Airtightness of large buildings in Japan

current situation and a proposal for the future

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Introduction

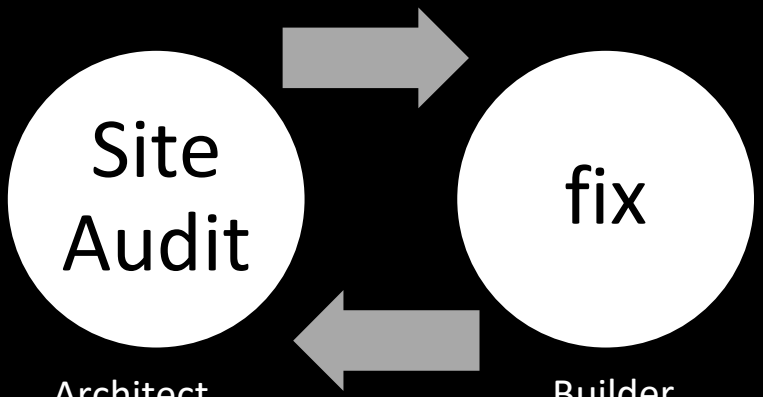
MEIKEN LAMWOOD Corp. Head Office

MEIKEN LAMWOOD Corp. Head Office
AIJ (Architectural Institute of Japan)
Annual Architectural Design Commendation 2022

Reasons of the commendation

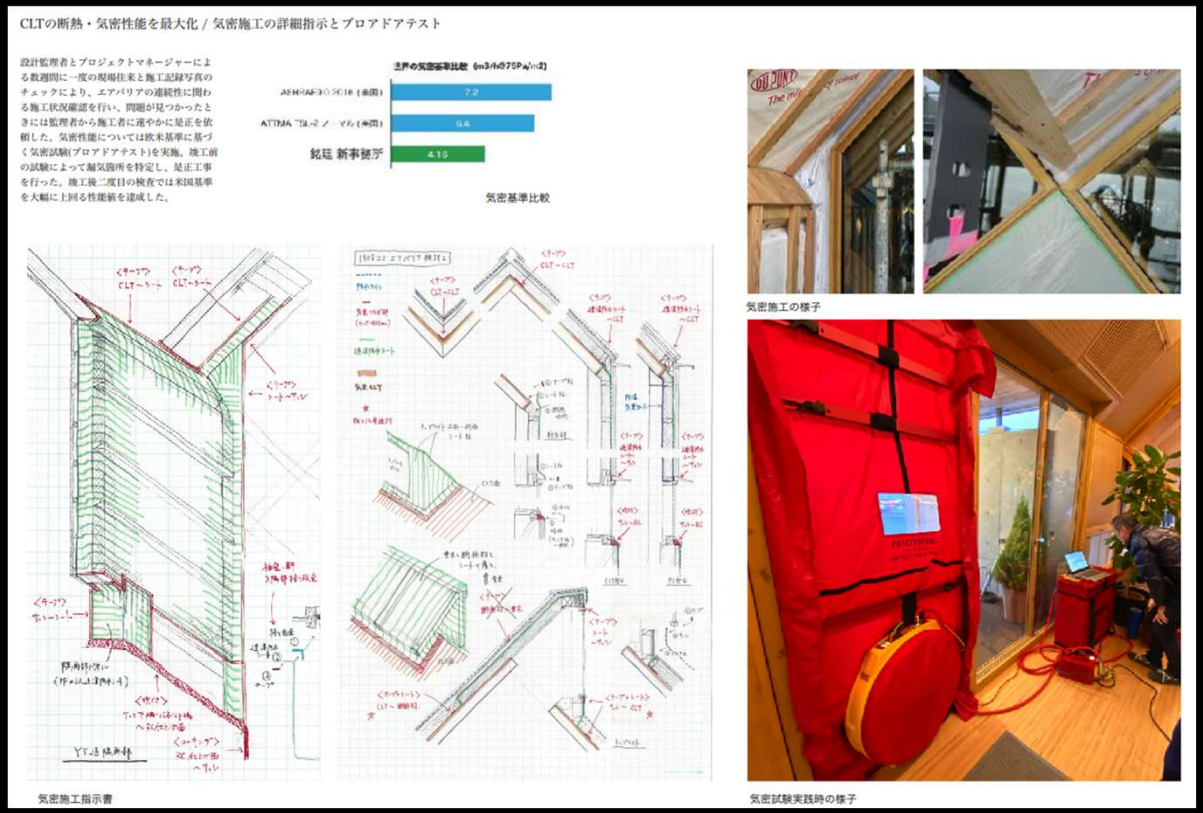
- Shows the company’s core competency using CLT material abundantly.
- Deeply thought both in beauty and function
- Highly airtight and the way to achieve the level

The process might be future model

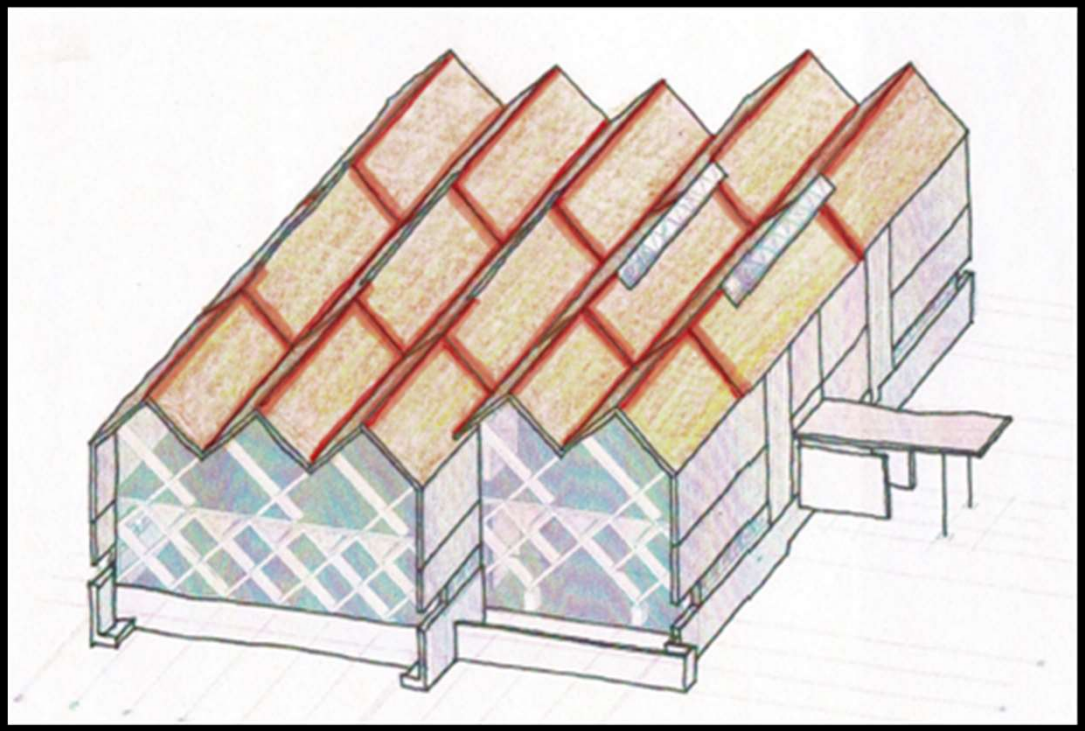


Pen check & Audit

Test



Our role



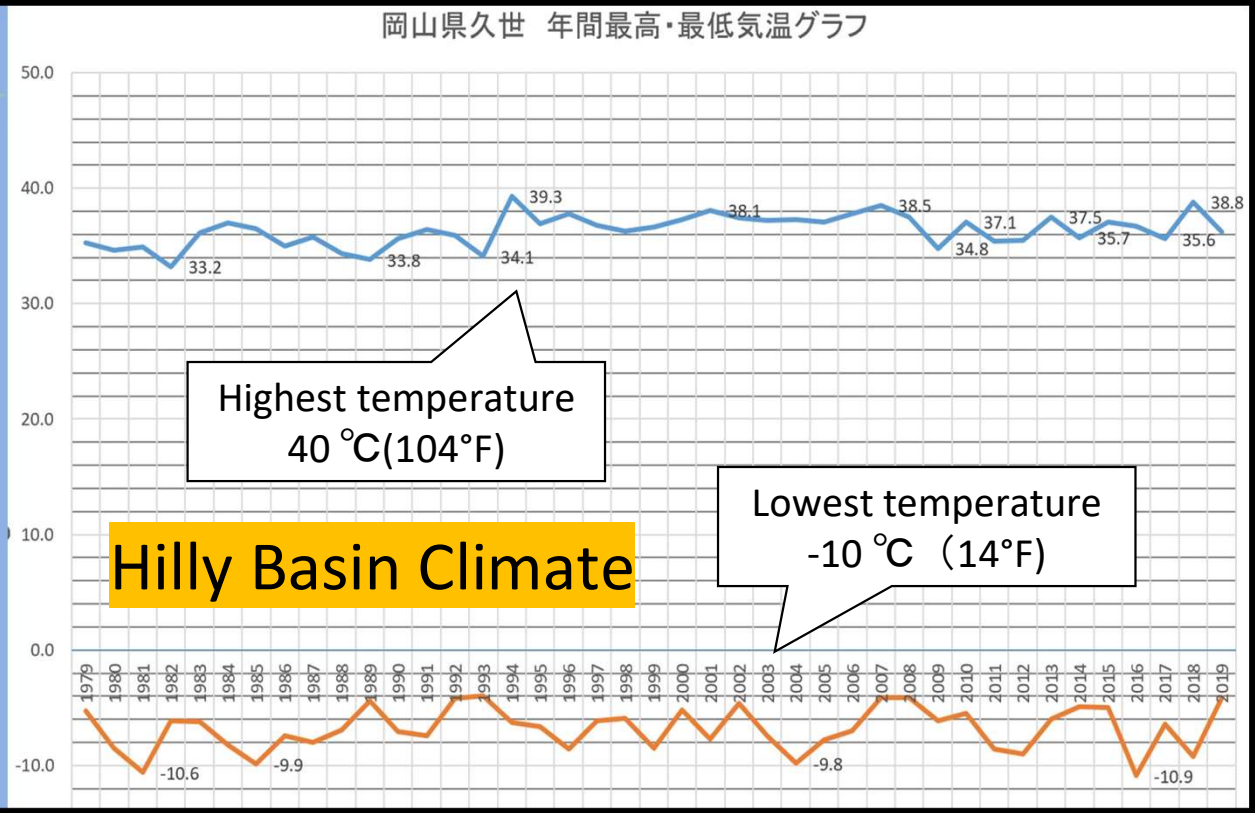
Continuous Air Barrier
main theme of Building Commissioning

