

The Sound of Sausage in Swollen Standard Casings

**The Past and Future of Ventilation Standards,
Rendered Through Music**



Westford Symposium on Building Science – August 5, 2026

Call Me the Breeze – J.J. Cale (1972); Nick Hurst, Summer Camp '26 Version – A
 [91 bpm/cfm??]

Intro: Jam in A

Verse 1:

A
 Oh yes, they call me the breeze, I keep blowin' down the road
 D D7 A
 Oh yes, they call me the breeze, I keep blowin' down the road
 E D D7 A
 If you want to help somebody, add that ventilation load.

Verse 2:

Ain't no change in the weather, Ain't no change in me
But when there's change in the weather, the stack effect is plain to see
 You can't hide from all that radon, but a little fan can set it free.

Call Me the Breeze

Verse 3:

I got that green light, baby, I got to keep movin' on

If I got that green light, baby, my ventilation fan is ON

I might go down to Bryan, Texas, might test the air, and then fly home.

Solos

Verse 4:

I got that red light, baby, I got to keep on hangin' on

If you got that red light, baby, please make sure your filter's on

I might go down to Westford's Orchard, pray Summer Camp will find a home.

Verse 1

Oh yes, they call me the breeze, I keep blowin' down the road

Oh yes, they call me the breeze, I keep blowin' down the road

If you want to help somebody, add that ventilation load. . . . *[last line X2]* . . . (END)

What I'm About to Say

- **Filtration** of outdoor air must improve in ventilation standards.
- **Climate-specific** requirements are needed in ventilation standards.
- **Performance-based approaches** should be promulgated.
 - **CO2 monitoring & actuation** encouraged in residential.
 - **Indoor / Outdoor monitoring** should be addressed in standards.
- **User experience** as a comfort metric and industry target.
- **Generational knowledge transfer** is critical for industry.
- **“Hands-on” experience** for youth is critical to inspire inquiry.

I'm a “fan” of “sausage” . . . I really am.



Nick Hurst

- Recovering Carpenter
- Serial Remodeler
- Concerned Committee Member
- Collaborative Consultant
- Musician

Open to Work!

[Find me on LinkedIn](#) – Nicholas (Nick) Hurst

Where I'm Coming From



My first timber
frame, straw
bale building.

Pittsburgh, PA
2003



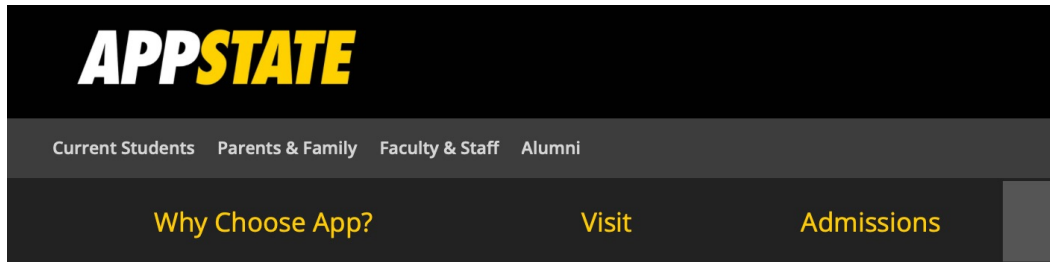








Mastering “BS” & “AT”



Home > Academics > Master's Programs >



ASU
“E-3 House”
2009











































Questions for the Experts in BS

1. What are the origins of “build tight, ventilate right”?
2. How did ASHRAE Standard 62.2 come to be, and why is it so hard to understand?
3. How can we measure IAQ . . . and what should we do about it?



Questions for the Experts in BS

1. What are the origins of “build tight, ventilate right”?



Dr. Joseph Lstiburek:
“The Swedes (1980s) . . .
“It’s cold up there . . .
and they speak English.”



Dr. Max Sherman:
“Arne Elmroth, Professor Emeritus of Building
Physics at Lund University, Sweden”



ISO/TC 163
International Energy Agency
(IEA)

Swedish Energy Agency
European Commission

Advisory to SP

Royal Swedish Academy of
Engineering and Science

Questions for the Experts in BS

Possible alternatives to “Build tight, ventilate right”?



Dr. Joseph Lstiburek:

“Leaky houses don't have great air quality.”



Dr. Max Sherman:

“Build Cheaply, Ventilate Weakly”

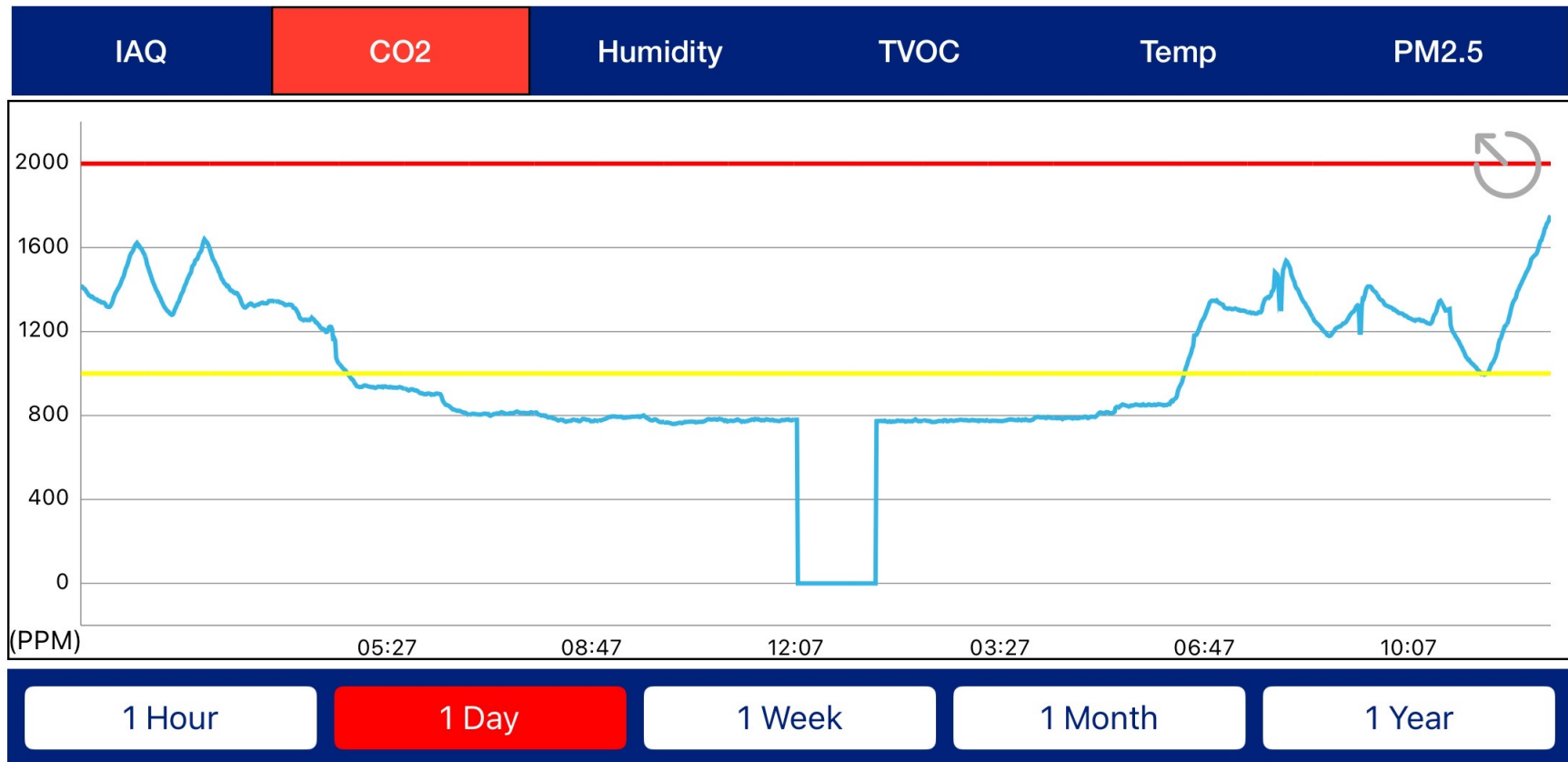
... or “Weekly??”

