amount of funding that will be used to develop the publications.
4. Empower shall be solely responsible for the level of funding it wishes to provide to support publication development and the level of funding will be specified in the Funding Agreement to be signed and binding by both parties.
5. ASHRAE shall be solely responsible for the decision to proceed with publication development. ASHRAE shall take into account the level of funding to be contributed by Empower and the level of funding and/or support committed by ASHRAE.
6. Acceptance of other sources of funding for the publications shall be subject to the mutual agreement of ASHRAE and Empower.

7. ASHRAE shall be solely responsible for selection of the author(s) for the publications.
8. ASHRAE shall be solely responsible for determining the process of authoring, reviewing and approving manuscripts for publication.
9. ASHRAE shall make the draft manuscript available to Empower at various stages of development as determined by ASHRAE to solicit comment and review from Empower on the publication's suitability for the Middle East region.
10. Empower shall be invited to provide resources to ASHRAE that can be considered by the author(s) in publication development.

13 January 2017

Shaping Tomorrow's Built Environment Today

1791 Tullie Circle NE • Atlanta, GA 30329-2305 • Tel: 404.636.8400 • Fax: 404.321.5478 • www.ashrae.org

Bjarne W. Olesen, Ph.D., R.
President-Elect

Reply to: International Centre for Indoor Environment and Energy
Technical University of Denmark
Nils Koppels Alle 402
Kongens Lyngby, 2800 Denmark
Phone: +4545254117
bwo@byg.dtu.dk

Date: December 29, 2016

To: ASHRAE Staff Directors

Subject: Society themes for 2017/18 presidential year
President Elect Bjarne W. Olesen

The society themes for 2017/18 will be aligned with our strategic plan and focus on the word EXTEND.

The overall topics are listed below:

EXTENDING OUR COMMUNITY

EXTEND our global community

- Increased global presence
- Global Alliance with sister societies
- Developing economies

EXTEND our technological horizons

- Residential design guide and topical conference
- Developing economies design guide and topical conference
- Web cast related to Residential or Developing Economies

• EXTEND our value to Members

- Student members
- YEA
- Members outside NA
- Members inside NA

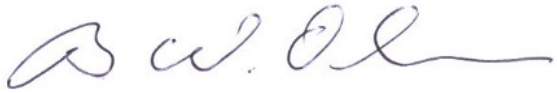
A detailed list of initiatives is enclosed in the excel file. This list is under development by PEAC and will include all three councils and several of their committees. Several of the initiatives are "business as usual" where the topic is focusing on the society theme.

Several of the initiatives require collaboration between two or more committees. Please make sure that these initiatives are on your agenda for Las Vegas and contact has been established between committees where needed. Please report back to me or to the PEAC member chairing one of our three SubC of PEAC:

EXTEND our Global Community: Bill Bahfleth, WBahnfleth@engr.psu.edu
EXTEND our technological Horizons: Max Sherman, mhsherman@lbl.gov
EXTEND our values to members: Julia Keen, jkeen@ksu.edu

Thank you for helping the society and me with the themes and initiatives for 2017/18 society year.

Sincerely yours,



Bjarne W. Olesen
President-Elect

Attachment

	Fiscal impact USD	Society committee	year	included in budget year 16/17	included in budget year 17/18	Comments	Drivers
Activities-GLOBAL							
1. Change AASA into the "The Global Alliance for HVAC&R" by ASHRAE						We need at the Global level a body that can represent the HVAC&R industry in global issues like global warming, UN-meetings, etc.	
a. Organize a first meeting outside NA in spring 2018 together with an ASHRAE-UNEP conference (South America, Copenhagen, Athens, important to look at a neutral place everybody can go to).	$ 50,000	**CEC/UNEP-liaison**	17/18		$ 50,000	We are working on a new work plan for UNEP-ASHRAE to be signed in Las Vegas. As we will haev a fisheries conference with UNEP in 2017 I think a further conference would be in the spring 2018. Meeting with UNEP in Las Vegas. Hope to get funding also by UNEP for such a conference	
i. AdHoc within AASA	$ 10,000	**AASA**	16/17	$ 10,000		An AdHoc within AASA has been formed with Bill Bahnfleth as chair. A first report will be presented at the January Las Vegas meeting. No activity has been reported yet. I have had some discussion with REHVA that support the idea and would also be member representing several smaller national societies in Europe. **Bill to give an update/plan**	
2. Extended outreach to Cuba			17/18				
a. Conduct initial Cuba Outreach	$ 8,000	**President**		$ 4,000	$ 4,000	We are not yet allowed to establish a chapter in Cuba	
i. Presidential outreach to Cuba						The plan is that president Tim Wentz and I will visit Cuba in June 2017 followed by a visit by me and Sheila in spring 2018. A first contact has been made.	
3. Extend our global outreach	$ -						
a. EXTEND beyond HVAC Societies and Broadening our Outreach	$ -	**Excom**					
i. Marketing must show ASHRAE as Building Techology and Global	$ 10,000	**Marketing**	16-18		$ 10,000	Around the world we are looked at as a North-American society only dealing with HVAC equipment. Marketing must make activities, dissiminations that show we are Building Tecnology and Global.(see also 4)	
4. Additional global activities		**Board Planning**				PLC has put 3 motions to the board (web-site, marketing of ASHRAE (see 3), train-the-trainer). These are not very global and only include a very little part of what was in the MCI report. 200.000$ has been allocated to PLC for 16/17 . A globalization SubC has been formed within PLC.	
1. Split an European region off RAL .	$ 50,000	**Members Council**	yearly from 17/18		$ 50,000	Rational – Due to the membership numbers, physical vicinity, and the commonalities of the chapters/individual members in the Europe, it is appropriate to explore the possibility to create a designated European Region separate from the Region-At-Large	
a. We have about 2000 members in Europe where a majority is not served by chapters and RAL is getting too big.						It is also important to get an European representative on the board, which will happend if we establish a new region	
i. RAL AdHoc and Members Council		**Members Council and RAL SubR_B Adhoc**				Under RAL three AdHoc is discussing how the members within the three subRegions can be served better. The AdHoc for SubRB-Europe has been asked to report to members council by Las Vegas. Memebers council will take that into account when working on the MBO related to our general regional structure. This may lead to further adjustment of our regions (merging-expanding) and also change in the number of board members. Excom has a postponed motion asking Mebers Council to establish an European region. This will eb discussed in Las Vegas. Several meetings between ASHRAE senior leadership REHVA and leading National societies are going on. The RAL-SubRegion B adhoc has made a questionnair to ASHRAE members in Europe. 70 % of thos who answered (200 total) would like a Region. So also at the grassroot level there is a support. The Adhoc seems however very reluctant to establish a new Region in Europe.	
Activities-Technological							

1. Compile a report listing and reviewing international standards and guidelines related to IEQ.	$ 10,000	**IEQ-GA and Special Pub.**	16/17	$ 10,000		
a. Should be developed under IEQ-GA and ready for distribution in the fall of 2017						A first short report is available. I am trying to find a student to work on this. I will probably have a post-doc to work on this in the spring 2017.
i. IEQ-GA						
2. Include a Residential chapter in our Green Guide .		**Residential Buildings C.**	16/17 +17/18			
a. Green guide should become available at the beginning of the presidential year with a new residential chapter.						This is going on and no additional budget is needed
i. TC2.8, Green Guide C., Residential building committee						
3. Develop a first Design Guide for Residential	$ 30,000	**Residential Building C**	17/18	$ 15,000	$ 15,000	
a. Residential committee should look at this (support from HUD, Building America, others?)						It was discussed by RBC after the stake holder meeting in Alexandria in September. It was decided that we need to make more than one guide to cover the different types of residential buildings. The first guide will cover Multi-family buildings
i. Activity underway in Residential Building Committee						
5. Develop Energy and/ IEQ design guide for Developing Economies.	$ 50,000	**EHC, RBC, UNEP-ASHRAE, Developing economies Consultants**.	17/18	$ 25,000	$ 25,000	WE are working closely with UNEP Ozone depletion program; but there are other activities within UNEP that may be more relevant for this initiative. I will make contact to a DTU-UNEP program related to energy use in developing economies
a. UNEP might provide funding						No activities yet on this initiative. Will be discussed with UNEP in Las Vegas
i. EHC together with UNEP committee						
7. Topical conference in spring 2018 on residential/developing economies	$ 30,000	**CEC**	17/18		$ 30,000	This would then be a good place to promote the guidelines mentioned above
a. This is related to global activities see above UNEP-AASA meeting.						
i. CEC (Conferences and Expositions Committee)						There will be in 2018 a Hot-Humid Climate conference in India.I have asked to make a track on residential buildings!!!!
8. Develop an ASHRAE residential conference		**CEC, RBC**				To show our involvement in Residential it is recommended to have an ASHRAE organized Residential topical conference at least every 3rd year and maybe sometimes outside NA.
a. Investigate with DOE and OKNL if ASHRAE can take over the Clearwater conference						It seems DOE want to stop supporting the conference. CEC is looking at the economy. WE could just start a completely new residential conference; but it would be more efficient to continue an existing conference. DOE support that ASHRAE take over the conference; but they may not continue to sponsor. Plan to haev a response from DOE in January. CEC is looking at the budget for such a conference.
i. When RBC has cleared with DOE/OKNL then CEC should implement			18/19			Steering committee must be established during 2017.
9. 2018 WEB cast related to Residential or Developing Economies	?????	**CTTC**	17/18	????	???????	To show our involvement in Residential or Developing Economies the topic of the 2018 web cast should be related to developing economies or residential buildings
						CTTC should work either with Residential Building Committee or representative from the previous AdHoc for developing economies
Activities-Members						This is now divided in 4 sub parts depending on the type of membership
Student members		**Student Activities, PEC, and MC**				Students are an important group to extend the global focus to as they are typically very receptive to thinking in a global context and they are the future influencers of ASHRAE

Priority 1: Get a higher profile in Solar Decathlon competitions worldwide	$ 50,000		every year		$ 50,000	Rationale – Solar decathlon is an excellent opportunity to introduce to a number of students and future ASHRAE members the technical resources ASHRAE has to provide the industry. We spend 20.000 $ on the US event every 2nd year	
5 activities in priority 1. Create a package of materials/resources that are sent to teams once they register (both for the North American event and the international venues).Intent is to get in front of the students early and reinforce the value of ASHRAE. Package should include things such as local ASHRAE Chapter contact information, ASHRAE Standards, ASHRAE Green Guide, AEDG, ASHRAE Handbook, etc. 2. Continue to sponsor meals at the North American event 3. ASHRAE provide judges to the events (making sure there is international representation at the events i.e. provide judges from outside North America to the SDE in Denver) 4. Provide financial backing (amount to be determined) to teams that also have an ASHRAE branch chapter at their institution.						USA-2017, China-2017, Europe -2018, Middle East-2018 Rationale – Solar decathlon is an excellent opportunity to introduce to a number of students and future ASHRAE members the technical resources ASHRAE has to provide the industry. Make connection between chapter and the student group involved.Connectis have been made. Discussion regarding judges are going on. Now we also have the list for the Solar Decathlon in China and similar connections should be made.	Assign PAOE points to chapters that get involved. Maybe unfair to some chapters where there are no participants!!!
Priority 2: Sister Student Branches	$ -		17/18				
a. 1. Develop networking and/or technical activities at the winter meeting student events that require collaboration between U.S. and international students to complete. It should require that students meet students from other chapters including a specified number of international chapters. 2. Create a manner by which to identify students 'home' location – i.e. national flag button 3. The presentation at the student event be focused on global HVAC&R design differences / similarities or issues / challenges of HVAC&R in a global context rather than focusing on a specific HVAC system as done in the past. This topic is one that can be a learning experience no matter the technical level of the student in attendance.		**Student Activities**				Rationale - Interpret the intent of this activity as a desire to encourage and facilitate cross cultural collaboration. There should be a sensitivity to adding more responsibility and requirements to the student branches since they are commonly fully extended to simply the accomplish the current tasks/function. A large group of students (Approximately 400; with 20% of these participants being from outside the U.S.) attend the winter meeting student events. Staff is investigating the possibility to add flags to the badges. Will not happen in Las Vegas; but maybe in Long Beach color printing will be possible	Assign PAOE points to chapters where student branches establish a sister branch.
Priority 3 Global student branch competion related to developing economies	$ 60,000		17/18	$ 30,000	$ 30,000		
a.Recommended actions/investments 1. Rather than beginning a new competition, focus the existing Student Competition – Engineering Challenge on the topic developing economies during the year 2017. 2. Additional advertising and promotion is suggested since past participation has been limited. a. 2015 - 7 entries; 2014 - 4 entries; 2013 - 13 entries (first year under Tom Watson – part of his presidential theme)		**Student Activities representatives from Developing Economies AdHoc**				Rationale – There are a significant number of the different engineering and design challenges provided to universities. ASHRAE currently has 4 competition categories: HVAC Design Calculations, HVAC System Selection, Integrated Sustainable Building Design, and the Applied Engineering Challenge. I have suggested that the 17/18 competition should be related to developing economies. We need to establish contact between People from the developing economy AdHoc and student actiivties to work on requirements/scope	Assign PAOE points to chapters where student branches participate in the competition. Assign extra points if a student branch from NA participaet with a student branch outside NA
YEA						No activities were listed for this category of membership but it is certainly a demographic that is very important to the future of ASHRAE	
Priority 1: Leadership Weekend in locations beyond North America	$		17/18			First is planned in 2016 in Greece	
Recommended actions/investments 1. Continue to promote and encourage participation by global members and to hold the event in locations beyond just the U.S		**YEA**				Rationale – Leadership weekend has been a great success in developing and identifying future leaderships in ASHRAE. They have held this event in locations outside the U.S. which is import to promoting the awareness to the globalization effort of ASHRAE.	
Priority 2: International Networking Event at the Society meetings	$		17/18				

Recommended actions/investments 1. Incorporate an intentional (international) focus at the social networking events to take advantage of the diverse group of participants with a particular focus on chapter/regional/national affiliation		**YEA**				Rationale – YEA Social events are well attended and very successful at the Society meetings. What do we need to do??	
International-outside North-America						As ASHRAE becomes a more global organizations there is a need to better serve the members that do not fit the North American model/structure from which ASHRAE has traditionally worked. These different needs can be attributed to many things such as existing strong national societies besides ASHRAE, expectations of the role of a professional society, density of members, etc.	
Priority 1: – Review Manual for Chapter Operations for locations with strong National Societies Recommended actions/investments 1. Review and move forward appropriate recommendations made by Members Council's ad hoc for the Review Manual for Chapter Operations for locations with strong National Societies.		**members council**	16/17 17/18			Rational – The traditional chapter model and the Manual for Chapter Operations used in North America may not be able to be successfully applied to other locations. This is identified as a topic priority because it has the opportunity to serve all the membership outside North America. A discussion going on in Europe operates with three types: traditional chapter/section, ASHRAE-group within a national society, individual members.	
Priority 2: European CRC Recommended actions/investments 1. ASHRAE sponsor a unique event/meeting for European members (with a title other than CRC to eliminate confusion, allow greater flexibility to serve the targeted audience, and remove preconceptions as to required format/purpose).	$ 30,000	**Members Council and CEC**	17/18		$ 30,000	Rational – Due to the membership numbers, physical vicinity, and the commonalities of the chapters/individual members in the Europe, it is appropriate to explore the possibility a meeting that devoted to the issues, concerns, and design in this locale. A CRC would be appropriate venue for this but would only once the European Region is established. Until that time, an ASHRAE sponsored meeting for the European members should not be called a CRC because of the fairly rigid and defined requirements of a CRC meeting My idea is to organize an European "CRC" in spring 2018 along with the REHVA yearly meeting together with a combined technical program	
North America						An audience that was not addressed in the activities assigned to the subcommittee is the North American membership. This demographic should not be overlooked or omitted since it composes 80% of ASHRAE membership	
Priority 1: 2017-18 Presidential Presentation have a global focus Recommended actions/investments 1. Create a presidential presentation explaining the benefits of globalization to all ASHRAE members.	$ -	**President**	17/18			Rationale – The President of ASHRAE has the opportunity to interact with and present to a number of different constituents including both ASHRAE members and non-members. Since Bjarne is from Denmark and he has had the opportunity to travel all over the world, he can address the issue of globalization in his presidential presentation. In this presentation, the importance of globalization for the advancement of ASHRAE and the industry should be emphasized as well as why now is the right time for this focus.	
Priority 2: Broaden the international exposure to all members Recommended actions/investments 1. Provide additional funding for CRCs and/or Chapters to support speakers that are international or speaking on topics that are specific to globalization. This could be tied to the DL program but it would not be required.		CTTC and Members Council				Rationale – Narrowness of thinking and lack of support of the globalization effort may be attributed to limited exposure and understanding. In order to advance the globalization effort it will be important to broaden knowledge and exposure.	Increase the numbers of DL from outside NA. Give chapter PAOE points if the choose a DL from outside NA or a topic related to global isues!!!!
	$ 388,000			$ 94,000	$ 294,000		
Included in Society budget by 2016-09-27	$ 438,000			$ 100,000	$ 338,000		

AIA + ASHRAE Conference Call Agenda
Thursday, December 15, 2016
11:00am – 12:00pm
Via Phone | 877-242-8841 | Passcode: 7343#

I. Sustainability + Codes

- DDX Overview + Potential for Collaboration *(AIA Staff – M. Wackerle and J.Siple)*
- AIA Retrofit Guide Overview *(AIA Staff - M. Wackerle and J.Siple)*
- Update on B503 Guide for Amendments to AIA Owner-Architect Agreements in collaboration with ASHRAE 209 Energy Modeling standard *(AIA Staff - M. Wackerle and J.Siple)*
- 189.1 & Overlay Code (IgCC) – *(AIA Staff – J. Peavey)*

II. Research

- AIA & NIBS BRIK Overview *(AIA Staff – M. Russo)*
- Upjohn Grants + Possible Promotion with ASHRAE *(AIA Staff – M. Russo)*
- AIA Research Summit Overview + Possible ASHRAE Involvement *(AIA Staff – M. Russo)*

III. Education

- AIA Emerge Program, Webinars, & Special Education Series with AIAU *(AIA Staff – J. Peavey)*

AIA and ASHRAE: 2016 Fourth Quarter Staff Call
Thursday, December 15, 2016
11:00am – 12:00pm

AIA Staff in Attendance

Paul Karrer, PaulKarrer@aia.org
Michele Russo, MicheleRusso@aia.org
Melissa Wackerle, MelissaWackerle@aia.org
Marta Zaniewski, MartaZaniewski@aia.org

ASHRAE Staff in Attendance

Joyce Abrams, JAbrams@ashrae.org
Kristin Gokce, KGokce@ashrae.org
Vanita Gupta, VGupta@ashrae.org
Jeff Littleton, JLittleton@ashrae.org
Karen Murray, kmurray@ashrae.org
Claire Ramspeck, cramspeck@ashrae.org

Agenda Items

DDX – Overview and Collaboration Opportunities

- AIA's program for 2030 commitment / carbon neutrality goals
- Report section with a dashboard to bolster firm value
- Understand how ASHRAE may be interested in this data
- Signatories are primarily arch firms
- How would engineering firms want to plug in?
- Code equivalence and data research
- Demonstration of the tool – down the road
- 400 firms total – how many engineering firms? handful of engineering firms
- Projects are held in close confidentiality – for client privacy issues
- ASHRA is developing an online portal for Building Energy Quotient (BEQ) labeling program, basic tenant is to energy model the building and compare design vs. actual performance ; the plan is to have this portal up and running in Q1 of 2017
- **Next Steps: Follow Up call / and Compare both tools especially as it relates to the building energy performance. (Staff Leads: Melissa and Claire) ASHRAE to schedule.**

AIA's Retrofit Guide Overview and Collaboration Opportunities

- AIA rebranding and re-releasing the Deep Energy Retrofit Guide in 2017; want to get it out there for mass consumption
- Can ASHRAE help promote? It's a cross promotion opportunity
- Per Jeff it's a good opportunity to help cross promote
- AHSRAE Staff: Vanita from ASHRAE may help with marketing opportunities

- Architect's Guide to Integrating Energy Modeling in the Design Process. ASHRAE rep for the revamp for energy guide.
- **Next Step: Group to be formed and ASHRAE can have a rep.**
- Perhaps we can co-brand the report? To be discussed.
- **Next Step: Melissa to follow-up / will work with Claire to ID someone from ASHRAE who can be on the task force**
- Both reports slated for release in late 2017 / AIA to refresh Should be Q3 or 4 2017

AHSRAE 209 Standard Collaboration Opportunities

- Melissa mentioned how we can make recommendations on contract language / when you want to add energy related language in contracts
- Incorporate 209 process or language into our contract language
- B503 Guide for Ammendments would also be used as a point of reference
- Claire to follow up with Melissa to let her know that standard has been finalized and provide timeline
- **Down the Road: AIA wont work on this until Q3 and Q4 of 2017 – more to come**
- This work and overlap will help with communication points between architects and engineers (contract docs can really help with this)

189.1 Overview

- AIA reiterated how important this work is and our ongoing relationship in this arena with ASHRAE and the IgCC
- ASHRAE also commented this has been a good effort & looks forward to future opportunities

What's New w/ AIA's Education and Possible Opportunities

- Opportunity for ASHRAE to join in webinars in 2017 as they are being planned – bimonthly for codes network (250 AIA members)
- Opportunity for AHSRAE: Help present on a webinar in 2017 – up to ASHRAE what topics may be on interest? And how many
- Jeff mentioned that for ASHRAE it would be helpful to have a discussion on design implications of flammable refrigerants
- **Next Step: ASHRAE to look at options of topics and send to Paul – codes@aia.org**
- Emerge Program: Targeted towards emerging professionals within AIA community, on path to licensure
- Addresses young architects' need of "how to be an architect"
- This is intended to fill gaps with the first years of a young architect's' life
- **Next Step: Marta to send link to Emerge to AHSRAE Staff (included with notes)**
- Example of partnership with Emerge: Introductory building codes module – ICC is sponsoring this piece
- Would ASHRAE want to help in suggestion topics for the program? Either help sponsor and / or work with AIA on the TBD content. AHSRAE needs more information before confirming. Point of Contact: Paul Karrer
- Emerge sets itself apart on AIAU due to its high level content presented and AIA members give accounts of "how this works" in day to day practice

- Jeff mentioned they were interested in sponsorship – what would that look like? AIA would do the work and put together the content – this is a financial sponsorship; **Next Step: Paul to send information to Jeff about costs for sponsorship;**
- There is also an opportunity to help put together a special education series with AIA and ASHRAE as co-developer of the content
- **Next Step: Follow up meeting on education – Paul, Wayne, Jeff and Karen – in 2017. Paul and John to follow up with ASHRAE.**

Research Overview & Opportunities

- Overview of research at AIA: We are not a research organization; currently the research department looks to serve members and research as it affect members (market focused)
- BRIK: Further discussion is needed; joint project with NIBS (50/50), partners join to add collection of research to BRIK; 750 research projects since it started, does not sell research independently, access to data is a benefit of membership, they do sell research to nonmembers – that could be an opportunity for cross promote
- **Next Steps: Marta to send information as to "how to become a partner" & what makes sense to collaborate (included in notes).**
- Overview on Upjohn Grants – multiple grants up to 30K; Latrobe – 100K every other year; both serve as direct funding for research
- Research Summit: bigger convening for key folks – first time this sort of gathering is happening at the AIA level; we have not had a strategic. Goal of the conference is to create a strategic plan and agendas for AIA – very member driven
- ASHRAE is more than welcome to attend and listen in on the conference and provide feedback
- Focused on mechanics on doing research
- AIA would love to learn more about ASHRAE's journal and how AIA can help promote and include information
- **Next Steps: Michele to keep Jeff and Steve on the summit, and opportunity to share and collaborate on research journals.**

Possible Future Agenda Items (2017 Q1 Call)

- Education – ongoing update and collaboration options
- Sustainability – ongoing update and collaboration options
  - Post building occupancy as a possible topic
- Research – ongoing update for future conversation (especially at Summit comes together)

The American Institute of Architects

Additional Information on BRIK

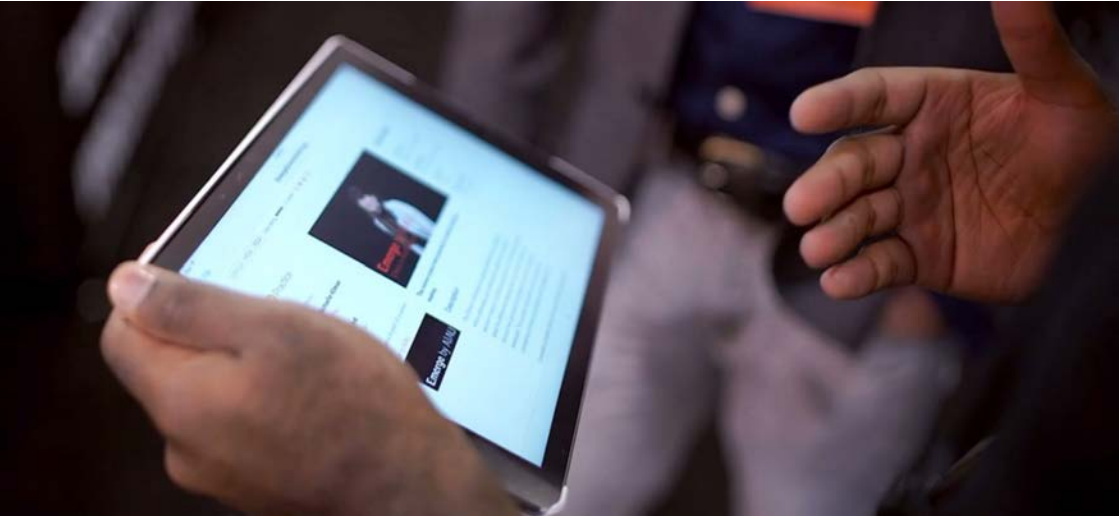
Why should my organization join BRIK to contribute research?

- Distinguish yourself as a pioneering part of the solution of knowledge-sharing.
- Increase the reach of your research efforts.
- Distribute the results of your studies.
- Announce your research events.
- Share your organization's lessons learned beyond your own profession.
- Include your organization's name and logo on BRIK as a Partner.

There is no cost to be a Partner, and content on BRIK is freely available. BRIK is a collaborative effort of AIA and NIBS.

Overview of education-related materials
Note: For further information, please contact John Peavey JohnPeavey@aia.org or at codes@aia.org.

1. AIA Codes Network webinar series
    - Previous 2016 webinars:
        - October: IEBC Code Requirements for Existing Buildings
        - November: Beyond ADA Compliance - Toileting and Bathing for Nursing and Assisted Living Populations
    - AIA is planning for bi-monthly webinars in 2017, so it's an open invitation to collaborate!
    - AIA is happy to participate in any similar webinar education events ASHRAE puts on.
2. (Attached) Sponsorship literature for the Emerge by AIAU program
    - More on Emerge can be seen here https://aiau.aia.org/emerge-aiau
    - If interested, AIA can send ASHRAE staff a promo code to preview the existing Emerge modules for free
3. AIAU special education series
    - This request is open-ended, so if they are interested, we are happy to set-up follow up conversations



Emerge by AIAU

Center for Emerging Professionals Sponsorship Opportunities

Learning doesn't stop at graduation. AIA recognizes the need for resources to supplement the knowledge gained in school to transition into the workforce. Emerge by AIAU is a new resource launched June 2016 to help over 17,000 Associate members **gain up to 120 hours across all required licensure experience areas.**

Engage the future of the profession

Show the rising generation of architects the value of your products and expertise, early in their careers. Your support for this series shows a commitment to architects' training and path to licensure. Your subject matter experts can be on the forefront of a new and innovative learning tool, **gaining access to a new market segment.**

Emerge by AIAU introduces Associates and emerging professionals to **online video-based continuing education courses**, supplying knowledge and skills that are not always available at firms. The online learning tool will allow you to **reach a national audience.**

An integrated approach

Emerge by AIAU provides a unique opportunity for sponsors to engage with the emerging generation of architects in a more integrated way than traditional opportunities. Sponsors have to opportunity to provide their subject matter experts for filming, content, thank you slide scripts, participants giveaways and more.

Build brand loyalty with the future of the profession. The Center for Emerging Professionals' offers a unique gateway to one of architecture's most untapped resources: **the next wave of the workforce.** Young architects, savvy associates and top students all look to the Center for Emerging Professionals to tailor and shape the road to licensure and their career development for years to come.

Get in front of tomorrow's leaders today.

AIA

Opportunities

Check out the newly launched series at **https://aiau.aia.org/emerge-aiau**, email emergingprofessionals@aia.org for a complimentary sponsor code.

The Center for Emerging Professionals would like any sponsorship to be a partnership. We will work to tailor all opportunities for mutual benefit and best fit with the selected partner. The following options are potential **baseline sponsor opportunities**:

Series sponsor **$10,000**

The Emerge by AIAU series will engage associate members via email blast every month. Series sponsors will have the ability to contribute to fresh content for the Emerge by AIAU bimonthly video uploads, provide their subject matter experts for filming, and be included in all touch-points regarding the series.

- 15 second intro and outro soundbites announcing series support and company mission for one course
- Inclusion in dedicated monthly Emerge by AIAU marketing emails
- Ability to provide content contributions for selected video topics
- Ability to provide on-camera subject matter experts for one course
- Logo placement on high-traffic series page and all included course pages

Multi-course sponsor **$7,500**

Multi-course sponsors will have the opportunity to showcase content expertise in one or many topic areas, gain brand recognition, and show support for those on the path to licensure.

- 10 second company promo script in closing credits before required quiz
- Ability to provide content contributions for sponsored courses
- One email promoting all sponsored courses (minimum of 3 courses required)
- Logo placement on individual course webpages

Video sponsor **$5,000**

Course sponsors will have the opportunity to engage Associate AIA members on an individual course basis, highlighting your company's expertise on a specific topic.

- Company logo included in closing credits before required quiz
- Inclusion in general Emerge by AIAU marketing materials
- Logo placement on individual course webpage

AIA

From: Abrams, Joyce [mailto:JAbrams@ashrae.org]
Sent: Tuesday, December 20, 2016 9:41 AM
To: Trent Hunt <trenth@mp-int.com>
Cc: Littleton, Jeff <JLittleton@ashrae.org>; Catchings, Tamera <TCatchings@ashrae.org>
Subject: Potential Region IX & X Joint CRC: Flight Costs

Hi, Trent. I know you would like some estimates of transportation costs in advance of tomorrow's conference call regarding a potential joint Region IX and Region X CRC. I hope the information below will be helpful!

In summary: Using Society's reimbursement criteria for airfares (e.g., booked at least 2 weeks in advance, coach), for 7 people per Chapter for all Chapters in both Regions, the total *difference* for transportation reimbursement to Honolulu, as compared with San Diego, would be approximately $134,000.

Estimates for airfare followed by the difference in costs, per person

Region IX	San Diego	Honolulu	Difference
BIG SKY	$348	$1,171	$823
BLACK HILLS	$440	$1,220	$780
EL PASO	$501	$982	$481
IDAHO	$403	$821	$418
KANSAS CITY	$529	$1,145	$616
NEBRASKA	$474	$1,556	$1,082
NEW MEXICO	$395	$1,183	$788
OZARKS	$515	$1,518	$1,003
PIKES PEAK	$438	$1,300	$862
ROCKY MOUNTAIN	$297	$1,044	$747
SOUTH DAKOTA	$481	$1,828	$1,347
UTAH	$196	$1,551	$1,355
WICHITA	$499	$1,658	$1,159
Totals	**$5,516**	**$16,977**	**$11,461**

For 1 delegate + 1 alternate + 5 Chapter Chairs per Chapter, the total *difference* for transportation reimbursement to Honolulu would be more than $80,000

Region X	San Diego	Honolulu	Difference (per person)
CENTRAL ARIZONA	$340	$825	$505
GOLDEN GATE	$292	$1,056	$764
HAWAII	$918	Host	($918)
NORTHERN NEVADA	$403	$1,132	$729
ORANGE EMPIRE	$445	$982	$537
SACRAMENTO VALLEY	$331	$1,067	$736
SAN DIEGO	Host	$781	$781
SAN JOAQUIN	$224	$848	$624

SAN JOSE	$392	$1,235	$843
SIERRA DELTA	$363	$1,036	$943
SOUTHERN CALIFORNIA	$264	$888	$624
SOUTHERN NEVADA	$165	$765	$600
TRI COUNTY	$601	$971	$370
TUCSON	$265	$817	$552
Totals	**$5,003**	**$12,403**	**$7,690**

For 1 delegate + 1 alternate + 5 Chapter Chairs per Chapter, the total *difference* for transportation reimbursement to Honolulu would be close to $54,000

C

ASHRAEXCHANGE℠

ASHRAExCHANGE℠ launched at the 2013 Annual Conference. The platform was intended to *"provide an online platform for real-time discussion and information exchange for design, construction, operation and support of the built environment."* Every effort and much hard work went into making ASHRAExCHANGE℠ a success. However, from the time it launched to date the worldwide social landscape and need for niche platforms continues to evolve. With competing social networks in the commercial sector on which ASHRAE also has a presence, such as LinkedIn, engagement on ASHRAExCHANGE℠ has yet to see critical mass.

