The Use of Indoor Surface Low-e Coatings: The Implications Regarding Condensation Resistance

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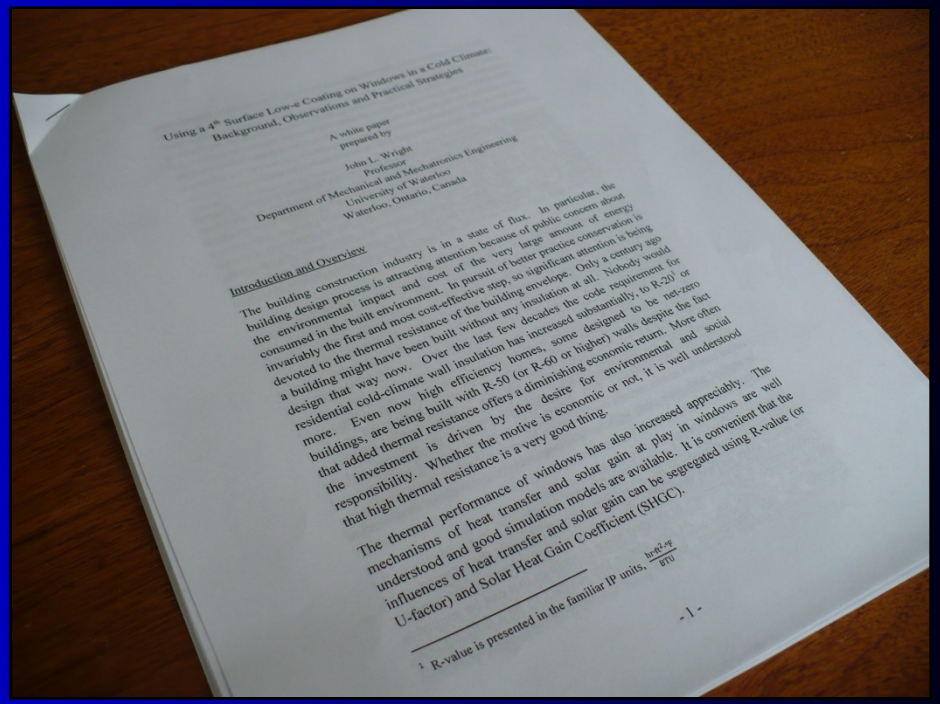
Topics of Interest

- a white paper* ⟶
- center-glass condensation resistance
- bottom-edge condensation resistance



Using a 4th Surface Low-e Coating on Windows in a Cold Climate:
Background, Observations and Practical Strategies

A white paper
prepared by

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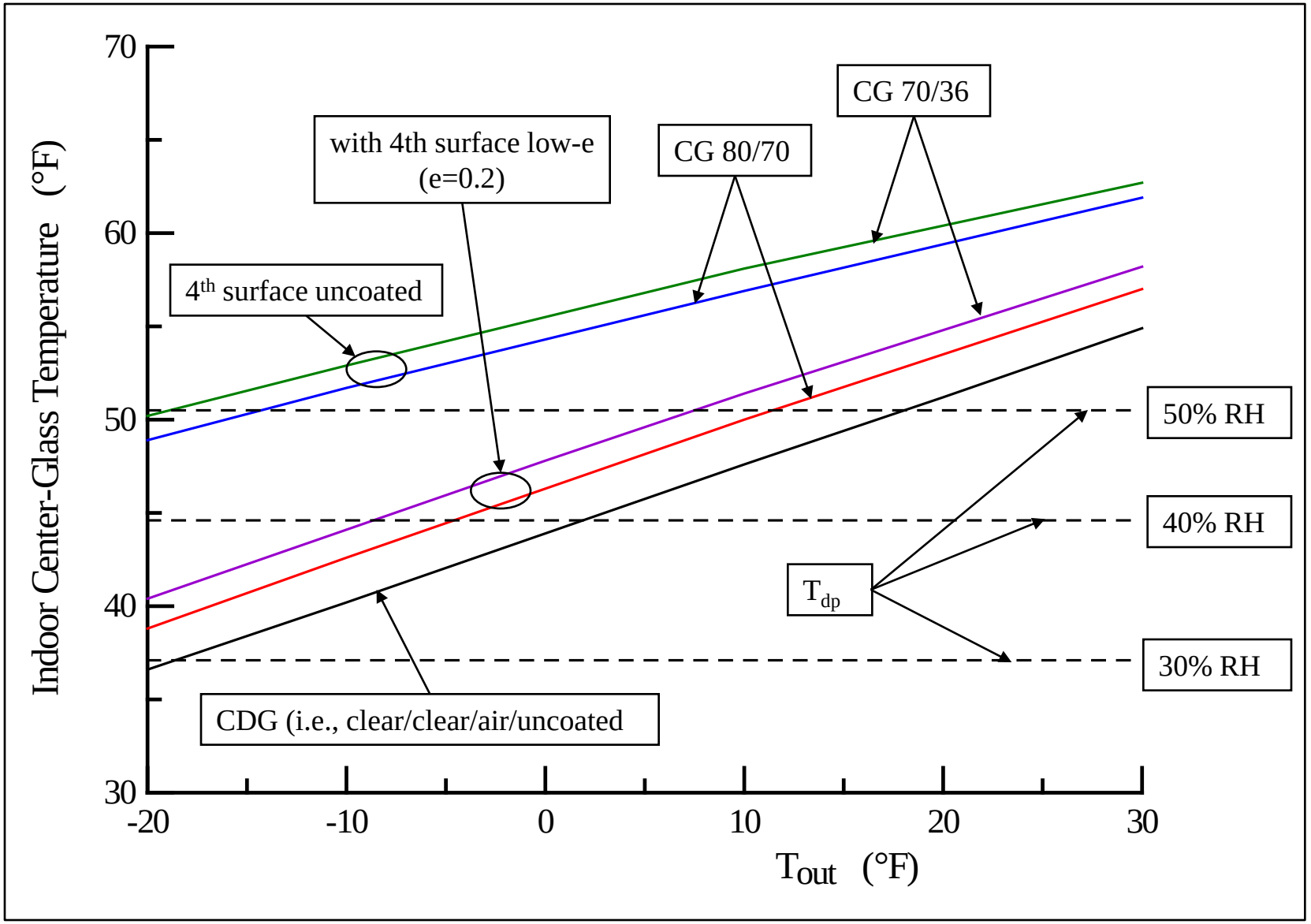
Introduction and Overview

The building construction industry is in a state of flux. In particular, the building design process is attracting attention because of public concern about the environmental impact and cost of the very large amount of energy consumed in the built environment. In pursuit of better practice conservation is invariably the first and most cost-effective step, so significant attention is being devoted to the thermal resistance of the building envelope. Only a century ago a building might have been built without any insulation at all. Nobody would design that way now. Over the last few decades the code requirement for residential cold-climate wall insulation has increased substantially, to R-20[1] or more. Even now high efficiency homes, some designed to be net-zero buildings, are being built with R-50 (or R-60 or higher) walls despite the fact that added thermal resistance offers a diminishing economic return. More often the investment is driven by the desire for environmental and social responsibility. Whether the motive is economic or not, it is well understood that high thermal resistance is a very good thing.

The thermal performance of windows has also increased appreciably. The mechanisms of heat transfer and solar gain at play in windows are well understood and good simulation models are available. It is convenient that the influences of heat transfer and solar gain can be segregated using R-value (or U-factor) and Solar Heat Gain Coefficient (SHGC).

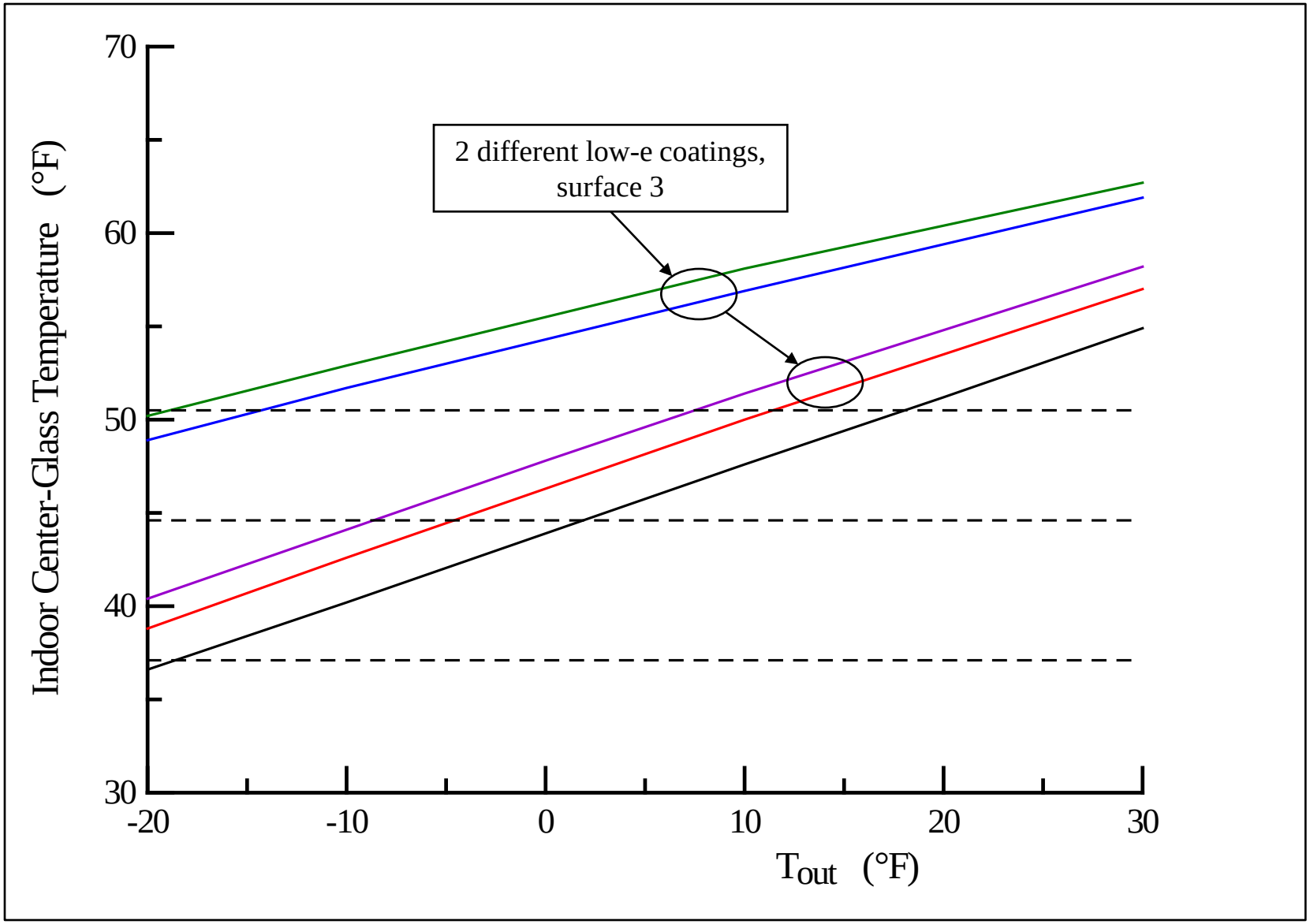
[1] R-value is presented in the familiar IP units, $\frac{hr\,ft^2\,{}^\circ F}{Btu}$

* Wright, J.L., Using 4th Surface Low-e Coating on Windows in a Cold Climate: Background, Observations and Practical Strategies, a white paper (2012) 21 pgs.