Questions for the Experts in BS

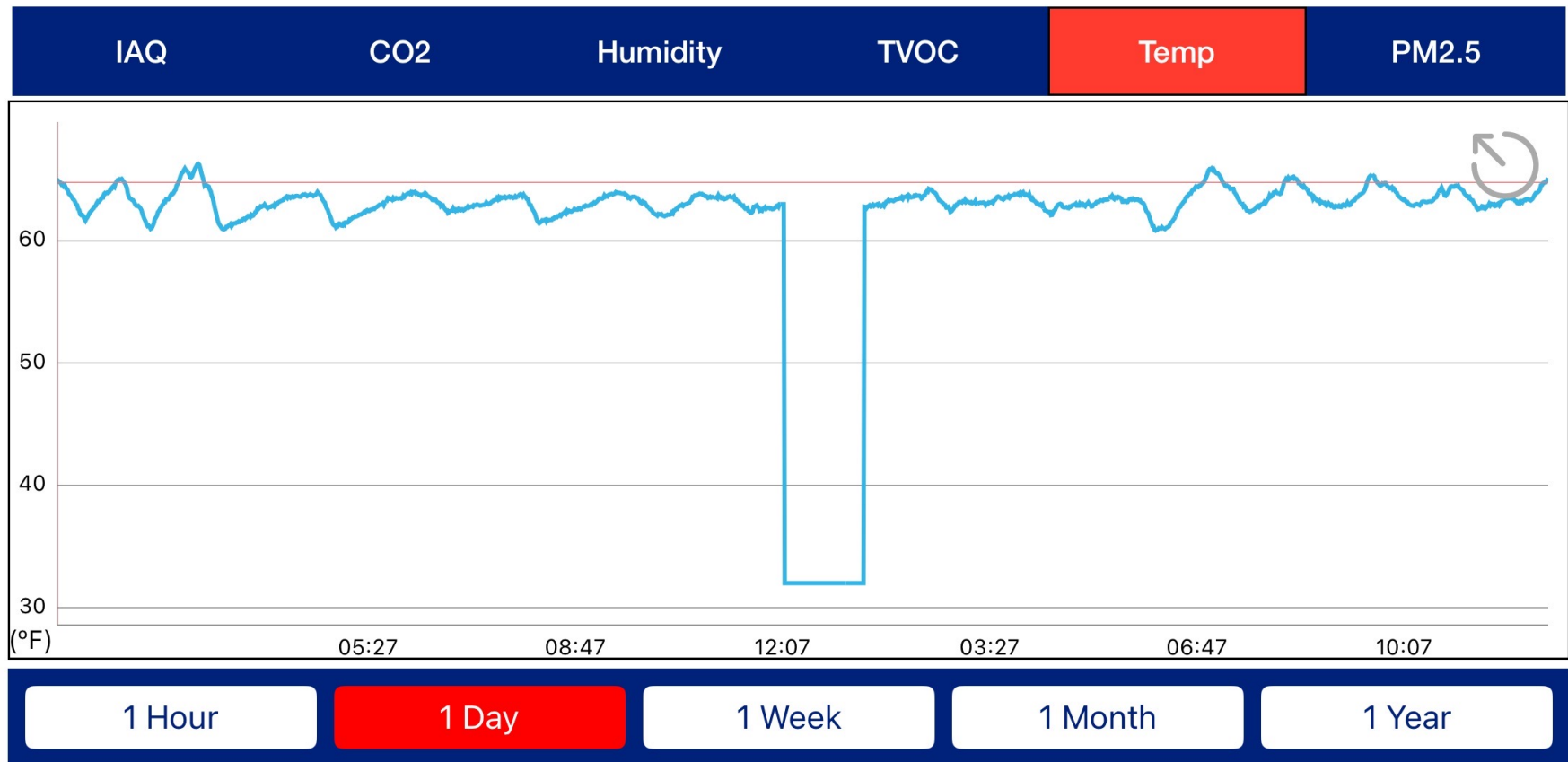
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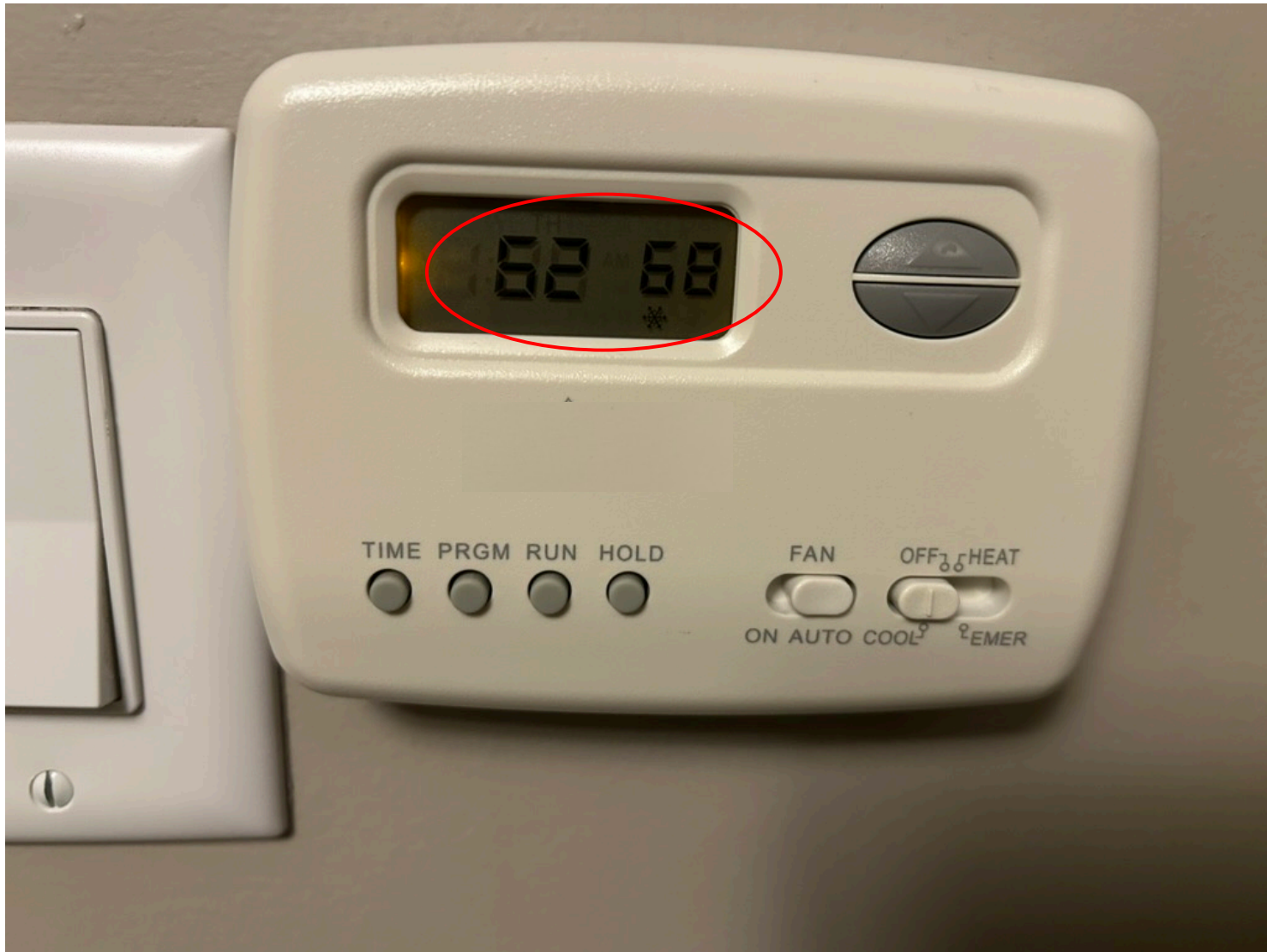




