Room Climate Standard

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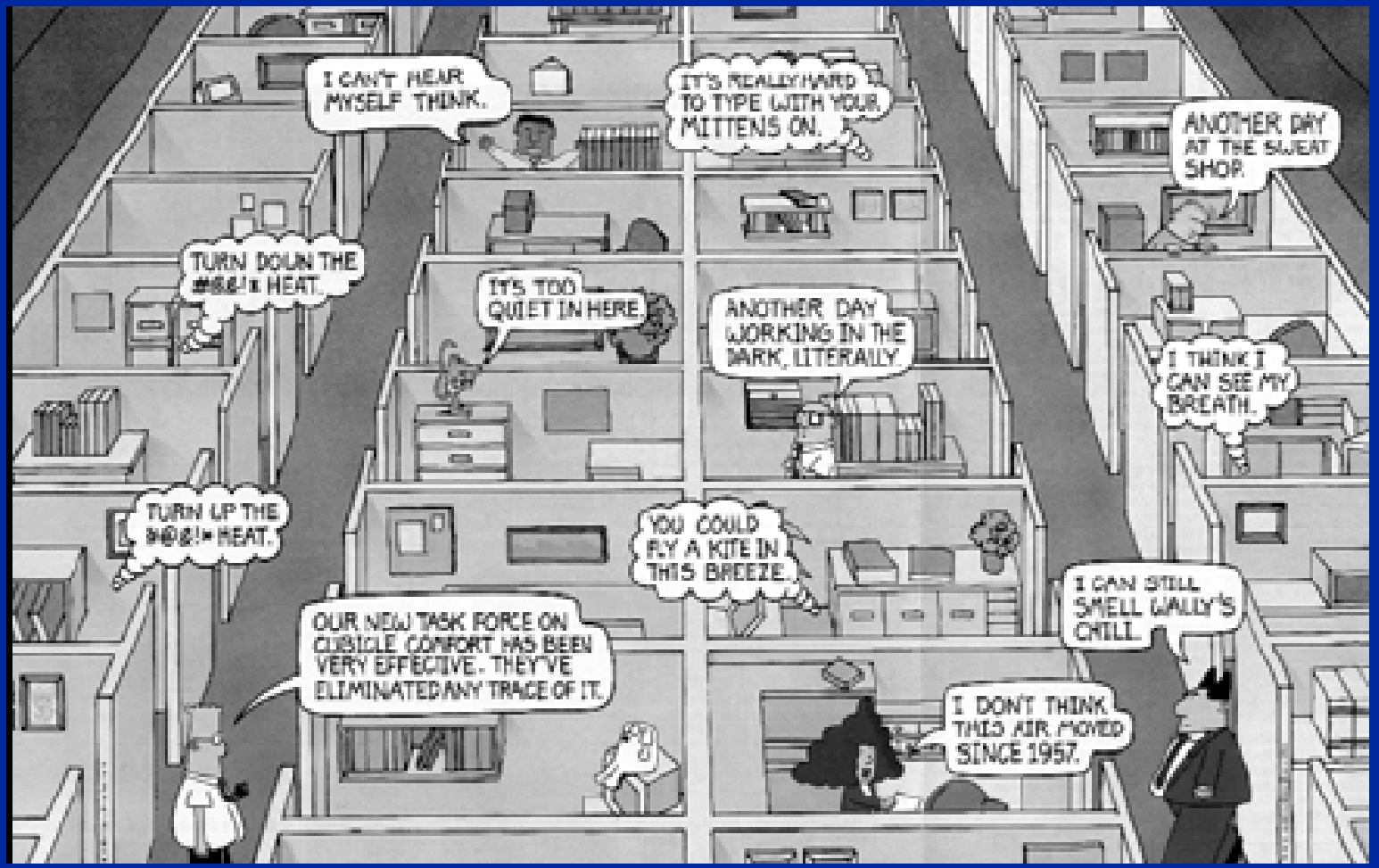
Room Climate Standard

