Commercial Building Airtightness Testing – Lessons Learned from the Red River College Airtightness Testing Program

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Background

- Number of houses tested in Canada – approx. 1,000,000
- Number of commercial buildings tested in Canada – approx. 200^{+}?

Objectives:

1. Develop practical expertise in commercial building airtightness testing.
2. Establish baseline airtightness data on Manitoba's commercial building stock.
3. Compare pre-and-post retrofit data.

What Did We Do?

Conducted airtightness tests on a diverse range on 26 commercial buildings in Manitoba (various types, ages, heights, styles, locations and sizes)

Category	Number of Buildings
Complete sample	26
New construction	5
Warehouses/light industrial	11
Office buildings	7
Schools	4
Churches	2
Greenhouses	2
Retrofits	3

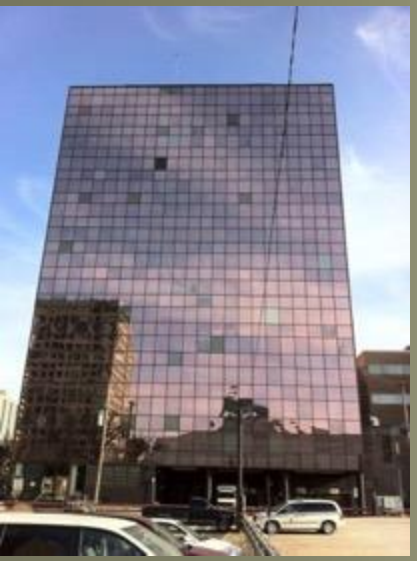







Pollock's














Manitoba Hydro
TRAINING CENTRE

Metric used for commercial buildings:

Normalized Leakage Rate @ 75 Pa (NLR_{75})

$$NLR_{75} = \frac{\text{(Total Leakage at 75 Pa)}}{\text{Envelope Area}}$$

Airtightness Reference Standards

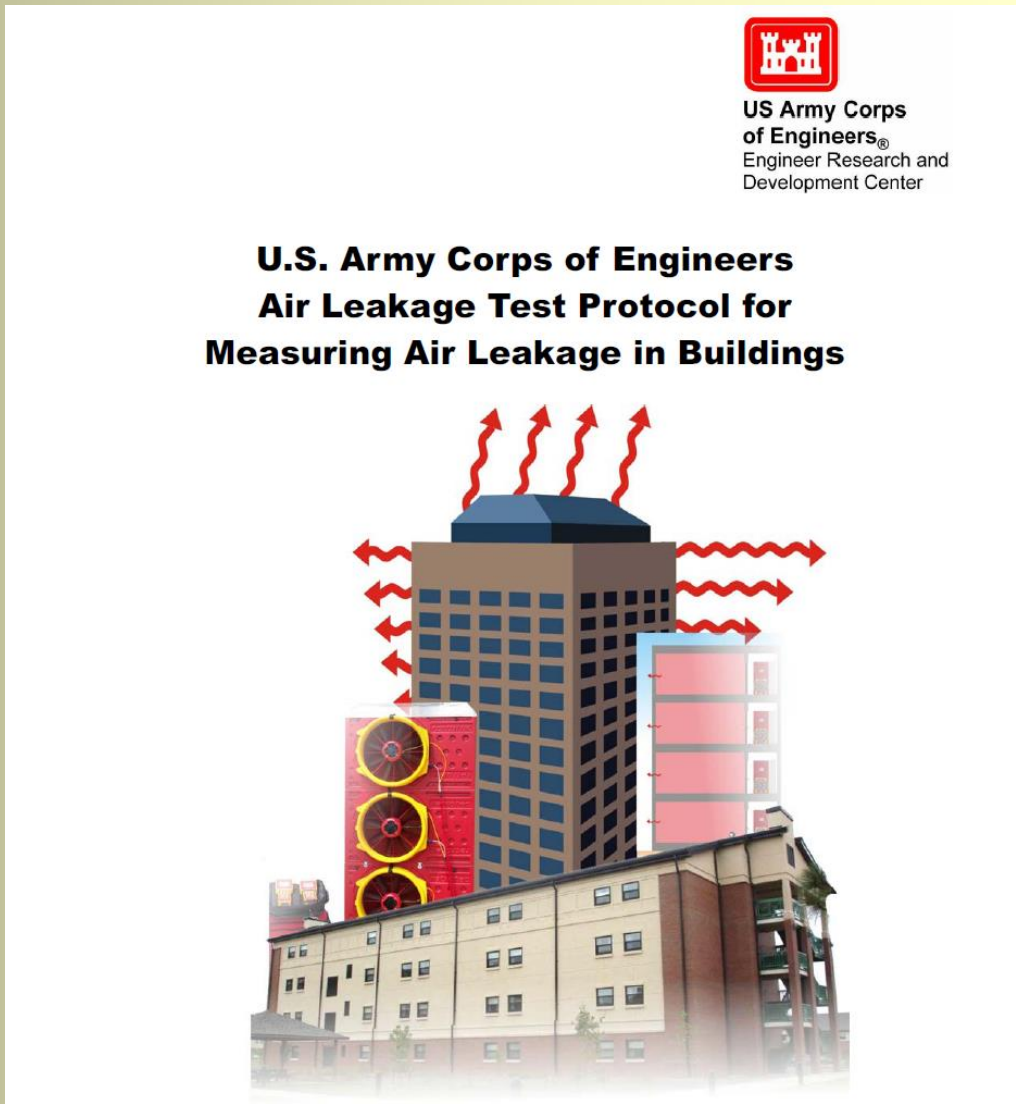
Comparative results – Results were compared to data from three references:

a) 2012 IECC (2.03 L/s•m^2)

b) 2012 USACE/ABAA (1.27 L/s•m^2)

c) 2010 NBC Air Barrier System recommendation (0.10 L/s•m^2)

Our Test Protocol



Quantitative Testing Of Building Airtightness

National Building Code of Canada now *recommends* the following for ***air barrier systems in opaque, insulated portions*** of the envelope...