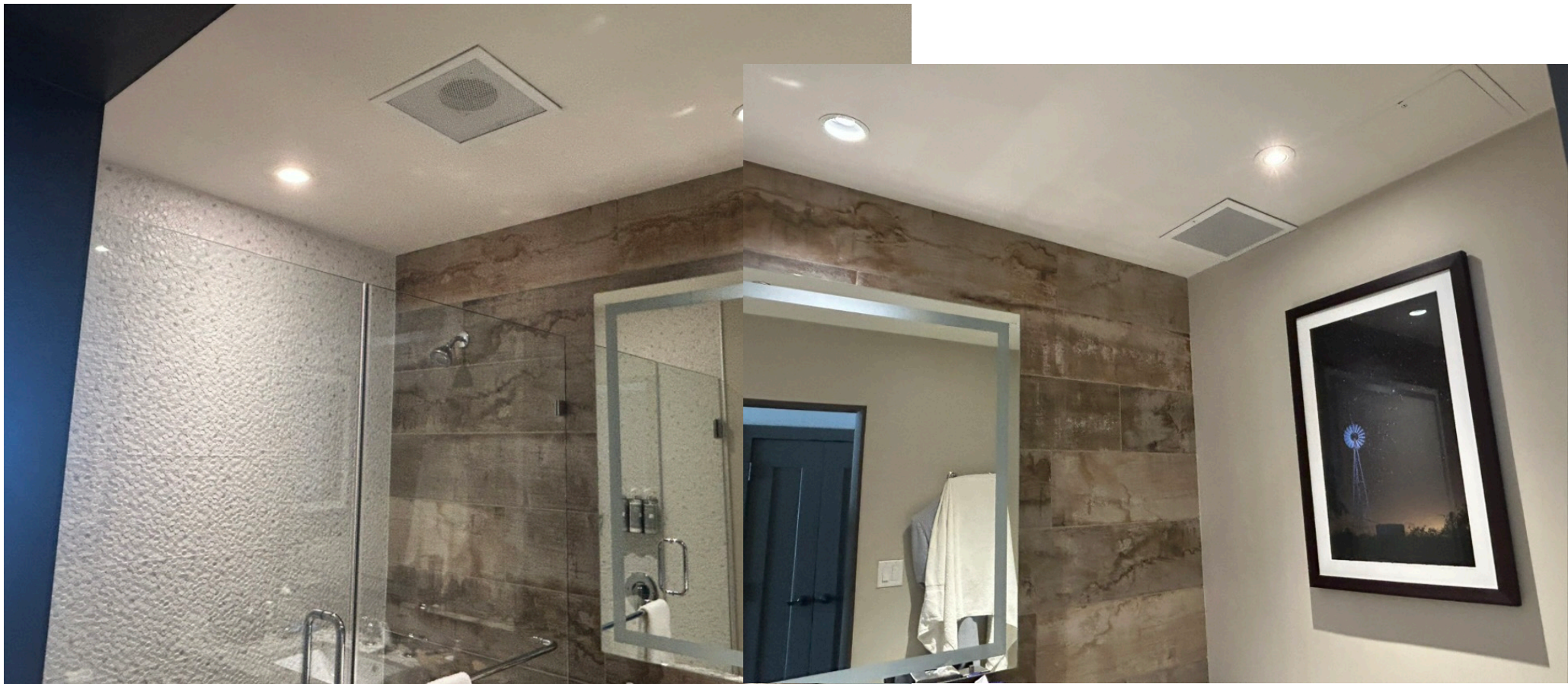
Wednesday afternoon through Thursday morning