The platform is externally hosted, and ASHRAE pays for hosting every three months at a cost of $285.00. However, the real expense is staff time. The software is written in an outdated framework that must be continually and laboriously patched to maintain security. The patches (as frequent as 6 per year) must be done to the source code and can take hours of staff time each time a patch is needed as there is no way to automatically update the software.

2016 POST STATISTICS

For the year ending December 31, 2016 ASHRAExCHANGE℠ had 23 posts by registered users and 93 by ASHRAE staff.

How many people (non-staff) are registered to post?

There were 92 new registrations received during the calendar year 2016, however only 23 posts were made during that same timeframe.

How do these numbers broadly compare to ASHRAE's LinkedIn company page?

ASHRAE's LinkedIn company page sees daily activity and currently has 25,050 followers, over 1,500% more than the users on ASHRAExCHANGE℠.

Memorandum of Understanding
ASHRAE and ISHRAE

Founded in 1894, ASHRAE, Atlanta, Georgia advances the arts and sciences of heating ventilating, air-conditioning and refrigeration to serve humanity and promote a sustainable world.

Founded in 1981, ISHRAE, New Delhi, India, advances the arts and sciences of Heating, Ventilation, Air Conditioning and Refrigeration Engineering and Related Services for the benefit of the general public.

ASHRAE and ISHRAE agree to support the Memorandum of Understanding to advance and promote the mutual interests of their respective members. We are committed to working together toward on the following activities and goals:

CONSISTENT LEADERSHIP COMMUNICATION

Recognizing the importance of communication in organizational collaboration, both organizations commit to hold a liaison meeting annually (either in person or via conference call) of designated ASHRAE/ISHRAE senior representatives to:

- Ensure ongoing advancement of collaborative projects.
- Keep each respective organization informed of major initiatives.
- Discuss new opportunities for collaboration.

ASHRAE/ISHRAE shall take responsibility for initiating the first annual liaison meeting. Action items with assigned responsibilities shall be recorded at each meeting. The parties responsible for ensuring this MOU is actively pursued through the term of the agreement are:

For ASHRAE:

Jeff Littleton
Executive Vice President
ASHRAE
1791 Tullie Circle, NE
Atlanta, GA 30329
Phone: 404-636-8400
Email: jlittleton@ashrae.org

For ISHRAE:

Ashwini Mehra
Executive Secretary
ISHRAE
K-43 (Basement), Kailash Colony
New Delhi 110048
Phone: +91 11 41635655
Email: mehrashwini@gmail.com

CONFERENCES AND MEETINGS

Each organization agrees to provide the other with a meeting invitation and two complimentary VIP registrations to the primary annual meeting.

ASHRAE and ISHRAE agree to explore opportunities to provide speakers at the other organization's meetings to help provide updates and perspectives on technologies and trends of mutual interest.

Where mutually beneficial, each organization shall help publicize the other organization's meetings and promote attendance.

CHAPTER COLLABORATION

ASHRAE and ISHRAE agree to coordinate promotion of joint grassroots meetings of respective members. Exchange of Chapter/Section leader contact information will be considered as one way to accomplish this objective.

ADVOCACY

Where mutually beneficial and to the extent allowed by laws and corporate policies, ASHRAE and ISHRAE agree to work together on common public affairs goals and ideologies. During annual liaison meetings, public affairs strategies will be discussed and common goals identified. Collaborative opportunities to be considered include:

- Joint promotion of codes and standards at the local, state and federal levels.
- Promoting mutually beneficial positions during the development and passage of state and federal legislation.
- Education of legislators on issues important to the members of each organization.

PUBLICATIONS

Recognizing that electronic and print publications are a primary means of disseminating new technologies, trends and practices, ASHRAE and ISHRAE agree to:

- Provide at least one complimentary subscription the primary membership periodical to be received at the headquarters location of the other organization.
- Explore opportunities to jointly produce publications of mutual benefit.
- Cross-market each organization's publications where appropriate and with industry standard distributor discounts.
- Use periodicals to promote the other organization's events, publications and other activities.
- Explore mutually beneficial ways to translate ASHRAE publications into [language] for distribution in [country].

EDUCATION

As leading providers of conventional and online educational services and in recognition of the vital role professional development has for our respective members, ASHRAE and ISHRAE agree to:

- Cross-market educational offerings and the regional, national and international levels.
- Explore opportunities to co-develop new courses or other training programs that take advantage of overlapping and complimentary expertise between ASHRAE and ISHRAE.
- Discuss ways that certifications programs can be jointly develop or administered.

TECHNICAL ACTIVITIES COORDINATION

ASHRAE and ISHRAE agree to foster technical cooperation in areas of common interest by:

- Encourage members in each organization to participate on technical committees and task forces.
- Provide opportunities to participate in and comment on proposed standards, guidelines, policies, and position statements developed on technical subjects as they relate to buildings and community developments.
- Establish liaison representatives to key technical committees where mutually beneficial to do so.
- Work together to promote the global harmonization of standards and coordinate activities to avoid creation of duplicated standards.

RESEARCH

Recognizing the importance research plays in accelerating the transformation to a more sustainable built environment, ASHRAE and ISHRAE agree to:

- Promote research in areas where research results will add to the body of knowledge in HVACR science and application
- Disseminate research results quickly, focusing on high-impact findings.
- Identify opportunities for research funding from other sources.

EXISTING RELATIONSHIP

ASHRAE & ISHRAE have an on-going Agreement for last several years whereby ASHRAE endorses the ISHRAE organized annual exhibition ACREX India. (Renewed on 07.09.2016, for a period of three years) ASHRAE Chapters in India are also compensated by ISHRAE/ACREX for their efforts to promote ACREX India.

ISHRAE is also authorized to market ASHRAE e-learning Courses in India, exclusively to their members at mutually agreed concessional prices.

TERMINATION

Either party may terminate this MOU, with or without stated cause, upon providing the other party with thirty (30) days written notice of intent to terminate.

TERM

The term of this Memorandum of Understanding shall begin when signed by both parties and shall terminate at the end of three (3) years unless extended at that time by written agreement.

LEGAL STANDING

This MOU reflects a commitment by ASHRAE and ISHRAE to continue and enhance their working relationship and individual efforts toward achieving mutual objectives described above. It does not create a binding obligation or agreement between the two organizations, and neither organization has an obligation to negotiate toward or enter into a binding written agreement. In addition, this MOU does not create a partnership, joint venture, fiduciary relationship or similar relationship between ASHRAE and ISHRAE. Furthermore, it is understood that this Memorandum of Understanding is conceived as a dynamic document, meant to change as circumstances and priorities warrant. It may be modified or amended by written agreement between both organizations.

FOR ASHRAE

Jeff Littleton/Executive Vice President
Printed Name/Title

_____
Signature

_____
Date

FOR ISHRAE

Vishal Kapur/ National President Elect
Printed Name/Title

_____
Signature

_____
Date

Timothy G. Wentz/President _____
Printed Name/Title

_____
Signature

_____
Date

Sachin Maheshwari/National President
Printed Name/Title

_____
Signature

_____
Date

REPORT TO ExCom
From Technology Council
February 1, 2017

Motions requiring ExCom Approval:

1. Technology Council recommends that the Board of Directors (BOD) ExCom initiate a revision of the *Refrigerants and their Responsible Use* position document (PD).

   BACKGROUND: The intent for the revision would be to update the PD (**Attachment A)** to reflect advancements since the initial publication, specifically changes from the Kigali Amendment to the Montreal Protocol. UNEP has expressed that updated guidance from ASHRAE is sought as soon as possible. The title, purpose and scope (TPS) (**Attachment B**) would not change**.** Refrigeration Committee (REF) passed another motion to reaffirm the current PD until a revision can be completed.

   TechC Vote: 9-0-0, CNV

2. Technology Council recommends that the BOD ExCom initiate a revision of the *Airborne Infectious Diseases* PD.

   BACKGROUND: The current PD (**Attachment C**) expired January 19, 2017. The TPS (**Attachment-D**) is only slightly changed**.** Environmental Health Committee (EHC) passed another motion to reaffirm the current PD until a revision can be completed.

   TechC Vote: 9-0-0, CNV

3. Technology Council recommends that the BOD ExCom initiate a revision of the *Climate Change* PD.

   BACKGROUND: The current PD expired February 26, 2016. Members of TC 2.5, Climate Change, led by Don Brundage worked on a reaffirmation draft (**Attachment E**). The main task was to reference an updated Intergovernmental Panel on Climate Change Assessment Report 5 report. Technology Council deemed changes to be beyond the editorial revisions appropriate for a reaffirmation.

   TechC Vote: 9-0-0, CNV

ASHRAE Position Document on Refrigerants and their Responsible Use

Approved by ASHRAE Board of Directors
January 25, 2012

Reaffirmed by ASHRAE Technology Council
July 2, 2014

Expires
July 2, 2017

ASHRAE
1791 Tullie Circle, NE • Atlanta, Georgia 30329-2305
404-636-8400 • fax: 404-321-5478 • www.ashrae.org

COMMITTEEROSTER

The Committee was established on October 27, 2010 with William Walter as chair. He is affiliated with Carrier Corporation.

William F. Walter (Chair)
Carrier Corporation
Syracuse, NY

Roberto Aguilo
Ing. Aguilo and Assoc.
Buenos Aires, Argentina

Warren Beeton
Emerson Climate Technologies
Sidney, OH

Lee Burgett
The Trane Company
La Crosse, WI

Patti Conlan
Arkema
King of Prussia, PA

Daniel Dettmers
University of Wisconsin
Madison, WI

Cynthia Gage
U.S. Environmental Protection Agency Research
Triangle Park, NC

Mark McLinden
National Institute of Standards and Technology
Boulder, CO

AndyPearson
Star Refrigeration Ltd
Glasgow, UK

Chun-Cheng Piao
Daikin Industries Ltd
Osaka, Japan

Mark Spatz
Honeywell
Buffalo, NY

Julian de Bullet*
McQuay International
Plymouth, MN

**Denotes a nonvoting member.*

HISTORY OF REVISION/REAFFIRMATION/WITHDRAWAL DATES

The following summarizes this document's revision, reaffirmation, or withdrawal dates:

1/25/2012—BOD approves Position Document titled *Refrigerants and their Responsible Use*

7/2/2014—Technology Council approves reaffirmation of Position Document titled *Refrigerants and their Responsible Use*

Note: ASHRAE's Technology Council and the cognizant committee recommend revision, reaffirmation, or withdrawal every 30 months.

ABSTRACT

Refrigeration and air conditioning provide many benefits to society, but these benefits carry environmental and societal consequences. Many of these consequences stem directly from the refrigerant chosen for each application. ASHRAE has a direct interest in this issue because the operation of refrigerating and air-conditioning equipment depends on refrigerants. Environmental concerns have caused ozone-depleting potential, global warming potential, energy efficiency, and life-cycle climate performance to become important factors. This often results in conflicts between choices: if a lower global warming potential (GWP) refrigerants less efficient than the fluid which it replaces, any direct global warming benefit maybe offset by increased energy consumption. ASHRAE's position is that the selection of refrigerants and their operating systems be based on a holistic analysis of multiple criteria. ASHRAE promotes responsible use of refrigerants and supports the efforts to advance technologies that minimize impact on the environment while enhancing performance, cost effectiveness, and safety.

Note: ASHRAE position documents are approved by the Board of Directors and express the views of the Society on a specific issue. The purpose of these documents is to provide objective, authoritative background information to persons interested in issues within ASHRAE's expertise, particularly in areas where such information will be helpful in drafting sound public policy. A related purpose is also to serve as an educational tool clarifying ASHRAE's position for its members and professionals, in general, advancing the arts and sciences of HVAC&R.

CONTENTS

ASHRAE Position Document on Refrigerants and their Responsible Use

SECTION **PAGE**

EXECUTIVE SUMMARY

"Refrigerants are the working fluids in refrigeration, air-conditioning, and heat-pumping systems. They absorb heat from one area, such as an air-conditioned space, and reject it into another, such as outdoors, usually through evaporation and condensation, respectively."

–ASHRAE Handbook—Fundamentals[1]

Refrigeration and air conditioning provide many benefits to society, but these benefits carry environmental and societal consequences, many of which stem directly from the refrigerant chosen for each application. This document represents ASHRAE's position on the selection and management of refrigerants.

Throughout the history of air conditioning and refrigeration, numerous substances have been used as refrigerants. However, choosing a refrigerant has become more complex in recent years. Earlier generations of refrigerants—chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs)—contributed to the depletion of stratospheric ozone and are being phased out under international treaty. CFCs and HCFCs largely have been replaced with hydrofluorocarbons (HFCs). Some of these HFCs have high global warming potentials (GWP) and are becoming subject to use restrictions in some European countries as the world deals with global climate change. Recently, lower GWP HFCs (referred to as hydrofluoroolefins or HFOs) have been introduced. They have zero ozone depleting potential (ODP) and very low GWP, but some of them are mildly flammable.

Natural refrigerants include ammonia, carbon dioxide, hydrocarbons, water, and air. Some of the natural refrigerants have been used in the market place for many decades although at varying degrees of application. Although environmentally superior favorable, natural refrigerants are not free of other concerns, such as corrosion, toxicity, high pressures, flammability, or in some cases lower operating efficiencies.

In addition, the energy that refrigeration systems consume is often produced from fossil fuels which results in emissions of CO_2, a contributor to global climate change. This indirect effect, associated with electrical generation, frequently presents larger environmental carbon footprint impact than the direct effect of refrigerant emissions.

ASHRAE's position is that the selection of refrigerants and their operating systems be based on a holistic analysis of multiple criteria. The criteria must include energy efficiency, system performance, potential impact on community safety, risk to personal safety, and minimization of direct and indirect environmental impacts. Additionally, the economic and social impacts of any fluid should also be considered. Technical and operational efforts to prevent refrigerant emissions must continue to be developed and implemented.

ASHRAE encourages and supports the ongoing effort to develop new refrigerants and improve the application of existing refrigerants to meet these criteria.

ASHRAE is committed to being a leader in the research to develop and advance HVAC&R technologies that enhance performance and safety and minimize negative environmental impact as well as the development of guidelines and standards to reduce direct and indirect emissions while improving energy efficiency.

1. ISSUES

Choosing a refrigerant for a given application has become more complex in recent years. Flammability and toxicity requirements are covered by the ASHRAE safety standards (Standard 15[2], Standard 34[3]) and their international equivalents (ISO 5149[4], ISO 817[5]), and environmental concerns have caused ozone depleting potential (ODP), global warming potential (GWP), energy efficiency, and life cycle climate performance (LCCP) to become important factors for consideration. Some countries have developed regulatory constraints, international protocols, or voluntary agreements in response. Although, conflicts may occur as a result of choices made. For example, if a lower GWP refrigerant is less efficient than the fluid it replaces then any direct global warming benefit maybe partially or totally offset by increased energy consumption. Since the implementation of the 1987 Montreal Protocol, fluids containing chlorine (e.g., CFC-11, CFC-12, HCFC-22, R-502, HCFC-123) have been restricted due to their ODP, resulting in the transition to alternatives such as hydrofluorocarbons (HFCs) and "natural refrigerants". Figure1 shows how the use of refrigerants is evolving.

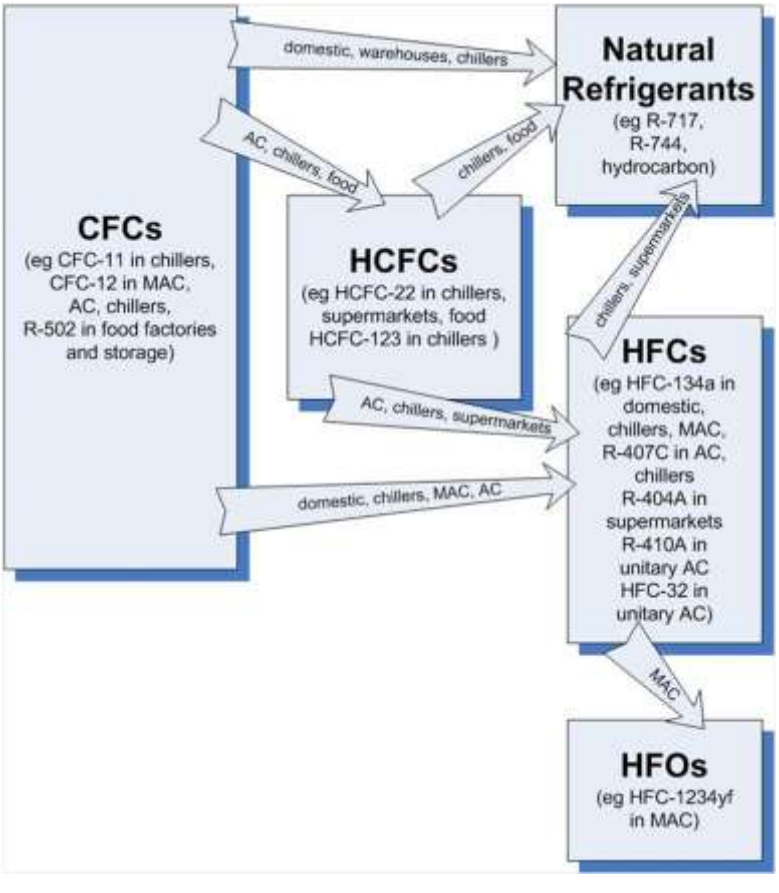


Figure 1 **Map of Refrigerant Change.** This map shows some of the routes that are being taken in the phase-out of CFCs and HCFCs. The process is moving at different speeds around the world: In some countries CFCs are already prohibited, in others their use is in decline as these countries move to complete prohibition. At present, the refrigerants that are likely to be used in the future are the natural refrigerants, the HFCs, the unsaturated HFCs (also known as HFOs), and possibly blends of these refrigerants.

The shift from CFCs was relatively rapid in the developed countries and has been more measured in the developing world. Metrics such as LCCP have been developed to enable comparisons between fluids [6]. (The LCCP methodology includes the environmental impact from the energy used by the refrigeration/air-conditioning system during its lifetime and the life cycle environmental impact of the system's refrigerant.) As such, LCCP can be used as an environmental assessment approach to compare alternative systems. In addition, systems are being designed to reduce the refrigerant charge, and procedures and equipment are being developed to monitor and minimize refrigerant leaks. The emphasis on corporate social responsibility (CSR) from end-users and manufacturers has led to an increased focus on energy efficiency and in some cases, an expressed preference for natural refrigerants. As a result, safety standards have been reassessed and are being updated to reflect the increasing interest in flammable or mildly flammable working fluids.

While each class of refrigerants has favorable performance and/or environmental aspects, none provide an ideal solution. Issues with natural refrigerants include flammability, toxicity, high pressures, or, in some cases, lower operating efficiencies, depending on the fluid. Concern about the high GWP of some HFCs has recently led to calls for a reduction in their use. This is spurring research to extend lower-GWP HFCs into new applications. The reduction has been proposed as a phase-down, however no country has formally adopted a proposal nor is it currently included in either the Kyoto or the Montreal Protocols. At the present time, some hydrofluoroolefins (HFOs) are available in limited quantities, but they are not yet fully tested in all applications. In addition, some HFOs and lower-GWP HFCs have mild flammability. Research is also investigating blends across these refrigerant classes to identify combinations that may optimize performance and minimize negative aspects.

End-of-life disposal of refrigeration and air-conditioning systems is another important issue. At that time, refrigerant should be recovered and recycled or disposed of safely to prevent loss of the charge to the atmosphere.

2. BACKGROUND

Refrigeration and air conditioning provide a broad range of benefits to society, including the preservation of food, comfort conditioning of living spaces and workplaces, and temperature control of industrial processes. The vast majority of refrigeration and air-conditioning equipment operates via the application of the vapor-compression cycle, and such cycles require a working fluid or refrigerant to operate. Refrigerants are thus at the heart of most modern refrigeration and air-conditioning equipment, and the careful selection of refrigerant has a significant impact on the safety, reliability, and energy consumption of the equipment.

A refrigerant must satisfy a number of requirements related to safety, chemical stability, environmental properties, thermodynamic characteristics, and compatibility among materials. There is no single setoff optimum characteristics (especially for thermodynamic properties), and often there are tradeoffs among desirable characteristics. Thus, a variety of refrigerants having a range of properties is needed to meet the requirements of various applications.

A broad range of fluids has been used as refrigerants over the years, and current usage is dominated by a range of fluorinated chemicals, known as HFCs, in addition to hydrocarbons and several inorganic compounds, including ammonia and carbon dioxide (CO_2). An earlier generation of refrigerants, the chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) contained chlorine, and environmental impacts related to ozone depletion resulted in the scheduled phase out of the CFC and HCFC refrigerants under the Montreal Protocol. And now, global climate change concerns have focused attention on the HFC refrigerants; in some countries, the HFCs are facing restrictions in certain applications.

The net climate impact of a refrigerant is dependent on direct and indirect effects. The direct effect is from the global warming impact of a refrigerant emitted to the atmosphere (either from a leak, accident, or from improper handling or disposal). The indirect effect is associated with the energy consumed during the operation of the heating, ventilating, air-conditioning, and refrigerating (HVAC&R) equipment. This indirect effect, which occurs as a result of the CO_2 produced from fossil fuel power plants, is usually much greater than the direct effect due to the GWP of the refrigerant itself. The refrigerant is contained within a sealed system and should not be emitted to the atmosphere at all under normal operation and with proper end-of-life disposal. In actual practice, systems are subject to leakage and breaks and require proper maintenance to minimize losses. Both direct and indirect effects are considered in metrics such as the total equivalent warming impact (TEWI)[7] and LCCP[6]. The total climate impact of a refrigeration system may increase in switching to a lower-GWP refrigerant if the energy efficiency is lower.

A more thorough discussion of the history of refrigerants, the classes of refrigerants and their attributes and tradeoffs, and means of mitigating risks associated with different classes of refrigerants is presented in the Appendix of this document.

2.1 ASHRAE Activities

ASHRAE has a direct interest in this issue because the operation of much of the heating, refrigerating, and air-conditioning equipment depends on refrigerants. ASHRAE contributed to the successful effort to phase out the ozone-depleting CFC and HCFC refrigerants, and it has a significant role to play in encouraging the proper and safe use of refrigerants going forward. ASHRAE is active in the following areas: policy, research, standards, codes and guidelines, and technology transfer and education.

ASHRAE plays a major role in the development of voluntary standards and guidelines governing the application and use of all types of refrigerants. Other organizations adopt the technical requirements developed by ASHRAE into various codes and regulations. The most important ASHRAE standards dealing with refrigerants are ANSI/ASHRAE Standard 34, *Designation and Safety Classification of Refrigerants* [3], ANSI/ASHRAE Standard 15, *Safety Standard for Refrigeration Systems* [2], and ANSI/ASHRAE Standard 147, *Reducing the Release of Halogenated Refrigerants from Refrigerating and Air-Conditioning Equipment* [8].

ASHRAE plays an important role in providing technical information on the proper application of refrigerants and in educating the technical community. These activities are carried out through handbooks, journals, technical meetings, special publications, and educational training. Local ASHRAE chapters also host refrigerant-related programs and speakers. Technical activities in this area are addressed within ASHRAE by the Refrigeration Committee, by committees responsible for the maintenance and revision of the Standards mentioned above, and by numerous technical committees.

ASHRAE is unique among technical engineering societies in sponsoring an extensive member-supported research program. The 2010–2015 research plan for the Society includes items to facilitate the application of low-GWP refrigerants, to investigate methods to reduce refrigerant charge in systems, and to improve system efficiency.

A major focus of ASHRAE's activities is on improving the energy efficiency of buildings. Reducing the heating and cooling load of buildings implies smaller HVAC&R systems with smaller charges of refrigerant and smaller indirect climate impacts resulting from energy generation.

3. RECOMMENDATIONS

ASHRAE acknowledges that HVAC&R systems have environmental consequences and ASHRAE is committed to making these systems more sustainable. Because of their environmental impacts, ASHRAE holds to the principle that refrigerants should be used prudently to provide best value to society.

3.1 ASHRAE's Strong Position

ASHRAE holds a strong position that:

- selection of refrigerants and their operating systems be based on a holistic analysis including energy efficiency and performance attributes; environmental impacts; community and personal safety; and economic considerations (e.g., a refrigerant should not be selected based on any one single factor such as GWP, operating pressure, flammability, etc., a variety of refrigerants are required to meet the range of HVAC&R applications);
- the HVAC&R industry should comply with all applicable regulations;
- refrigerant emissions should be reduced through research, education, improved design and maintenance procedures, and enforcement;
- at the end equipment life, all refrigerants should be recovered for reuse, reclamation or destruction

3.2 ASHRAE's Research Recommendations

ASHRAE recommends that further research be conducted on:

- balancing the safety, energy efficiency, cost, and environmental impact for refrigerants using a consistent and comprehensive methodology across all refrigerants and system types using benchmarks like LCCP, life cycle assessment (LCA) or TEWI;
- advancing the design and development of refrigeration and air conditioning equipment that facilitate reduced refrigerant emissions
- developing methodologies and practices to minimize or prevent refrigerant loss during installation, operation, maintenance, and decommissioning of refrigeration systems;
- developing tools, equipment, and approaches to identify, and thus minimize, refrigerant emissions during system operation
- developing new refrigerants that minimize environmental impacts and safety concerns

3.3 ASHRAE's Commitment

ASHRAE is committed to:

- supporting research to develop and advance HVAC&R technologies that minimize impact on the environment while enhancing performance, cost effectiveness, and safety;
- supporting development of guidelines and standards to improve energy efficiency and to reduce refrigerant emissions;
- supporting responsible refrigerant use through education, information dissemination, and proper technician training;
- being a leader of those dedicated to advancing responsible refrigerant use by working with societies, universities, and government agencies
- promoting responsible use of refrigerants

APPENDIX—BACKGROUND

Refrigeration and air conditioning provides a broad range of benefits to society, including the preservation of food, comfort conditioning of living spaces and workplaces, and temperature control of industrial processes.

The vast majority of refrigeration and air-conditioning equipment operates by application of the vapor-compression cycle wherein a working fluid, i.e., a refrigerant, is alternately compressed and condensed (releasing heat) and then expanded and evaporated (absorbing heat) thereby transferring heat from a low-temperature volume (e.g., a refrigerator) to a higher-temperature volume (such as ambient air). The same process can be used as a heat pump to extract low-temperature heat from an ambient source and "upgrade" it to provide heating. These processes require the input of work (usually in the form of electricity) to drive the compressor and auxiliary fans and pumps. Vapor-compression equipment is responsible for a significant portion of total global energy consumption.

Refrigerants are thus at the heart of most modern refrigeration and air-conditioning equipment, and the careful choice of the refrigerant has a significant impact on the safety, reliability, and energy consumption of the equipment.

History of Refrigerants

Mechanical refrigeration based on the vapor compression cycle was first demonstrated in the 1830s and for the next century a broad range of substances were used; these included toxic compounds, such as sulfur dioxide, as well as refrigerants still in widespread use, such as ammonia. Calm and Hourahan[9,10] characterized this "first generation" of refrigerants as "whatever worked." The widespread adoption of home refrigerators in the 1930s spurred the development of nonflammable and low-toxicity refrigerants, and the CFC (chlorofluorocarbon) and later HCFC refrigerants dominated this "second generation" of fluids.

Ozone Issue and the Montreal Protocol

CFCs and HCFCs contain chlorine, and chlorine in the stratosphere (the region of the atmosphere between about 10 and 50 km above the surface) was established as one of the primary causes of the depletion of stratospheric ozone which led to the formation of the Antarctic ozone hole each spring, along with smaller losses at high latitudes in both hemispheres. Ozone absorbs harmful ultraviolet radiation from the sun, protecting the earth's surface. The mere presence of chlorine in a molecule is not sufficient to threaten stratospheric ozone—the molecule must first be released to the atmosphere and then remain intact in the atmosphere sufficiently long for it to be transported to the stratosphere. A metric termed the ozone depletion potential (ODP) quantifies the destructive effect on ozone of a chemical released to the atmosphere relative to that of CFC-11, which is assigned an ODP value of 1.

On all counts, the properties and usage of the CFC and HCFC refrigerants combined to make them significant contributors to ozone depletion. They contain chlorine. They were relatively inexpensive chemicals and thus there was little incentive to fix leaks or recover them from equipment, leading to emissions to the atmosphere. They have significant atmospheric lifetimes—on the order of decades to centuries.

In response to this environmental concern, the Montreal Protocol on Substances That Deplete the Ozone Layer was adopted in September 1987 under the auspices of the United Nations and entered into force January 1, 1989.It has now been ratified by every member

country of the United Nations. The original Protocol called only for a 50% phasedown of the CFCs, but subsequent changes to the Protocol mandate a complete phase out of both the CFC and HCFC refrigerants.

One of the initial responses to the Montreal Protocol was to transition certain applications of CFCs to HCFCs, which have ODP values that are significantly lower than CFCs, although not zero. The transition to HCFCs was recognized as an interim measure and allowed for a rapid phase out of the more detrimental CFCs. Concurrently, a range of HFCs (which have ODPs of zero) and blends of HFCs were developed to meet the requirements of most refrigeration applications. In addition, increased attention was given to reducing emissions from refrigeration equipment and recovering refrigerant during servicing and at disposal; in some cases these are mandated by regulations.

Although the primary purpose of the Montreal Protocol was to protect ozone, it also resulted in a large reduction in greenhouse gas emissions. This is because the CFCs were, as a class, much more potent greenhouse gases than the HFCs that replaced them. The IPCC reports: "In 2010, the decrease in annual ODS emissions under the Montreal Protocol is estimated to be about10 gigatonnes of avoided CO_2-equivalent emissions per year, which is about five times larger than the annual emissions reduction target for the first commitment period (2008–2012) of the Kyoto Protocol." [11].

Global Climate Change: The Kyoto Protocol and F-Gas Legislation

The HFCs are greenhouse gases due to their absorption of infrared (heat) radiation. CO_2 also absorbs IR radiation, but an HFC molecule is more effective than a molecule of CO_2 in contributing to climate change in part because HFCs absorb at wavelengths where the atmosphere is otherwise largely transparent. A metric termed the "global warming potential" or GWP quantifies this effect; GWP values are relative to CO_2, which is assigned a GWP value of 1. This is a time-dependent process, and an "integration time horizon" must be defined for every GWP value; a 100-year time horizon is most commonly used (GWP_{100}).

In response to the impacts that global climate change would have on human societies and the global ecosystem, the United Nations Framework Convention on Climate Change (UNFCCC) was develop data summit held in Rio de Janeiro in June 1992.The UNFCCC did not set limits on greenhouse gases but did provide for updates (or "protocols") that would mandate limits. The first of these was the Kyoto Protocol, which was adopted December 1997 and entered into force in February 2005. The Kyoto Protocol has been ratified by 191 nations; the United States signed the Protocol but has not ratified it. The Protocol set limits for developed countries only for four greenhouse gases (CO_2, methane, nitrous oxide, and SF_6) and two groups of gases (perfluorocarbons and hydrofluorocarbons); emissions of these gases were converted to their CO_2 equivalent (using GWP values), and the emission limits for a given country were in terms of the total CO_2 equivalent. The CFCs and HCFCs were not included because a phaseout of these chemicals was already mandated by the Montreal Protocol. Thus, under the Kyoto Protocol, there are no specific mandates for reductions or phase out of the HFCs or any other refrigerants.

The climate impact of refrigeration equipment is much larger than the direct global warming impact of a refrigerant emitted to the atmosphere (either from a leak, accident, or from improper handling or disposal). Refrigeration equipment consumes energy during its operation, and

when this energy is produced by fossil fuels, CO_2 is produced. In some applications, this "indirect" effect of producing energy is much greater than the direct effect due to the GWP of the refrigerant itself. The refrigerant is contained within a sealed system and should not be emitted to the atmosphere at all under normal operation and with proper end-of-life disposal. In actual practice, systems are subject to leakage and accidents and require proper maintenance to minimize losses.

The concept of total equivalent warming impact (TEWI)[7] was developed to include both direct and indirect impacts of refrigeration systems. This has been modified to the LCCP through addition of the (direct and indirect) impacts from refrigerant and component manufacturing. Both TEWI and LCCP are much more complicated metrics than the direct GWP of the refrigerant itself. They must include (and make assumptions about) the energy efficiency of equipment, local CO_2 equivalent of energy generation, system charge, emission rates during operation, average lifetime of equipment, and the recovery (or not) of refrigerant from equipment prior to disposal. TEWI and LCCP values are thus specific to a particular application and may differ from region to region.

