2025 PARTNER EXCHANGE
35th Anniversary

New Regulations, Standards and Guidelines Are Going to Make Your Firm Do WHAT?!?

Beth Braddy, Unitary Regulatory Affairs Leader
Mick Schwedler, Applications Engineer
May 6, 2025

This presentation is protected by U.S. and international copyright laws. Reproduction, distribution, display, and use of the presentation without written permission of Trane is prohibited. All trademarks referenced in this document are the trademarks of their respective owners. | © 2025 Trane. All Rights Reserved.

WAVES of INNOVATION
TOGETHER WE RISE

TRANE

Special Thanks to our Sponsors:

Agenda

- Introduction
- Safety Standards
- Energy
- Indoor Environmental Quality (IEQ)
- Emissions
- Operations

Goals for Today

Standards and Guidelines

- Provide high level knowledge of present and upcoming changes
- Recognize concepts
  - Likely to affect serving your customers moving forward
  - That would be beneficial for staff training in advance of customers' requests
- Identify materials available
- Position your firm as a source of unbiased knowledge
- What will not occur…
  - Deep dives into equations, details and specific applications

ASHRAE® Guidelines and Standards

Titles

Type	Number / Year	Title
Guideline	36-2024	High Performance Sequences of Operation for HVAC Systems
Guideline	44-2024	Protecting Building Occupants from Smoke During Wildfire and Prescribed Burn Events
Standard	15-2022	Safety Standard for Refrigeration Systems
Standard	34-2022	Designation and Safety Classification of Refrigerants
Standard	62.1-2022	Ventilation and Acceptable Indoor Air Quality
Standard	90.1-2022	Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings
Standard	100-2024	Energy and Emissions Building Performance Standard for Existing Buildings
Standard	189.1-2023	Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings
Standard	228-2023	Standard Method of Evaluating Zero Net Energy and Zero Net Carbon Building Performance
Standard	240P	Quantification of Life Cycle Greenhouse Gas Emissions of Building
Standard	241-2023	Control of Infectious Aerosols
Standard	242P	Standard Method for Calculation of Building Operational Greenhouse Gas Emissions

ASHRAE Guidelines and Standards

Categorized

Type	Number / Year	Safety	Energy	IEQ	Emissions	Operations
Guideline	36-2021		Y			Y
Guideline	44-2024			Y		
Standard	15-2022	Y			Y	Y
Standard	34-2022	Y			Y	
Standard	62.1-2022			Y		
Standard	90.1-2022		Y		Y	Y
Standard	100-2024		Y		Y	Y
Standard	189.1-2023		Y	Y	Y	Y
Standard	228-2023		Y		Y	Y*
Standard	240P				Y	Y
Standard	241-2023	Y		Goes beyond		Y
Standard	242P				Y	Y

Agenda

- Introduction
- Safety Standards
- Energy
- Emissions
- Indoor Environmental Quality (IEQ)
- Operations

Safety

- ASHRAE Standards 241, 15, 34

Safety – ASHRAE Standard 241

Control of Infectious Aerosols

- Compressed publication timeframe by ASHRAE
  - U.S. Whitehouse encouraged ASHRAE "*…to take the lead in developing a new standard for control of airborne pathogens"*
  - December 6, 2022: Title, Purpose and Scope approval by ASHRAE Board of Directors
  - June 24, 2023: Publication approval by ASHRAE Standards Committee
- First, comply with applicable ventilation standards
  - Commercial ANSI/ASHRAE 62.1
  - Residential: ANSI/ASHRAE 62.2
  - Healthcare: ANSI/ASHE/ASHRAE 170
- Terms to know
  - Infection Rate Management Mode (IRMM) and Building Readiness Plan (BRP)
  - Equivalent Clean Airflow (ECA)
  - Indoor air cleaning
  - Defined inspection and maintenance tasks and intervals

Safety – ASHRAE Standard 241

IRMM and BRP

- ***9.1.3 Modes:***
  *"The **operator and building owner, AHJ, or public health official** shall determine which mode of operations shall be used for the facility. Modes of operation shall be identified as one of the following:*
  - *Normal mode, occupied and unoccupied*
  - *IRMM: occupied and unoccupied*
  - *Temporary shutdown*
- Infection Risk Management Mode (IRMM)
  - *"the mode of operation in which measures to reduce infectious aerosol exposure documented in a building readiness plan are active"*
- Building Readiness Plan (BRP)
  - *"a plan that documents the engineering and nonengineering controls that the facility systems will use for the facility to achieve its goals."*

Safety – ASHRAE Standard 241

Section 5: Equivalent Clean Airflow (ECA) For Infection Risk Mitigation

$$V_{ECAi} = ECAi \; x \; PZ_{,IRMM}$$

- V_{ECAi} = minimum equivalent airflow rate **required** in the breathing zone to mitigate risk in long-range transmission in IRMM
- ECAi = equivalent clean airflow rate per person (Table 5-1)
  Occupancy category and space dependent. From 20 – 90 cfm/person [10 to 45 L/s/person]
- $P_{Z,IRMM}$ = number of people in the breathing zone *in IRMM*

Equivalent clean airflow
- Outdoor air
- Cleaned air

- Clean Airflow Rate

$$\sum[z_f \times (V_{OT} + VMVS)] + \sum(V_{ACS} + VNV) \geq VECAi$$

  - Z_f = zone air fraction
  - V_{OT} = Outdoor air intake flow rate
  - V_{MVS} = Multizone air cleaning system equivalent clean airflow rate
  - V_{ACS} = Air cleaning system equivalent clean airflow rate…typically as a function of the recirculated airflow rate to be treated
  - V_{NV} = outdoor airflow rate from natural ventilation system

