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# Windows and Occupant Comfort

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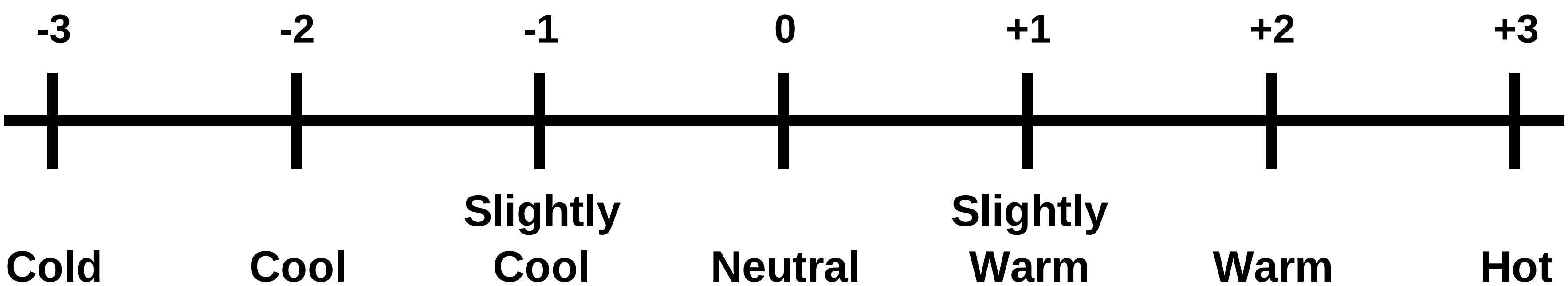
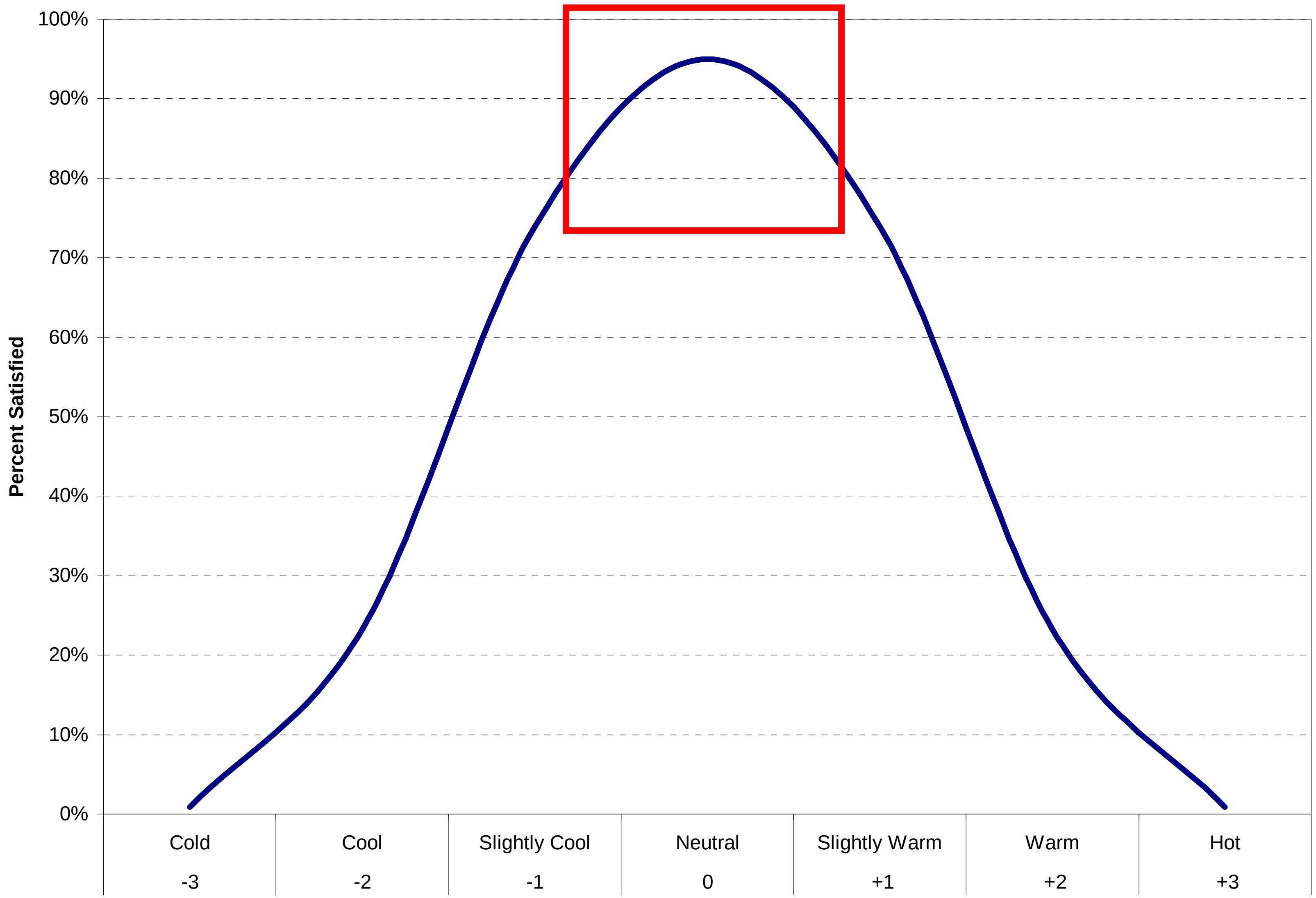
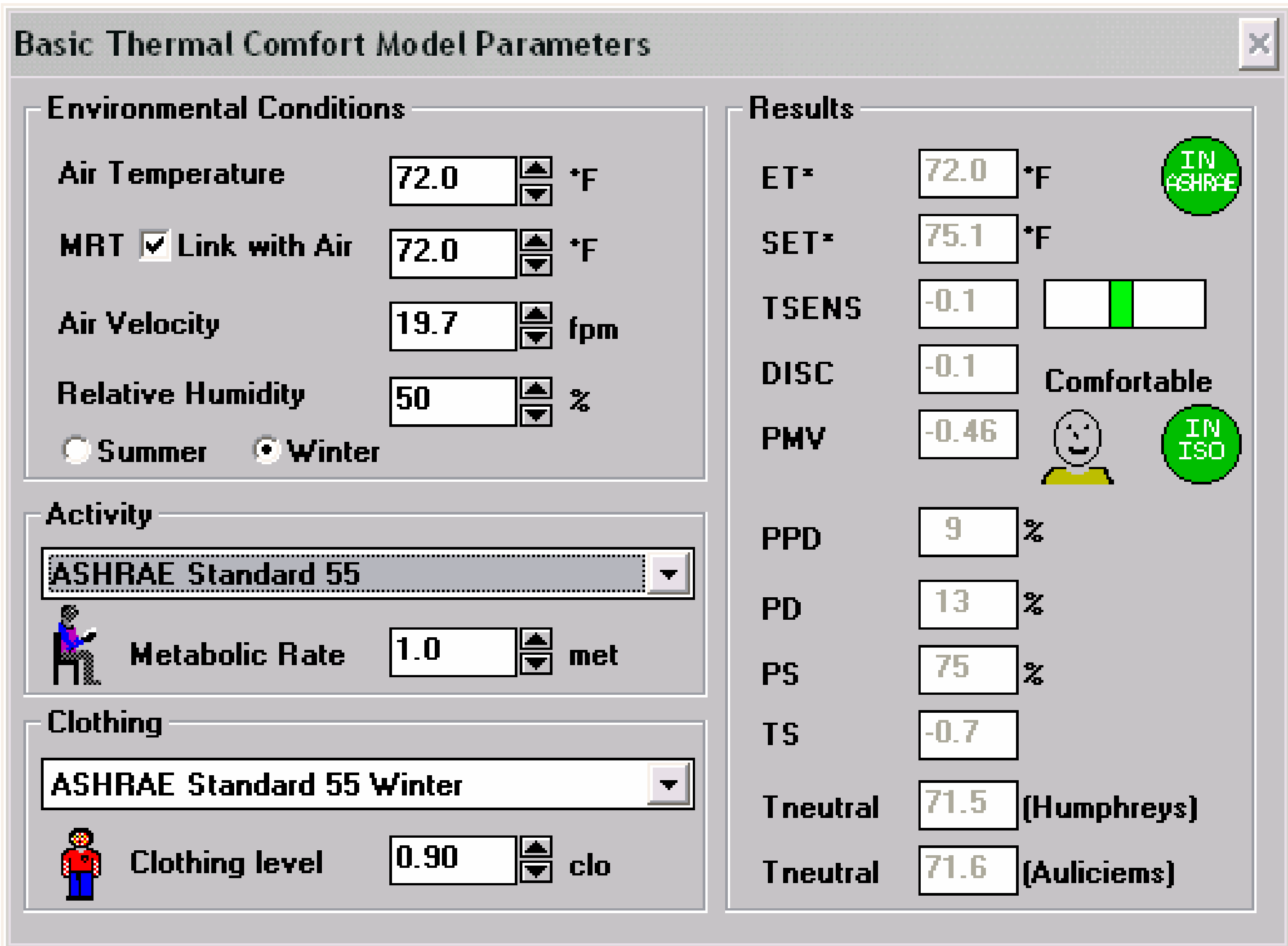
# The 7 Point Comfort Scale