HFCs, in all applications, presently contribute only about 2% of the total anthropogenic warming[12]. However, HFC emissions are increasing due to the last of the CFC-and HCFC-based equipment being replaced with HFCs and the increased use of air conditioning worldwide. Assuming "business as usual" with regards to refrigeration and a significant replacement of fossil fuels with renewable energy, the HFCs could account for a significant fraction of total GHG emissions (on a CO_2 equivalent basis) by the middle of the century[13]. This concern has resulted in the European Union enacting regulations covering HFCs, perfluorocarbons, and SF_6 in all their applications. This so-called F-Gas Legislation provides for inspection, recovery, reporting, and training requirements when these gases are used in all but small refrigeration systems. The associated Mobile Air-Conditioning Directive bans the use of HFC-134a in new vehicle models beginning in 2011 and in all new vehicles beginning in 2017.This Directive also requires that the replacement refrigerant must have a GWP_{100} less than 150.

In 2010, the United States co-sponsored (with Canada and Mexico) a proposed amendment to the Montreal Protocol that would phase down by 2033 the use of HFCs to 15% of the combined 2005–2008 consumption of HFCs plus 85% of HCFCs based on GWP weightings[14]. This proposal explicitly recognizes that there are not alternatives for all HFC applications and therefore calls for a phasedown as opposed to a phaseout. The baseline includes HCFCs due to the continuing transition from HCFCs to HFCs. Although the Montreal Protocol addressed ozone depletion, it resulted in a universally accepted program for restrictions on refrigerants, and thus provides a mechanism for including HFCs. A total of 91 countries signaled their readiness to regulate HFCs through the Montreal Protocol by signing a declaration that recognized that the projected increase in the use of HFCs poses a major challenge for the world's climate system.

These developments have led to renewed and increased interest in natural refrigerants and the development of new low-GWP options, as discussed in following sections.

Requirements of a Refrigerant

A refrigerant must satisfy a number of (sometimes conflicting) requirements as discussed by McLinden and Didion[15].The most essential requirement is chemical stability; a refrigeration system is expected to operate many years, and all other properties would be meaningless if the refrigerant decomposed or reacted to form something else. The next most important criteria relates to health and safety; the ideal refrigerant would have low toxicity and be nonflammable. ASHRAE Standard 34[3] classifies refrigerants according to their toxicity (with "A" being a "lower degree of toxicity" as indicated by a "permissible exposure limit" of 400 ppm or greater, while "B" refrigerants have a "higher degree of toxicity") and flammability (ranging from "1" for nonflammable fluids to "3" for highly flammable fluids, such as the hydrocarbons). Flammability class"2" has a further subclass ("2L") for refrigerants of very low flammability, as defined by a burning velocity of less than 10 cm/s. Thus, an ideal refrigerant would be class "A1," and such refrigerants can be used with minimal health and safety restrictions. Other classes are restricted, such as maximum limits on the system charge or restriction to use in dedicated machine rooms. Such restrictions are enunciated in mechanical codes, many of which are based on ASHRAE Standards 34[3] and 15[2] and corresponding international standards, such as ISO/FDIS 817[5] and ISO/FDIS 5149[4].

Another important set of criteria relate to the performance (i.e., energy efficiency and capacity) of a system. The thermodynamic characteristics (most importantly normal boiling point, critical temperature, and heat capacity) must be matched to the application for the system to operate efficiently. Here there is no single set of optimum values, and a variety of refrigerants having a range of properties is needed to meet the requirements of various applications. Favorable transport properties (low viscosity and high thermal conductivity) have an impact on the size of the heat exchangers and thus cost of the overall system. Energy efficiency, along with the ozone depletion potential and global warming potential are key environmental criteria. Environmental impacts related to ozone depletion drove the phase out of the CFC and HCFC refrigerants. Global climate change concerns have focused attention on the HFC refrigerants. The atmospheric lifetime of a refrigerant affects both ODP and GWP; low values are associated with short atmospheric lifetimes. Here there is often a direct conflict between the need for chemical stability (within the sealed refrigeration system) and the need for chemical breakdown if a refrigerant is released to the atmosphere.

A final set of practical criteria relate to materials and impact the long-term reliability of a system. The refrigerant must be compatible with common materials of construction, including metals and seals. A suitable compressor lubricant must be available.

Classes of Refrigerants

Hydrocarbons and Inorganic Compounds

These include ammonia, CO_2, simple hydrocarbons, and water; they are often referred to as "natural refrigerants." (Although these molecules are found in nature, generating sufficient quantities for refrigeration requires industrial separation processes or, in the case of ammonia, industrial synthesis.) They have zero ODP and low GWP values. There has been increased interest and application of these refrigerants in recent years, although all of these fluids present one or more drawbacks (such as toxicity, flammability, corrosivity, high pressures, and/or lower efficiency) that require consideration when designing systems.

Ammonia has been used as a refrigerant for more than 150 years. It has excellent thermodynamic characteristics and provides a very high refrigeration effect per mass, but the volumetric cooling capacity is similar to many halocarbon refrigerants. It also has a very high discharge temperature from the compressor, and this has to be taken into account when designing systems. It is applicable to a wide range of cold-side temperatures. Ammonia has a toxicity classification of B according to ASHRAE Standard 34 [3] and has an ASHRAE flammability rating of 2L. It is not compatible with copper and copper alloys.

Ammonia is very common in large beverage processing, food storage, and industrial refrigeration systems where its thermodynamic characteristics and low cost outweigh the regulatory burdens. Interest in small ammonia systems has increased in recent years, and compressors and other components compatible with ammonia are commercially available. For additional information see the ASHRAE Position Document on Ammonia as a Refrigerant [16].

Absorption chillers with ammonia/water mixture are suitable and cost effective for some specific applications, especially using a waste heat, in Combined Chilling, Heat and Power (CCHP) systems and district cooling.

Ammonia used in refrigeration is produced as anhydrous ammonia for fertilizer. Ammonia has a production process has a carbon equivalent of 2 kg CO_2 eq per kg[17].

$CO_2$is nonflammable and has low toxicity; its ODP is zero, and it has a $GWP_{100}$of one; it has an ASHRAE classification of A1. The pressure/temperature characteristics of CO_2, however, have two major implications for refrigeration system design. First, it operates at very high pressures, approximately ten times the pressure of halocarbon or ammonia systems. Second, the low critical temperature of 31.0 ˚C implies a trans-critical cycle in many applications requiring direct heat exchange with the outdoor environment. While transcritical operation may lead to low operating efficiency at higher ambient temperatures in cooling mode, a trans-critical cycle, with its gliding temperature across the condenser gas cooler, can increase the efficiency of applications such as water-heating heat pumps that have gliding temperatures of the sink fluid. The high operating pressure simply a dense refrigerant that requires smaller piping and compressor sizes and reduced penalties from pressure drops can yield operation and design benefit particularly when evaporator temperatures drop to the -30 to -50°C..

CO_2 has been used as a refrigerant since the mid-19th century, but was largely displaced by ammonia and the CFC and HCFC refrigerants by the mid-20th century. There has been a resurgence of interest since the early 1990s as an alternative to the halocarbon refrigerants. It is being used in heat pump water heater applications (primarily in Japan). CO_2 is experiencing high growth in supermarket refrigeration systems either in a transcritical cycle or in the low-temperature stage of a cascade system that allows this refrigerant to operate in a sub-critical mode (i.e. a normal vapor-compression cycle). CO_2 is also being used as the heat-transfer fluid in secondary heat-transfer loops (also termed “pumped CO_2”).

The carbon dioxide used as a refrigerant is generally of industrial or scientific grade, and is typically recovered from the waste streams of industrial processes. The embedded energy required to reclaim, clean, liquefy and transport carbon dioxide is estimated to have a carbon equivalent of 1 kg CO_2 eq per kg [17].

Hydrocarbons are constituents of natural gas and petroleum. The most common hydrocarbon refrigerants are propane, butane, and isobutane. They generally have good thermodynamic properties. Hydrocarbons with a wide range of boiling points are available to meet refrigeration requirements over a wide range of temperatures. These refrigerants have zero ODP, low GWP, and are generally of low toxicity. However, they are highly flammable, and this is the major impediment to their wider use.

Hydrocarbons have long been used for process refrigeration in the petrochemical industry; here flammability of the refrigerant is not an issue because the products being produced are of similar hazard. Household refrigerators using isobutane as the refrigerant were introduced in Europe in1992 and now account for more than one-third of global production. The growth of hydrocarbons as refrigerants is rapid in China and India, countries with high GWP tax on refrigerants (Australia) are also adding hydrocarbons to mainstream use. The growth of hydrocarbons is limited by the current state of safety training for service personal and the additional costs involved in flammability safety mitigation.

Hydrocarbons used as a refrigerant are generally of industrial or scientific grade. They are recovered from the natural gas industry and the embedded energy required to clean, liquefy and transport are less than a carbon equivalent of 1 kg CO_2 eq per kg [17].

Water could be considered the ultimate in safe and environmentally benign refrigerants, but it has a very low vapor density, requiring large compressor and piping sizes. Pressure drops across components extracts a larger efficiency penalty compared to higher-pressure equipment. The equipment operates under a vacuum posing the problem of drawing air into a system. Development of prototype vapor-compression equipment using water is underway for large chilled-water systems (such as those used in large building air-conditioning).Water is used in absorption-type refrigeration equipment (with lithium bromide as the absorbent), but this type of refrigeration cycle has low energy efficiency and is typically used only when a waste heat source is available at very low cost. The lower temperature limit for water is 0˚C.

Halocarbon Refrigerants

The halocarbon refrigerants include one or more of the halogens (i.e., the elements fluorine, chlorine, or much less frequently, bromine or iodine) in a molecule with a carbon backbone. These chemicals were first commercialized in the 1930s and include CFCs (i.e., containing carbon, fluorine, and chlorine), HCFCs (also containing hydrogen), and HFCs (which do not contain chlorine).

The most commonly used CFCs used CFC refrigerants were CFC-12 and CFC-11. CFC-12wasusedinamultitudeof applications ranging from automotive air conditioning and various refrigeration applications to large centrifugal water chillers. It possessed very good performance characteristics and was widely available and affordable. The refrigerant application of CFC-11 was in low-pressure centrifugal chillers. As discussed previously, the production of these refrigerants was phased out by year end 1995 in developed countries and by year end 2009 in developing countries due to their impact on stratospheric ozone.

The most common HCFC is HCFC-22. It was extensively employed in a wide array of stationary air-conditioning systems that ranged from small window units, ducted and duct-less split systems, to large screw water chillers and even some very large centrifugal chillers. It also found use in a number of refrigeration applications from walk-in coolers/freezers to large industrial refrigeration systems. It performs well over a wide range of application temperatures. Its only performance drawback is a high compressor discharge temperature when applied in low temperature refrigeration systems. As mentioned previously, it does have an ODP (0.055) and is being phased out. No new equipment containing HCFC-22 is being produced in the US, Europe and Japan. HCFC-123 replaced CFC-11 in low pressure centrifugal chiller applications. Chillers using this refrigerant have very good efficiency. Both the ODP and GWP of this refrigerant are quite low (0.02 and 77 respectively), but it is scheduled to be phased-out under the Montreal Protocol in the developed countries for new equipment in 2020. It is classified by ASHRAE as having higher toxicity (“B1”), but this has not been an issue in low emission equipment such as chillers which are typically located in machine rooms.

The most common HFCs in use are HFC-134a and the blended refrigerants R-410A, R-404A, and R-507. HFC-134a is currently being used for automotive air conditioning, in small refrigeration systems such as home refrigerators and vending machines, and in larger water chillers where screw and centrifugal compressors are employed. R-410A (a blend of HFC-32 and HFC-125) is used in many residential and small commercial air-conditioning systems as the replacement for HCFC-22. It operates at approximately 50% higher pressure, which dictates redesign of equipment, but this higher pressure does allow for more compact equipment to meet specified efficiency targets. In some equipment where redesign was not practical, a blend of HFC-32, HFC-125, and HFC-134a (designated R-407C) is used. This refrigerant operates at pressures that are similar to HCFC-22. The only drawback of this refrigerant is the higher temperature glide that can cause fractionation concerns and its somewhat lower efficiency relative to either HCFC-22 or R-410A. R-404A (R-125/143a/134a) and R-507 (R-125/143a) are used in commercial refrigeration systems such as supermarkets and replace R-502 (a CFC/ HCFC blend). Their low discharge temperature allows reliable operation of low temperature systems, however their efficiency is somewhat less than HCFC-22 in medium temperature refrigeration application and their GWP_{100} are fairly high (above 3900). Lower GWP HFC blends (e.g.R-407A) have been used mainly to retrofit and replace older HCFC-22 systems but have also been used in place of R-404A.

In an attempt to retain the desirable properties of the widely used HFC refrigerants, but with low GWP values, a new class of HFCs has recently been introduced. These incorporate a carbon-carbon double bond into the molecular structure; thus they belong to the chemical class of “olefins” and these new refrigerants are termed HFOs, for “hydrofluoroolefin.” The double bond provides a mechanism for rapid degradation in the atmosphere, leading to low GWP values. As of early 2011, two such HFOs (HFO-1234yf with a GWP_{100} of 4 and HFO-1234ze (E) with a GWP_{100} of 6) have been publicly disclosed; additional HFOs are under development. These two fluids have low toxicity and very low flammability (ASHRAE classification A2L). HFO 1234yf is offered as a low-GWP option for automotive air-conditioning applications, and has been approved for this use in the US. The HFOs are being actively investigated for many other applications, but much research remains to determine their application suitability.

Fluorocarbons and fluoroolefins are specially made for the application in air conditioning and refrigeration systems. The embedded energy required to manufacture these materials are typically about a carbon equivalent of 9 kg CO_2 eq per kg[17].

Lower-GWP Options

There is no generally accepted definition for what constitutes a “low-GWP” refrigerant. A regulatory inferred definition comes from the MAC directive of the European Union, which stipulates that only refrigerants with a direct global warming potential of 150 or lower (relative to CO_2 on a 100-year time horizon) may be used in automotive air-conditioning systems. This is an arbitrary value that was chosen to allow the use of HFC-152a but this is not based on a rigorous analysis nor does it denote an environmentally benign refrigerant. It should be noted that this limit was set only for auto air-conditioning applications, which are generally more leak prone than many other applications.

The UNEP Technical Options Committee for Refrigeration, Air-conditioning, and Heat Pumps [18] proposed seven groups based on the refrigerants GWP* and defines low-GWP as less than 300. These GWP groups, although proposed in 2010, have not been adopted by others. The difficulty arises from the fact that based on the current refrigerants in use each application has a different baseline and what constitutes '"low-GWP" is often referenced to the refrigerant that has traditionally been used in that application. It should be noted that the proposed amendment to the Montreal Protocol by the U.S., Canada, and Mexico does not set GWP limits but instead would introduce a GWP-weighted phase-down of all HFCs. This would allow flexibility for multiple GWP options as long as a country remains below its reduction target.

The refrigerants currently being evaluated to replace the higher-GWP HFCs all have drawbacks. HFC-32 has a GWP_{100} value of 675, and, like HFO-1234yf and HFO-1234ze (E), has an ASHRAE classification of A2L, which means that it is mildly flammable. Of the refrigerants with a GWP_{100} value less than 150, HFC-152a and the hydrocarbons are flammable. Ammonia is toxic. CO_2 operates at very high pressures and, often, in a trans-critical cycle (with generally lower efficiency).

In addition to the HFOs used as single-component refrigerants, blends of HFOs with conventional HFCs are being investigated. Such blends are tailored to match, as closely as possible, the characteristics of current refrigerants and thus meet the requirements of various applications. These blends have GWP_{100} values higher than the HFOs but lower than the HFCs they are intended to replace.

As pointed out earlier in this report, GWP should not be used as the sole criterion of environmental acceptability. If a lower GWP refrigerant is less efficient than the fluid which it replaces, any direct global warming benefit maybe offset by increased energy consumption. It is also clear that in order to meet the range of HVAC&R applications, a variety of refrigerants are required.

Mitigation of Risk

Risks of all types can be lessened by reduction of total system charge. Smaller charges can reduce the safety risks of a flammable refrigerant (a gas will not ignite in air below a finite concentration known as the "lower flammability limit" or LFL), and may allow the use of such refrigerants in many more applications. Reduction of charge would reduce the environmental consequences of refrigerant release due to leaks, accident, or improper disposal.

Ideally, refrigerants should not be emitted from equipment during normal operation. In practice, refrigerant losses are a function of system size, design, installation, and maintenance of the equipment. In general, small factory-sealed systems such as refrigerators can operate to the end-of-life without loss of refrigerant charge. Automotive air-conditioning systems may require recharging due to losses through hoses. Larger field-erected systems, such as those used in supermarkets, are more vulnerable to refrigerant losses due to the magnitude of components and piping required to meet their refrigeration loads. Proper design, fabrication, installation, maintenance and disposal procedures can greatly reduce the emissions and environmental impact of refrigerants.

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*- The 2010 Assessment Report of the Technical Options Committee for Refrigeration, Air-conditioning, and Heat Pumps, published by UNEP, has proposed a classification scheme that distinguishes between very low (or ultra-low) with GWP ≤30,very low with GWP ≤100,low with GWP ≤300, moderate with GWP ≤1000, high with GWP ≤3,000,very high with GWP ≤10,000,and ultra-high with GWP ≤10,000.

To address these issues, ASHRAE has published Standard 147,*Reducing the Release of Halogenated Refrigerants from Refrigerating and Air-Conditioning Equipment*[8]. An example of a best practices guide is also available from the EPA[19].

One strategy for reducing both system charge and emissions that has been successfully applied in supermarkets is to locate the refrigeration equipment outside or in a machine room with heat exchange loops circulating a secondary coolant (e.g., CO_2 or a glycol/water solution) to the refrigerated display cases. This approach can also be applied to other systems, and requires good design practice to offset any energy penalty from the additional heat exchange loop [20].

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Title: Refrigerants and Their Responsible Use

Purpose: To inform ASHRAE members, policymakers and the building industry about the major issues related to the use of refrigerants in HVAC&R equipment and systems and complement other Position Documents dealing in a more detailed way with narrower aspects of refrigerant application.

Scope: Consider all refrigerant classes in a balanced manner.

Limit discussion to refrigeration applications, i.e., exclude other applications of refrigerant materials as blowing agents, solvents, fire suppressants.

Discuss all major technical and policy considerations for refrigerant selection and use.

Address secondary effects of refrigerant use including energy consumption, climate change and other environmental impacts, safety and health.

Recommend actions in the areas of research, standards development, guidance and public policy.

ASHRAE Position Document on Airborne Infectious Diseases

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HISTORY OF REVISION/REAFFIRMATION/WITHDRAWAL DATES

The following summarizes this document's revision, reaffirmation, or withdrawal dates:

6/24/2009—BOD approves Position Document titled Airborne Infectious Diseases

1/25/2012—Technology Council approves reaffirmation of Position Document titled Airborne Infectious Diseases

1/19/2014—BOD approves revised Position Document titled Airborne Infectious Diseases

Note: ASHRAE's Technology Council and the cognizant committee recommend revision, reaffirmation, or withdrawal every 30 months.

Note: ASHRAE position documents are approved by the Board of Directors and express the views of the Society on a specific issue. The purpose of these documents is to provide objective, authoritative background information to persons interested in issues within ASHRAE's expertise, particularly in areas where such information will be helpful in drafting sound public policy. A related purpose is also to serve as an educational tool clarifying ASHRAE's position for its members and professionals, in general, advancing the arts and sciences of HVAC&R.

CONTENTS

ASHRAE Position Document on Airborne Infectious Diseases

ABSTRACT

Infectious diseases spread by several different routes. Tuberculosis and in some cases influenza, the common cold, and other diseases spread by the airborne route. The spread can be accelerated or controlled by heating, ventilating, and air-conditioning (HVAC) systems, for which ASHRAE is the global leader and foremost source of technical and educational information.

ASHRAE will continue to support research that advances the state of knowledge in the specific techniques that control airborne infectious disease transmission through HVAC systems, including ventilation rates, airflow regimes, filtration, and ultraviolet germicidal irradiation (UVGI).

ASHRAE's position is that facilities of all types should follow, as a minimum, the latest practice standards and guidelines. ASHRAE's 62.X Standards cover ventilation in many facility types, and Standard 170 covers ventilation in health-care facilities. New and existing health-care intake and waiting areas, crowded shelters, and similar facilities should go beyond the minimum requirements of these documents, using techniques covered in ASHRAE's *Indoor Air Quality Guide* (2009) to be even better prepared to control airborne infectious disease (including a future pandemic caused by a new infectious agent).

EXECUTIVE SUMMARY

This position document (PD) has been written to provide the membership of ASHRAE and other interested persons with information on the following:

- the health consequences and modes of transmission of infectious disease
- the implications for the design, installation, and operation of heating, ventilating, and air-conditioning (HVAC) systems
- the means to support facility management and planning for everyday operation and for emergencies

There are various methods of infectious disease transmission, including contact (both direct and indirect), transmission by large droplets, and inhalation of airborne particles containing infectious microorganisms. The practice of the HVAC professional in reducing disease transmission is focused primarily on those diseases transmitted by airborne particles.

1. THE ISSUE

The potential for airborne transmission of disease is widely recognized, although there remains uncertainty concerning which diseases are spread primarily via which route, whether it be airborne, short range droplets, direct or indirect contact, or multimodal (a combination of mechanisms).

Ventilation and airflow are effective for controlling transmission of only certain diseases. Several ventilation and airflow strategies are effective and available for implementation in buildings.

Although this PD is primarily applicable to diseases that spread from person to person, the principles also apply to infection from environmental reservoirs such as building water systems with *Legionella* spp. and organic matter with spores from mold (to the extent that the microorganisms spread by the airborne route).[1] The first step in control of such a disease is to eliminate the source before it becomes airborne.

2. BACKGROUND

2.1 Introduction to Infectious Disease Transmission

This position document covers the spread of infectious disease from an infected individual to a susceptible person, known as *cross transmission* or *person-to-person transmission*, by small airborne particles (an aerosol) that contain microorganisms.

This PD does not cover direct or indirect contact routes of exposure. Direct contact means any surface contact such as touching, kissing, sexual contact, contact with oral secretions or skin lesions, or additional routes such as blood transfusions or intravenous injections. Indirect contact involves contact with an intermediate inanimate surface (fomite), such as a doorknob or bedrail that is contaminated.

Exposure through the air occurs through (1) droplets, which are released and fall to surfaces about 1 m (3 ft) from the infected and (2) small particles, which stay airborne for hours at a time and can be transported long distances. The aerobiology of transmission of droplets and small particles produced by a patient with acute infection is illustrated in Figure 1.

Because large droplets are heavy and settle under the influence of gravity quickly, general dilution, pressure differentials, and exhaust ventilation do not significantly influence droplet concentrations, velocity, or direction, unless they reduce diameter by evaporation, thus becoming an aerosol. The term *droplet nuclei* has been used to describe desiccation of large droplets into small airborne particles (Siegel et al. 2007).

Of the modes of transmission, this PD's scope is limited to aerosols, which can travel longer distances through the airborne route, including by HVAC systems. The terms *airborne*, *aerosol*, and *droplet nuclei* are used throughout this PD to refer to this route. HVAC systems are not known to entrain the larger particles.

The size demarcation between droplets and small particles has been described as having a mass median aerodynamic diameter (MMAD) of 2.5 to10 µm (Shaman and Kohn 2009; Duguid 1946; Mandell 2010). Even particles with diameters of 30 µm or greater can remain suspended in the air (Cole and Cook 1998). Work by Xie and colleagues (2007) indicates that large droplets are those of diameter between 50 and 100 µm at the original time of release. Tang and others (2006) proposed a scheme of large-droplet diameter $\geq$60 µm,

[1] For ASHRAE's position concerning *Legionella*, see ASHRAE (2012a). Readers are referred to other resources that address mitigation of transmission of this waterborne pathogen (ASHRAE 2000; CDC 2003; the forthcoming ASHRAE Standard 188; OSHA 1999; SA Health 2013, and WHO 2007). For ASHRAE's position concerning mold and moisture, see ASHRAE (2013d).

small droplet diameter < 60 µm, and droplet nuclei with a MMAD of <10 µm. The exact size demarcation is less important than knowing that large droplets and small particles behave differently and that the latter can remain airborne.

Small particles that can become airborne are typically generated by coughing, sneezing, shouting, and to a lesser extent by singing and talking. Even breathing may generate such particles in sick and highly infectious individuals (Bischoff 2013). Particle size distributions of coughed materials are thought to encompass a broad range of diameters, from very small to large droplets, depending on differences in patients and diseases (Riley and Nardell 1989).

Fennelly et al. (2004) measured cough aerosol emanating directly from tuberculosis patients. The patients generated infectious aerosol that contained from three to four colony-forming units (CFU, a direct measure, using culturing techniques, of the number of viable, growing, and infectious organisms) to a maximum of 633 CFU. The size distributions that were measured in this study suggest that most of the viable particles in the cough-generated aerosols were immediately respirable, ranging from 0.65 to 3.3 µm. Wainwright et al. (2009) also measured cough aerosols from cystic fibrosis patients and documented that 70% of viable cough aerosols containing *Pseudomonas aeruginosa* and other Gram-negative bacteria were of particles ≤ 3.3 µm. Positive room air samples were associated with high total counts in cough aerosols.

There are not, however, enough data to fully describe or predict cough particle size distributions[2] for many diseases, and research is needed to better characterize them (Xie et al. 2009).

In the 1950s, the relationship among particle size, airborne suspension, and transmission implications began to become clear. The different routes require different control strategies, which have evolved over many years of infectious disease practice, and there are now standards of practice for infectious disease and hospital epidemiology. See the Professional Practice documents available from the Association for Professionals in Infection Control and Epidemiology at www.apic.org.

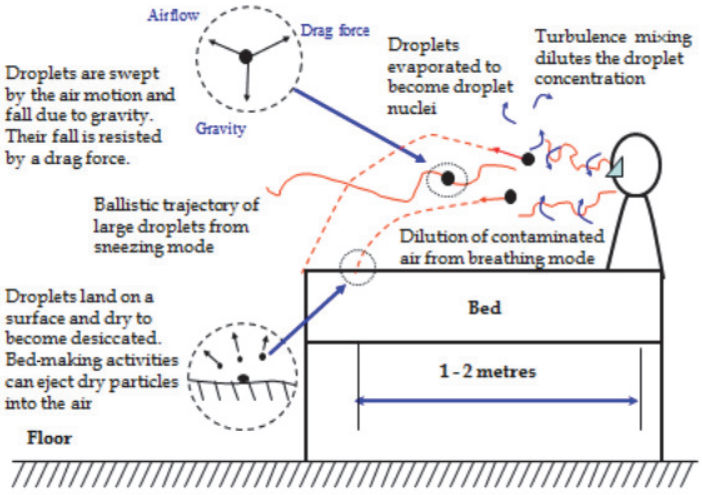

Figure 1 Droplet suspension: illustration of the aerobiology of droplets and small airborne particles produced by an infected patient.

[2] Cough particle size distributions are likely to vary based on the infected person's viscosity of secretions, anatomical structures in the oropharynx (roughly meaning throat) and airways, and disease characteristics.

Many diseases have been found to have higher transmission rates when susceptible individuals approach within close proximity, about 1 to 2 m (3 to 7 ft).[3] Over this short range, the susceptible person has a substantially greater exposure from the infected individual to droplets of varying size, both inspirable large droplets and airborne particles (e.g., see Figure 1). Nicas and Jones (2009) have argued that close contact permits droplet spray exposure and maximizes inhalation exposure to small particles and inspirable droplets. Thus, particles/droplets of varying sizes may contribute to transmission at close proximity (Li 2011).

To prevent this type of short-range exposure, whether droplet or airborne, maintaining a 2 m (7 ft) distance between infected and susceptible is considered protective, and methods such as ventilation dilution are not effective.

2.2 Mathematical Model of Airborne Infection

Riley and Nardell (1989) present a standard model of airborne infection usually referred to as the *Wells-Riley equation*, given below as Equation 1. Like all mathematical models, it has its limitations, yet it is useful for understanding the relationship among the variables such as the number of new infections (C), number of susceptibles (S), number of infectors (I), number of doses of airborne infection (q) added to the air per unit time by a case in the infectious stage, pulmonary ventilation per susceptible (p) in volume per unit time, exposure time (t), and volume flow rate of fresh or disinfected air into which the quanta are distributed (Q).

$$C = S(1 - e^{-Iqpt/Q}) \quad (1)$$

The exponent represents the degree of exposure to infection and $1 - e^{-Iqpt/Q}$ is the probability of a single susceptible being infected. Note that this model does not account for varying susceptibility among noninfected individuals. For this and other reasons, exposure does not necessarily lead to infection.[4] The parameter q is derived from the term *quantum*, which Wells (1995) used to indicate an infectious dose, whether it contains a single organism or several organisms. The ability to estimate q is difficult at best and has been reported in the literature to be 1.25 to 249 quanta per hour (qph) in tuberculosis patients (Riley et al. 1962; Catanzaro 1982) and 5480 qph for measles (Riley et al. 1978).

Because of the uncertainty in knowing q, Equation 1 is most useful for understanding the general relationships among the variables, for instance, the impact of increasing the volume of fresh or disinfected air on airborne infection. Increasing Q decreases exposure by diluting air containing infectious particles with infectious-particle-free air. Q can also be impacted through the use of other engineering control technologies, including filtration and UVGI, as discussed in Section 3.2. Therefore, a more complete representation of Q should include the total removal rate by ventilation, filtration, deposition, agglomeration, natural deactivation, and other forms of engineered deactivation.

[3] Infectious pneumonias, like pneumococcal disease (Hoge et al. 1994) or plague (CDC 2001) are thought to be transmitted in this way.

[4] This applies differently to various microorganisms, whether they be fungal, bacterial, or viral. After exposure, the microorganism must reach the target in the body (e.g., lung or mucosa) to cause infection. Some infective particles must deposit on mucosa to result in infection, and if they instead deposit on the skin, infection may not result. Another important element that influences a person's risk of infection is his or her underlying immunity against select microorganisms and immune status in general. For example, individuals with prior *M. Tuberculosis* infection who have developed immunity are able to ward off the infection and a person who had chicken pox as a child or received chicken pox vaccine is not susceptible even if living in the same household as an individual with acute chicken pox. On the other hand, individuals infected with human immunodeficiency virus (HIV) are more susceptible to becoming infected, for instance, with tuberculosis.

2.3 For Which Diseases is the Airborne Transmission Route Important?

Roy and Milton (2004) describe a classification scheme of aerosol transmission of diseases as obligate, preferential, or opportunistic[5] on the basis of the agent's capacity to be transmitted and to induce disease. Under this classification scheme, tuberculosis may be the only communicable disease with obligate airborne transmission—an infection that is initiated only through aerosols. For *Mycobacterium tuberculosis*, the aerodynamic diameters of the airborne particles are approximately 1 to 5 µm.

Agents with preferential airborne transmission can naturally initiate infection through multiple routes but are predominantly transmitted by aerosols. These include measles and chicken pox.

There are probably many diseases with opportunistic airborne transmission—infections that naturally cause disease through other routes such as the gastrointestinal tract but that can also use fine-particle aerosols as an efficient means of propagating in favorable environments. The relative importance of the transmission modes for many of these diseases remains a subject of uncertainty (Shaman and Kohn 2009; Roy and Milton 2004; Li 2011).

The common cold (rhinoviruses) and influenza can both be transmitted by direct contact or fomites; there is also evidence of influenza and rhinovirus transmission via large droplets and the airborne route (D'Alesssio et al. 1984; Wong et al. 2010; Bischoff et al. 2013).

Work by Dick and colleagues (1967, 1987) suggests that the common cold may be transmitted through the airborne droplet nuclei route. Experimental studies (Dick et al. 1987) document the possibility of transmission beyond 1 m (3 ft) under controlled conditions in experimental chambers and strongly suggest airborne transmission as at least one component of rhinoviral infection. A recent field study (Myatt et al. 2004) supports this result and documents its likely importance in a field investigation.

Other literature acknowledges the potential importance of the airborne routes while suggesting that droplet transmission is far more important, at least for common viral diseases such as the common cold (Gwaltney and Hendley 1978).

Control of seasonal influenza has for decades relied on large-droplet precautions even though there is evidence suggesting a far greater importance for airborne transmission by small particles. For instance, a 1959 study of influenza prevention in a Veterans Administration nursing home identified an 80% reduction in influenza in staff and patients through the use of upper-room ultraviolet germicidal irradiation (UVGI) (McLean 1961). This suggests that air currents to the higher-room areas where the UVGI was present carried the airborne infectious particles, and they were inactivated. The inactivated (noninfectious) particles were therefore unable to infect staff and patients in control areas with UVGI, as compared to areas without UVGI.