The Challenge



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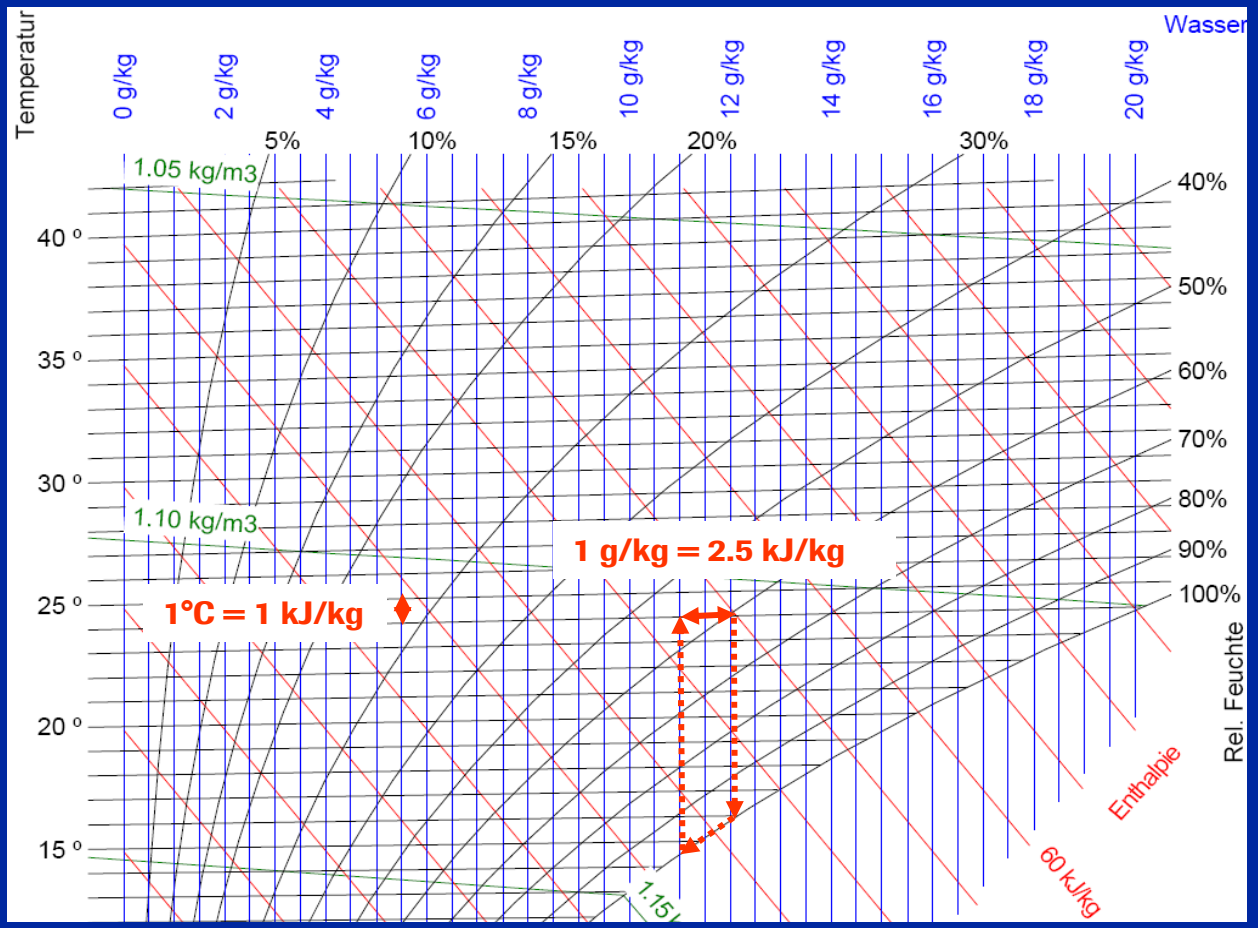
The Motivation