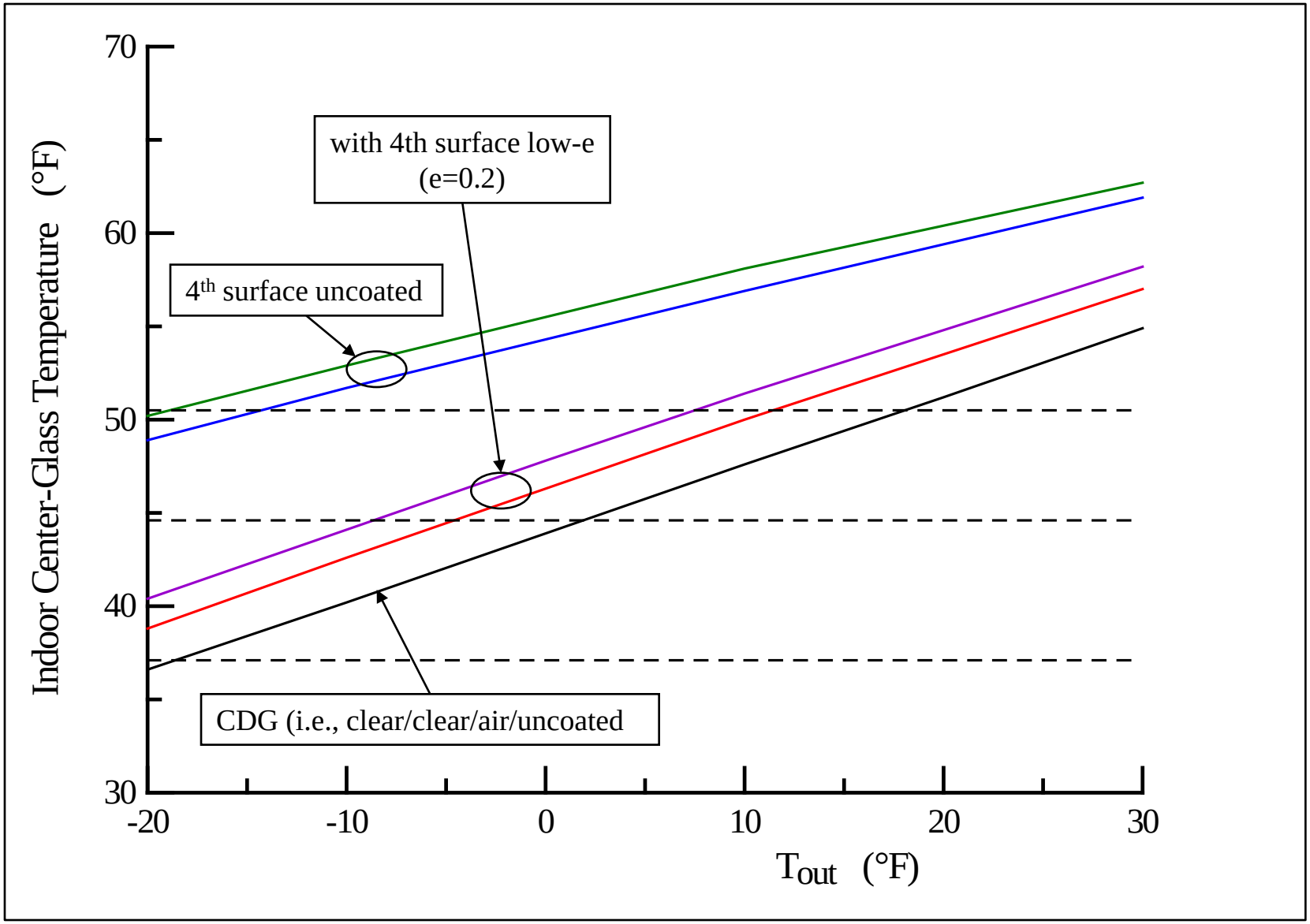


Double Glazed - T_{cg} versus T_{out}, with/without low-e coating(s)

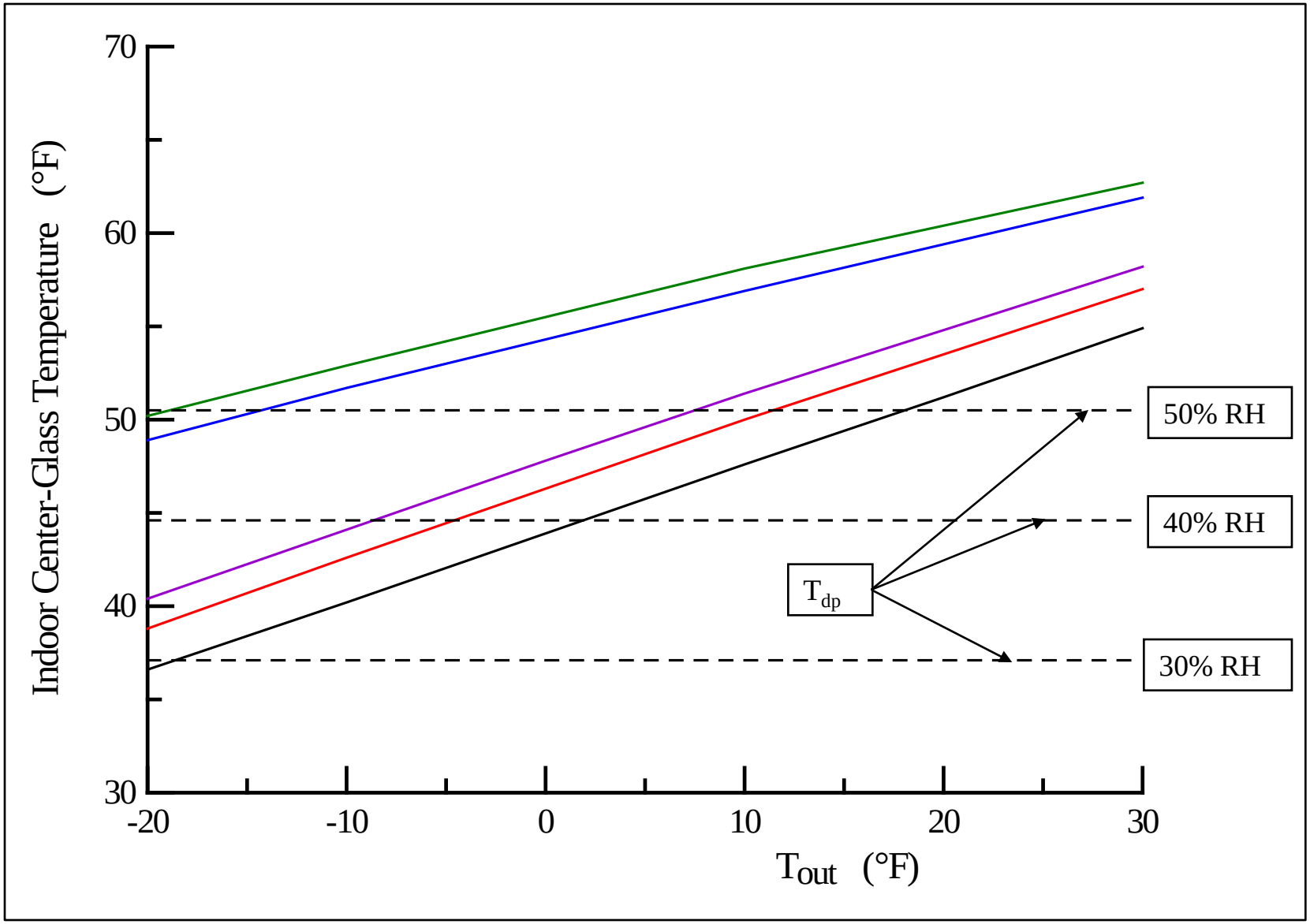
Chart taken from: Wright, J.L., Using 4th Surface Low-e Coating on Windows in a Cold Climate: Background, Observations and Practical Strategies, a white paper (2012) 21 pgs.
Data generated using: VISION 5.1



Double Glazed - T_{cg} versus T_{out}, with/without low-e coating(s)



Double Glazed - T_{cg} versus T_{out}, with/without low-e coating(s)

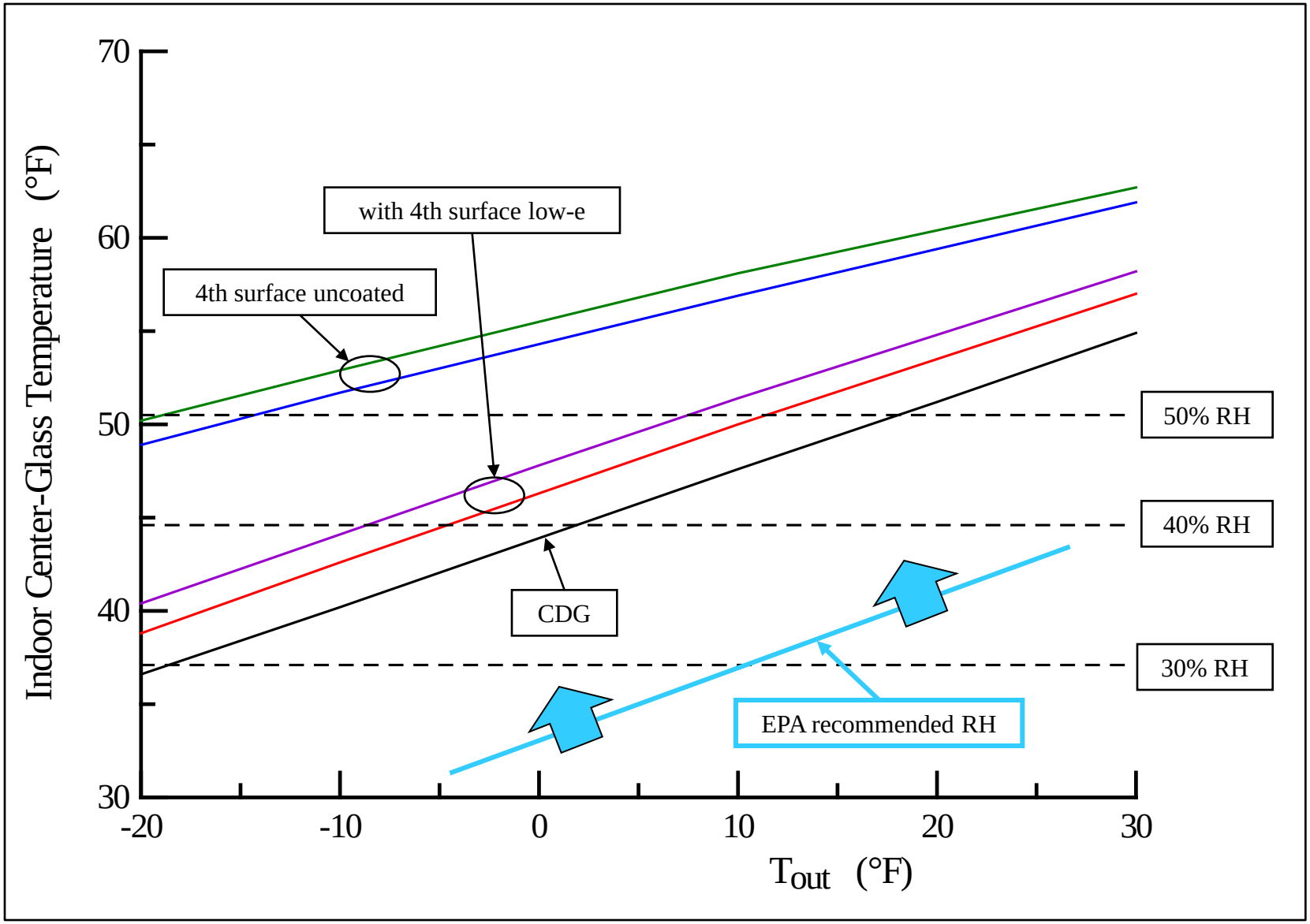


Double Glazed - T_{cg} versus T_{out}, with/without low-e coating(s)

