Federal Interagency
Committee on
Indoor Air Quality (CIAQ)

ASHRAE Standard 62.1

The IAQ Procedure and LEED

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an SKF Group company SKF

Important Notice

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Introduction

- An important challenge today is how to **improve and maintain IAQ in buildings** while, at the same time, **reducing their overall energy consumption**.
- **One cannot discuss the issue of IAQ** without giving some attention to the role that **energy conservation measures** may play.

Introduction (2)

- **Ventilation standards and mechanical codes have evolved** to address both IAQ and energy conservation.
- **Air cleaning technologies have developed** to provide healthy and comfortable indoor environments.
  - There are ever-increasing numbers of applications for both **particulate and gas-phase air filtration in HVAC system designs.**
    - Selecting and specifying the **appropriate control strategies** requires special consideration.

Introduction (3)

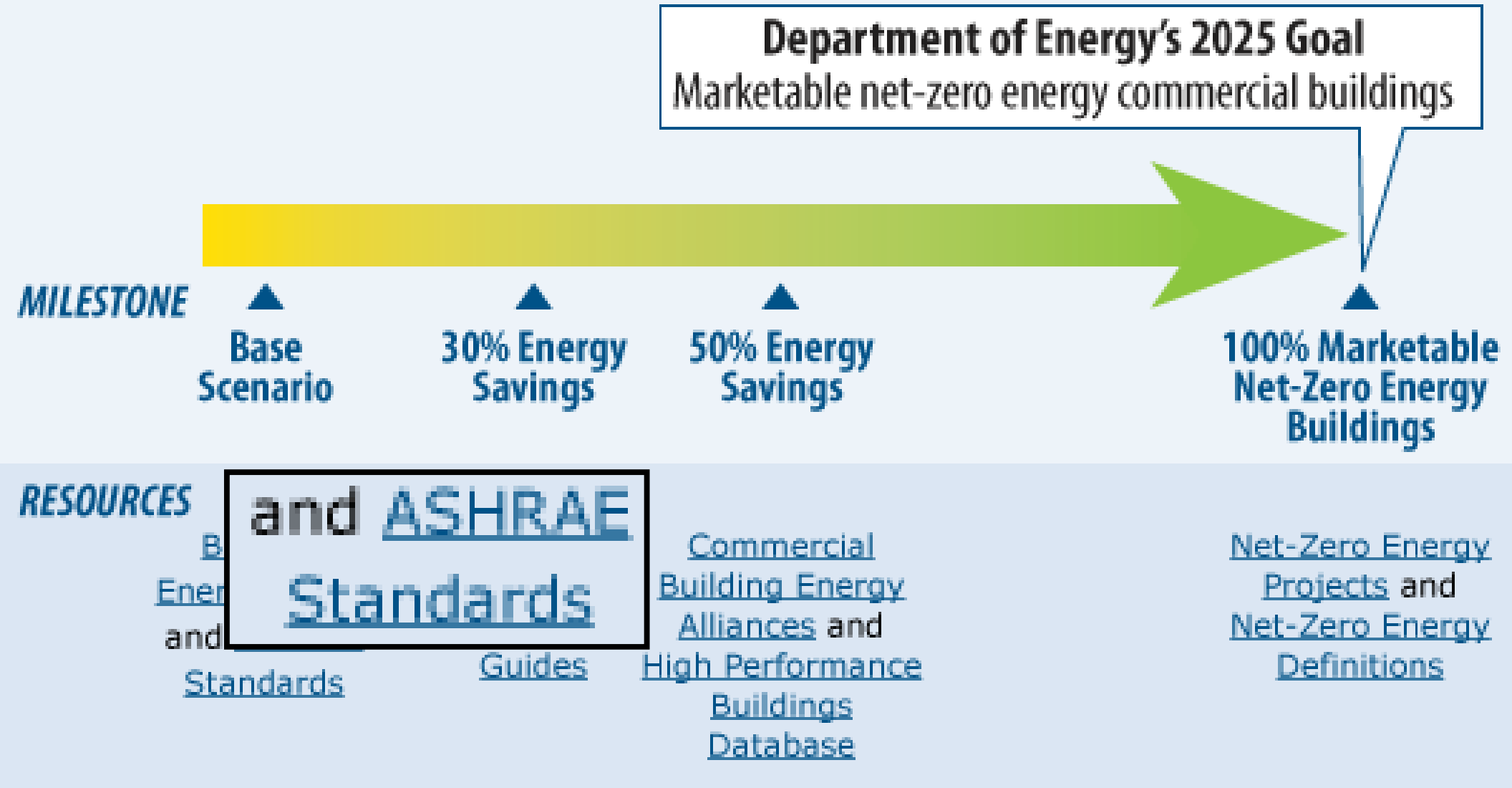
- **Air cleaning** – for both particulate and gas-phase contaminants - can be **a critical component in achieving acceptable Indoor Air Quality** as well as implementing energy conservation measures with ASHRAE Standard 62.1-2013.

Trending Towards “Net Zero”