Safety – ASHRAE Standard 241

Sources of outdoor and clean air

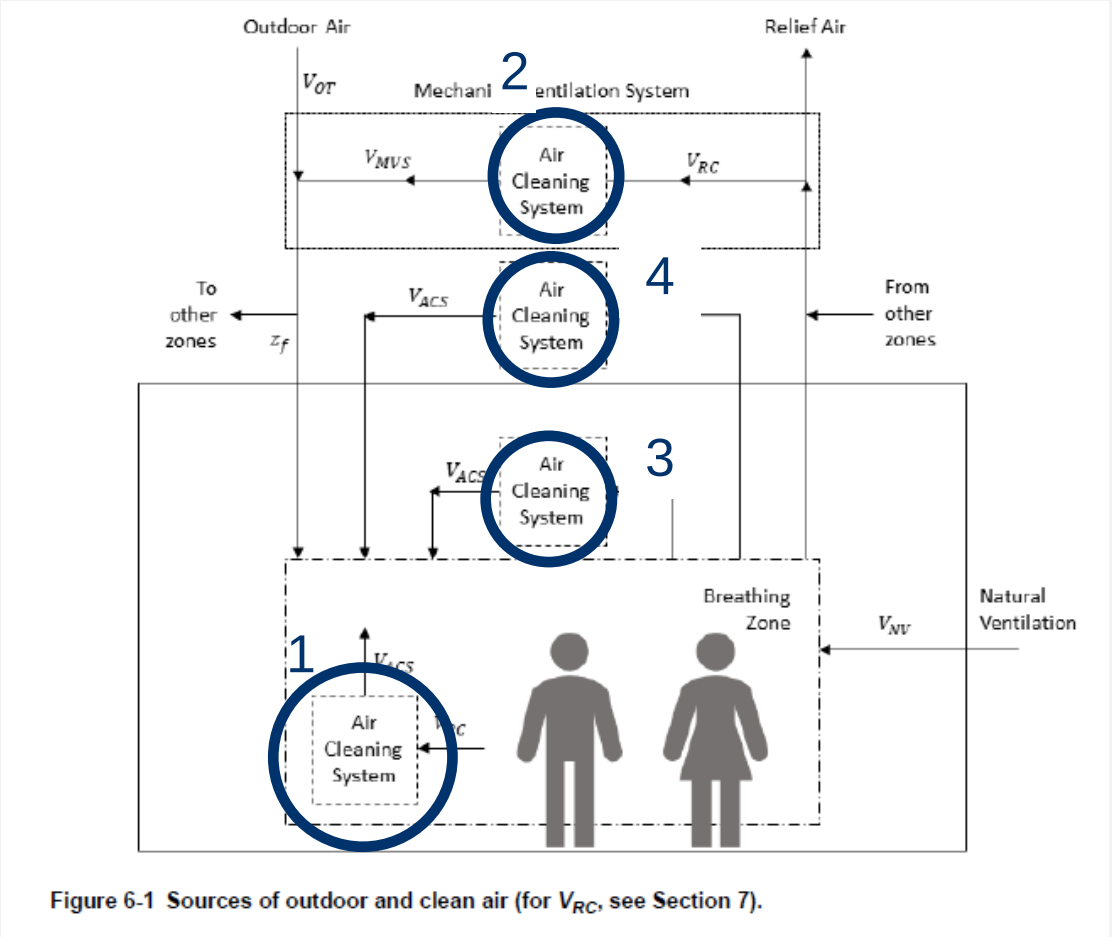


Figure 6-1 Sources of outdoor and clean air (for V_{RC}, see Section 7).

Safety – ASHRAE Standard 241

Air Cleaning System Effectiveness

- **7.3 Mechanical Fibrous Air Cleaning System**
- **7.4 Air Cleaning Systems that Inactivate Infectious Aerosols**
  - ***Ultraviolet***
    - In-Duct Ultraviolet Germicidal Irradiation (ANSI/ASHRAE Standard 185.1)
    - Upper-Room Ultraviolet Germicidal Irradiation (ANSI/IES RP-44-21)
  - ***Other In-Duct or In-Room Cleaning Systems*** effectiveness determined in accordance with Normative Appendix A
    - *"Testing shall be performed by third-party independent laboratory required"*
    - *"All air cleaning systems shall be tested in-chamber as described in Section A1.2.2. for ozone, formaldehyde, and airborne particulates."*

Standard 52.2 MERV (prior to 1/1/2025) MERV-A (After 1/1/2025)	Weighted Aerosol Removal Efficiency (%)
11	60
12	71
13	77
14	88
15	91
16	95
HEPA	99

Summary: ASHRAE Standards 15 & 34

15: Safety Standard for Refrigeration Systems
34: Designation and Safety Classification of Refrigerants

- Technology Transition Product Bans
  - Understand the equipment impacts / dates
- A2L refrigerants
  - Leak detection and response
  - Increased exhaust air requirements
  - Cannot be used in existing systems

U.S. EPA HFC Technology Transfer Rule

Chillers/Heating: 700 GWP

- Comfort cooling: 2025
- Skating rinks: 2025
- Data centers: 2025
- Industrial Process Refrigeration (IPR) with temperature of chilled fluid
  - > -22 °F (-30 °C) (2026)
  - -50 °C (-58 °F) to -30 °C (-22 °F) (2028)
  - <-50 °C (-58 °F) no mandate

Data centers; self-contained; 700 GWP: 2027

Air conditioning (AC) / heat pumps (HPs): 700 GWP

- Unitary (light commercial and residential): 2025
- Dehumidifiers: 2025
- Variable refrigerant flow ≥ 65,000 BTU/h (5.4T): 2026
  2027 (Install deadline)

Refrigeration

- Stand-alone: 150 GWP; 2025
- Non-chiller IPR (2026), remote condensing (2026), supermarket (2027)
  - > 200 lbs charge: 150 GWP
  - ≤ 200 lbs charge: 300 GWP
  - High temperature side of cascade system: 300 GWP
  - IPR, where refrigerant entering evaporator Is between 30 and 50ºC: 2028

Foams: 150 GWP

- Excluding marine space vehicles, military and aerospace uses: 2025
- Military and aerospace uses: 2026
- Foams for export: 2028

October 2023 American Innovation and Manufacturing (AIM) Act Technology Transition (TT) Rule. **Updated 2024.**

https://www.epa.gov/climate-hfcs-reduction/regulatory-actions-technology-transitions

USEPA TT Rule Fact Sheet

Other Countries' Actions

Canada

- Industrial Refrigeration
  Phase-out of
  GWP > 2200 by 2020
- Transport Refrigeration
  Phase-out of
  GWP > 2200 by 2025
- HVAC Chillers
  Phase-out of
  GWP > 750 by 2025

Japan

- Mini-Splits
  Phase-out of
  GWP >750 by 2018
- Commercial Split (not VRF)
  Phase-out of
  GWP >750 by 2020
- Centrifugal Chillers
  Phase-out of
  GWP >100 by 2025

European Union

- Few product bans in place
  Phase-out of
  GWP > 750 by 2025
  (mini-splits)
- Aggressive allocation restrictions for HFCs
- Refrigerant price driving transition rather than product bans

ASHRAE® 15-2022, Low-Probability Systems
Machinery Room Using Class 2L Refrigerants

Impacted Product Types:

- Water Chillers (indoors)

Impacted Refrigerants:

- R-1234ze
- R-32
- R-454B
- R-1234yf

NEW REQUIREMENTS

Refrigerant Detectors:

- **If refrigerant concentration > 25% of LFL (Lower Flammability Limit):**
  - **Actuate audible and visual alarms**
  - **Activate mechanical ventilation**
  - **Turn off compressors, refrigerant pumps, electrical sources of ignition**

Remote Control:

- **Must include remote control immediately outside the machinery room possible to shut down all refrigeration equipment and activate the mechanical ventilation system.**

Multiport Refrigerant Detector:

- **No longer allowed for 2L refrigerants**

Mechanical Ventilation

- **Two ventilation rates required:**
  - **Trouble alarm = Level 1 ventilation rate**
  - **Emergency alarm = Level 2 ventilation rate**
- **Level 2 ventilation rate is significantly higher than for an A1 or B1 refrigerant**

ASHRAE® 15-2022, High-Probability Systems
Occupied Space Using Class 2L Refrigerants

Impacted Product Types:

RTU | VRF | WSHP | DX Splits

Impacted Refrigerants:

R-32 | R-454B

NEW REQUIREMENTS

Listed Equipment:

- **Equipment must be listed in accordance with UL 60335-2-40 or UL 484**

Refrigerant Detector:

- **Factory installed in the equipment**
- **If refrigerant concentration ≥ 25% of LFL (Lower Flammability Limit), must generate output signal (within 30 seconds) to initiate the following mitigation actions:**
  - **Actuate air circulation fan and open zone dampers, if equipped**
  - **Turn off electric heaters and other electrical sources of ignition**
  - **Close safety shutoff valves, if equipped**
  - **Activate mechanical ventilation, if required**

Ignition Sources:

- **No open flame or unclassified electrical devices allowed in ductwork**
- **Electric heaters allowed if air velocity > 200 ft/min with interlocked proof of airflow device**

Section 7.6.1.1, Equation 7-8 (High Probability System) EDVC for Systems With Air Circulation

$$EDVC = V_{eff} \times LFL \times 0.50 \times F_{occ}$$

where:

EDVC = effective dispersal volume charge, lb

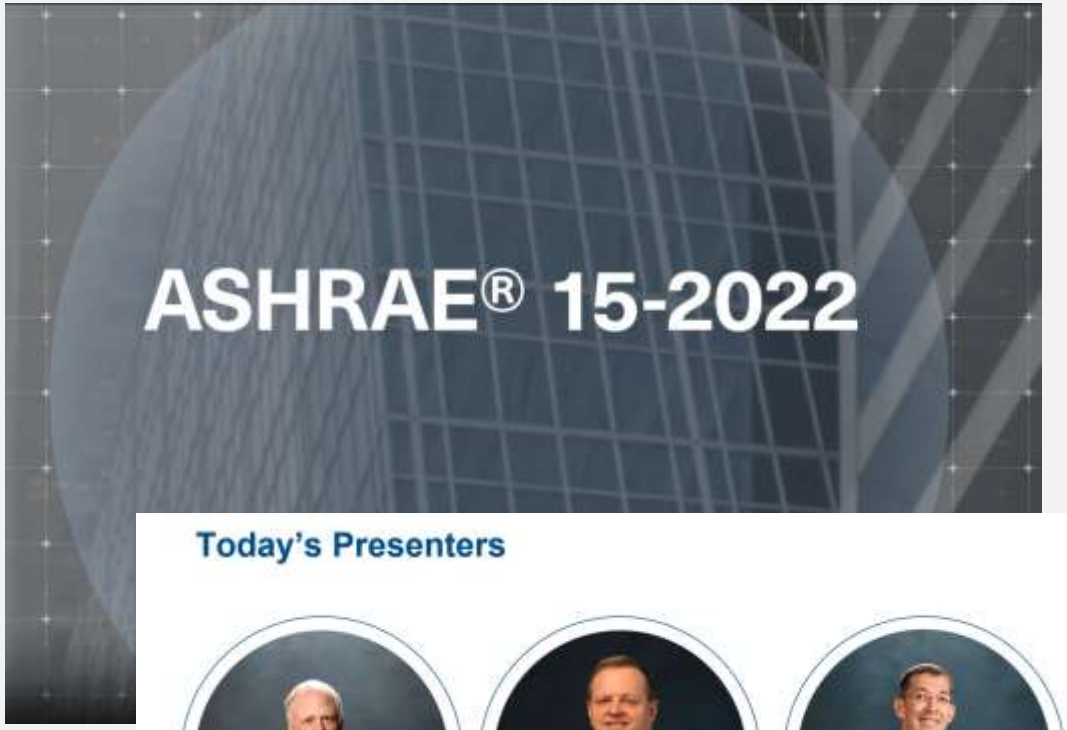
V_{eff} = effective dispersal volume per Sections 7.2.1 – 7.2.3, ft^3

LFL = lower flammability limit published in ASHRAE 34, lb/ft^3 *

F_{occ} = occupancy adjustment factor (0.5 for institutional; 1.0 for all others)

* Note that values tabulated in ASHRAE Standard 34 are in units of $lb/1000\ ft^3$, so be sure to convert to the correct units when using this formula.

ASHRAE Standard 15 Updates - References



2025 PARTNER EXCHANGE 35th Anniversary

"Strategies for Sustainable Refrigerant Solutions" session recording will also be made available

Agenda

- Introduction
- Safety Standards
- Energy
- Indoor Environmental Quality (IEQ)
- Emissions
- Operations

Energy

- ASHRAE Guideline 36
- ASHRAE Standards 90.1, 100, 189.1, 228

ASHRAE Guideline 36-2024

High Performance Sequences of Operation for HVAC Systems

- What?
  - Sequences for equipment and system control
  - System optimization (Trim/Respond)
    Balance energy efficiency and comfort
    - Trim: Reset a setpoint to reduce energy use
    - Monitor “requests” as comfort conditions in various spaces change
    - Respond: Re-reset the setpoint
  - Sustainable performance
    (Fault detection and diagnostics)

- Why?
  - Sequences are tested, proven and efficient
  - Controls providers can pre-program
    (as much as possible)
  - Potential to streamline design, installation and commissioning

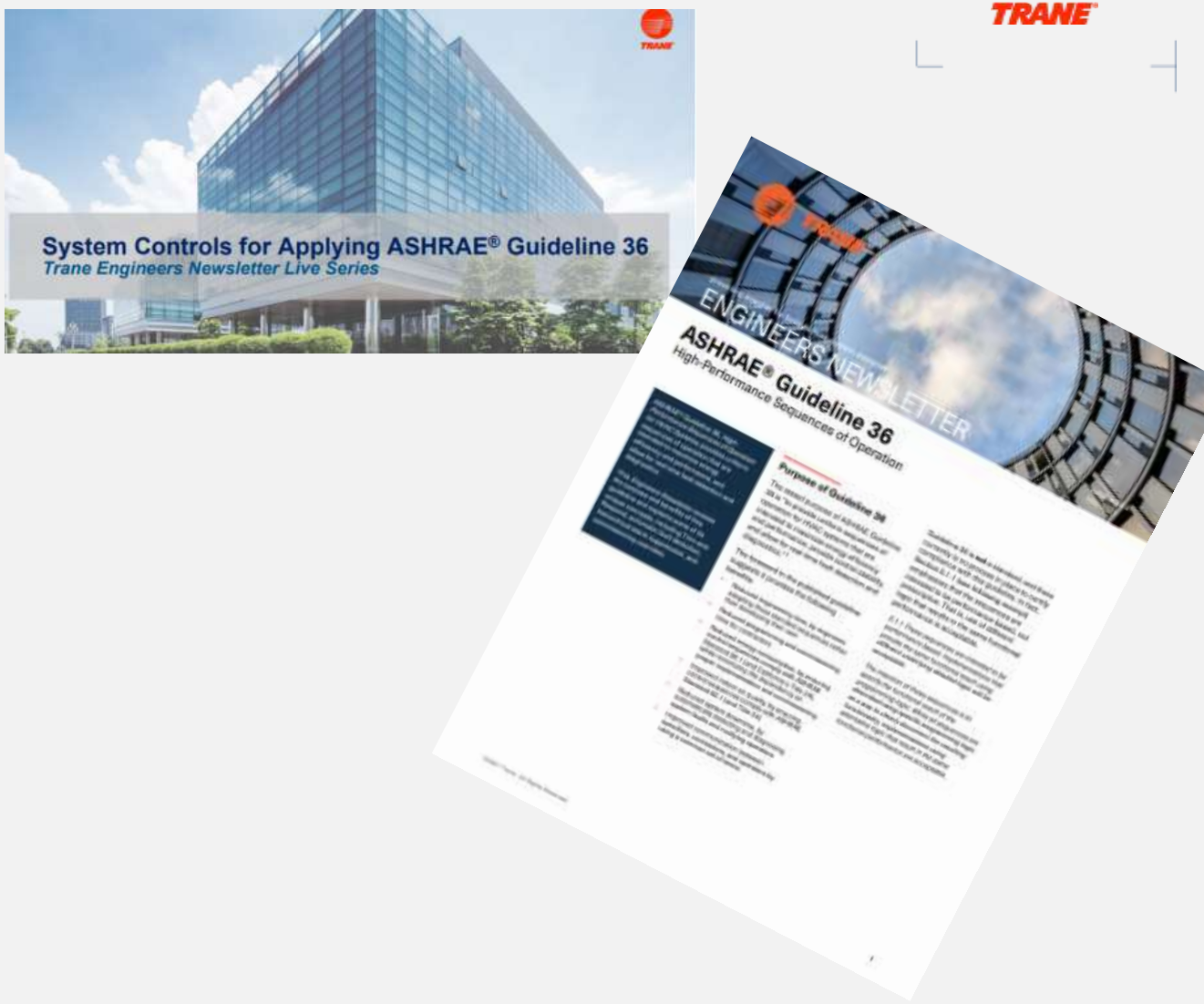
Updates in ASHRAE Guideline 36-2024

- Outdoor air pollution mode
  - Wildfires, smog, other poor outdoor air quality events
- Staged fans and economizer dampers
  - High airflow units with low turndown (e.g. fan arrays)
- Humidity control
  - Trim/respond algorithm, maintain maximum 60ºF dewpoint temperature
  - Exceptions allow by ASHRAE 62.1 Addendum K not included yet, perhaps later in 2025