# 80% Satisfaction Criteria



# The ASHRAE Comfort Program

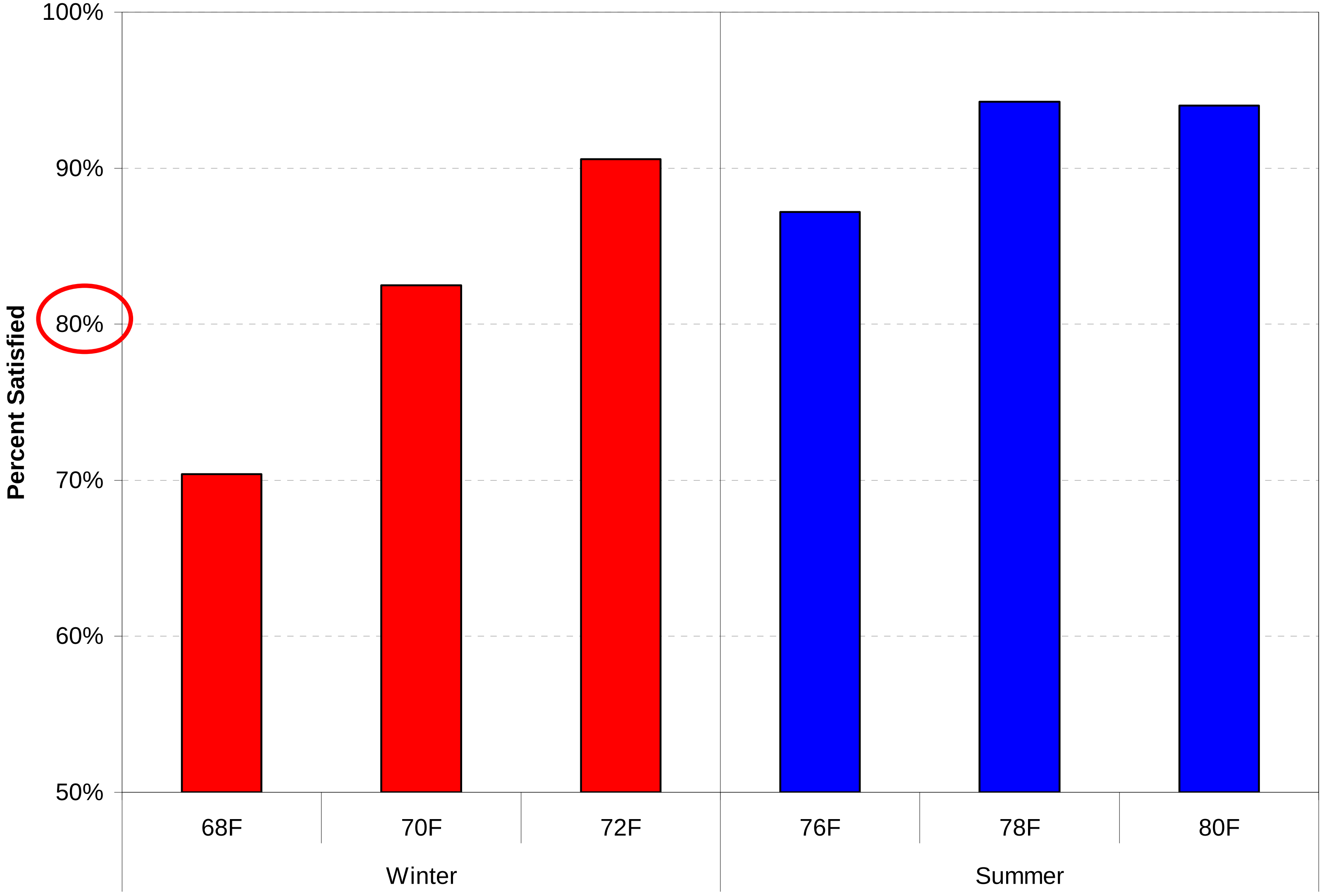


# Using the Comfort Program to Determine Thermostat Setpoints

- Set *mean radiant temperature* equal to air temperature
  (assumes exterior walls are at room temp)

- Use standard conditions for relative humidity and air movement, seasonal clothing levels, and sedentary activity

# Comfort at the Thermostat



# Thermostat Recommendations

- Heating: 70°F minimum
- Cooling 78°F maximum

Actual settings for 80% comfort compliance will vary with MRT



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# Conditions for Comfort Analysis