Influenza transmission occurred from one index case to 72% of the 54 passengers aboard an airliner on the ground in Alaska while the ventilation system was turned off (Moser et al. 1979). This outbreak was widely thought to represent a second piece of evidence for airborne transmission, and it was also thought that the high attack rate was due in part to the ventilation system not being in operation (Moser 1979). A review by Tellier (2006) acknowledges the importance of these papers and suggests including consideration of airborne transmission in pandemic influenza planning. However, one systematic review by Brankston et al. (2007) concluded that the airborne transmission route was not important in the same outbreak.

[5] This use of the word *opportunistic* differs from the medical term of art, *opportunistic infection*, which refers to an infection caused by a microorganism that normally does not cause disease but becomes pathogenic when the body's immune system is impaired and unable to fight off infection.

A 1986 outbreak from the H1N1 influenza virus among U.S. Navy personnel was attributed to their having flown on the same airplanes. Many of the infected susceptibles were displaced considerably more than 2 m (7 ft) from the infected individuals (Klontz et al. 1989). This suggests the airborne route of transmission.

A 2009 outbreak of influenza A pandemic (H1N1) developed from a single index case patient in nine tour group members (30%) who had talked with the index case patient and in one airline passenger (not a tour group member) who had sat within two rows of her. None of the 14 tour group members who had not talked with the index case patient became ill. The authors therefore concluded that this outbreak was caused by droplet transmission and that airborne transmission was not a factor (Han et al. 2009).

Chu et al. (2005) documented that airborne transmission of severe acute respiratory syndrome (SARS, a severe form of pneumonia caused by a member of the coronavirus family of viruses—the same family that can cause the common cold) could occur. In one dramatic outbreak of SARS in the Amoy Gardens high-rise apartment, airborne transmission through droplet nuclei seemed to represent the primary mode of disease spread. This was likely due to a dried-out floor drain and airborne dissemination by the toilet exhaust fan and winds (Yu et al. 2004; Li et al. 2005a, 2005b). The observed pattern of disease spread from one building to another, and particularly on the upwind side of one building, could not be explained satisfactorily other than by the airborne route.

A study of Chinese student dormitories provides support for the theory of the airborne spread of the common cold (Sun et al. 2011). Ventilation rates were calculated from measured carbon-dioxide concentration in 238 dorm rooms in 13 buildings. A dose-response relationship was found between outdoor air flow rate per person in dorm rooms and the proportion of occupants with annual common cold infections $\geq$6 times. A mean ventilation rate of 5 L/(s·person) (10 cfm/[s·person]) in dorm buildings was associated with 5% of self-reported common cold $\geq$6 times, compared to 35% at 1 L/(s·person) (2 cfm /[s·person]).

A literature review by Wat (2004) tabulates the mode of transmission and seasonality of six respiratory viruses, indicating that rhinovirus, influenza, adenovirus, and possibly coronavirus are spread by the airborne route.

The reader of this document should keep an open mind about the relative importance of the various modes of transmission due to the uncertainty that remains (Shaman and Kohn 2009) as illustrated by the studies described above. Disease transmission is complex, and one-dimensional strategies are not suitable for universal application.

3. PRACTICAL IMPLICATIONS FOR BUILDING OWNERS, OPERATORS, AND ENGINEERS

Small particles may be transported through ventilation systems, as has been documented for tuberculosis, Q-fever, and measles (Li et al. 2007). Therefore, when outbreaks occur in the workplace, transmission through HVAC systems must be considered. As disease transmission by direct contact, fomite, and large-droplet routes is reduced by more efficient prevention strategies, the airborne route is likely to become relatively more important.

If influenza transmission occurs not only through direct contact or large droplets, as is the long-standing public health tradition, but also through the airborne route, as newer data suggest, HVAC systems may contribute far more both to transmission of disease and, potentially, to reduction of transmission risk.

There are practical limits to what HVAC systems can accomplish in preventing transmission of infections in large populations. In some cases, infections are transmitted in the absence of HVAC systems.

Owners, operators, and engineers are encouraged to collaborate with infection prevention specialists knowledgeable about transmission of infection in the community and the workplace and about strategies for prevention and risk mitigation.

3.1 Varying Approaches for Facility Type

Health-care facilities have criteria for ventilation design to mitigate airborne transmission of infectious disease (FGI 2010; ASHRAE 2008). Yet most infections are transmitted in ordinary occupancies in the community and not in industrial or health-care occupancies.

ASHRAE does not provide specific *requirements* for infectious disease control in schools, prisons, shelters, transportation, and other public facilities other than the general ventilation and air quality requirements of Standards 62.1 and 62.2 (ASHRAE 2013b, 2013c). However, the *guidance* in this PD does apply to these facilities.

In health-care facilities, many common interventions to prevent infections aim to reduce transmission by direct or indirect contact (for example, directly via the hands of health-care personnel). Interventions also aim to prevent airborne transmission (Aliabadi et al. 2011).

Because of the difficulties in separating out the relative importance of transmission modes, recent work in health-care facilities has focused on “infection control bundles” (i.e., use of multiple modalities simultaneously) (Apisarnthanarak et al. 2009, et al. 2010a, et al. 2010b; Cheng et al. 2010). For two prototype diseases, tuberculosis and influenza, this bundle includes administrative and environmental controls and personal protective equipment in health-care settings. Given the current state of knowledge, this represents a practical solution.

For studies and other publications with specific guidance on air quality and energy in biomedical laboratories, animal research facilities, and health-care facilities, see the National Institutes of Health (NIH) Office of Research Facilities’ website (http://orf.od.nih.gov/PoliciesAndGuidelines/Bioenvironmental).

A prerequisite to all of the strategies is a well-designed, installed, commissioned, and maintained HVAC system (Memarzadeh et al. 2010; NIOSH 2009a).

In considering going beyond requirements that include codes, standards, and practice guidelines, use guidance from published sources such as “Guidelines for Preventing the Transmission of Mycobacterium Tuberculosis in Health-Care Settings” (CDC 2005), *Guidelines for Design and Construction of Health Care Facilities* (FGI 2010), *Indoor Air Quality Guide: Best Practices for Design, Construction and Commissioning* (ASHRAE 2009), apic.org, and Table 1 in the Recommendations section, and discuss risk with the facility user. HVAC system designers can assist closely allied professionals such as architects and plumbing engineers to understand how sources of unplanned airflow can impact airborne infectious disease transmission. Examples include wastewater drains (especially if improperly trapped) and wall and door leakage (including the pumping action of swinging doors).

3.2 Ventilation and Air-Cleaning Strategies

Because small particles remain airborne for some period of time, the design and operation of HVAC systems that move air can affect disease transmission in several ways, such as by the following:

- supplying clean air to susceptible occupants
- containing contaminated air and/or exhausting it to the outdoors
- diluting the air in a space with cleaner air from outdoors and/or by filtering the air
- cleaning the air within the room

The following strategies are of interest: dilution ventilation, laminar and other in-room flow regimes, differential room pressurization, personalized ventilation, source capture ventilation, filtration (central or unitary), and UVGI (upper room, in-room, and in the airstream).

ANSI/ASHRAE/ASHE Standard 170-2008, *Ventilation of Health-Care Facilities*, covers specific mandatory HVAC requirements including ventilation rates, filtration, and pressure relationships among rooms (ASHRAE 2008). The *Guidelines for Design and Construction of Health Care Facilities* (FGI 2010) include the Standard 170 requirements and describe other criteria that can guide designers of these facilities.

Ventilation represents a primary infectious disease control strategy through dilution of room air around a source and removal of infectious agents (CDC 2005). Directed supply and/or exhaust ventilation, such as nonaspirating diffusers for unidirectional low-velocity airflow, is important in several settings, including operating rooms (FGI 2010; ASHRAE 2008).

However, it remains unclear by how much infectious particle loads must be reduced to achieve a measurable reduction in disease transmissions and whether the efficiencies warrant the cost of using these controls.

Energy-conserving strategies that reduce annualized ventilation rates, such as demand-controlled ventilation, should be used with caution, especially during mild outdoor conditions when the additional ventilation has low cost. Greater use of air economizers has a positive impact both on energy conservation and annualized dilution ventilation.

Natural ventilation, such as that provided by user-operable windows, is not covered as a method of infection control by most ventilation standards and guidelines. There are very few studies on natural ventilation for infection control in hospitals. One guideline that does address it recommends that natural ventilation systems should achieve specific ventilation rates that are significantly higher than the ventilation rates required in practice guidelines for mechanical systems (WHO 2009).

Room pressure differentials are important for controlling airflow between areas in a building (Siegel et al. 2007; CDC 2005). For example, airborne infection isolation rooms (AIIRs) are kept at negative pressure with respect to the surrounding areas to keep potential infectious agents within the rooms. Some designs for AIIRs incorporate supplemental dilution or exhaust/capture ventilation (CDC 2005). Interestingly, criteria for AIIRs differ substantially between cultures and countries in several ways, including air supply into anterooms, exhaust from space, and required ventilation air (Subhash et al. 2013; Fusco et al. 2012). This PD takes no position on whether anterooms should be required in practice guidelines.

Hospital rooms with immune-compromised individuals are kept at positive pressure in protective environments (PEs) to keep potential infectious agents (e.g., *Aspergillus* sp. or other filamentous fungi) out of the rooms (Siegel et al. 2007; FGI 2010; ASHRAE 2008).

Personalized ventilation systems that supply 100% outdoor air, highly filtered, or UV disinfected air directly to the occupant's breathing zone (Cermak et al. 2006; Sekhar et al. 2005) may be protective as shown by CFD analysis (Yang et al. 2013). However, there are no known field studies that justify the efficacy. Personalized ventilation may be effective against aerosols that travel both long distances as well as short-range routes (Li 2011).

The addition of highly efficient particle filtration to central ventilation systems is likely to reduce the airborne load of infectious particles (Azimi and Stephens 2013).[6] This control strategy can reduce the transport of infectious agents within individual areas and from one area to another when these areas share the same central ventilation system (e.g., from patient rooms in hospitals or lobbies in public access buildings to other occupied spaces).

Local, efficient filtration units (either ceiling mounted or portable, floor-standing) reduce local airborne loads and may serve purposes in specific areas such as health-care facilities or high-traffic public occupancies (Miller-Leiden et al. 1996; Kujundzic et al. 2006).

There are two UVGI strategies for general application: (1) installation into air handlers and/or ventilating ducts and (2) irradiation of the upper air zones of occupied spaces with shielding of the lower occupied spaces because UV is harmful to room occupants (Reed 2010). Two strategies used in some but not all health-care occupancies are in-room irradiation of unoccupied spaces and of occupied spaces (e.g., operating suites) when personnel have appropriate personal protective equipment (PPE) (NIOSH 2009b).

All UVGI depends on inactivation of viable agents, both in the air and on surfaces, depending on the strategy. ASHRAE (2009) describes effective application of the first two UVGI strategies. For efficacy of in-room irradiation. see, for instance, “Decontamination of Targeted Pathogens from Patient Rooms Using an Automated Ultraviolet-C-Emitting Device” (Anderson et al. 2013).

In both duct-mounted and unoccupied in-room UVGI, the amount of radiation applied can be much higher compared to what can be used for upper-zone UVGI, resulting in higher aerosol exposure and quicker inactivation. Duct-mounted UVGI can be compared to filtration in the central ventilation system, because it inactivates the potentially infectious organisms while filtration removes them. UVGI does not impose a pressure drop burden on the ventilation system.

There is research that shows UVGI in both the upper-room and in-duct configurations can inactivate some disease-transmitting organisms (Riley et al. 1962; Ko et al. 2002; CDC 2005; Kujundzic et al. 2007; VanOsdell and Foarde 2002; Xu et al. 2003, et al. 2005), that it can affect disease transmission rates (McLean 1961), and that it can be safely deployed (Nardell et al. 2008).

Upper-zone UVGI, when effectively applied (ASHRAE 2009; NIOSH 2009a; Miller et al. 2013; Xu et al. 2013), inactivates infectious agents locally and can be considered in public access and high-traffic areas such as cafeterias, waiting rooms, and other public spaces. The fixtures are typically mounted at least 2.1 m (7 ft) above the floor, allowing at least an additional 0.3 m (1 ft) of space above the fixture for decontamination to occur. It is typically recommended when ventilation rates are low.

At air change rates much greater than 6 ach (air changes per hour), there is evidence that upper-room UVGI is less effective relative to particle removal by ventilation. This is thought to be because the particles have less residence exposure time to UV.

In-room UVGI may be performed in patient rooms between successive occupants using elevated levels of irradiation applied in the unoccupied room for a specified length of time. This is primarily a surface disinfectant strategy, though it also disinfects the air that is in the room at the time of irradiation (Anderson et al. 2013; Mahida et al. 2013). Because the UV is turned off before the next patient arrives, it has no continuing effect on the air.

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[6] Filter efficiency varies with particle size, so the type of filtration required in order to be effective varies with the type of organism and the aerosol that carries it. ASHRAE Standard 52.2 (ASHRAE 2012b) describes a minimum efficiency reporting value (MERV) for filter efficiency at various particle sizes, and HEPA filtration may not be necessary. Specific personnel safety procedures may be required when changing filters, depending on the types of organisms and other contaminants that have been collected on the used media.

A strategy of continuous irradiation of the air during surgery has been used, though this is not currently standard practice. When using this strategy, protection of operating room personnel from the UV radiation is advised.

Note that no controlled intervention studies showing the clinical efficacy of all of the above strategies have been conducted, *including dilution ventilation and pressure differential that are required under current practice standards and guidelines*.

If studies can be conducted, they should specifically include occupancies such as jails, homeless shelters, and health-care facilities. Compared to other facilities, these have a higher risk for both infected and susceptible individuals, which results in higher rates of disease transmission, making the impact more measurable and significant. Such research may lead to other recommended changes in HVAC system design. More research is also needed to document intrinsic (specific to microorganism) airborne virus and bacteria inactivation rates. See Table 1 for a summary of occupancy categories in which various strategies may be considered and priorities of research needs.

3.3 Temperature and Humidity

Many HVAC systems can control indoor humidity and temperature, which can in turn influence transmissibility of infectious agents. Although the weight of evidence at this time suggests that controlling relative humidity (RH) can reduce transmission of certain airborne infectious organisms, including some strains of influenza, this PD refrains from making a universal recommendation.

According to Memarzadeh (2011), in a review of 120 papers conducted on the effect of humidity and temperature on the transmission of infectious viruses, numerous researchers suggest that three mechanisms could potentially explain the observed influence of RH on transmission. One possible mechanism is slower evaporation from large droplets influenced by higher humidity that a lower humidity would more rapidly change them into droplet nuclei. Nicas and colleagues (2005) show by modeling that emitted droplets will evaporate to 50% of their initial diameter and that if the initial diameter is <20 µm this process will happen before the droplets fall to a surface. For larger diameters and higher humidity this does not happen quickly enough to change large droplets into droplet nuclei before they fall. Wang et al. (2005) found that people inhaled fewer droplets at a higher RH.

The second possible mechanism is that RH may act at the level of the host. Breathing dry air could cause desiccation of the nasal mucosa, which would in turn render the host more susceptible to respiratory virus infections. The third possible mechanism is that RH may act at the level of the virus particle to affect its virulence.

Yang and Marr (2012b) discuss in a minireview the complexities of the relationship between aerosolized viruses and RH, including multiple hypotheses such as water activity, surface inactivation, and salt toxicity, that may account for the association between humidity and viability of viruses in aerosols. They also propose their own hypothesis that changes in pH (induced by evaporation) within the aerosol compromise the infectivity. They conclude that the precise mechanisms underlying the relationship remain largely unverified; there are still large gaps in the literature, and a complete understanding will require more in-depth studies with collaboration across disciplines.

Memarzadeh (2011) further concludes that there is insufficient evidence to say that maintaining an enclosed environment at a certain temperature and at a certain RH, is likely to reduce the airborne survival and therefore transmission of influenza virus when compared with a similar environment that does not adhere to such tight control of indoor temperature and RH.

A sample of the findings of numerous individual studies follows.

Schaffer et al. (1976) revealed that viral transmission at low (<40%) and high (>80%) relative humidity was much higher than at medium relative humidity (about 50%).

Lowen et al. (2007) and Shaman and Kohn (2009) conclude that low humidity and low temperature strongly increase influenza transmission between guinea pigs and hypothesize this is caused by rapid formation of droplet nuclei and increased survival of the infectious agent. Lowen suggests that humidification of indoor air (particularly in places, such as nursing homes and emergency rooms, where transmission to those at high risk for complications is likely) may help decrease the spread and the toll of influenza during influenza season.

Yang et al. (2012a) studied the relationship between influenza A virus (IAV) viability over a large range of RH in several media, including human mucus. They found the relationship between viability and RH depends on droplet composition: viability decreased in saline solutions, did not change significantly in solutions supplemented with proteins, and increased dramatically in mucus. Thus, laboratory studies that do not use mucus may yield viability results that do not represent those of human-generated aerosols in the field. Their results also suggest that there exist three regimes of IAV viability defined by three different ranges of RH.

Noti et al. (2013) found that at low relative humidity (23%), influenza retains maximal infectivity (71% to 77%) and that inactivation (infectivity 16% to 22%) of the virus at higher relative humidity (43%) occurs rapidly (60 min) after coughing. This study used manikins and aerosolization in a nebulizer, using a cell culture medium.[7]

Another factor to consider before using higher indoor humidity to reduce airborne disease transmission is that it may interfere with the effectiveness of UVGI. Two studies with *S. marcescens* showed an increased survival in the presence of UV light at higher RH levels. This was suggested to be due to the protective effect of larger particle sizes, as evaporation would be less at these higher RH levels, thus indicating a protective effect of a thicker water coat against UV radiation (Tang 2009). Two other studies also show that UVGI is less effective at higher RH and suggest it is due to a change in DNA conformation (Peccia et al. 2001; Xu et al. 2005).

In addition to the above, there are comfort issues to be considered when selecting indoor temperature and humidity parameters for the operation of buildings. For instance, the optimum temperature to reduce the survival of airborne influenza virus may be above 30°C (86°F) at 50% rh (Tang 2009), which is not usually acceptable for human thermal comfort (ASHRAE 2013a). Furthermore, higher humidity increases the potential for mold and moisture problems (ASHRAE 2013b).

For all of the above reasons, this PD does not make a broad recommendation on indoor temperature and humidity for the purpose of controlling infectious disease. Practitioners may use the information above to make building design and operation decisions on a case-by-case basis.

3.4 Non-HVAC Strategies

Building owners and managers should understand that education and policies, such as allowing and encouraging employees to stay at home when ill, are more effective than any HVAC interventions. Administrative measures such as prompt identification of patients with

[7] Email correspondence with coauthor Linsley on November 22, 2013, explains that the medium used was complete Dulbecco's modified Eagle's medium (CDMEM), which consists of Dulbecco's modified Eagle's medium, 100 U/ml penicillin G, 100 µg/ml streptomycin, 2 mM L-glutamine, 0.2% bovine serum albumin, and 25 mM HEPES buffer.

influenza-like illness and use of source control (respiratory hygiene[8]) are also important, especially in health-care settings. In some cases, high-efficiency personal protective equipment (e.g., N95 respirators [CDC 2014]) may be considered.

Vaccination, a general public health measure, is efficient and effective for many diseases, in part because it does not rely on facility operation and maintenance. On the other hand, vaccination is sometimes unavailable or insufficiently effective. For example, despite an average effectiveness of 60% to 70% for influenza (Osterholm et al. 2012), effectiveness can decline to as low as 10% in "bad match" years (Belongia et al. 2009). In such a case, HVAC interventions may be more important, even though they are less well understood. For example, recent modeling (Gao et al. 2012) suggests that dilution ventilation can support pandemic management as an essential complement to social distancing and can reduce the necessity of school closures.

For current information on these nonventilation strategies, readers should consult websites maintained by public health and safety authorities, such as the Centers for Disease Control and Prevention (CDC), Department of Homeland Security (DHS), flu.gov, the official influenza website of the U.S. Department of Health and Human Services (USDHHS), and the World Health Organization (WHO) (in particular, www.who.int/influenza/preparedness/en/, WHO 2014).

3.5 Emergency Planning

Four worldwide (pandemic) outbreaks of influenza occurred in the twentieth century: 1918, 1957, 1968, and 2009 (BOMA 2012). Not classified as true pandemics are three notable epidemics: a pseudopandemic in 1947 with low death rates, an epidemic in 1977 that was a pandemic in children, and an abortive epidemic of swine influenza in 1976 that was feared to have pandemic potential. The most recent H1N1 pandemic in 2009 resulted in thousands of deaths worldwide but was nowhere near the death toll of the 1918 Spanish flu, which was the most serious pandemic in recent history and was responsible for the deaths of an estimated more than 50 million people. There have been about three influenza pandemics in each century for the last 300 years. If a new outbreak occurs and is caused by a microorganism that spreads by the airborne route, fast action affecting building operations will be needed.

Some biological agents that may be used in terrorist attacks are addressed elsewhere (USDHHS 2002, 2003).

Engineers can support emergency planning by understanding the design, operations, and maintenance adequacy of buildings for which they are responsible and helping emergency planners mitigate vulnerabilities or develop interventions. For instance, there may be means to increase dilution ventilation, increase relative humidity, or quickly apply upper-room UVGI in an emergency room, transportation waiting area, shelter, jail, and crowded entries to buildings in an emergency, provided that this does not create either (1) flow of air to less contaminated areas or (2) conditions of extreme discomfort. In other situations, curtailing ventilation or creating pressure differentials may be the appropriate strategy. Actions should be thoughtfully undertaken in collaboration with infection control professionals and based on knowledge of the system and its operation and the nature and source of the threat.

[8] Respiratory hygiene includes behavior such as coughing into and disposing of facial tissue or putting masks on ill individuals to prevent dissemination of particles (CDC 2001; Siegel et al. 2007).

At the building level, engineers may provide support by (1) identifying vulnerabilities with air intake, wind direction, shielding, etc.; (2) identifying building systems and safe zones in the general building environment; (3) identifying approaches to interrupting air supply to designated "shelter-in-place" locations in general building environments; and 4) identifying cohorting possibilities for pandemic situations so that whole areas of a hospital may be placed under isolation and negative pressure. For guidance, see "Airborne Infectious Disease Management Manual: Methods for Temporary Negative Pressure Isolation" (MDH 2013).

Building operators and engineers should have information about how to contact public health authorities and other emergency planning support (BOMA 2012).

4. RECOMMENDATIONS

Some infectious diseases are transmitted through inhalation of airborne infectious particles, which can be disseminated through buildings by pathways that include ventilation systems. Airborne infectious disease transmission can be reduced using dilution ventilation; directional ventilation; in-room airflow regimes; room pressure differentials; personalized ventilation;[9] and source capture ventilation, filtration, and UVGI.

Engineers play a key role in reducing disease transmission that occurs in buildings. Goal 11 of the ASHRAE Research Strategic Plan for 2010–2015, "Understand Influences of HVAC&R on Airborne Pathogen Transmission in Public Spaces and Develop Effective Control Strategies," recognizes the key role that ASHRAE plays (ASHRAE 2010).

Societal disruption from epidemics and the unexpected transmission of disease in workplaces, public access facilities, and transportation warrants further research on the effectiveness of engineering controls.

ASHRAE recommends the following:

- All facility designs should follow the latest practice standards, including but not limited to ASHRAE Standard 55 for thermal conditions (ASHRAE 2013a); ventilation Standards 62.1 (ASHRAE 2013b), 62.2 (ASHRAE 2013c), and 170 (ASHRAE 2008; and FGI *Guidelines for Design and Construction of Health Care Facilities* (FGI 2010).
- Commissioning, maintenance, and proper operation of buildings, and, in particular, systems intended to control airborne infectious disease, are necessary for buildings and systems to be effective.
- Building designers, owners, and operators should give high priority to enhancing well-designed, installed, commissioned, and maintained HVAC systems with supplemental filtration, UVGI, and, in some cases, to additional or more effective ventilation to the breathing zone. Filtration and UVGI can be applied in new buildings at moderate additional cost and can be applied quickly in existing building systems to decrease the severity of acute disease outbreaks. *Indoor Air Quality Guide* (ASHRAE 2009) contains information about the benefits of and techniques for accomplishing these enhancements.
- New health-care facilities, including key points of entry such as emergency, admission, and waiting rooms; crowded shelters; and similar facilities should incorporate the infrastructure to quickly respond to a pandemic. Such infrastructure might include, for

[9] For the purpose of this PD, personalized ventilation is a mechanical ventilation strategy of supplying air directly to the occupant's breathing zone without mixing it with contaminated room air.

example, HVAC systems that separate high-risk areas; physical space and HVAC system capacity to upgrade filtration; the ability to increase ventilation even as high as 100% outdoor air; the ability to humidify air; and receptacles at the upper room and ceiling heights of at least 2.4 m (8 ft) to enable effective upper-room UVGI. Once the building is in operation, rapid availability of filter elements and upper-room UV fixtures should be arranged for rapid deployment in an emergency.

- Infection control strategies should always include a bundle of multiple interventions and strategies (not just ventilation).
- Multidisciplinary teams of engineers, building operators, scientists, infection prevention specialists, and epidemiologists should collaborate to identify and implement interventions aimed at mitigation of risk from airborne infectious disease and understand the uncertainty of the effectiveness of current practice recommendations.
- Building operators and engineers have a role to play in planning (BOMA 2012) for infectious disease transmission emergencies.
- Committees that write and maintain practice standards and guidelines for critical environments such as health-care facilities and crowded shelters should consider recent research and understanding of infectious disease control and consider adding or strengthening requirements for the following:
  - Improved particle filtration for central air handlers
  - Upper-room and possibly other UVGI interventions or at least the ceiling heights and electrical infrastructure to quickly deploy them
  - The ability to quickly and temporarily increase the outdoor air ventilation rate in the event of an infectious disease outbreak
  - Avoiding unintended adverse consequences in infectious disease transmission resulting from lower ventilation levels motivated solely by reduced energy consumption
- Airborne infectious disease researchers should receive input on study design, methodology, and execution from many discipline experts (including engineers, infection prevention specialists, health-care epidemiologists, public health officials, and others) to provide a better picture of the interplay between building systems and disease transmission.
- Controlled intervention studies should be conducted to quantify increases or decreases in disease propagation resulting from various ventilation rates.
- Controlled intervention studies should be conducted to quantify the relative airborne infection control performance and cost-effectiveness of specific engineering controls individually and in combination in field applications. Table 1 summarizes the research priority and applicable occupancy categories for each strategy. Studies should include occupancies at high-risk (such as jails, homeless shelters, schools, nursing homes, and health-care facilities).
- Research should quantify rates of airborne removal by filtration and inactivation by UVGI strategies specific to individual microorganisms and should field validate in real facilities the effectiveness of these interventions in preventing transmission.
- Research should be conducted to better characterize the particle size distributions of coughed materials, which are thought to encompass a broad range of diameters.

Table 1 Airborne Infectious Disease Engineering Control Strategies: Occupancy Interventions and Their Priority for Application and Research

Strategy	Occupancy Categories Applicable for Consideration*	Application Priority	Research Priority
Dilution ventilation	All	High	Medium
Temperature and humidity	All except 7 and 11	Medium	High
Personalized ventilation	1, 4, 6, 9, 10, 14	Medium	High
Local exhaust	1, 2, 8, 14	Medium	Medium
Central system filtration	All	High	High
Local air filtration	1, 4, 6, 7, 8 10	Medium	High
Upper-room UVGI	1, 2, 3, 5, 6, 8, 9, 14	High	Highest
Duct and air-handler UVGI	1, 2, 3, 4, 5, 6, 8, 9, 14	Medium	Highest
In-room flow regimes	1, 6, 8, 9, 10, 14	High	High
Differential pressurization	1, 2, 7, 8 11, 14	High	High

Note: In practical application, a combination of the individual interventions will be more effective than any single one in isolation.
*Occupancy Categories:

1. Health care (residential and outpatient)
2. Correctional facilities
3. Educational < age 8
4. Educational > age 8
5. Food and beverage
6. Internet café/game rooms
7. Hotel, motel, dormitory
8. Residential shelters
9. Public assembly and waiting
10. Transportation conveyances
11. Residential multifamily
12. Retail
13. Sports
14. Laboratories where infectious diseases vectors are handled

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Request Form for a revised ASHRAE Position Document
To: TECHNOLOGY COUNCIL Document Review Subcommittee
Originator: Environmental Health Committee
Date: 30 January 2017

Title:
Airborne Infectious Diseases

Purpose:
Inform the ASHRAE membership and the public of the impact of HVAC systems on exposures to airborne infectious diseases such as SARS, TB, Pandemic Flu (Avian Flu etc.) ~~and Legionellosis.~~

Scope:
Provide the membership of ASHRAE and other interested persons with information on the health consequences of exposure to Airborne Infectious Diseases, and on the implications for the design, installation and operation of HVAC systems.

Attachment E

ASHRAE Position Document on

CLIMATE CHANGE

Approved by ASHRAE Board of Directors
June 24, 2009

Reaffirmed by ASHRAE Technology Council
~~February~~ Month ~~25~~X, ~~2013~~201X

Expires ~~February~~ Month ~~25~~XX, ~~2016~~201X

COMMITTEE ROSTER

The ASHRAE Position Document on "Climate Change" was developed by the Society's Climate Change Position Document Committee.

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HISTORY

of

REVISION / REAFFIRMATION / WITHDRAWAL DATES

The following summarizes the revision, reaffirmation or withdrawal dates:

7/2/1992 – BOD approves Position Document titled *Climate Change*

6/24/1999 – BOD approves revision to Position Document titled *Climate Change*

7/1/2004 – BOD approves revision to Position Document titled *Climate Change*

6/24/2009 – BOD approves revision to Position Document titled *Climate Change*

2/25/2013 – Technology Council approves reaffirmation of Position Document titled *Climate Change*

XX/XX/2017 – Technology Council approves reaffirmation of Position Document titled *Climate Change*

Note: Technology Council and the cognizant committee recommend revision, reaffirmation or withdrawal every 30 months.

CONTENTS

ASHRAE Position Document on "Climate Change"

ABSTRACT

Worldwide concern for changes in global climate has escalated as the scientific evidence has become more definitive, linking increased concentrations of atmospheric greenhouse gases with increased global temperatures. The recent entry into effect of the Paris Agreement ~~on~~ and the adoption of the Kigali Amendment to the Montreal Protocol show that broad international consensus exists on the need for action. ASHRAE's direct interest in, and concern regarding, greenhouse gases and climate change is reflected in its activities in HVAC&R technologies and applications. HVAC&R systems contribute to greenhouse gas emissions through refrigerant release (CFCs, HCFCs, and HFCs) and through CO_2 releases associated with the energy needed for operating buildings and building systems. As a result ASHRAE and its members have an important role in mitigating and adapting to climate change. ASHRAE is committed to a leadership role in responding to and reducing building climate change footprints. In support of this commitment, ASHRAE continuously advances the HVAC&R field by performing research and developing guides and standards for designing systems which minimize energy use and reduce emissions of refrigerants.

Commented [HS1]: Dave Godwin: Or were you planning to add a date here? It is 11/4/16; see http://unfccc.int/paris_agreement/items/9485.php

EXECUTIVE SUMMARY

Policy focus on global climate change has significantly increased in the past decade with greater confidence in the projected effects of climate change.~~, along with science certainty~~. Heating, ventilating, air conditioning and refrigerating (HVAC&R) systems, and total buildings, offer significant opportunities for climate change mitigation and adaptation, making this a key area for ASHRAE and its members.

In each of its quadrennial reports, the Intergovernmental Panel on Climate Change (IPCC) has noted increased atmospheric levels of carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O~~),~~ While the abundance of chlorofluorocarbons (CFCs), which have extremely high global warming potential (GWP), has been decreasing, hydrochlorofluorocarbons (HCFCs), which are transitional substitutes for CFCs, continues to increase. Most hydrofluorocarbons (HFCs), many perfluorocarbons (PFCs), nitrogen trifluoride (NF3) and sulfur hexafluoride (SF6) all continue to increase relatively rapidly, but their contributions to radiative forcing are less than 1% of the total (Hartmann, et al.).~~and the industrial gases chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs) in recent decades (IPCC 2007a).~~ The IPCC predicts continuing increases in global temperatures resulting from these greenhouse gases.

Commented [DSG2]: Either "(HCFCs)…continue ~~continues~~ to increase" or "the abundance of hydrochlorofluorocarbons (HCFCs) … continues to increase" or "while that of hydrochlorofluorocarbons … continues to increase."

On October 15, 2016 the Parties to the Montreal Protocol met in Kigali, Rwanda and adopted a new amendment to gradually phase down the use of HFCs over the next 20-30 years. This means that in most applications HFCs will be gradually replaced by the next generation of products with much lower GWP including hydrofluoroolefins (HFOs), hydrocarbons and other gases.