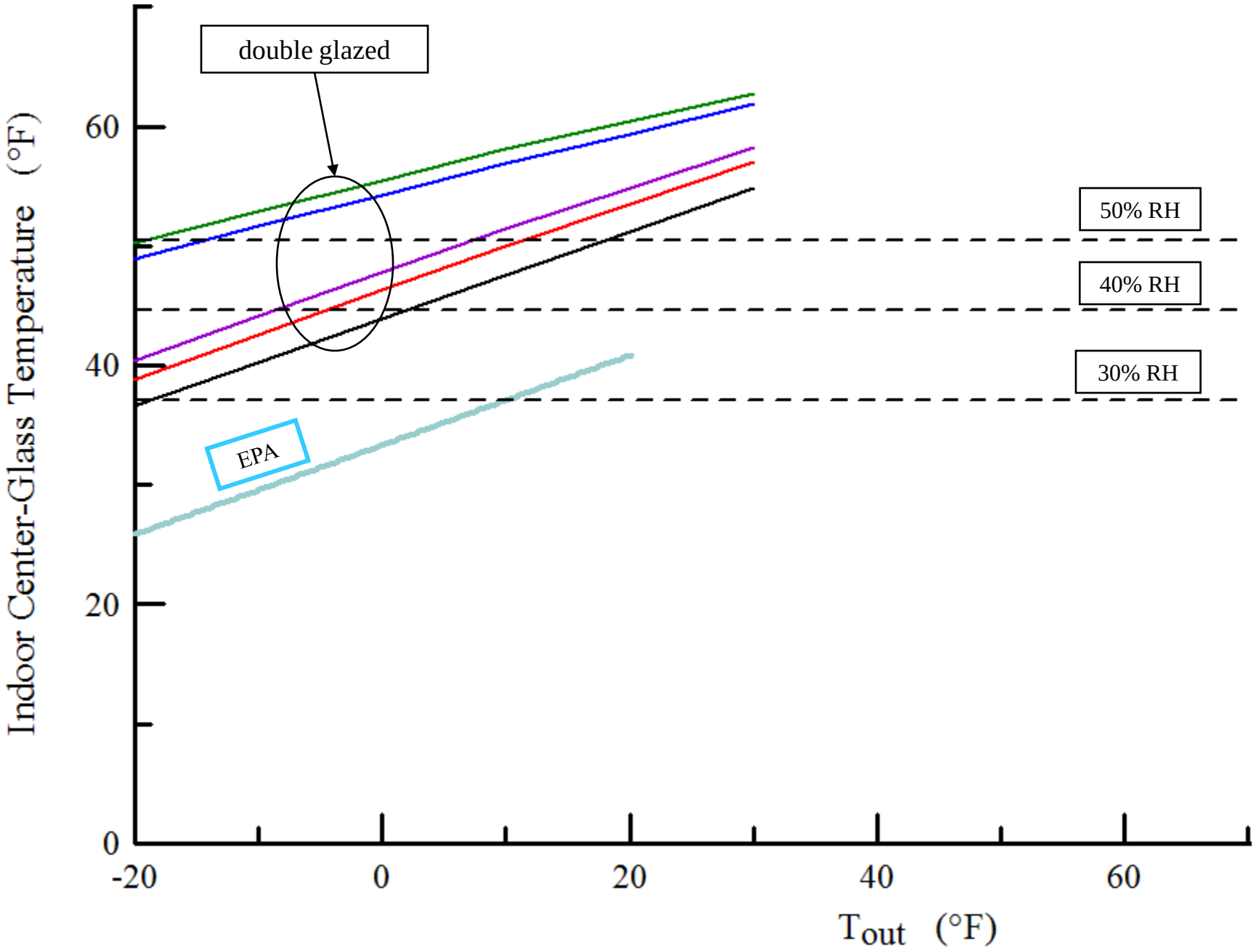
EPA Recommenced RH

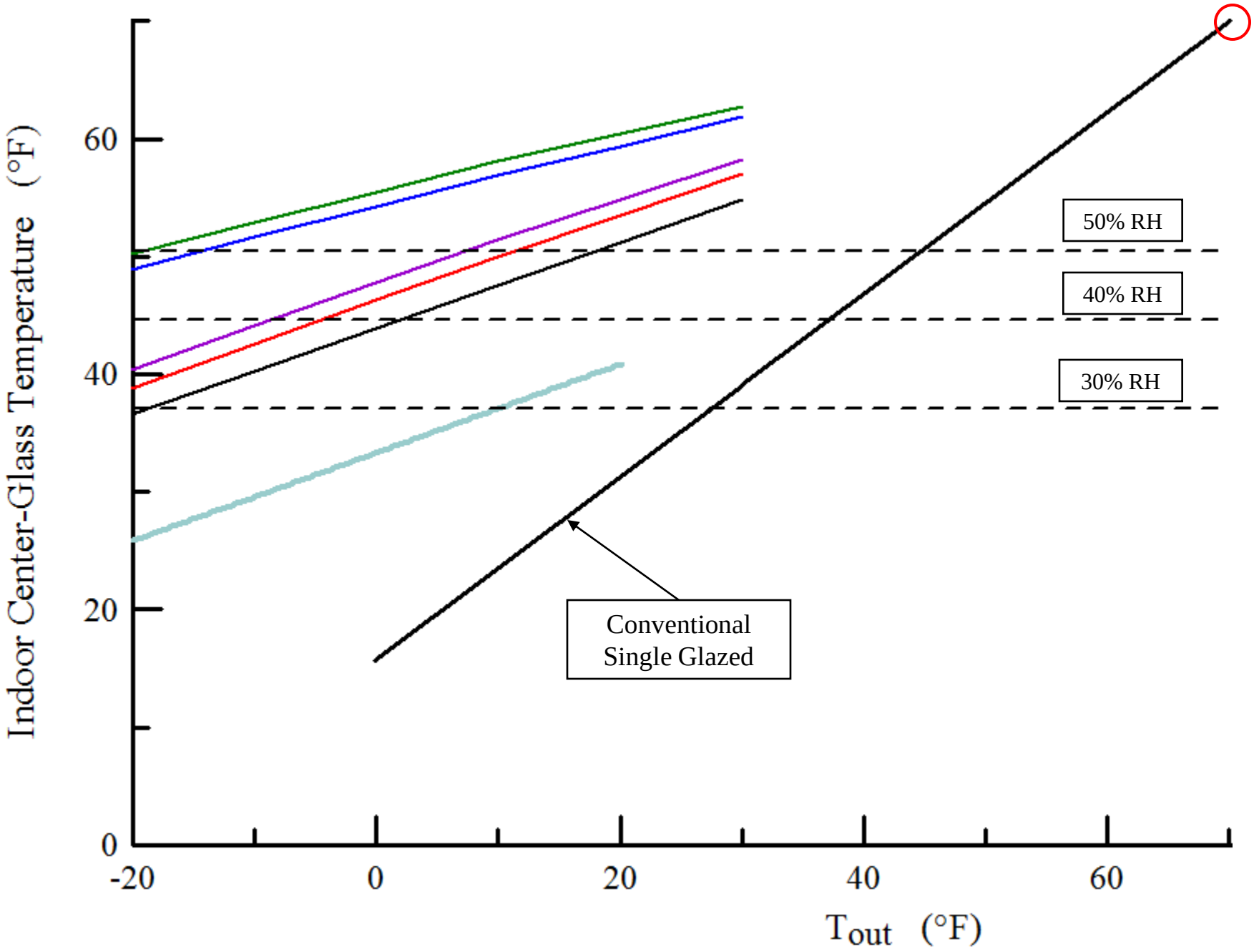
Temperature Outdoors	Indoor Relative Humidity
20 F	35%
10 F	30%
0 F	25%
-10 F	20%
-20 F	15%

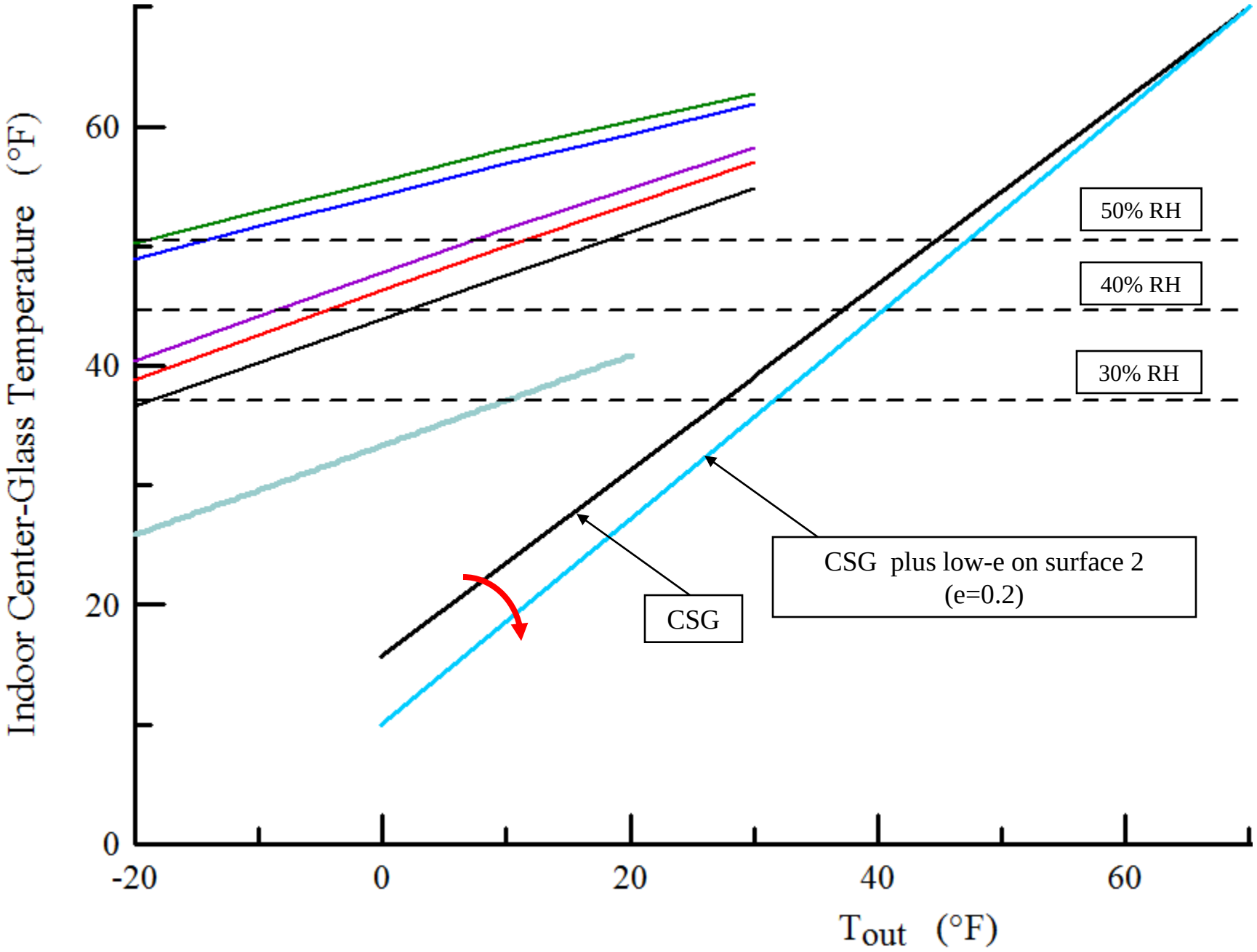
taken from: http://www.epa.gov/mold/moldresources.html