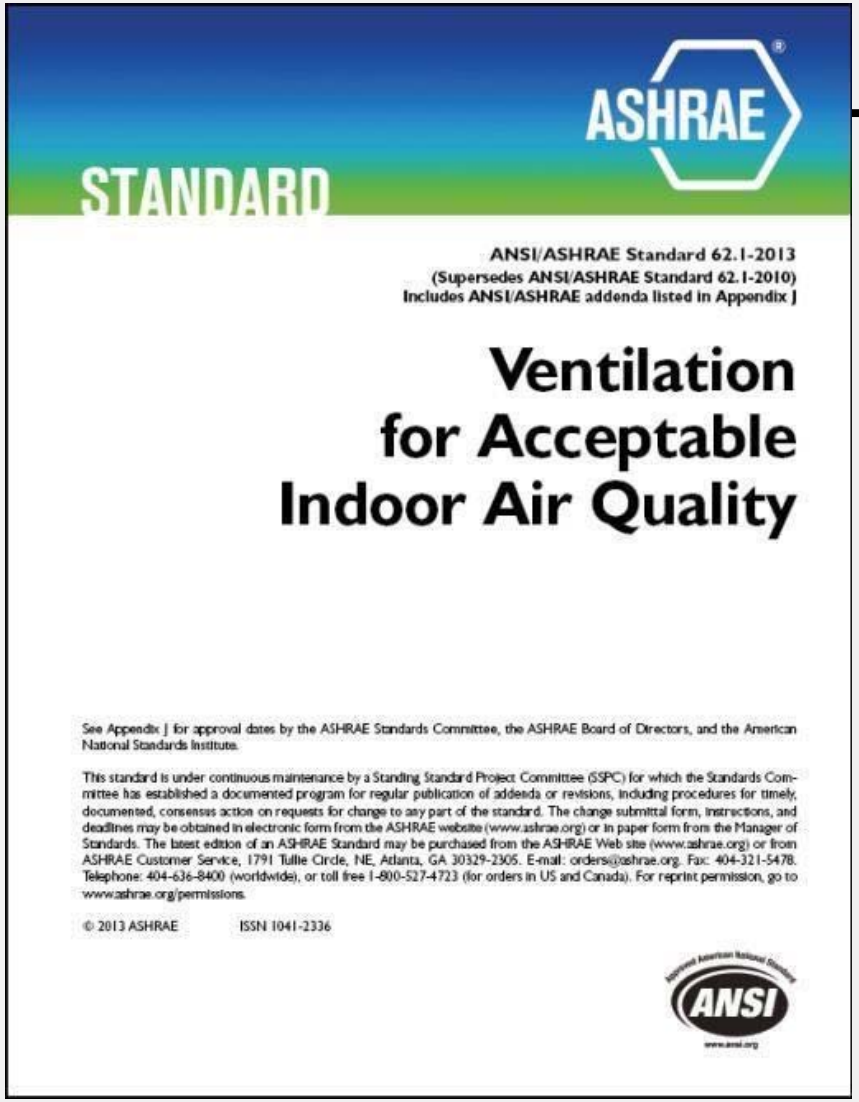
- A Net Zero Building is one that produces as much energy as it uses over the course of a year.
  - Net Zero Energy Buildings are by design very energy efficient and any remaining energy needs are typically met with on-site renewable energy.

Understand that there is no such thing as a "zero energy building! *EVERY* building uses energy, or you may as well be in a cave!

Net Zero – Momentum is Building



ASHRAE Standard 62.1



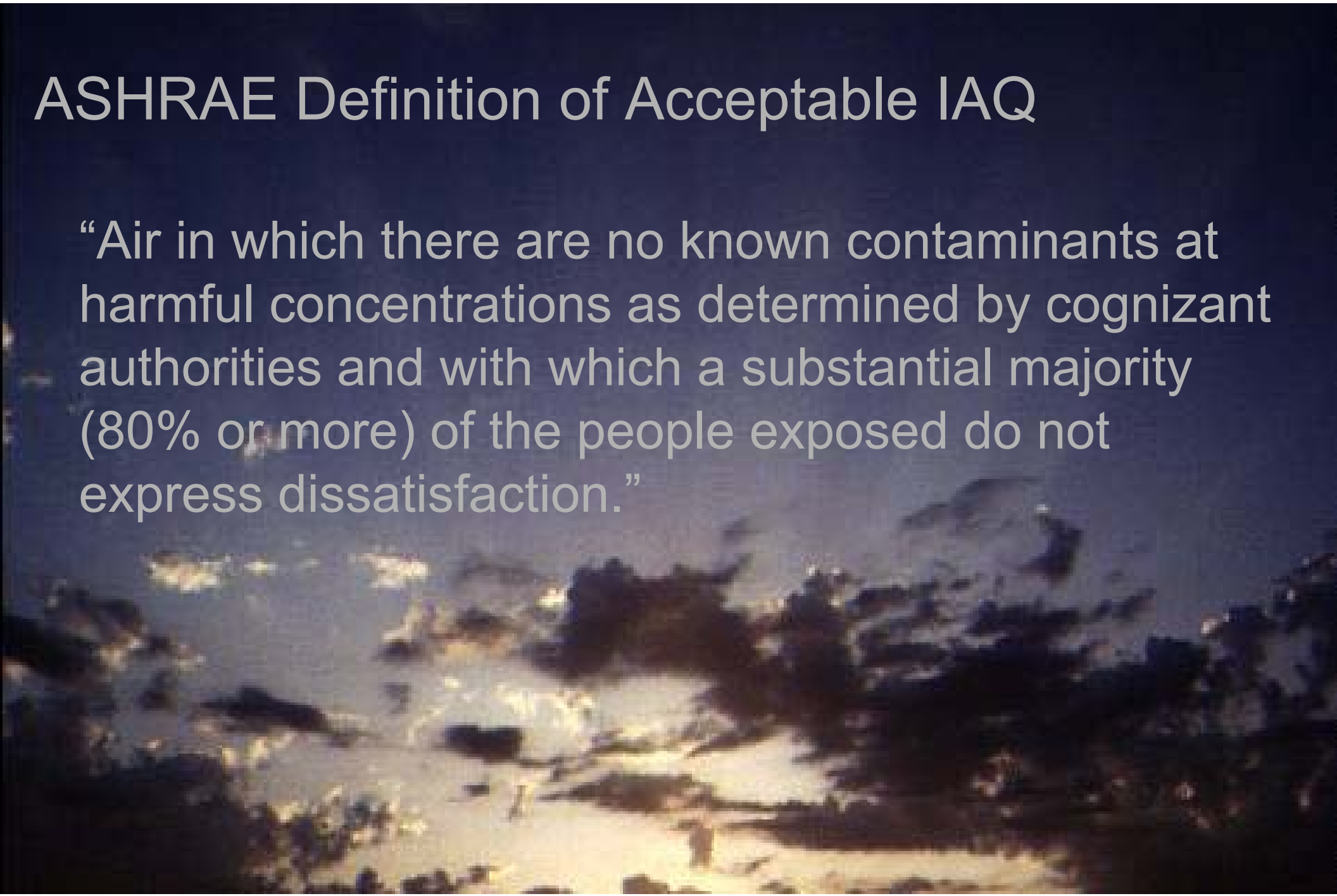
62-1973

- 62-1981
- 62-1989
- 62.1-2001
- 62.1-2004
- 62.1-2010
- 62.1-2013

???