ASHRAE Guideline 36-2024

High Performance Sequences of Operation for HVAC Systems

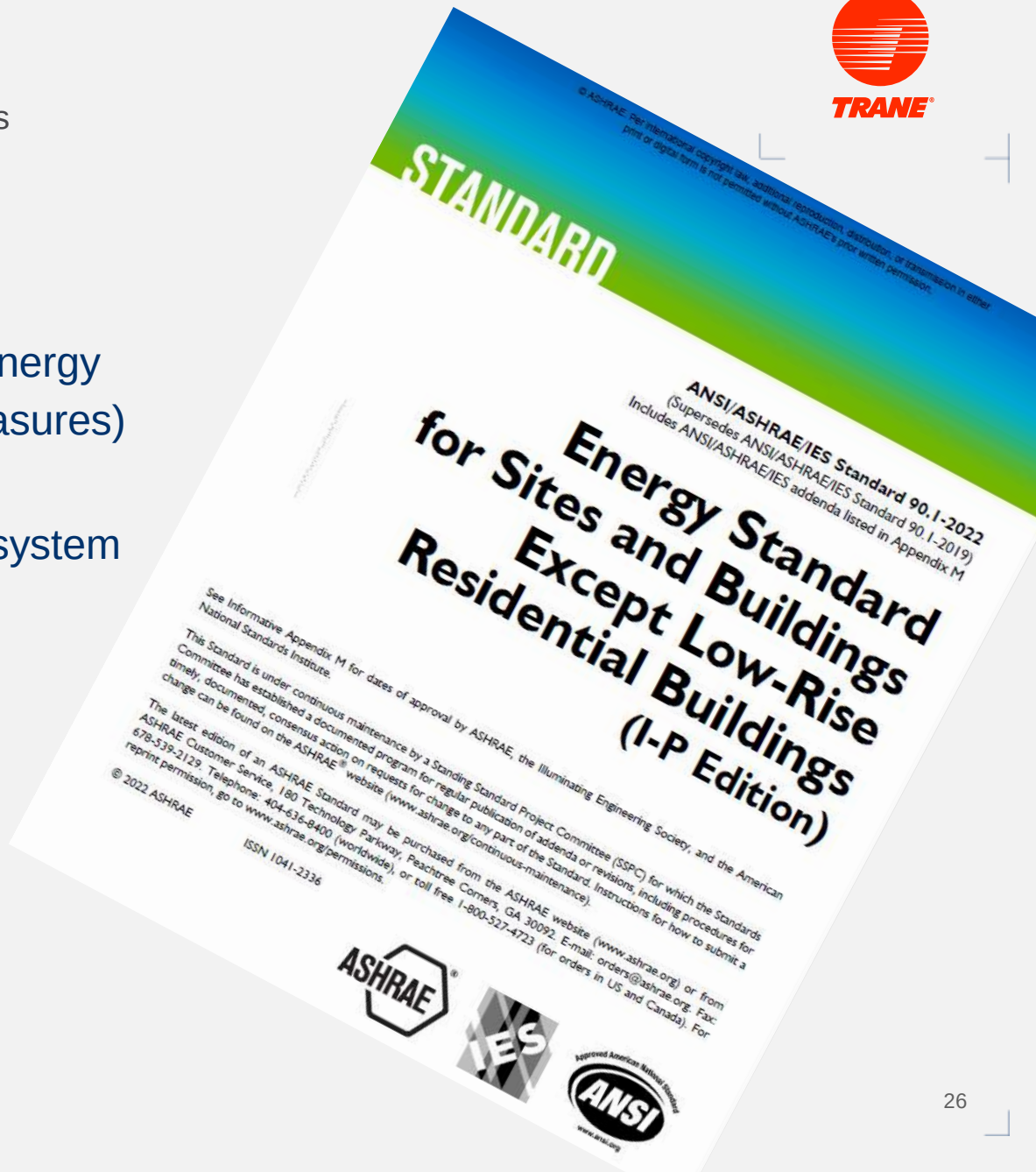
- How?
  - Specifying
  - Commissioning
    - Gaps today
    - Efforts underway to close the gaps
  - There are multiple allowable implementations that meet intent
    - Example: Chiller staging



ASHRAE 90.1-2022: Updates

Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings

- General
  - New energy credit requirements
  - Minimum prescriptive requirement for on-site renewable energy
  - New informative appendix for using alternate metrics (measures)
- Mechanical
  - Mechanical System Performance Path that allows HVAC system efficiency tradeoffs
    - Total System Performance Ratio (TSPR)
    - New metrics
      - Heat recovery (COPHR)
      - Anticipated unitary efficiency metrics



90.1-2022: Section 11: Energy Credits

4-5% Beyond Mandatory and Prescriptive Requirements

- Number of required energy credits dependent on building type and climate zone
- Building Types
  - Multifamily
  - Health care
  - Hotel/motel
  - Office
  - Restaurant
  - Retail
  - Education
  - Warehouse
  - Other

Category	Energy Credit Type
Envelope	Improved Envelope Performance
HVAC	Heating Performance Improvement Cooling Performance Improvement Residential Space HVAC Control Ground-Source Heat-Pump System Dedicated Outdoor Air System (DOAS)/Fan Controls Improved HVAC Sequence of Operations Reduced Energy Use in SWH
Service Water Heating (SWH)	Heat Recovery for Service Water Heating (SWH) Preheating Heat-Pump Water Heater Efficient Gas Water Heater SWH Piping Insulation Increase Point-of-Use Water Heater Thermostatic Balancing Valves Dwelling-Unit SWH Submeters Right-sizing the SWH Distribution System Shower Drain Heat Recovery
Power	Power Monitoring
Lighting	Continuous Dimming and High-End Trim Occupancy Sensor Control Areas Increased Daylighting Control Area Lighting Control for Multifamily Buildings Reduce Interior Lighting Power
Renewable Energy	On-Site Renewable Energy
Equipment	Efficient Elevator Equipment Efficient Kitchen Equipment Fault Detection and Diagnostics
Load Management	Lighting HVAC Automated Shading Electric Energy Storage HVAC Cooling Energy Storage SWH Thermal Storage Building Thermal Mass/Night Flush

Energy Credits Example: Minneapolis, Healthcare

Climate Zone 6A: Cold, Humid

EC Abbreviated Title	CZ 6A
Representative Location	Minneapolis
Required	**50**
Available	**81**
Available : HVAC, SWH + controls, FDD	**32**
Available Ground-Source Heat Pump	**14**
Available: Storage	**15**
Heating Efficiency	6
Cooling Efficiency	5
Ground-Source Heat Pump	14
DOAS/Fan Controls	9
Guideline 36 Sequences	3
SWH Preheat Recovery	2
Heat-Pump Water Heater	1
Efficient Gas Water Heater	1
SWH Pipe Insulation	1
Thermostatic Balancing Valves	1
Fault Detection and Diagnostics	3
Electric Energy Storage	10
HVAC Cooling Energy Storage	4
SWH Thermal Storage	1

- **50 credits can be delivered by mechanical…but…**

<u>The project team needs to</u>

- **know the design will be expensive.**
- **Decide which non-mechanical credits will be achieved**