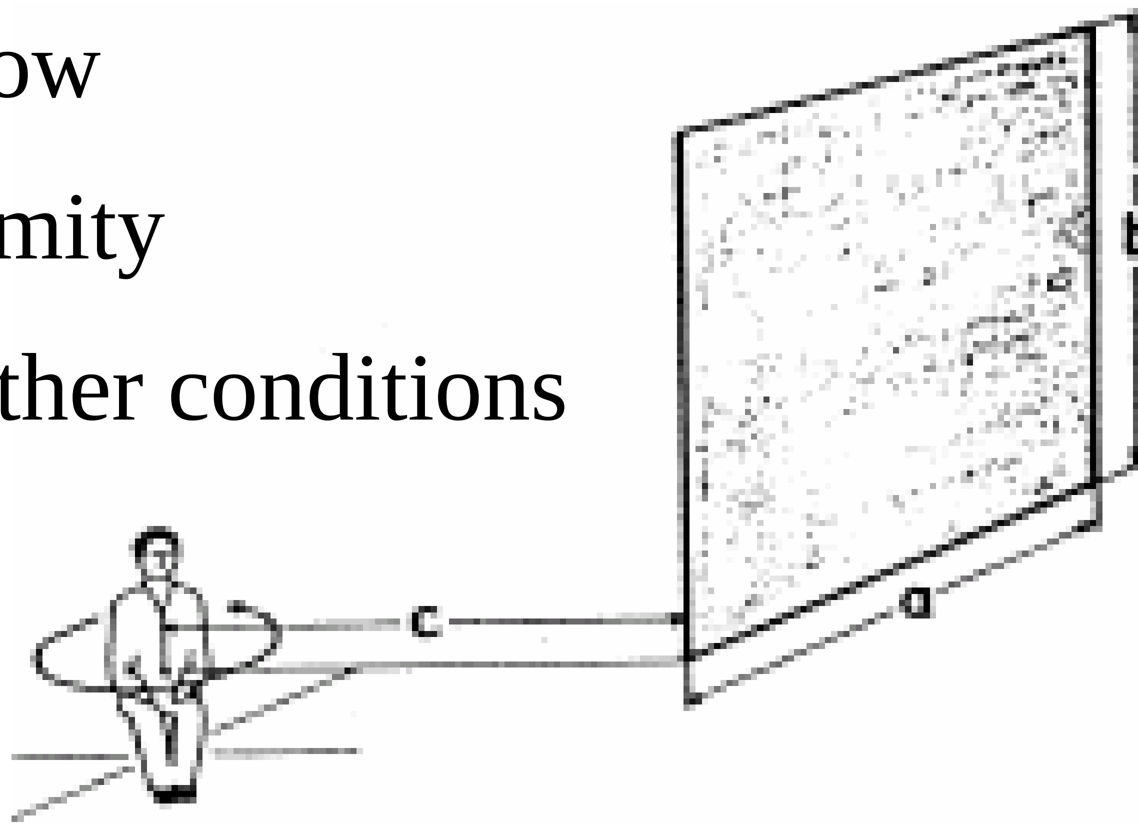
- Discomfort is usually a response to temperature extremes
- Recommend that comfort analysis be performed for peak conditions
- Analogous to sizing HVAC equipment – if occupant comfort can be met at time of peak load it should be adequate during off peak times

# Comfort Analysis for Windows

- Clothing Insulation *seasonal variation*
- Activity Level *sedentary*
- Air Movement *<20 fpm*
- Humidity *50% RH*
- Radiant Temperature
  - *Function of glass size, proximity, surface temperature*
- Air Temperature *thermostat setting*

# Worst Case for Window Comfort

- Large window
- Close proximity
- Design weather conditions



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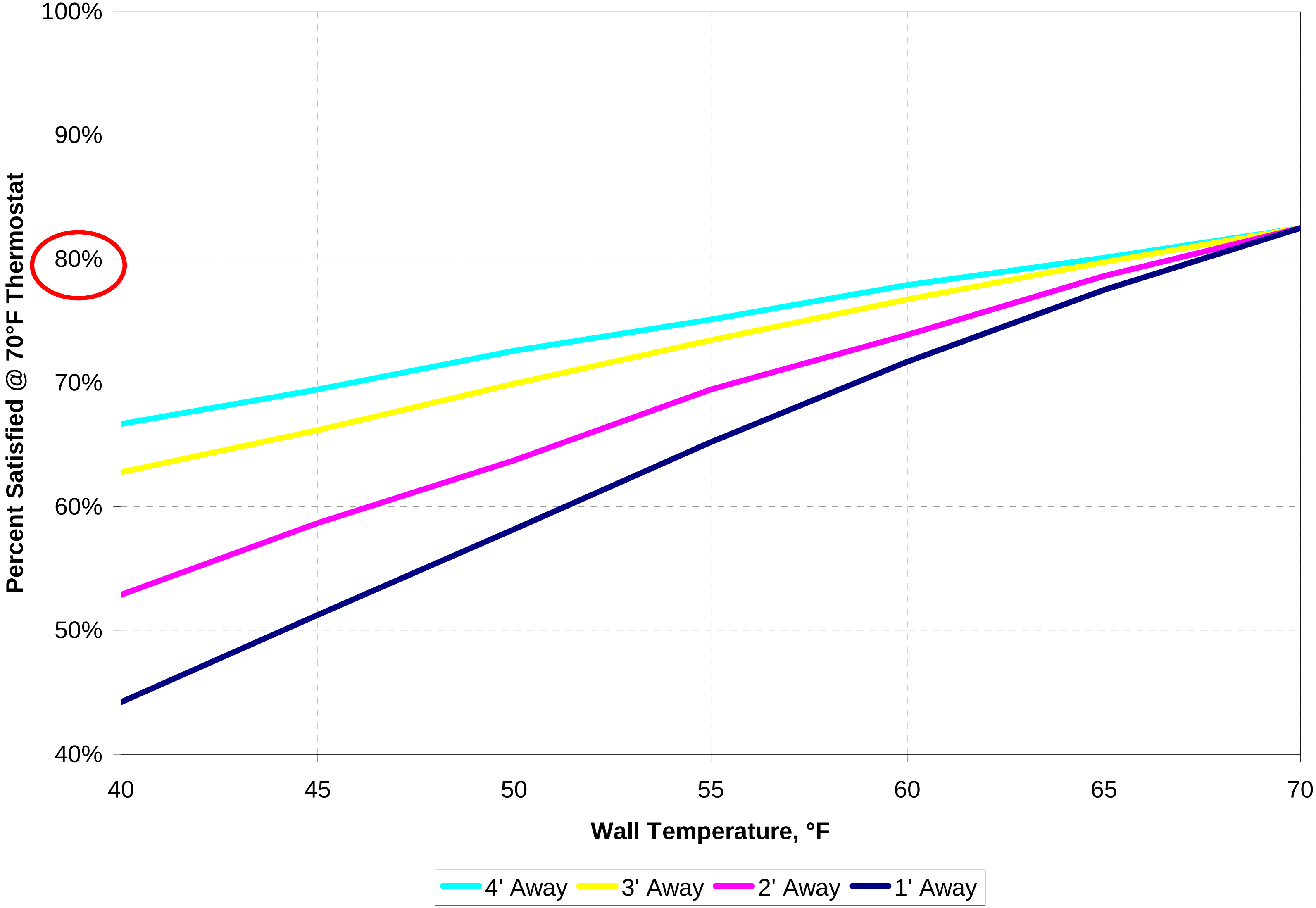
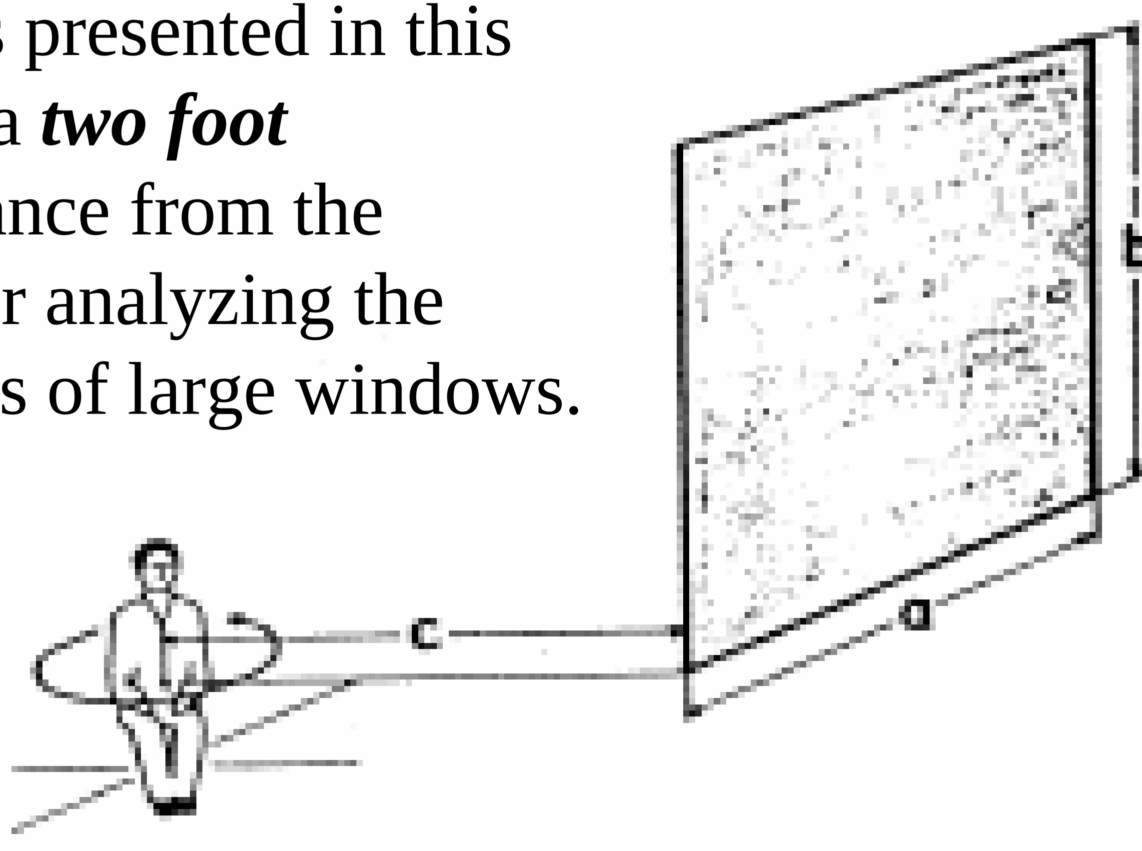
# Comfort vs. Proximity to Cool Surface