- Energy vs. room climate conditions



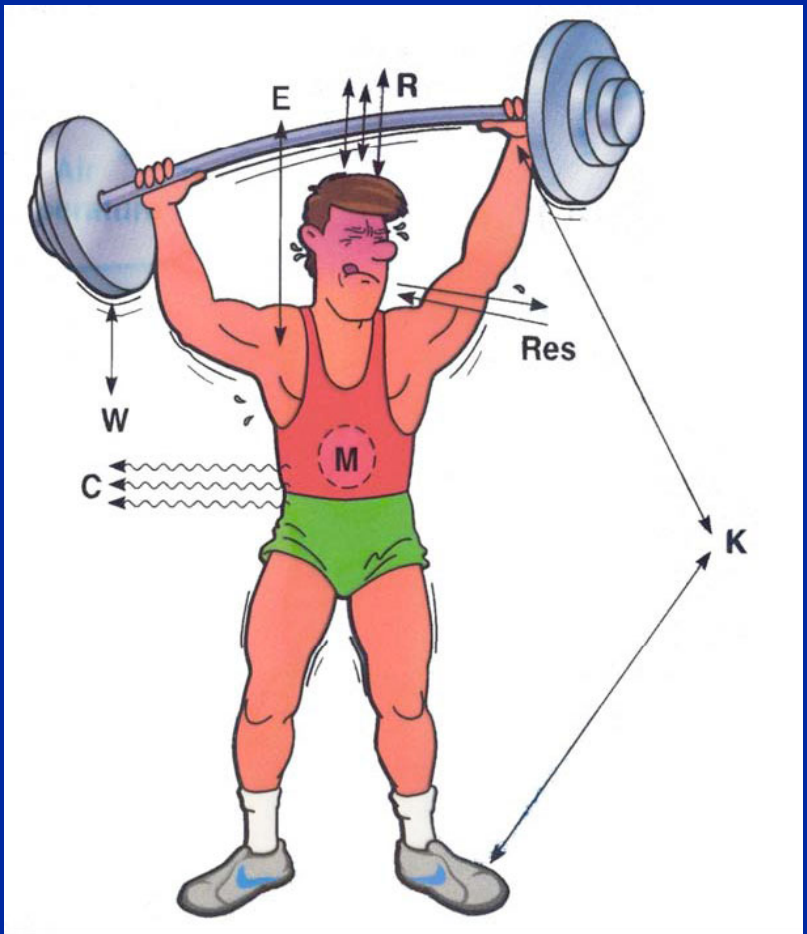
Room Climate Standard
The Definition

- Thermal Comfort:
  - That condition of mind which expresses satisfaction with the thermal environment (wishing neither colder, warmer, drier nor wetter air conditions)
  - Prerequisite is the thermal balance between body and ambiance without having to adapt by “thermal stress“ (sweating, increased blood flow, shivering, reduced blood flow)
  - Absence of thermal discomfort
  - Condition in which high percentage of people do not express dissatisfaction

Room Climate Standard

The Basics

- Energy Balance around Human Body
  - Radiation (R)
  - Convection (C)
  - Evaporative heat loss (E)
  - Conduction (K)
  - Respiration (RES)
  - Metabolism (M)
  - Physical Work (W)



Room Climate Standard

The Basics

- Factors that impact thermal comfort

	Primary Factors	Secondary Factors	Subsidiary Factors
Physical	Air Temperature Radiant Temperature Relative Humidity Air Movement	Noise Effects Optical Effects Air contaminants Air Pressure	
Intermediate	Clothing Activity	Room occupancy	Adapt ion Acclimatization Daily/Seasonal Fluctuations
Physiological			Age Ethnicity Gender Physique Constitution

Room Climate Standard

The Basics

- Next to whole body comfort there are localized discomfort issues
  - Radiant temperature asymmetry
  - Draught
  - Vertical temperature gradient
  - Floor temperature

Room Climate Standard

The Basics

- Relevant Norms and Standards
  - ISO 7730 “Ergonomics of the Thermal Environment“
  - ASHRAE *) Standard 55-2004 “Thermal Environmental Conditions for Human Occupancy“

    *) ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers

Room Climate Standard
The Basics

- Adaptive Models:
  - Applicable for non mechanically conditioned spaces
  - Based on the fact, that
    - lower expectations on thermal ambiance results in acceptance of more uncomfortable conditions
    - occupants accept more uncomfortable conditions, if room climate can be individually manipulated

- Static Models:
  - Applicable to mechanically conditioned spaces
    - where expectations on thermal ambiance are high
    - where occupants have no control over room climate conditions

Room Climate Standard
The Basics

- Fanger Model (Static Model):
  - Based on climate chamber experiments
  - Expresses comfort with set of equations that reflect empirical results
  - Acknowledges the interrelation between thermal sensation and heat balance around body
  - Incorporates the following variables that influence body heat balance:
    Air temperature, radiant temperature, air velocity, humidity, clothing, metabolistic rate
  - Comfort equation calculates difference from being in thermal balance with environment
  - This difference is translated into the Predicted Mean Vote (PMV) as integrative percept value
    PMV: predicted mean value of votes on a 7 step thermal sensation scale
    (hot, warm, slightly warm, neutral, slightly cool, cool, cold)
  - For a given PMV, the Predicted Percentage of Dissatisfied (PPD) can be determined
    PPD: prediction of percentage of thermally dissatisfied people