Interior Relative Humidity (%)	Maximum Recommended NLR_{75}
<27%	0.15
27% to 55%	0.10
>55%	0.05

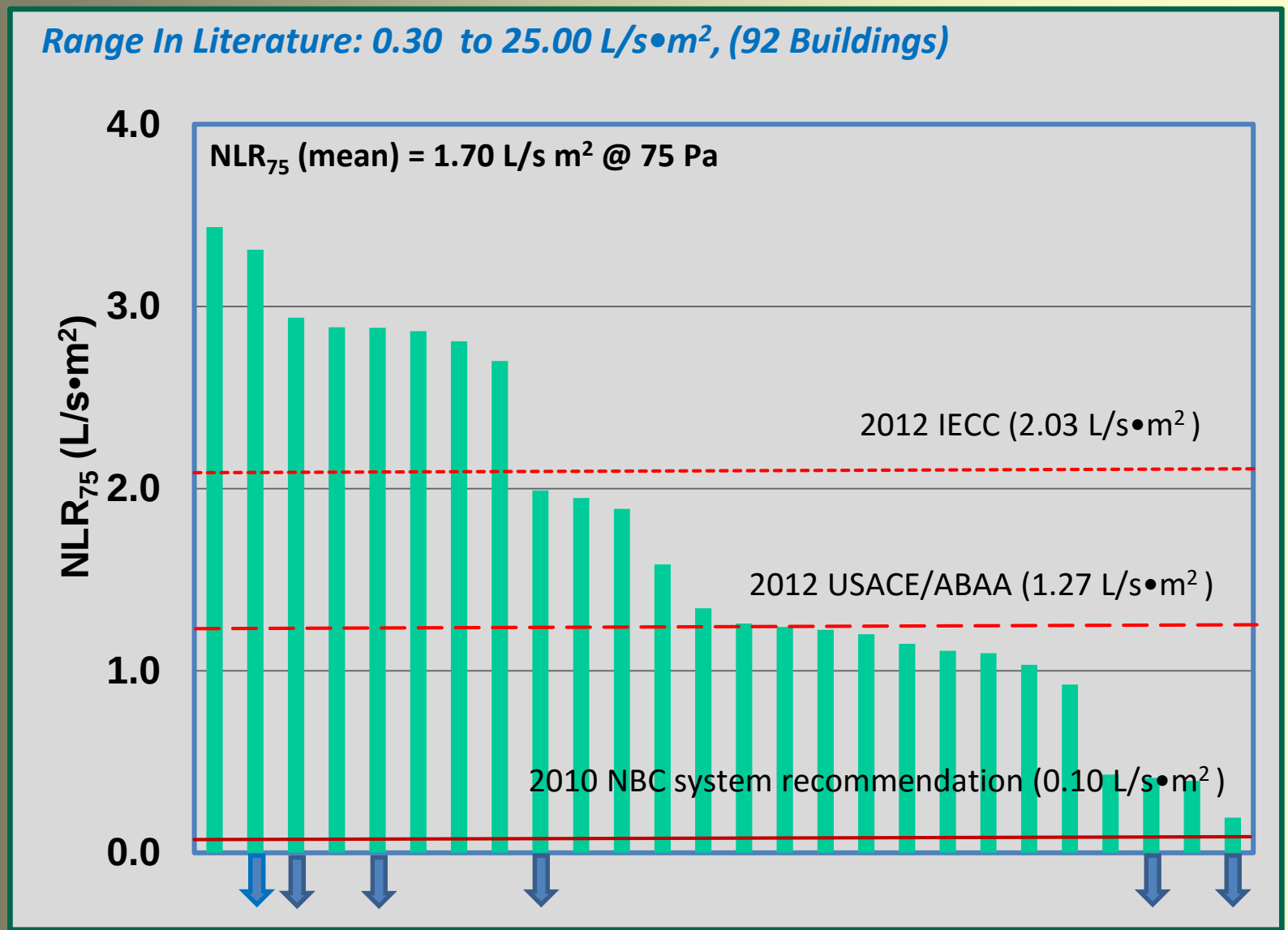
Oh yeah, the climate is somewhat “challenging” (i.e. terrible)

5,900 – 9,200 HDD (metric)
10,000 – 17,000 HDD (imperial)

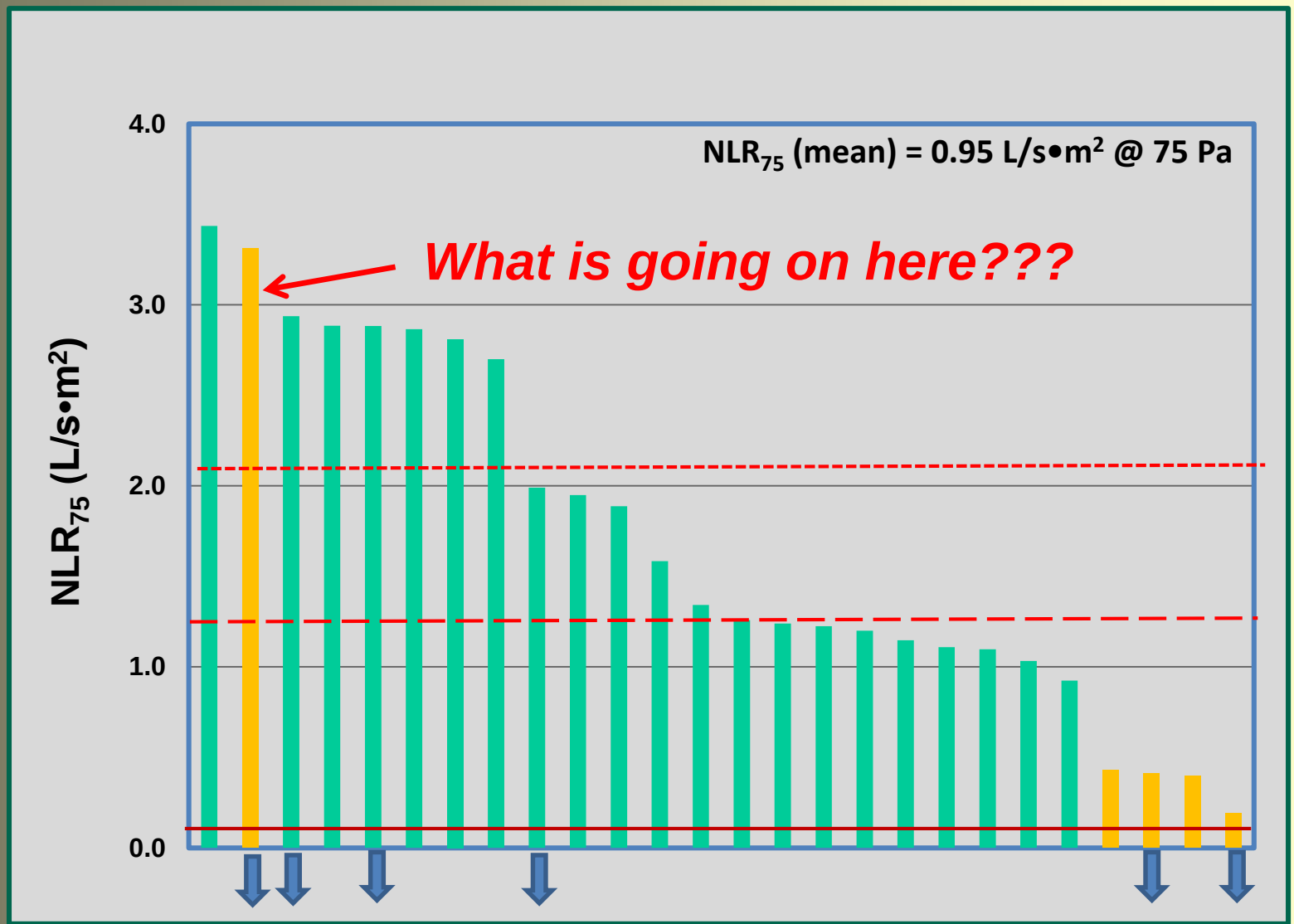
For example: how well do most tapes stick at -40°?


