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Transforming an Existing Building into a High-Performing Facility

ASHRAE DL, Dinner Presentation, London, ONT – 03/25/19

James L. Newman

CEM, LEED AP BD+C, ASHRAE OPMP & BEAP

ASHRAE
- Trainer, ANSI/ASHRAE/IESNA Energy Standard 90.1
- Corresponding Member, Air-to-Air Energy Recovery Technical Committee and Operations and Maintenance Technical Committee
- Past Vice-Chair, Industrial Air Conditioning Technical Committee
- Member, 2008 Energy Position Committee
- Distinguished Service Award, 2012, 2013
- Past Board Member; Distinguished Service Award (Local), 2005

BUILDING OWNERS & MANAGERS ASSOCIATION (BOMA)
- Member, Energy & Environment Committee (National)
- Past Judge, TOBY Awards (The Office Building of the Year - Local)
- Chair, Sustainability for Savings Committee (Local)

BUILDING OWNERS & MANAGERS INSTITUTE INTERNATIONAL (BOMI)
- Trainer, High Performing Buildings

ENGINEERING SOCIETY OF DETROIT (ESD)
- Distinguished Service Award, 2007; Fellow, 2010
- Member, Construction & Design Committee

U.S. GREEN BUILDING COUNCIL (USGBC)
- Founding Member, Detroit Regional Chapter
- Past Board Member; Distinguished Service Award (Local), 2008
- Past Chair, Public Policy/Advocacy Committee (Local)

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Course Name: Transforming an Existing Building into a High-Performing Facility
Approval Date: September 12, 2016 Course ID: NEWMAN02

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COURSE NAME:
Transforming an Existing Building into a High-Performing Facility

By James L. Newman

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Approval date: 09/12/2016

Course ID: 0920010401

Approved for:

X General CE hours

X LEED-specific hours

LEED GREEN ASSOCIATE
LEED AP BD+C
LEED AP HOMES
LEED AP ID+C
LEED AP ND
LEED AP O+M

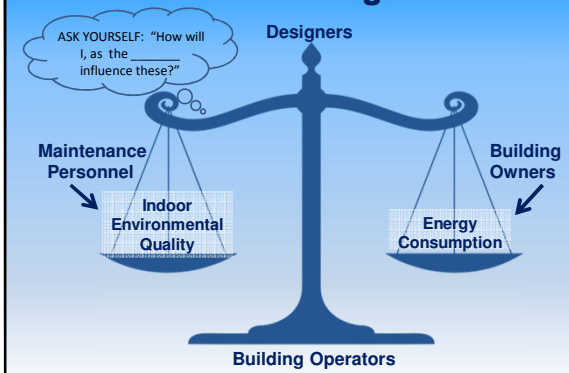
Why Do People Change?

"It's not the strongest who survive, nor the most intelligent – it's those most adaptable to change." Charles Darwin

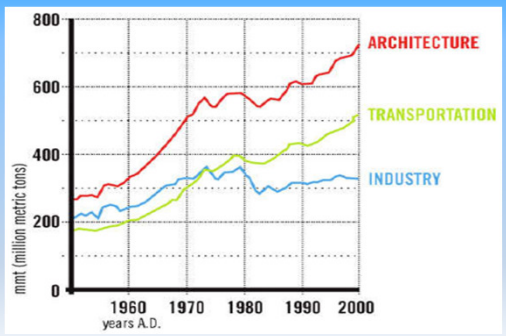
- Stay flexible
- Try new things
- Think outside the box
- Don't fear difficult moments
- Educate yourself – *continuously*

Growth comes from change – and so does survival!

The Balancing Act

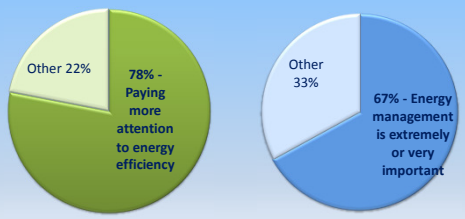


U.S. CO_2 Emissions by Sector



Energy Efficiency - Never More Important

From >1400 respondents in major industries:



What Happens to HVAC Systems as Time Passes?