Wednesday afternoon through Thursday morning

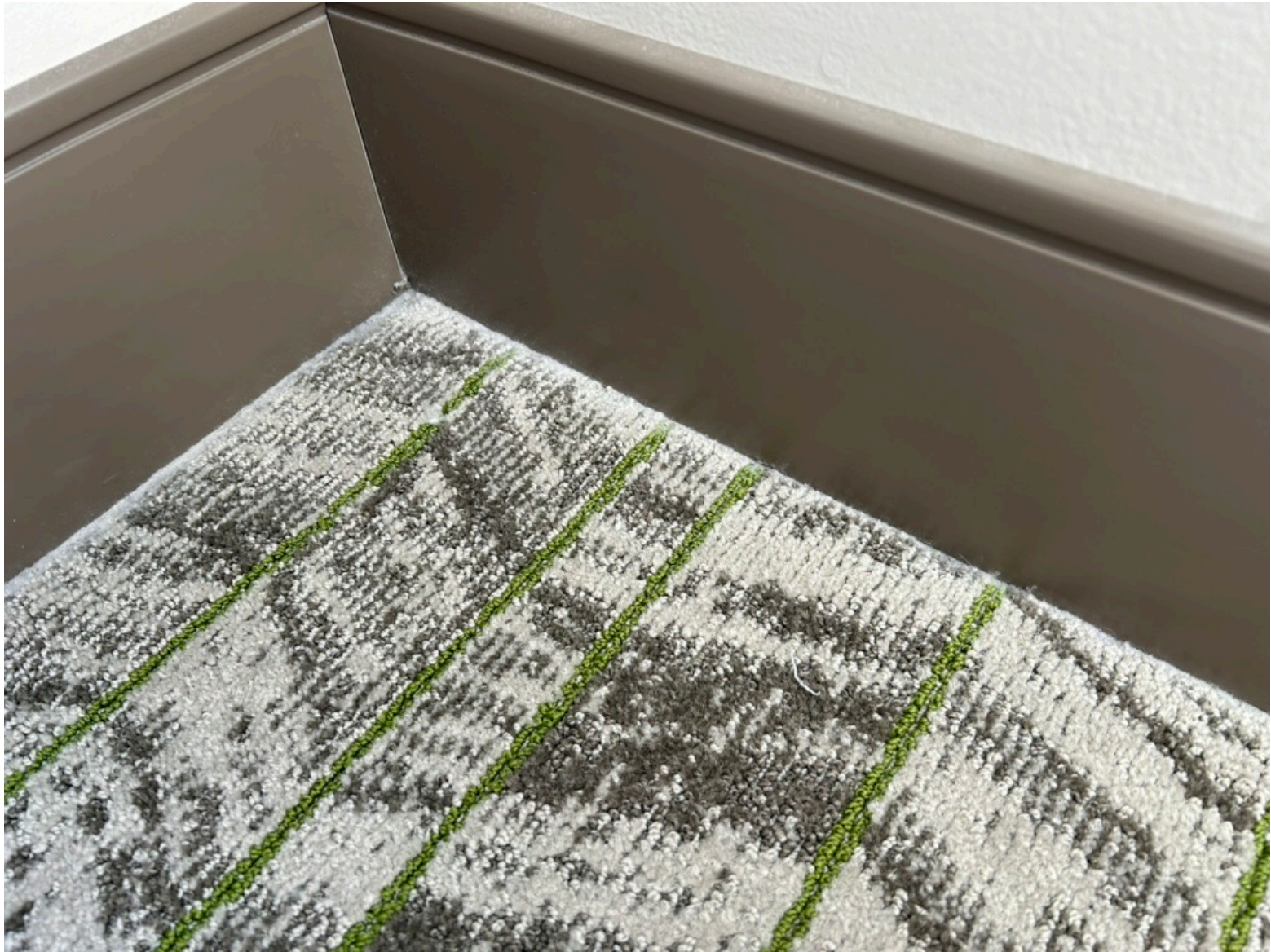


















Ventilation Through History

Early Humanity

Fire for space conditioning, thermal comfort.



Middle Ages

Concern for spread of disease indoors.

1775

Antoine-Laurent de Lavoisier, the “father of gaseous chemistry” . . .
Excess CO₂ = bad air



Ancient Egypt

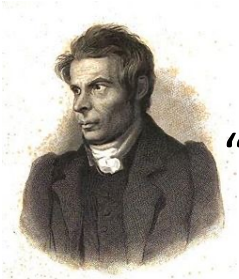
Stone carvers, dust control.

1600

King Charles I of England requires 3m. ceilings and taller windows.
Smoke control.



Ventilation Emergence – 1800s



1824

Thomas Tredgold

“Principles of Warming
& Ventilating . . .”
(**4 cfm/person**).

1893

Billings writes *Ventilation
and Heating*, promoting
30cfm/person – spread of
tuberculosis.

1862

Pettenkofer: biological
contaminants create “vitiating air.”
CO₂ is a good “surrogate.”

1895

ASH&VE adopts 30cfm/person,
“ready to accept the ideas of
hygienists and physiologists.”
Mech. ventilation emerges.

Physiological (i.e. health) needs . . . ?

Or comfort factors (i.e. perceptions, satisfaction)?

Ventilation Emergence – 1900s

1911

Willis Carrier:
psychrometric chart.

Rise of “air
conditioning.”



1935

Lemberg, Yaglou studied odor intensity based on occupant density. Yaglou: **12cfm/person @ 300c.f./person.**



1914

ASH&VE writes
model code including
30cfm/person
outdoor air.