ASHRAE Definition of Acceptable IAQ

"Air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (80% or more) of the people exposed do not express dissatisfaction."



ASHRAE Standard 62.1-2013

Ventilation for Acceptable Indoor Air Quality

- Since 2001, Standard 62.1 has been **written to be code-enforceable containing only mandatory language.**
  - New update to be published in 2013.
- **User's Manual**
  - First published in 2005, updated in 2007, 2010, and 2013, next scheduled update 2016.
    - Provides information on how to use and apply Standard 62.1 with practical examples of compliance.

- **Advanced IAQ Design Guide**
  - Best practices for design, construction & commissioning.

ASHRAE Standard 62.1-2013 (2)

Ventilation for Acceptable Indoor Air Quality

- IAQ is based upon subjective criteria.
  - ***Comfort*** **not health !!**
  - **Intended to *minimize* adverse health effects !!**
  - **Not carbon dioxide concentration !!!!**
- Ventilation Rate Procedure (VRP)
  - ***Minimum*** **acceptable outdoor air quality !!**
  - **Requires air cleaning for ozone, PM_{10} and $PM_{2.5}$!!**

- Indoor Air Quality Procedure (IAQP)
  - **Allows a balance to be struck between IAQ and energy conservation.**

Energy Conservation Potential

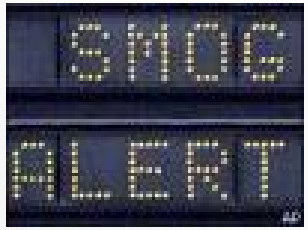
Why Not Use the IAQ Procedure?

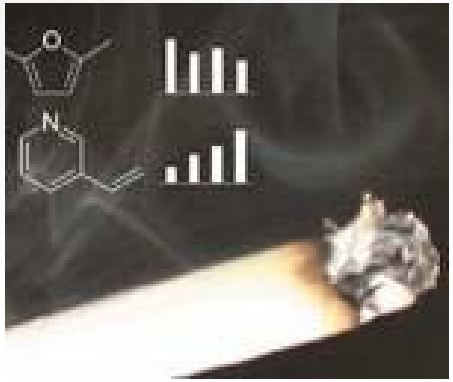
- If you have to apply air cleaning for ozone, PM_{10}, or $PM_{2.5}$ the **use of the IAQP** could pay for upgrades to the air cleaning system AND **provide for a reduction in overall HVAC operating costs**.

- **The IAQP allows** credit to be taken - in the form of **a reduction of the outside air intake rate(s) for controls that remove contaminants** and that result in indoor contaminant concentrations equal to or lower than those achieved using the ventilation rate procedure (VRP).

IAQP Requirements

- Specific requirements for compliance:
  - **Outdoor Air Quality Investigation (Section 4)**
  - **Outdoor Air Treatment (Section 6.2.1)**
  - Contaminant Sources (Section 6.3.1)
    - Identify contaminants of concern (COC)
  - Contaminant Concentration (Section 6.3.2)
  - Perceived Indoor Air Quality (Section 6.3.3)
    - Design Approaches (Section 6.3.4)
    - Documentation (Section 6.3.6)





The IAQP and Energy Savings

- The IAQP provides **improved IAQ** and **reduces the amount of energy** used to condition ventilation air.
- It provides **direct control of indoor air contaminants**.
- **Many different applications can be designed using the IAQ Procedure**.

- The most common applications, and those with the greatest potential for capital cost savings and operational cost reductions, involve **new construction and renovation**.

Example 1 - Movie Theater, New Construction

- An engineer applied the IAQP in the construction of a new General Cinema movie theater in Houston, TX with air cleaning (filtration) and recirculation would be used in an effort to **reduce the outdoor air below the 20 cfm per person prescribed by the VRP**.

- A reduction in the amount of outside air also meant that less air would have to be tempered by the HVAC system.

Operational savings of $15,000/year.

Example 2 - Office Building Renovation

- An **office building** built in Atlanta, GA in the mid-1970s **was being renovated for a new owner**.
- **The IAQP was recommended** and a cost/benefit analysis was performed.

Item	Amount
Cost Avoided:	$300,000
Energy Savings ($/yr):	$10,400
Media Replacement ($/yr):	+ (US $21,000)
Annual Operation:	+ (US $11,000)
Time to Equalization:	28 years

Example 3 - Lecture Hall, New Construction

- **Design considerations**…
- For all of the contaminants of concern, **5 cfm per person** provided space concentrations less than the target concentrations and therefore **complied with the requirements of the IAQP**.
- **Summary of savings for reduction of conditioned outside air**.

Capital Equipment Savings: ***$8,643.00***

Operational Savings: ***$1,136.00 / year***

Example 4 - Retail Store, New Construction

- A retail store design with a number of different zone types…
- All of the **contaminants of concern were less than the target concentration** limits when using a mass balance analysis design approach.
- **Summary of savings for reduction of conditioned outside air**.

Capital Equipment Savings: ***$8,845.00***

Operational Savings: ***$2,641.00 / year***

Example 5 - North East ISD, San Antonio, TX

- 1 of 13 school districts in San Antonio, TX.
- 62,000 students - ***increasing by 2,000 students per year***.
  - Elementary Schools: 42
  - Middle Schools: 13
  - High Schools: 7

Example 5 - New Schools

Operating Cost Savings

Ridgeview Elementary School

Weather Data From: SAN ANTONIO, TX

Air Recirculated or Saved:	6,270	**CFM**
Refrigeration Ton Hours Saved:	30,831	**TON-HRS / YR**
Heating Fuel Saved:	1,800	**THERMS / YR**

Annual Operating Costs and Savings

Cooling Cost Saved:	2,525.02
Water and Chemical Cost Saved:	0.00
Heating Cost Saved:	1,313.87
Humidification Cost Saved:	0.00
Enersave Cost:	-1,798.59
Net Operating Cost-Savings	2,040.32

Net operating cost savings of over $2,000 per year for classroom addition.