Blower Door Test, twice

Location and comportments

Meiken Lamwood Corporation Head Office

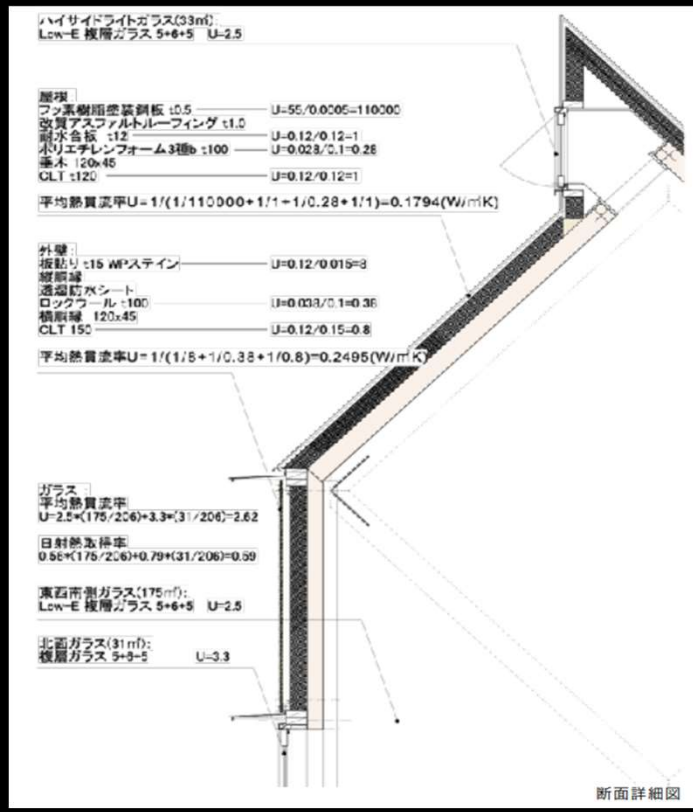
Location and climate



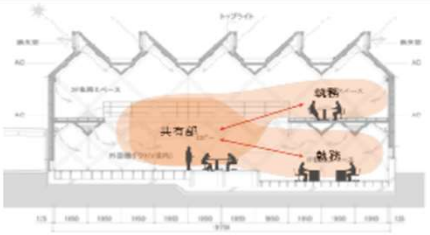
Basic information

- 2-story building forming one large space
- Total floor area: 1,000 m^2
- Enclosure area: 2,235 m^2
- Volume: 5,428.4 m^3 (roughly)

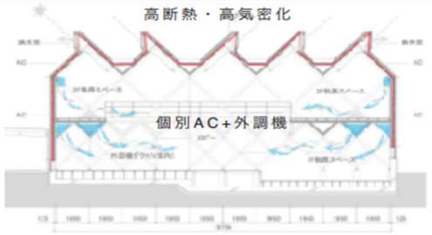
Specification: Roof, Wall, and Base
No word “Air Barrier” nor ”Continuity”



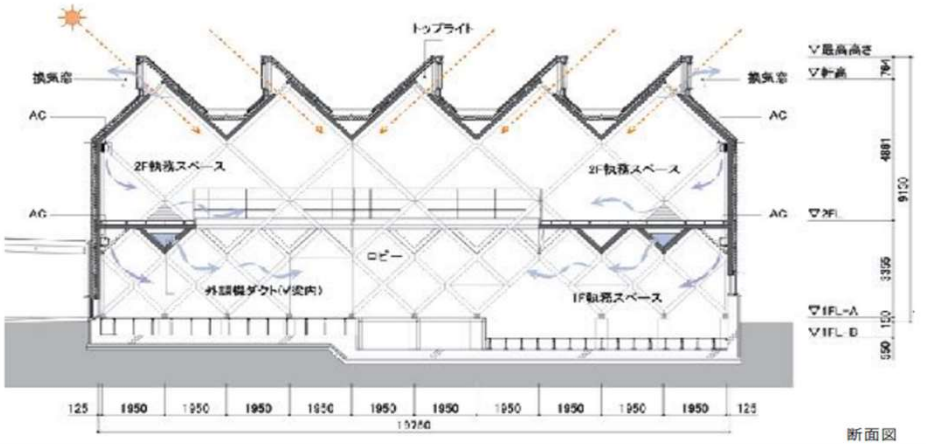
断面詳細図



レベル差を活かして吹き抜け回りに広がる一体空間



高断熱・高気密化・構造と一体化した設備システム



断面図

But air barrier materials were well arranged

Tyvek sheet is AB Product

Structure of exterior (vacant insulation)

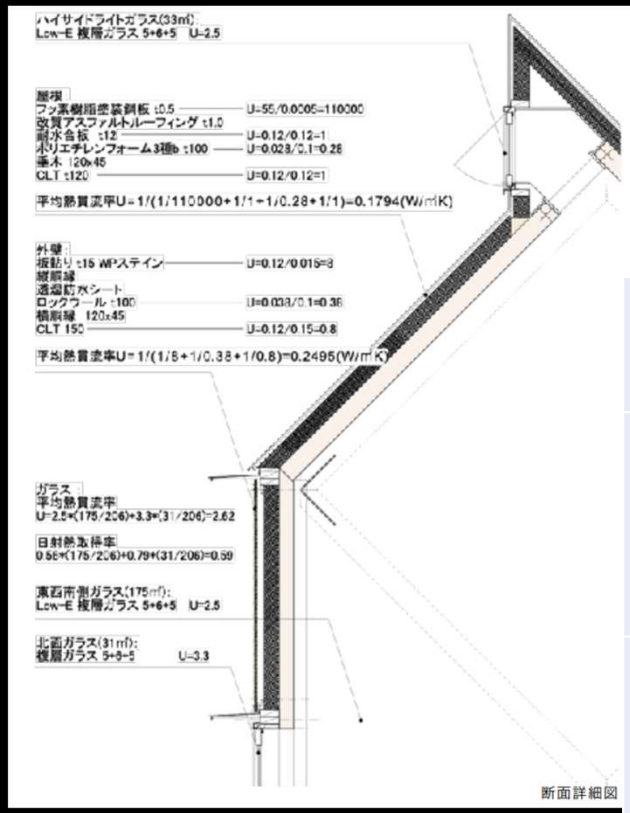
Process to improve air tightness

What was done in this project

Three checks for continuous air barrier

① 2019 May. : Air barrier materials were checked
② 2019 Aug. : Pen check started
③ 2019 Oct. : Intermediate inspection

①Material check (2019 May)



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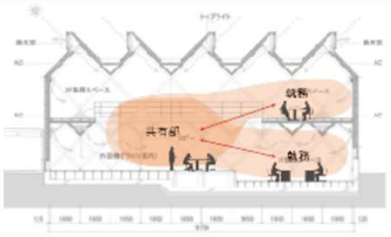

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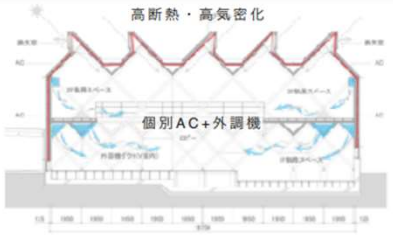
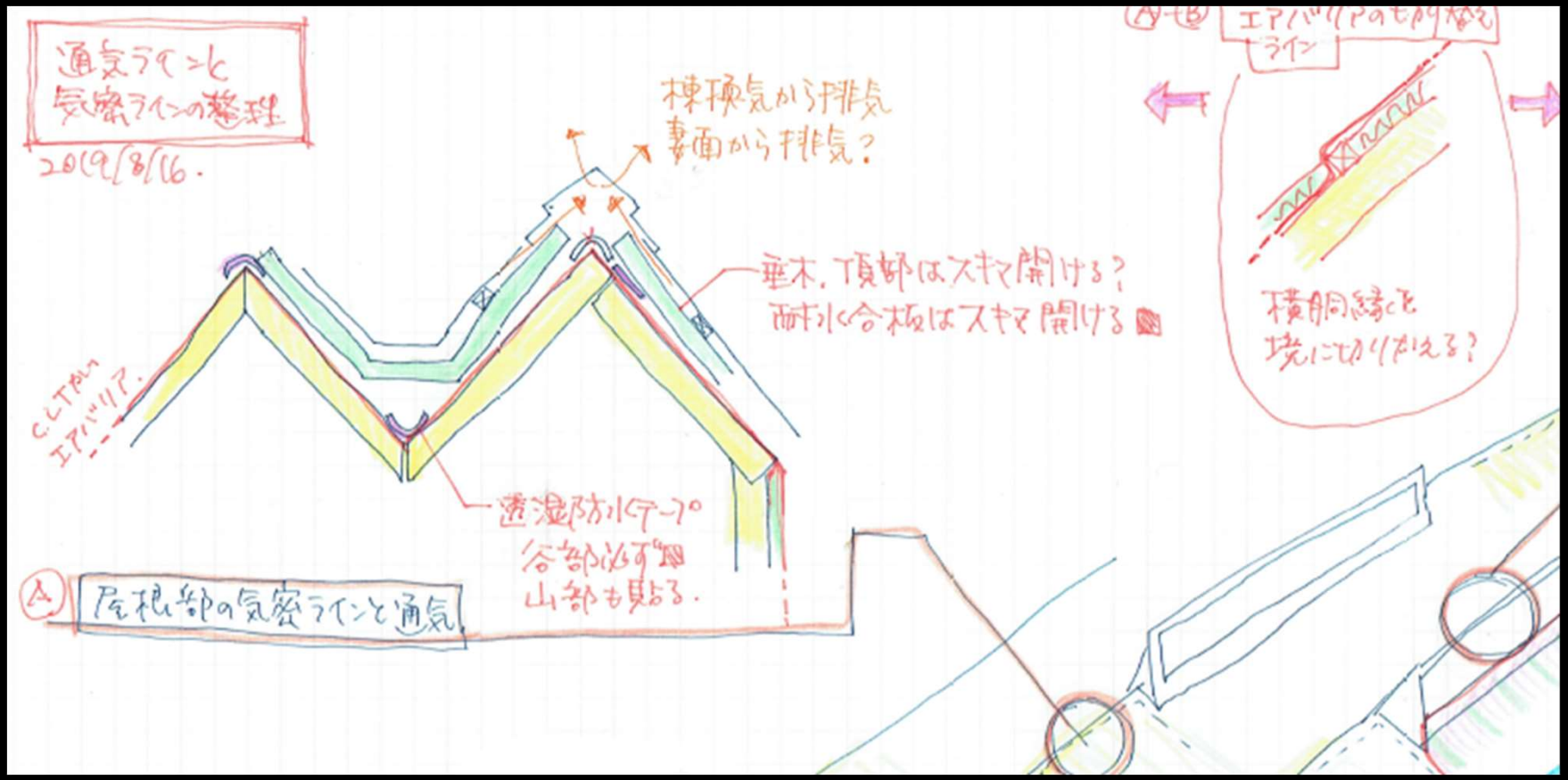