Buildings and their HVAC&R systems contribute to greenhouse gas emissions through electricity consumption largely generated from combustion of fossil fuels (resulting in CO2 emissions) and from industrial gas emissions. Rigorous energy and resource conservation measures can reduce the building climate change footprint resulting from direct emissions and the approximately ~~39~~19% of total societal CO2 emissions resulting from building energy consumption. ~~The global building sector has the greatest potential for economical greenhouse gas mitigation between now and 2030 (IPCC, 2007b).~~

ASHRAE is committed to a leadership role in responding to and reducing building climate change footprints.

1. THE ISSUE

Worldwide concern for changes in the global climate has escalated as the scientific evidence has become more definitive, linking increased concentrations of atmospheric greenhouse gases with increased global temperatures. The Kyoto Protocol adopted in 1997 (UNFCCC 2012), with entry into force on 16 February 2005; the Paris Agreement, which entered into force on 4 November 2016; ~~,~~ and the ongoing international efforts to address this issue are responses reflecting this heightened ~~concern~~ level of concern.

The global climate is controlled by the equilibrium between incoming solar energy and outgoing radiated energy from the earth. This state of equilibrium is dependent on the interactions between natural processes on the land and in the oceans and the earth's atmosphere. Approximately one-third of the solar radiation (sunlight) reaching the earth is reflected back into space by clouds, small particles in the atmosphere, and the earth's surface. The remaining energy is absorbed by the earth's surface and by atmospheric gases. Greenhouse gases, such as carbon dioxide (CO_2) and water vapor, as well as small particles, trap heat—maintaining the average temperature of the earth's surface about 34°C (61°F) warmer than it would be if these gases and particles were not present ~~(IPCC 2007a)~~.

Increases in greenhouse gases in the atmosphere ~~will~~ are altering the historic interactions between the earth and the sun's radiation. Along with CO_2, other significant anthropogenic greenhouse gases include methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), nitrogen trifluoride (NF_3), and sulfur hexafluoride (SF_6). These greenhouse gases impact penetration of the atmosphere by infrared radiation emitted by the earth's surface. Greater concentration levels of these gases in the atmosphere increase the energy-trapping capabilities of the lower troposphere.

Commented [HS3]: David Godwin - I think we are distinguishing between all GHGs (including the most abundant, water vapor) and man-made well mixed GHGs.

While climate change and variability occur naturally, the current concern stems from the potential for human activities to enhance the greenhouse effect. If unmitigated, by 2100, these releases of greenhouse gases due to human activity could lead to concentrations ~~by 2100~~ that are more than double preindustrial values. This is forecast to result in a climate shift beyond any experienced in recorded human history. Such CO_2 levels would be well in excess of those determined from geological records for the past several hundred thousand years (Hansen et al. 2008).

ASHRAE's direct interest in, and concern regarding, greenhouse gases and climate change is reflected in its activities in ~~heating, ventilating, air conditioning and refrigerating (~~HVAC&R~~)~~ technologies and applications. HVAC&R systems contribute to greenhouse gas emissions through refrigerant release (CFCs, HCFCs, and HFCs) and through CO_2 releases associated with the energy needed for operating buildings and building systems. As a result, ASHRAE and its members have an important role in mitigating and adapting to climate change.

2. BACKGROUND

2.1 Summary of IPCC (Climate Change) Findings

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 to assess climate

change information and to provide reliable, relevant, ~~(and~~ unbiased~~)~~ information on all climate change science aspects. The IPCC is an independent international body, cosponsored by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO). The IPCC ~~Fourth~~ Fifth Assessment Report, released in four parts between September 2013 and November 2014 was authored by over 830 experts (IPCC, 2015).~~: Climate Change 2007 (AR4) (2007a, 2007b, 2007c, 2007d) was prepared and reviewed by more than 2000 experts.~~

According to the IPCC (~~2007a~~2013), the atmospheric carbon dioxide concentration has increased from a preindustrial value of about 280 ppm to ~~379~~ 391 ppm in 201~~105~~ (+~~35~~40%)—primarily from burning of fossil fuels and from land-use change. The CH4 abundance of about ~~1774~~ 1803 parts per billion (ppb) is about 150% more than its preindustrial value.~~more than double its preindustrial value~~. The concentration of N2O in ~~2005~~ 2011 was ~~319~~ 324 ppb, about ~~18~~20% higher than its preindustrial value. ~~The concentration of HFCs has been rising steadily over the last decade as these chemicals have moved into the marketplace to replace the Montreal Protocol gases, CFCs and HCFCs. HFC-134a, for example, grew from 1 part per trillion in 1995 to 35 part per trillion ten years later. All of the halocarbons (CFCs, HCFCs, and HFCs) contribute to global warming. Even though CFCs and HCFCs are being phased out, their present atmospheric concentrations account for 95% of the halocarbon component of warming.~~

~~Although the international focus on climate change is centered in the United Nations Framework Convention on Climate Change, "The Montreal Protocol… is mitigating climate emissions by 11 billion metric tons of CO2 equivalent between 1990 and 2010, delaying climate change up to 12 years…. Overall, protecting the ozone layer is delaying climate change 35-41 years when earlier voluntary efforts and national measures are considered along with the Montreal Protocol" (Velders et al. 2007).~~

Environmental impacts from increased greenhouse gas concentrations have also been observed and reported by the IPCC (~~2007c~~2013). Between 1880 and 2012, the globally averaged combined land and ocean surface temperature warmed 0.85 (0.65 to 1.06) °C. The increase is 0.78 (0.72 to 0.85) °C when the average for the period 1850 to 1900 is compared to the average for the period 2003-2012. Over the last two decades, the Greenland and Antarctic ice sheets have been losing mass, glaciers have continued to shrink almost worldwide, and Arctic sea ice and Northern Hemisphere spring snow cover have continued to decrease in extent.~~Over the 100-year period between 1906 and 2005, the earth's surface temperature has risen 0.07°C (0.126°F) per decade (±0.02°C/decade [±0.036°F/decade]). The rate for the 50 years from 1955 to 2005 has been 0.13°C (0.234°F) per decade, with the rate increasing to 0.18°C (0.324°F) per decade in the 1980–2005 period. Since 1961, the global mean sea level has risen at an average rate of 1.8 mm/yr (with error bounds of 1.2 to 2.3 mm/yr) (0.07 in./yr [with error bounds of 0.05 to 0.09 in./yr]), and since 1993 at an average annual rate of 3.1 mm/yr (i.e., 2.4 to 3.8 mm/yr) (0.12 in./yr [i.e., 0.09 to 0.15 in./yr]).~~

Even if greenhouse gas emissions were held constant at today's level, warming would continue for several more decades until the earth-atmosphere system reached temperature equilibrium. Carbon dioxide and some of the other greenhouse gases will remain in the atmosphere for many decades or even centuries. Therefore, existing atmospheric greenhouse gas impacts will continue for decades and the effects will persist for centuries. The magnitude, timing, and regional characteristics of end-of-century climate change are uncertain because of uncertainty about future greenhouse gas emissions and about carbon cycle feedbacks.

Commented [HS4]: David Godwin - This is hardly a parenthetical.

Commented [DSG5]: 150% of or 150% more than the pre-industrial value? Figure 2 from this source makes it look like 150% more than (from ~500-700 ppb to ~1800 ppb): https://www.epa.gov/climate-indicators/climate-change-indicators-atmospheric-concentrations-greenhouse-gases

Commented [DSG6]: I am not sure the average reader would understand the differences in these two sentence. It could easily be misunderstood to indicate that global warming is slowing down. Would recommend picking one sentence only.

The IPCC analyzed a variety of Representative Concentration Pathways to project changes in the climate system. Projected changes in global mean surface air temperature and global mean sea level rise are provided in Appendix A.

~~Using several different climate models, the IPCC (2007b) analyzed a variety of future CO2 emissions scenarios ranging from CO2 emissions peaking in 2030 to continued emission growth out to 2100. Over the range of scenarios, the mean global temperature increase is projected to be in the range of 2.0°C to 6.1°C (3.6°F to 11°F) by 2100; and the mean sea level rise is predicted to be in the range of 0.4 to 3.7 m (1.3 to 12.1 ft), primarily due only to thermal expansion. The annex at the end of this document provides the IPCC's assessment of global impacts from climate change.~~

2.2 Excerpts from the ~~IPCC Assessment Report 4 [~~AR5~~4]~~ Synthesis Report

The IPCC, in the ~~AR4~~ AR5 Synthesis Report(~~2007d~~2014c), states that:

> "Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems. Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen. Each of the last three decades has been successively warmer at the Earth's surface than any other preceding decade since 1850."
>
> ~~[The term] 'Climate change' in IPCC usage refers to a change in the state of the climate that can be identified… by changes in the mean and/or variability of its properties and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity….~~

In the discussion of ~~Causes~~ causes of ~~Change~~change, the Synthesis Report says that~~:~~ "Anthropogenic greenhouse gas emissions have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever. This has led to atmospheric concentrations of carbon dioxide, methane and nitrous oxide that are unprecedented in at least the last 800,000 years. Their effects, together with those of other anthropogenic drivers, have been detected throughout the climate system and are extremely likely to have been the dominant cause of the observed warming since the mid-20th century."~~"There is *very high confidence* that the global average net effect of human activities since 1759 has been one of warming … " and further that " Most of the observed increase in global average temperature since the mid-20th century is *very likely* due to the observed increase in anthropogenic [caused by humans] GHG concentrations…"[1]~~

In regards to future climate changes, the Synthesis Report states, "Continued emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems. Limiting climate change would require substantial and sustained reductions in greenhouse gas emissions which, together with adaptation, can limit climate change risks."

~~In the discussion of Observed Changes, the Synthesis Report says that:~~

> ~~Warming of the climate system is unequivocal, as is now evident from observations of~~

~~[1] The italics are those of the IPCC and are used to identify terms where they have provided very explicit interpretations in the Synthesis Report.~~

~~increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level.~~

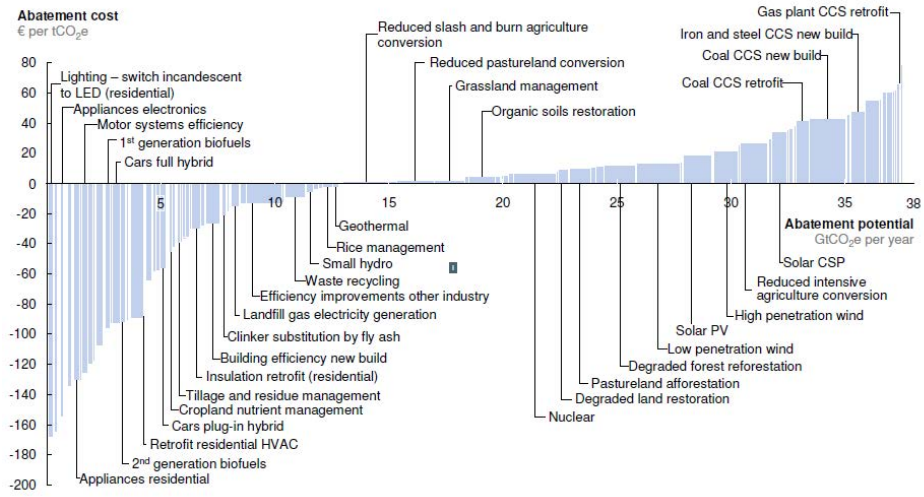
~~In the discussion of responses to climate change, the Synthesis Report says "A wide range of mitigation options is currently available or projected to be available by 2030 in all sectors" and further that~~

> ~~Mitigation efforts and investments over the next two to three decades will have a large impact on opportunities to achieve lower stabilisation levels. Delayed emissions reductions significantly constrain the opportunities to achieve lower stabilisation levels and increase the risk of more severe climate change impacts.~~

2.3 Relevance to HVAC&R

HVAC&R systems contribute to greenhouse gas emissions through refrigerant releases and through CO2 releases resulting from the energy used to power the HVAC&R systems. This energy can be provided by electricity, where the CO2 is released during the generation of the electricity, or by the on-site combustion of fossil fuels. As a result of these factors, ASHRAE and its more than 50,000 members have the opportunity to make a marked contribution to reducing greenhouse gas emissions.

Figure 1 summarizes the maximum potential of technical abatement measures to reduce GHG emissions at a cost up to 80 euros per ton of CO2 equivalent avoided emissions. The range of emission reduction actions reflects what is possible with available technologies or the potential that has a high degree of certainty in a 2030 time horizon. The least cost options on the left of the abatement curve mostly relate to energy use in buildings, which are within the responsibilities of ASHRAE and its members. The negative costs associated with HVAC&R related technical abatement measures (e.g., insulation retrofit, lighting, HVAC) highlight the opportunity for the sector to contribute to global emission reduction compared to the investment-intensive measures on the right of the curve.



Note: The curve presents an estimate of the maximum potential of all technical GHG abatement measures below €80 per tCO_2e if each lever was pursued aggressively. It is not a forecast of what role different abatement measures and technologies will play.
Source: Global GHG Abatement Cost Curve v2.1

Figure 1: Global GHG abatement cost curve beyond business-as-usual (BaU)
(From McKinsey and Company, 2010)

Refrigerants play a vital role in society by their use in systems to preserve food and medicine, produce ice, to condition space for human welfare and controlled environments, and to support industrial processes. The impact of HFCs on climate change can be minimized by reducing their release from HVAC&R systems. This is achieved by incorporating rigorous refrigerant conservation measures during design, manufacture, installation, operation, service, recovery and ultimate disposal of equipment. Substitution of low global warming potential refrigerants such as natural refrigerants or hydrofluoroolefin (HFO) refrigerants for HFCs may also be an option, but only when energy efficiency and safety are not compromised. The benefits of reducing refrigerant emissions extend beyond climate change since refrigerant loss during HVAC&R operation reduces system performance and reliability and may increase energy demand and operational costs.

Table 1 ~~(EPA 2012)~~ presents information on the amount and relative magnitude of HFC emissions in the United States from HVAC&R systems and other applications as these gases~~refrigerants~~ have replaced the ozone-depleting substances (CFCs and HCFCs) over the last 20 years. HFC ~~refrigerant~~ release is a relatively small component of total greenhouse gas emissions, contributing only 2.43% ~~1.6%,~~ of total greenhouse gas emissions; ~~and~~ the majority of that is from ~~the transportation sector, not~~ the buildings sector. (From U. S. EPA, Inventory of U. S. Greenhouse Gas Emissions and Sinks, 1990-2014.)

Commented [DSG7]: Note this percent is different from the total in Table 1 because this number includes other HFC sources, primarily HFC-23 emitted from HCFC-22 production.

Table 1: U.S. Annual Emissions of HFCs (Tg CO_2 eq) from Their Use as ODS Substitutes
(From U.S. EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2014*)
~~(Excerpted from Table 2-14 EPA, 2012)~~

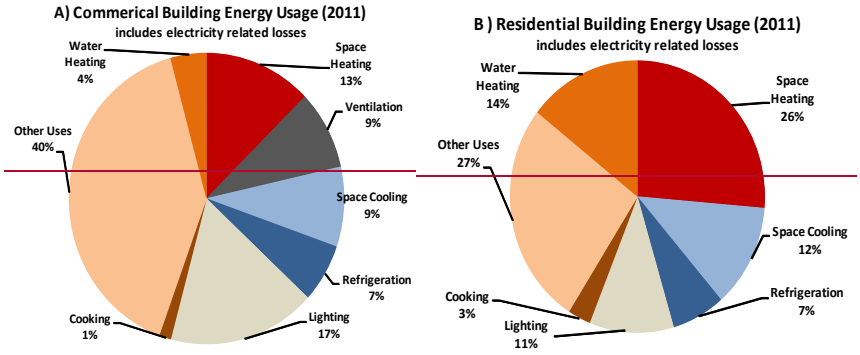
Sector	1990	~~1995~~	~~2000~~	2005	2010	Percent*
Transportation	+	~~18.6~~	~~55.7~~	67.1~~72.9~~	65.6~~58.4~~	0.69%~~0.9%~~
Industrial	+	~~1.2~~	~~3.2~~	7.3~~6.4~~	15.3~~13.5~~	0.32%~~0.2%~~
Commercial	+	~~0.7~~	~~5.4~~	17.6~~12.3~~	38.5~~23.6~~	0.72%~~0.3%~~
Residential	0.3	~~8.1~~	~~10.1~~	7.7~~7.3~~	21.8~~19.1~~	0.62%~~0.3%~~
Total	0.3	~~28.5~~	~~74.4~~	99.7~~98.9~~	141.2~~114.6~~	2.35%~~1.7%~~

+ Does not exceed 0.05 Tg CO_2 Eq.

* Percent of all GHG emissions for year 2010

Figure 2 (EIA 2015) quantifies the component of building energy usage resulting from HVAC&R systems. Buildings represent a significant portion of global energy consumption. In the U.S., buildings account for approximately 40% of total primary energy use and 39% of CO2 emissions (approximately equal to the combined total emissions of Japan, France, and the United Kingdom).

~~Figure 1: Impacts of HVAC&R Services on U.S. Building Energy Usage~~
~~(Excerpted from Tables A4 and A5, EIA, 2012)~~



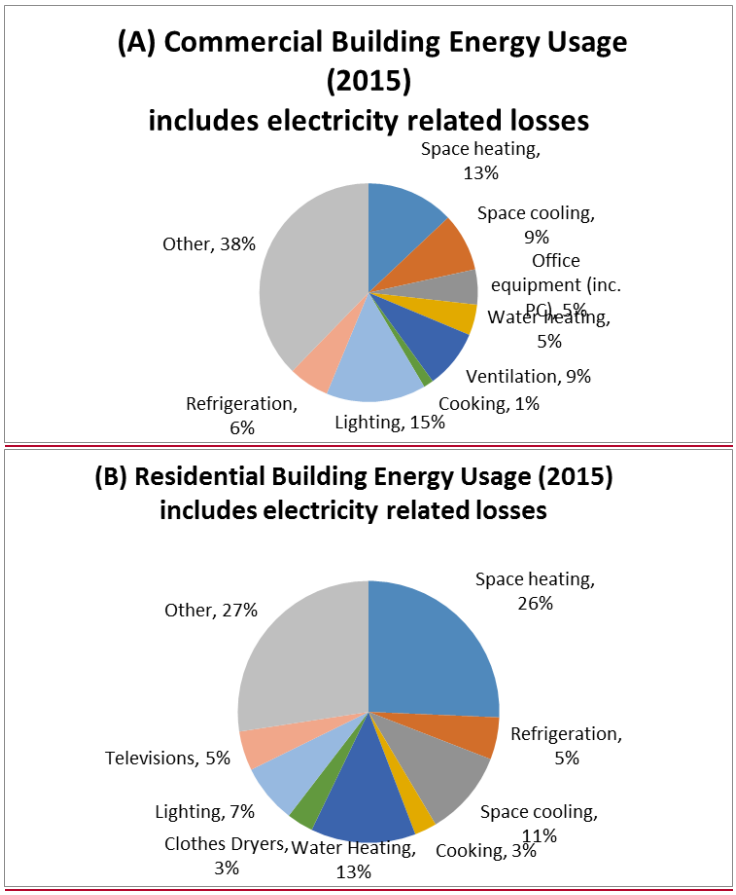


Figure 2: Impacts of HVAC&R Services on U.S. Building Energy Usage
(From EIA, *Annual Energy Outlook, 2015*)

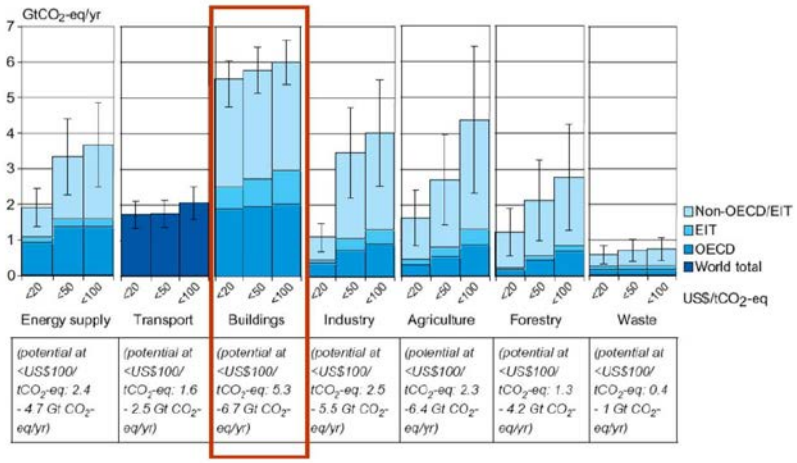
~~Figure 1 (EIA 2012) quantifies the component of building energy usage resulting from HVAC&R systems. Buildings represent a significant portion of global energy consumption. In the U.S., buildings account for approximately 40% of total primary energy use and 39% of CO2 emissions (approximately equal to the combined total emissions of Japan, France, and the United Kingdom). The IPCC (2007b) indicated that the buildings sector has the greatest potential for economical mitigation of greenhouse gas emissions between now and 2030 with costs ranging from $20 to $100 per metric tons of CO2 equivalent, as shown in Figure 2 (with special highlight on the buildings sector portion).~~

Minimizing energy use by HVAC&R systems involves optimizing energy efficiency at the point of design and ensuring efficiency through controlled operation and equipment maintenance. Operational issues such as temperature setpoints and setbacks, natural ventilation and energy

recovery, and integrated building operations have an impact on HVAC&R energy requirements and performance. Reducing the energy consumption of equipment, systems, and buildings and informing owners and operators of the importance of their actions on energy consumption can have a significant environmental benefit in the buildings sector. ASHRAE standards and guidelines provide the tools for the design and application of comprehensive energy-savings techniques in buildings and for the selection and proper use of efficient equipment and system integration. See Appendix B for a list of related ASHRAE documents.

Other design and construction choices influence HVAC&R systems and their associated greenhouse gas emissions. These include factors such as building envelope design decisions, types and amounts of insulating materials, lighting and daylighting, glazing and fenestration, internal plug loads, and other features associated with the building envelope and loads.

To minimize the greenhouse gas emissions associated with HVAC&R equipment, ASHRAE must form linkages with organizations representing other segments of the building industry. ~~The~~ ASHRAE's Advanced Energy Design Guides are examples of successful collaborations on comprehensive building energy savings.



~~Figure 2: Economic Mitigation Potential by 2030~~
~~(Figure SPM.6 from IPCC, 2007b)~~

2.4 Recent regulatory developments

Two major regulatory developments took place in October of 2016:

- The entry into force of the Paris Agreement, under which UN member countries take on commitments to reduce their greenhouse gas emissions. This agreement is not legally binding.
- The adoption of the Kigali Amendment to the Montreal Protocol which provides schedules for developed and developing countries to gradually phase down their production and consumption

of HFCs over the period of 20-30 years. Upon the amendment's entry into force these schedules will become legally binding.

ASHRAE supports both developments.

The Kigali Amendment's approach is to require nations to cap and phase down HFC production and consumption, in CO2-equivalent terms, over time. It does not set specific product bans although nations may choose to adopt bans of certain HFCs in certain products to ease compliance with the Amendment.

The Kigali Amendment is supported by both the industry and the environmental community.

The Kigali Amendment will result in gradual conversion of HVAC equipment using HFCs to the next generation of low GWP gases, including HFOs, hydrocarbons, CO2 and others. The new gases have different properties (some are flammable) and will require more research, testing and training before they are widely adopted.

Commented [DSG8]: Below is a sentence that industry and environmental community support Kigali. ASHRAE released press releases expressing their support of Kigali. Likely similar statements were made after Paris. If so, a simple statement of ASHRAE's support should be stated, probably in lieu of or at least before a statement speaking on behalf of the industry and environmental community.

Commented [DSG9]: "This approach" is vague. I don't know the difference between a PD and a special publication. A PD should probably only discuss whether ASHRAE itself supports the Amendment or not, but perhaps this statement is ok in a special publication.

Commented [DSG10]: I moved this statement about the effect below the description of what Kigali does and does not do.

3. RECOMMENDATIONS

ASHRAE holds a strong position that:

- Climate change is the most formidable environmental challenge ever faced by society.
- Opportunities exist within the HVAC&R industry to provide solutions to reduce greenhouse gas emissions. These include refrigerant selection and practices, demand load reductions, energy efficiency, and use of renewable energy.
- ASHRAE members and staff need to become actively involved worldwide with policy-setting entities to encourage sound, balanced, and innovative actions to address long-range environmental problems and objectives.

ASHRAE recommends that further research be conducted on:

- Improving energy efficiency/utilization in HVAC&R technology to minimize energy-use CO2 emissions.
- Design and integration of all building systems and components to improve overall energy performance.
- Improving analysis tools to help engineers, designers, and owners make choices that are economically and environmentally sound over the building lifetime.
- Properties of the next generation refrigerant gases and the necessary design changes to use them safely
-

ASHRAE is committed to:

- Taking a leadership role in responding to climate change by developing and achieving ASHRAE goals such as those outlined in ASHRAE Vision 2020: Producing Net Zero Energy Buildings (2008) and in ASHRAE's Sustainability Roadmap (2006).
- Developing strategic collaborations with other societies and organizations in order to provide comprehensive approaches to climate change.
- Developing and adopting designs, materials, components, systems, and processes that minimize environmental impacts, including climate change.

- Promoting the use of life-cycle, environmental, and economic impact assessments in HVAC&R design and operation.
- Developing and disseminating standards and guidelines supporting the minimization of greenhouse gas emissions by HVAC&R systems and the buildings sector.
- Informing designers and decision makers about practices that lower the risk of environmental degradation and its damaging effects on health and the economy worldwide through activities such as the development of green building design guides.
- Educating building owners and operators on effective use of life-cycle cost techniques to empower them to make the best investment decisions.
- Recognizing and promoting case studies of high-performance buildings that achieve high levels of energy efficiency and significant reductions in environmental impact.
- Working with educators to incorporate sustainability and energy conservation practices into the curriculum of engineering and design schools.
- Working with educators and school board administrators to improve science, technology, engineering, and mathematics education across all grade levels to raise scientific literacy and public recognition of energy-related issues.
- Participate in research and testing required to implement transition to more climate friendly technologies.

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IPCC. ~~2007b~~2013. Mitigation of Climate Change. Contribution of Working Group II to the ~~Fourth~~ Fift Assessment Report of the Intergovernmental Panel on Climate Change. Geneva: International Governmental Panel on Climate Change.

IPCC. ~~2007c~~2014c. Impacts, Adaptation, and Vulnerability. Contribution of Working Group III to the ~~Fourth~~ Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva: International Governmental Panel on Climate Change.

IPCC. ~~2007d~~2014c. Climate Change ~~2007~~2013-2014: Synthesis Report. Contribution of Working Groups I, II and III to the ~~Fourth~~ Fifth Assessment Report of the

Commented [HS11]: Update reference

Commented [HS12]: Update reference

Intergovernmental Panel on Climate Change. Geneva: International Governmental Panel on Climate Change.

UNFCC. 2012. United Nations Framework Convention on Climate Change 2012. http://unfccc.int/kyoto_protocol/items/2830.php.

~~Velders, G.J.M., S.O. Anderson, J.S. Daniel, D.W. Fahey, and M. McFarland. 2007. The Importance of the Montreal Protocol in Protecting Climate. Proceedings of the National Academy of Sciences 104(12):4814–19.~~

Commented [HS13]: Need to match reference in text to appropriate report

APPENDIX A
GLOBAL AVERAGE TEMPERATURE CHANGE

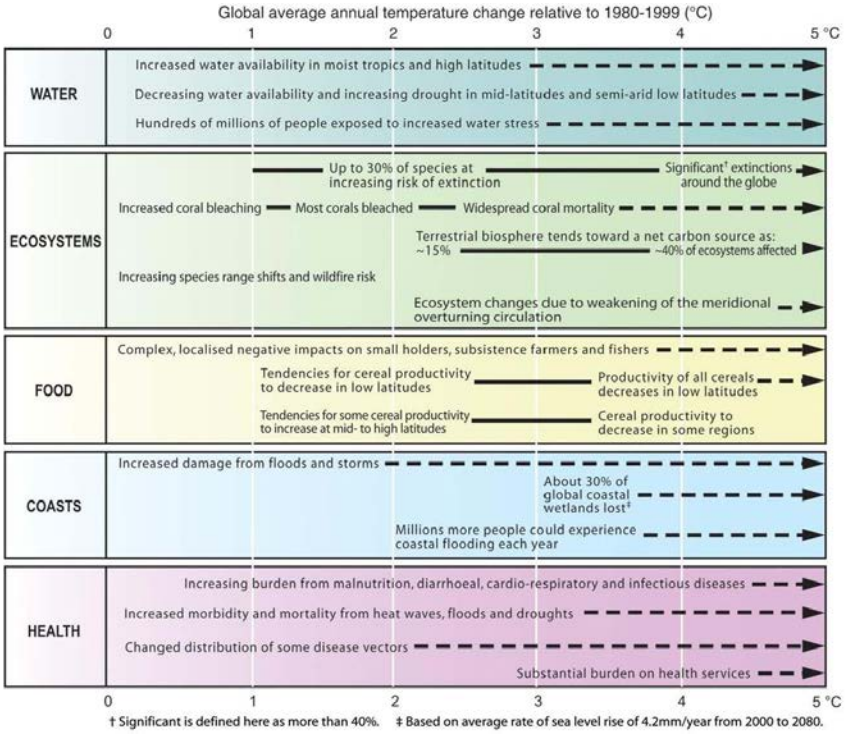


Figure A.1 Global Average Temperature Change Relative to 1980–1999 (°C) Source: IPCC (2007d), Figure SPM.7

Figure A.1 provides illustrative examples of global impacts projected for climate changes (and sea level and atmospheric CO2 where relevant) associated with different amounts of increase in global average surface temperature in the twenty-first century. The solid lines link impacts; broken-line arrows indicate impacts continuing with increasing temperature. Entries are placed so that the left-hand side of text indicates the approximate level of warming that is associated with the onset of a given impact. Quantitative entries for water scarcity and flooding represent the additional impacts of climate change relative to the conditions projected across the range of emissions scenarios included in IPCC Fourth Assessment Report: Climate Change 2007 (AR4) (2007a, 2007b, 2007c, 2007d). For more information on these scenarios, see "IPCC Special Report: Emissions Scenarios, Summary for Policymakers"[2] Adaptation to climate change is not included in these estimations. Confidence levels for all statements are high.

[2] IPCC (2000), IPCC Special Report: Emissions Scenarios, Summary for Policymakers, IPCC Working Group III for the Intergovernmental Panel on Climate Change, Geneva, www.ipcc.ch/pdf/special-reports/spm/sres-en.pdf

Appendix B
Related ASHRAE Documents

Standards

- ANSI/ASHRAE Standard 34, *Designation and Safety Classification of Refrigerants*
- ANSI/ASHRAE Standard 15, *Safety Standard for Refrigeration Systems*
- ANSI/ASHRAE Standard 147, *Reducing the Release of Halogenated Refrigerants from Refrigerating and Air-Conditioning Equipment*
- ANSI/ASHRAE/IESNA Standard 90.1, *Energy Standard for Buildings Except Low-Rise Residential*
- ANSI/ASHRAE Standard 90.2, *Energy Efficient Design of Low-Rise Residential Buildings*
- ANSI/ASHRAE Standard 100, *Energy Conservation in Existing Buildings*
- ASHRAE/IES/USGBC Standard 189.1 – Standard for the Design of High-Performance Green Buildings, Except Low-Rise Residential Buildings

Design Guides

- 30% Advanced Energy Design Guide for K-12 School Buildings
- 50% Advanced Energy Design Guide for K-12 School Buildings
- 30% Advanced Energy Design Guide for Small Retail Buildings
- 50% Advanced Energy Design Guide for Medium to Big Box Retail Buildings
- 30% Advanced Energy Design Guide for Small Office Buildings
- 50% Advanced Energy Design Guide for Small to Medium Office Buildings
- 30% Advanced Energy Design Guide for Small Warehouses and Self-Storage Buildings
- 30% Advanced Energy Design Guide for Highway Lodging
- 30% Advanced Energy Design Guide for Small Hospitals and Healthcare Facilities
- 50% Advanced Energy Design Guide for Large Hospitals

Position Documents

- ASHRAE Position Document on Natural Refrigerants (2011)
- ASHRAE Position Document on Energy (2008)
- ASHRAE Position Document on Refrigerants and their Responsible Use (2012)

Strategic Documents

- Vision 2020 Producing Net-Zero-Energy Buildings
- Sustainability Roadmap

Strategic Partnership Agreement

ASHRAE, CIBSE and REHVA

Founded in 1894, ASHRAE, Atlanta, Georgia advances the arts and sciences of heating ventilating, air-conditioning and refrigeration to serve humanity and promote a sustainable world.

Founded in 1897, CIBSE is the professional body that supports the science, art and practice of building services engineering, by providing members and the public with first class information and education services and promoting the spirit of fellowship that guides their work.