Example 5 – Schools, New Construction

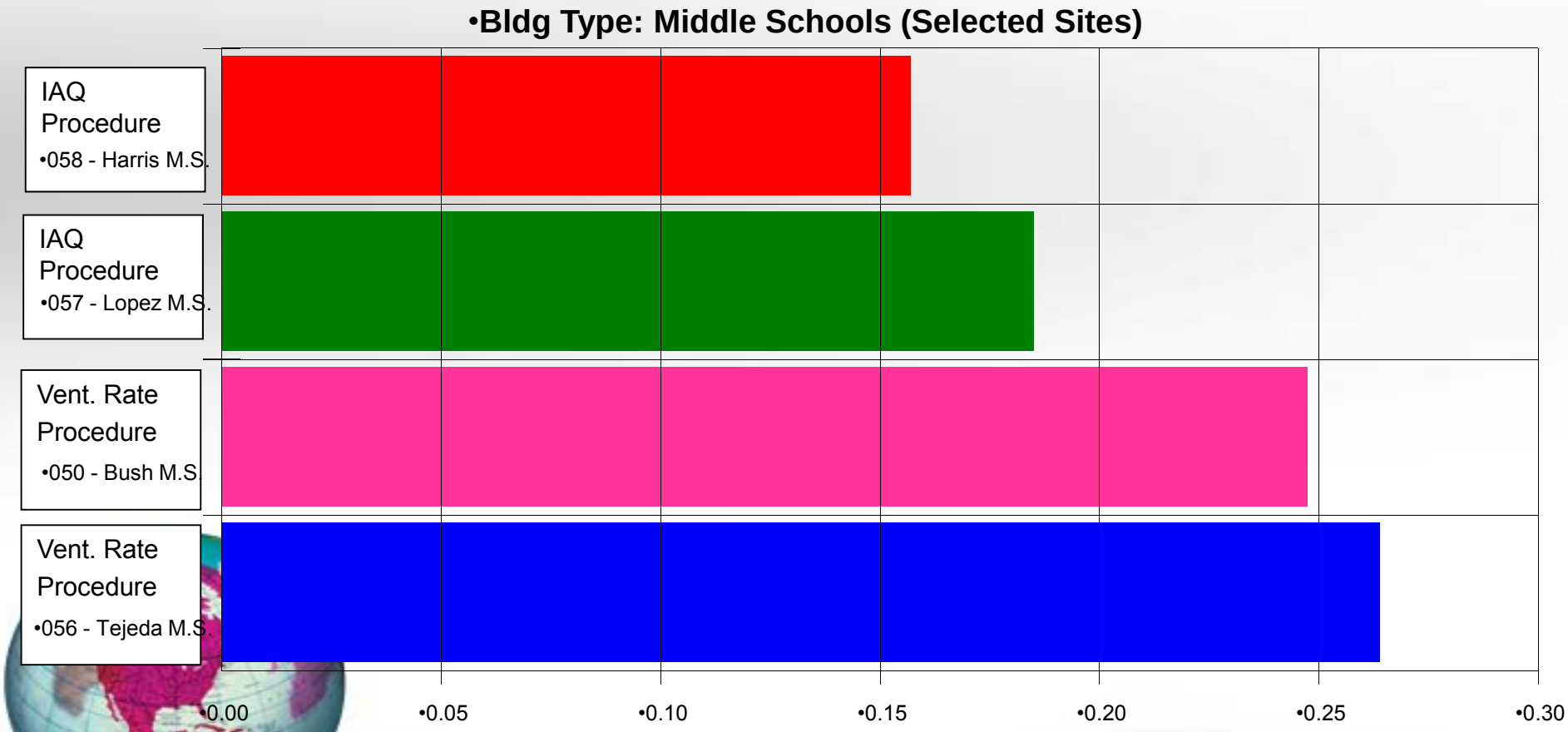
- **Twelve Schools**
  - 6 High Schools
  - 4 Elementary Schools
  - 2 Middle Schools

- **85 Separate HVAC Systems**
  - VAV Systems
  - Roof Top Units
  - Constant Volume Syste

Over 110,000 CFM of OA reduction!!

Example 5 - Energy Cost Comparisons

Total energy Costs



Quarterly energy costs are up to $0.10 less per square foot of space.

Example 5 - Sustainable Impacts

- Annual estimates for enhanced filtration and outdoor air reduction:
  - ***Outdoor Air Reduction*** = 9,760 cfm
    - VRP_{2007} = 12,000 cfm
    - $IAQP_{2007}$ = 2,240 cfm
  - ***Energy Related Savings*** = $11,900
    - Electricity Savings = 68,897 kWh
    - Gas Savings = 4,091 therms
  - ***CO_2 Emissions Reduction*** = 72 tons

Based on San Antonio, TX weather and utility rate data

Example 5 - Particulate Air Filter Types

	Group 1	Group 2	Group 3	NEISD
MERV	Av. Eff. %	Av. Eff. %	Av. Eff. %	Standard
Valve	(0.30 to 1.00)	(1.00 to 3.00)	(3.00 to 10.00)	Application
1	n/a	n/a	E3<20	
2	n/a	n/a	E3<20	
3	n/a	n/a	E3<20	Window Unit
4	n/a	n/a	E3<20	
5	n/a	n/a	20<35	
6	n/a	n/a	35<50	
7	n/a	n/a	50<70	
8	n/a	n/a	70	Classrooms
9	n/a	E2<50	85	
10	n/a	50<65	85	
11	n/a	65<80	85	
12	n/a	80	90	
13	E1<75	90	90	
14	75<85	90	90	
15	85<95	90	90	Near IS Hwy.
16	95	95	95	Rifle Ranges

Selected filters for removal of airborne particle contaminants.