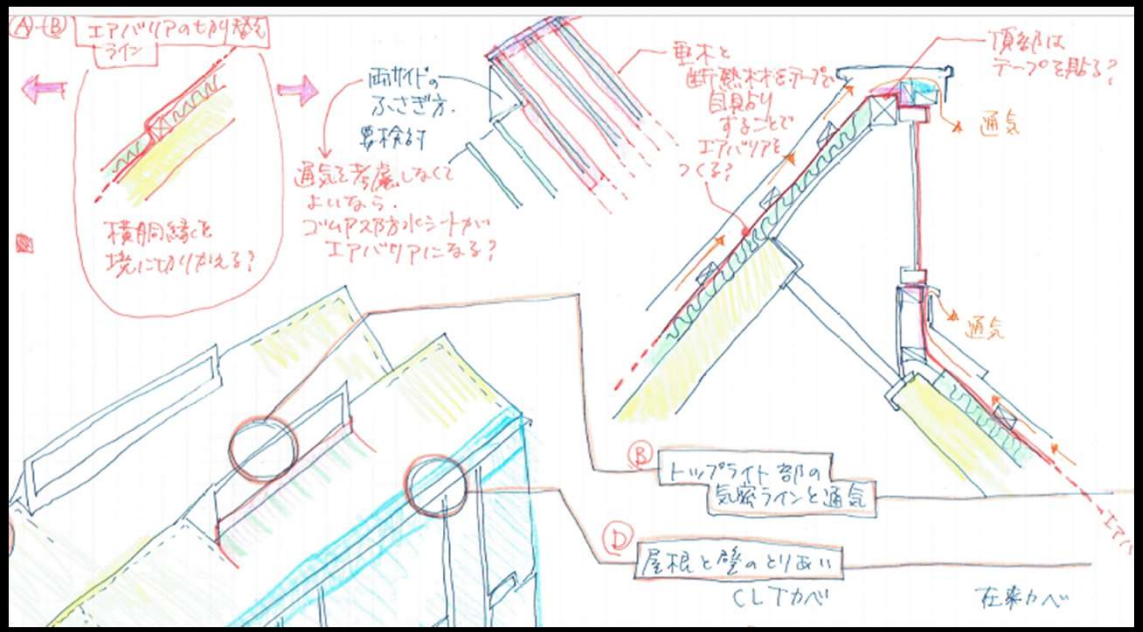
高断熱・高気密化・構造と一体化した設備システム

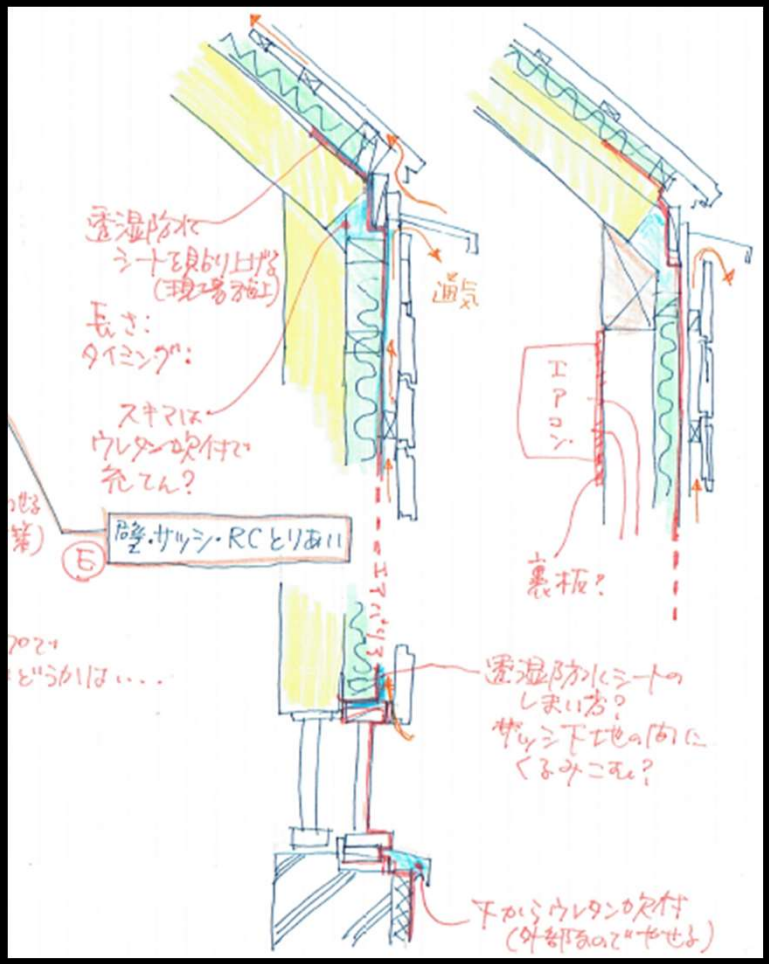
	Air Barrier Materials ,Products, and component
Roof	Modified bituminous roof membrane
	Tyvec Sheet
Wall	Tyvec Sheet
	Wooden doors ＆Windows
Base	Cast-in-place concrete

②Pen check (2019 Aug.〜)
By Architect & Project Manager



②Pen check (2019 Aug.~)





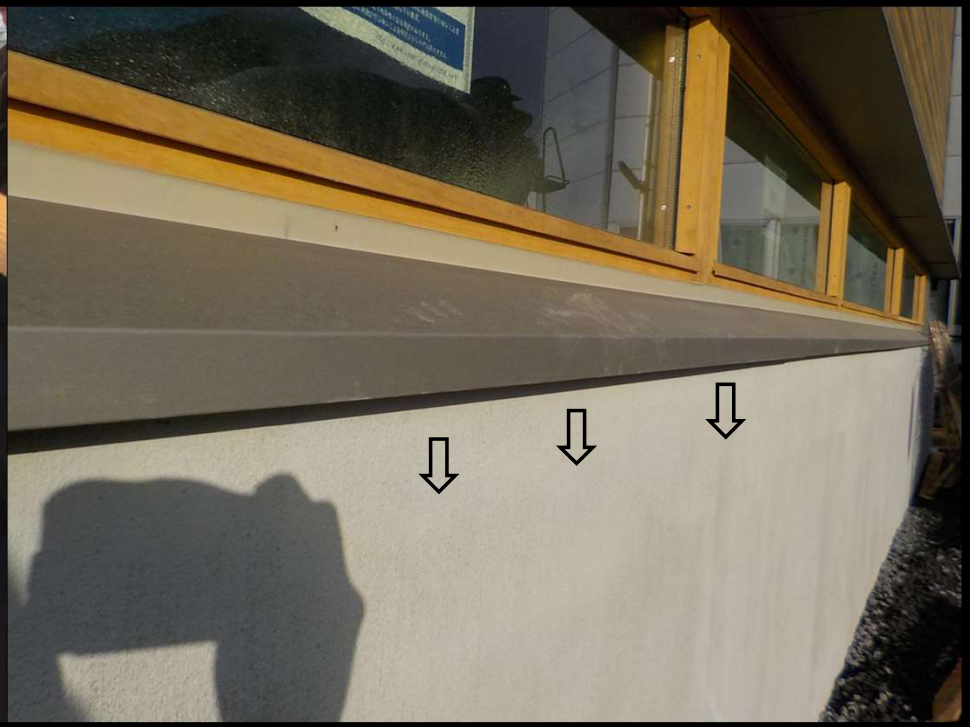
③Intermediate inspection (2019 Oct.)

1st test (2019 Dec.)

- Measured air tightness:
  5.15 ($m^3/h@75Pa/m^2$)
- Goal : ASHRAE 90.1 requirement
  7.2 ($m^3/h@75Pa/m^2$) or less

⇒PASS

Leakage was found



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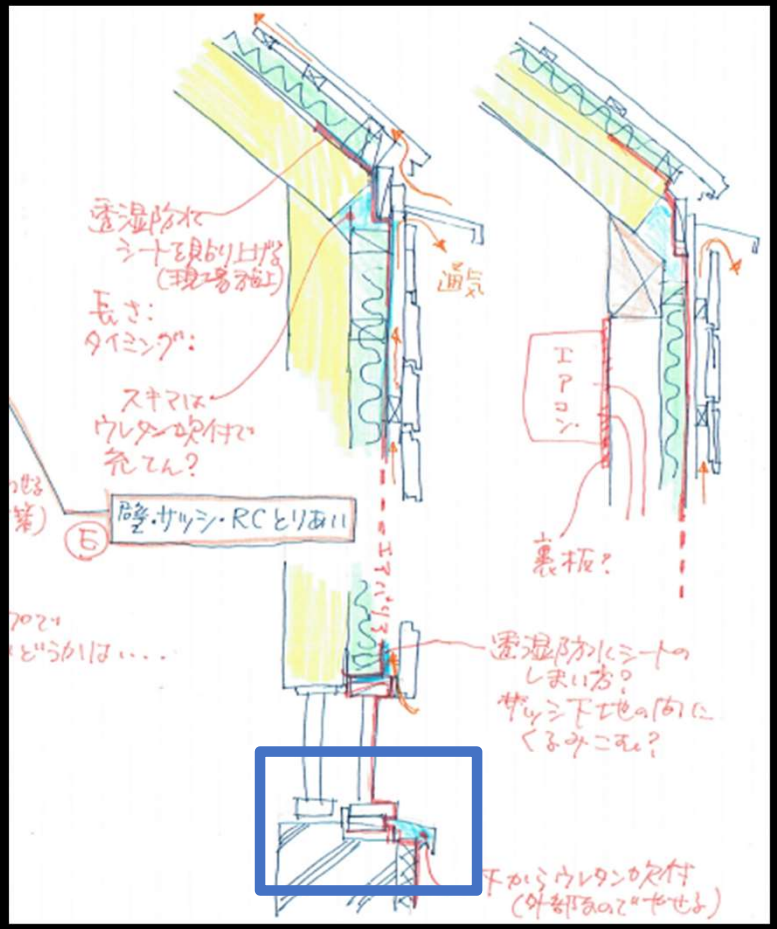


Red lines are Air

There was discontinuity
Eyes and hands enable to reach
Another solution preferable

2nd test (2020 Feb.)

- 1st test:

  5.15 ($m^3/h@75Pa/m^2$)

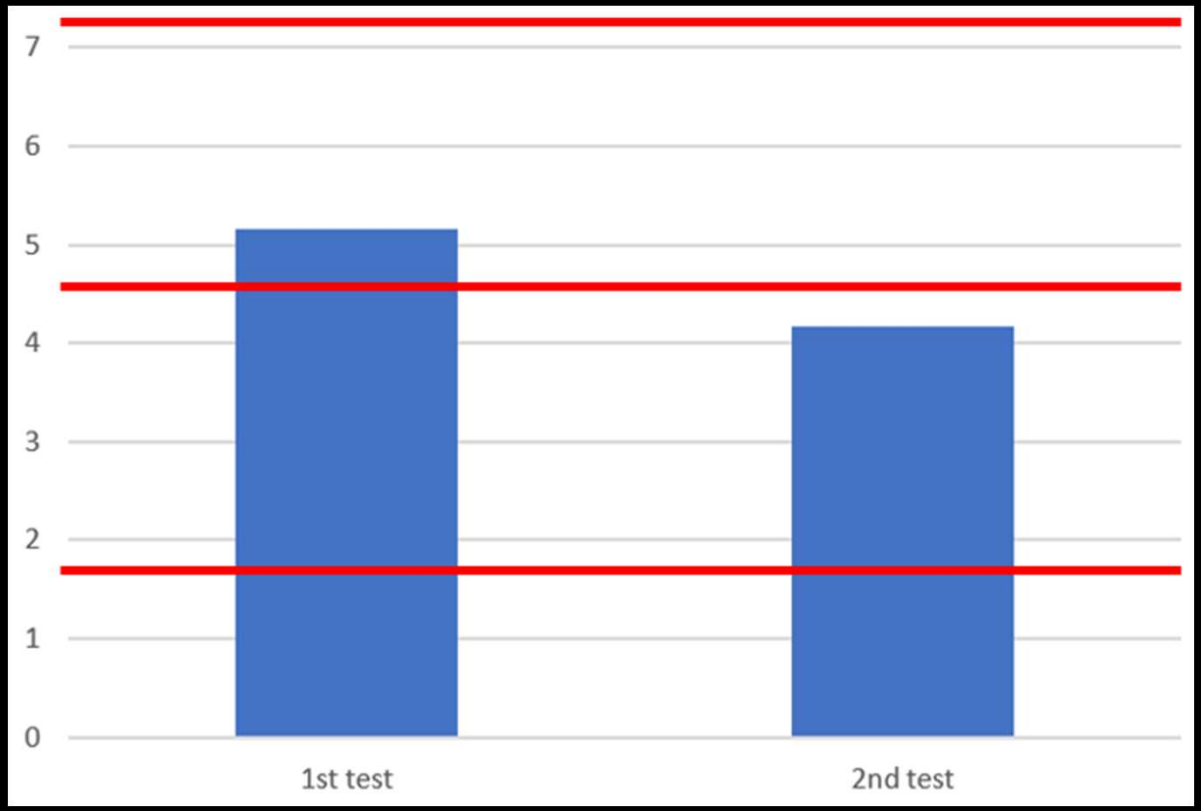
- 2nd test:

  4.16 ($m^3/h@75Pa/m^2$)

⇒19.2% improved

Result

Consideration: standards



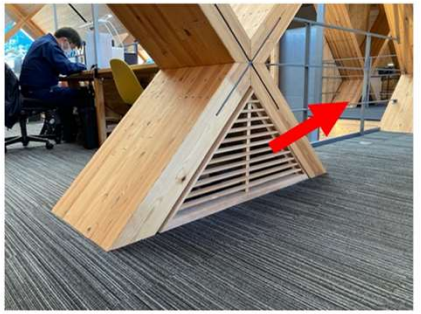
- ASHRAE 90.1:
  7.2 $m^3/h/m^2$ 75Pa
- USACE Protocol
  4.572$m^3/h/m^2$ 75Pa
  (0.25CFM/ft^2 0.3in)
- Passive house
  1.78$m^3/h/m^2$ 75Pa
  (0.6ACH50)

Meiken Lamwood report

本社事務所の空調

MEIKEN

外調機が活躍



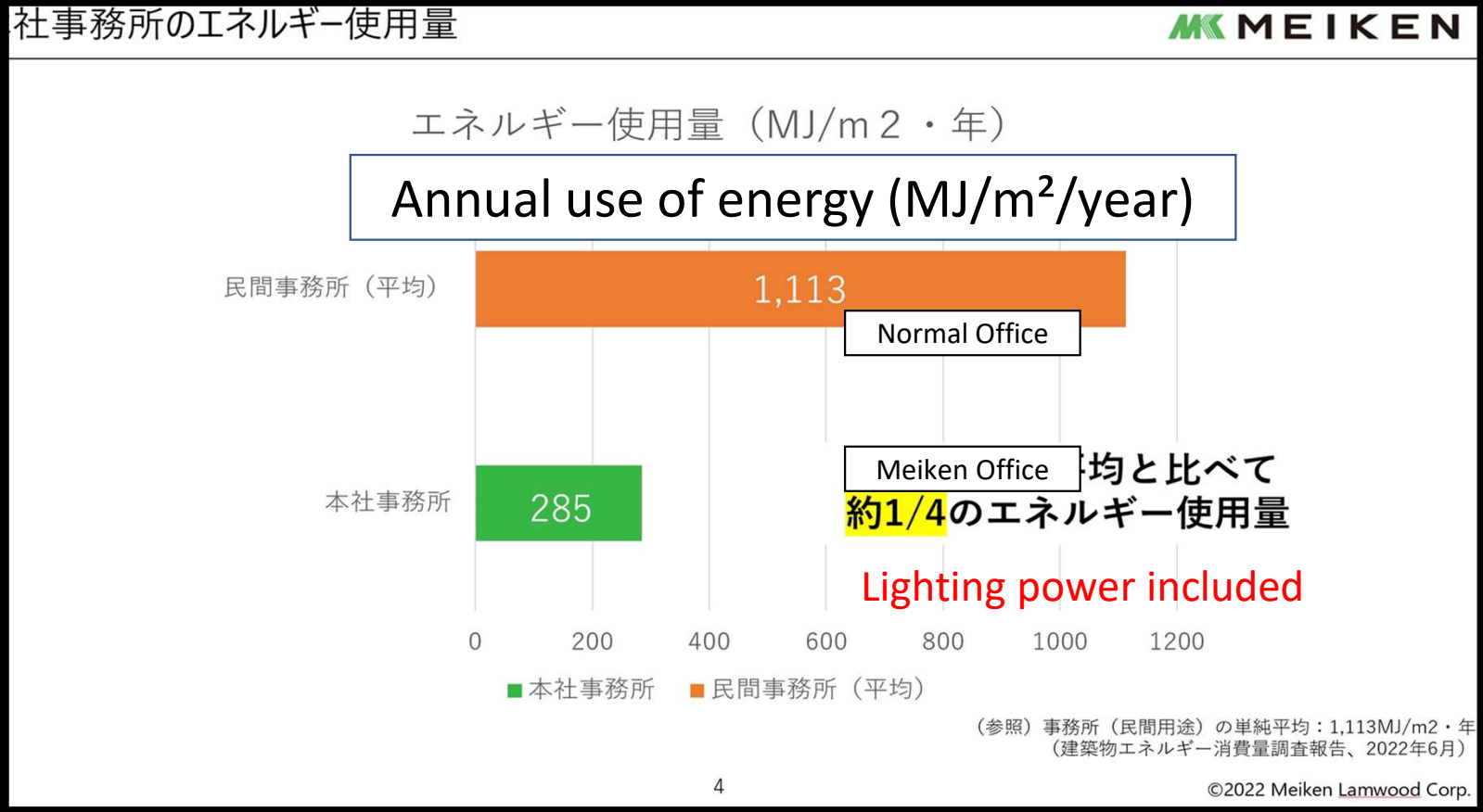
温湿度調整のベースとなる外調機（外気調和機）は24時間稼働だが、全体に占める割合は年平均で20%。全体の電気利用量の削減に大きく貢献。