Energy Credits: Additional Examples

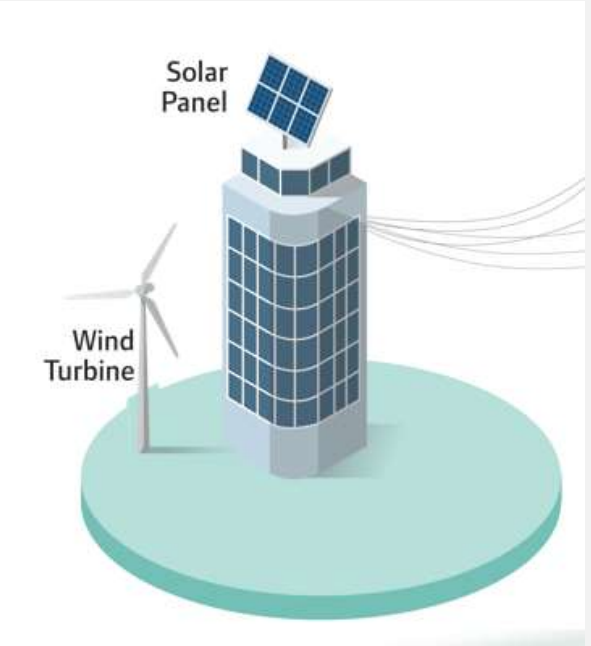
Building Type	Healthcare	Healthcare	Healthcare	Hotel-Motel	Education	Education	Multifamily	Multifamily
Climate Zone	CZ 6A	CZ 5B	CZ 4A	CZ 1A	CZ 3A	CZ 7	CZ 2B	CZ 4C
Representative Location	Minneapolis	Denver	St. Louis, Philadelphia	Nassau Bahamas	Atlanta	Calgary, Winnipeg	Phoenix	Vancouver, Portland, OR
Required	50	50	46	47	50	50	50	46
Available	81	84	89	146	205	172	227	241
Available : HVAC, SWH + controls, FDD	32	32	35	43	48	41	89	110
Available Ground-Source Heat Pump	14	11	11	7	6	12	4	6
Available: Storage	15	16	17	63	60	26	48	45

Questions to ask:

- How many energy credits will come from “non-HVAC”?
- What additional budget is available for the energy credits?

90.1-2022: Section 10.5.1.1 On-Site Renewable Energy

- Equipment for on-site renewable energy with a rated capacity of not less than 0.50 W /ft^2 or 1.7 Btu/ft^2 multiplied by the sum of the gross conditioned floor area for all floors up to the three largest floors
- Exceptions
  - Low incident solar radiation
  - 80% of the roof area covered by equipment, planters, vegetated space, skylights or occupied roof deck.
  - Shading criteria for 50% of roof area shaded from direct-beam sunlight
    - By natural object or structures not part of the building
    - Shaded more than 2500 annual hours between 8 am and 4 pm (312.5 days)
  - New construction or additions with sum of three largest floors less than 10,000 ft^2
  - Alterations



90.1-2022: Alternative Metrics

- Present metric is energy cost (a surrogate for “source energy”)
- Informative Appendix I
  - NOT a requirement in the standard
  - Provides method that, “…may be adopted by the rating authority for the Appendix G Performance Rating Method…”
  - Appendix G is the “computer modeling” path to 90.1 compliance
- Measurement metrics allowed by Appendix I
  - Site energy
  - Source energy
  - Carbon emissions
- Possible Impact
  - Local codes may be modified to one of the new metrics

90.1-2022 Section 6.6.2
Mechanical System Performance Path

$$TSPR_p > \frac{TSPR_r}{MPF}$$

Definitions

- Total System Performance Ratio (TSPR)
- $TSPR_p$ = proposed TSPR (Appendix L)
- $TSPR_r$ = reference TSPR (Appendix L)
- MPF = mechanical performance factor based on *climate zone* and *building use type*
  - Lowest: 0.36 (CZ 8, retail)
  - Highest: 0.84 (CZ 1A, office-large)

$$TSPR_p = \frac{Loads_r}{HVACinput_p}$$

$$TSPR_r = \frac{Loads_r}{HVACinput_r}$$

- $Loads_r$ = Sum of annual cooling and heating loads reference building
- HVAC $input_r$ = Sum of annual energy for heating, cooling, fans, energy recovery, pumps and heat rejection; reference building
- HVAC $input_p$ = Sum of annual energy for heating, cooling, fans, energy recovery, pumps and heat rejection; proposed building

90.1-2022 Section 6.6.2 Mechanical System Performance Path (Appendix L)

Building Types

- Office (small and medium)
- Office (large)
- Retail
- Hotel/motel
- Multifamily/dormitory
- School/education
- Others <1000 ft^2 and <10% conditioned floor area

Excluded System Types

- Data centers and computer rooms, power density > 20 W/ft^2 and exceeding 10 kW of equipment load
- Laboratories with fume hoods
- Locker rooms with more than four showers
- Cafeterias and dining rooms
- Multifamily/dormitory
- Restaurants and commercial kitchens, cooing capacity > 100,000 Btu/h
- Natatoriums or rooms with saunas
- Areas with commercial refrigeration equipment > 100 kW of power input

90.1-2022: Efficiency Tables
Energy Efficiency Over the Years

US Department of Energy Federally Regulated Metrics

Full Load

- **EER** – Energy Efficiency Ratio
- Utilized until **1/1/2010**
- Measure of energy efficiency at **one operating point** when the unit is cooling
- Return Air Conditions
  - 80°F dry bulb
  - 67°F wet bulb
- Outdoor Air Conditions
  - 95°F dry bulb

Part Load

- **IEER** – Integrated Energy Efficiency Ratio
- Utilized from **1/1/2010 until 1/1/2029**
- Measure of energy efficiency at **four operating points** when the unit is cooling
- Outdoor Air and Return Air Conditions vary depending on:

$$IEER = (0.020 \cdot A) + (0.617 \cdot B) + (0.238 \cdot C) + (0.125 \cdot D)$$

Part Load & More!

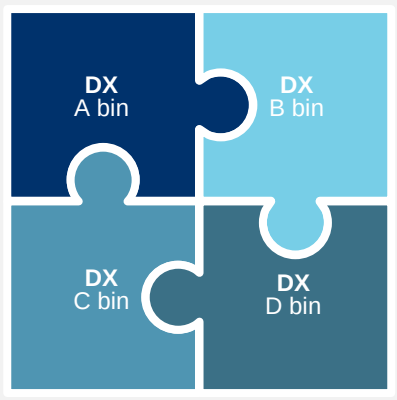
- **IVEC** – Integrated Ventilation, Economizer and Cooling
- Goes into effect **1/1/2029**
- Measure of energy efficiency at **multiple conditions**
  - Non-refrigeration modes
  - Increased static pressure requirements
  - Part load condition changes

IVEC – Driver of Innovation?

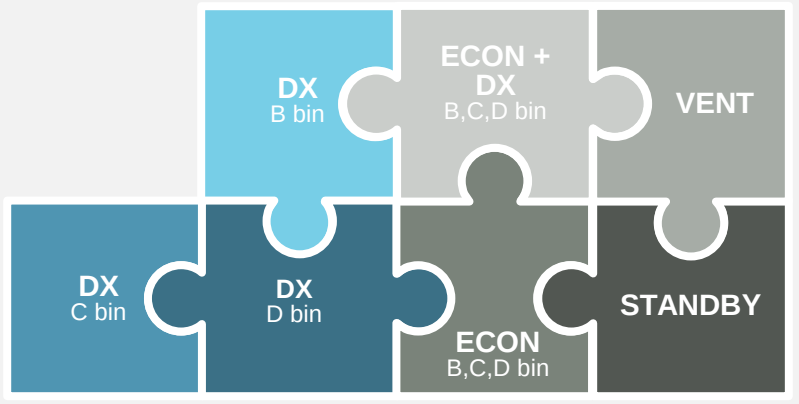
The Game Has Been Changed Again…

EER

IEER



IVEC



90.1-2022: Addenda ae, ba and cv (90.1-2025)