Example 5 - VRP Analysis

Contaminant	Guideline Limits	VRP Levels	VRP %
Ozone	**0.08 ppm**	**0.104**	**130%**
TVOC	**1.0 ppm**	**0.764**	**76%**
Formaldehyde	**0.12 mg/m3**	**0.07**	**58%**
Nitrogen Dioxide	0.053 ppm	0.017	32%
Carbon Monoxide	9 ppm	2.6	29%
Phenol	0.1 mg/m3	0.029	29%
Hydrogen Sulfide	0.04 mg/m3	0.008	22%
Ammonia	0.5 mg/m3	0.103	21%
Methyl Alcohol	1.5 mg/m3	0.228	15%
Sulfur Dioxide	0.03 ppm	0.004	13%
Acetone	7 mg/m3	0.171	2%

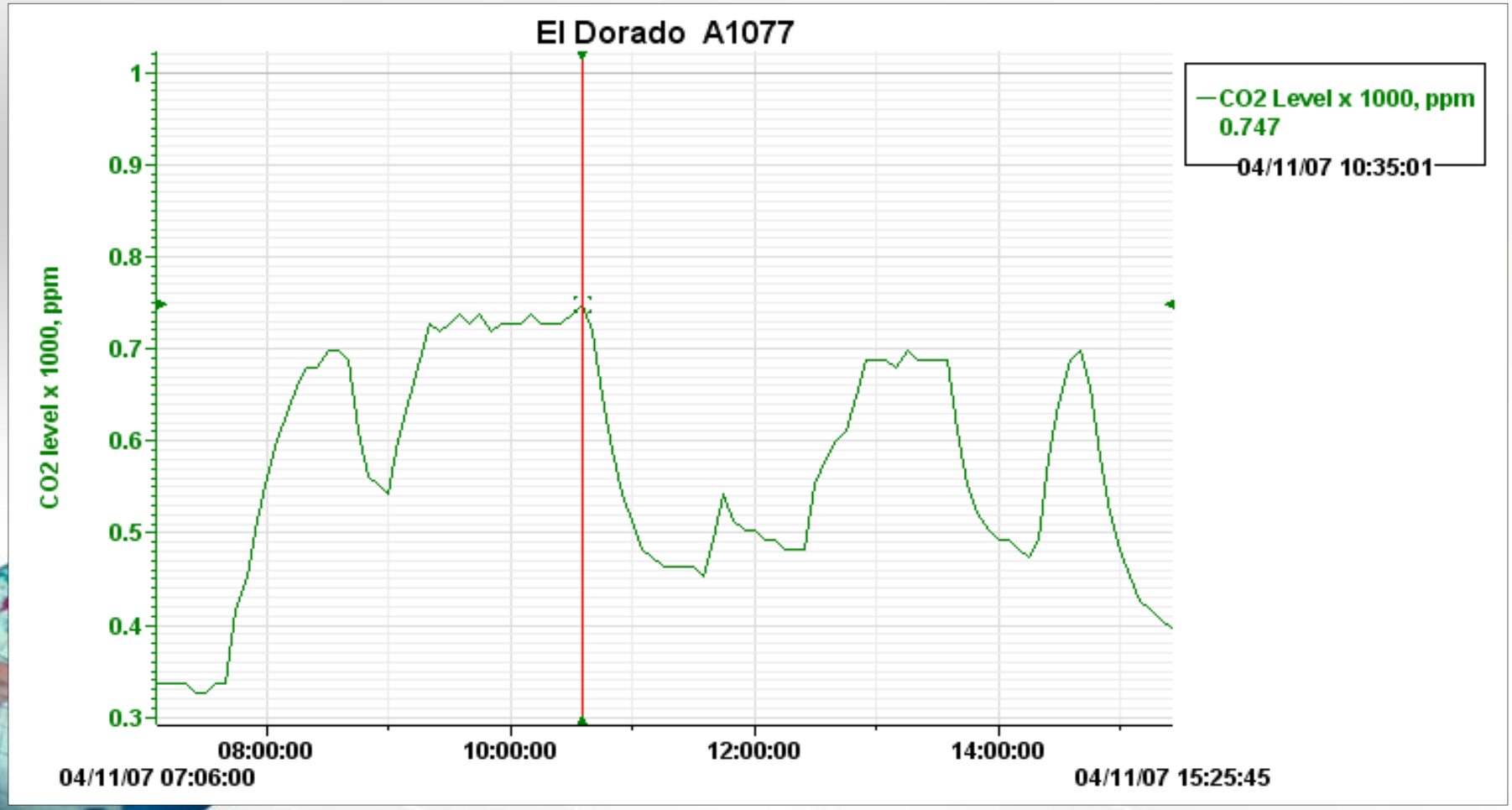
Unacceptable levels of contamination still possible with Ventilation Rate Procedure.

Example 5 - IAQ Procedure Analysis

Contaminant	Guideline Limits	IAQP Levels	IAQP %
Ozone	0.08 ppm	0.024	30%
TVOC	1.0 ppm	0.483	48%
Formaldehyde	0.12 mg/m3	0.044	37%
Nitrogen Dioxide	0.053 ppm	0.004	7%
Carbon Monoxide	9 ppm	2.6	29%
Phenol	0.1 mg/m3	0.019	20%
Hydrogen Sulfide	0.04 mg/m3	0.006	14%
Ammonia	**0.5 mg/m3**	**0.211**	**42%**
Methyl Alcohol	1.5 mg/m3	0.153	10%
Sulfur Dioxide	0.03 ppm	0.0009	3%
Acetone	7 mg/m3	0.107	2%

Contaminant levels are less than 50% of Guideline Limits.

Example 5 - Classroom CO_2 Levels



CO_2 Monitoring shows that a classroom is empty for half of day-time hours.

Example 5 - Elementary Schools Experience

Use of medical inhalers by asthmatic students has been reduced by as much as 50% from prior year's usage!!

No complaints about IAQ from teachers!!

Example 5 - High Schools Experience

- **IAQP** – Primary solution for high school air quality concerns.
- District's evaluation favored the continued use of the IAQP.
- Currently available air cleaning technology can be used to apply the IAQP.
  - Additional school operational experience has been successful in using the IAQP.

Example 5 - North East ISD Conclusions

- **IAQP Summary.**
  - Enhanced air cleaning, both gas-phase & particulate decreased outside air requirements.
  - Decreased energy usage.
  - Provided improved indoor air quality.
- **Energy and environmental incentive.**
  - An IAQP design can reduce HVAC energy requirements, saving money and cutting carbon emissions.

- **Acceptable air quality & lower outdoor air amounts.**
  - An IAQP Design incorporating enhanced air cleaning can provide acceptable air quality with lower outdoor air.