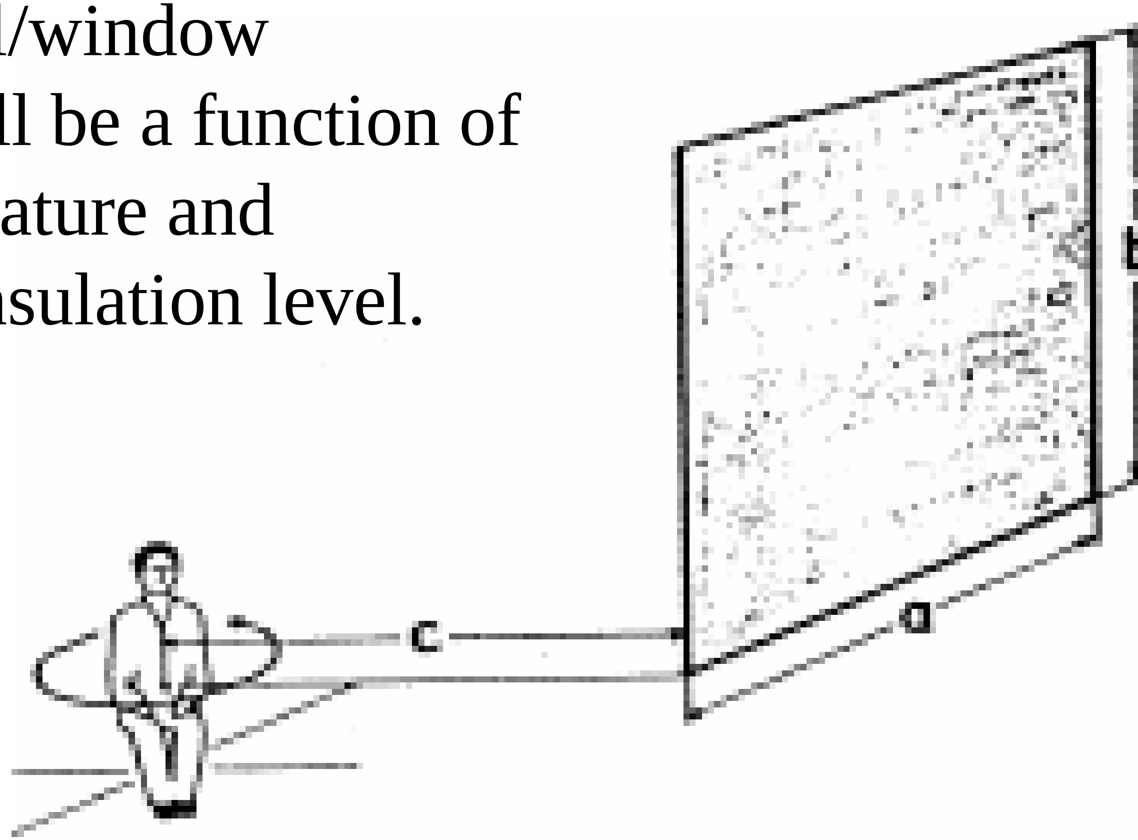
# Proximity

The comparisons presented in this discussion use a ***two foot*** separation distance from the exterior wall for analyzing the comfort impacts of large windows.



# Exterior Wall/Window Temperatures

The exterior wall/window temperature will be a function of outdoor temperature and wall/window insulation level.