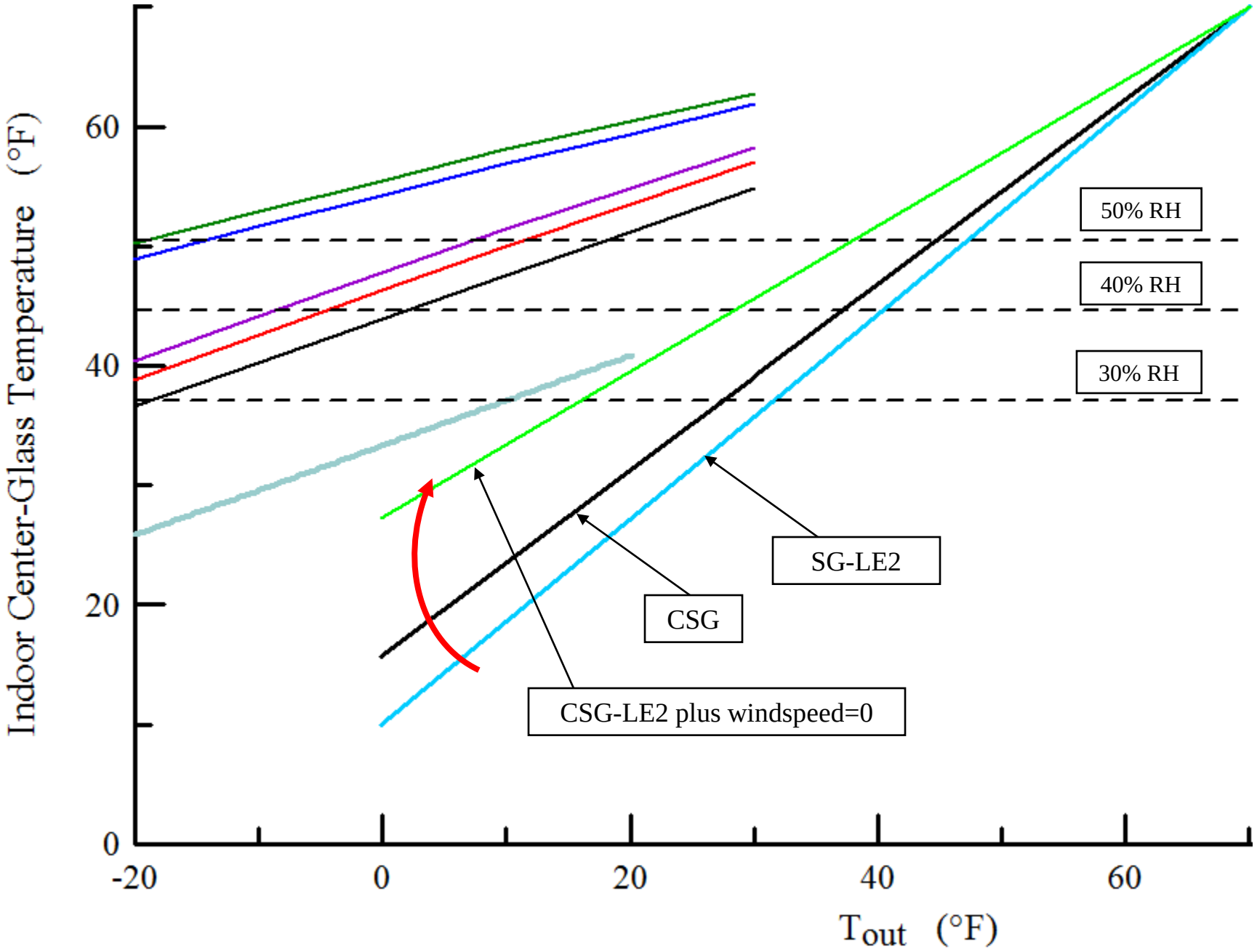


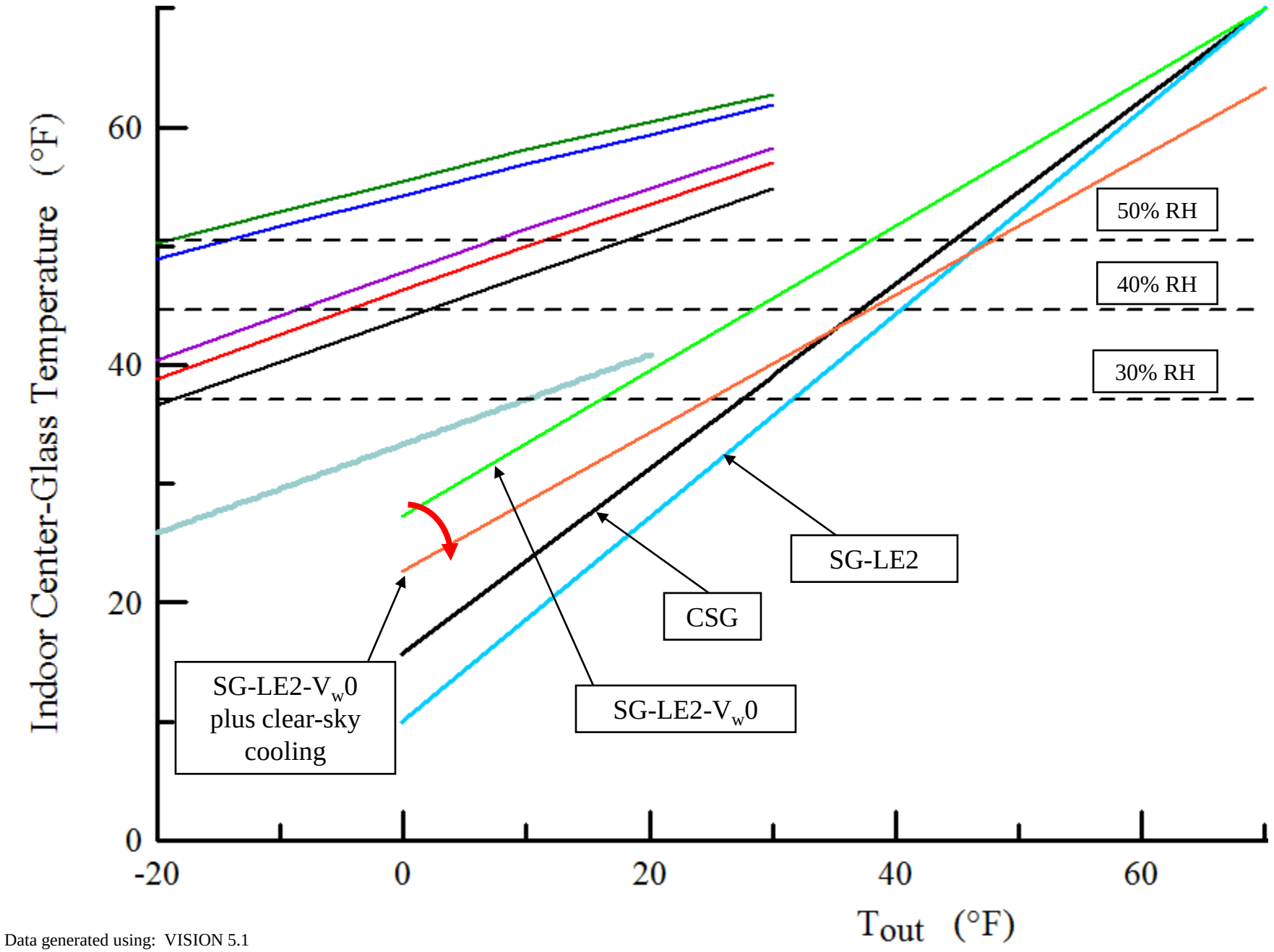
Double Glazed - T_{cg} versus T_{out}, with/without low-e coating(s)


double glazed
50% RH
40% RH
30% RH
EPA
Indoor Center-Glass Temperature (°F)
60
40
20
0
-20
0
20
40
60
Tout (°F)


Indoor Center-Glass Temperature (°F)
60
40
20
0
-20
0
20
40
60
Tout (°F)
50% RH
40% RH
30% RH
Conventional
Single Glazed


Indoor Center-Glass Temperature (°F)
60
40
20
0
-20
0
20
40
60
Tout (°F)
50% RH
40% RH
30% RH
CSG plus low-e on surface 2
(e=0.2)
CSG


Indoor Center-Glass Temperature (°F)
60
40
20
0
-20
0
20
40
60
Tout (°F)
50% RH
40% RH
30% RH
SG-LE2
CSG
CSG-LE2 plus windspeed=0



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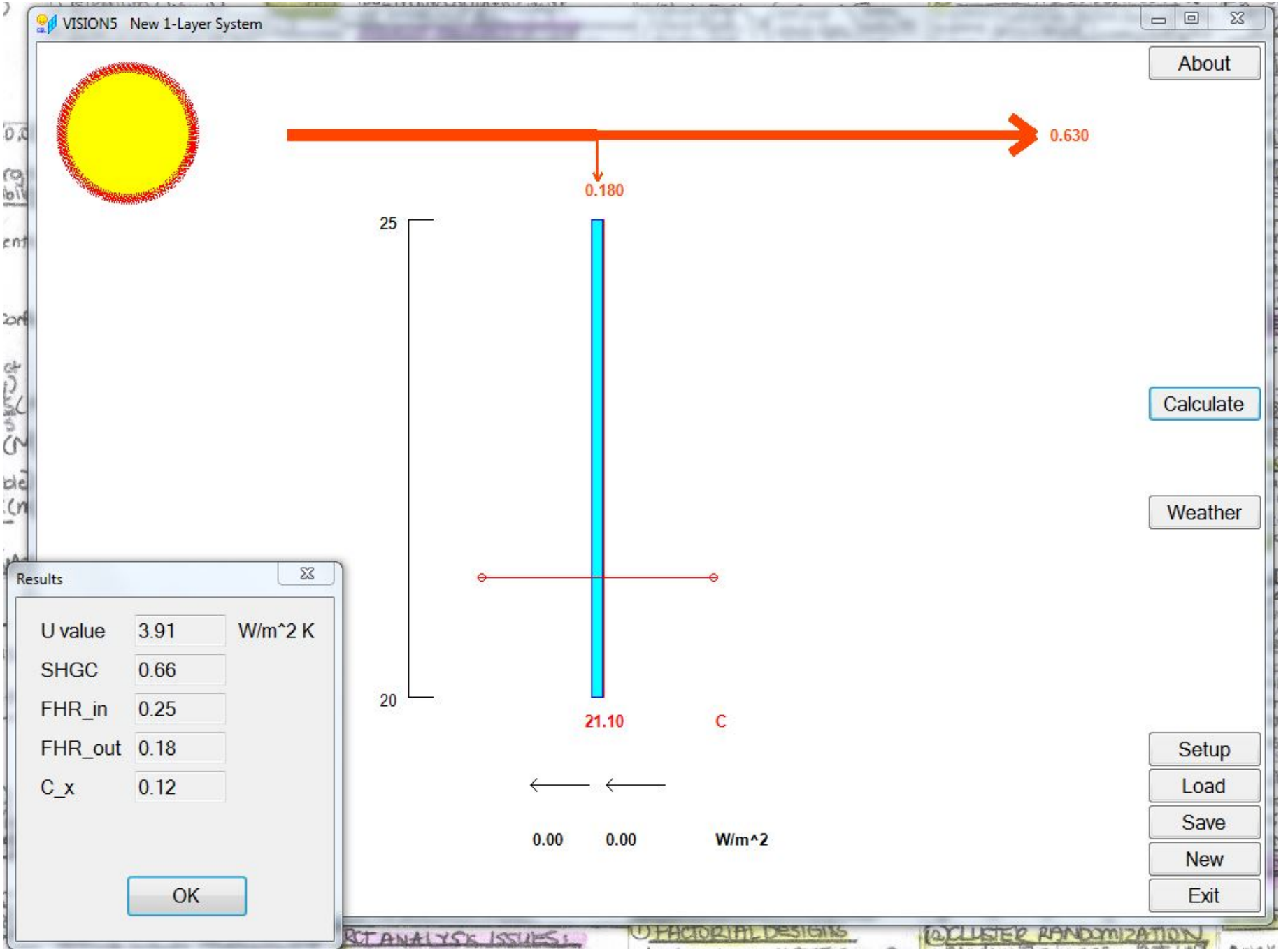
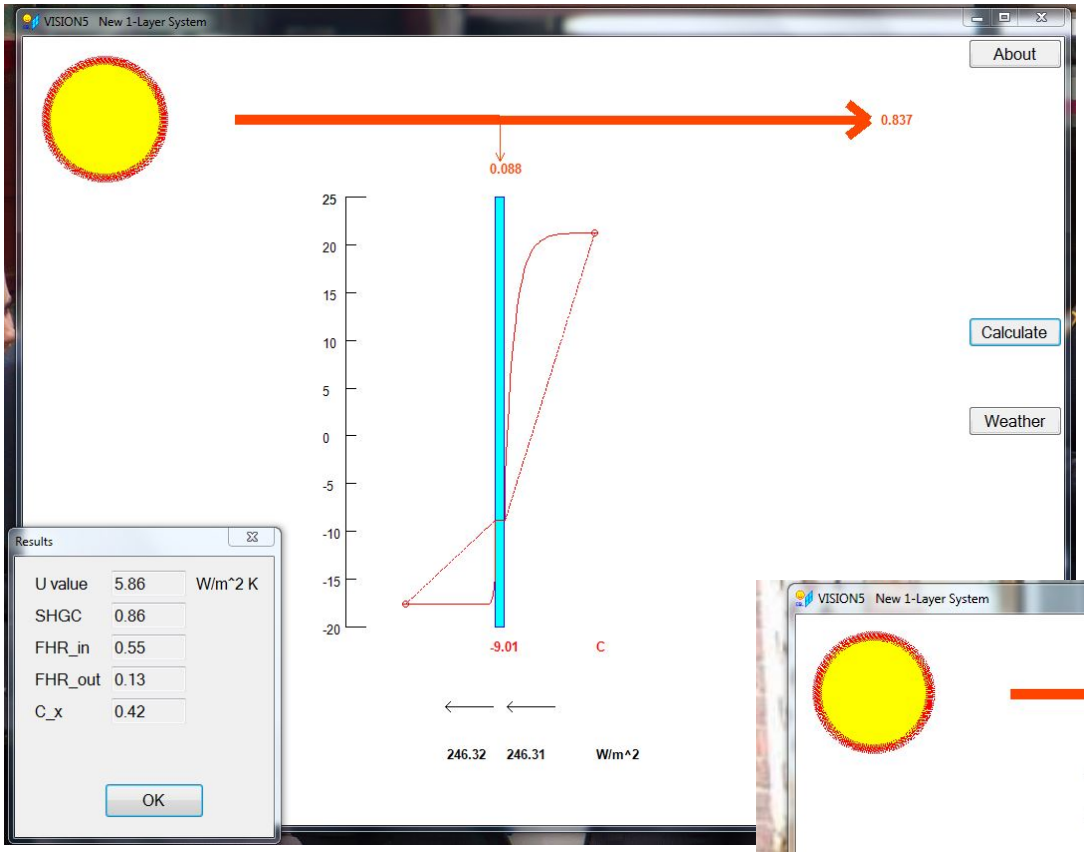
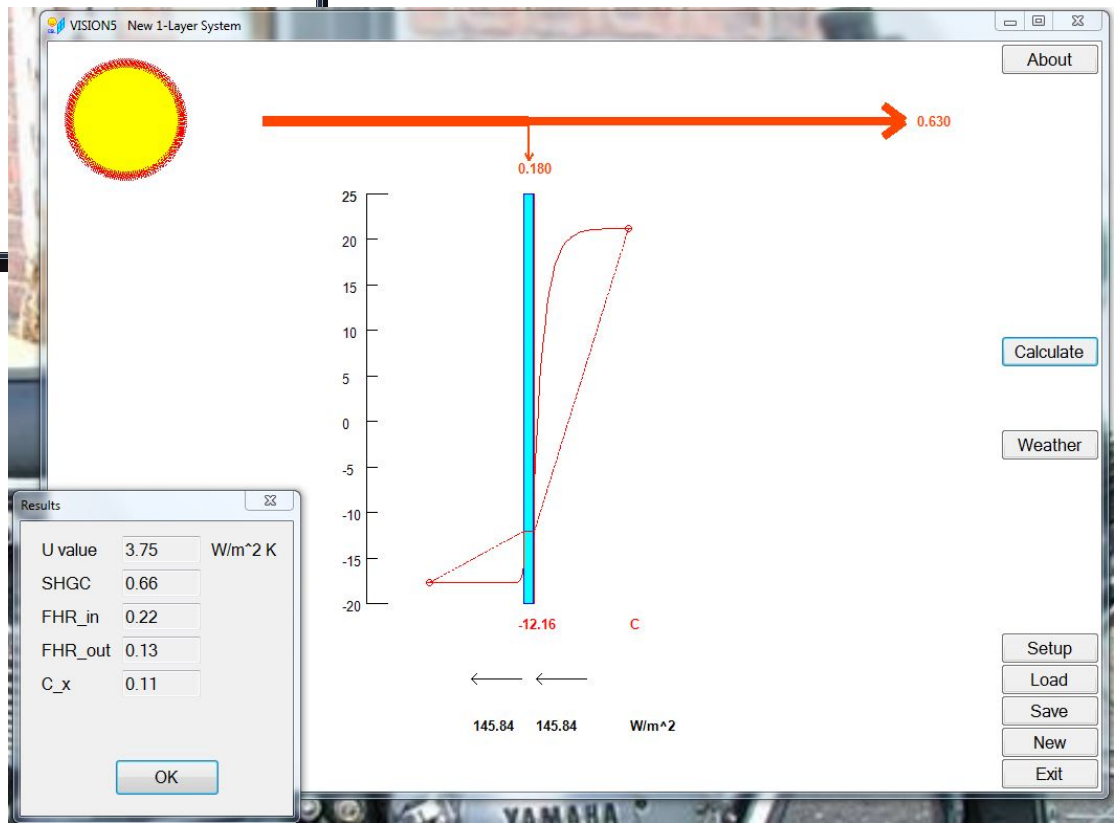