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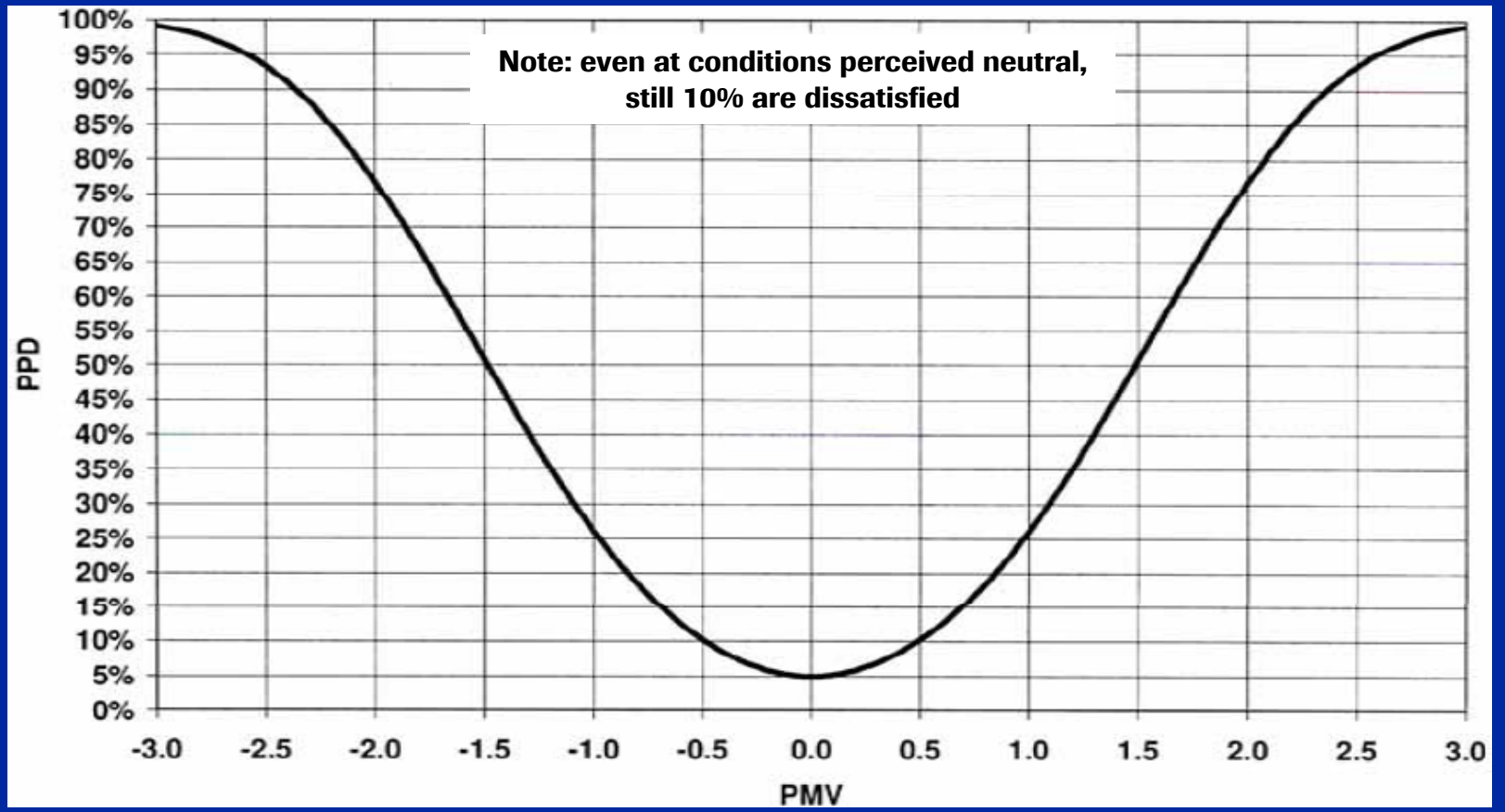
The Basics

- PPD vs. PMV:



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The Basics

- MET: Metabolism is measured in Met (1 MET =58.15 W/m2)