エアコンは必要時のみ利用

夏は2F、冬は1Fのエアコンを必要な時につければ全体が快適になる。

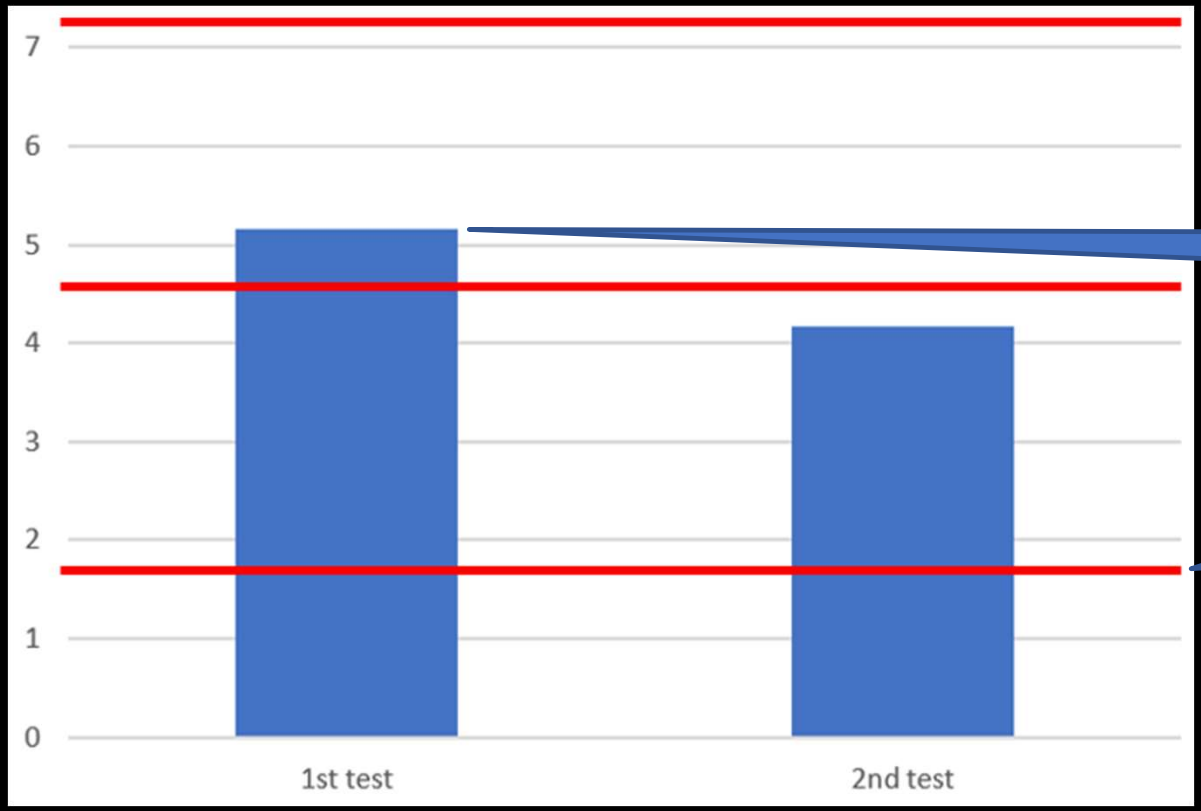
2

Meiken Lamwood report



Steps and improvement

Without pen-check



- ASHRAE 90.1:
  7.2 $m^3/h/m^2$

Without additional sealant

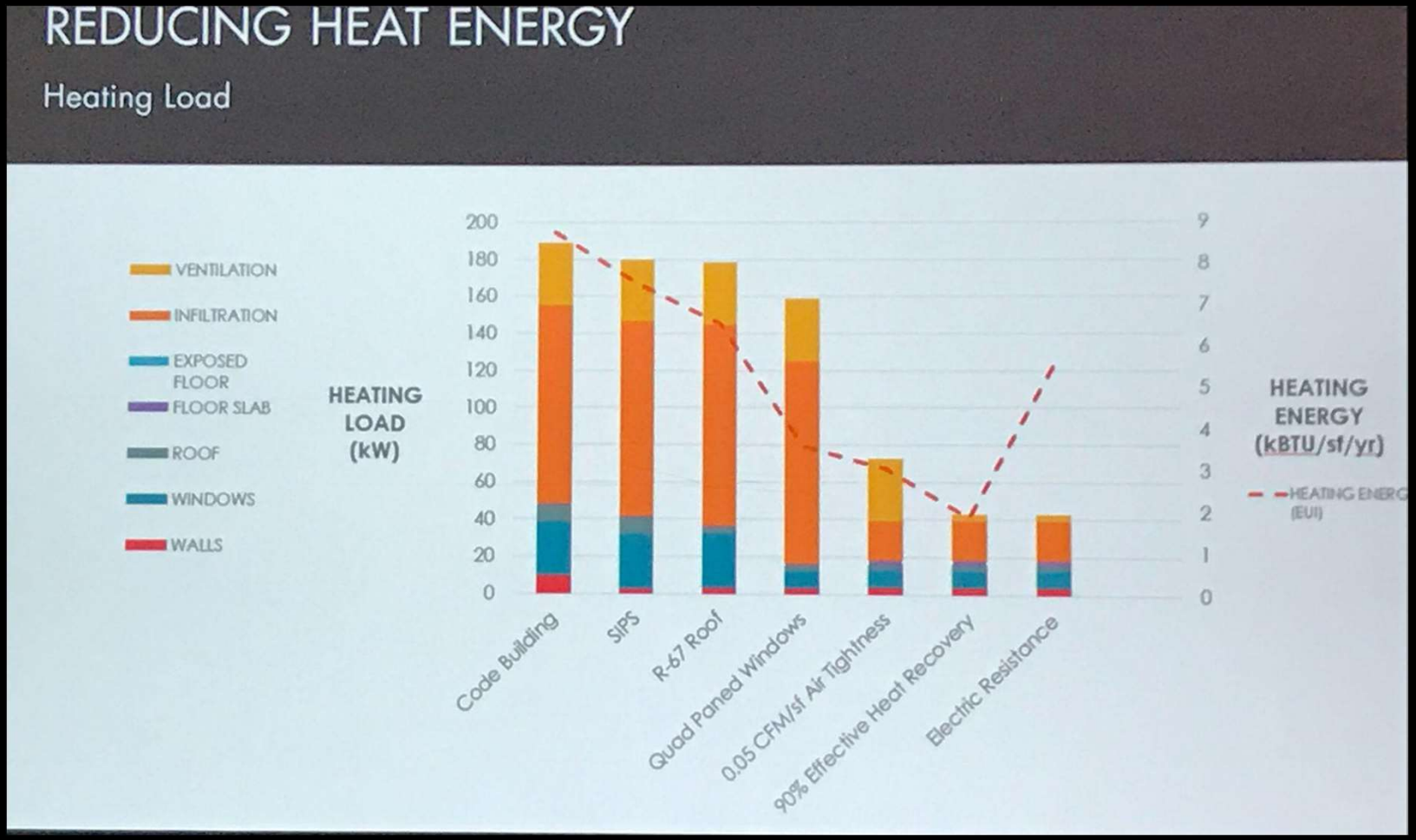
- USACE Protocol
  4.572$m^3/h/m^2$ (0.25CFM/ft^2)

Possible?

- Passivhaus
  1.78$m^3/h/m^2$ (0.6ACH50)

Consideration

Importance of airtightness / reducing heat load



Greenbuild2017

By
Rocky Mountain Institute

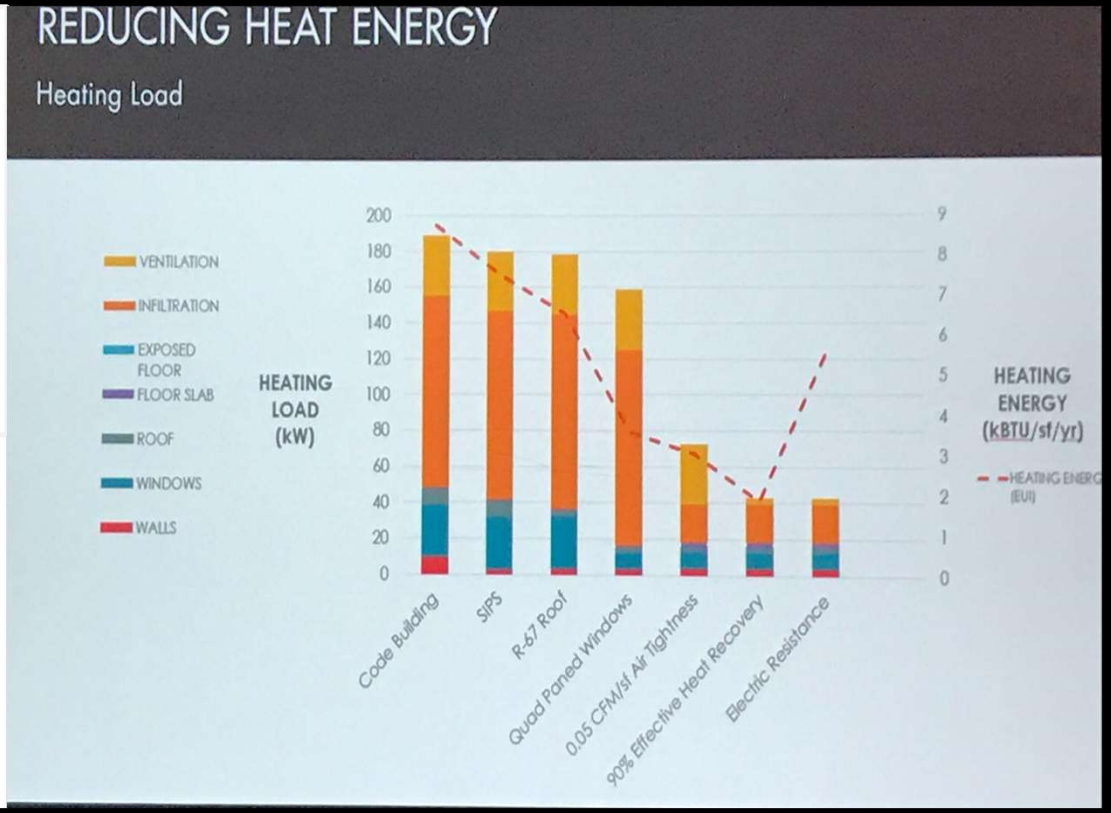
Blower door test / Air tightness test in Japan

- Commercial buildings: hardly
- Residential buildings: possibly

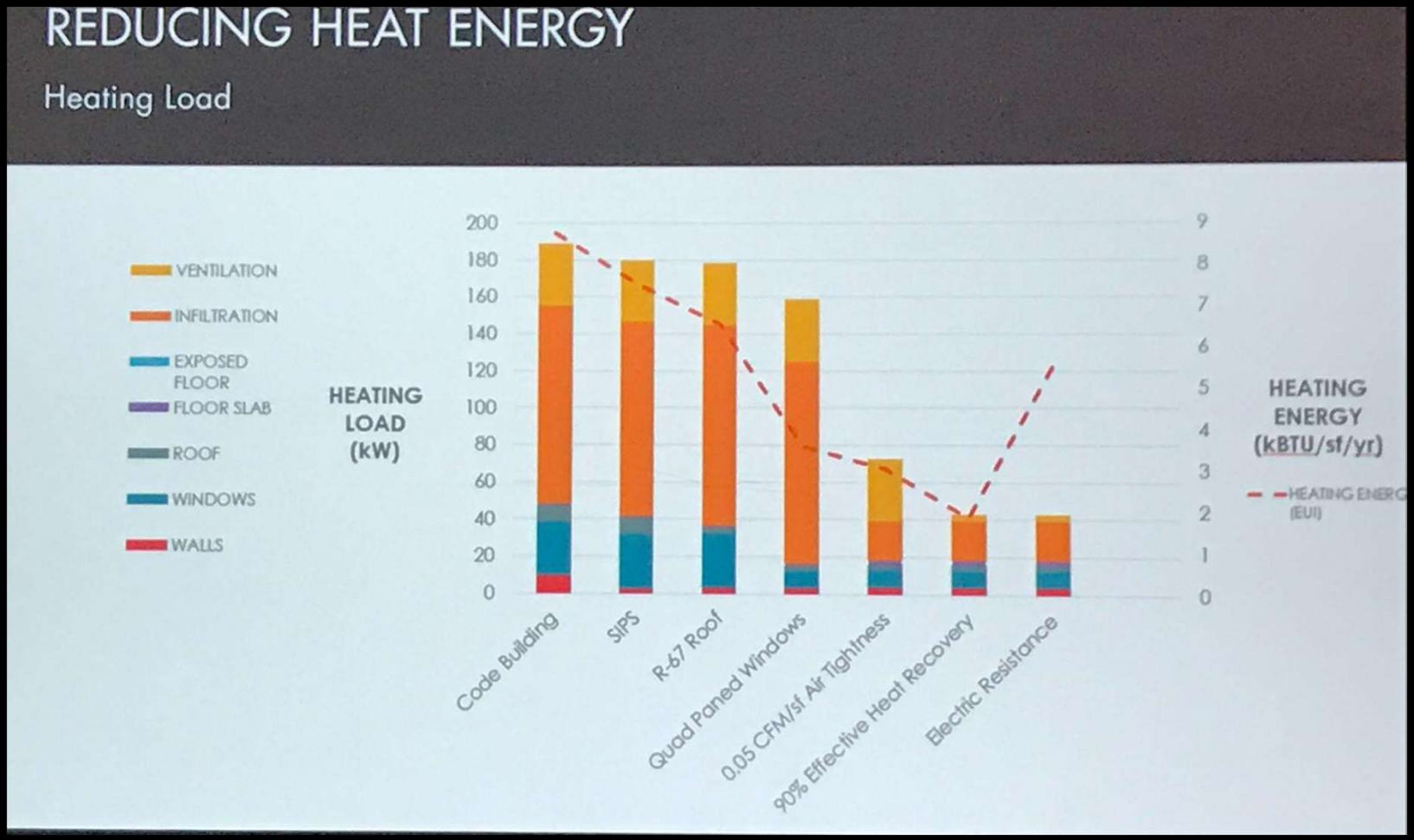
2 coincidences

On the way to build a zero energy building, among the approaches with latest technologies, reducing air leakage which is old school, worked best.