Screen capture: VISION 5.1

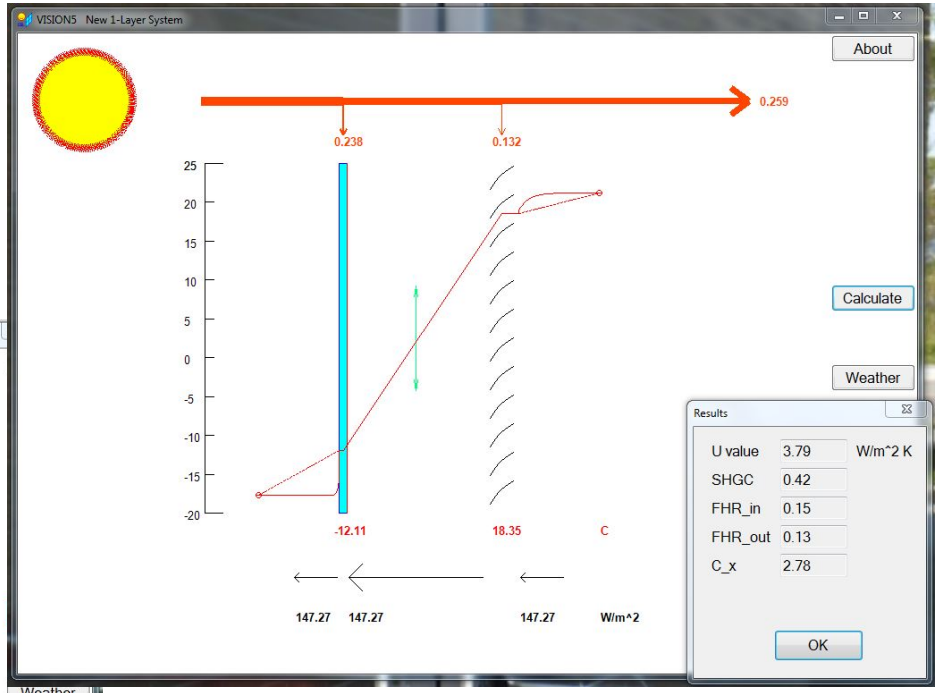


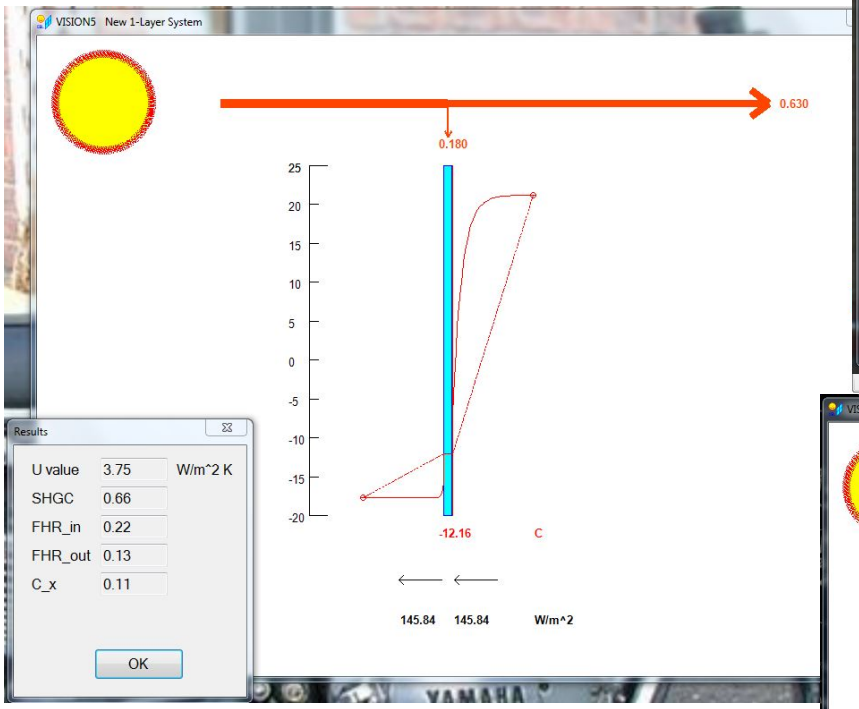
add low-e



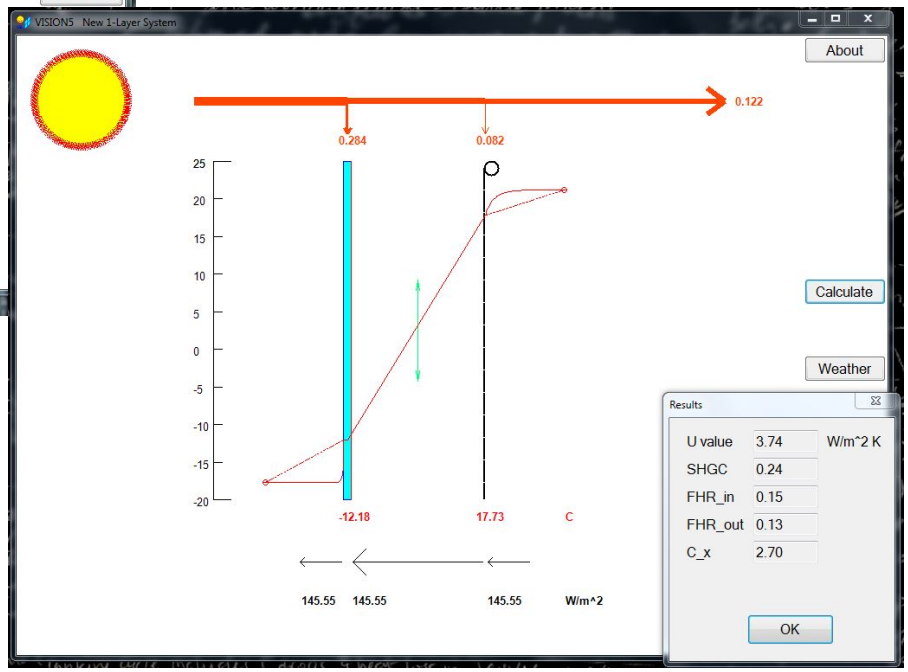
Screen captures: VISION 5.1

add venetian blind



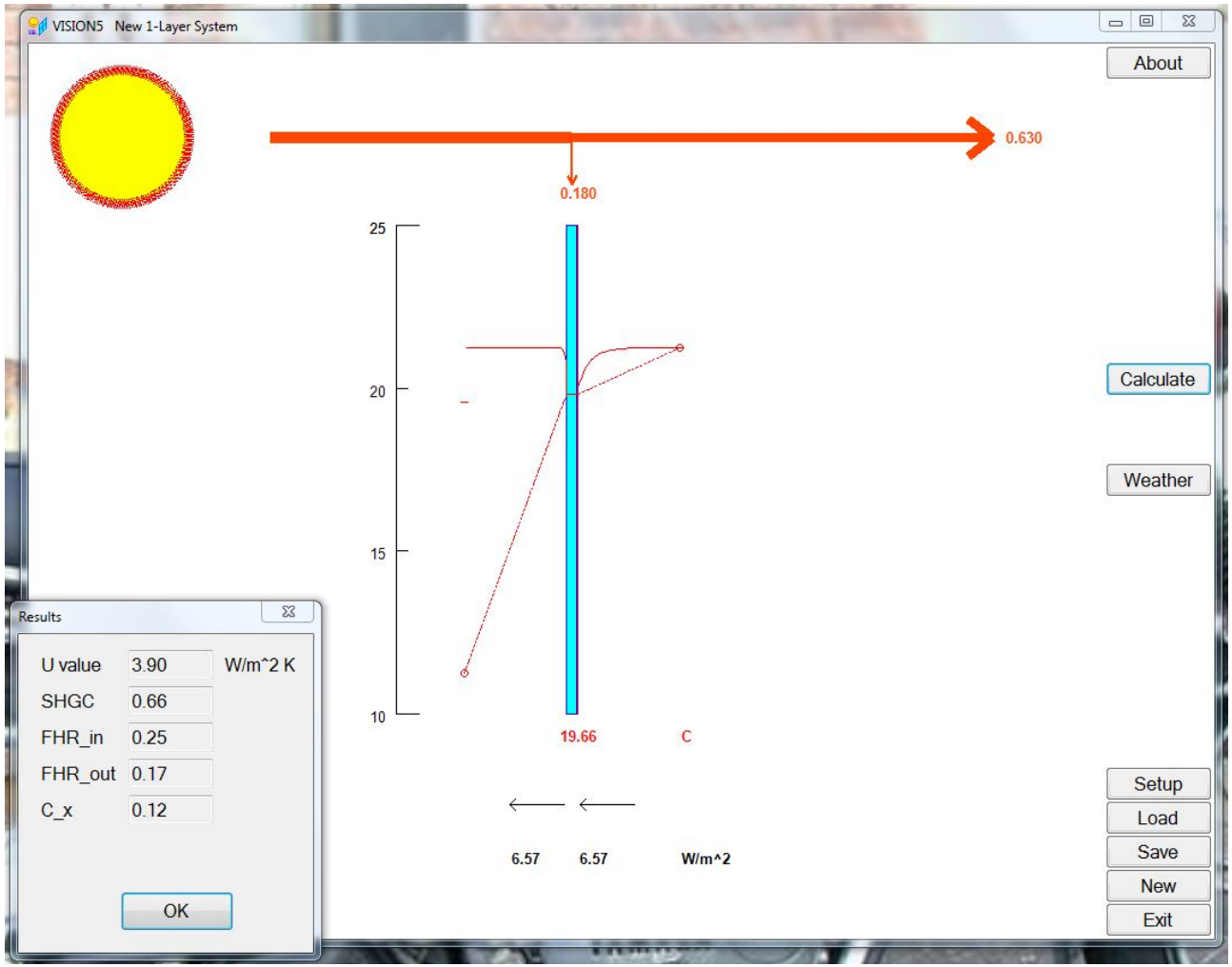


add roller blind

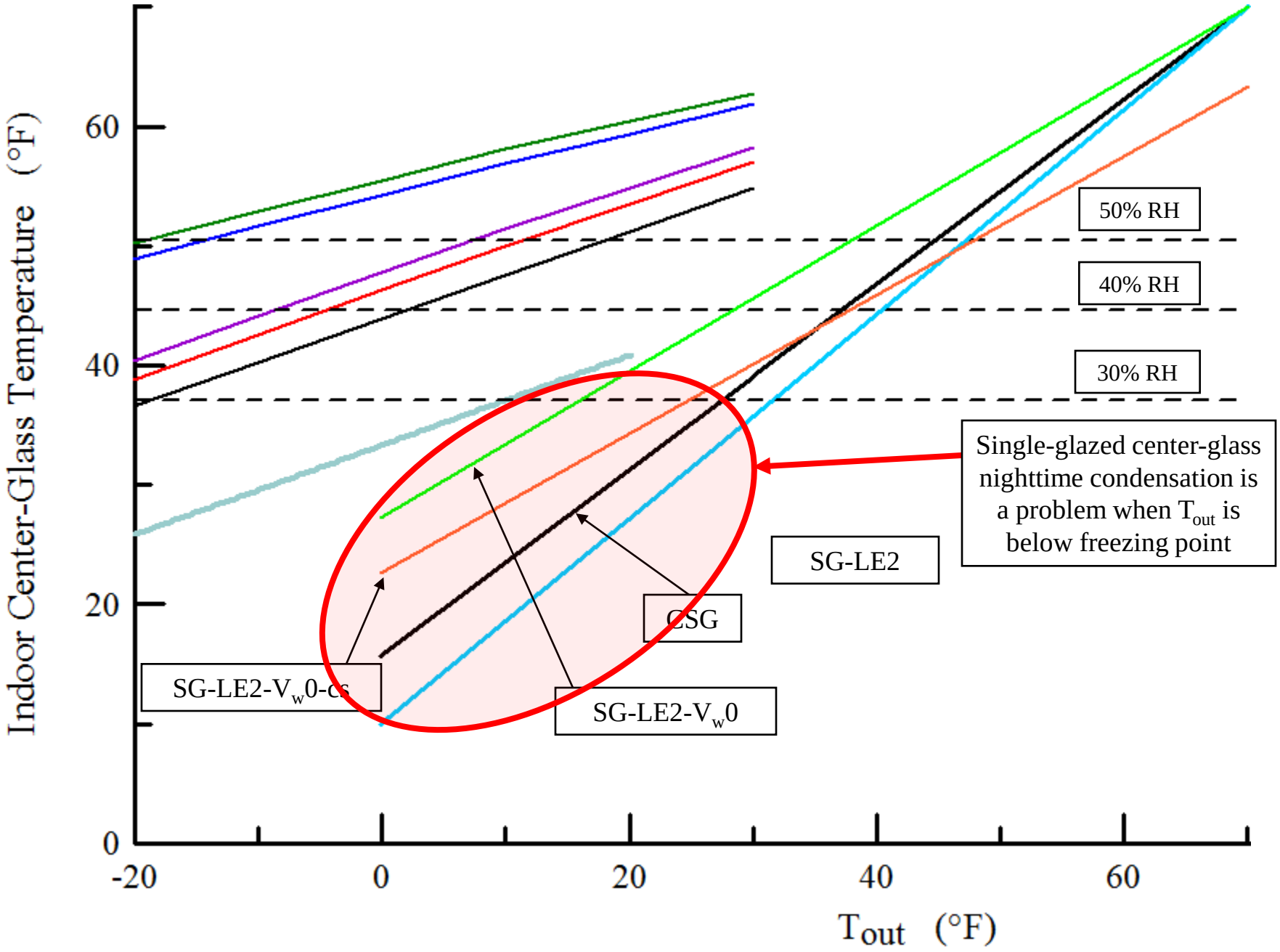


Screen captures: VISION 5.1

clear-sky cooling



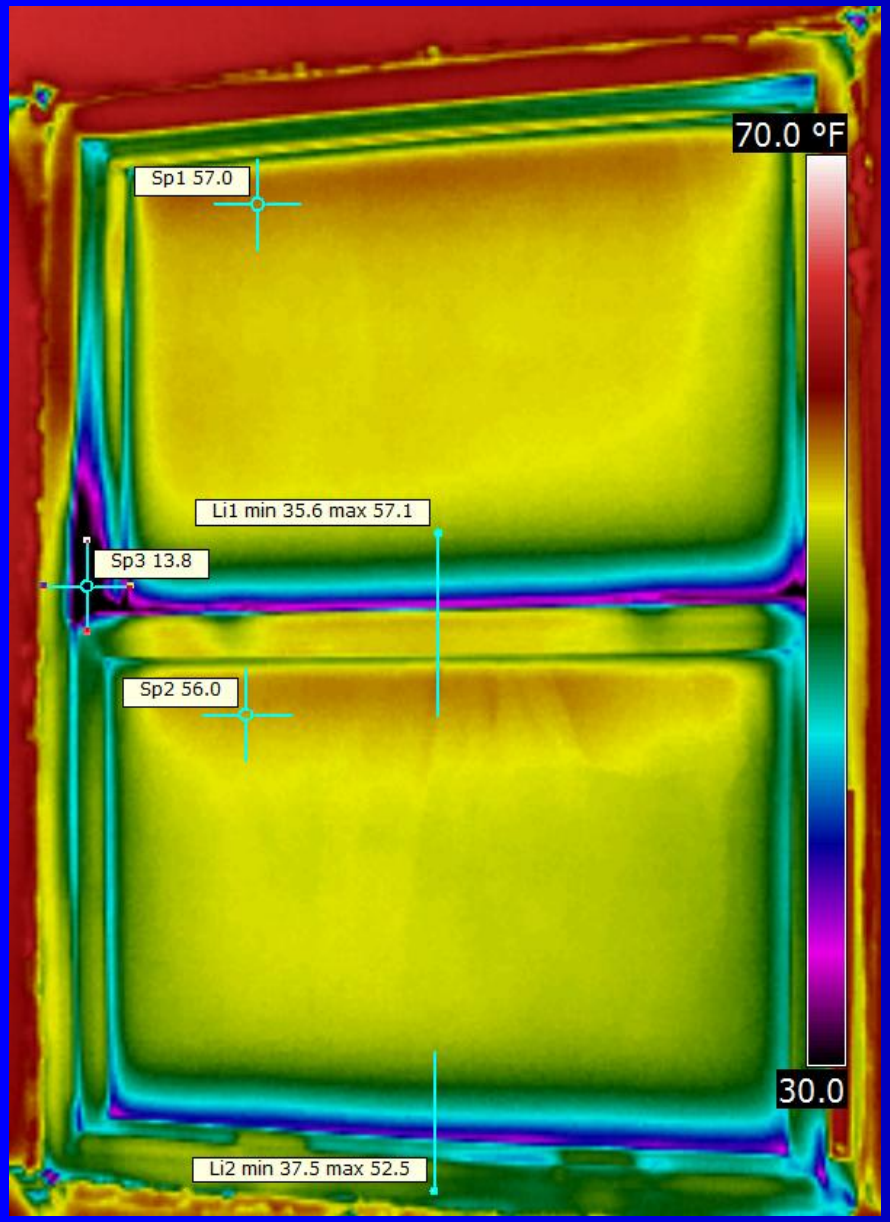
Screen capture: VISION 5.1


Indoor Center-Glass Temperature (°F)
60
40
20
0
-20
0
20
40
60
Tout (°F)
50% RH
40% RH
30% RH
Single-glazed center-glass nighttime condensation is a problem when Tout is below freezing point
SG-LE2
CSG
SG-LE2-Vw0-cs
SG-LE2-Vw0

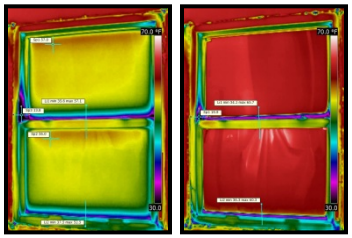
Bottom-edge condensation is caused by edge-seals, fill-gas flow, indoor backset, growth of indoor boundary layer, clear-sky cooling ...

doesn't apply to single glazing

Photo from: Wright, J.L., Using 4th Surface Low-e Coating on Windows in a Cold Climate: Background, Observations and Practical Strategies, a white paper (2012) 21 pgs.



Photos from: Wright, J.L., Using 4th Surface Low-e Coating on Windows in a Cold Climate: Background, Observations and Practical Strategies, a white paper (2012) 21 pgs.