Founded in 1963, REHVA, the Federation of European Heating, Ventilation and Air Conditioning Associations, develops and disseminates cost effective and, energy efficient building mechanical systems and services technologies that result in healthy buildings to serve its members and the field of building engineering.

All three organizations play important roles in creating a more sustainable world by providing the technical expertise, educational products and research needed to produce a comfortable, healthy and energy efficient built environment. The basis of this agreement is the belief that by working together all three organizations can amplify their ability to provide these services to its members and the general public while simultaneously eliminating duplication and conflicts. Strong collaboration between ASHRAE, CIBSE and REHVA will also allow each organization to address the major issues facing our industry worldwide, including adapting to a rapidly evolving technology, harmonization of standards and codes, mitigating the impact of climate change and many other common issues. By sharing experiences and applying divergent resources, the three organizations can successfully address common issues to benefit the industry as a whole.

This Strategic Partnership Agreement provides a framework for those benefits to be realized: it creates a roadmap to advance and promote the mutual interests of ASHRAE, CIBSE and REHVA with a practical commitment to work together on the following activities and goals that serve our collective membership and the public to promote a more more energy conscious, healthy, comfortable, productivity-enhancing and sustainable world. Nothing in this agreement will preclude ASHRAE, CIBSE or REHVA from conducting business individually, nor does this agreement contain any conditions, requirements or criteria that would limit competition, set pricing or otherwise restrain free trade.

CONSISTENT LEADERSHIP COMMUNICATION

Recognizing the importance of communication in organizational collaboration, all three organizations commit to hold a strategy meeting of senior leadership at least annually (preferably in person, or via electronic meetings) of designated ASHRAE/CIBSE/REHVA senior representatives to:

- Increase networking internationally

- Ensure ongoing advancement of collaborative projects.
- Discuss new opportunities for collaboration.
- Monitor progress on collaborative projects underway
- Keep each respective organization informed of major initiatives.
- Develop strategies for positioning all three organizations as leaders in addressing mutual challenges.

These strategy meetings should be scheduled to ensure that enough time is allocated to properly conduct strategic discussions. It is recommended that strategy meetings are held separately from the program of general society meetings ASHRAE/CIBSE/REHVA shall take responsibility for initiating the first annual strategy meeting to include senior leadership from each organization. Action items with assigned responsibilities shall be recorded at each meeting.

To further communication and increase international networking, REHVA will be invited to join the ASHRAE Associate Society Alliance (AASA). Membership in AASA will further REHVA's mission of serving as a bridge between organizations to generate opportunities and stimulate networking. . This Strategic Partnership Agreement applies only to REHVA and not its national association members. Nothing contained in this agreement shall preclude any of REHVA's national associations from entering into a separate agreement containing terms and conditions to account for the specific needs of that national association.

COLLABORATION

ASHRAE, CIBSE and REHVA each deploy a different model to serve their members and the general public. Both ASHRAE and CIBSE, as charitable enterprises, serve individual members along with the general public. REHVA's members are national associations in Europe and the surrounding geographic area. Collaboration between the three organizations can take advantage of the strengths of each model to better serve each organization's diverse membership.

It is the intent of this agreement to produce a long-term relationship that is mutually beneficial to each organization's membership such that each organization will grow stronger. In order to achieve this intent, the three organizations agree to form a task force to explore in Europe the development of a relationship that supports regions, chapters, clubs, national associations and also individual members that are not members of a region, chapter, club or national association. The task force would be kept informed and would also be charged with creating initiatives for such groups and with writing a Reference Document that establishes the relationship between all three organizations. This initiative shall not preclude the formation of new chapters, regions, clubs or some other new, hybrid forms of a chapter, region or club by any organization. The task force will specifically include in the Reference Document how the following will be accomplished:

- Administrative and technical support, as well as volunteer support, for each organization.
- Collaboration efforts listed below between respective members within a country where a REHVA national association exists.
- Collaboration efforts listed below between countries where REHVA national associations exist.

It is the intent of this agreement that once the above referenced Reference Document is approved by all three organizations, new, customized Reference Documents will be written for each REHVA national association that believes that they need a customized version. This ensures that a Reference Document will apply to everyone equitably.

SCOPE OF COLLABORATION

EDUCATION - As leading providers of conventional and online educational services and in recognition of the vital role professional development has for our respective members, ASHRAE, CIBSE and REHVA agree to:

- Cross-market educational offerings at the national and international levels.
- Explore opportunities to co-develop new courses or other training programs that take advantage of overlapping and complimentary expertise between ASHRAE, CIBSE and REHVA.
- Investigate and implement ways that certification programs can be jointly developed or administered.
- Explore the development of online courses that can be used to disseminate information worldwide.
- Form a joint task force to build a business plan for a ~~CIBSE/~~ASHRAE/CIBSE/REHVA educational programme for Europe with the possibility of creating business plans for other geographic areas as well.
- Investigate the development of a European speaker's bureau comprised of distinguished lecturers from each organization. The purpose of the speaker's bureau is to increase communication between the three organizations, create an environment of technology cross-pollination, provide opportunities for each organization's members to learn from the other organization's experts, and provide an avenue to identify future collaboration opportunities.
- Investigate building technologies to support the de-carbonization of society.

CONFERENCES AND MEETINGS - Recognizing that specialty conferences are an excellent method of serving members in specific geographic areas, industry sectors or climate zones, each organization will alert the other organization of specialty conferences under consideration or development. Unless prohibited by other contractual agreements, each organization shall help publicize the other organization's meetings and promote attendance, focusing on targeted audiences with potential interest in the particular conferences. Where appropriate, ASHRAE, CIBSE and REHVA may collaborate on a special conference that addresses common industry issues. Of particular interest are collaboration opportunities in emerging topics such as resiliency, legionella and sustainable cities. ASHRAE, CIBSE and REHVA agree to jointly develop a master calendar showing all of the pertinent activities, meeting and conferences of each organization.

ADVOCACY - Where mutually beneficial and to the extent allowed by laws and corporate policies, ASHRAE, CIBSE and REHVA agree to work together on common public affairs goals and ideologies. During the annual strategic leadership meeting, public affairs strategies will be discussed and common goals identified. Collaborative opportunities to be considered include:

- Joint promotion of codes and standards
- Promoting mutually beneficial positions during the development and passage of legislation.
- Education of regulators on issues important to the members of each organization.

STANDARDS HARMONIZATION – It is well known that the current environment of fragmented technical standards, both within countries and internationally, does not serve our members or the general public well. Fragmentation is a significant obstacle in creating a more sustainable world, which is a part of each organization's mission. At the same time, local conditions, culture and languages must be accommodated in standards if they are to be successfully applied and implemented. Providing harmonization or alignment between the major standards used by the three organizations, without attempting to supplant any standard, would be a major step forward for our industry. To that end, ASHRAE, CIBSE and REHVA agree to form a task force to develop strategies to support standards harmonization.

TECHNICAL DISSEMINATION – Dissemination of technical information is a key element of each organization's purpose. Accordingly, ASHRAE, CIBSE and REHVA agree to foster technical dissemination and cooperation in areas of common interest by:

- Exploring opportunities to jointly produce publications of mutual benefit. Of particular interest are publications on emerging topics such as resiliency, legionella and sustainable cities.
- Cross-marketing each organization's publications where appropriate and with industry standard distributor discounts.
- Using periodicals, websites and social media to promote the other organization's events, publications and other activities.
- Exploring mutually beneficial ways to translate ASHRAE, CIBSE and REHVA publications for distribution around the globe.
- Encouraging members in each organization to participate on technical committees and task forces.
- Providing opportunities to participate in and comment on proposed standards, guidelines, policies, and position statements developed on technical subjects as they relate to buildings and community developments.
- Establishing liaison representatives to key technical committees where mutually beneficial to do so.
- Providing at least one complimentary subscription of the primary membership periodical to be received at the headquarters location of the other organization.

RESEARCH - Recognizing the importance research plays in accelerating the transformation to a more sustainable built environment, ASHRAE, CIBSE and REHVA agree to:

- Promote research in areas where research results will advance the arts and sciences of building engineering.
- Disseminate research results quickly, focusing on high-impact findings.
- Identify opportunities for research funding from other sources and mutual support to draw from these resources.

ADMINISTRATIVE CONTACTS

The administrative contacts for actions tied to this Strategic Partnership Agreement shall be:

For ASHRAE:

Jeff Littleton
Executive Vice President
ASHRAE
1791 Tullie Circle NE
Atlanta, GA 30320
Tel: 404-636-8400
Email: jlittleton@ashrae.org

For CIBSE:

Stephen Matthews
Chief Executive/Secretary
CIBSE
22 Balham High Road
London SW12 9BA
Tel: +44 (0)20 8675 5211
Email: smatthews@cibse.org

For REHVA

Anita Derjanecz
Managing Director
REHVA
Rue Washington, 40
1050 Brussels, Belgium
Tel: +32 2-514 11 71
Email: ad@rehva.eu

TERMINATION

Any party to the agreement may terminate this agreement, with or without stated cause, upon providing the other parties with sixty (60) days written notice of intent to terminate.

TERM

The term of this agreement shall begin when signed by all parties and shall terminate at the end of three (3) years unless extended at that time by written agreement.

LEGAL STANDING

This agreement reflects a commitment by ASHRAE, CIBSE and REHVA to continue and enhance their working relationship and individual efforts toward achieving mutual objectives described above. It does not create a binding obligation or legal agreement between the three organizations, and none of the three organizations has an obligation to negotiate toward or enter into a binding written agreement. In addition, this agreement does not create a partnership, joint venture, fiduciary relationship or similar relationship between ASHRAE, CIBSE and REHVA. Furthermore, it is understood that this agreement is conceived as a dynamic document, meant to change as circumstances and priorities warrant. It may be modified or amended by written agreement between all three organizations.

FOR ASHRAE

Jeff Littleton, Executive Vice President

_____
Signature

_____
Date

Timothy G. Wentz, PE
ASHRAE President, 2016-2017

_____
Signature

_____
Date

FOR CIBSE

Stephen Matthews, Chief Executive/Secretary

_____
Signature

_____
Date

John Field, MA, CEng, FCIBSE, MEI, CMVP
CIBSE President, 2016-2017

_____
Signature

_____
Date

FOR REHVA

Anita Derjanecz, Director

_____
Signature

_____
Date

Stefano P. Corgnati, Ph.D., Prof.
REHVA President, 2016-2019

_____
Signature

_____
Date

Report of President Timothy Wentz
ASHRAE Travel for July 1, 2016
Through January 31, 2017

Date	Meeting	Location	Comments
July 5-7	White House meeting	Washington, DC	
July 9 - 12	Purdue Compressor Conference	West Lafayette, IN	
July 13 -16	APPA Convention	Nashville, TN	
July 21 - 24	Senior Officers Retreat	Omaha, NE	
July 28 - 21	Region V CRC	Dayton, OH	
Aug 4 - 7	Region IX CRC	Omaha, NE	
Aug 10 - 14	Region IV CRC	Atlanta, GA	
Aug 17 - 21	Region I CRC	Rochester, NY	
Sept. 7 - 8	Arkansas Chapter visit	Little Rock, AR	
Sept 9 - 12	CIBSE/ASHRAE staff exchange	Atlanta, GA	
Sept 12 - 13	NSF meeting	Ann Arbor, MI	
Sept 14 - 17	Lacrosse Chapter	Lacrosse, WI	
Sept 19 - 21	AHR Mexico Exhibition	Monterrey, Mexico	
Sept 24 - 28	Hong Kong and Macao Chapter visits	Hong Kong and Macao	
Sept 29 – Oct 2	Region XIII and Region at Large CRC	Bangkok, Thailand	
Oct 3 - 5	Board and ExCom meeting	Bangkok, Thailand	
Oct 6 - 10	Ireland and Midlands UK section visits	Dublin, Ireland and Loughborough, UK	
Oct 11 – 15	ASHRAE/CIBSE 40th anniversary	London, England	
Oct 16 - 20	ICC Conference	Kansas City, MO	
Oct. 26 - 28	New York City Chapter visit	New York, NY	
Oct 29 – Nov 1	ASPE convention	Phoenix, AZ	
Nov 6 to Nov 20	Colombia, Brazil, Chile and Argentina Chapter visits	Bogota, Colombia, Rio de Janeiro and Belo Horizonte, Brazil, Santiago, Chile, Buenos Aires, Argentina	
Nov 28 - Dec. 2	Danube Chapter visit, attend the 47th International Congress and Exhibition	Belgrade, Serbia	
Dec 3 – Dec 6	60th Anniversary of the Quebec City Chapter	Quebec City, Quebec, Canada	
Dec 11 – Dec 18	Sacramento Valley, Southern California, Orange Empire, Tri-County, Golden Gate, San Jose and San Diego chapter visits	Sacramento, Los Angeles, San Francisco and San Diego, California	
Jan 8 – 12, 2017	Charleston Chapter, Myrtle Beach Section, Savannah Section and New Jersey Chapter visits	Charleston and Myrtle Beach, South Carolina, Savannah, Georgia and Newark, New Jersey	

Jan 16 - 20	Space Coast, Sarasota Section, Florida West Coast, Southwest Florida, Central Florida chapter visits	Tampa, Fort Meyers and Orlando, Florida	
January 25-February 2	ASHRAE Winter Conference & AHR Exhibition	Las Vegas, Nevada	

Short Report to ASHRAE Board of Directors

Subject: The National Institute of Building Sciences (NIBS) (referred to as "The Institute" in this report) Building Innovation 2017 Conference, Washington, DC January 9-12, 2017

By: M. Dennis Knight, ASHRAE Director at Large

I was fortunate to attend the subject conference as a representative of ASHRAE and participate in key discussions with other industry and government leaders. You may click here for access to the conference website and additional information. The following is a short report provided for your information regarding my activities at the conference and the sessions I attended and/or participated in:

A. I arrived at the conference Monday morning January 9th and the first meeting I attended was the NIBS Board of Directors meeting.
    a. The Institute's board voted to sunset the High Performance Buildings' Council. It was felt that this is a positive move and was done at the recommendation of the council itself. The council made the recommendation because they see high performing buildings and a high performing built environment to be at the core of the work of NIBS and already integrated well and adequately into the work of the other councils and that additional oversight and coordination by the HPB council was no longer necessary or an efficient use of volunteer time and resources.
    b. The Institute has issued their annual letter to the President with respect to Institute recommendations and has been working closely with the President Elect's transition team and agency transition teams to ensure continuity of the work of the Institute moving forward. The Institute also feels it is important to continue to keep the broader industry, outside of the government, engaged and apprised of their work.
    c. Ryan Colker gave a report from the Institute's Consultive Council's 2016 recommendations that were included in the letter to the President and President Elect titled "Moving Forward: Findings and Recommendations from the Consultive Council." Copies of the report may be downloaded from the NIBS website. The Council believes that the "design, construction, operation and regulation of buildings and infrastructure, while operating in the background of our daily lives, is the foundation of every aspect of the nation's economy…" in a nutshell, there were two significant recommendation made in the report that are believed to be significant challenges to our industry and deserve our serious focus and attention "Moving Forward:" These two issues were identified as 1. The availability of a skilled building-related workforce; and, 2. The importance of of potable water and the efficient and healthy use of this limited resource.
    d. One board member asked that the Institute upgrade its messaging strategy to better market and disseminate the good work being done within the Institute, its councils and the collaborative work going on between the Institute and its kindred organizations in our industry.

B. I attended th Consultive Council Meeting. Ryan Colker facilitated the discussions and reports. Some highlights of the discussions are as follows. More details may be obtained from the reports posted online.
    a. Work should be done on forecasting the potential effects of climate change on future editions of building codes [personal note – weather data - this is an area where ASHRAE has particular expertise and I recommend we be a positioned as trusted resource and participate in these discussions in the future.]
    b. The Institute is prepared an industry statement on Resiliency and released it in May 2014.
    c. The Council will participate in the White House Building Resilience summit.
    d. With the current leadership change going on due to the transition to a new President and administration, the Council is focused on being able to reengage with key (new) contacts within the DOE and EPA and other agencies.
    e. Particular focus is being placed on determining what is next in terms of standards for energy efficiency and water efficiency. Currently there is a document (apologize I do not have a reference) with 140 significant issues identified with recommendations for worl to be done by the federal government. Peter Demarco with IAPMO suggest that document be summarized and paired down to a single page with maybe the top 4 or 5 issues that have the potential to have the most positive effects on energy efficiency and water efficiency, and that list be presented to the new administration for consideration. The Council took that request as an action item.
C. I attended the session titled "STEM and the Future Industry Workforce
    a. This session was primarily a demonstration of the Mars City STEM learning tool designed to introduce K-12 students to the building operations and maintenance trades through an online BIM, Virtual Reality and Gaming platform.
    b. The project was presented by Dr. Kerry Joels of the Total Learning Research Institute and representatives of the architectural firm Kieran Timberlake who have been instrumental in creating the BIM models and the VR technology to allow students to navigate the model and facility and work on various facility operations and maintenance scenarios.
    c. Personal note: I believe a similar challenge and tool could be used at the professional level to train and increase both the adoption of BIM and the creation of BIM content for our industry and that we should discuss whether that may be something we want to suggest and put resources toward either internally or with co-interested organizations in the future. Could be hosted by data.ashrae.org as well.
    d. Click here for more details about the Mars City project.
D. I attended the keynote presentation delivered by Judson J. McIntire, AIA. Mr. McIntire is the Smithsonian Institutes Executive Program Director and was in charge of the newly opened National Museum of African American History. He gave an hour long presentation highlighting the Smithsonian's choice of the CM at Risk for the project delivery method and their analysis of the design-bid-build, design-build and the Integrated Project Delivery (IPD) options for procuring the buildings design and construction. He gave an informative and entertaining, story based, discussion of both the successes and lessons learned throughout the nearly 13 year process to

bring this project to substantial completion and ultimately opening in 2016 including the selection process for the HVAC systems and the Value Engineer that occurred. It was interesting to note that they selected the design teams through a competition and ultimately contracted with the top four firms to deliver the design. Also interesting was the fact they after selecting the contractor, actual in ground construction had been underway for over 1 year before a final GMP was agreed to. In addition, once the 70 foot deep excavation was started it was determined that the water table was just 5 feet below existing grade, the entire foundation system had to be redesigned on the fly and below grade construction took 2 years to complete. Even with that the project completion was only delayed about 4 months. The lessons learned were highlighted as follows:

a. The CM at Rsik project delivery method served the Smithsonian weel because they wanted to retain a direct relationship with the design team to adhere to their rigorous design standards.
b. Changes will occur and owners might as well budget some time and money for them, and
c. Collaboration and team work among all stakeholders was the key to the successful completion of the project.
d. As a side bar: I had the opportunity to walk down to the museum right next to the Washington Monument on evening. It is truly and iconic building. I also noted that tickets are currently sold out through April 2017 – so if you want to visit the museum, go online and plan your trip and purchase tickets well in advance.

E. I attended a session titled “Collaboration through Effective Teams.”
   a. The title was a little deceiving, however the presenters and the topics were first rate. One speaker gave a presentation the use of BIM and digital data in the design process and the challenges associated with creating and adhering to standard data structures. The speaker stressed the need for standards in this area. (Note: I believe ASHRAE could and should consider taking a leadership role in working with NIBS and the buildingSMART alliance in the further development of the HVACie (ie = Information Exchange standard).
   b. The second speaker gave a detailed case study of the use and application of the COBie standard (Commercial Building Operations information exchange).
   c. The final speaker presented the case for the role of the building official in the early design phases and made the case for more development in using BIM and data exchange standards to perform automated code checking and permitting.

F. On Tuesday afternoon Stephanie Stubbs with NIBS, Ernie Conrad (BOMA and an ASHRAE member), Mr. Johnny Fortune (representing the AEC industry) and I (representing ASHRAE) gave a presentation on the National BIM Guide for Owners (NBGO). The NBGO was published and rolled out as part of the conference. As a side note, the authorship team worked on this guideline for only 8 months before rolling out the first public review draft in June 2016. The documented was completed in October 2016 including addressing all commenters, 1 year from the time the original team of authors met for the first time to begin outlining the Guideline. The Guideline and the team of authors also received the Institutes 2017 Honor Award at the awards banquet on Wednesday evening. In addition, it is planned that the guideline will be passed off

to ASHRAE to be developed into a standard. Preliminary planning is underway to develop the formal title, purpose and scope and begin the process of soliciting and assembling the committee to transform this guideline into a standard.

G. I attended the session titled "Preparing the High Performance Workforce." This session was focused on the theme of the conference and recommendation of the Consultive council. The speakers provided good information and made the case for the need to continue to put resources into our educational system and institutions to develop and train the workforce of the future to design, construct, operate and maintain a high performance built environment.

H. On Wednesday I attended the buildingSMART Alliance annual meeting where I was honored to be nominated to serve as the Vice-Chair of the Alliance for the next two years. The focus I expressed to the members of the Alliance when they ask me to address the group is to foster continued engagement and collaboration with ASHRAE and other kindred organizations on the initiatives supported by NIBS and the bsA and to help us (each organization) become more involved in developing HVAC relevant data exchange standards and better ways to leverage the use of technology and BIM to plan, design, construct and operate better buildings.

I. I attended the Fedcon breakfast keynote presentation delivered by Mr. Shawn Norton, Branch Chief for Sustainable Operations and Climate Change for the National Park Service. Mr. Norton presented a concise history of our national parks from the time that they were conceived in 1832 right through today and into the future. As you can imagine, the presentation was filled with inspiring images of our national parks and the facilities located in them. Currently there are 419 areas set aside that fall under the NPS and 59 designated and protected National Parks. The NPS is 100 years old and has gone through three distinct "Parkitecture" phases to date including the Rustic Era where most facilities were constructed using local materials and hand labor, the "Mission 66" phase from 1950 through 1966 in preparation for the NPSs 50th anniversary where more modern, faster construction processes were employed to meet the increasing demands for visitors centers and roads that were the result of increased vistorship and the use of the automobile. The NPS, since about 1980, has been in its Sustainability and Preservation phase. The NPS is currently in the middle of planning its next phase of Parkitecture which includes doing "all hazards" assessments and developing adaptability scores for all 419 NPS areas and all 70,000 facilities located within the parks. AS part of the plans the NPS is looking at what facilities can be taken to net zero energy/net zero carbon emissions, what assets have to/ should be preserved "as-is," what facilities may be adapted and hardened to deal with more severe climate events and what facilities will ultimately have to be allowed to succumb to the potential negative effects of climate change. Some of the barriers to net zero Mr. Norton mentioned were the high visitation/high demand profile of their larger visitor centers, location and climate zone in which the facilities are located. Personal note: ASHRAE members can certainly participate in and benefit from the numerous projects that will ultimately result from these assessments and ASHRAE can contribute to the research, science and best practices that will be needed to use weather data to forecast the potential effects of climate change.

J. Finally, outside the conference, I visited the USGBC headquarters in DC and meet with Mr. Brendan Owens, Chief Engineer, and discuss possible sessions and content that the USGBC may be able to provide as part of ASHRAE's 2017 Building Performance Analysis specialty conference currently scheduled to be held in Atlanta between September 27-29, 2017. Discussions

between the conference steering committee, ASHRAE staff and the USGBC are ongoing. Potential content may include a USGBC pre-conference workshop on energy modeling, a session highlighting a case study of several high performing buildings focused on the processes and workflows used to achieve and maintain the high performance building during design, construction and operations.

This is the end of my report. Please let me know if you have any questions or would like to receive more information regarding my activities conducted on behalf of ASHRAE at this conference. I may be reached at dknight@wholebuildingsystems.com.

Sincerely,

M. Dennis Knight, P.E., FASHRAE

From: Matt Nelson [mailto:mnelson@ecocommissions.com]
Sent: Thursday, January 12, 2017 2:45 PM
To: Kline, Tim <TKline@ashrae.org>
Subject: Re: Report from Yesterday's CCWC Meeting ... Monday?

The annual meeting for the Commercial Workforce Credentialing Council (CWCC) Board of Advisors was held at the NIBS Building Innovation 2017 conference on January 11, 2017 in Washington D.C.. Matt Nelson was in attendance representing ASHRAE. All major groups representing commissioning programs were in attendance.

It was announced that there are three programs currently recognized as compliant with the Better Building Workforce Guidelines (BBWG): The Certified Energy Manager (CEM) and Certified Energy Auditor (CEA) certifications issued by the Association of Energy Engineers, and Certified Commissioning Professional (CCP) certification issued by the Building Commissioning Association (BCA). Additional certifications pursuing compliance and currently in the ANSI evaluation stage of the process included ASHRAE's two certifications (BCxP and BEAP) and NEBB's certification. No other organizations spoke up at this time.

In accordance with the established scheme procedures, annual feedback on the schemes was solicited and requested to be submitted in writing. This feedback would be reviewed by the scheme committee and responded to accordingly. It was also discussed that all schemes will be re-evaluated in or around 2020 as part of a 5-year periodic review. Organization of this effort would start more than a year ahead of time and include how this re-evaluation would be paid for. Both feedback and periodic re-evaluation of the schemes are required as part of the ANSI process. These procedures are also followed for our own certifications and are familiar to the certification committee.

It was announced at the meeting that a new simpler job title and job task analysis are in the process of being developed. The Building Oprerations Journey-Worker will act as a predecessor of the Building Operations Professional job title already established. This was developed as a certificate program and that the guidelines for this will be available within the next two months. It was felt that this simpler job title needed to be developed because of the broad and unrealistic scope of knowledge for the original Building Operations Professional job title.

At the meeting the Department of Energy announced that a new online Building Science Education Program is being developed as a free, peer-reviewed content resource for learning about building science. This resource tool will enable people interested in a job title to be able to not only determine what areas of knowledge they need to be proficient in but also the level of knowledge that is required. This is still under development but more information is coming. Review of the powerpoint will provide some additional details.

In other news, a new job title is being considered. It centers around Security Workforce Development. This is to follow the other job title processes in regards to the developing schemes and assembling a subject matter expert (SME) committee.

On the demand side, no new agencies have joined on to require DOE recognized certifications but this will also continue to be an area of focus for the NIBS staff this year.

Additional meeting information and slides will be forthcoming from Roger Grant (NIBS).

###

Thanks,
Matt Nelson
Managing Principal

Cell: 216-832-8616

ECO Commissions
www.ecocommissions.com
888-988-4ECO

Commercial Workforce Credentialing Council

a council of the National Institute of Building Sciences

Attachment 2b
ExCom Minutes: 2017 January 28, February 1 and 2

Commercial Workforce Credentialing Council Annual Meeting

January 11, 2017

Agenda

1:45 PM	Welcome, Introductions, and 2016 Update	Roger Grant Priya Swamy
2:00 PM	BOD Charter Revisions	Roger Grant
2:05 PM	Review of Schemes for Needed Updates	Roger Grant
2:15 PM	Building Operations Journey-worker JTA	Roger Grant
2:25 PM	Certificate Program Guidelines	Roger Grant Christine Niero
2:40 PM	Efforts to Build Demand for Qualified Workforce	Roger Grant Priya Swamy
2:50 PM	DOE Building Science Education Program	Cheryn Metzger Sam Rashkin
3:05 PM	Security Workforce Development	Roger Grant
3:15 PM	Wrap-up and Next Steps	Roger Grant
3:20 PM	Adjourn	

Commercial Workforce Credentialing Council

Board of Direction

Name	Organization
Frank DiGiovanni	US Department of Defense
Francis M. Cain	
Jonathan Flaherty	Tishman Speyer
Brian Gilligan	US General Services Administration
Don Gilligan	National Association of Energy Service Companies (NAESCO)
Priya Swamy	Department of Energy
Lauren Zullo	NRDC
Jerry Kettler	Facility Performance Associates
John Lee	NYC Mayor's Office
Kim Lenihan	NYSERDA
Kelly Herbert	The South-central Partnership for Energy Efficiency as a Resource
Paul Rode	SVP of Engineering, Related Companies
Carolyn Sarno Goldthwaite	NEEP
	CTTSO/DoD/DHS
	Open
	Open

Commercial Workforce Credentialing Council

Board of Advisors

James Barry	Building Services 32BJ Training Fund
Ray Bert	AABC Commissioning Group (ACG)
Michael Bobker	CUNY
Peter Crabtree	NSF BEST Center/Laney College
Eliot Crowe	PECI, Technical Program Manager
Russel Duke	IUOE Stationary Engineer Training Department
Roger Ebbage	Lane Community College - Energy Management Program
Deane M. Evans	New Jersey Institute of Technology (NJIT) Center for Building Knowledge - Energy Commissioning Agents/Auditors (ECAA)
Liz Fischer	Building Commissioning Association
Stan Price	NEEC - Northwest Energy Efficiency Council
Jeff Horn	BOMI
Sydney Roberts	Southface
Michele Jones	National Insulation Association
Tony Keane	IFMA
Bill Kent	Association of Energy Engineers
Cindi Hereth	National Environmental Balancing Bureau
Matt Nelson	ASHRAE / Eco Commissions
Jim Page	NEMI / TABB
Christopher Surak	ASTM International
Dave Walls	ICC

Update on Accreditation and Recognition

Better Buildings® U.S. DEPARTMENT OF ENERGY

PARTNERSHIPS

Better Buildings Workforce | Workforce Guidelines | Building Re-Tuning Training

Home » Workforce Guidelines » DOE Recognition

DOE Recognition

Third-party Accreditation

The Department of Energy recognizes certification programs that are aligned with the Better Buildings Workforce Guidelines and which have received qualified accreditation by the American Standards National Institute, International Accreditation Service, or other qualified accreditation bodies who are in compliance with ISO/IEC 17024:2012. Once programs have received accreditation, they can submit their request for recognition through an online form.

Department of Energy Recognized Programs

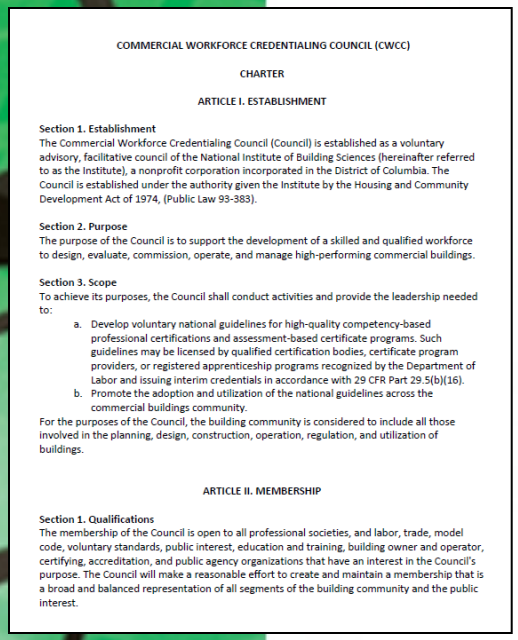
Association of Energy Engineers, CEM® - A DOE Recognized Program
The Certified Energy Manager is the first recognized program under the Better Buildings Workforce Guidelines. Certified Energy Managers are individuals who optimize the energy performance of a facility, building or industrial plant. The CEM® is a systems integrator for electrical, mechanical, process and building infrastructure, analyzing the optimum solutions to reduce energy consumption in a cost effective approach.

Association of Energy Engineers, CEA® - A DOE Recognized Program
The Certified Energy Auditor program is the first energy auditing program recognized under the Better Buildings Workforce Guidelines. Certified Energy Auditors are individuals who evaluate and analyze how energy is being used in a facility, identify energy conservation opportunities and make recommendations where consumption can be reduced or optimized.

Building Commissioning Association, CCP - A DOE Recognized Program
The Certified Commissioning Professional is the first commissioning certification to be recognized under the Better Buildings Workforce Guidelines. Certified Commissioning Professionals are individuals who lead, plan, coordinate and manage commissioning for new and existing buildings.

https://betterbuildingssolutioncenter.energy.gov/workforce/participating-certifying-organizations

Better Buildings® U.S. DEPARTMENT OF ENERGY
RECOGNIZED PROGRAM
MEETS U.S. DEPARTMENT OF ENERGY GUIDELINES



COMMERCIAL WORKFORCE CREDENTIALING COUNCIL (CWCC)

CHARTER

ARTICLE I. ESTABLISHMENT

Section 1. Establishment
The Commercial Workforce Credentialing Council (Council) is established as a voluntary advisory, facilitative council of the National Institute of Building Sciences (hereinafter referred to as the Institute), a nonprofit corporation incorporated in the District of Columbia. The Council is established under the authority given the Institute by the Housing and Community Development Act of 1974, (Public Law 93-383).

Section 2. Purpose
The purpose of the Council is to support the development of a skilled and qualified workforce to design, evaluate, commission, operate, and manage high-performing commercial buildings.