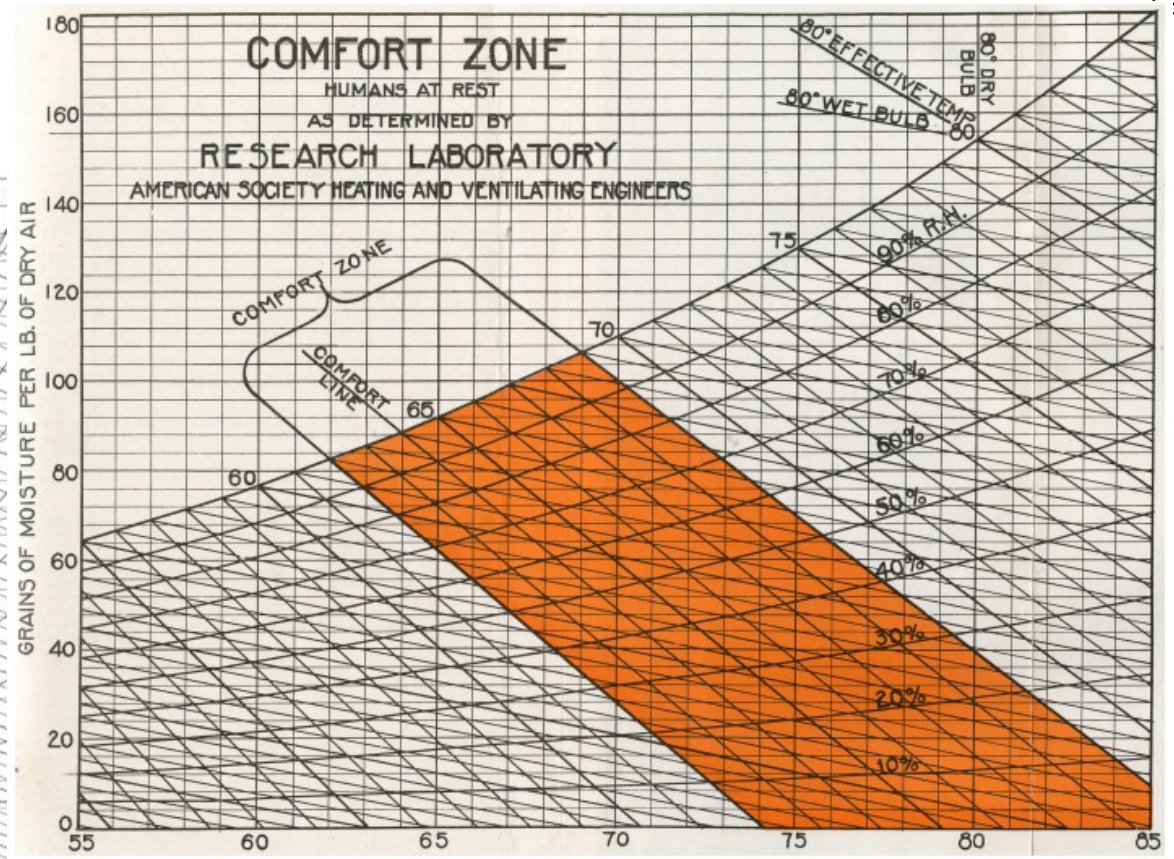
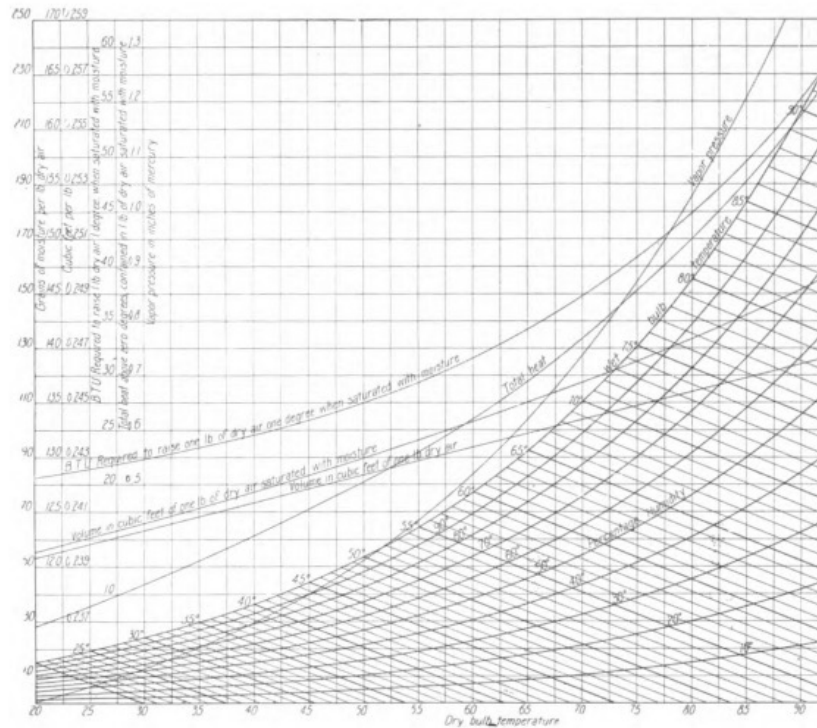
1922 -1924

ASH&VE publishes “comfort chart” in *Heating and Ventilating Guide*;
22 states have **30cfm in building code.**

1946

American Standards Association (ASA)
publishes **10cfm** as
a recommended
code minimum

Carrier's psychrometric chart



ASH&VE's comfort chart

Source:

https://www.researchgate.net/publication/369394729_Highway_to_the_Comfort_Zone_History_of_the_Psychrometric_Chart

Ventilation Standardization – Late 1900s

1955

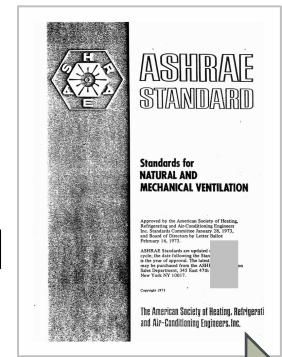
Home Ventilating Institute formed to address fan performance & standardization.

Mid-60's

"Invasion"
Animals,
Beatles, and
Stones, oh my!

1973

ASHRAE 62, Standards for Natural and Mechanical Ventilation. Recommended rates for **266** applications.



1960

Texas A&M begins fan testing, followed by HVI labeling and directory.



Not "Satisfied"

1972

HVI adds sound ratings.



1974

ASHRAE Standard 55, Thermal Comfort is published, featuring "comfort chart" from 1924 guide.