30% RH | 40% | 50% | 60%

Double-glazed, double-hung, low-e/Ar windows, 2 edge-seal types: with/without 4th surface low-e (e=0.2)

low-e 80/70 surface 3

low-e on 4th surface

low-e 70/36 surface 2

4th surface uncoated

composite butyl spacers

U-channel spacers

sightline

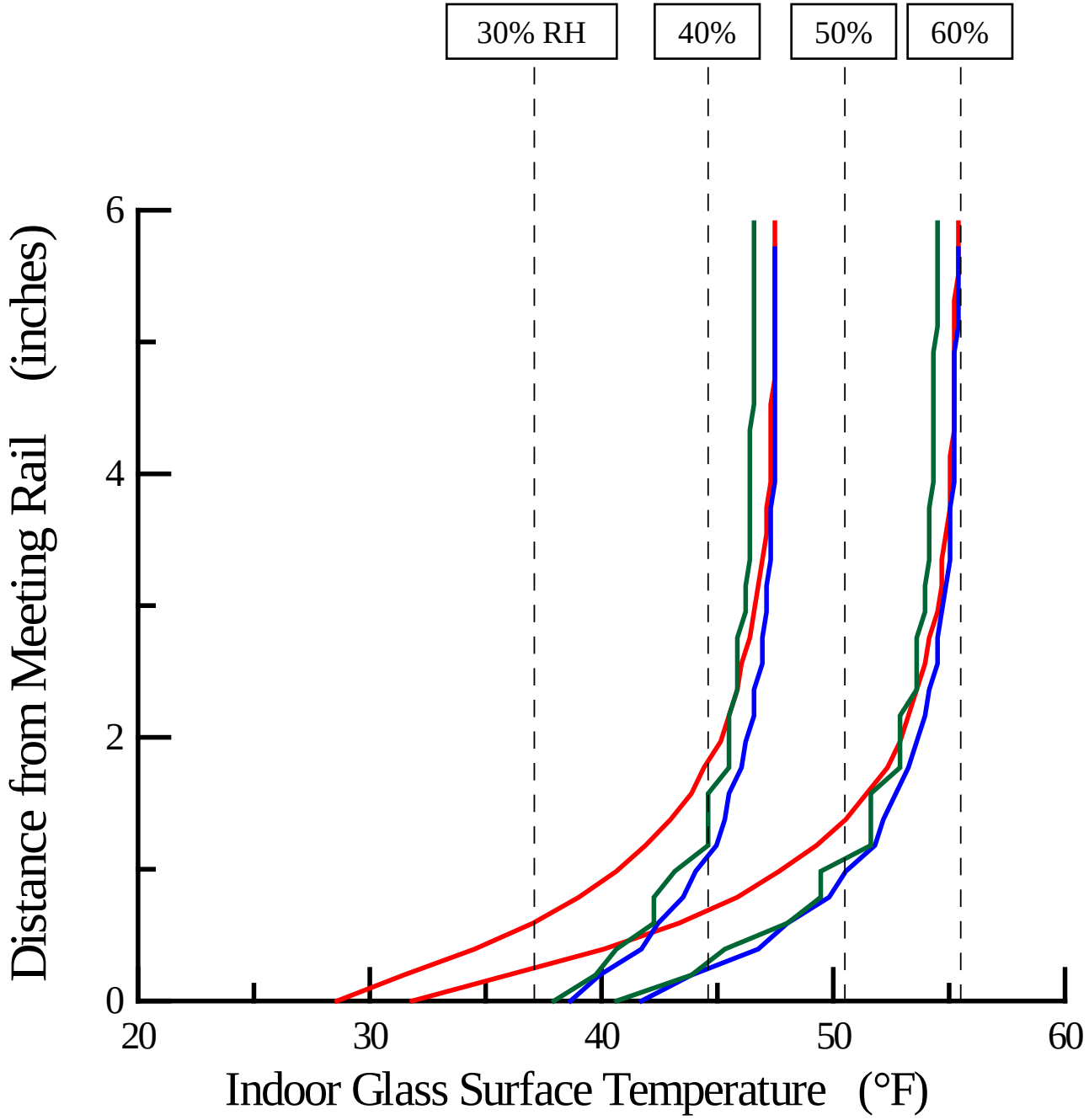
Distance from Meeting Rail (inches)