Unitary AC & HP

New Efficiency Metrics & Minimums

1/1/2029

- Tables 6.8.1-1, 6.8.1-2
- AC/HP = EER2, IVEC
- HP = $COP2_{H17}$, $COP2_{H5}$, IVHE, $IVHE_C$
- Heating depends on Climate Zone

WSHP

New Efficiency Metrics & Minimums

1/1/2029

- Table 6.8.1-15
- AEER, IEER, $ACOP_H$
- Water Loop WSHP only
- Geothermal & W2W unchanged

DX DOAS

New Efficiency Metrics & Minimums

5/1/2024

- Table 6.8.1-13, 6.8.1-14
- ISMRE2, ISCOP2
- DOE certification & enforcement begins 5/7/2025

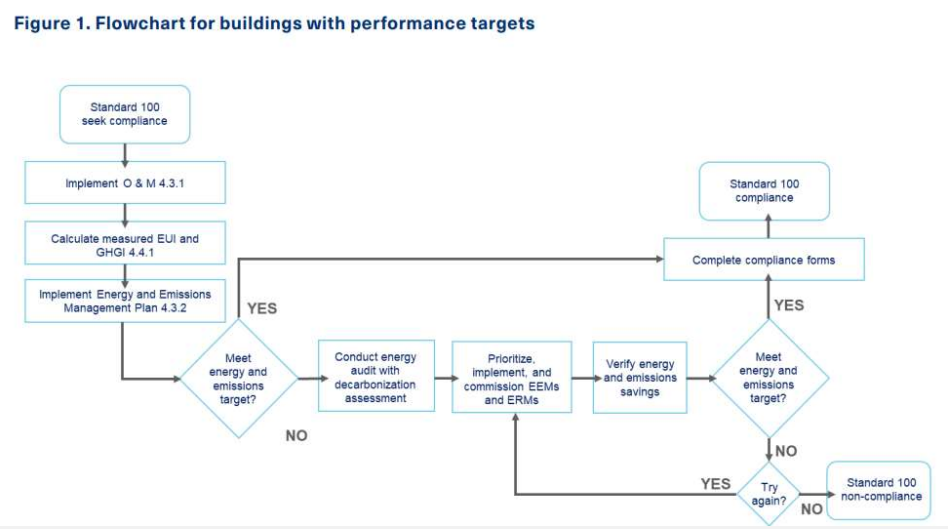
90.1-2025 and beyond: What's coming?

- 2025
  - Scope will include emissions
  - Net Zero Operating Energy Emissions (NZOEE) Prescriptive Pathway
  - System fan power calculation
  - For architects: Thermal bridges
- 2031 Goal: Net-zero carbon

ASHRAE 100-2024

Energy and Emissions Building Performance Standard for **Existing Buildings**

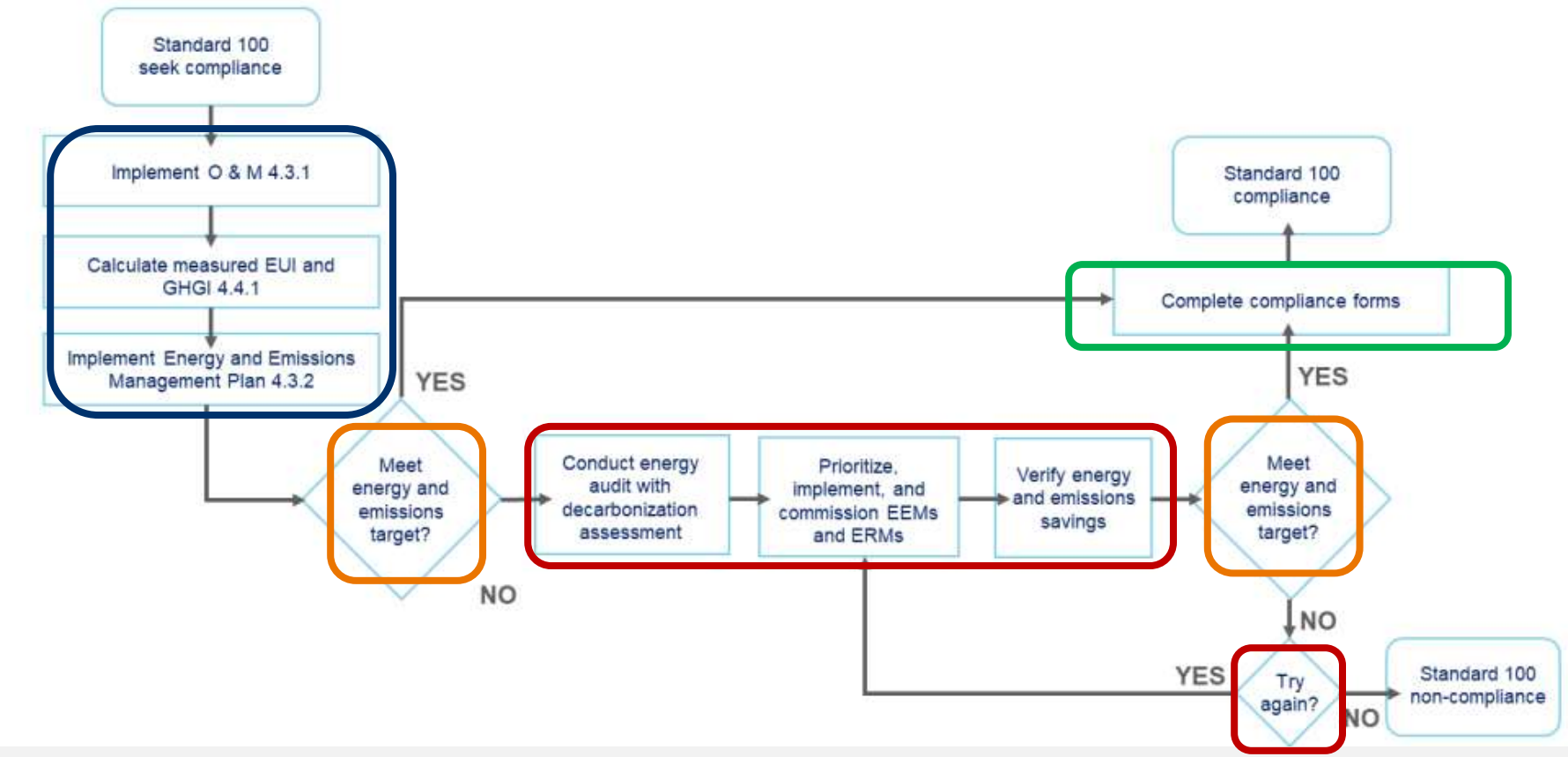
- Actual GHG emissions and energy use
- This standard is directed toward
  - Setting performance targets
  - Accommodating more stringent performance targets
  - Providing technical basis for setting building performance standards (BPS)
  - Providing procedures and programs essential to energy-efficient operation, maintenance, management and monitoring



ASHRAE 100-2024 - Process

Energy and Emissions Building Performance Standard for **Existing Buildings**

Figure 1. Flowchart for buildings with performance targets



ASHRAE 100-2024 - Existing Buildings

Energy and Emissions Building Performance Standard for **Existing Buildings**

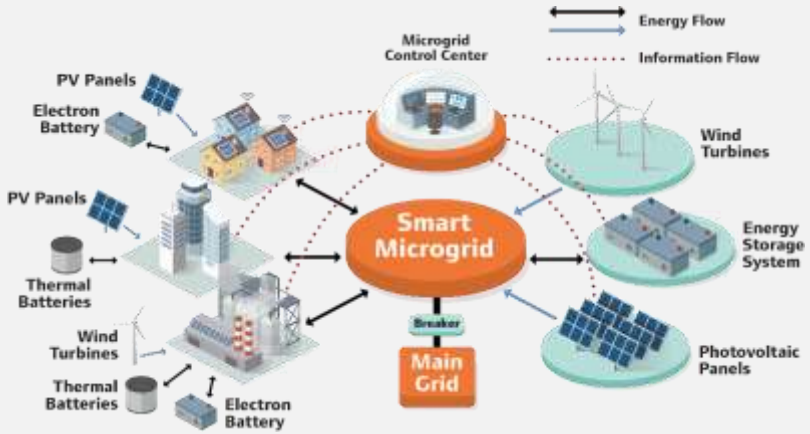
- Building Energy and Emissions Monitoring
- Site Energy, Source Energy, Greenhouse Gas Emissions Calculations
- Tables by Climate Zone and Building Type (55 of them)