Greenbuild 2017では、「建築単体」の日々の改良に関わる多様な取り組み事例が紹介された。最新技術を導入したグリーンビル事例では、ZEB実現に最も大きな効果をもたらしたのは気密性の確保（すきまからの熱損失防止）というきわめて古典的な手法だったという報告があった。ロングライフビルに関しては、歴史様式建築の



Article of BELCA NEWS Jan. 2018



Greenbuild2017

By
Rocky Mountain Institute

Rocky Mountain Institute Innovation Center

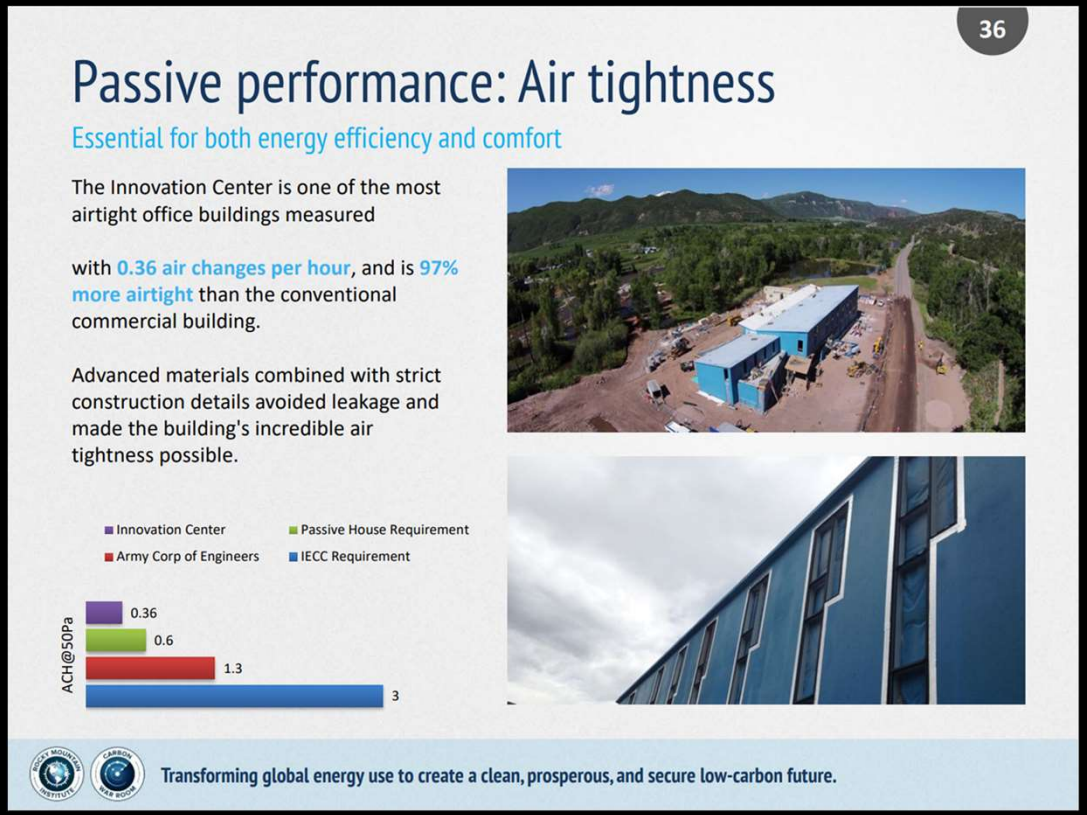
Tim Griffith

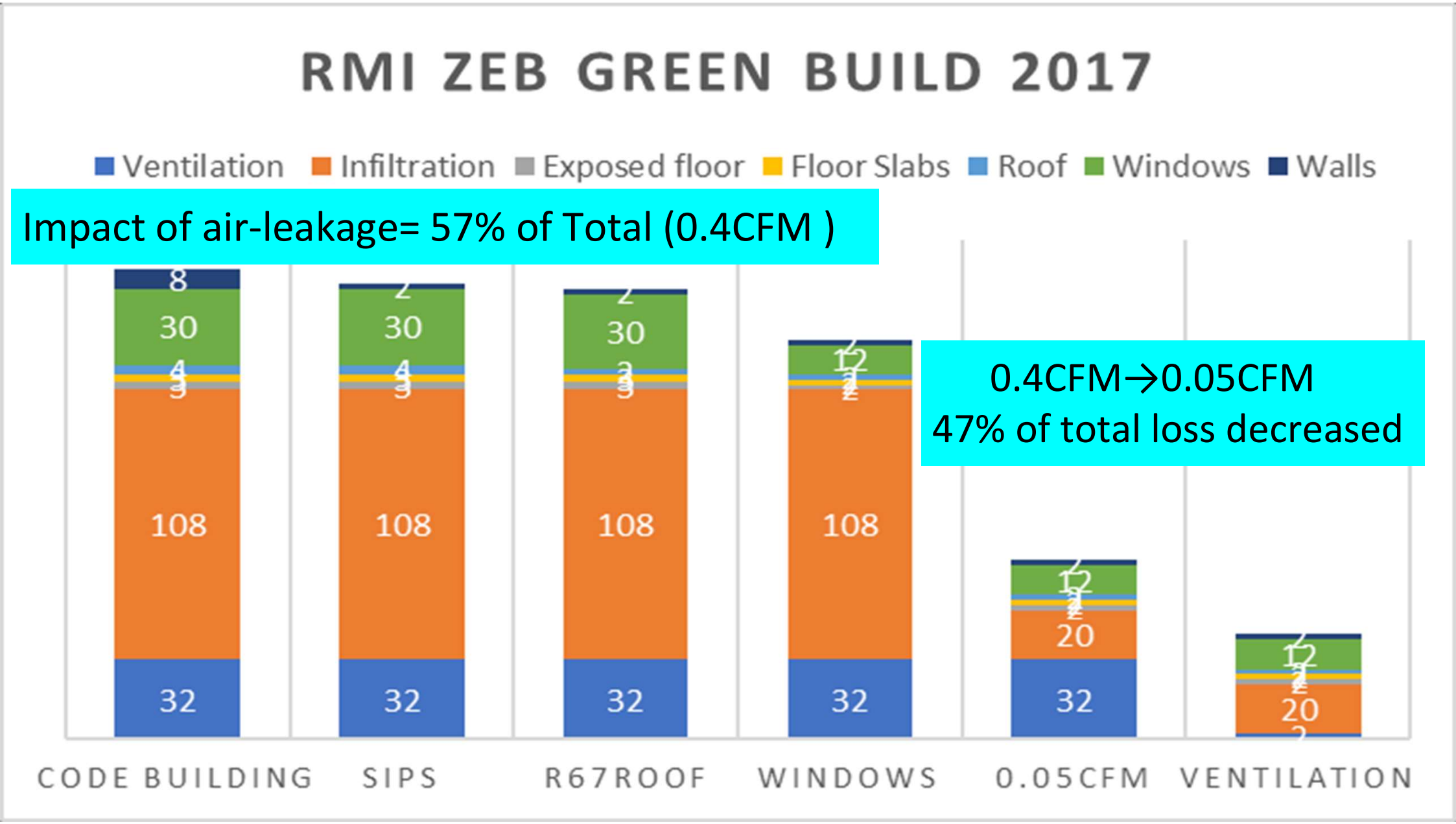
RMI's new headquarters in Basalt, Colo.

It seems cold.

Rocky Mountain Institute Innovation Center

- Built in 2016
- Colorado
- LEED Platinum certified
- Passive House Certified
- PHIUS+ Source Net Zero Project and meets Architecture 2030 goals
- Very airtight (0.36 ACH)




RMI ZEB GREEN BUILD 2017
Ventilation
Infiltration
Exposed floor
Floor Slabs
Roof
Windows
Walls
Impact of air-leakage= 57% of Total (0.4CFM)
0.4CFM→0.05CFM
47% of total loss decreased
CODE BUILDING
SIPS
R67ROOF
WINDOWS
0.05CFM
VENTILATION

Past experience

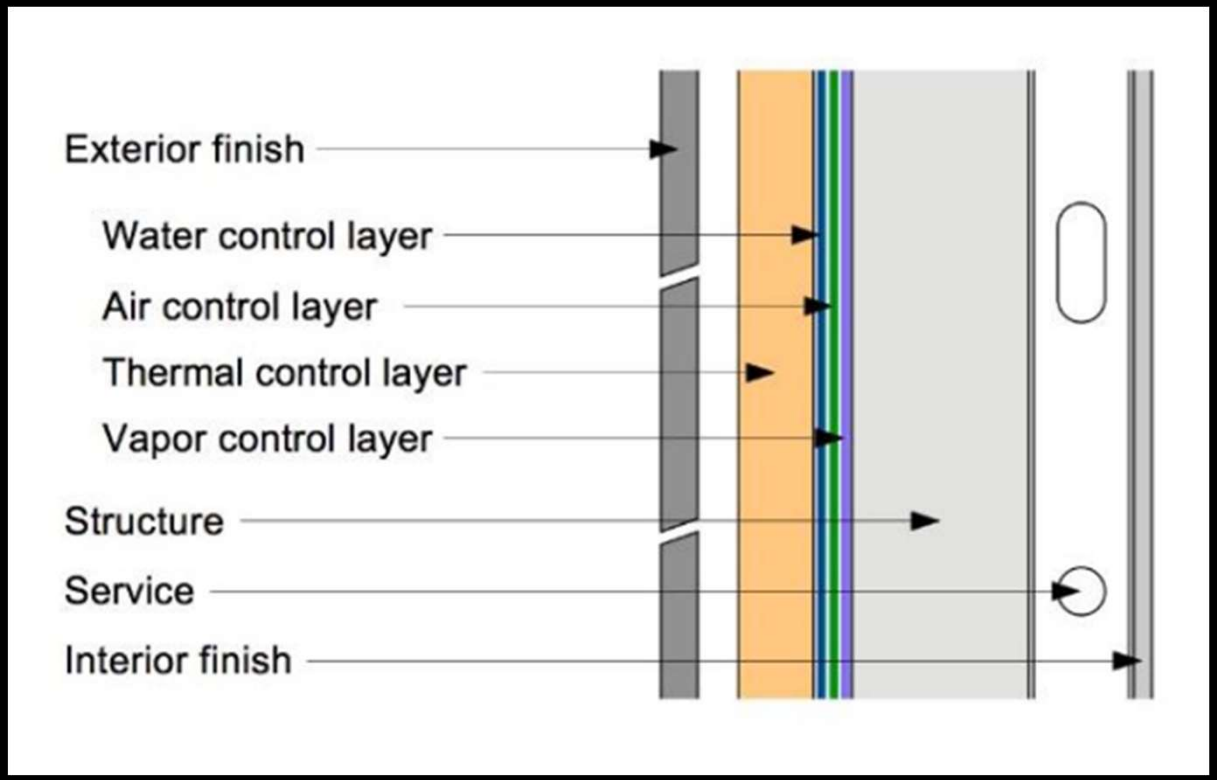
ALL Passed, but half failed Code requirement without pencheck

Building	Structure	No of Floor	Size m2	CMH/cm2 @75Pa	CFM @75Pa	Without Pen-Check
Meiken	W	2	1,000	4.16	0.231	**Fail**
Office	S	4	6,460	5.06	0.281	**Fail**
Office	S	4	2,392	4.46	0.248	Passed
Office	S	4	2,655	5.003	0.278	Passed
Office	S	4	2,567	5.00	0.278	Passed
Training Accomodation	S	3	2,000	3.21	0.178	**Fail**
Office	-	-	3,600	6.21	0.345	**Fail**
Church	RC	2	1,188		0.000	Passed

Value	These passed USACE requirement, 0.25 cfm/sf 0.3 IW
Fail	These would not have passed ASHRAE requirement, but for Pen-check

Japanese engineers think BECx is difficult and special?

What is Building Enclosure?