The World According to 62.1

- What about those other guys?
  - International Code Council and the **International Mechanical Code (IMC)**
  - U.S. Green Building Council and **Leadership in Energy and Environmental Design (LEED)** Green Building Rating System

What about where the IMC is King?

- Section 105.2 on alternative materials, methods, equipment and appliances.

"An alternative material or method of construction shall be approved where… the proposed design is satisfactory and complies with the intent of the provisions of this code…"

- Does not prevent the use of the IAQ Procedure.

What about LEED?

- LEED Indoor Environmental Quality (EQ) Prerequisite 1 requires that the mechanical ventilation system is to be designed using the ***Ventilation Rate Procedure (VRP)*** of Standard 62.1 or the applicable local code – whichever is more stringent.
- There are LEED certified buildings located in non-attainment areas for PM_{10} and $PM_{2.5}$ as well as those located in parts of the country where air cleaning for ozone is required that are not in full compliance with these provisions of the VRP.

LEED-NC and the IAQP?

"If I'm going for LEED certification AND I'm required to use air cleaning for compliance with the VRP anyway, why can't I just go ahead and use the IAQ Procedure?"

- A few questions remain about its application and some of the design considerations that have to made.
  - How many and which contaminants are chosen for modeling?
  - What are the recommended control levels?

LEED-NC and the IAQP?

It Can Be Done (and has been done)!

- **Duke Energy Center, Charlotte, NC (USA)**
  - Owner ***demanded*** LEED certification **AND** to use the IAQ Procedure for energy savings and IAQ.
  - LEED consultants said: 

  - Owner said: “Find me a way!”

Result: “*Wells Fargo’s Duke Energy Center, in Charlotte, N.C., has earned the U.S. Green Building Council’s Leadership in Energy and Environmental Design (LEED) Platinum certification*.”

(Environmental Leader, June 8, 2010).

The IAQP: Current Work

- **ASHRAE Technical Resource Group (TRG 4.IAQP), IAQ Procedure Development**
  - Developing specific guidance to allow users to apply the IAQP method as defined under ASHRAE Standard 62.1.
- **USGBC IAQ Performance Testing Working Group (IAQP WG)**

  - Charged with developing a performance methodology for IAQ using the IAQP as outlined in ASHRAE 62.1 as a basis.
  - In order for a building to use gas phase filtration, the manufacturer data from the testing performed on the filters using ASHRAE Standard 145.2 is required.

LEED IAQP Pilot Credit

- **Pilot Credit Intent**
  - To contribute to the comfort and well-being of building occupants by establishing minimum standards for IAQ.
- **Requirements**
  - This prerequisite is available for pilot testing by the following LEED rating systems:
    - New Construction
    - Retail NC (excluding restaurants)
    - Schools (excluding laboratories within school buildings)
    - Commercial Interiors
    - Retail CI (excluding restaurants)
    - Existing Buildings Operation & Maintenance

IAQ Procedure for LEED

IAQP Pilot Credit presentation from Greenbuild 2012

- **Part 1**: Introduction and Credit Overview
  - ***Amy Boyce, PE, LEED AP BD+C***
    - LEED Energy and Atmosphere Technical Specialist, USGBC
- **Part 2**: What Do You Do, What Do You Look For, and How Do You Do It?
  - ***Charlene Bayer, Ph.D.***
    - Hygieia Sciences LLC and The Georgia Institute of Technology

- **Part 3**: Applying the IAQ Procedure to Retail and Office Buildings: Selected Case Studies
  - ***Jeremy R. Poling, PE, LEED AP BD+C, LEED AP O+M***
    - Goby LLC

IAQ Procedure for LEED

IEQ Pilot Credit 68

- Not in LEED 2009 – alternate route used VOC testing to receive credit, not health based.
- Recent emphasis on health issues is being brought to the forefront in LEED v4.
  - **Heavy health emphasis** – LEED v4 certification is not going to be as easy as in previous versions.
  - **Applies to all buildings** whether VRP or IAQP.
  - **Performance standards** are used for everything.
  - LEED vs. ASHRAE **does not require gas-phase air filtration**.
  - Clearly defined **occupant perception procedure**.
  - CoCs all have PELs and health-based endpoints and **pilot program is health-based**.

Determining Ventilation Rates

ASHRAE 62.1 VRP vs. IAQP

Ventilation Rate Procedure

- Currently only option allowed in LEED
- Basis for IMC code language
- Design, not performance standard
  - Difficult for existing buildings
- Prescriptive
  - Does not take into account individual building conditions

IAQ Procedure

- Less defined
  - Which contaminants to test for?
- Less used
  - *Not much public test data available for Standard 145.2*.
- Better option for existing buildings
  - Minimizes need to track down existing documentation.
  - Confirms or invalidates building's presumption of good IAQ.

Pilot Credit Development

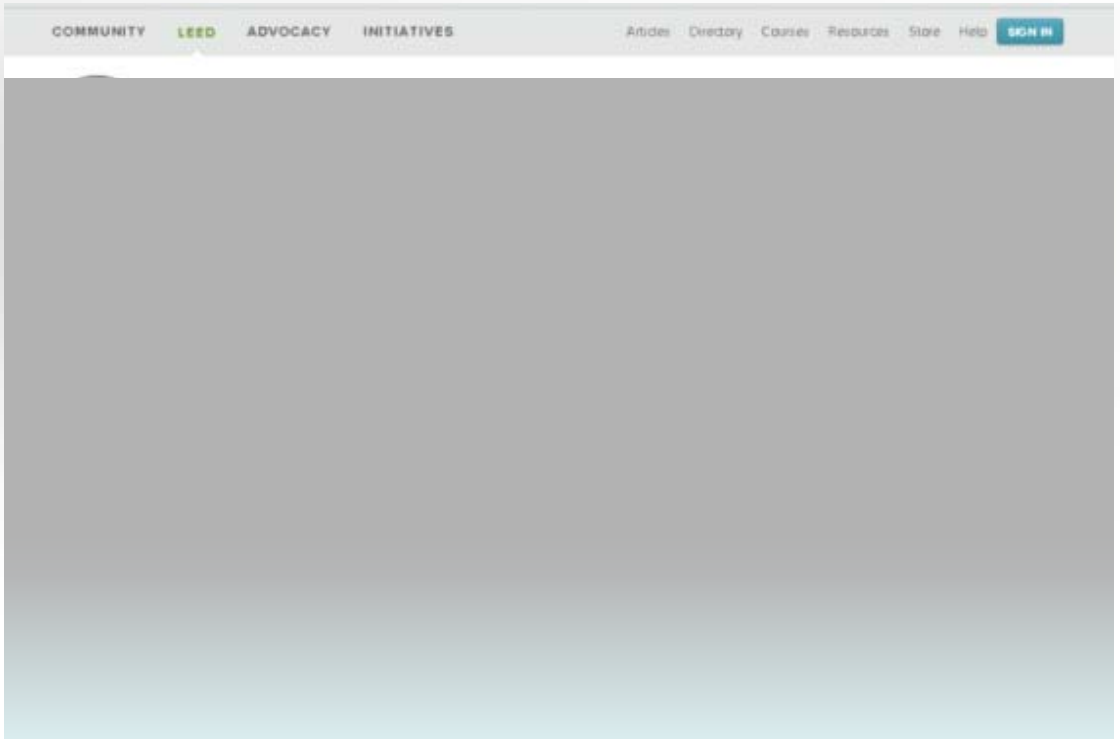
Alternative Compliance Path for IEQ Prerequisite 1