EXIT
retrotec
retrotec

Airtightness of Manitoba's Commercial Buildings – 2015 RRC Study



New Construction – 5 Buildings




This is what's going on!

A Revelation:

Two, different sealing schedules for the mechanical system are required for commercial building airtightness testing:

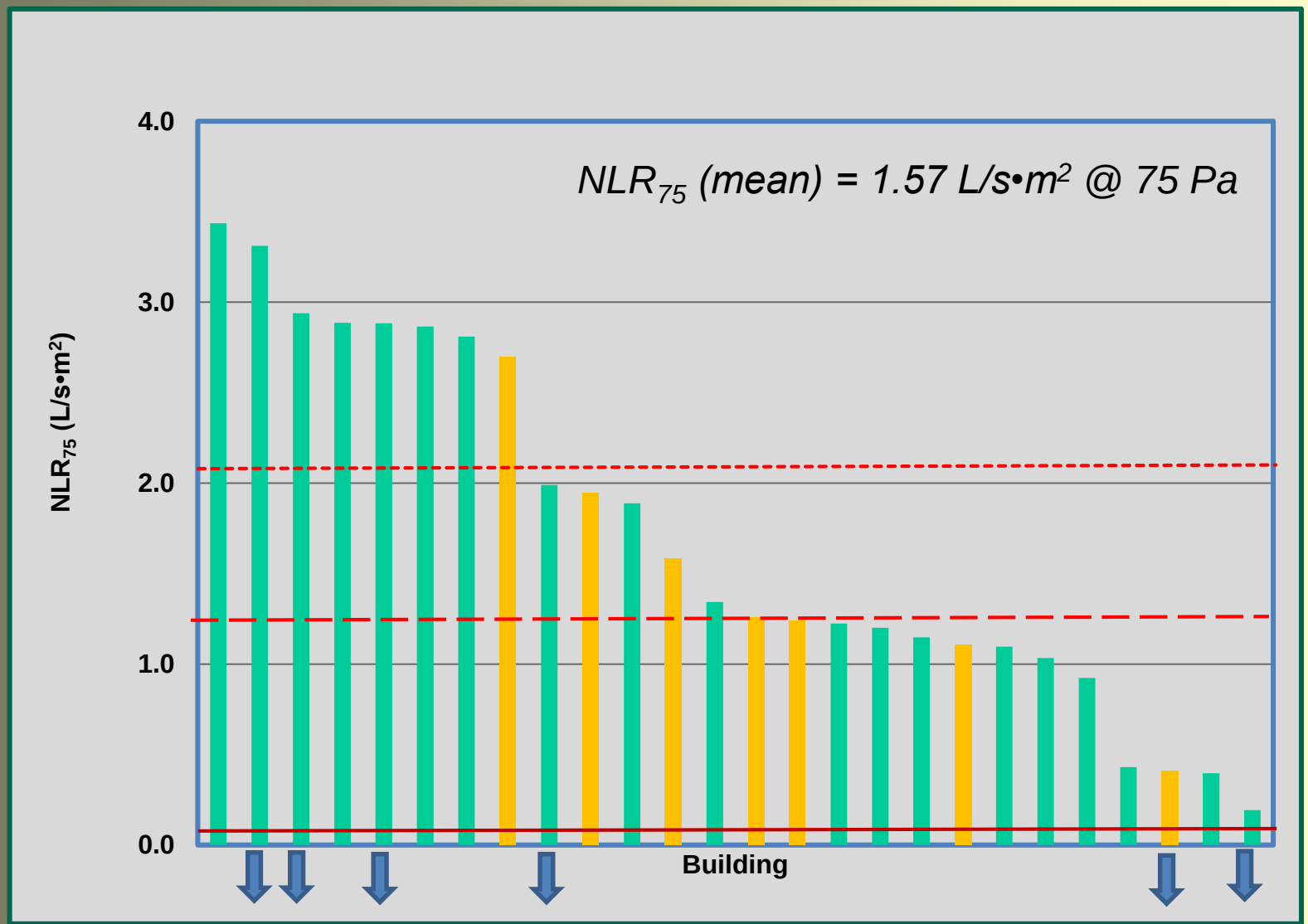
Envelope Tests – Evaluate the integrity of the building envelope
- Mechanical system sealed

Energy Tests - Evaluate the impact of air leakage on energy performance
- Mechanical system unsealed.

Note: the difference between these two results is the damper leakage.