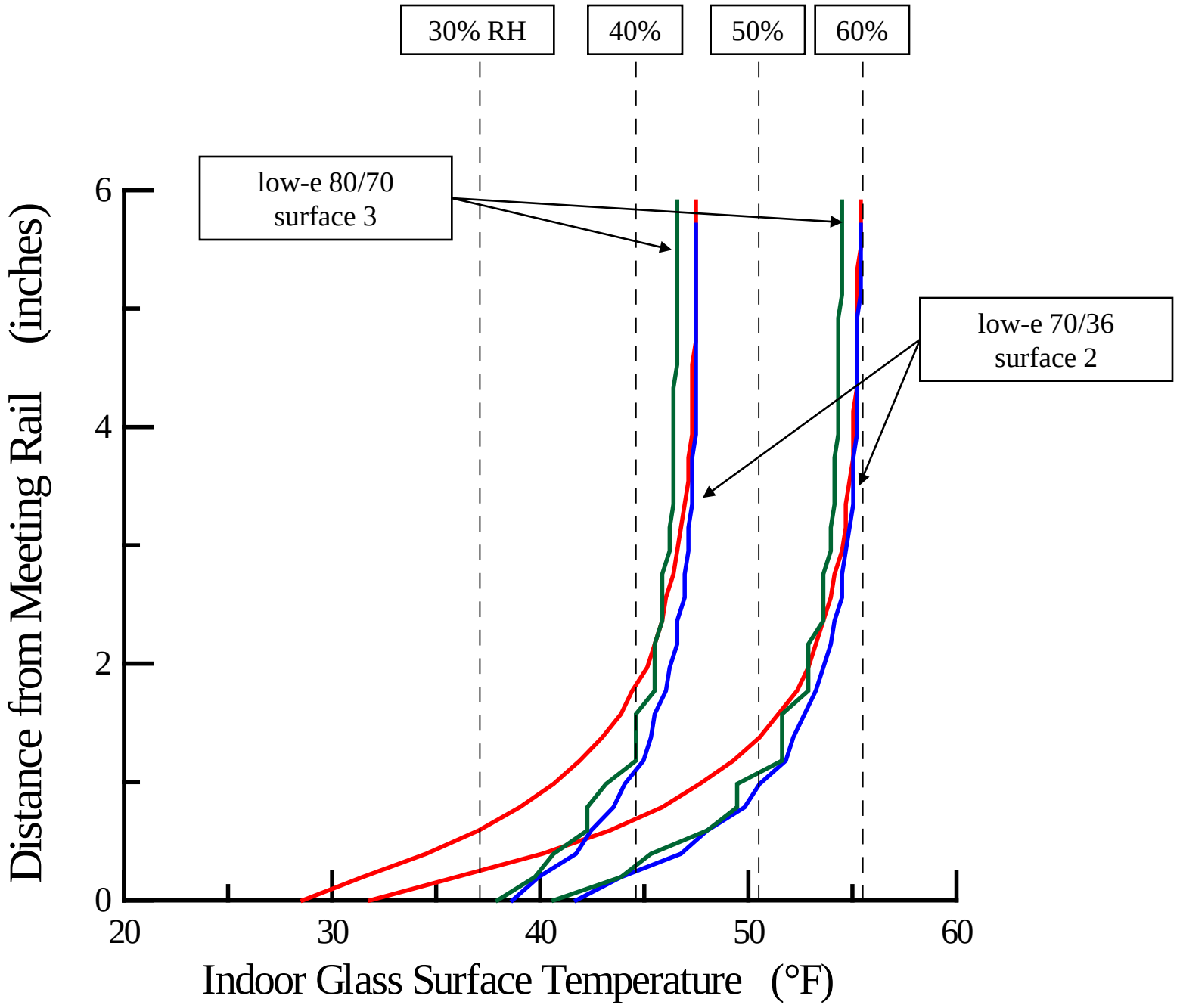
0 2 4 6

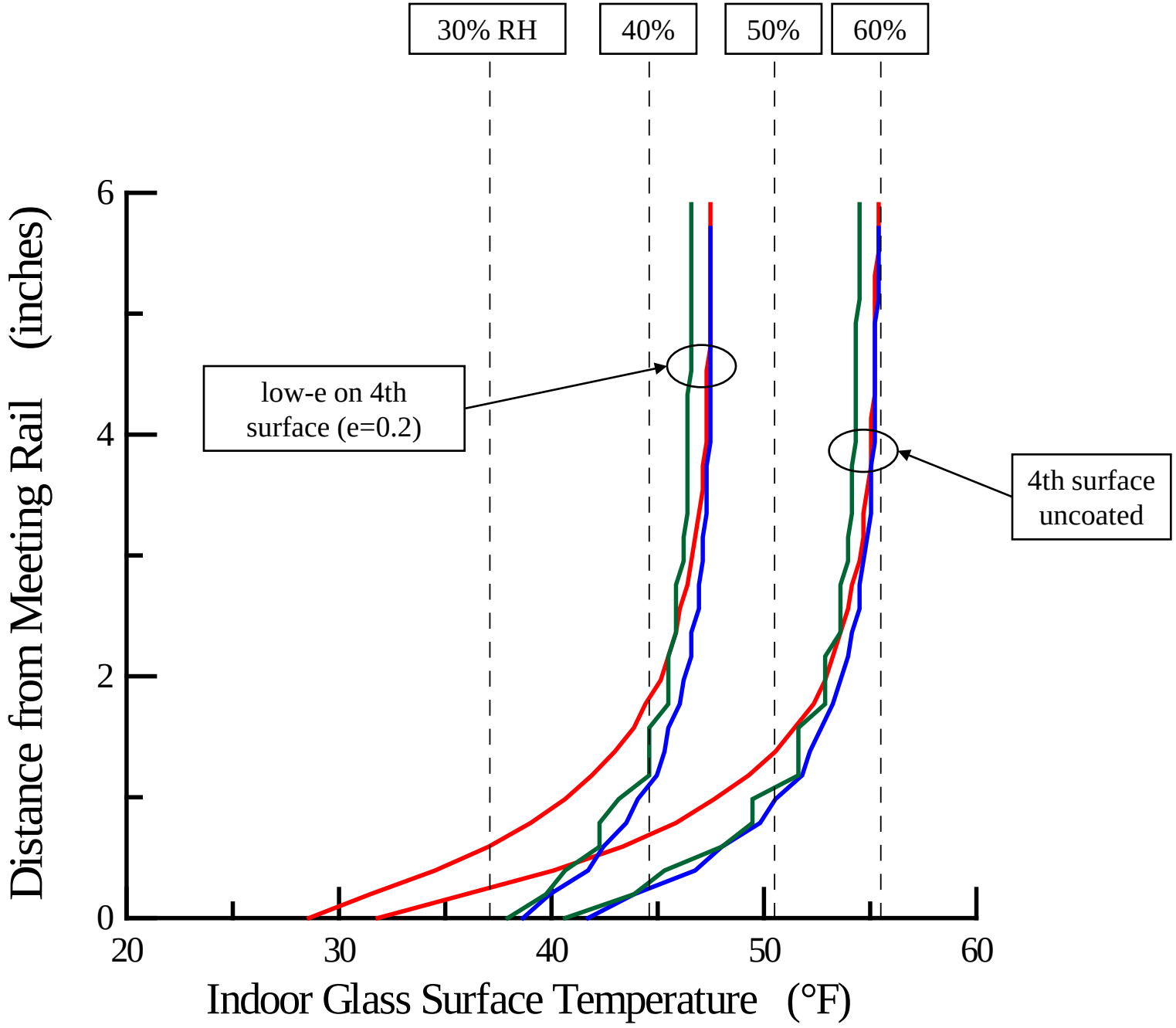
20 30 40 50 60

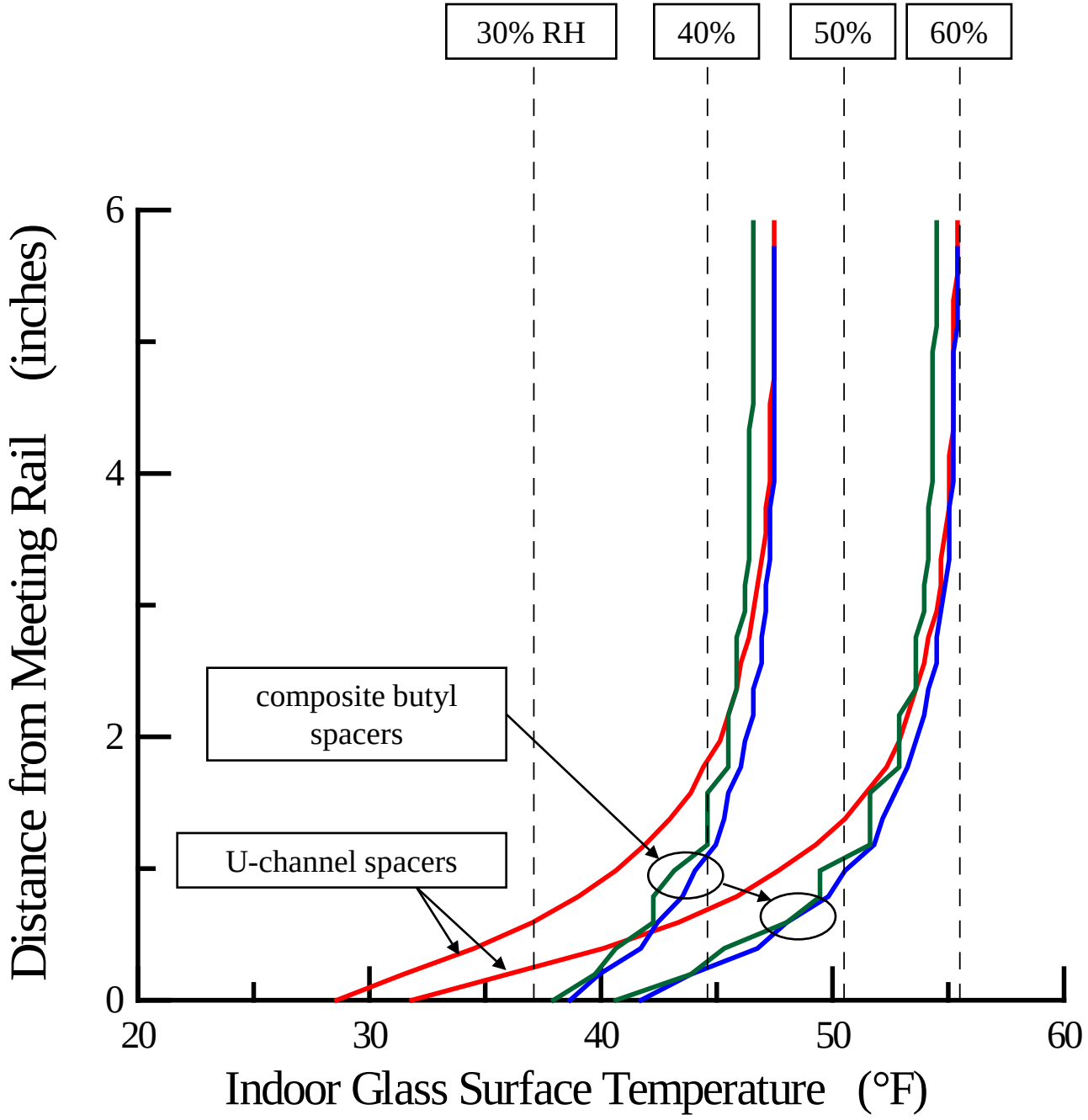
Indoor Glass Surface Temperature (°F)

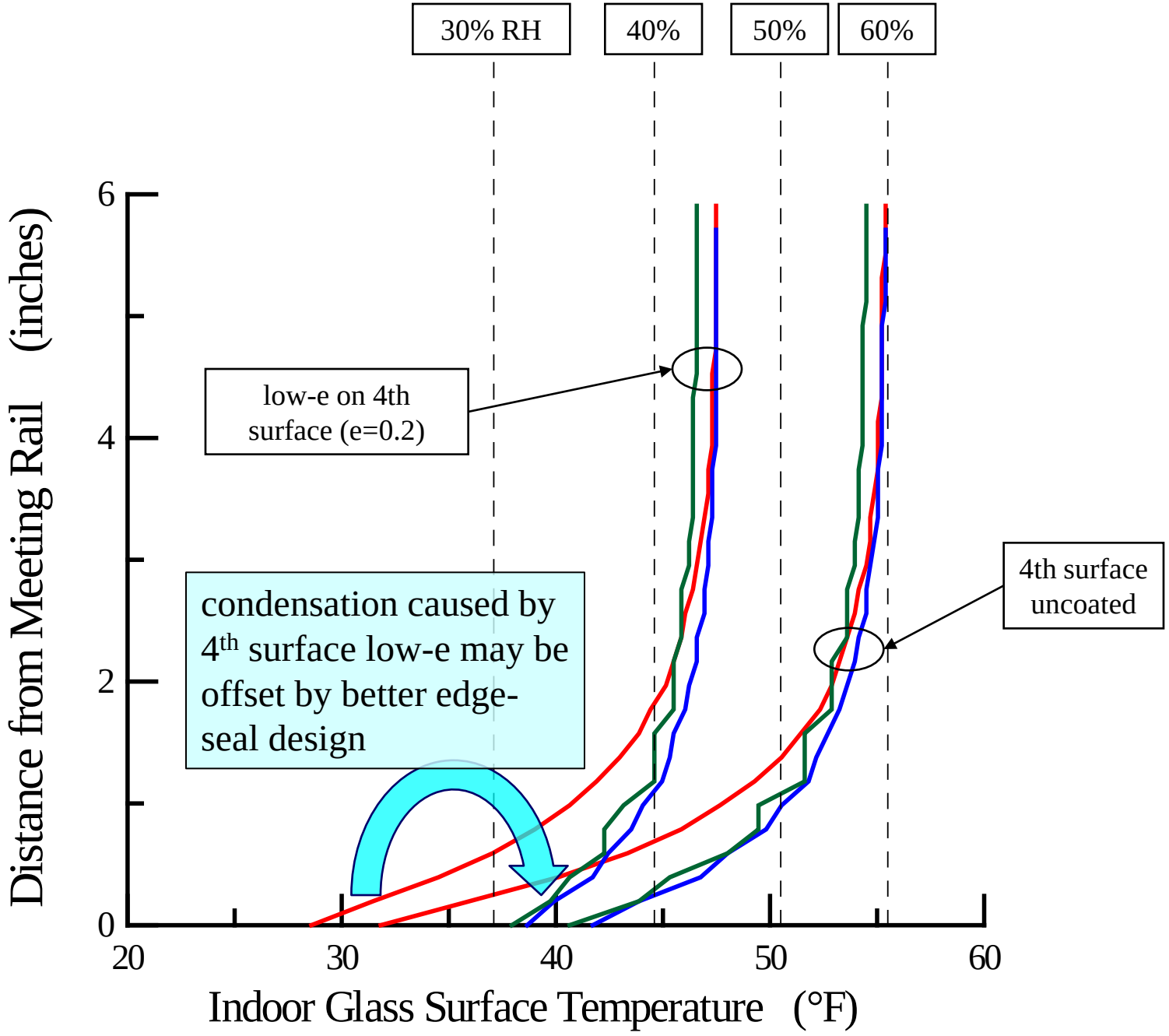
Chart: Wright, J.L., Using 4th Surface Low-e Coating on Windows in a Cold Climate: Background, Observations and Practical Strategies, a white paper (2012) 21 pgs. Data: Window/THERM, LBNL

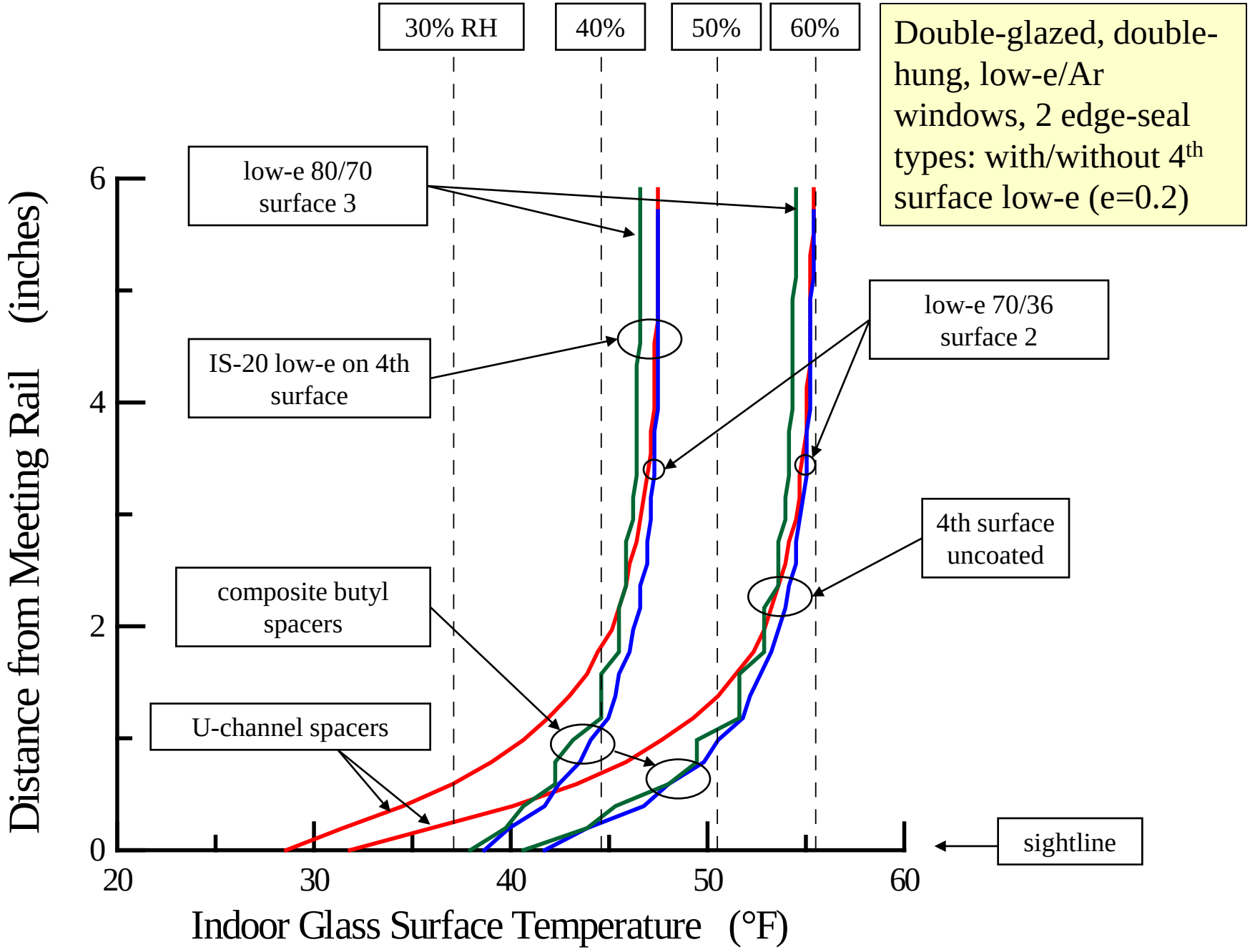

30% RH
40%
50%
60%
Distance from Meeting Rail (inches)
6
4
2
0
20
30
40
50
60
Indoor Glass Surface Temperature (°F)


30% RH
40%
50%
60%
low-e 80/70
surface 3
low-e 70/36
surface 2
Distance from Meeting Rail (inches)
0
2
4
6
20
30
40
50
60
Indoor Glass Surface Temperature (°F)


30% RH
40%
50%
60%
low-e on 4th surface (e=0.2)
4th surface uncoated
Distance from Meeting Rail (inches)
0
2
4
6
20
30
40
50
60
Indoor Glass Surface Temperature (°F)


30% RH
40%
50%
60%
6
4
2
0
Distance from Meeting Rail (inches)
composite butyl spacers
U-channel spacers
20
30
40
50
60
Indoor Glass Surface Temperature (°F)


30% RH
40%
50%
60%
low-e on 4th surface (e=0.2)
4th surface uncoated
condensation caused by 4th surface low-e may be offset by better edge-seal design
Distance from Meeting Rail (inches)
0
2
4
6
20
30
40
50
60
Indoor Glass Surface Temperature (°F)


30% RH
40%
50%
60%
Double-glazed, double-hung, low-e/Ar windows, 2 edge-seal types: with/without 4th surface low-e (e=0.2)
low-e 80/70 surface 3
low-e 70/36 surface 2
IS-20 low-e on 4th surface
4th surface uncoated
composite butyl spacers
U-channel spacers
sightline
Distance from Meeting Rail (inches)
0
2
4
6
20
30
40
50
60
Indoor Glass Surface Temperature (°F)

Observations

Indoor-surface low-e increases U-value, but for single-glazing,

a) U-value is sensitive to indoor surface convection coefficient, h_{in}
b) and indoor low-e will aggravate condensation problems
c) allowable indoor RH will be even more restricted

Centre-glass condensation will be a problem for single-glazing when $T_{out} < 32°F$

Center-glass condensation will

(a) negate the benefit of an indoor-surface low-e coating
(glass will warm up, U-value will increase if surface is wet)
(b) negate the thermal comfort benefit

Condensation will form most readily at the bottom sightline even though single-glazing has no edge-seal and no fill-gas motion

Simulation tools are available to assess the bottom-edge condensation resistance of single-glazing

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Questions ?