- Water barrier
(water control layer)
- Air barrier
(air control layer)
- Vapor barrier
(vapor control layer)
- Thermal barrier
(thermal control layer)

BE is consist of 4 barriers, which have order

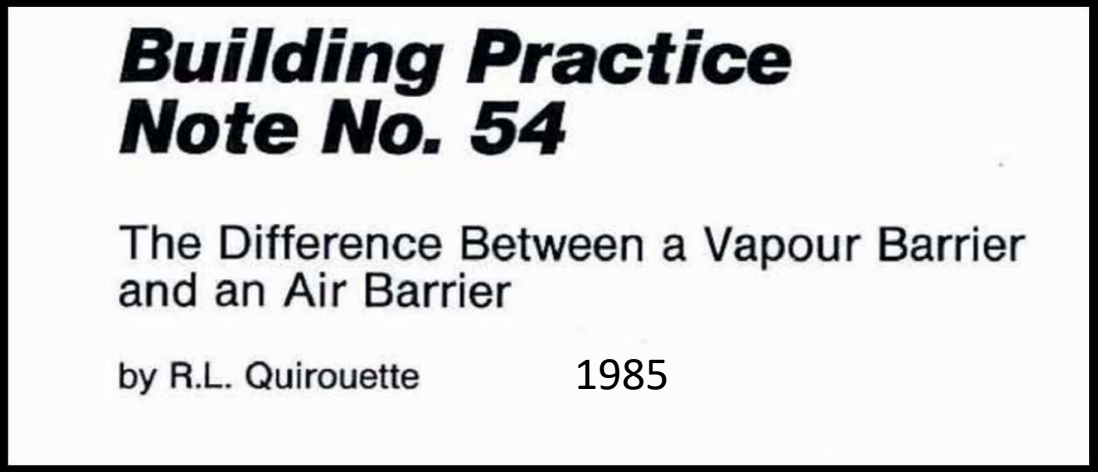
J. Lstiburek

Inportance	Barrier	Principle
1	Water	Gravity
2	Air	Contiuity
3	Vapor	Vapor Pressure
4	Thermal	Enough Amount

Order of occurence

Beginning	Barrier	Age
1	Water	Ancient
2	Thermal	1930's
3	Sheet Polyethylene Air & Vapor	1950's
4	Air	1980's

Air barrier made BECx possible



Building Practice Note No. 54

The Difference Between a Vapour Barrier and an Air Barrier

by R.L. Quirouette 1985

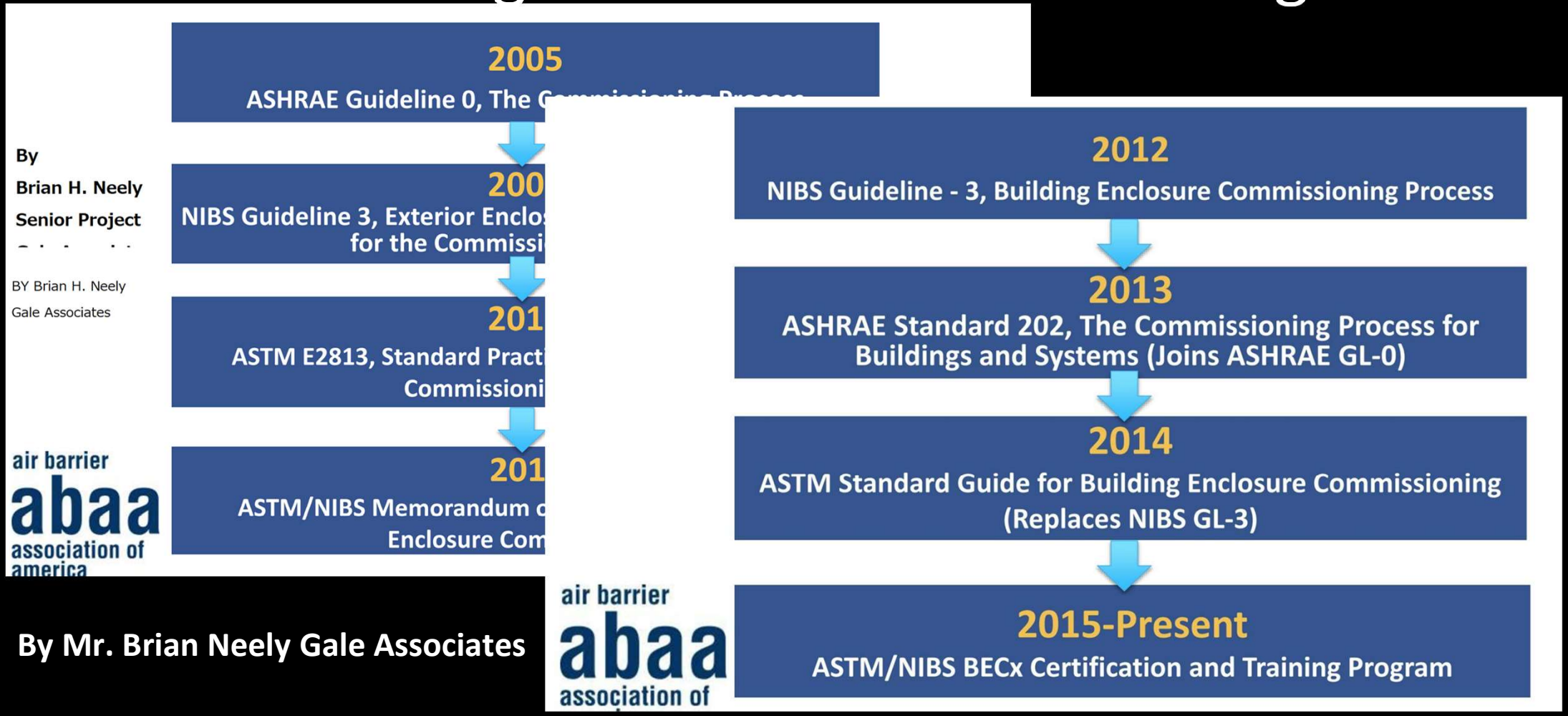
- ASHRAE 90.1

Building: 7.2 $m^3/h/m^2$ at 75Pa

Assembly: 0.72 $m^3/h/m^2$ at 75Pa

Material: 0.072 $m^3/h/m^2$ at 75Pa

BECx: Building Enclosure Commissioning



By Mr. Brian Neely Gale Associates

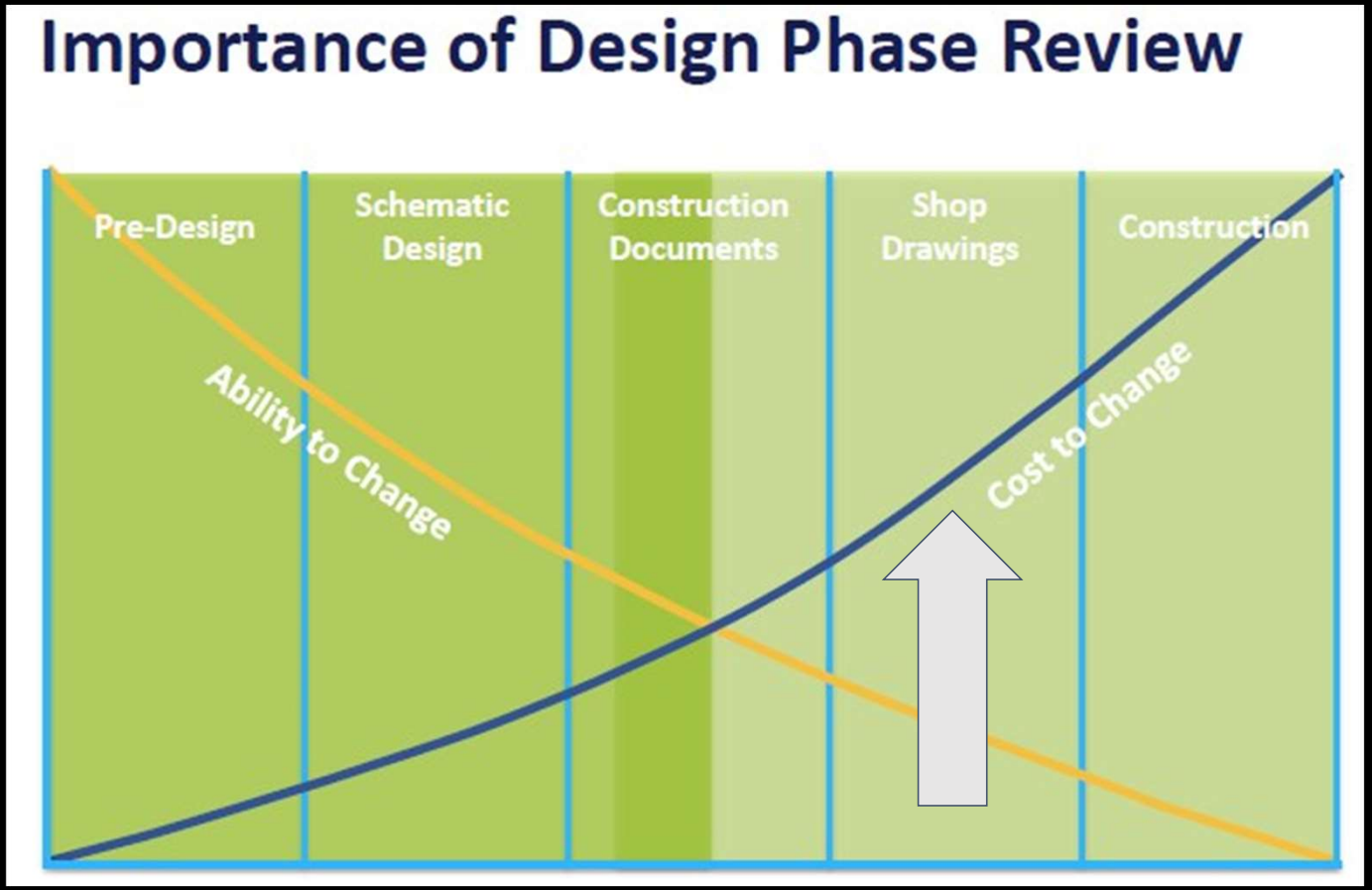
Points for improvement

Meiken Lamwood

Points to improve airtightness from BECx view

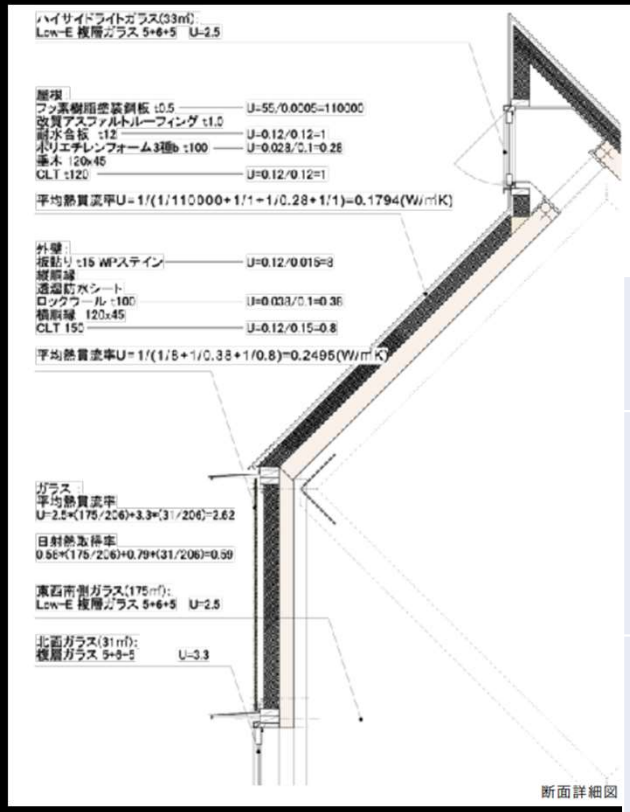
① Start earlier
② Recognize what and where Air Barrier is
③ Check if new material is air barrier
④ Air barrier Plan at schematic design