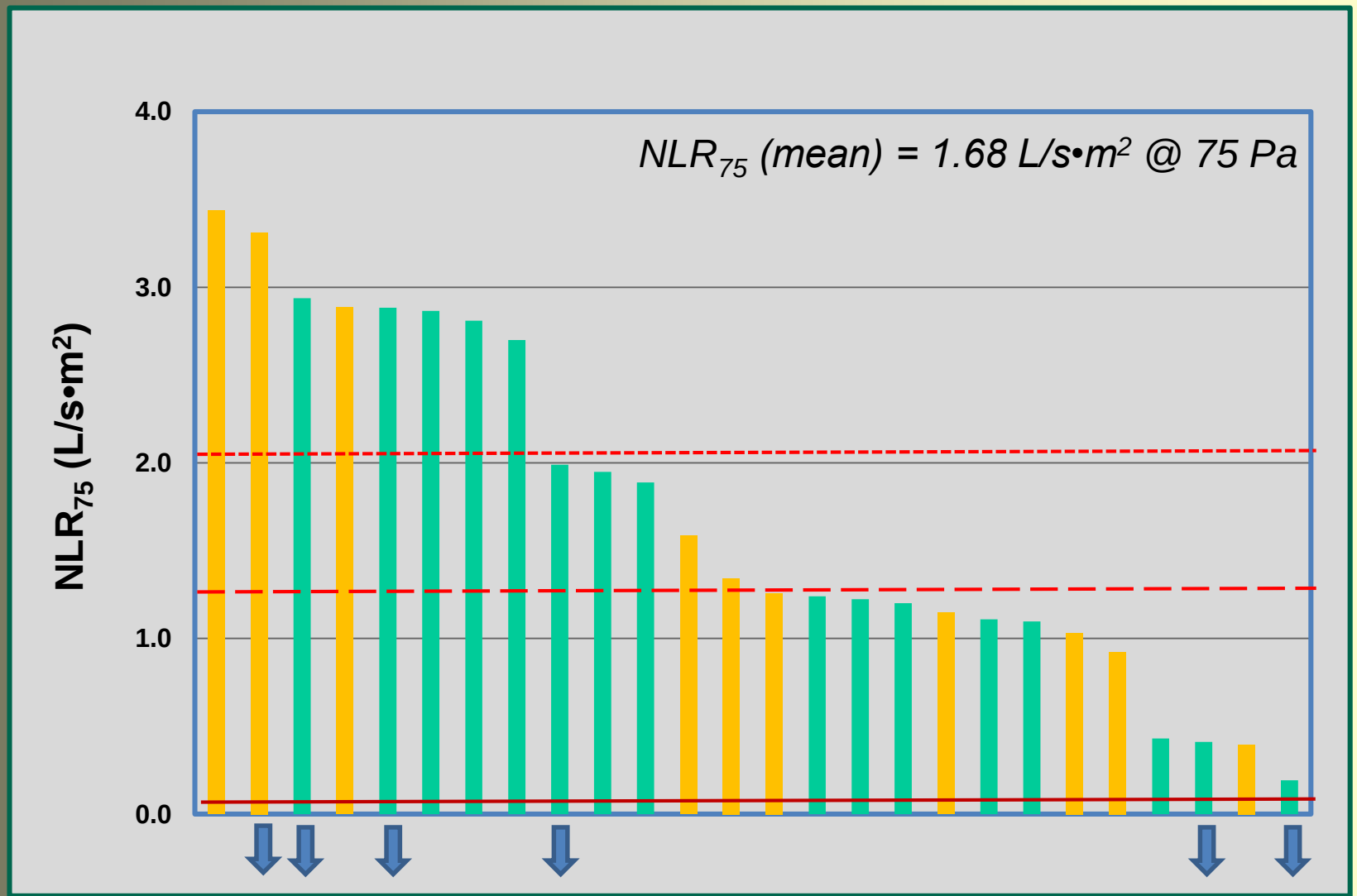
Office Buildings:

Lots of Variation



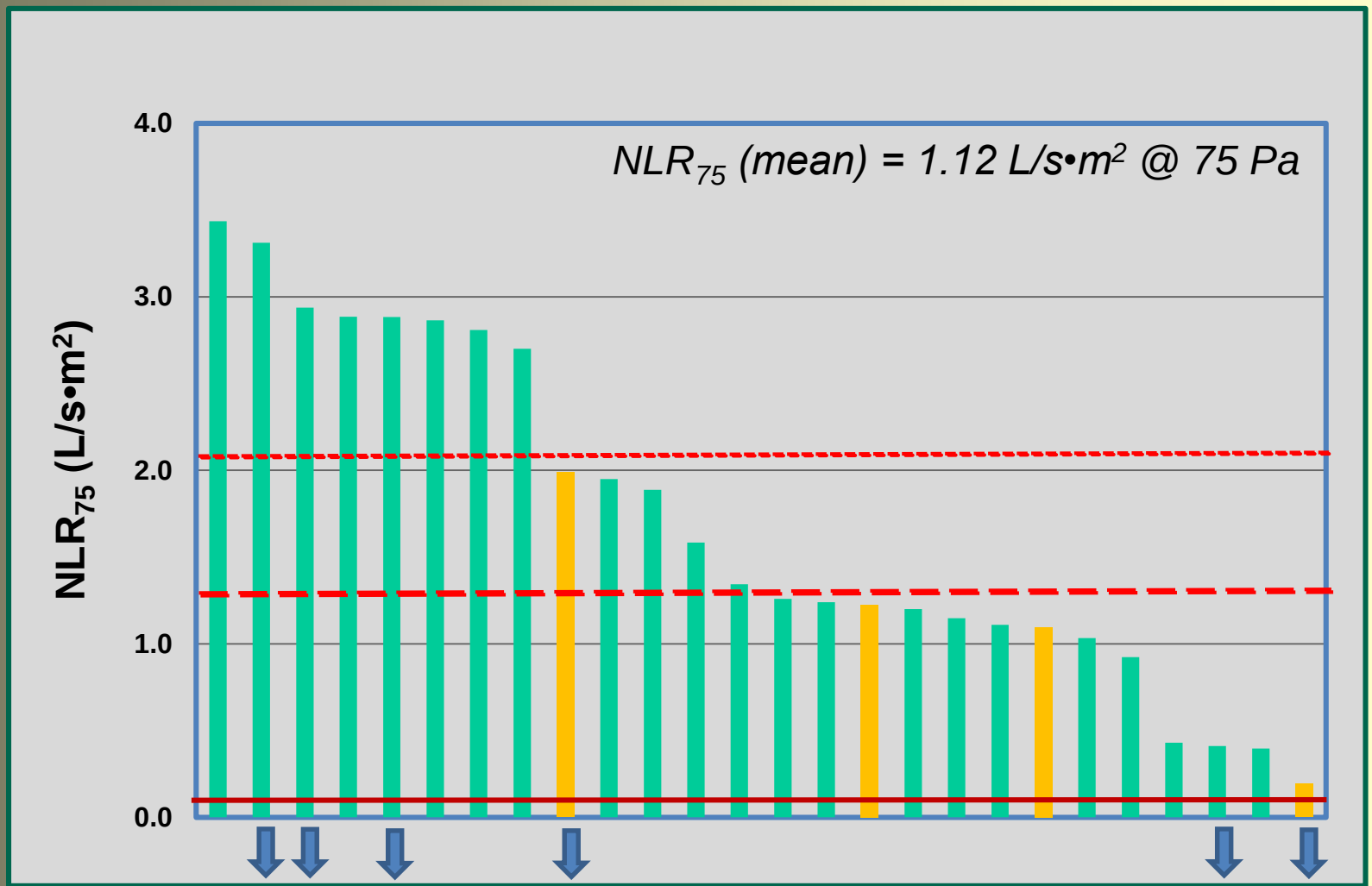
Warehouses:

Highly Variable Leakage



Schools:

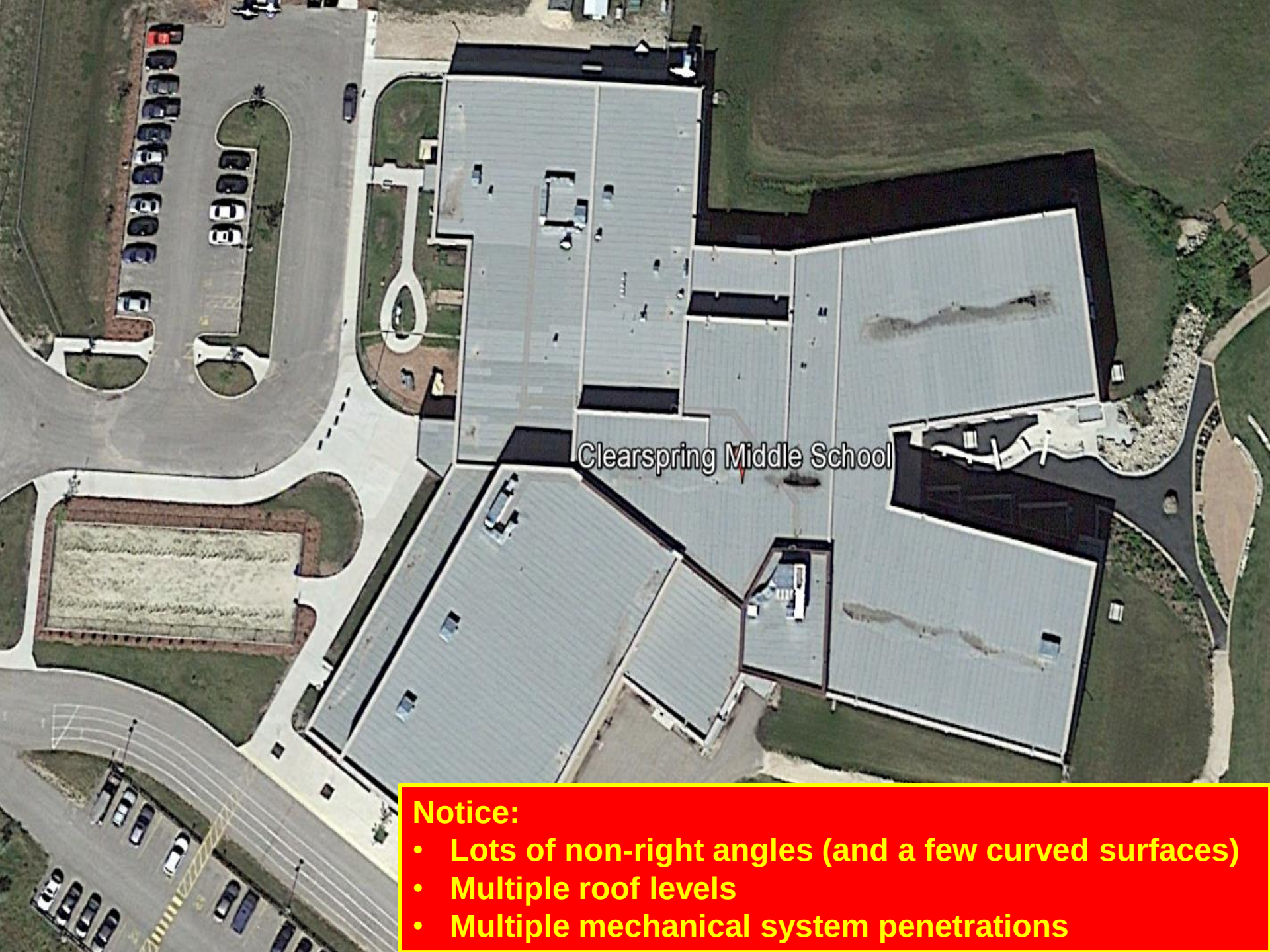
Some Can Be Built Surprisingly Tight!



What is Possible with New Construction:

- 2010 NBC **system** NLR_{75} recommendation - 0.10 L/s•m^2
- Clearspring School, Steinbach, ***whole building*** NLR_{75} – 0.19 L/s•m^2

Is this the tightest school in the world?