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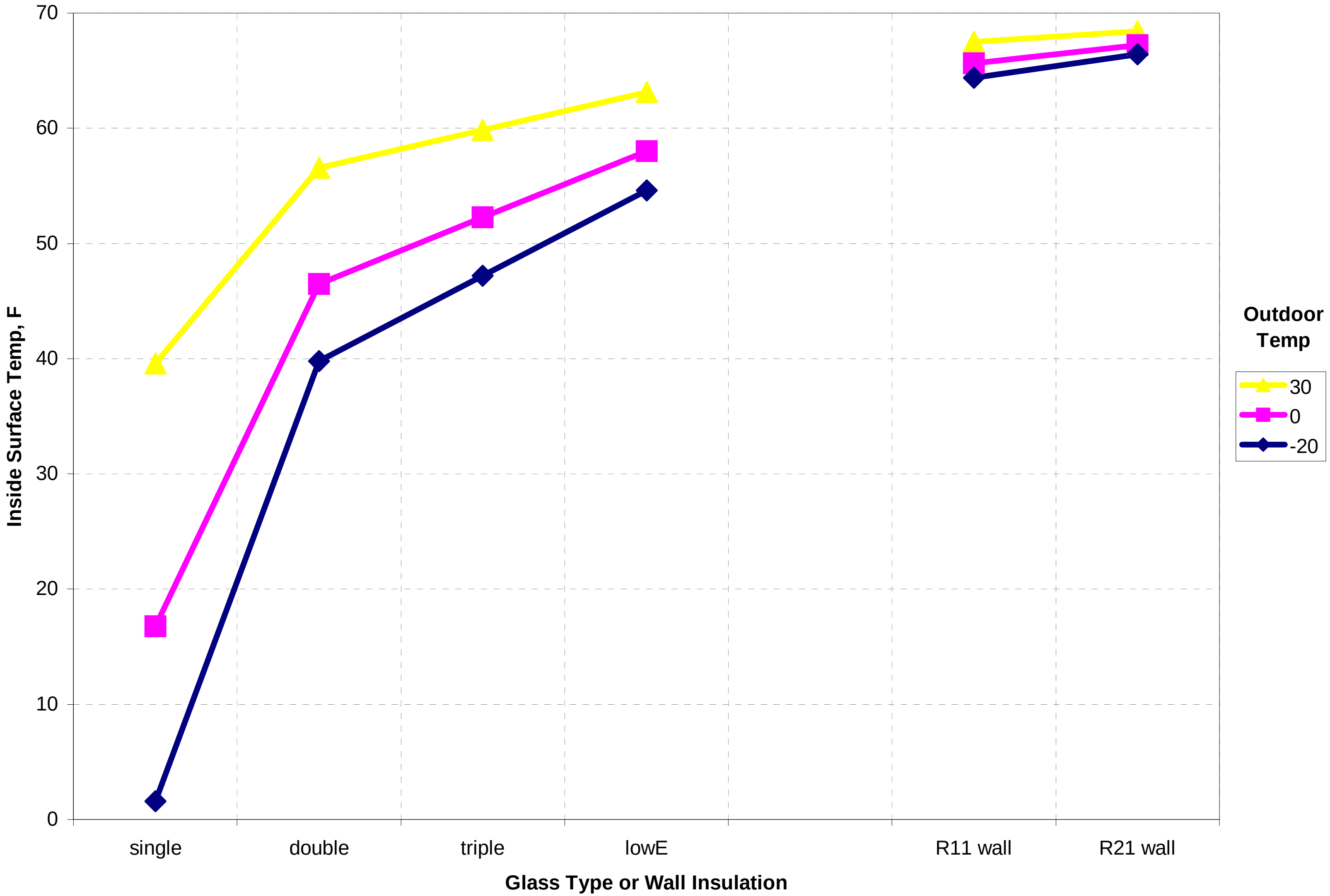
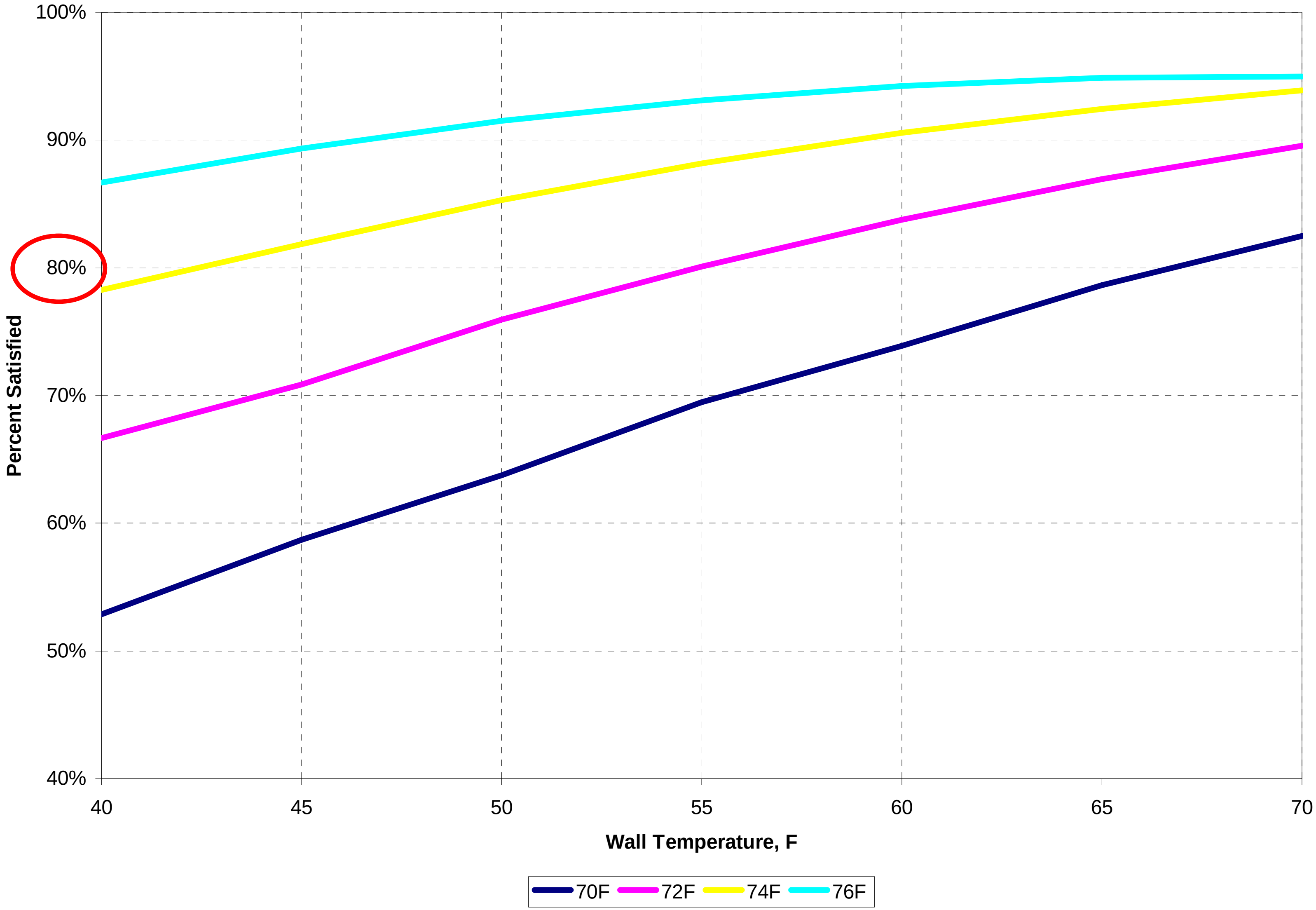
# Perimeter Wall Temperatures in Winter