Activity	Metabolic Rates [M]	
Reclining	46 W/m^2	0.8 Met
Seated relaxed	58 W/m^2	1.0 Met
Clock and watch repairer	65 W/m^2	1.1 Met
Standing relaxed	70 W/m^2	1.2 Met
Car driving	80 W/m^2	1.4 Met
Standing, light activity (shopping)	93 W/m^2	1.6 Met
Walking on the level, 2 km/h	110 W/m^2	1.9 Met
Standing, medium activity (domestic work)	116 W/m^2	2.0 Met
Washing dishes standing	145 W/m^2	2.5 Met
Walking on the level, 5 km/h	200 W/m^2	3.4 Met
Building industry	275 W/m^2	4.7 Met
Sports - running at 15 km/h	550 W/m^2	9.5 Met

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The Basics

- Clo: Clothing insulation value in clo (1 clo = 0,155 m2 °C/W)

  Can be calculated by adding up values for all worn garments

  Typical values for complete outfit:

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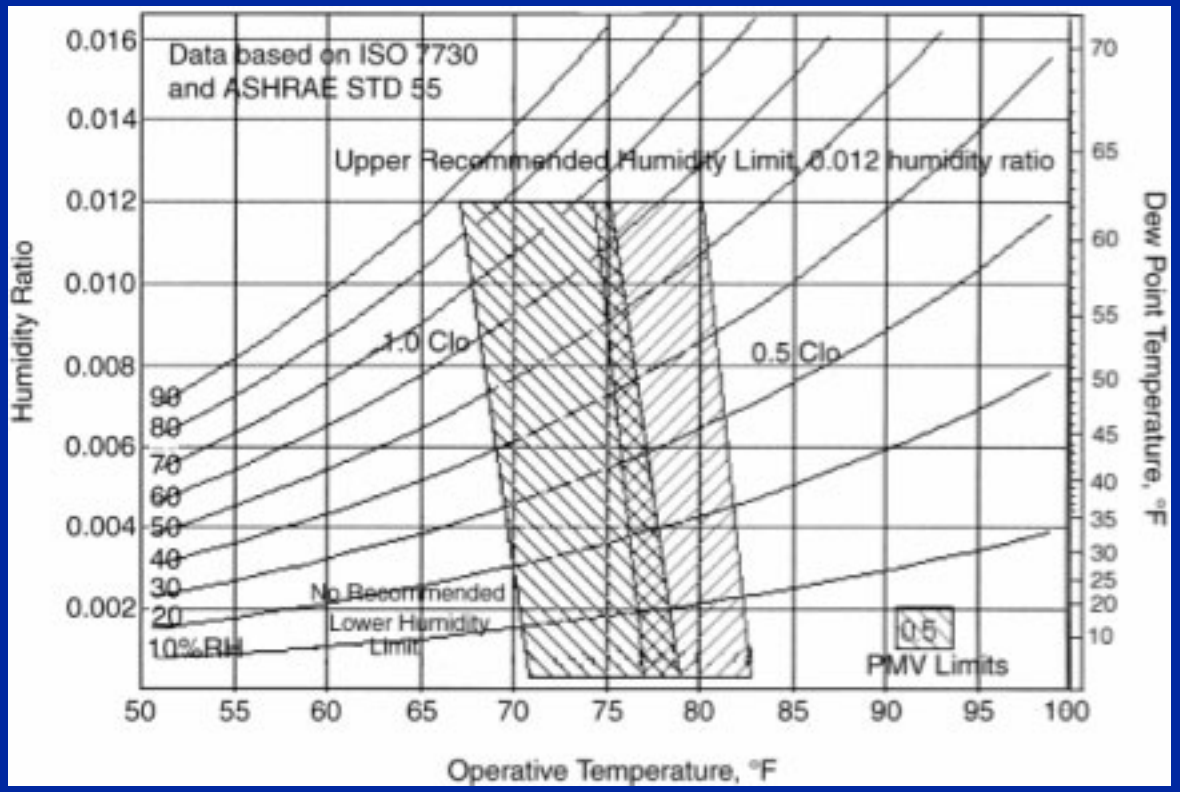
The Basics

- Fanger Model forms the basis of ISO 7730 and ASHRAE Standard 55-2004



Comfort envelope for 1.1met, 0.5 clo (summer) and 1.0 (winter), 0.1 m/s (20 ft/min), less than 10% dissatisfied