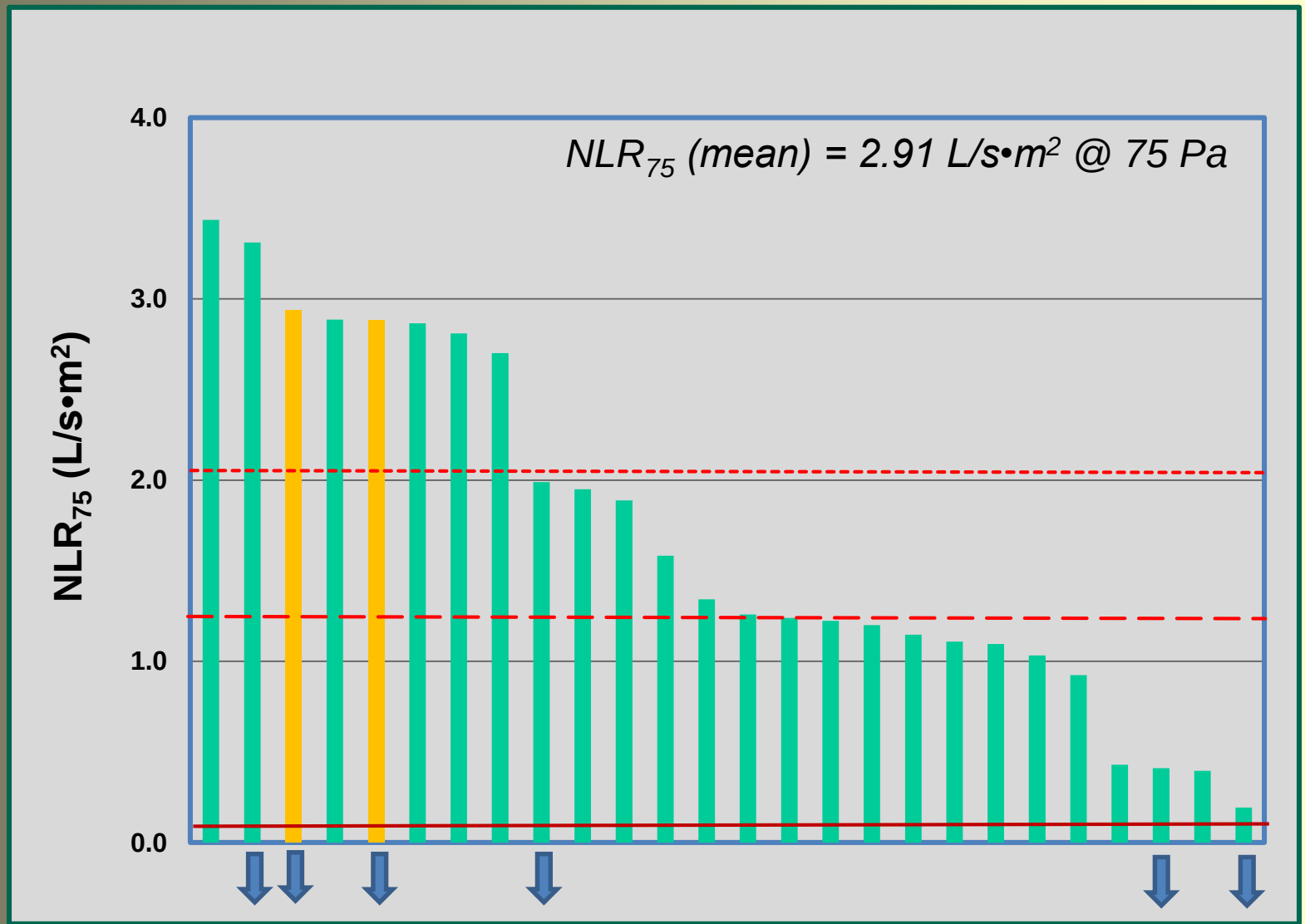


Notice:

- **Lots of non-right angles (and a few curved surfaces)**
- **Multiple roof levels**
- **Multiple mechanical system penetrations**

Greenhouses:

Leaky, leaky & leaky...