Green

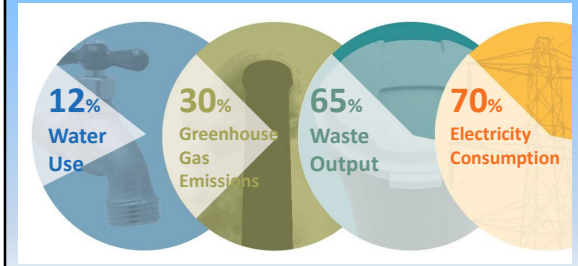
↓

Gray

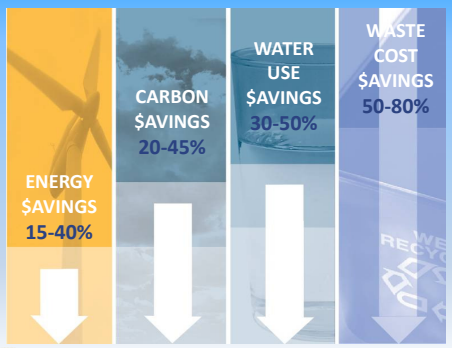
"Most buildings will lose up to 30% of their efficiency in the first three years of operation."

Bill Harrison,
ASHRAE Presidential Member
(Data based on Texas A&M Study)

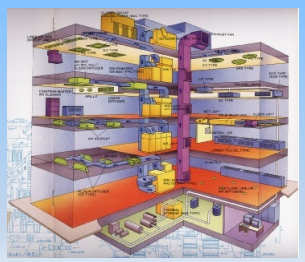
Major Building Impacts on Energy, Natural Resources and the Environment



$avings of Green Buildings



Why Be So Concerned about HVAC Systems?



HVAC is the "Heart and Lungs" of a Building

Don't compromise.

What Does "Green" Mean to HVAC?

- **Install a high-efficiency boiler / chiller**
- **Reduce the size of that boiler / chiller**
- **Avoid the need for that boiler / chiller**
- **Provide a high-performance, hybrid HVAC system**
  - Energy efficient components
  - Design strategies to maximize capabilities of those components

Electrical Loads

- Lower Electrical Loads = Smaller Starters, Wiring, Switchgear, etc. = Lower First Cost
- Important to remember when reducing size of mechanical equipment

High Performance HVAC Benefits

Innovative Engineering and Design

- Increases Life of Building Equipment
- Improves
  - System Performance
  - Indoor Air Quality (IAQ)
  - Productivity

High Performance HVAC Benefits

Innovative Engineering and Design

- Reduces (Or Maintains) First Costs
- Reduces
  - Energy Costs
  - Life Cycle Costs
  - Maintenance Costs

How to Reduce Energy Consumption

Surpass ASHRAE Energy Std. 90.1 Owner Saves Money

- ASHRAE Advanced Energy Design Guides
  - Building Envelope, Lighting, HVAC Equipment & Systems, Service Water Heating (30% & 50%)
  - New Systems
  - New Equipment
- Think Outside-the-Box
  - Different ways of using existing systems
  - Ah-ha moments

Methods of Reducing Energy – HVAC (No Cost/Low Cost)

$$$

- Calibrate sensors and 'stats
- Use programmable thermostats
- **Adjust / repair economizer dampers**
- Use occupancy-based control w/CO_2 sensors
- **Adjust for proper volume of outside air**
- Optimize discharge temperature (air and water)
- Minimize plug loads
- **Optimize start-stop of equipment**
- **Clean / replace filters regularly**

Methods of Reducing Energy – HVAC (Moderate Cost)

$$$

- Optimize VAV systems with thermally-powered diffusers
- Use VFDs on fans, chillers, pumps where possible
- Repair steam leaks, traps
- Add insulation to steam valves, traps, connections
- **Repair AHUs rather than replace**
- Use Variable Refrigerant Flow (VRF) systems

Methods of Reducing Energy – HVAC (Usually Not Considered)

- Seal ducts
- Clean cooling, heating and condenser coils - ***properly***
- Have actionable analytics for energy use (BEMIS)
  - Conduct fault detection and diagnostics (FDD)
  - Automatically repair faults (when possible)

It's all about proper and effective O & M practices!

HVAC System Leakage

Why Seal Ducts?