- Cross-disciplinary working group
  - Engineers
  - Industrial hygienists
  - Filter manufacturers
  - Owner groups
    - Goals
      - Defined contaminant list
      - Include perceived IAQ
      - Identify standards for testing that are both comprehensive yet not overly onerous
    - Available as Pilot ACP in the Pilot Credit Library

IEQ Pilot Credit 68

Indoor Air Quality Procedure

- Loosely follows structure of 62.1, Section 6.3
- Four main parts:
  - Contaminants of Concern
  - Acceptable thresholds
  - Testing procedures
  - Corrective Action



http://www.usgbc.org/node/2616403?view=language

Typical Sources of Contaminants

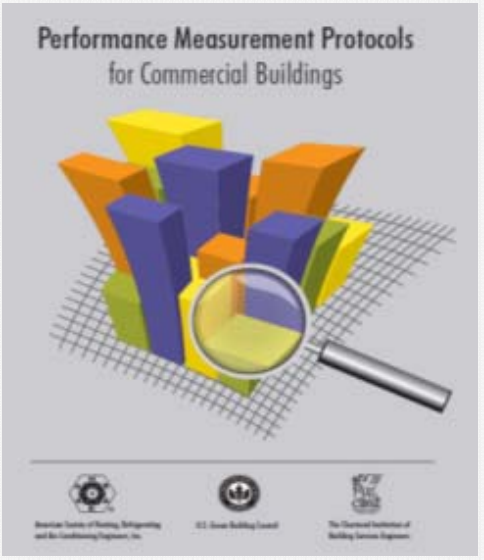
New Construction

- Furnishings & building materials
- Cleaning products
- Outdoor air
- People and Personal care products
- Pesticides
- Cooking
- Plants
- Finishes, paints, varnishes
- Combustion devices

Existing Buildings

- Cleaning products
- People and Personal care products
- Pesticides
- Outdoor air
- Cooking
- Plants
- Ventilation systems
- Furnishings
- Combustion devices

Resources: Determining Contaminants and Measurement Methods



ASHRAE STANDARD 62.1-2013
Appendix B Tables

Selected CoCs and target concentrations and regulations.

ASHRAE INDOOR AIR QUALITY GUIDE: BEST PRACTICES FOR DESIGN, CONSTRUCTION, & COMMISSIONING

ASHRAE developed resource covering the full range of IAQ issues important to practitioners in the building community.

ASHRAE PERFORMANCE MEASUREMENT PROTOCOLS FOR COMMERCIAL BUILDINGS

ASHRAE developed protocols identifying what to measure, how it is measured, and how often it is measured.

Resources: Determining Contaminants

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH

Office of Environmental Health Hazard Assessment (OEHHA)

http://www.oehha.ca.gov/air/allrels.html

- List of acute, 8-hour, and chronic exposure levels
- Includes organic and inorganic gaseous pollutants, particulate matter, and inorganic and metallic non-gaseous pollutants
- Target levels are health-based
- Hazard index and target organ-system listed

Resources: Determining Contaminants

WORLD HEALTH ORGANIZATION (WHO)

Guidelines for indoor air quality: selected pollutants

http://www.euro.who.int/__data/assets/pdf_file/0009/128169/e94535.pdf

Guidelines and evidence to protect health globally from the impact of indoor air pollutants by recommending target levels for CoCs to significantly reduce exposure health risks and providing a scientific basis for legally enforceable standards in all world regions.

Benzene	Carbon Monoxide
Formaldehyde	Naphthalene
Nitrogen Dioxide	Tetrachloroethylene
Radon	Trichloroethylene

Polycyclic Aromatic Hydrocarbons

World Health Organization

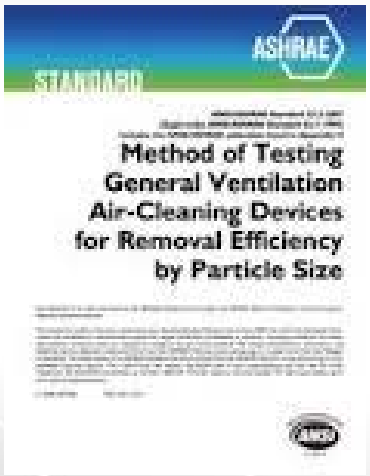
Resources: Air Filter Testing

ASHRAE Standard 52.2-2012

- Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size (ANSI Approved)

ASHRAE Standard 145.2-2011

- Laboratory Test Method for Assessing the Performance of Gas-Phase Air Cleaning Systems: Air Cleaning Devices (ANSI approved)



Resources: IAQ Testing

ASHRAE 189.1-2009: Standard for the Design of High-Performance Green Buildings

- Section 10.3.1.4: Similar to LEED NC
- Post-Construction, Pre-Occupancy Baseline IAQ Monitoring
  - IAQ testing to be conducting with HVAC system operating using protocols consistent with EPA Compendium, and ASTM Method D5197
    - Concentrations in HVAC return airstreams not to exceed maximum concentration levels in Table 10.3.1.4
      - Testing locations (choose either):
        - One location per 25,000 ft^2 (2,500 m^2)
        - In each contiguous floor air