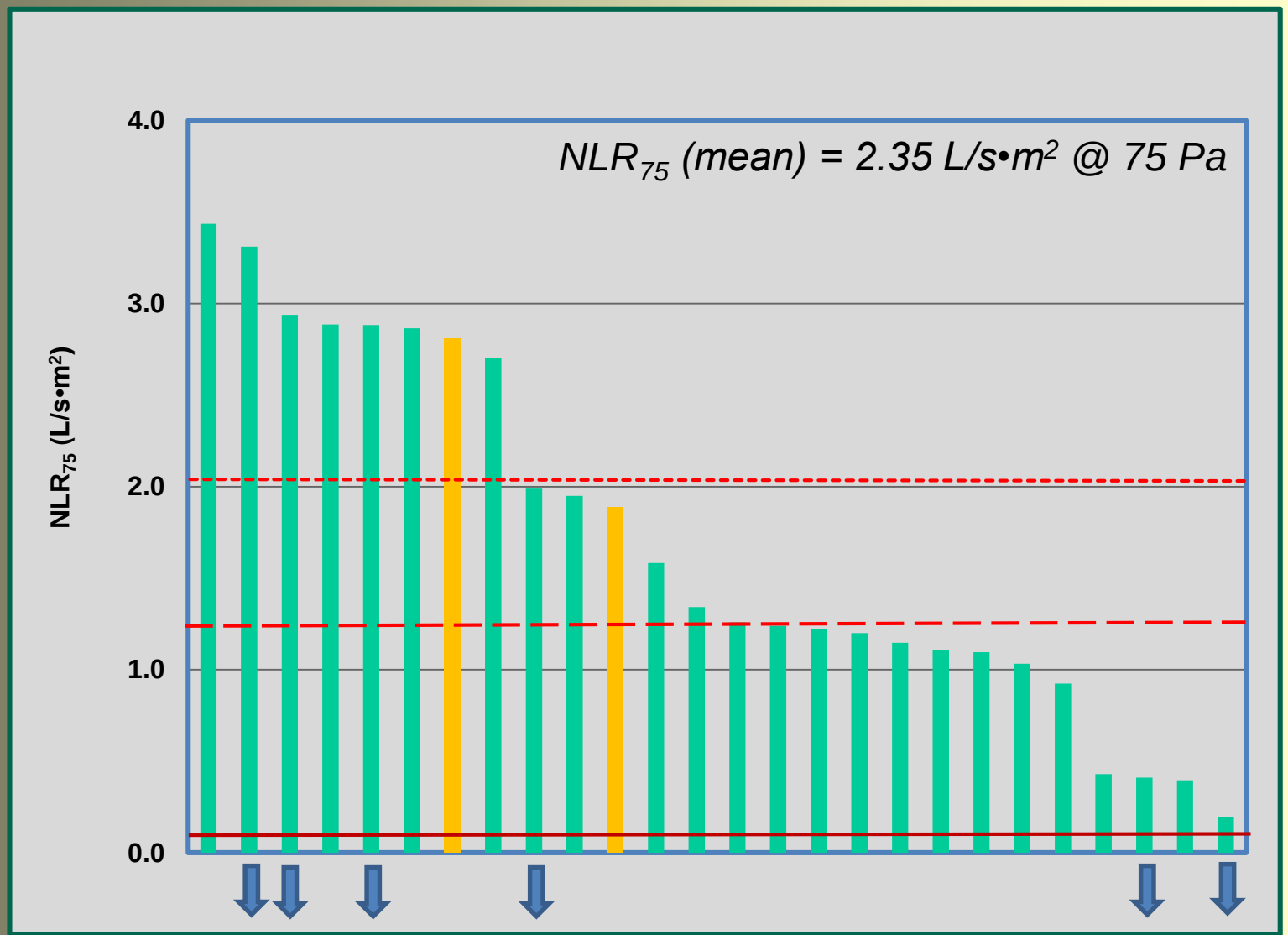


*Passive, "energy efficient" greenhouse NLR_{75} = **2.94** l/s•m^2*

*Conventional greenhouse NLR_{75} = **2.88** l/s•m^2*

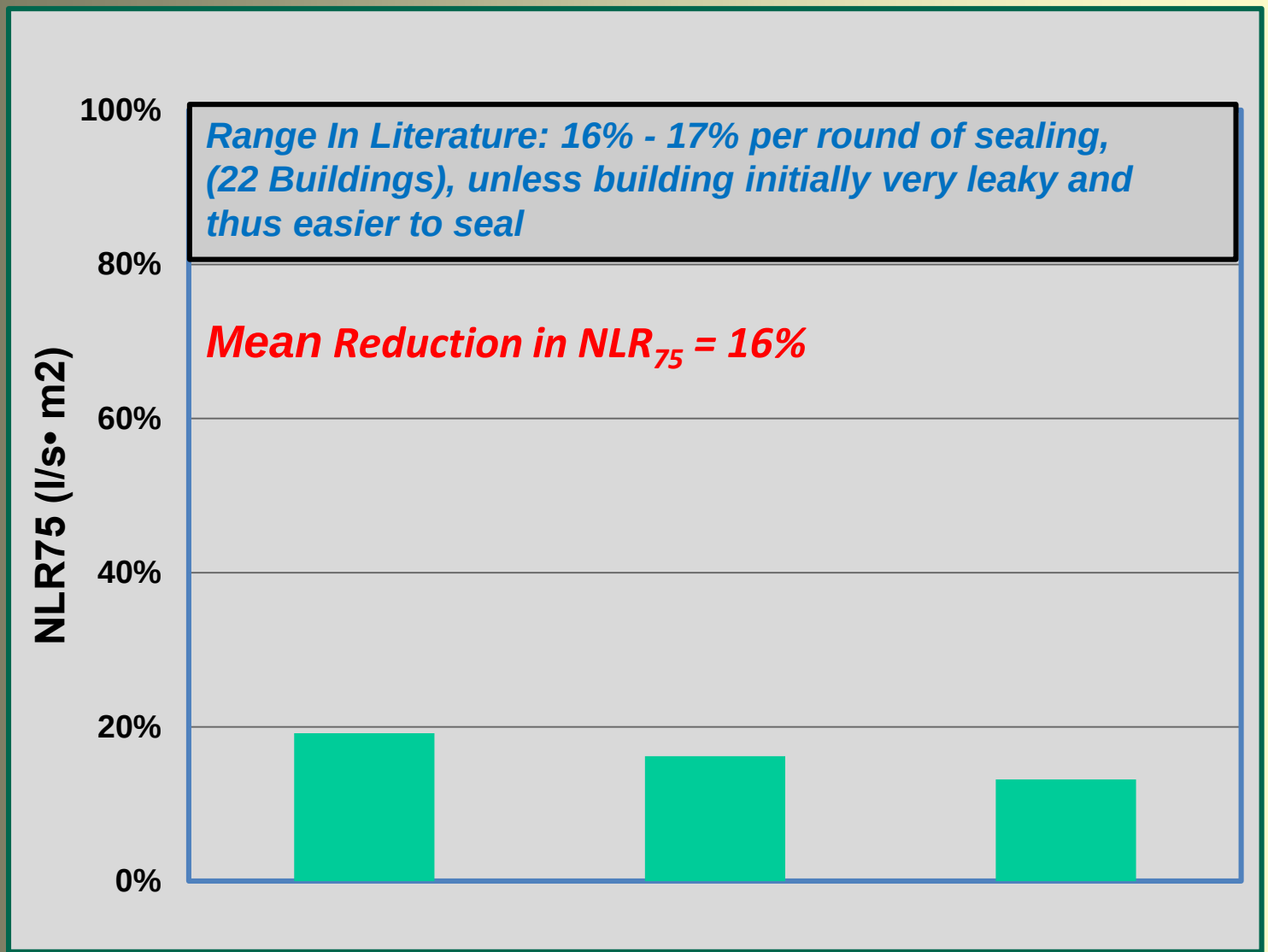
Churches:

Above-average leakage rates, BUT
both had major leakage from chapel areas into attics



Retrofits:

How Much Can Leakage Be Reduced?



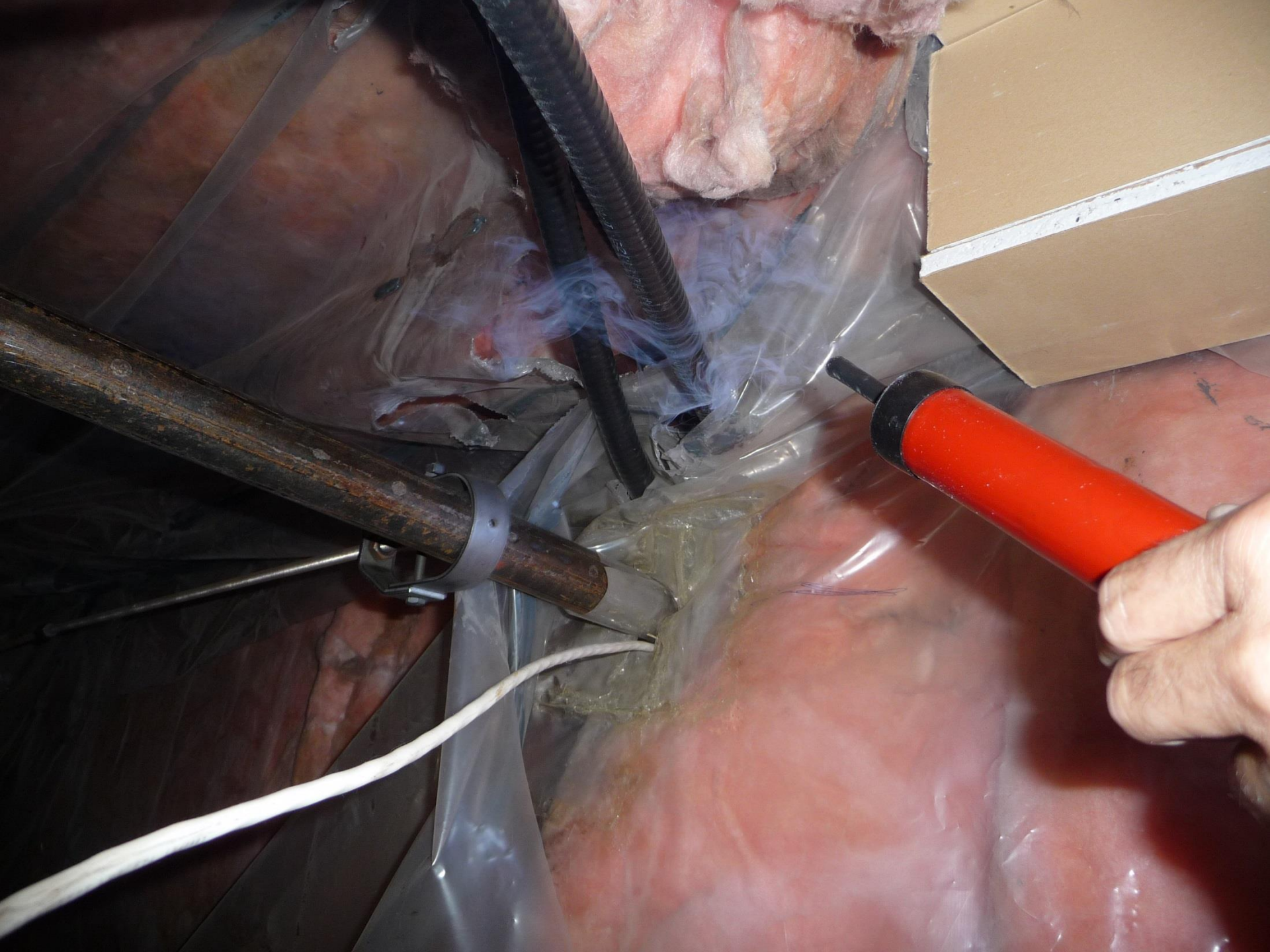
Where Does Air Leakage Occur In Commercial Buildings? *"At joints, intersections and & penetrations"*