- Energy (reduce usage, costs)
- Indoor Air Quality (airflow, odor, airborne contaminants)
- Comfort (temperature, drafts, noise)
- Cost and turmoil of replacing ductwork
- Unsightly mastic on architectural ductwork in occupied spaces

Why Seal Ducts?

- Duct Leakage = 10-30%
- Duct Sealing Payback
  - Exhaust Ducts: 2-3 years
  - Supply/ Return Ducts: 3-7 years

Air Ducts Leak

Duct Leakage:

- ASHRAE 10-25%
- Light commercial 30% [1]
- Typical ductwork 25-40% [2]
- Newly installed 10-30% [2]

[1] Florida Solar Energy Center, CA Energy Commission
[2] Lawrence Berkley National Lab (LBNL), SMACNA

Duct Sealing Payback

- Exhaust Ducts: 2-3 years
- Supply/ Return Ducts: 3-7 years

Who cares?

- Building owners (cost)
- Facility managers (cost)
- Tenants and employees (comfort)

What is the cost of an uncomfortable employee?

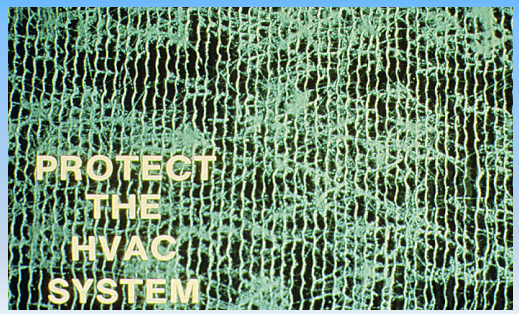
System Candidates for Maximum Savings

- High - or fixed - outside air requirement
- High number of operating hours
- High cfm/sq. ft.
- High operating pressure
- High electrical demand penalties
- **Constant volume AHUs, or variable volume AHUs that run near 60 HZ continuously**
- Ducts located outside of occupied spaces
- Unsealed slip and drive duct connections

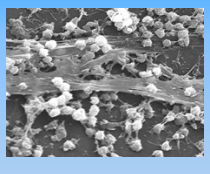
Clogged Filters

Clogged Filters That Didn't Make It

Potential IAQ Problems: HVAC

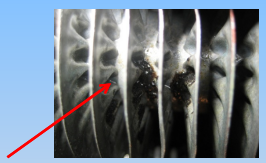


Biofilm Challenge

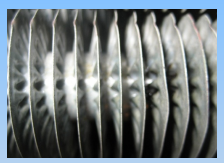


- Bacteria grow in/on coils and fins
- Reduces efficiency of the system
- Resulting odors can be irritating and may lead to health issues

Biofilm Challenge

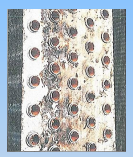


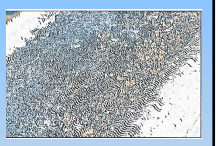
Close-up of coil after conventional cleaning (note: black tar like substance is biofilm)



Close-up of coil after cleaning using engineered EFM after conventional cleaning

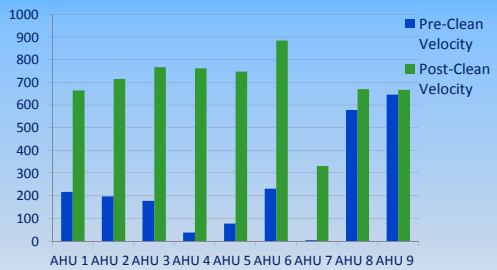
Coil Cleaning Methods Unproven and Unreliable





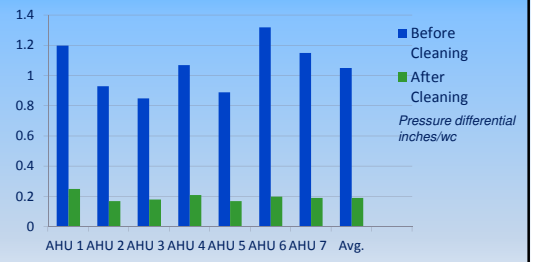
Standard methods clean 1-2 rows.
Inner rows on 5 to 8-row coils typically unaffected.

Results: Elementary School



- Velocity increased an average of xxx per air handling unit.