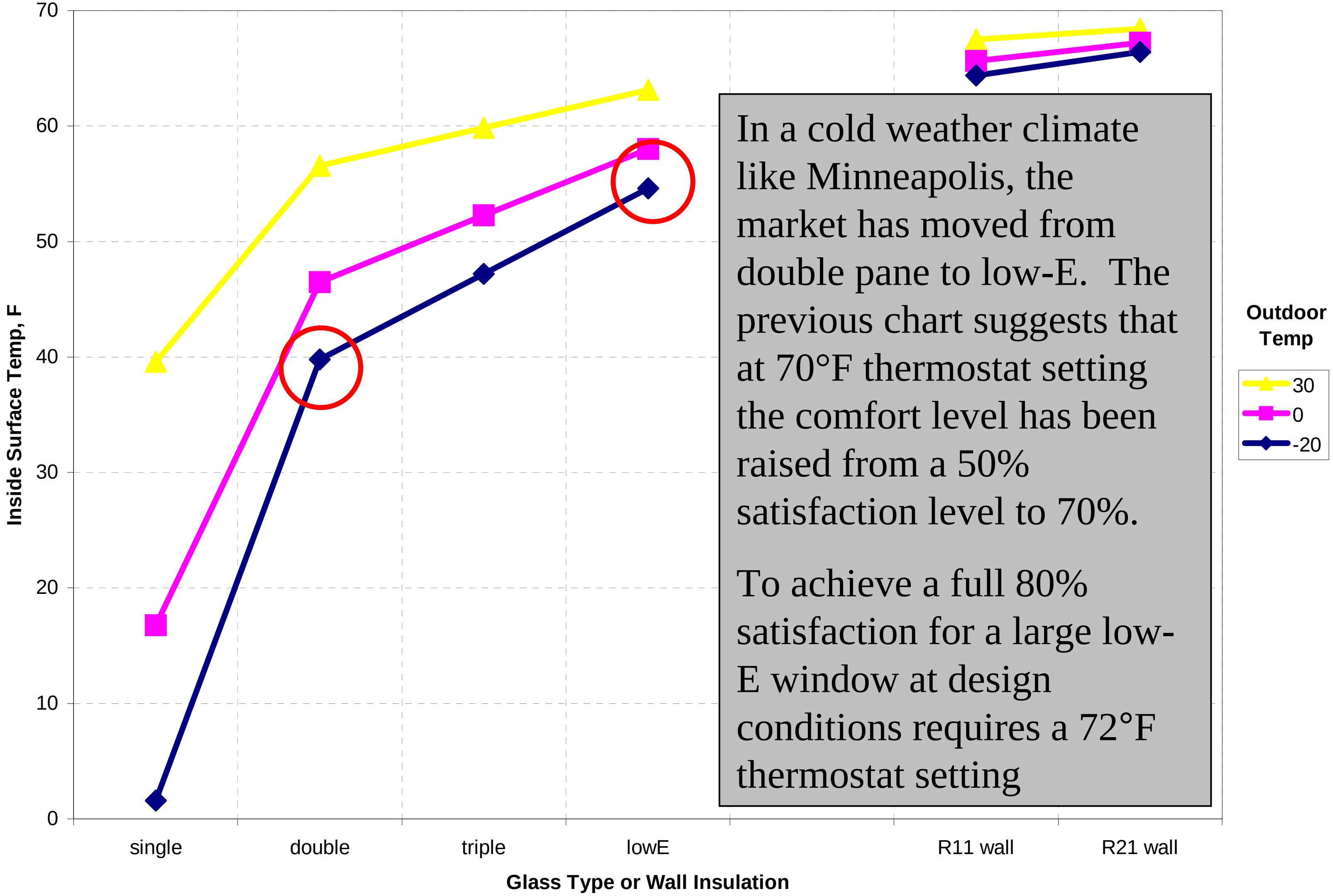
# Window vs. Wall Trade-Offs

- The previous chart shows that window surface temperatures are much cooler than an insulated wall
- Trading off window performance for more insulation in the wall may deliver the same energy performance, but can seriously erode comfort
- If the goal of a weatherization program is to improve occupant comfort along with a reduction in heating bills need to consider upgrading single pane windows before looking to further increase wall insulation

# Winter Comfort vs. Thermostat & Wall



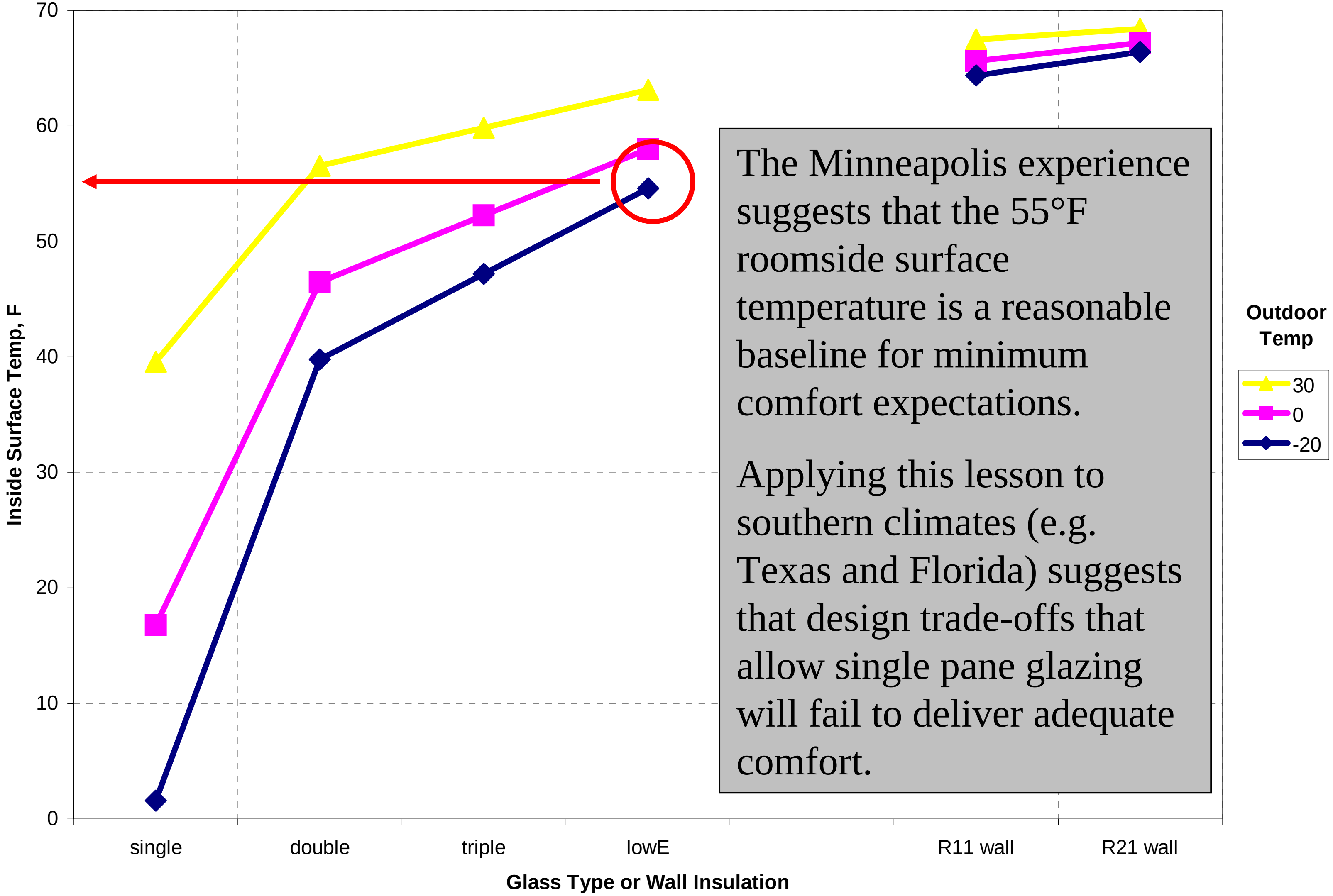
# Cold Climate Experience




In a cold weather climate like Minneapolis, the market has moved from double pane to low-E. The previous chart suggests that at 70°F thermostat setting the comfort level has been raised from a 50% satisfaction level to 70%.

To achieve a full 80% satisfaction for a large low-E window at design conditions requires a 72°F thermostat setting

# Learn from Past Experience




The Minneapolis experience suggests that the 55°F roomside surface temperature is a reasonable baseline for minimum comfort expectations.

Applying this lesson to southern climates (e.g. Texas and Florida) suggests that design trade-offs that allow single pane glazing will fail to deliver adequate comfort.

# Solar Offset to Comfort Vote

For every 100 btu/ft² of solar gain, the comfort vote shifts to the positive by approximately 0.8

Examples:

Cool (-2) plus moderate sun = Slightly Cool (-1)

Neutral (0) plus high sun = Warm (+2)