First Purpose and Scope

ASHRAE 62 - 1973 STANDARDS FOR NATURAL AND MECHANICAL VENTILATION

SECTION 1.0 PURPOSE AND SCOPE

This standard* defines ventilation requirements for spaces intended for human occupancy and specifies minimum and recommended ventilation air quantities for the preservation of the occupants' health, safety, and well-being.

Good ventilation practice exists when clean ventilation air is provided in sufficient quantities to maintain the required oxygen, carbon dioxide, and other air quality levels in the space under consideration.

Prescriptive rates – no “IAQ-P.”
No “acceptable IAQ.”
No satisfaction?

The standard does not specify the air quantities required for the control of temperature and humidity or the exhaust quantities required for source control of domestic or industrial wastes. The specifications are based on the current state of knowledge and acceptable practice related to air filtration, odor control and environmental physiology.

*Replaces the ventilation section of ASA Standard A53.1 dated May 23, 1946.

Ventilation Re-evaluation

Late 70's

Energy crisis,
tighter homes,
more insulation.



1981

ASHRAE 62 lowers rates
to **5cfm/person** (non-
smoking).
IAQ-P introduced.



Disco.



Early 80's

Sick building
syndrome.
NRCan's R2000
Program.
HERVs gain traction.

1983

P.O. (Ole) Fanger
proposes CO₂
correlation to odor
and new "comfort
equation".



Ventilation and Body Odor

P.O. Fanger, D. Sc. B. Berg-Munch

CONCLUSIONS

- The carbon dioxide concentration may be used as an index of the body odor intensity experienced by visitors entering a space with occupants at a given activity and temperature.
- No significant influence of space volume per occupant on body odor intensity or steady-state ventilation requirement was found.
- A relationship between percentage of dissatisfied visitors and CO₂ concentration has been established for sedentary male occupants.

https://www.aivc.org/sites/default/files/airbase_2090.pdf



Ventilation and Body Odor

P.O. Fanger, D. Sc. B. Berg-Munch

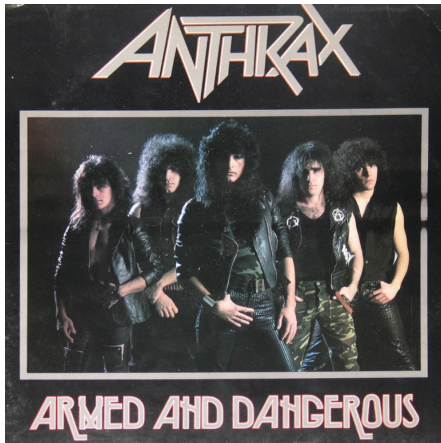
The present results (Fig. 6) show that a substantial part of the population is quite sensitive to body odor, and high ventilation rates are required to satisfy this group. This agrees well with the results of Cain et al. [4]. ASHRAE's new ventilation standard [7] defines acceptable air quality as a condition where the air quality is accepted by at least 80% of the population (20% dissatisfied). The present results show (Fig. 6) that 20% dissatisfied correspond to a CO₂ concentration of 0.10% and a required steady-state ventilation rate of 7 l/s·person. This is nearly three times higher than the ventilation rate of 2.5 l/s·person in the ASHRAE standard. Fig. 6 predicts as many as 50% dissatisfied at a ventilation rate of 2.5 l/s·person. It is obvious from the present study that much higher ventilation rates than recently recommended will be required to satisfy visitors.

https://www.aivc.org/sites/default/files/airbase_2090.pdf

Ventilation Re-evaluation

Mid-80s

*Rise of Anthrax,
Poison,
Black Sabbath...*



1984

Radon industry
emerges in PA.
Watras incident:
2700 pCi/L.



**Compliance
Issues?**
*The Police,
Warrant...*



1988

EPA passes
Indoor Radon
Abatement
Act.

1989

ASHRAE 62 is
republished,
15cfm/per.
Committee starts
on 1999 ver.

<https://basc.pnnl.gov/>

Ventilation Rate Debate

- 150+ years of scientific research and debate
- Significant changes in building codes and practices
- Impacts of energy costs
 - Better, tighter construction
 - “Sick buildings syndrome”
 - “Building Tightness Limit”
 - Negotiation and compromises over min. required ventilation
- One “62” standard for many space types.