① Start earlier

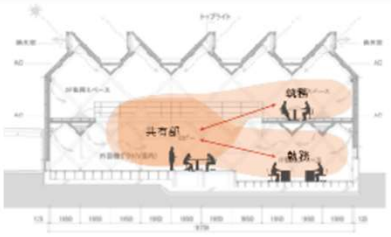


By Mr. Brian Neely

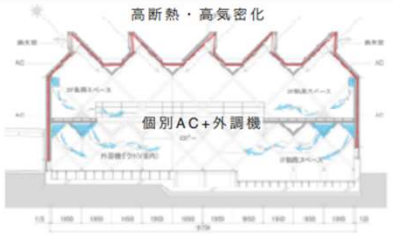
② Recognize Air Barrier



断面詳細図



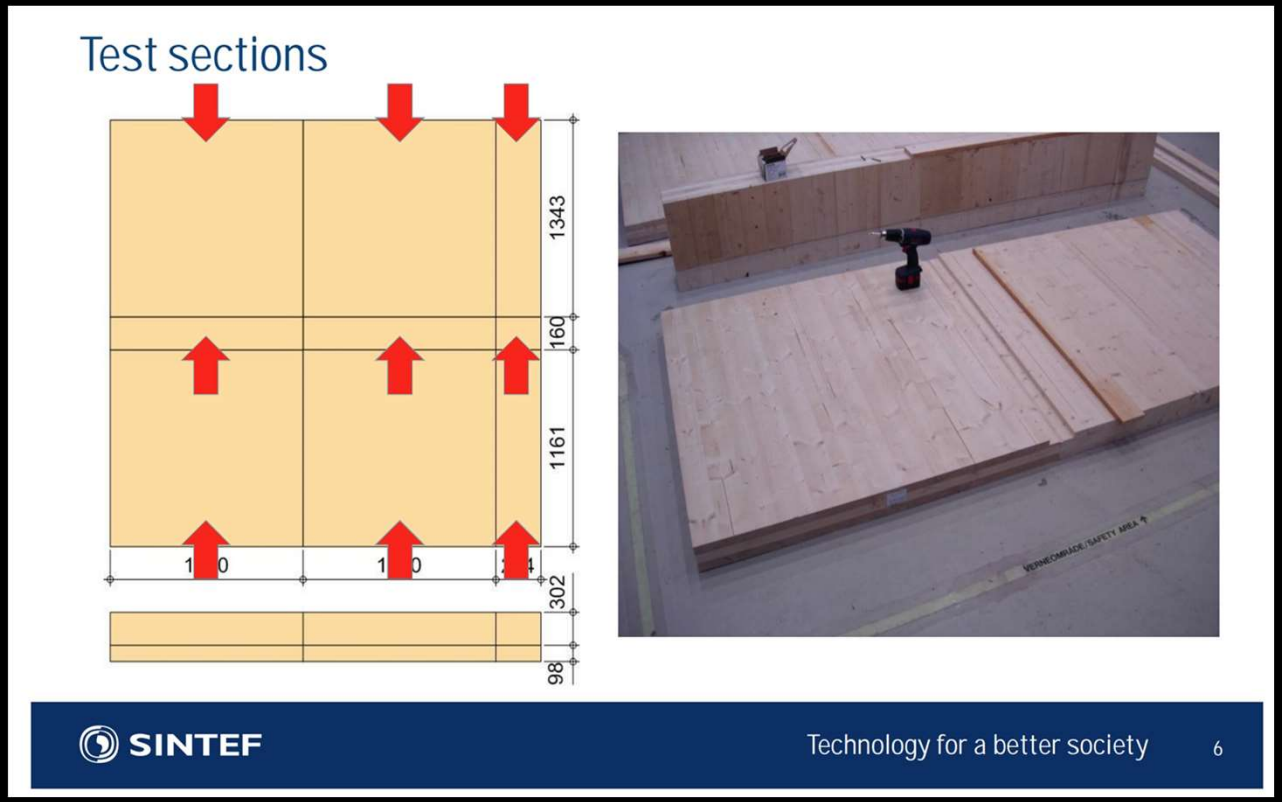
レベル差を活かして吹き抜け回りに広がる一体空間



高断熱・高気密化・構造と一体化した設備システム

	Air Barrier Material ＆ Product
Roof	Modified bituminous roof membrane
	Tyvec Sheet
Wall	Tyvec Sheet
	Wooden doors ＆Windows
Base	Cast-in-place concrete

③ Check if new material is air barrier



- CLT is NOT air barrier material, while plywood is.
- Test has to be done
- ASHRAE 90.1 requirement

  Material

  0.072 $m^3/h/m^2$ at 75Pa

Upper Air Leakage

Air leaks from CLT itself

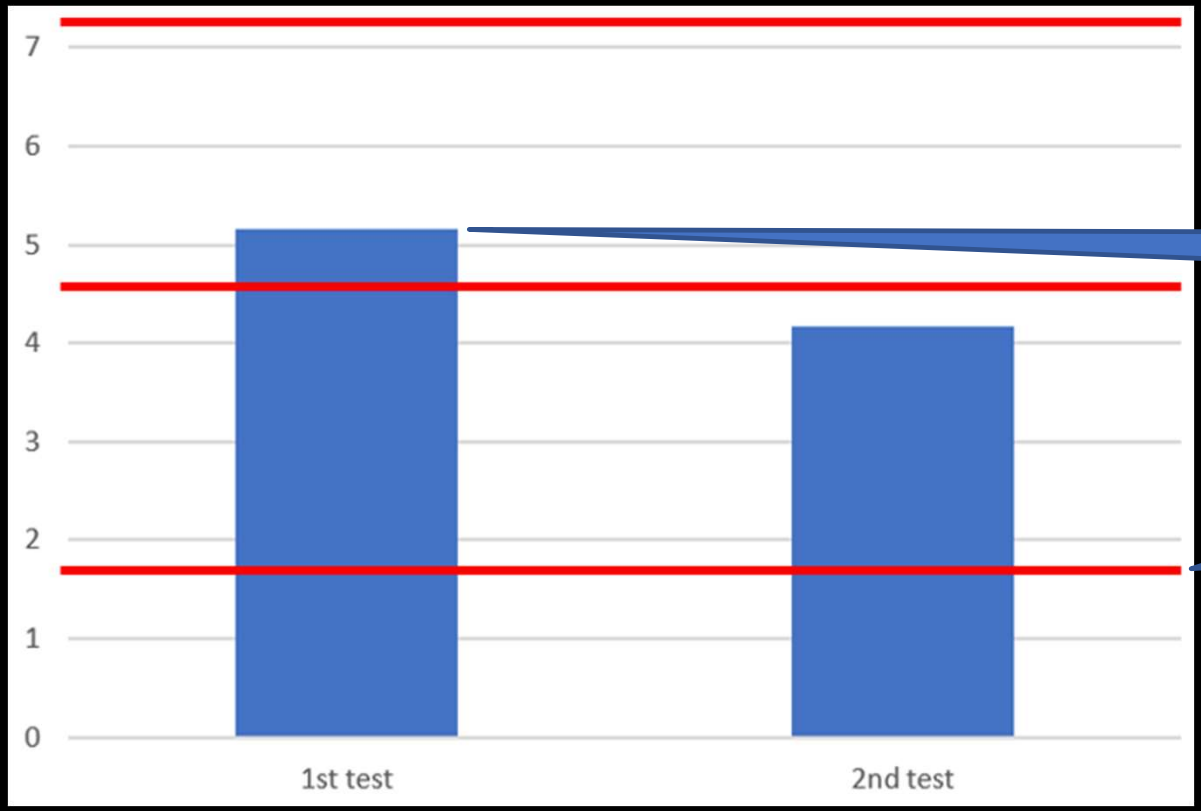
Moisture content greatly affect air leakage

④ Air barrier plan at schematic design

ARCHITECTURE

A-001	ABBREVIATIONS, REFERENCE SYMBOLS, AND GENERAL NOTES
A-002	INTERIOR WALL DETAILS
A-003	INTERIOR WALL TYPES
A-004	INTERIOR WALL TYPES
A-005	UL WALL TYPES
A-101.1	FIRST FLOOR PLAN - NOTATIONS
A-101.2	FIRST FLOOR PLAN - DIMENSIONS
A-111	FIRST FLOOR REFLECTED CEILING PLAN
A-121	ROOF PLAN
A-131	AIR BARRIER PLAN
A-132	AIR BARRIER DETAILS
A-201	NORTH AND SOUTH ELEVATIONS
A-202	EAST AND WEST ELEVATIONS
A-301	BUILDING SECTIONS
A-302	BUILDING SECTIONS
A-311	WALL SECTIONS

Potential to improve



Without pen-check

- ASHRAE 90.1:
  7.2 $m^3/h/m^2$

Without 1st test

- USACE Protocol
  4.572$m^3/h/m^2$ (0.25CFM/ft^2)

Possible?

- Passive House
  1.78$m^3/h/m^2$ (0.6ACH50)

Conclusion and proposal

Proposal: Let’s start study air barrier

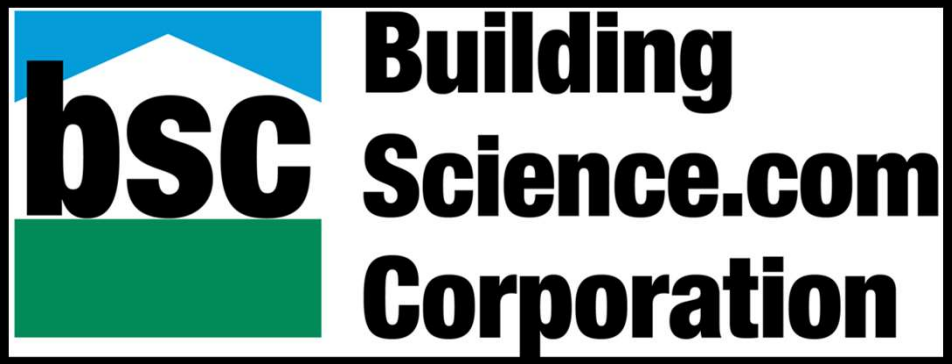
AB is a new concept,
architectural term having clear criteria,
which is different from what we Japanese imagine.

Free Text : BSC, ABAA, NIBS, IECC, and etc.

Proposal: Let’s start study air barrier

- First step: pen-check
- You will see the importance if you try it
- The word “Importance” means that you might find large or long enough gaps to be astonished with and laugh, not tiny holes
- It is not difficult to pass CODE requirement.

Proposal: Let’s start study air barrier



- Home Page | buildingscience.com

- The Air Barrier Association of America (ABAA) | Home

Thank you!

Reference

Meiken Lamwood website
https://www.meikenkogyo.com/works/1084/

AIJ Annual Architectural Design Commendation 2022
https://www.aij.or.jp/jpn/design/2022/data/5_award_004.pdf

RMI Innovation Center Year 1 Insights, Results, and Lessons Learned Current as of February , 2017
https://rmi.org/our-work/buildings/scaling-zero-net-carbon/rmi-innovation-center/

Ayako Omura [1 ロングライフビルと LEED　2018
ー Built Environment のサステナビリティ向上をあらためて考える]

SINTEF [Air leakage thorough cross laminated timber (CLT) constructions]

Air leakages through cross laminated timber (CLT) constructions - SINTEF