Section 3. Scope
To achieve its purposes, the Council shall conduct activities and provide the leadership needed to:

a. Develop voluntary national guidelines for high-quality competency-based professional certifications and assessment-based certificate programs. Such guidelines may be licensed by qualified certification bodies, certificate program providers, or registered apprenticeship programs recognized by the Department of Labor and issuing interim credentials in accordance with 29 CFR Part 29.5(b)(16).
b. Promote the adoption and utilization of the national guidelines across the commercial buildings community.

For the purposes of the Council, the building community is considered to include all those involved in the planning, design, construction, operation, regulation, and utilization of buildings.

ARTICLE II. MEMBERSHIP

Section 1. Qualifications
The membership of the Council is open to all professional societies, and labor, trade, model code, voluntary standards, public interest, education and training, building owner and operator, certifying, accreditation, and public agency organizations that have an interest in the Council's purpose. The Council will make a reasonable effort to create and maintain a membership that is a broad and balanced representation of all segments of the building community and the public interest.

Section 2. Admission of Members
Qualified organizations will be admitted as members upon filing a completed membership application with the Secretary or Staff Director of the Council and approval by the Board of Direction. Member organizations will designate a representative and an alternate authorized to act on behalf of the organization. Any change in the authorized representative or alternate will be accomplished by filing a written notice of such change with the Secretary or Staff Director.

Section 3. Rights of Members
Each member organization shall be entitled to one (1) vote on all matters brought before the Council, and shall receive notice of meetings, minutes of such meetings, and other appropriate documentation of the affairs of the Council. Each organization serving on any committee, panel or other unit of the Council shall be entitled to one (1) vote on all matters before that unit. Alternates of representatives elected to the Board of Direction may act on matters coming before that body in the absence of the primary representative.

Section 4. Removal of Members
Members or their representative may be terminated in the event such member or representative is in breach of one or more of the requirements of membership, conducts him/herself with flagrant disregard for the rules or policies of the Council or the National Institute of Building Sciences, or acts in a manner which is clearly detrimental to the purpose and objectives of the Council. Failure to return mail ballots may be considered a cause for removal. Such a termination may be effected only by a vote of seventy-five percent (75%) of the Board of Direction at a duly called and convened (in-person or virtual) meeting. Prior to such meeting, the affected member or representative shall receive thirty (30) days written notice from the Board of Direction. The decision of the Board of Direction in this regard shall be conclusive and no right of rehearing or appeal, administrative or judicial, shall exist as to the terminated member or representative.

ARTICLE III. CONDUCT OF COUNCIL BUSINESS

Section 1. Policy
The business of the Council shall be conducted in accordance with the Institute's Bylaws; the Charter of the Council; and the policies, rules, and procedures established by vote of the members of the Council.

Section 2. Meetings
The Council shall hold at least one meeting annually that shall be designated as its annual meeting. The annual meeting shall be held preferably in conjunction with the Institute's annual meeting with at least (30) days' notice. Other meetings will be called by the Chair or Staff Director of the Council upon at least fifteen (15) days written notice to all members. These meetings shall be called upon majority vote either of the Council or its Board of Direction or by petition of at least twenty (20) percent of the members, with the same notice.

CWCC Charter Revisions

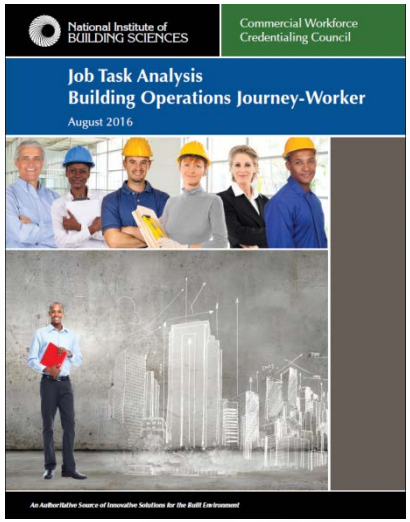
1. Allow for Design jobs to be covered by CWCC
2. Clarify Staff Director role
3. Allow alternate representatives to accommodate absences or where different expertise is needed

Annual Review of Schemes

Policies of the Board of Direction:

Scheme Review and Revision: At its annual meeting, the CWCC shall address the schemes to assure the scheme content and requirements are current and relevant… Should the CWCC determine at its annual meeting that a review is warranted, upon approval of the Board, the respective scheme committee shall be notified…

Building Operations Journey-worker JTA



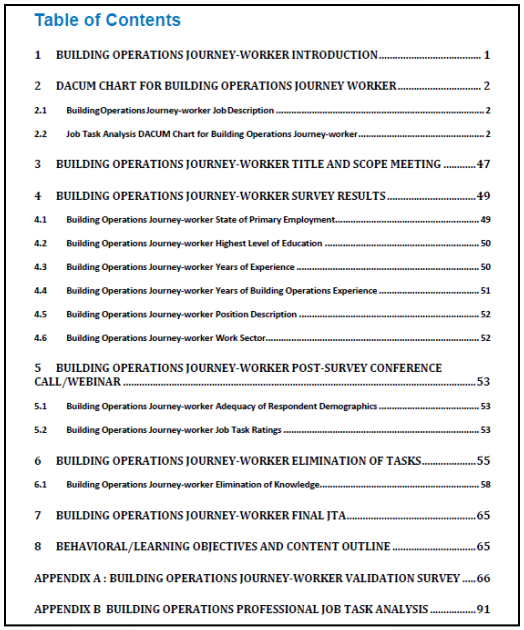
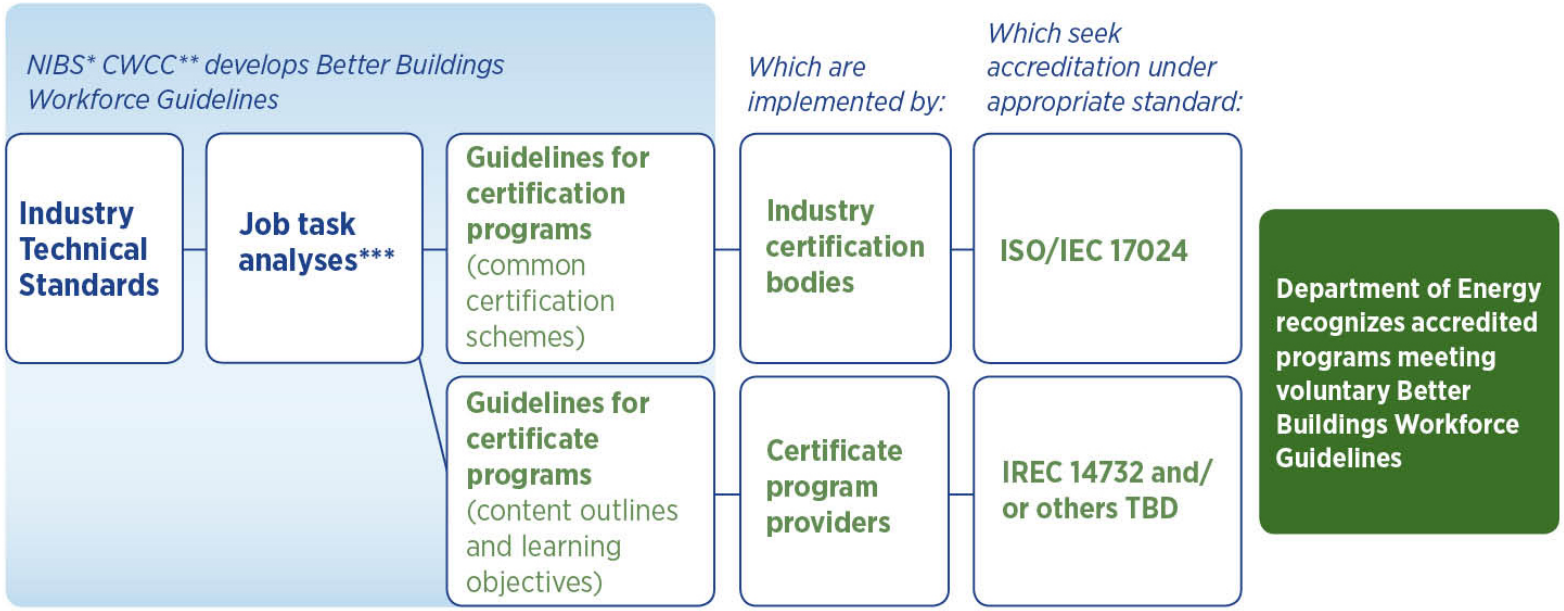


Table of Contents

Job Description

- The Building Operations Journey-worker maintains and operates building systems and installed equipment, and performs general maintenance to maintain the building's operability, optimize building performance, and ensure the comfort, productivity and safety of the building occupants. The Building Operations Journey-worker may provide leadership and training to less senior personnel.

Developing Certificate Recognition Program



*National Institute of Building Sciences
**Commercial Workforce Credentialing Council
*** Building Energy Auditor; Building Commissioning Professional; Energy Manager; Building Operations Professional; Facility Manager (Government and FBPTA focus)

1. Research certificate programs
2. Identify job titles – e.g., BOP Technician
3. Develop scales from existing JTA
4. Survey industry on revised jobs
5. Validate with SME
6. Revise materials for new job

1. Research certificate programs
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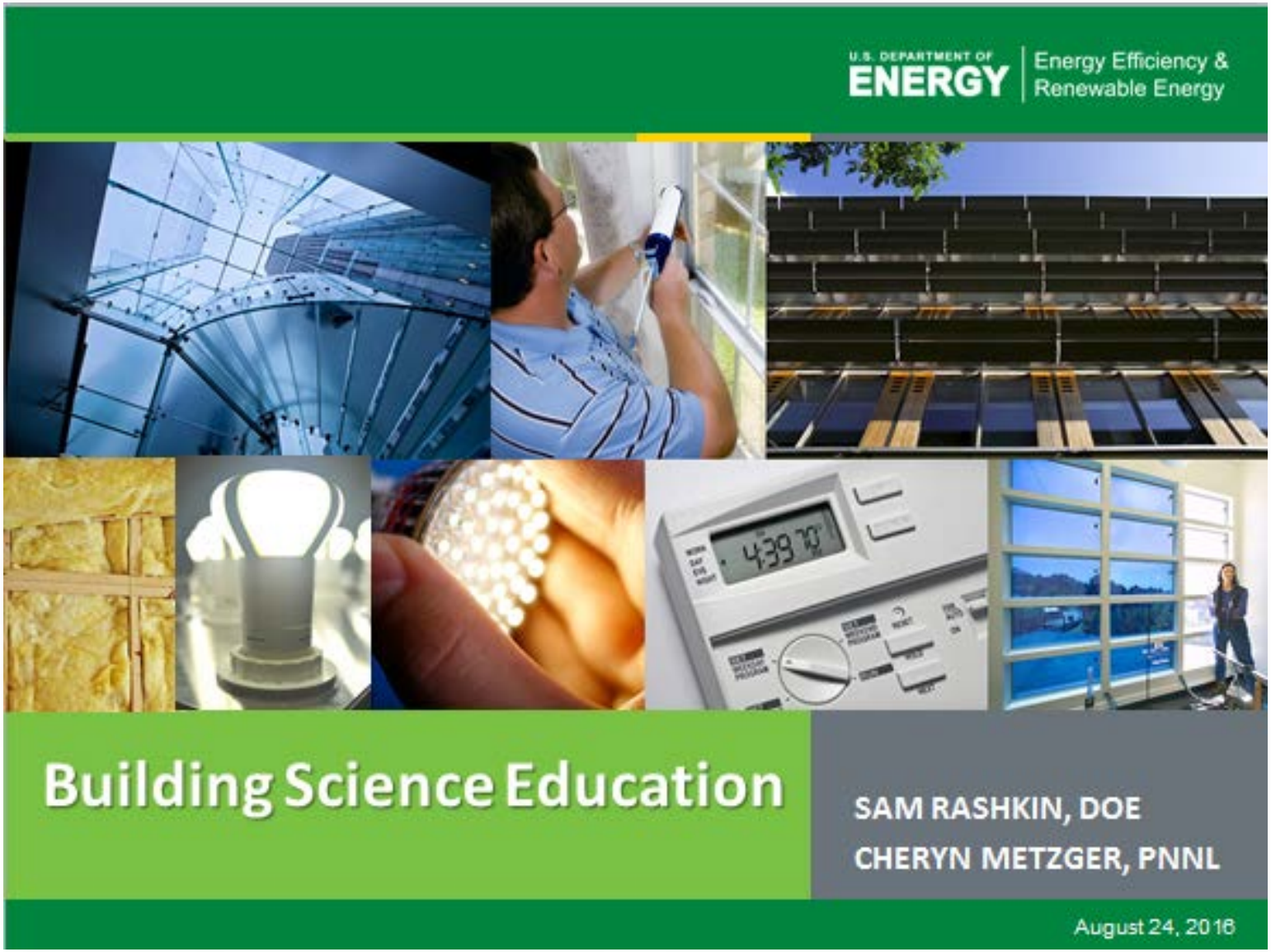
Certificate Program Guidelines

- Recognized 3rd party standards
  - ANSI/ASTM E-2659
  - IREC 14732
- Certificates vs. Certifications
- Accreditation Requirements
- Planning for Accreditation
- Achieving DOE Recognition

Outreach / Demand Building Programs

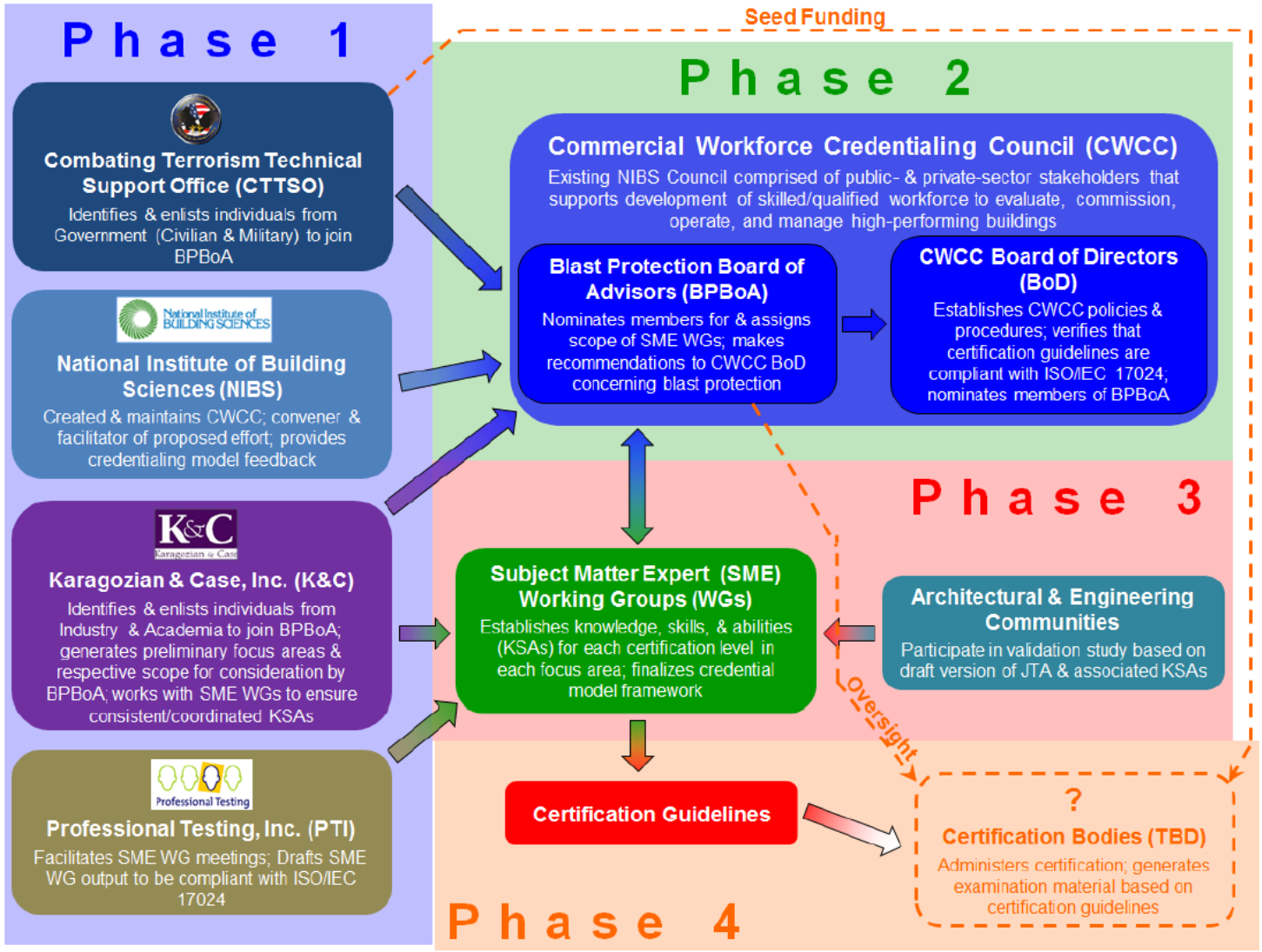
1. Education program development to align with the BBW jobs – Community College Cohort
2. Certificate program for education supporting each BBW job – BOJ JTA and Guidelines
3. Continued support for credentialing bodies to achieve accreditation and DOE recognition
4. City Energy Project Audit and Commissioning Ordinances
5. Federal procurement language
6. Aligning federal requirements
    a. Federal Buildings Personnel Training Act
    b. Council on Environmental Quality/Office of Personnel Management – Energy Manager Job Series
    c. DOD Energy Manager
7. Additional Ideas….

DOE Building Sciences Education Program



CWCC Expansion to Security

CTTSO Blast Professional Credentials Project



CWCC Expansion to Security

- Charter modifications
- Modifications to CWCC BOD
- Formation of CWCC BP BOA
  - Related existing certifications/certifying bodies
  - Education and Training Providers
  - Government and Private Stakeholders
- Formation of Blast Professional JTA and Scheme Committees
- Development of Blast Professional JTA and Scheme
- Adoption and deployment of new JTA

2017 Status and Activity Plan

Completed

- Materials available on NIBS website for download and use, linked from DOE site
- Crosswalks of existing ANSI approved credentials – AEE CEM and ASHRAE Cx
- DOE Recognition awarded to AEE CEM, AEE EA, BCA CCP
- BOJ JTA for certificate program developed

Next Steps

- Release Certificate Recognition Program Guidelines
- Continue to support programs applying for accreditation
- Develop Community College cohort to advance education for EE
- Continued engagement with GSA and other federal agencies to include preferential language in contract
- Ongoing engagement with cities, states and regional energy organizations on energy efficiency regulations
- Ongoing support and outreach activities
- Prepare for updating of EE JTA
- Develop Blast Professional JTA

Timeline

- 2013 – Project Launch
- 2014 – JTA & Scheme Development
- 2015 – Implementation / Roll Out

  ANSI Certification Obtained
- 2016 – First Certifications Recognized

  Certificate Program developed

Annual Meeting 01-11-17

- 2017 – Accreditation, Recognition

  Outreach, Planning for Update
- 2018 – BP JTA/Scheme Available,

  EE JTA Update Process Begins

Commercial Workforce Credentialing Council

Questions?

Contact Information:

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rgrant@nibs.org

Priya Swamy

priya.swamy@ee.doe.gov

Commercial Workforce Credentialing Council

a council of the National Institute of Building Sciences

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Building Science Education

SAM RASHKIN, DOE
CHERYN METZGER, PNNL

August 24, 2016

Overview of Presentation

New Partnership between commercial and residential buildings efforts

- Focus on external perception of a united front
- We need your input on some key decisions to move forward

Survey to obtain feedback on:

- Additional job classifications
- Additional core competency topics
- Website integration

Survey Link:

https://www.surveymonkey.com/r/72CHV9F

Why Building Science Education

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Supply System:
Workforce Competent in Building Science

Product on Shelf:
Better Buildings
> Comfort
> Health
> Safety
> Durability

Market Demand:
Consumers and Transaction Process That Value Better Buildings

Better Buildings Big Prize:
- **$100s B** Savings
- **Millions** MMTCe
- **100,000s** of Jobs
- National Security

Coordination with Commercial Building's Better Buildings Workforce Guidelines

Similarities

- **Goals:**
  - Improving building performance
  - Better credentials for a better workforce
  - Critical mass of knowledgeable workforce

- **Development**
  - Industry involvement
  - Many input opportunities for stakeholders
  - Partnering with education programs for alignment
  - Aligning with other private and federal efforts
- **Collective Impact Process:**
  - Adoption of guidelines by education/training programs

Differences

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Workforce Guidelines

Framework	End Goal	Partner Strategy
4 Specific workforce classifications (specific task training)	Specific knowledge, skills & abilities related to those tasks	Exclusive involvement

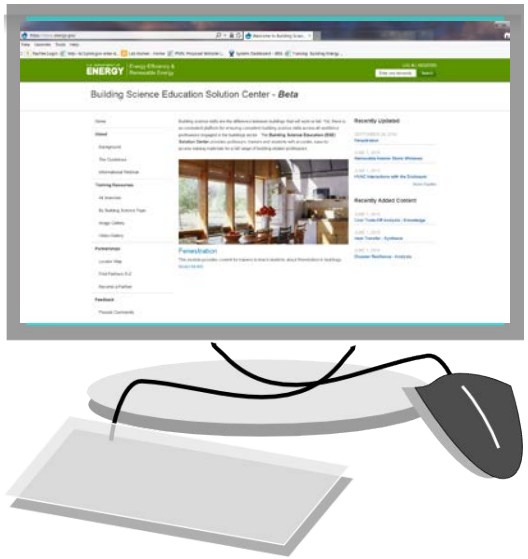
Guidelines for Building Science Education

Framework	End Goal	Partner Strategy
Full spectrum workforce classifications (general BS knowledge)	Workforce prepared to integrate building science into all tasks	As much involvement as possible

Our Approach

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

1. Online Solution Center



- Audience: professors and trainers
- Easy access to consistent, peer reviewed training materials

2. Collective Impact Campaign*

- Target Partners: Educational Institutions (small programs to big universities)
- Easy access to official partners for students

*Kania and Kramer, Stanford Social Innovation Review, 2011

Consistent Framework – Career Classifications

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Career Classifications

1 High-School Ed.	2 Builder/ Remodel Pros	3 Program/ Project Manager	4 Transact. Process Pros	5 Design/ Construc. Pros	6 Building Science Pros	7 Home Energy Pros	8 Building Depart.
Physics	Builder	Utllity	Realtor	A/E Degree	Forensics	Auditors	Code Offic.
	GC/Forem.	Energy Eff.	Appraiser	Lic. Arch.	QA Envel.	Perf Assess	
	Remodeler	Maint. Pro	Home Insp	Mech. Eng.	QA M&E		
	Insulater	Facil. Man.	Insurers	Civil/Struc.			
	HVAC		Lenders	Mat. Sci.			
	Plumber			Designers			
	Home Perf.			Landscape			
				Const. Man			

= Overlap with Better Buildings Workforce Guidelines

Consistent Framework – Building Science Skills

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Building Science Skills

1 Integration of Whole-Bldg. Sys.	2 Building Science Principles	3 Operations & Maintenance	4 Building Testing
1.1 Performance	2.1 Heat Transfer	3.1 User Interface/Cont.	4.1 Commissioning
1.2 Life-Cycle Cost Eff.	2.2 Material Selection	3.2 Preventative Maint.	4.2 Diag. & Forensics
1.3 Disaster Resistance	2.3 Moisture Transport	3.3 Replacement/Renov.	4.3 Perf. Mon./Assess.
I.4 Int. Design & Const.	2.4 Control Layers		4.4 Ntl. Codes & Stds
1.5 Quality Management	2.5 Convective Transprt.		4.5 Cert. Programs
1.6 Bldg/Energy Model'g	2.6 Hygrothermal Anal.		
1.7 Cost Trade-Off Anal.	2.7 HVAC Systems		
	2.8 HVAC Inter. w/Struc.		
	2.9 Fenestration		
	2.10 Plumbing Systems		
	2.11 Electrical Systems		
	2.12 Lgting & Appliances		
	2.13 Indoor Air Quality		
	2.14 Control/Automation		

Consistent Framework – Proficiency Levels

Building Science Proficiency Based on Blooms Taxonomy

6	**Create** (Design)
5	**Evaluate** (Synthesis)
4	**Analyze** (Analysis)
3	**Apply** (Application)
2	**Understand** (Comprehension)
1	**Remember** (Knowledge)

Consistent Framework - Building Science Education Matrix

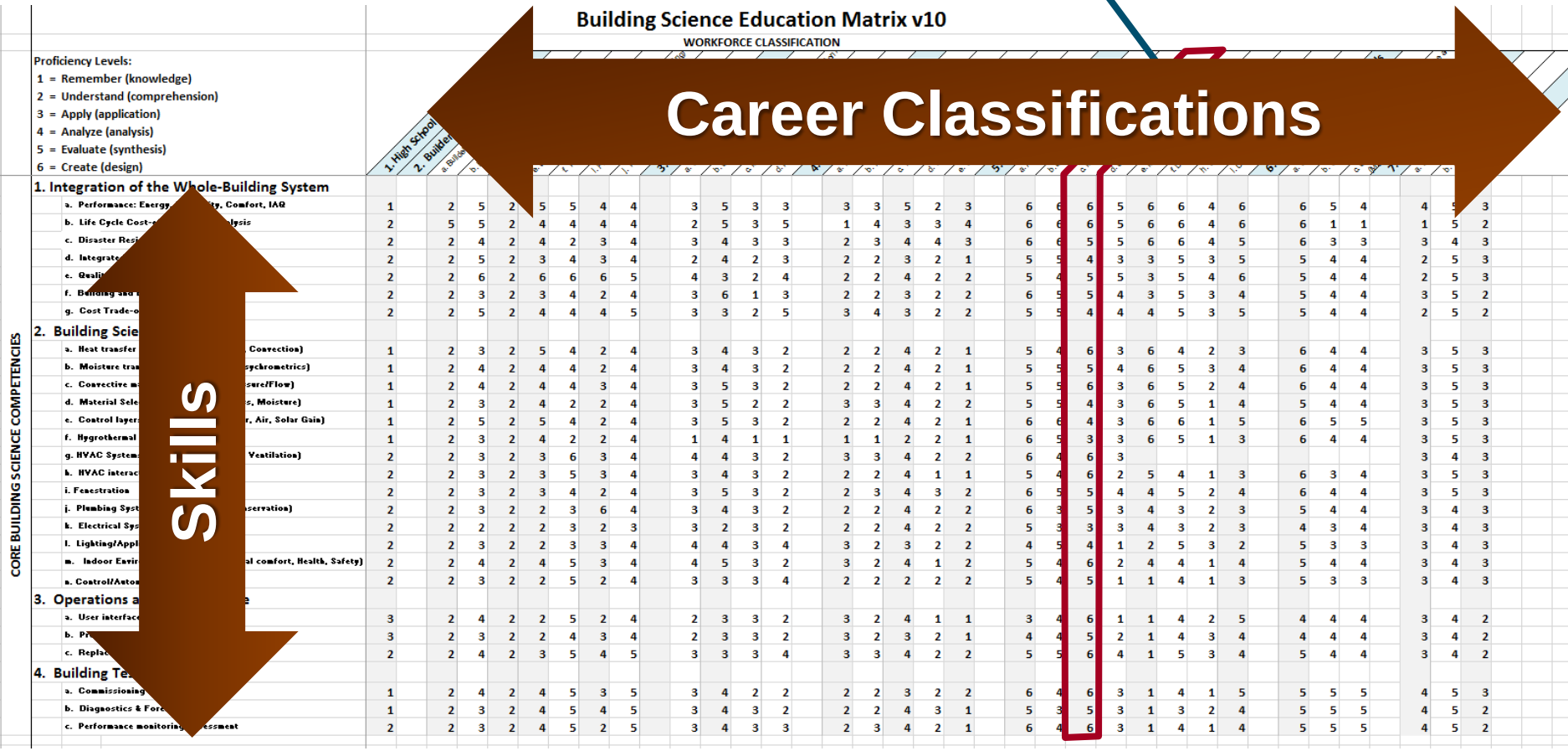
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Mechanical Engineer Guideline

Work in Progress

Career Classifications

Skills

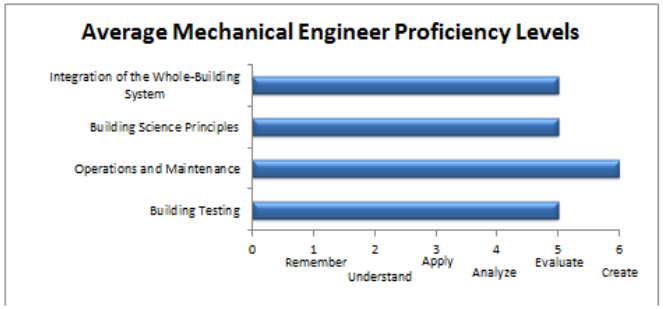


Consistent Framework – Sample Guideline

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Building Science Education Guidelines for Mechanical Engineers

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



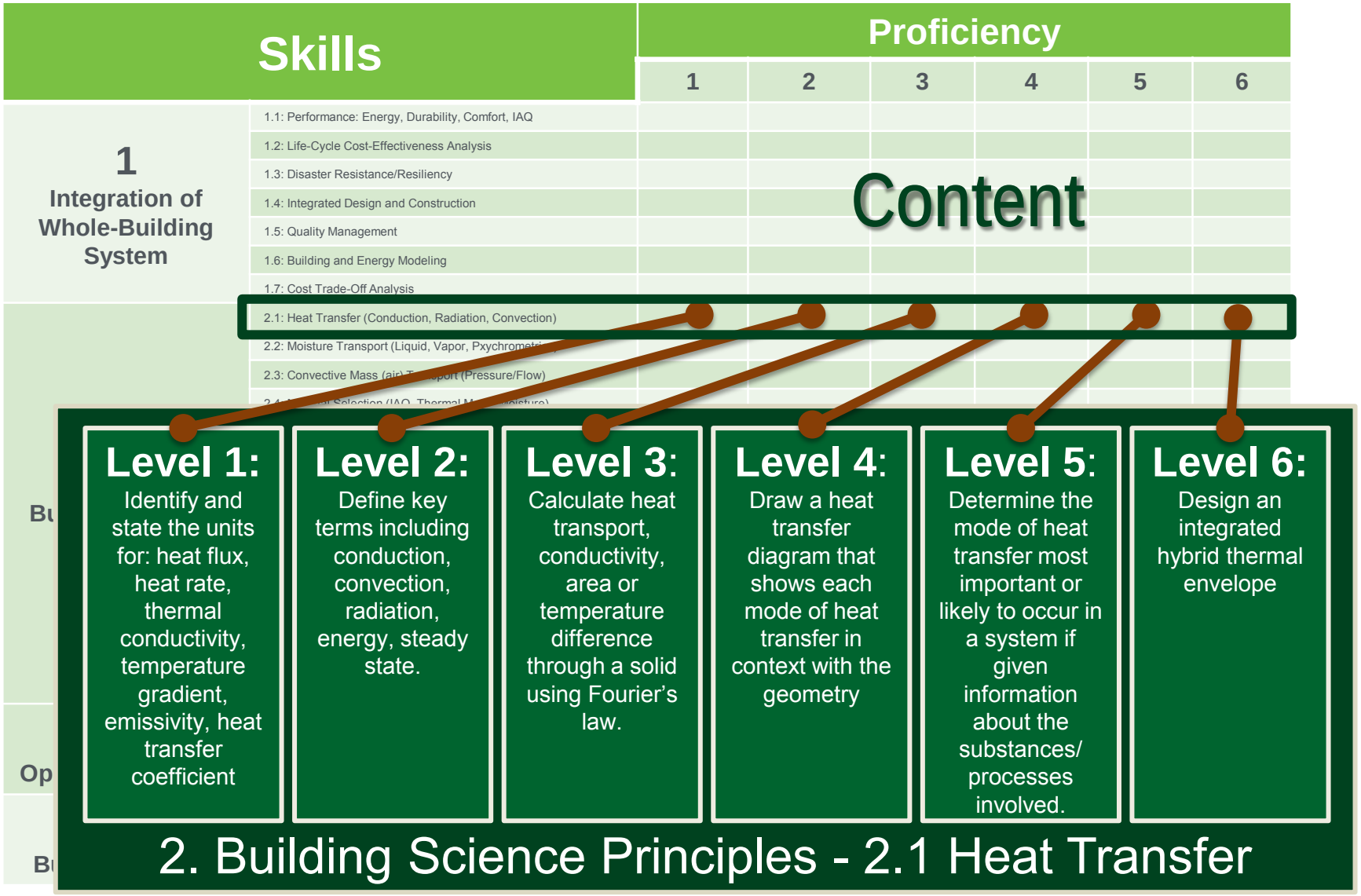
As the entity responsible for managing home energy certifiers, a mechanical engineer should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 5	
Simultaneous consideration of energy, durability, comfort and IAQ	6	☐
Annualized cash flow	6	☐
Building techniques related to natural and man-made disasters	5	☐
Integrated design and construction	4	☐
Quality management	5	☐
Building energy modeling	5	☐
Cost trade-off analysis (optimized first costs)	4	☐
Building science principles related to the enclosure	Average = 5	
Heat transfer (convection, conduction and radiation)	6	☐
Moisture transport of liquid	5	☐
Convective air transport due to pressure differences	6	☐
Material selection (IAQ, thermal mass, moisture)	4	☐
Controls layers (heat, vapor, water, air and solar gain)	4	☐
Hygrothermal analysis	3	☐
HVAC systems (heating, cooling and ventilation)	6	☐
HVAC interactions with the enclosure	6	☐
Fenestration considerations	5	☐
Plumbing systems (heating, distribution, conservation)	5	☐
Electrical systems	3	☐
Lighting/appliances and miscellaneous loads	4	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	6	☐
Control/automation systems	5	☐
Operations and maintenance	Average = 6	
User controls (ex: thermostat)	6	☐
Preventative maintenance (ex: cleaning air filters)	5	☐
Determination of appropriate replacement choices	6	☐
Building testing and certification	Average = 5	
Commissioning	6	☐
Diagnostics and forensics	5	☐
Monitoring	6	☐
National codes and standards	3	☐
Certification programs	3	☐