Resources: IAQ Testing

ASHRAE 189.1-2009: Standard for the Design of High-Performance Green Buildings

- Section 10.3.2.1.4.5: Similar to LEED EBOM
- Plan for Operation documenting procedures for maintaining & monitoring IAQ after occupancy
- Biennial monitoring of IAQ by one of 3 methods:
  - IAQ testing
  - Monitoring occupant perceptions of IAQ by any method
  - Occupant complaint/response program for IEQ

ASHRAE 189.1-2009

Selected CoCs in Table 10.3.1.4

MUST DEMONSTRATE THAT MAXIMUM CONCENTRATION LEVELS OF COCS ARE NOT EXCEEDED IN HVAC RETURN AIRSTREAM

Contaminant	Maximum Allowable Concentration
Formaldehyde	33 ppb
Particulates (PM_{10})	150 µg/m^3 (24-hr)
Particulates (PM_{25})	35 µg/m^3 (24-hr)
TVOCs	Shall be reported in accordance with CA/DHS/EHB/R-174
CO	9 ppm or $\leq$ 2 ppm above outdoor levels
Ozone	0.075 ppm (8-hr)
Acetaldehyde	140 µg/m^3
Benzene	60 µg/m^3
Styrene	900 µg/m^3
Phenol	200 µg/m^3
Toluene	300 µg/m^3

IAQP – Alternate Compliance Path

EQpc68 | Required

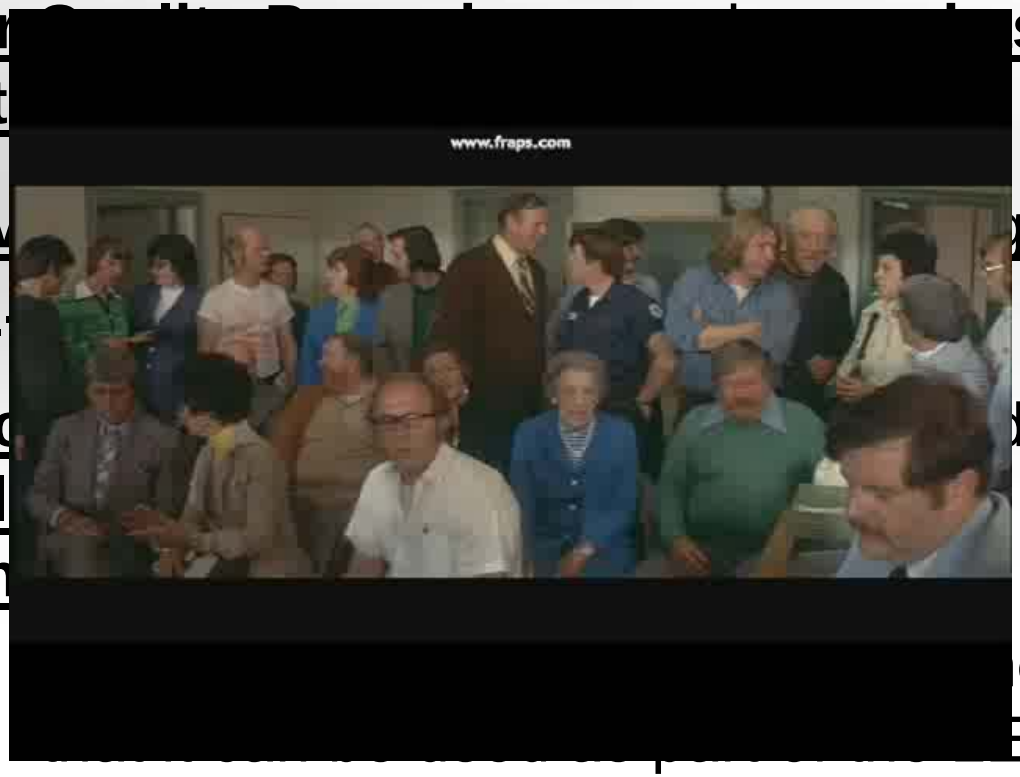
Contaminant Compound	Concentration Limit (µg/m3)	Contaminant Compound	Concentration Limit (µg/m3)
Acetaldehyde	140	Formaldehyde	33
Benzene	60	Hexane (n-)	7,000
Carbon disulfide	800	Isophorone	2,000
Carbon tetrachloride	40	Isopropanol	7,000
Chlorobenzene	1000	Methyl	1,000
Chloroform	300	M loride	400
Dichlorobenzene (1,4-)	800	t-butyl ether	8,000
Dichloroethylene (1,1)		Naphthalene	9
Dimethylformamide (N,N-)		Phenol	200
Dioxane (1,4-)	3,000	Propylene glycol monomethyl ether	7,000
Epichlorohydrin	3	Styrene	900
Ethylbenzene	2,000	Tetrachloroethylene	35
Ethylene glycol	400	Toluene	300
Ethylene gl yl ether	70	Trichloroethylene	600
Ethyl onoethyl ether acetate	300	Vinyl acetate	200
Et ycol monomethyl ether	60	Xylenes	700
Ethylene glycol monomethyl ether acetate	90		

There are verifiable and documented **Health Effects** for all CoCs listed.

LEED IAQP Pilot Credit

Summary and Conclusions

- The **Indoor Air** **s an alternative to the Ventilat**
- The IAQP **prov** **g and controlling contaminants**
- Allows for **a mo** ding good air quality since **al** **considered an**
  - g the IAQP now EED certification process.



…but it ain't gonna be easy.

Summary and Conclusions (3)

Applying the IAQ Procedure shows that **using as little as 5 cfm/person of outdoor air** can reduce the total space contaminant concentration to levels low enough to be below published guidelines, **provide *BETTER* indoor air quality, and meet the requirements of ASHRAE Standard 62-2001-2013**.

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PURAFIL FIRST IN CLEAN AIR™

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IEQ Pilot Credit 68: Indoor Air Quality Procedure

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