		EUIs by Building Type by Climate Zone (kBtu/ft²·yr)																		
		ASHRAE Climate Zone																		
No.	Commercial Building Type	0A	0B	1A	1B	2A	2B	3A	3B Coast	3B Other	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
27	High school	57	54	43	51	43	40	44	31	40	33	51	43	45	57	49	46	68	58	78	102
28	Preschool/daycare	54	53	45	51	45	43	46	36	42	37	50	45	44	53	48	44	60	54	68	88
29	Other classroom education	33	32	27	31	27	26	28	22	26	23	30	27	27	32	29	26	36	33	41	53
30	Fast food	286	282	264	278	269	269	285	247	274	256	312	289	293	339	314	306	375	346	413	482
31	Restaurant/cafeteria	205	199	184	197	188	186	201	169	191	177	223	206	211	241	223	222	265	246	291	338
32	Other food service	72	70	64	69	66	65	70	59	67	62	78	72	74	85	78	78	93	86	102	119
33	Hospital/inpatient health	181	185	169	177	178	158	174	156	160	162	175	159	164	168	156	154	175	165	181	192

ASHRAE Standard 100-2024 – Building Activity Targets

Energy Use Intensity (EUI) and Greenhouse Gas Intensity (GHGI)

- Site EUI (kBtu/ft^2-yr)
- Source EUI (kBtu/ft^2-yr)
- GHGI (lb-CO_2e/ft^2-yr)
- Electricity Site EUI (kBtu/ft^2-yr)
- Fossil-Fuel Site EUI (kBtu/ft^2-yr)



Additional Factors

- Building Operating Shifts Normalization Factor (dependent on weekly hours)
- Source
  - Site Energy Conversion Factor (SEF) dependent on energy form, e.g.
    - Fuel oil
    - Natural Gas
    - Grid electricity
    - …
- GHGI
  - Greenhouse Gas Emission Factor (GEF), e.g.
    - Grid electricity
    - Grid natural gas
    - Coal
    - ...

ASHRAE 100-2024 - References

Energy and Emissions Building Performance Standard for **Existing Buildings**

- Trane Engineers Newsletter
  - Available on www.trane.com

Providing insights for today's HVAC system designer

ENGINEERS NEWSLETTER

TRANE

Building Performance Standards and ASHRAE® Standard 100-2024

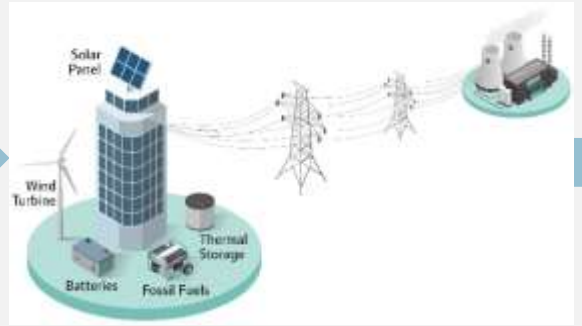
Introduction

Brief History

Energy

Standard 228: Zero Net Energy and Zero Net Carbon Building Performance

- Energy Imported (EI)
  - Non-renewable, EI_{nren}
  - Specific off-site EI_{spec}
  - Transportation vehicle EI_{v}
  - Landscaping EI_{l}



- Exported Energy (Ex)
  - Non-renewable, Ex_{nren}
  - Renewable, Ex_{ren}
  - Transportation vehicle Ex_{v}

rec

Qualified off-site renewable Energy, E_{rec}

$$E_{net} = \sum(E_{imp} \times SFimp) - [\sum(E_{exp} \times SFexp) + \sum(Erec \times SFrec \times DFrec)]$$

- Energy Other
  - Off-site renewable, Eo_{ren}
  - On-site renewable energy used on site, Eo_{nren}

SF: Source Energy Factor
DF: Discount Factor for offsite renewable energy

Agenda

- Introduction
- Safety Standards
- Energy
- Indoor Environmental Quality (IEQ)
- Emissions
- Operations

Emissions

- **ASHRAE Standards 15, 34: Refrigerant GWP**
- **Standards 90.1, 100, 189.1, 228, 240P, 242P**

Emissions

Standard 228: Zero Net Energy and Zero Net Carbon Building Performance

- Energy Imported (EI)
  - Non-renewable, EI_{nren}
  - Specific off-site EI_{spec}
  - Transportation vehicle EI_v
  - Landscaping EI_l

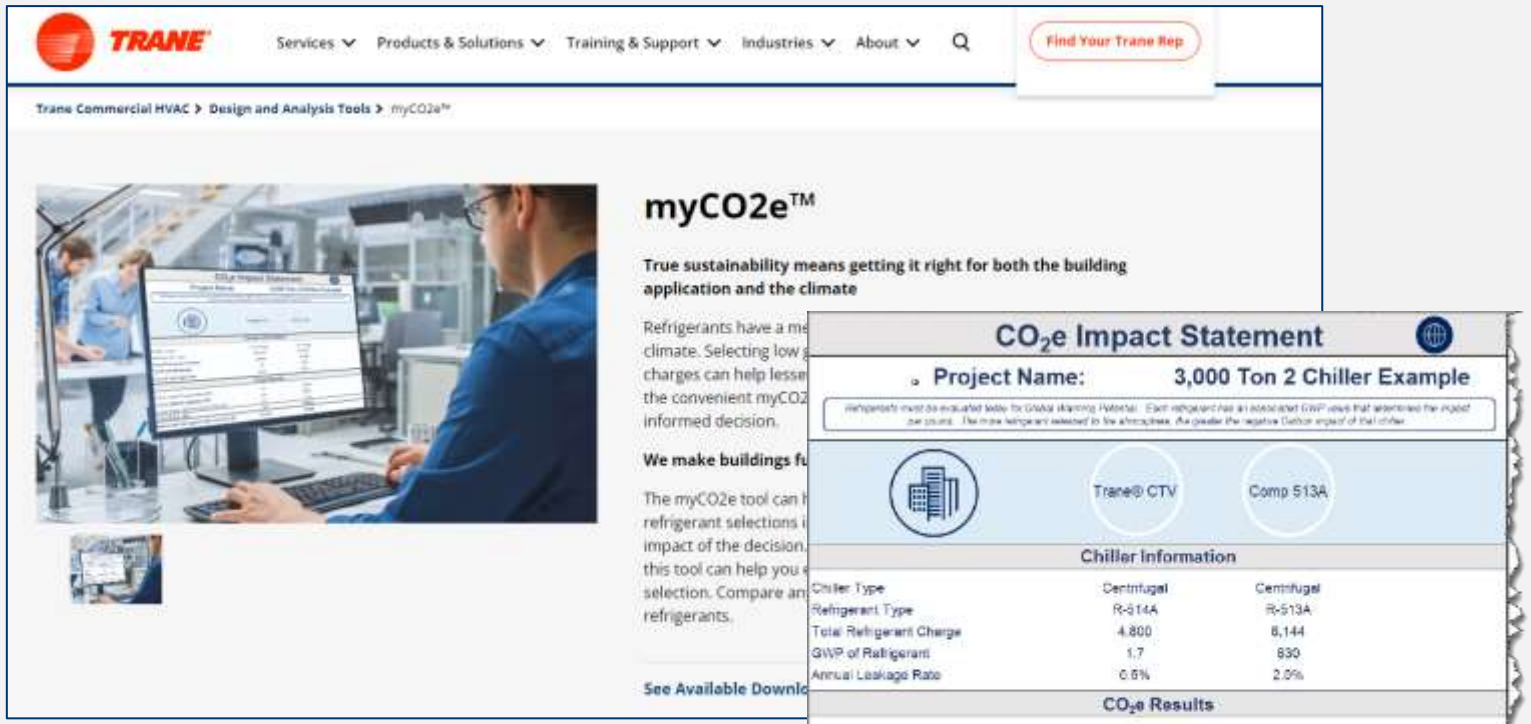
- Exported Energy (Ex)
  - Non-renewable, Ex_{nren}
  - Renewable, Ex_{ren}
  - Transportation vehicle Ex_v

$$GHG_{net} = \sum(E_{imp} \times GEFimp) + \sum(REFleak \times GEFref) - [\sum(E_{exp} \times GEFexp) + \sum(E_{rec} \times GEFrec \times DFrec + CCO)]$$