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The Scope

- Applicable for mechanically conditioned spaces (hence, based upon static model)
- Applicable for all spaces with sedentary and office type activities (1-1.3 met)

  -> offices, meeting rooms, conference rooms, training/education rooms
- Suitable for all climate zones (entire Roche world)
- Supported and justified by science and norms
- Climate appropriate clothing is expected
- Settings must offer sufficient room to absorb localized discomfort issues
- Easy to implement and control
- Yielding the lowest energy consumption while
  - ensuring low percentage of dissatisfied occupants
  - high productivity

Room Climate Standard

The Settings

- Settings are evaluated on the basis of Fanger's Static Comfort Model
- Settings are compliant with comfort norms ISO 7730 and ASHRAE 55-2004
- Room Climate Conditions are established for ensuring less than 10% dissatisfied
- Settings are established for seasonal dressing (0.5 clo in summer, > 1 clo in winter)
- Settings are good for typical air velocities (0.1 – 0.2 m/s, 20 – 40 ft/min)
- Settings prescribe air temperature and not operative temperature since
  - difference between the two is marginal in well designed and built buildings
  - incremental comfort loss due to their difference is absorbed by the margin the stringent target "less than 10% dissatisfied" creates
- Localized discomfort issues are not separately tackled since
  - they typically do not appear in well designed and built buildings
  - they are absorbed by the margin the stringent target "less than 10% dissatisfied" creates
  - they can and should be individually and locally solved

Room Climate Standard

The Settings

- Cooling Period
  - Mechanical cooling with set-point below 24°C (75°F) is not acceptable.
  - It is recommended that indoor temperatures float with outdoor temperatures (However, a maximum temperature cap should be considered)
  - De-humidification must not result in humidity lower than 0.0110 g/g (0.0110 lb/lb).
  - Air that is de-humidified by sub-cooling should not be re-heated (to meet 24°C (75°F)). Instead, the increased temperature lift should be utilized to lower flow rates.

- Heating Period
  - Heating with set-point above 22°C (71.5°F) is not acceptable.
  - Humidification must not result in humidity larger than 0.006 g/g (0.006 lb/lb).

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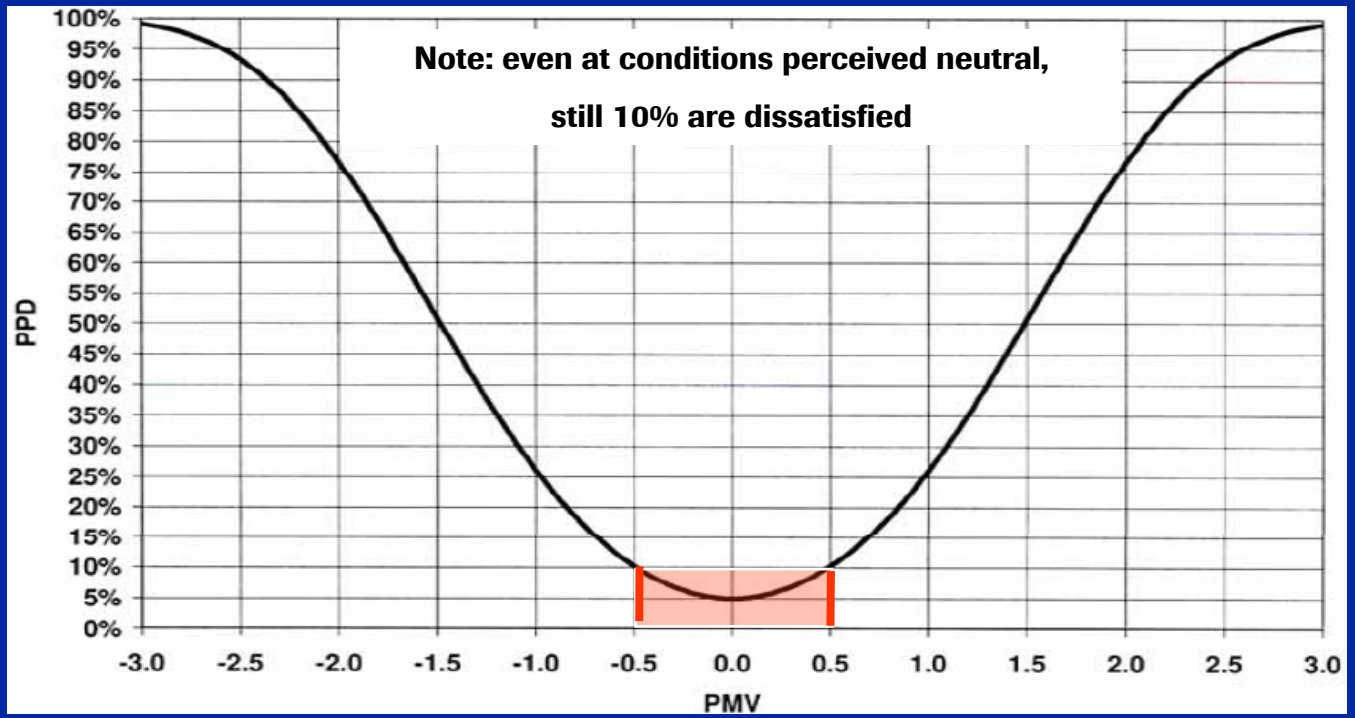
The Basics