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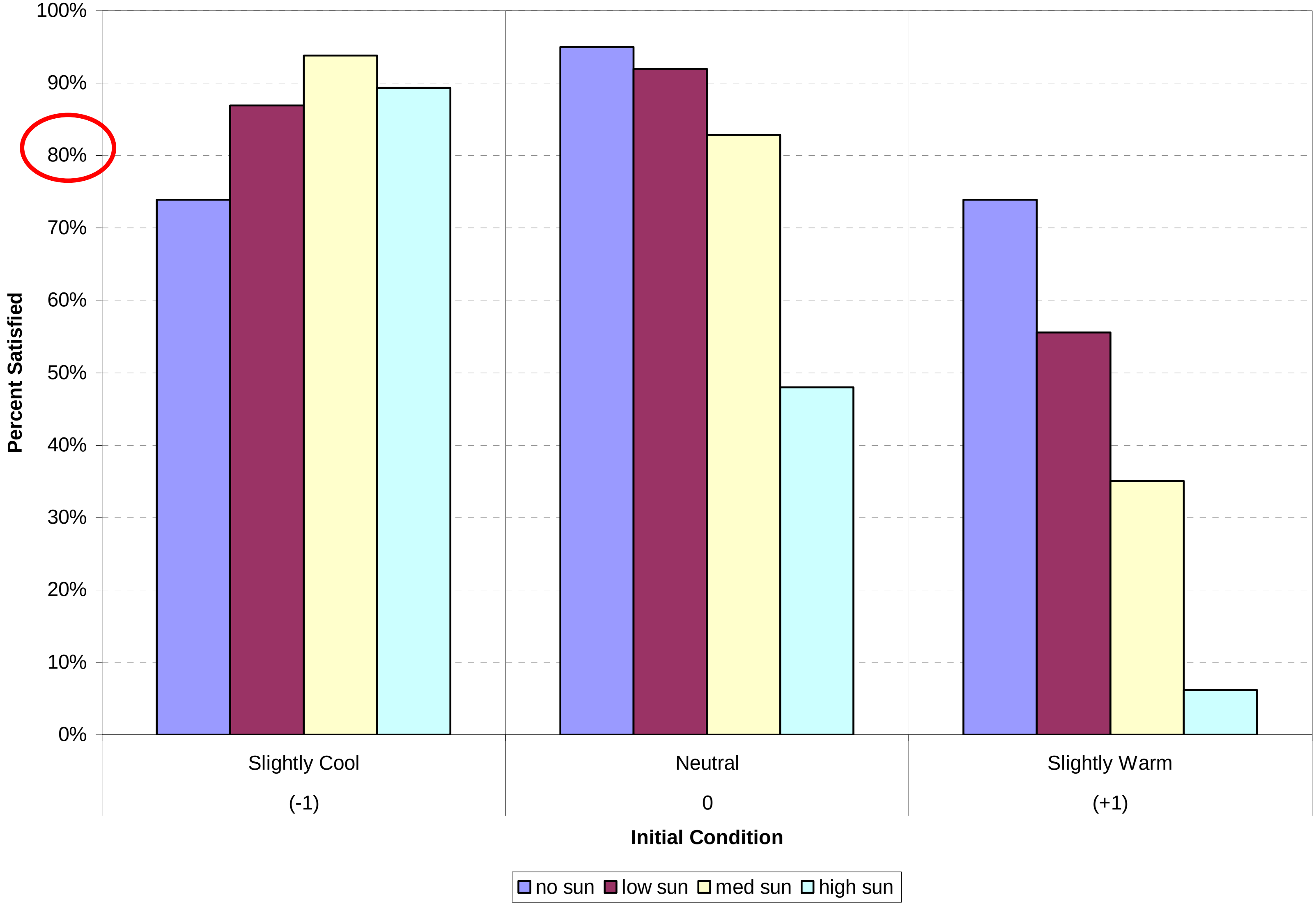
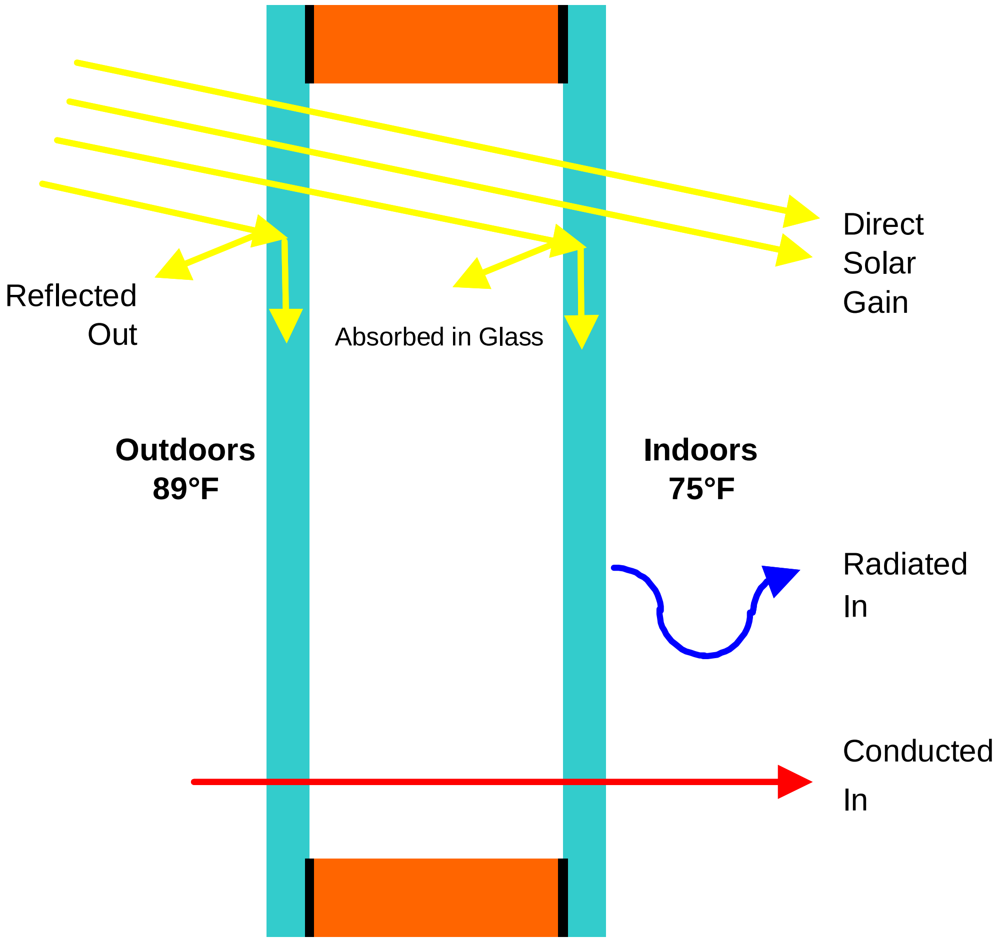
# Solar Impacts vs. Initial Comfort



# Solar Properties of 3 Glass Types

| | SHGC | Heat Gain | Temp |
|---|---|---|---|
| 2 pane clear | 0.76 | 182 | 91 |
| High Solar Gain Low-E (HSLE) | 0.72 | 169 | 101 |
| Low Solar Gain Low-E (LSLE) | 0.41 | 98 | 84 |