- Exhaust and make-up air fans with one-way dampers
- Roof/wall intersections, especially on walls running perpendicular to roof deck flutes
- Unintentional bulkhead leakage into attic spaces
- Overhead doors, mainly at base and sides, not between sections
- CMU/floor slab intersections
- Curtain wall/floor slab intersections
- Unsealed walls above ceiling lines
- Ductwork and pipe penetrations
- Doors and windows (both broken and unbroken)
- Underground steam lines
- Etc., etc., and etc.

And Occasionally, Air Leakage Occurs Via Rather Complicated Pathways

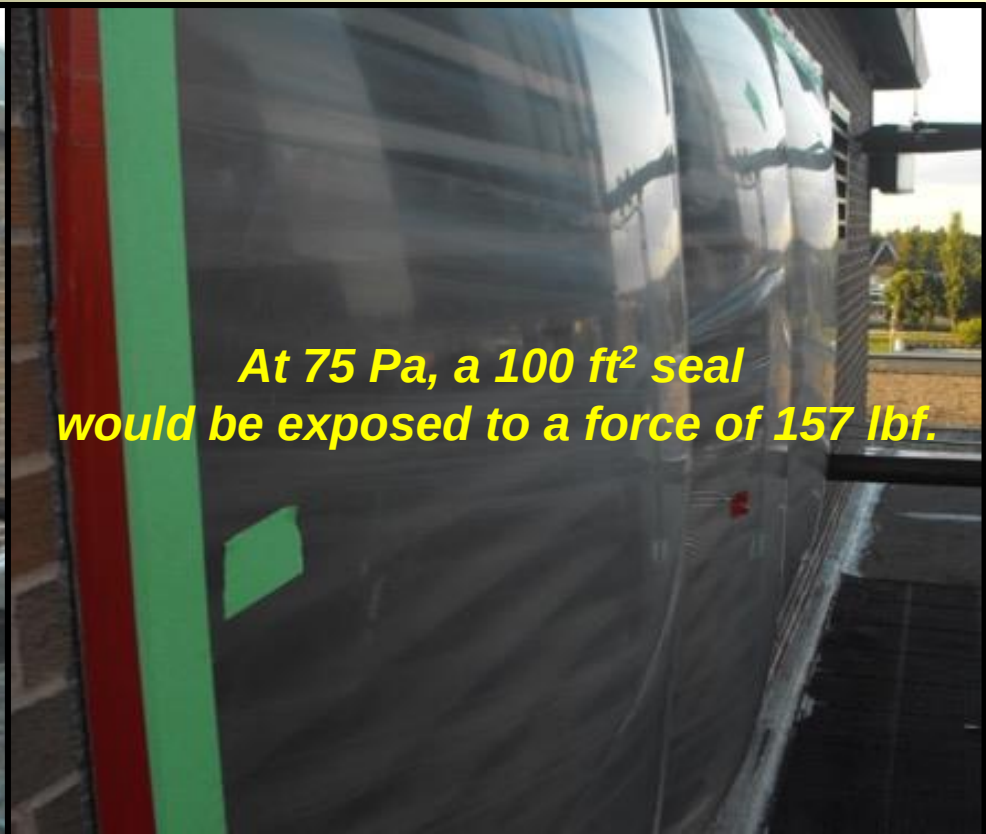
Air Movement Due To Stack Effect Under Natural Winter Conditions


And sometimes finding a crack is pretty easy



Some Practical Aspects of Commercial Building Airtightness Testing

Sealing mechanical penetrations



Some Practical Aspects of Commercial Building Airtightness Testing

Safety Issues

Commercial vs. Residential Airtightness Testing

	Commercial	Residential
Primary application	Large, commercial-style buildings	Houses
Typical air flow capacity required	25,000 l/s (50,000 cfm)	2500 l/s (5,000 cfm)
Test pressure range	up to 75 Pa	15 Pa to 50 Pa
Positive or negative pressurization	Positive and negative	Negative only
Sealing schedules for intentional openings	Two (Energy and Envelope)	One (Envelope)
Time requirements (on-site)	4 to 12 hours	1 hour
Required crew size	4 to 12^{+}	1
Equipment weight	750^{+} kg (1500^{+} lb.)	75 kg (150 lb.)
Equipment costs	≈ $100,000$^{+}	≈ $3,000

Some Conclusions:

- The mean NLR_{75} for the 26 building sample was **1.70** L/s•m^2.
- Very low airtightness rates are achievable with current technology, even for complex designs (e.g. **0.19** L/s•m^2.
- The measured airtightness of the buildings varied by a factor of **18:1** between the tightest and leakiest structures.
- The typical NLR_{75} of new construction was about **0.40** l/s m^2.
- Retrofits produced an average reduction in the measured NLR_{75} of about **16%** (although up to **50%** has been subsequently achieved).
- Commercial building airtightness testing requires significant planning, coordination and manpower resources.
- Two sealing schedules are required: energy and envelope, depending on whether the focus is on energy performance or envelope durability – or both.

A Suggestion For Regulatory Bodies Considering Implementing Requirements For Airtightness & A/T Testing of Commercial Buildings...

Mandatory requirements should first be targeted at buildings:
a) Which have very humid interiors:
- *Indoor swimming pools*
- *Greenhouses, etc. and*

A Suggestion For Regulatory Bodies Considering Implementing Requirements For Airtightness & A/T Testing of Commercial Buildings...

b) Buildings which, once occupied, can never be tested. These include:

- *Hospitals*
- *Personal care homes*
- *Hotels*
- *Prisons, etc.*


Any Questions??