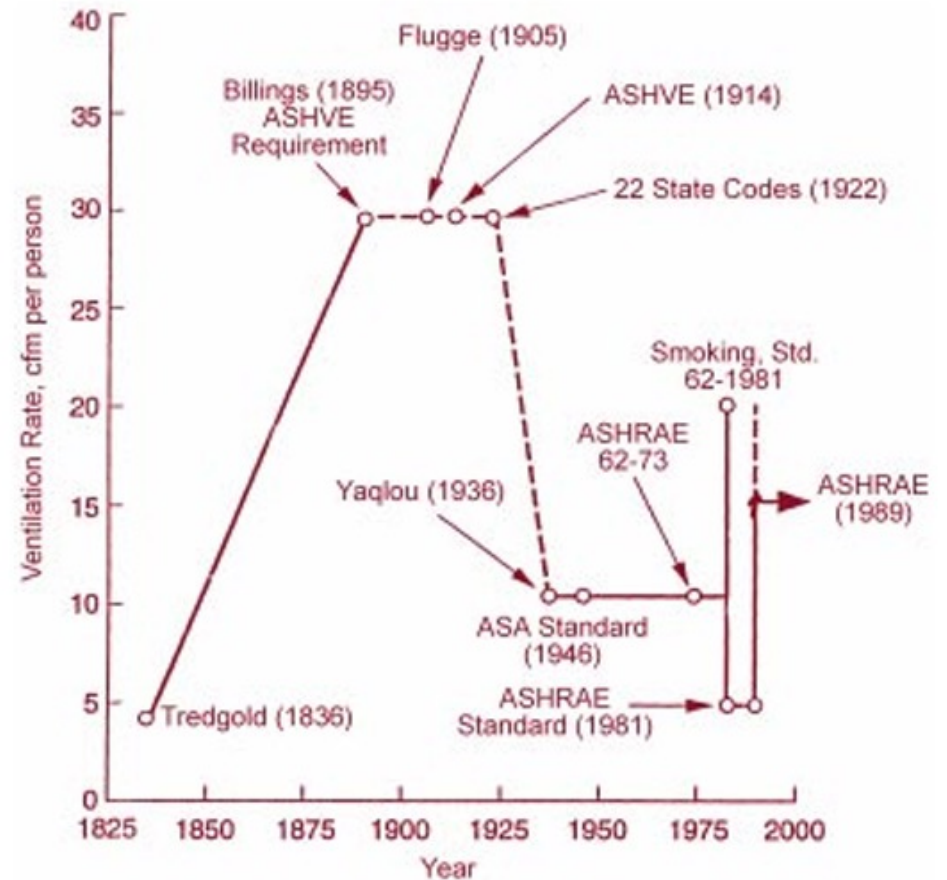
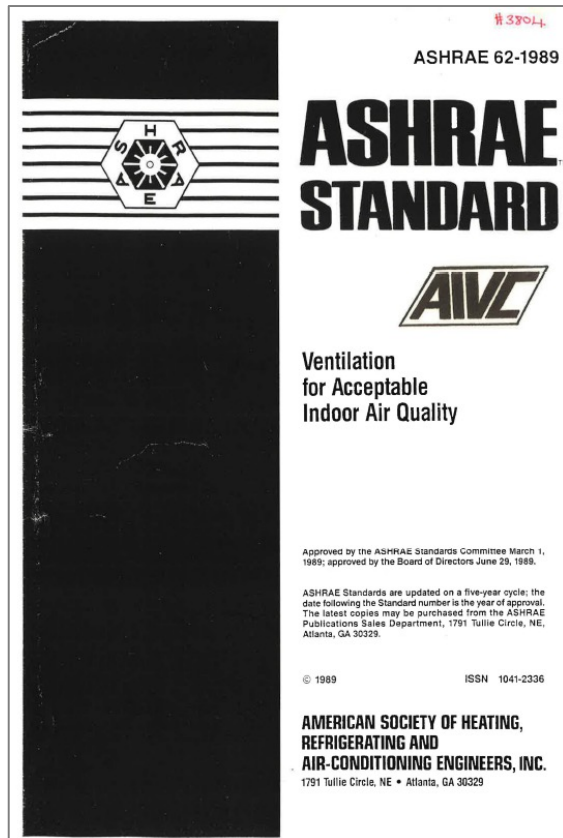


Image: John E. Janssen, ASHRAE Journal, Oct. 1999

62-1989 . . . Acceptable? . . . Satisfied?



1. PURPOSE

To specify minimum ventilation rates and indoor air quality that will be acceptable to human occupants and are intended to avoid adverse health effects.

2. SCOPE

This Standard applies to all indoor or enclosed spaces that people may occupy, except where other applicable standards and requirements dictate larger amounts of ventilation than this Standard. Release of moisture in residential kitchens and bathrooms, locker rooms, and swimming pools is included in the scope of this Standard.

acceptable indoor air quality: 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.

Ventilation Division

Early 90's

IAQ is elevated by U.S. EPA.

EPA Radon Zone map published.

Tobacco industry is targeted for SHS exposure.

EPA releases IRIS assessment on formaldehyde.

1997

ASHRAE Board splits off
“low-rise res.” to 62.2
and moves to
**continuous
maintenance.**

1989

ASHRAE 62 is
republished (after
'81 update).
Committee starts
on 1999 ver.

Grunge is airborne.



1996

Huge rewrite of ASHRAE
“62-89” receives 9000+
comments from
builders, tobacco, &
formaldehyde interests.

2003

First edition of
ASHRAE 62.2
published.
Committee
continues the
“rate debate.”

“Modern” Ventilation History – 62.2

2003

First edition of
ASHRAE 62.2
published.

2012

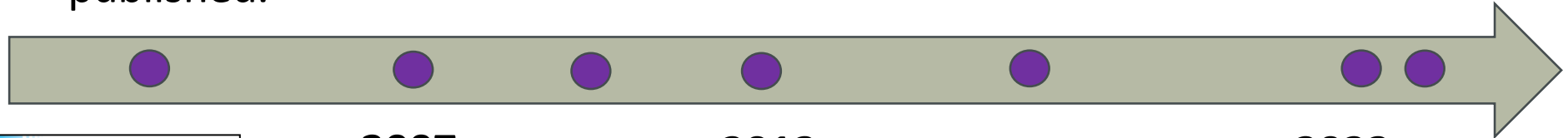
DOE WAP
requires
ASHRAE 62.2

2014

National WAP
evaluation concludes
ASHRAE 62.2 works!

2025

MERV 11 and
groundcovers
required



2007

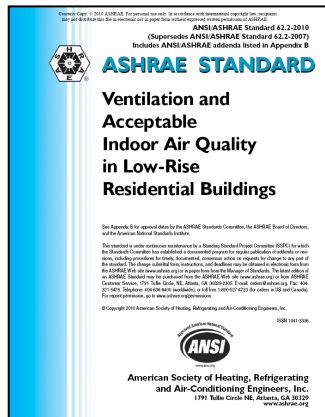
ASHRAE 62.2
Alternate
Compliance
Path (1
exhaust fan)

2013

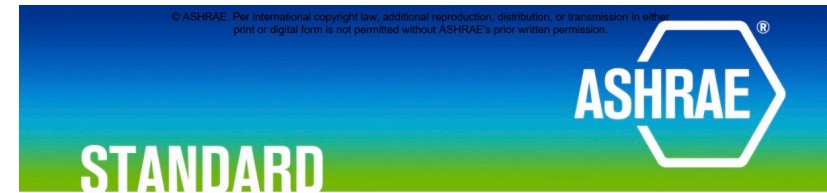
Unvented
combustion in
ASHRAE 62.2
Scope

2023

First Female
Chair of SSPC
ASHRAE 62.2



Continuous recipe maintenance



ANSI/ASHRAE Standard 62.2-2025
(Supersedes ANSI/ASHRAE Standard 62.2-2022)
Includes ANSI/ASHRAE addenda listed in Appendix G

Ventilation and Acceptable Indoor Air Quality in Residential Buildings

*The 2025 edition of this standard incorporates changes from 16 addenda to the 2022 edition. Significant updates include a change from MERV 6 to **MERV 11 filtration**, a new (optional) **IAQ Procedure path** to meet the dwelling-unit ventilation rate, a requirement for local exhaust in toilet rooms, a new exception allowing for a shorter separation distance between an air intake and a dwelling unit's exhaust, ozone requirements for air-cleaning devices, a replacement of hydraulic diameter with equivalent diameter in the prescriptive duct sizing section, **requirements for a ground cover over exposed earth**, and an informative appendix on how to manage infectious aerosols (based on ASHRAE Standard 241). For a complete description of changes, refer to Informative Appendix G.*

Creep?