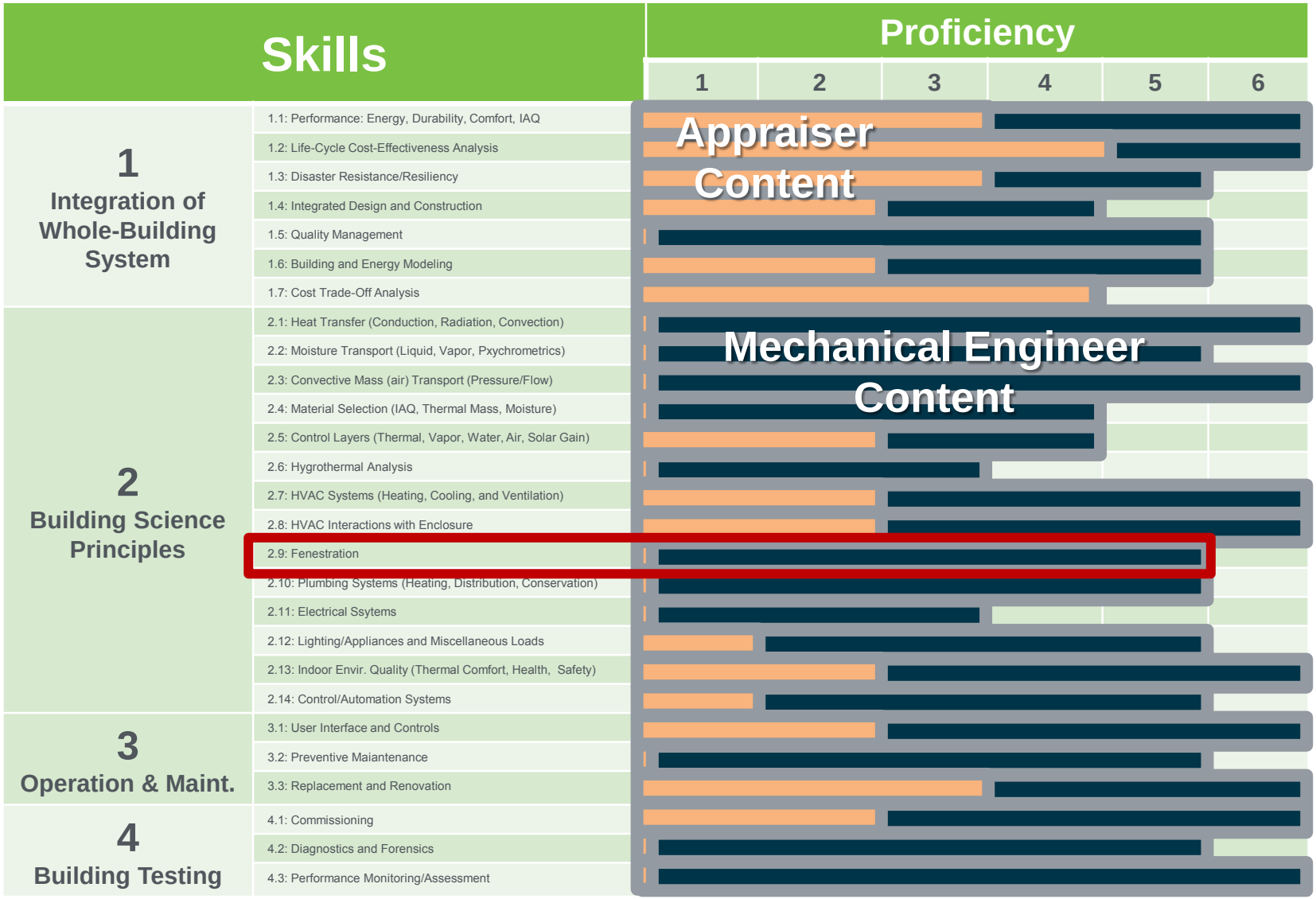
The _____ mechanical engineer certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category


Skills
Proficiency
1
2
3
4
5
6
1
Integration of Whole-Building System
1.1: Performance: Energy, Durability, Comfort, IAQ
1.2: Life-Cycle Cost-Effectiveness Analysis
1.3: Disaster Resistance/Resiliency
1.4: Integrated Design and Construction
1.5: Quality Management
1.6: Building and Energy Modeling
1.7: Cost Trade-Off Analysis
2.1: Heat Transfer (Conduction, Radiation, Convection)
2.2: Moisture Transport (Liquid, Vapor, Pxychrometri
2.3: Convective Mass (air) T sport (Pressure/Flow)
Content
Level 1:
Identify and state the units for: heat flux, heat rate, thermal conductivity, temperature gradient, emissivity, heat transfer coefficient
Level 2:
Define key terms including conduction, convection, radiation, energy, steady state.
Level 3:
Calculate heat transport, conductivity, area or temperature difference through a solid using Fourier's law.
Level 4:
Draw a heat transfer diagram that shows each mode of heat transfer in context with the geometry
Level 5:
Determine the mode of heat transfer most important or likely to occur in a system if given information about the substances/ processes involved.
Level 6:
Design an integrated hybrid thermal envelope
2. Building Science Principles - 2.1 Heat Transfer

Content


Skills
Proficiency
1
2
3
4
5
6
1
Integration of Whole-Building System
1.1: Performance: Energy, Durability, Comfort, IAQ
1.2: Life-Cycle Cost-Effectiveness Analysis
1.3: Disaster Resistance/Resiliency
1.4: Integrated Design and Construction
1.5: Quality Management
1.6: Building and Energy Modeling
1.7: Cost Trade-Off Analysis
2
Building Science Principles
2.1: Heat Transfer (Conduction, Radiation, Convection)
2.2: Moisture Transport (Liquid, Vapor, Pxychrometrics)
2.3: Convective Mass (air) Transport (Pressure/Flow)
2.4: Material Selection (IAQ, Thermal Mass, Moisture)
2.5: Control Layers (Thermal, Vapor, Water, Air, Solar Gain)
2.6: Hygrothermal Analysis
2.7: HVAC Systems (Heating, Cooling, and Ventilation)
2.8: HVAC Interactions with Enclosure
2.9: Fenestration
2.10: Plumbing Systems (Heating, Distribution, Conservation)
2.11: Electrical Ssytems
2.12: Lighting/Appliances and Miscellaneous Loads
2.13: Indoor Envir. Quality (Thermal Comfort, Health, Safety)
2.14: Control/Automation Systems
3
Operation & Maint.
3.1: User Interface and Controls
3.2: Preventive Maiantenance
3.3: Replacement and Renovation
4
Building Testing
4.1: Commissioning
4.2: Diagnostics and Forensics
4.3: Performance Monitoring/Assessment
Appraiser Content
Mechanical Engineer Content

ENERGY.GOV
Office of Energy Efficiency & Renewable Energy

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BUILDING SCIENCE EDUCATION SOLUTION CENTER

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Job Classification

Click on the image above to find content organized by job classification. Examples include mechanical engineer, appraiser, home performance contractor, code official and many more!

READ MORE

The Building Science Education Solution Center provides complete, accurate training material and curriculum for a full range of building-related professions. New to the BSE Solution Center? Visit our webinar for detailed information and a tour of the BSE Solution Center.

As a community-driven tool, we welcome your comments on how to continuously improve the Solution Center. Educators and professors should register to unlock assessment questions and practice problems.

RECENTLY UPDATED

AUGUST 17, 2015
Disaster Resilience - Analysis

AUGUST 17, 2015
Cost Trade-Off Analysis - Knowledge

AUGUST 17, 2015
Commissioning - Understand

More Guides

RECENTLY ADDED CONTENT

AUGUST 17, 2015
Removable Interior Storm Windows

AUGUST 17, 2015
Taped Insulating Sheathing Drainage Panes

AUGUST 17, 2015
Job Classification

http://bsesc.energy.gov

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Job Classifications

Click on the component for a list of corresponding component subcategories. Select on subcategory to display a list of related Guides.

DESIGN & CONSTRUCTION PROFESSIONALS

- Architect
- Mechanical Engineer
- Civil Engineer
- Landscape Architect
- Material Science Engineer

TRANSACTION PROFESSIONALS

CODE OFFICIALS

BUILDING SCIENCE PROFESSIONALS

PROGRAM MANAGERS

K-12 SCHOOLS

HOMEOWNERS

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Mechanical Engineer Checklist

- ▶ Building Science Principles
- ▶ Integration of the Whole-Building System
- ▶ Operations and Maintenance
- ▶ Building Testing and Certification

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Mechanical Engineer Checklist

▶ Building Science Principles

▶ Integration of the Whole-Building System

Heat Transfer
Moisture Transport
Convection Mass (air) Transport
Material Selection
Control Layers
Hygrothermal Analysis
HVAC Systems
HVAC Interactions with the Enclosure
Fenestration
Plumbing Systems
Electrical Systems
Lighting, Appliance, and Miscellaneous Loads
Indoor Environmental Quality
Control/Automation systems

▶ Operations and Maintenance

▶ Building Testing and Certification

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Fenestration

Learning Objectives | Lecture Notes | Teaching Materials | Problem Sets

Proficiency Level 1: Remember

Define key terms including u-factor, NFRC label, SHGC, VT, air leakage, and LSG.

Describe different window operation methods and be prepared to comment on air leakage implications.

Proficiency Level 2: Understand

Describe types of window frames and glazing including low-e, tinting, and reflective coatings

Describe ways that sunlight transmittance is measured and rated.

Explain distinguishing features of each of the primary glazing types including tints, low-e, etc.

Proficiency Level 3: Apply

Sketch the primary components of a window and describe the role that each plays (frame, panes, sill, etc.).

Proficiency Level 4: Analyze

Classify window performance for specific regions using information from the NFRC label.

Explain the importance of u-factors in predicting window performance.

Proficiency Level 5: Evaluate

Select the best window system for specific orientations and geography.

Automatic or manual proficiency level filter

Fenestration (i.e. windows and skylights) provide our homes with light, warmth, and ventilation. When properly designed, selected and installed, energy-efficient windows can help minimize heating, cooling, and lighting costs, while improving comfort for building occupants.

Level 1: Remember
Level 2: Understand
Level 3: Apply
Level 4: Analyze
Level 5: Evaluate
Level 6: Design

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Fenestration

Learning Objective | Lecture Notes | Teaching Materials | Problem Sets

Proficiency Level 1: Remember

Fenestration – Key Terms - Remember

Fenestration – Primary Window Components - Remember

Proficiency Level 2: Understand

Fenestration – Window Types - Understand

Fenestration – Physical Measurements and Rating Labels - Understand

Fenestration – Distinguishing Features - Understand

Proficiency Level 3: Apply

Fenestration – Correct Window Installation Methods -- Apply

Proficiency Level 4: Analyze

Fenestration – Window Performance - Analyze

Fenestration – Importance of U-Factors - Analyze

Proficiency Level 5: Evaluate

Fenestration – Primary Window Components - Evaluate

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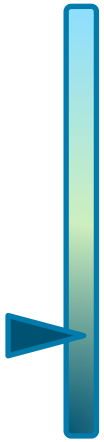

Level 1: Remember
Level 2: Understand
Level 3: Apply
Level 4: Analyze
Level 5: Evaluate
Level 6: Design

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Fenestration

Learning Objectives | Lecture Notes | Teaching Materials | Problem Sets

Videos That Explain High Performance Glass

This series of videos explains everything from basic types of windows, to the physics associated with cold ar window performance.

Glazing Type Handout

This handout can be altered to provide the basis for a homework problem.

Videos

Daylighting

This video describes how to encourage daylighting design in buildings to save on energy costs associated w lighting.

Window U-Value Calculation

This video describes how window U-value is calculated.

Thermal Conductivity and Thermal Resistance

This video describes how to calculate thermal conductivity and thermal resistance of building components.

Fenestration (i.e. windows and skylights) provide our homes with light, warmth, and ventilation. When properly designed, selected and installed, energy-efficient windows can help minimize heating, cooling, and lighting costs, while improving comfort for building occupants.

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Fenestration

Learning Objectives | Lecture Notes | Teaching Materials | Problem Sets

Appropriate Use of Low-E Coatings

Should Low-E coatings be used in a hot climate area?

Improving Window Performance

Which of the following options would NOT improve the performance of a window?

(a) Increase airtightness of a window

(b) Increase the number of glass panes.

(c) Increase the thermal performance of the window frame.

(d) Increase the thickness of glass.

NFRC Label Information

List 3 window performance measures that appear on an NFRC label?

Advantage of Inert Gas in Windows

Type of Problem: Homework

One of the advantages of a window assembly that uses an inert gas in the air gap is:

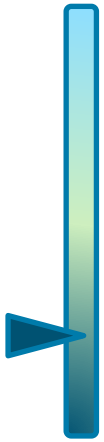
(a)Inert gases are not explosive.

(b)The inert gas acts as an insulator and reduces the heat transfer through the window.

(c)These windows can use single pane glazing.

(d)Windows with inert gases are low cost.

Fenestration (i.e. windows and skylights) provide our homes with light, warmth, and ventilation. When properly designed, selected and installed, energy-efficient windows can help minimize heating, cooling, and lighting costs, while improving comfort for building occupants.



Level 1: Remember
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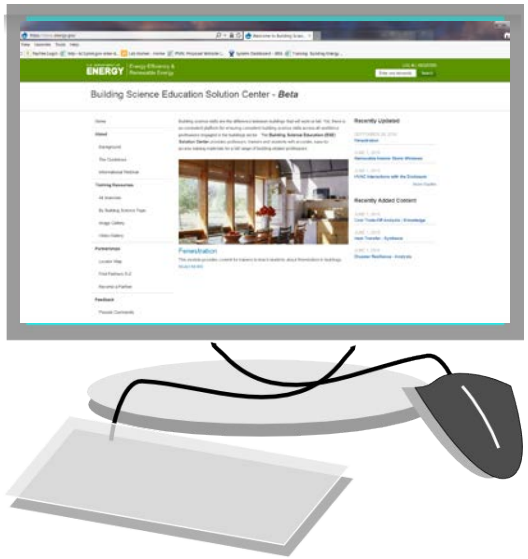
Our Approach

1. Online Solution Center



- Audience: professors and trainers
- Easy access to consistent, peer reviewed training materials

2. Collective Impact Campaign*

- Target Partners: Educational Institutions (small programs to big universities)
- Easy access to official partners for students

*Kania and Kramer, Stanford Social Innovation Review, 2011

Targeted Stakeholders

Trade Associations

- Licensing Exams
- Continuing Education

Universities/Colleges

- Existing curriculum infusion
- New classes
- Structured minor
- State Licensing Exams

General Public

- High Schools

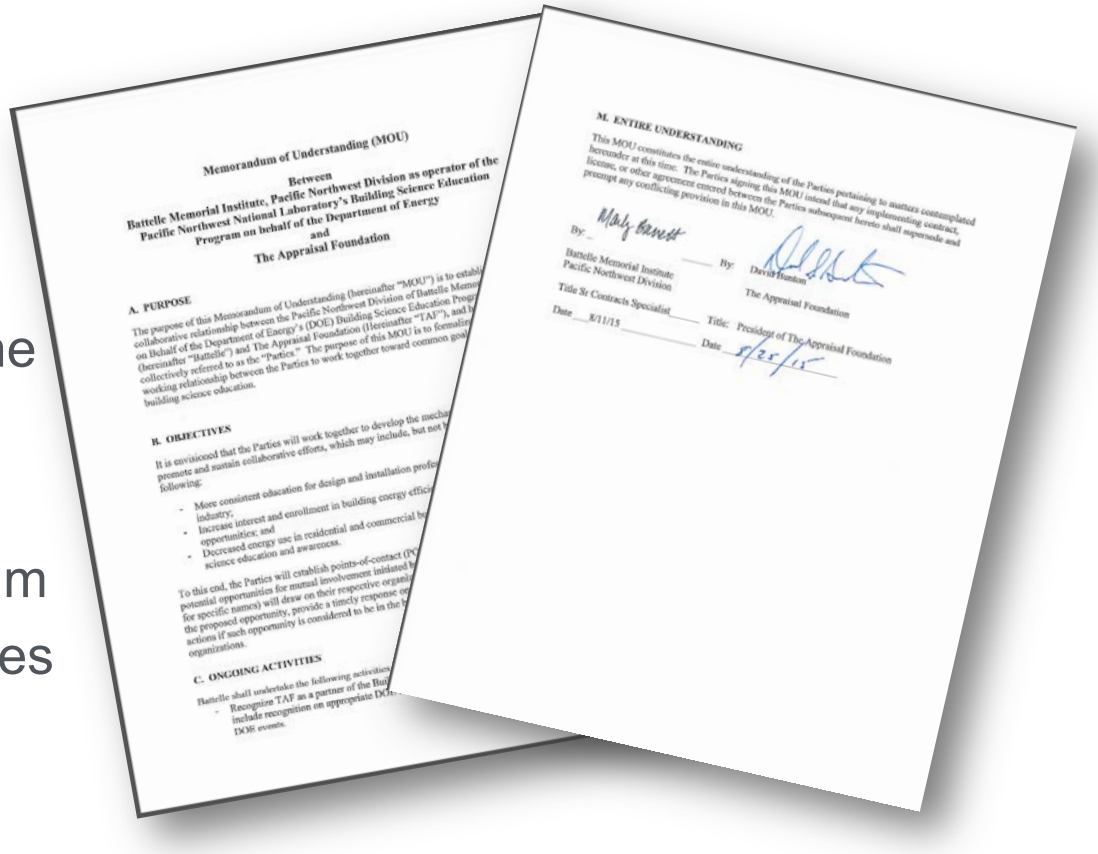
Stakeholder Classifications

Collaborators

- Partner content used on Building Science Education Solution Center (BSESC) website
- Peer reviewer of content

Stakeholders

- MOUs developed to collaborate on final guideline content for a given job classification
- Agreement to have curriculum consistent with the guidelines
- Entity listed/promoted on website


Memorandum of Understanding (MOU)

Between

Battelle Memorial Institute, Pacific Northwest Division as operator of the Pacific Northwest National Laboratory's Building Science Education Program on behalf of the Department of Energy

and

The Appraisal Foundation

A. PURPOSE

B. OBJECTIVES

C. ONGOING ACTIVITIES

M. ENTIRE UNDERSTANDING

This MOU constitutes the entire understanding of the Parties pertaining to matters contemplated hereunder at this time. The Parties signing this MOU intend that any implementing contract, license, or other agreement entered between the Parties subsequent hereto shall supersede and preempt any conflicting provision in this MOU.

By: _____ By: _____

Battelle Memorial Institute
Pacific Northwest Division

Title Sr Contracts Specialist

Date 8/11/15

The Appraisal Foundation

Title: President of The Appraisal Foundation

Date 8/25/15

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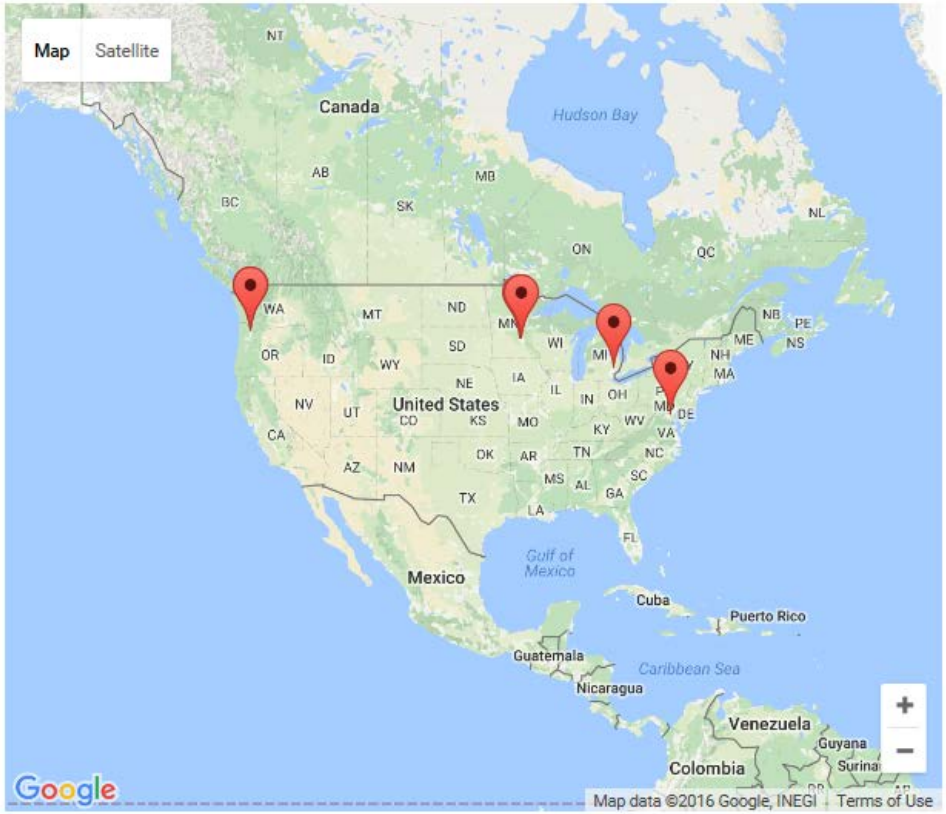
Partners Map



BUILDING TYPE

Residential (6)
Both (4)
Commercial (4)

JOB CLASSIFICATION

Material Science Engineers (2)
Mechanical Engineers (2)
Appraisers (1)
Builders/Remodelers (1)
Civil and Structural Engineers (1)

PARTNERSHIP LEVEL

Silver (4)

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Shiley School of Engineering - University of Portland

The University of Portland is a thriving community of over 5,000 students, faculty and staff located on a bluff overlooking the booming metropolitan city of Portland, Oregon.

Featured Story:

"The University of Portland's Shiley School of Engineering recognizes that the high performance building industry is a growing field. Our School is excited to partner with the Pacific Northwest National Laboratory to bring awareness to these job opportunities and support the Department of Energy's Guidelines for Building Science Education. Thanks to Dr. Heather Dillon of the Mechanical Engineering program, who helped develop this partnership, our students will be some of the first in the country to have access to the world-class teaching materials available through PNNL and DOE."

Dean Sharon Jones – Shiley School of Engineering

Partner Website: http://engineering.up.edu/

Action Item – Respond to Survey

https://www.surveymonkey.com/r/72CHV9F

Length: 5 Minutes

Deadline: COB Thursday, January 12th

Survey Questions:

- Additional job classifications
- Additional core competency topics
- Website integration

Food for Thought:

- "Just enough" job classification and topic coverage
- "Just enough" information to users on both websites to provide information when they need it without confusing them.
- How to balance publically accessible information with information that can be used for profit.

Thank you!

Sam Rashkin
Samuel.Rashkin@ee.doe.gov

Cheryn Metzger
Cheryn.Metzger@pnnl.gov

To: ASHRAE President, Tim Wentz; ASHRAE Excom; Mary Townsend

From: Dan Pettway, ASHRAE NATE Liaison

Subject: Report from NATE Fall Board Meeting

NATE (North American Technician Excellence) held its Fall Board Meeting on October 19th, 2016 at the AHRI Headquarters in Arlington, Virginia. ASHRAE President, Tim Wentz, assigned me to be Society's liaison to NATE for this year. I was quite surprised to learn that the assignment also placed me on the NATE Board of Trustees. For those who may not be familiar with the organization, NATE is an independent, non-profit national organization that represents a shared commitment to improving the HVAC/R industry through voluntary testing and certification of HVAC/R service technicians, similar to ASE Certifications in the automotive industry. NATE operates under an administration services agreement with AHRI, probably similar to how IAQA operates under ASHRAE.

Meeting Highlights

Discussions that organizations are moving towards installation quality assessment programs and away from equipment only ratings, as poor installation quality affects loss of performance and increased warranty issues. Improper duct sizing and improper system charging are the worst offenders preventing equipment from reaching rated performances.

EPA is considering moving from its Energy Star Quality Installation Program to an Energy Star Verified Installation Program. No Details of either programs were provided.

ACCA is in discussions with DOE about producing a mandated quality installation program. No details were provided.

NATE is advising EPA on a planned overhaul of the Part 608 Refrigerant Handling Exam, adding re-certifications and flammable refrigerant handling. There was mention of considerations by AHRI for a globally recognized Refrigerant Driver's License, especially driven with the advent of flammable refrigerants.

NATE was considering attaining ANSI Certification for its Master Technician Certification at a budgeted cost of $40,000.00. NATE has determined no need for the ANSI Certification at this time.

NATE staff reported strong financial results for the year to date. Additional revenues resulted from changes in their testing vendor, changes in their recertification requirements decreasing the continuation education requirements, reducing the number of years between re-certification, reducing the re-certification fee, and introducing online payments. Exam sales to date have exceeded budget and are projected to finish at 21% for year end. Their receivables are down due to effective collection efforts by Staff. The

board approved a 2017 budget which included hiring two new staff members for customer service and marketing. The board approved a new slate of officers for the upcoming year.

In closing I would like to thank Tim Wentz for the opportunity to serve as ASHRAE's Liaison to NATE. I discovered that two long time acquaintances are currently serving there. This opportunity also allows me to provide additional volunteer service to improve the industry through another industry organization. Please direct any questions to my email.

Respectfully Submitted

REPORT TO THE EXECUTIVE COMMITTEE
From ASHRAE representative to the AEDG Steering Committee
As of January 28, 2017

Recommendations for ExCom Approval:

1. None.

Information Items:

1. Distribution Recap as of January 13, 2015
   - 580,364 AEDGs downloaded as of January 13, 2016
   - 26,256 titles distributed in print
   - **606,620 total copies in circulation as of January 13, 2016**
   - 150,860 registrants account for free AEDG downloads

   - 63,178 copies of 50% AEDG-SMO since May, 2011
   - 29,281 copies of 50% AEDG-K12 since October, 2011
   - 44,550 copies of 50% AEDG-Retail since January 2012
   - 20,165 copies of 50% AEDG-Hospital since May 2012
   - 5,595 copies of 50% AEDG-Grocery since March 2015

2. Development of the *Advanced Energy Design Guide for K-12 Buildings: Achieving a Zero Energy Building* began in October 2016. The Project Committee met in October 2016 and January 2017. The first Peer Review is scheduled for February 6-20, 2017.

3. One of the deliverables for the K-12 ZEB AEDG is a Resource Review list detailing documents, tools, websites and other resources related to zero energy schools. This list will continue to be expanded throughout the development of the guide.

4. DOE has launched an Accelerator for zero energy K-12 schools that will coordinate information with the new AEDG. This concentrated outreach effort will look for states, school districts, and individual schools that desire to build zero energy schools. The accelerator will promote previously constructed K-12 schools and use the lessons-learned to help others achieve the same goal.

5. A presentation on the K-12 ZEB guide has been accepted for the AIA annual convention in Orlando on April 27-29. A presentation has also been submitted for Greenbuild 2017 in November 2017.

6. TC 9.6 is looking into the development of a zero energy design guide for large hospitals in collaboration with a European society. They have reached out to the AEDG Steering Committee regarding coordination on that initiative.

Date

Pat Graef, ASHRAE Representative

Attachment 5
ExCom Minutes: 2017 January 28, February 1 and 2

CRC SCHEDULE 2016-2017

FALL 2016	HOST CHAPTER LOCATION	ALTERNATE CHAPTER LOCATION	TARGET MONTH/WEEK (1st, 2nd, 3rd week, etc.)	ACTUAL CRC DATES	OFFICIAL VISITOR	STAFF	CRC CHAIR
REGION I	ROCHESTER ROCHESTER, NY	LONG ISLAND GARDEN CITY, NY	AUGUST 3RD WEEK	AUGUST 18-20	WENTZ/CHAKROUN	WRIGHT	JIM BROWE
REGION II	NB/PEI MONCTON, NB	MONTREAL MONTREAL, PQ	AUGUST 4TH WEEK	AUGUST 26-28	HAYTER/SCOGGINS	ABRAMS	DAN BOUDREAU
REGION III	PHILADELPHIA PHILADELPHIA, PA	ROANOKE ROANOKE, VA	AUGUST 3RD WEEK	AUGUST 18-20	HAYTER/TSUI	MITCHELL	GARY DEBES
REGION IV	ATLANTA ATLANTA, GA	NORTH PIEDMONT GREENSBORO, NC	AUGUST 2ND WEEK	AUGUST 11-13	WENTZ/TSUI	LITTLETON	BRIAN JUSTICE
REGION V	DAYTON DAYTON, OH	NORTHERN INDIANA SOUTH BEND, IN	JULY 4TH WEEK	JULY 28-30	WENTZ/GRAEF	ABRAMS	EVAN NUTT
REGION VII	BIRMINGHAM BIRMINGHAM, AL	TENNESSEE VALLEY CHATTANOOGA, TN	AUGUST 1ST WEEK	AUGUST 4-6	OLESEN/SCOGGINS	COMSTOCK	CHRIS GRAY GREG HAMAKER
REGION IX	NEBRASKA OMAHA, NE	KANSAS CITY KANSAS CITY, MO	AUGUST 1ST WEEK	AUGUST 4-6	WENTZ/GRAEF	LITTLETON	TYLER GLESNE
REGION X	SOUTHERN CALIFORNIA LOS ANGELES, CA	SACRAMENTO VALLEY SACRAMENTO, CA	AUGUST 3RD WEEK	AUGUST 11-13	OLESEN/CHAKROUN	MASTERSON	CHRISTINE LAZO
REGION XII	SOUTHWEST FLORIDA FORT MEYERS, FL	BRASIL SAO PAULO, BRAZIL	AUGUST 3RD WEEK	AUGUST 4-6	HAYTER/CHAKROUN	RAMSPECK	RICHARD BROOKS
REGION XIII**	THAILAND BANGKOK, THAILAND	SINGAPORE SINGAPORE	AUGUST 4TH WEEK	SEPT 30 – OCT 2	ALL OFFICERS	ALL DIRECTORS ADELEMANN	APICHIT LUMLERTPONGPANA
RAL**	THAILAND BANGKOK, THAILAND	SRI LANKAN COLOMBO	SEPTEMBER 3RD WEEK	SEPT 30 – OCT 2	ALL OFFICERS	ALL DIRECTORS ADELEMANN	PANKAJ DHARKAR
SPRING 2017	**HOST CHAPTER LOCATION**	**ALTERNATE CHAPTER LOCATION**	**TARGET MONTH/WEEK (1st, 2nd, 3rd week, etc.)**	**ACTUAL CRC DATES**	**OFFICIAL VISITOR**	**STAFF**	**CRC CHAIR**
REGION VI	ST LOUIS ST LOUIS, MO	IOWA DES MOINES, IA	MAY 1ST WEEK	APRIL 20-22	WENTZ/SCOGGINS	PETTIGREW	BRIAN INGENTHRON
REGION VIII	CENTRAL OKLAHOMA OKLAHOMA CITY, OK	ALAMO SAN ANTONIO, TX	APRIL 4TH WEEK	APRIL 27-29	OLESEN/TSUI	COMSTOCK	JOHN SEMTNER JOE SANDERS
REGION XI	PUGET SOUND SEATTLE, WA	VANCOUVER ISLAND VICTORIA, BC	MAY 2ND WEEK	MAY 18-20	WENTZ/GRAEF	GUPTA	TAMAS BENCSIK

Additions and/or revisions are shaded. ** Joint CRC Regions
Revised: January 17, 2017
Distribution: EXCOM, DRCs, LITTLETON, TOWNSEND, COMSTOCK, WRIGHT, ABRAMS, RAMSPECK, GUPTA, MITCHELL, ADELMANN, PETTIGREW, GURLEY, MASTERSON, SCARBOROUGH, GRANT, KELLER, RATCLIFF