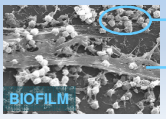
Results: High School



- Average coil pressure decreased an average of 80%
- Average CFM increased 40%

What Is Biofilm?

- Aggregates of predominately bacterial cells attached to and growing on a surface. (Costerton J.W. and Stewart, P.S., 2001 Battling Biofilms. Sci. Am., 285:74-81)
- Forms when bacteria begin to excrete a slimy, sticky substance that allows them to adhere to surfaces.
- Extracellular polymeric substance (EPS) increases biofilm's resistance to antimicrobial agents, heat/cold and cleaners.



Micro-organisms
(bacteria, fungi, algae…)

Biofilm EPS binding matrix
(exopolysaccharides, proteins…)

Repair or Replace

Typical Median Service Life (yrs.) (Examples)

- DX Air Distribution Equipment (except Rooftop Units) >25
- Chillers, Centrifugal >25
- Cooling Towers, Metal >22
- Boilers, Water-Tube (H.W., Steam) >22

- ASHRAE, Abramson et al., 2005

See ASHRAE database for up-to-date information:
www.ashrae.org/database

Example: Air Handling Units

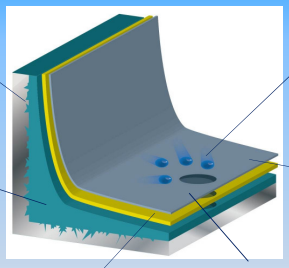
Repair or Replace?

What to think about:

- Age
- Available space
- Efficiency of new equipment
- Cost of removal and installation
- Time involved/disruption of operation
- Etc.

System Installation

Technology



Epoxy with nanotechnology provides superior bond strength

Epoxy halts corrosion & restores structure to surfaces

Sloped application improves drainage & eliminates standing water (ASHRAE 62.1)

Smooth hygienic surface with active antimicrobial abates biological growth

Advanced fire barrier provides fire code compliance (NFPA 90A)

Durable water-proof polymeric topcoat provides extended-life

Methods of Reducing Energy - HVAC (Higher Cost)

$$$

- Variable flow chilled water systems
- Smaller centrifugal compressors
  - Oilless, with magnetic bearings (up to 1500 tons)
- Total energy recovery heat exchangers
- Cool storage (ice, water)
- Indirect evaporative cooling
- Chilled beam

Methods of Reducing Energy - HVAC (Higher Cost – cont.)

$$$

- Dual Path Ventilation – Separation of ventilation air from heating/cooling processes (Dedicated Outdoor Air System – DOAS)
- Radiant Heating and Cooling
- Ground loop water source heat pumps (Geothermal)
- Under floor air distribution (UFAD)

Methods of Reducing Energy - Lighting

- Linear Fluorescent Lamps: T-8/T-5 w/Electronic Ballast
- LED Lamps
- Sensors: Light, Motion
- Dimming
- Zoning

Methods of Reducing Energy – Natural Daylighting

- Light Shelves
- Skylights
- Light Tubes

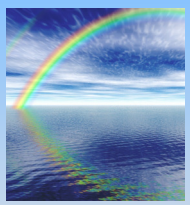
Methods of Reducing Energy – Renewable

Renewable Energy: Passive and Active

- Solar
- Solar Photo-Voltaic
- Wind Energy
- Wave Energy
- True Geothermal

What Else Is There?

Smarter Water for a Smarter Planet



Q: How many gallons of *potable* water do Americans use every day – *just to flush toilets*?

A: Almost 8 billion!

Water Savings

Exterior

- Water efficient landscaping
- No potable water use or no irrigation

Interior

- Toilets & urinals (low-flow or waterless)
- Sinks (low-flow, with or without sensors)
- Showers (low-flow)
- Shower with a friend

Water Saving/Reuse

Gray Water ≡ Water that can be recycled and reused:

- Condensate from (clean) drain pans
- Water from sinks
- Water from washing machines, dishwashers
- Rainwater
  - Collection cisterns
  - "Green" Roofs