ASHRAE 62-1989:

1. PURPOSE

To specify minimum ventilation rates and indoor air quality that will be acceptable to human occupants and are intended to avoid adverse health effects.

ASHRAE 62.2-2025:

1. PURPOSE

This standard defines the roles and minimum requirements for mechanical and natural ventilation systems and the building envelope intended to provide acceptable indoor air quality (IAQ) in residential buildings.

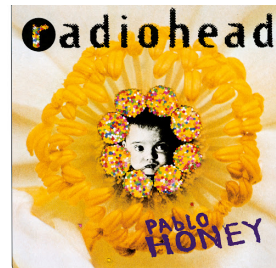
acceptable indoor air quality: air toward which a substantial majority of occupants express no dissatisfaction with respect to odor and sensory irritation and in which there are not likely to be contaminants at concentrations that are known to pose a health risk.

“Creep: slow movement, especially at a steady but almost imperceptible pace.”

acceptable indoor air quality: 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.

“Creep: one who behaves in an obsequious way in the hope of advancement.”

“I’m a creep . . .”



The Future of Ventilation & IAQ

- **Filtration** of outdoor air (and fewer dwelling-unit exhaust-only strategies).
- **Climate-specific** ventilation standards
- **Performance-based approaches**
 - Range hood capture efficiency
 - Range hood automation (e.g., temperature rise?)
 - IAQ monitoring and response – Temp, RH, CO2, PM2.5
- **User experience** as a comfort metric. (Quiet range hoods!)
 - *Smarter* product design . . . but not more complicated!
 - Fault detection and user education (not just notification).
 - App engagement with long-term logging capability.
- **Trades and Installer Training**
 - Hands-on building science and mechanical design for whole-home IAQ.
 - Connect youth and young professionals with mentors.



<https://www.thegritfoundation.com>

[Verse 1]

Am G Am
Embargoes seem to strike a tone, building tightness limits throned.

F C F C
Came a standard from a small camp, who warned of droplets when it's cold and damp.

F C C/B Am C
Then their eyes got big, and the passion for more than "fine" . . . split Eighty Nine.

G Am
And thus two brands of sausage.



The Sound of Sausage

[Verse 3]

Am G Am
 And Dr. Sherman just might roar, “We need more data, even more!”
 F C F C
 People talking without stopping, people hearing without listening,
 F C C/B Am C
 People righting “wrongs” . . . and some who couldn’t bear, but no one dare
 G Am
 Disturb the squeeeeeel of sausage.



Am G Am
 “Fools,” said Paul, “we do not know when Stachybotrys starts to grow.
 F C F C
 Hear my words that I might teach you, psychometrics feeds I–A–Q.”
 F C C C/B Am
 But his words like mighty brainfarts fell (and went to hell)
 C G Am
 And entrained with the smelllllllls of sausage.



The Sound of Sausage

[Verse 5]

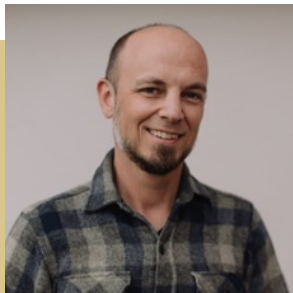
Am G Am
 Committee members rowed and cased, o'er stewing cauldrons that they faced.
 F C F C
 And the Board without much warning, of the strains that it was forming,
 F C
 Made the Chair say, "the words of this standard shall continuously be maintained!"
 C C/B Am
 New rectal pains
 C G Am
 Share whispers of the sounds post-sausage.



Thank You! - Questions?

What I Just Said/Sang . . .

- **Filtration** of outdoor air must improve in ventilation standards.
- **Climate-specific** requirements are needed in ventilation standards.
- **Performance-based approaches** should be promulgated.
 - **CO2 monitoring & actuation** encouraged in residential.
 - **Indoor / Outdoor monitoring** should be addressed in standards.
- **User experience** as a comfort metric and industry target.
- **Generational knowledge transfer** is critical for industry.
- **“Hands-on” experience** for youth is critical to inspire inquiry.



I'm a “fan” of “sausage” . . . I really am.

[Find me on LinkedIn](#) – Nicholas (Nick) Hurst

(I Can't Get No) Satisfaction

Intro: E E E-A-D D-D-A 4x

[Chorus 1]:

E A E A
I can't get no satisfaction, I can't get no comfort action.

E B7 E A
'Cause I try and I try and I try and I try.

E E E-A-D A E E E-A-D A
I can't get no, I can't get no.

Music by The Rolling Stones - 1965

(I Can't Get No) Satisfaction

[Verse 1]

E A----D A E A-D A
 When I type in my search bar, "Can a fan solve my complaints at home?"
 E A-D A E A-D
 and they're telling me the definition is at least four-fifths recognition
 A E A-D
 Of a non-odorous condition.

[Prechorus]:

A E E E-A-D A E [tap, tap, tap...] E E-A-D A E E E-A-D
I can't get no, oh no no no. Hey hey hey, that's what I say.

(I Can't Get No) Satisfaction

[Chorus 2]:

E A E A
 I can't get no satisfaction, I can't get no latent fraction.
 E B7 E A
 'Cause I try and I try and I try and I try.
 E E E-A-D A E E E-A-D A
I can't get no, I can't get no.

[Verse 2]

A E A-D A E A---D A-----E A-D
 When I'm watchin' my TV, and a man comes on to tell me, how he can fix my old A/C.
 A E A-----D A E A-D
 But I can't buy his fan if he's blowing smoke 'cause he can't explain enthalpy.

 A E E E-A-D A E [*tap, tap, tap...*] E E-A-D A E E E-A-D
I can't get no, oh no no no. Hey hey hey, that's what I say.

(I Can't Get No) Satisfaction

[Outro]:

E E E-A-D A E E E-A-D A E E E-A-D
I can't get no, I can't get no. I can't get no,

A E E E-A-D
 no satisfaction,
 A E E E-A-D
 no comfort action,
 A E E E-A-D
 no latent fraction,
 A E E
no satisfaction.