GEF: Greenhouse Gas Emission Factor

CCO: Credited Carbon Offset

Refrigerant emissions tools…



Available at: [myCO2e™ (trane.com)]

Emissions

Standard 228: Zero Net Energy and Zero Net Carbon Building Performance

Generation Type	GHG Factor (kg CO2e / kWh)
Coal	1.106
Oil	0.819
Natural Gas	0.506
Nuclear	0.042
Hydro	0
Biomass	0
Wind	0
Solar	0
Geothermal	0
Other	0.953

Equipment Type	Typical Annual Leakage Rate
Supermarket refrigeration	30%
Commercial condensing units	15%
Water chillers	5%
Hermetic units with no field installed refrigerant piping	1%
Rooftop unit air conditioner	6%
Residential heat pump and air conditioner	2%
Variable refrigerant flow air conditioner	10%
Other refrigeration	2%
Other air conditioning	2%

Refrigerant Type	GWP (kg CO2e / kWh)*
HCFC-22	1760
HCFC-123	79
HFC-134a	1300
R-404A	5
R-407C	1620
R-408A	3260
R-410A	1920
R-438A	2060
R-504	4300
Ammonia	0
CO_2	1
R-32	677
R-454B	467
R-513A	573
R-515B	298
R-514A	1.7
R-1233zd(E)	1

*…GWP $_{100s}$ from IPCC (2013) , ASHRAE Handbook of Fundamentals (2021)

Emissions

P = Proposed Standard

Standard 240P

- Quantification of Life Cycle Greenhouse Gas Emissions of Building
- Provides methodology to *quantify and document greenhouse gas emissions* across building life cycle
- Defines documentation requirements for *embodied carbon* for all building elements
  - Embodied Carbon = Emissions from upstream manufacturing activities
  - Environmental Product Declarations (EPD) for MEP equipment
- Creates a *common platform for measuring, reporting and acting upon the GHG emissions of buildings*
- Publication expected in 2025

Standard 242P

- Overarching goal
  - Provide a dedicated resource for ASHRAE energy and decarbonization standards to obtain operational emissions data
- Title Purpose and Scope subject to change
- In-person meetings
  - Three since forming in spring 2024
  - Another planned for January 2025
  - Investigated >600 permutations for emissions table… Narrowed to 54 so far
- Target is 1st public review draft shortly after January 2025 meeting

Agenda

- Introduction
- Safety Standards
- Energy
- Emissions
- Indoor Environmental Quality (IEQ)
- Operations

Indoor Environmental Quality

62.1 - Ventilation and Acceptable Indoor Air Quality
189.1 - Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings
Guideline 44 – Protecting Building Occupants from Smoke During Wildfire and Prescribed Burn Events

Standard 62.1-2022

- Explicit maximum of 60°F dew point temperature (addendum k to 2022)
- Ozone generating devices must shall be listed and labeled in accordance with UL 2998
- Filters not required for sensible-only cooling coils
- ASHRAE provides spreadsheet tools for Ventilation Rate and IAQ Procedure calculations (for a fee)
- IAQ Procedure improvements
  - Table of potential contaminants of concern with design limits

Standard 189.1-2023

- Increased ventilation
- Acoustical control
- Thermal ventilation requirements
- Filtration and air cleaner requirements
- Daylighting
- Materials and emissions
- Lighting for presentations

Guideline 44-2024

- Operation of HVAC before, during and after event
- Particulate Matter As Low As Reasonably Achievable (ALARA)
  - Reduction of PM2.5 infiltration
  - Removal of PM2.5 in the indoor air
- Balance IAQ with Safety
- Strategies for Smoke Readiness
  - Envelope sealing and tightening
  - Use high efficiency filters
  - Maintain positive building pressure
  - Temporary disabling of ASE
  - Temporary disabling of DCV

Agenda

- Introduction
- Safety Standards
- Energy
- Indoor Environmental Quality (IEQ)
- Emissions
- Operations

Operations Examples

# / Year	Operation Examples	Opportunities
36-2021	Sequences for airside, some chilled water, trim & respond.	**Use library sequences to reduce onsite cost/labor**
15-2022	Requirements for monitoring, turning equipment off, ventilation.	**Ensure proper upgrades with 2L refrigerants.**
62.1-2022	Monitoring, controls to perform (e.g.) Demand Control Ventilation (DCV).	**DCV, CO2 sensors, sequences**
90.1-2022	Many airside, hydronic and building controls required to be available	**Controls and monitoring, HVAC, lighting, submeters…**
100-2024	This is all about operation and actual, measured building performance	**This is all about operations. Use Std 100 as the maximum for buildings, provide ECMs**
189.1-2023	Base operations per 90.1, additional controls and monitoring for credits	**Higher end monitoring and controls, Also beyond HVAC system**
228-2023	Measurement, monitoring and calculation of energy and emissions streams	**Upgrading systems for imported and exported energy, as wall as GHG monitoring**
240P	Operations determine levels of emissions	**Real time monitoring to enhance performance**
241-2023	Monitoring, measurement, implementation of IRMM	**Be the local SME (e.g. healthcare)**
242P	Measurement and calculation of building operational greenhouse gas emissions	**GHG emission monitoring and reporting**

Agenda

- Introduction
- Safety Standards
- Energy
- Indoor Environmental Quality (IEQ)
- Emissions
- Operations

Takeaways

- Understand the shift of focus from energy to emissions
- Provide staff education to ensure clients view your firm as the local expert
  - Might supporting their membership on some ASHRAE committees be beneficial?
- Determine if customer offerings of newer standards provides additional business
- Support
  - Trane has Subject Matter Experts (SMEs) involved in the development of these standards!
  - Contact your Account Manager with conceptual or detailed questions for connection to SMEs
- Update internet favorites tab to include:
  - Trane educational materials (Engineers Newsletters, Engineers Newsletter Live!)
    Engineers Newsletters | Trane Commercial HVAC
  - Industry articles
    ASHRAE Articles | Trane Commercial HVAC
  - Blogs
    Search | Trane Commercial HVAC

Thank you!

If you would like to receive PDH credit for this session, please be sure to provide your feedback in the applicable session survey.
(Also available via the event App!)

**Surveys close 6/4/25*

Breakout Workshops

2025 PARTNER EXCHANGE
35th Anniversary

2025 PARTNER EXCHANGE

35th Anniversary

WAVES of INNOVATION

TOGETHER WE RISE

This presentation is protected by U.S. and international copyright laws. Reproduction, distribution, display, and use of the presentation without written permission of Trane is prohibited.
All trademarks referenced in this document are the trademarks of their respective owners. | © 2025 Trane. All Rights Reserved.