Be Careful What You Design

Less potable water being used for flushing toilets

Good

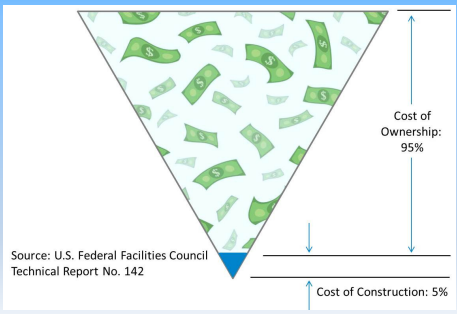
- Conserve potable water
- Lower power requirements for water distribution plants
- Lower volume of leakage in infrastructure

Not So Good

- Drains and drain lines plug up

Putting It All Together

Cost of Owning a Building



Quality Assurance

- Testing and Balancing – To ensure ***HVAC systems*** are performing as designed
- Commissioning – To ensure ***Building*** is performing as designed

Operation & Maintenance

- Best Designs and Construction - Doomed to failure without proper and ongoing maintenance
- Commissioning and Re-Commissioning
- Retro-Commissioning to return to original design concepts and operation

An Effective Maintenance Strategy Improves Performance (and Increases the Bottom Line)

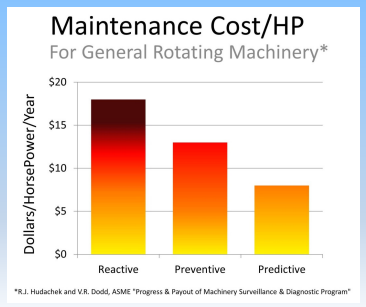
- Energy and operating costs
- Maintenance costs
  - Emergencies, unscheduled teardowns, secondary damage
- Unscheduled downtime
- Equipment life and operating efficiency
- QA for warranty, recurring problems
- Proactive and predictive vs. reactive and crisis

Convince People Who Are Paying the Bill!

BEMIS – Building Energy Management *Information* Systems

- More than point checking of controls
- More than the "cloud"
- More than analytics
- Internet of Things (IoT)
  - "Smart" recommendations
  - *Complete integration*

Maintenance Costs: Reactive vs. Preventive vs. Predictive



How to Compare Building Energy Costs

EPA Portfolio Manager ENERGY STAR® Analysis

or

ASHRAE bEQ

then

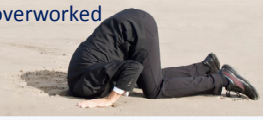
An Energy Audit

Energy Audits

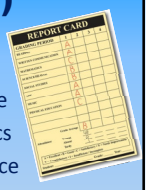
- Identify and develop modifications to reduce energy use and/or cost of operating a building
- Types:
  - Preliminary: Examine Utility Bills for Information
  - Level I: Walk-Through Analysis
  - Level II: Energy Survey & Analysis
  - Level III: Detailed Analysis of Capital Intensive Modifications

Why Do Building Owners Turn Down Energy Audits?

- Cost of the audit
- Cost of what has to be done after the audit
- Fear - of what?
  - Lack of expertise of the auditor
  - Exposure - Poor O & M practices, no maintenance at all, lack of knowledge
  - More work for the overworked building staff
- What else?



Energy Audits – (2)



Steps:

1. Collect and analyze historical energy use
2. Study building, operation, characteristics
3. Identify potential modifications to reduce energy use/cost
4. Analyze engineering and economics of potential modifications
5. List rank-order, appropriate modifications
6. Document analysis process, results, report

What Energy Audits Look At

- Building Energy Consumption:
  - *Envelope (Walls, Windows, Roof)
  - *Lighting (Interior and Exterior)
  - *HVAC
  - *Domestic and Process Water (Hot & Cold)
  - Laundry
  - Food Preparation
  - Conveying Systems
  - Plug Loads
  - Other Systems – Compressed Air, Steam Traps, etc.

* in EPAct 2005 for tax deductions (expired 12/31/13 – back through 2016)

What To Do After the Audit

Re-commissioning or retro-commissioning based on audit results

- Repair building envelope (walls, windows, roof) as required
- Ensure HVAC systems are operating properly and most efficiently – beyond simple thermostat adjustments
- Remove and replace inefficient HVAC and service water systems

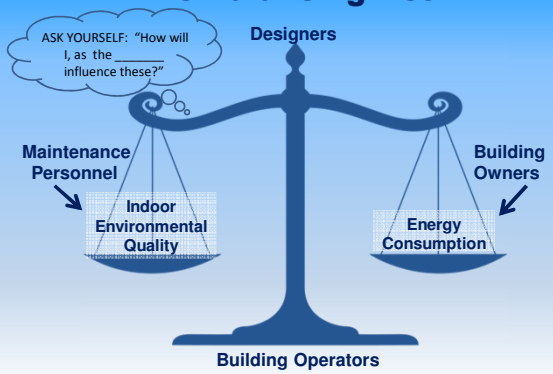
"Ongoing Commissioning"

Technology ≠ Performance

"An inefficient system run well can perform better than an efficient system run poorly."