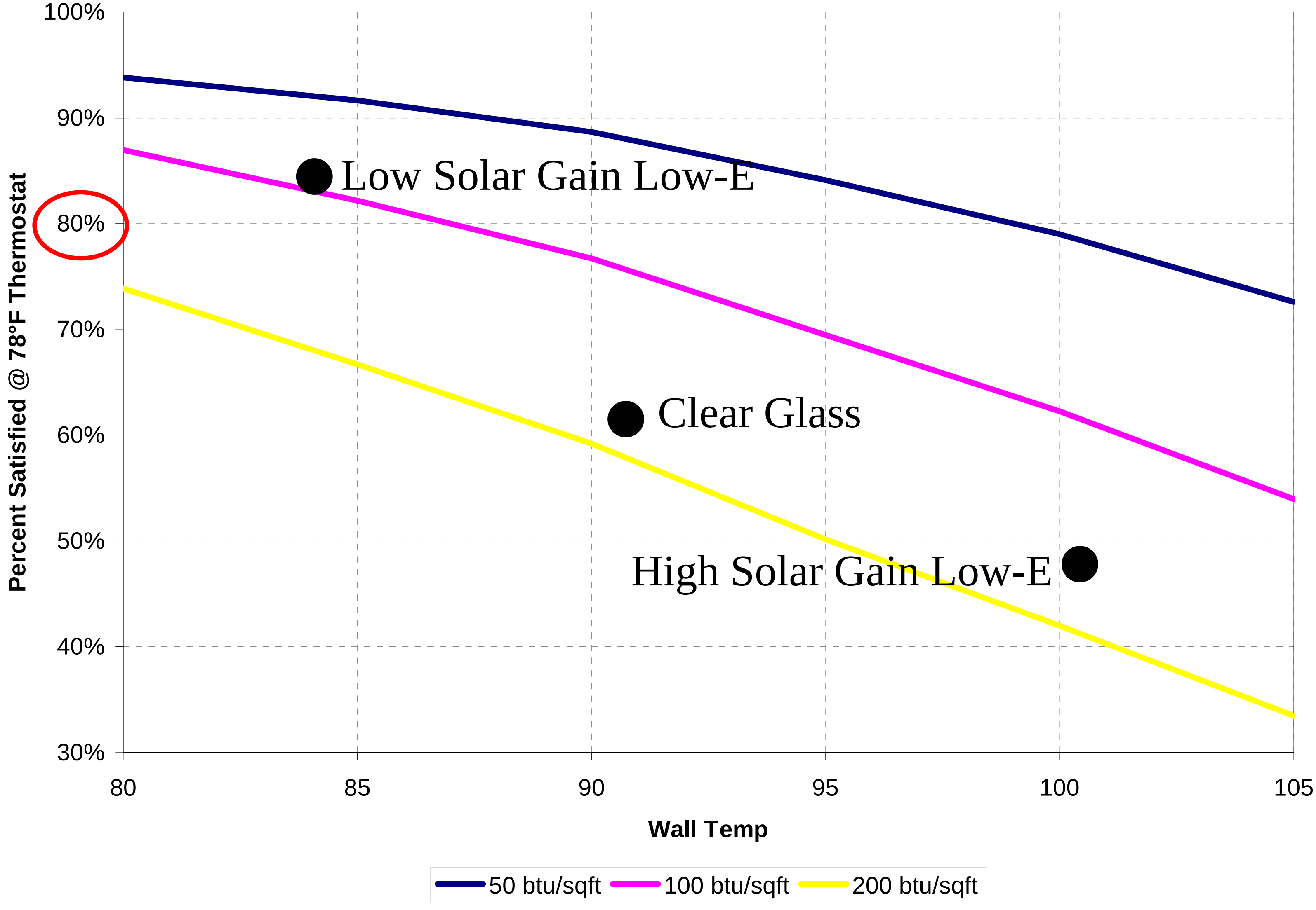
# Why is the High Solar Gain Low-E so Hot?



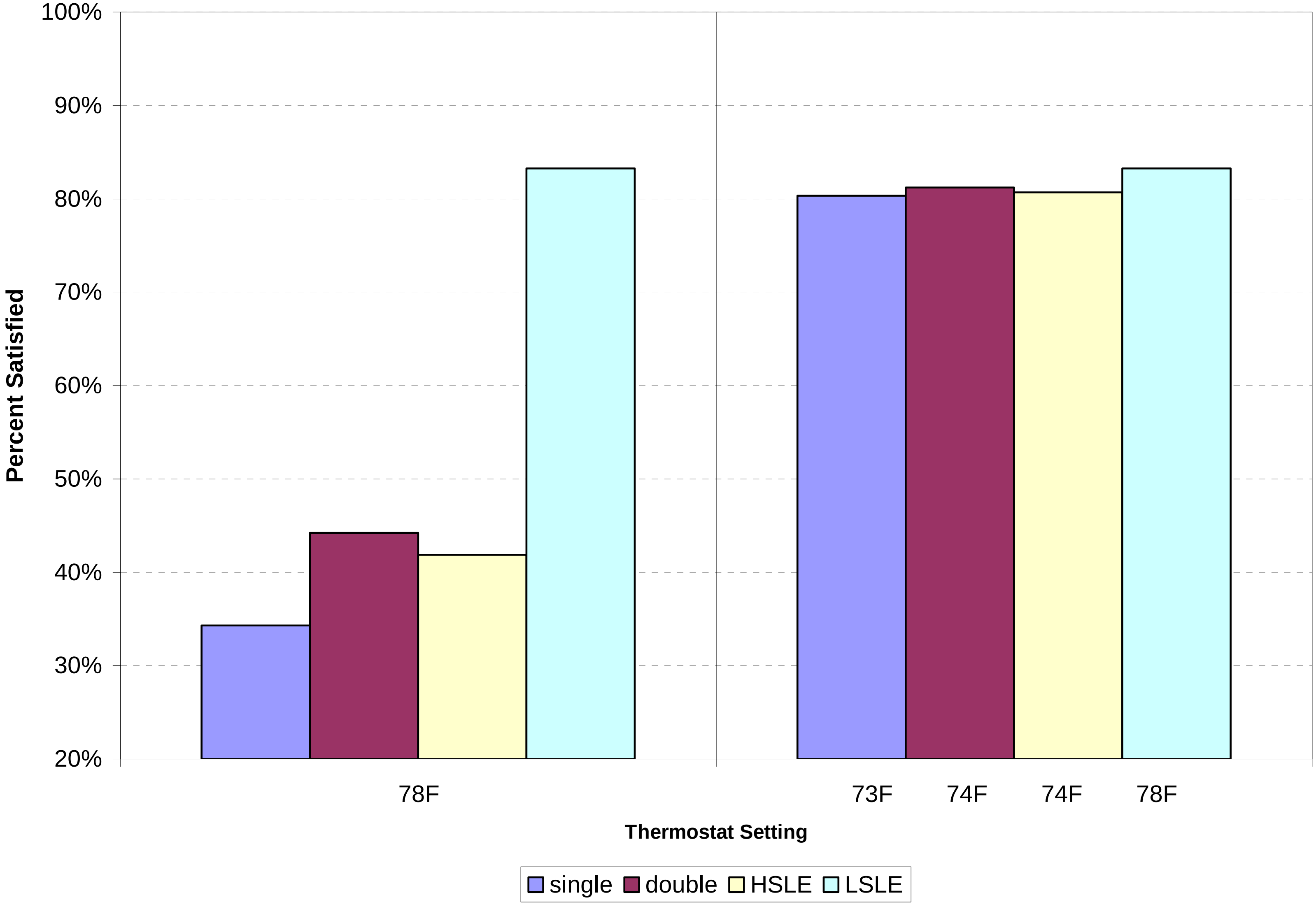

To maximize solar gains, the coating is placed on the airspace side of the inboard pane of glass.

The low-E coating absorbs twice as much solar energy as clear glass, so the inside pane of glass heats up to 25+ degrees hotter than the room air temperature.

# Comfort for Summer Peak Day



# Thermostat Settings for Summer Comfort



# Cooling Thermostat

78°F is an adequate setpoint temperature for:

- A room with no windows
- A room with low solar gain windows

For rooms with high solar gain glass:

- Tuff it out
- Close the drapes
- Leave the room
- Turn the thermostat down



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# Comfort Summary

- The minimum heating thermostat setpoint for comfort should be 70°F
  - Perimeter zone conditions may require up to a 4°F <u>setup</u> to maintain 80% comfort compliance
- The maximum cooling thermostat setpoint for comfort should be 78°F
  - Perimeter zone conditions may require up to a 4°F <u>setdown</u> to maintain 80% compliance

# Windows and Energy Codes

The baseline window requirements in the IECC form a basis for minimal comfort expectations.

- Low U-factor's in cold weather climates deliver warm glass surface temperatures
- Low solar heat gain in hot weather climates reduce cooling loads and temperature fluctuations



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# Window Caution!

When using a performance path analysis to qualify a design that deviates from basic window requirements beware:

- The occupants may not be satisfied with the comfort conditions of their “energy efficient” building
- The real energy consumption can be much greater than predicted if the occupant chooses to set the thermostat for comfort.