- PPD vs. PMV:

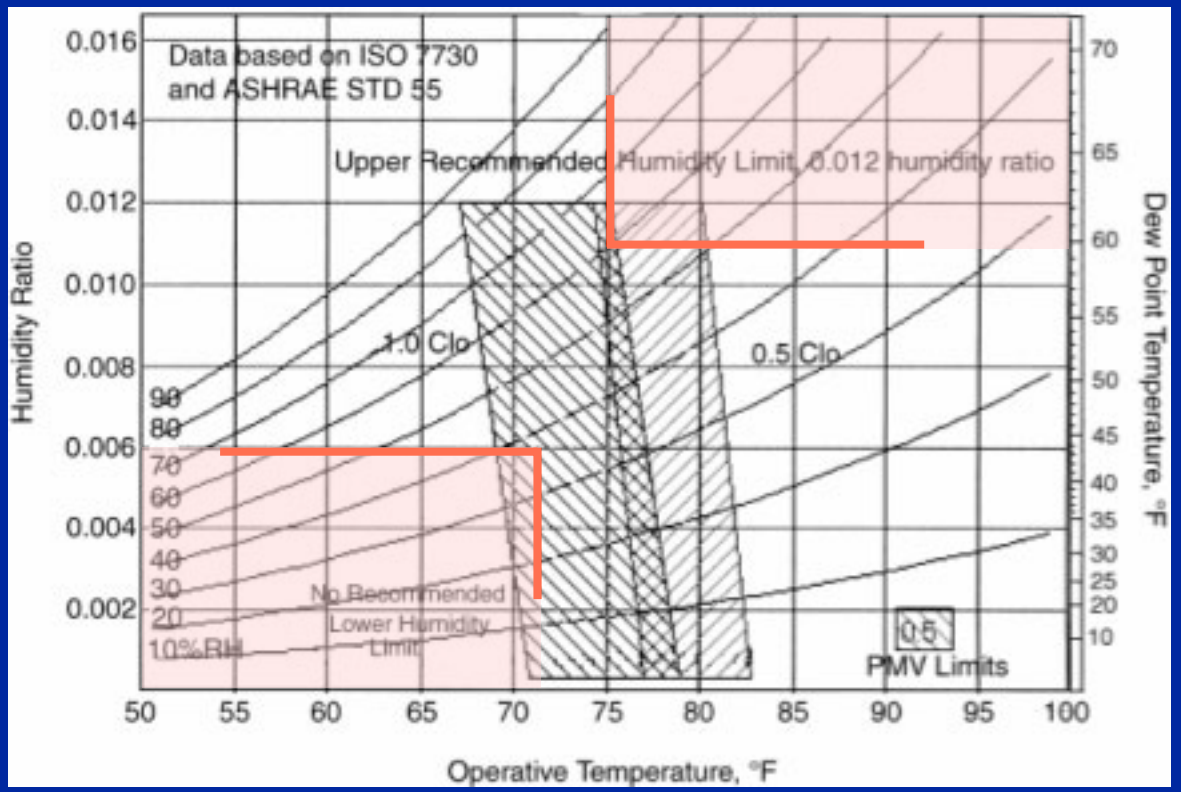


range of PMV values and PPD values covered by Roche settings

Room Climate Standard

The Settings

- Roche Room Climate Conditions vs. ASHRAE Standard 55-2004



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