- Newman

The Balancing Act



"If You're Not Green – You're Nuts!"

Albert Berriz, CEO, McKinley Inc.
DTE/ESD Energy Conference, 2012

*"If you're not into 'do no harm,' if you're not into sustainability, if you don't care about the environment — **you ought to care about 30% return on investment**.*

This is not frou-frou. This is bottom line dollars.

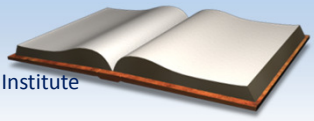
Our owners are thrilled about sustainability … because obviously, it makes money."

Where To Get Information - ASHRAE

- Procedures for Commercial Building Energy Audits
- Energy Conservation in Existing Buildings
- Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
- Standard Measures of Measuring, Expressing and Comparing Building Energy Performance
- Preparation of O & M Documentation for Building Systems
- Sustainable, High-Performance O & M (2012)
- Advanced Energy Design Guides (AEDG)

Where To Get Information - Other

- USGBC: LEED-EB: O & M Guidelines
  - Based on EPA Energy Star® Portfolio Manager, ASHRAE Energy Standard 90.1, Green Operations Guide
- BOMA: Preventive Maintenance & Building Operation Efficiency (2003)
- AIA - COTE
- IFMA Foundation: Sustainability "How-To" Guides
- EPA Energy Star
- PECI
- Rocky Mountain Institute



References & Resources

www.ashrae.org
www.usgbc.org
www.wgbc.org (World Green Building Council)
www.aia.org/cote (AIA Committee on the Environment)
www.eren.doe.gov
www.sustainable.doe.gov
www.energystar.gov
www.nrel.gov (Renewable Energy)
www.rmi.org (Rocky Mountain Institute)

References & Resources (cont.)

www.peci.org (Portland Energy Council – O & M Techniques)
www.greenseal.org
www.greenguard.org
www.fpl.fs.fed.us/ahrc/mold/mold-methods.html (Forest Products Lab)
www.ifmafoundation.org
www.NCGconsulting.us.com
www.leanandgreenmi.com

Mass. Clean Energy Center

Incentives for commercial-scale applications

Technology	Maximum Incentive per project	Basis for calculating
Air Source Heat Pumps		
VRF	$250,000	Capacity of system
Other	$225,000	Capacity of system
Ground-Source Heat Pumps	$250,000	Capacity and efficiency of system
Solar Hot Water	$100,000	Panel rating, number of panels
Central Wood Heating	$250,000	Capacity of system

Details of the programs can be found, by technology, here:
http://www.masscec.com/business/clean-heating-and-cooling
Contact: Amy Barad, Director of Commercial Programs
617-315-9310, abarad@masscec.com

So What Now?

- Use what you're learning today – never stop learning
- Think "Outside the Box"
- Keep up-to-date
  - ASHRAE Standards, LEED Guidelines
  - BOMA/IFMA/USGBC/ASTM, etc.
  - Government Regulations
- Join professional organizations
- Get a professional certification
- Be a teacher, not just a student

76

You Have To Be Flexible

"The greatest challenge we face today is failure to adapt to change"

Tim Wentz, ASHRAE President, 2016-17

For Further Information:

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- www.newmanconsultinggroup.us
- +1-248-626-4910

Become A Future ASHRAE Leader
Write the Next Chapter
In Your Career

ASHRAE Members who are active at their chapter and society become leaders and bring information and technology back to their job.

YOU ARE NEEDED FOR:

- Society Technical Committees
- Society Standard Committees
- Chapter Membership Promotion
- Chapter Research Promotion
- Chapter Student Activities
- Chapter Technology Transfer

Find your Place in ASHRAE and volunteer

www.ashrae.org/volunteer