

Indoor Environments for people with Physical Disabilities

Ken Parsons

Human Thermal Environments Laboratory
Loughborough University

ISO Thermal Comfort System

General Methods

ISO 7730 PMV/PPD and DR.

ISO 10551 Subjective methods

Special Populations

ISO 14415 - People with special requirements

Special environments

ISO 14505 Parts 1 to 3 - Vehicles

ISO 13732 Part 2 - Contact with surfaces of moderate temperature

Thermal comfort

BS EN ISO 7730 1995

Moderate thermal environments - Determination of the PMV and PPD indices and specification of the conditions for thermal comfort

Predicted Mean Vote PMV

..an index that predicts the mean value of the votes of a large group of persons on the following 7-point thermal sensation scale.

+3 hot

+2 warm

+1 slightly warm

0 neutral

-1 slightly cool

-2 cool

-3 cold

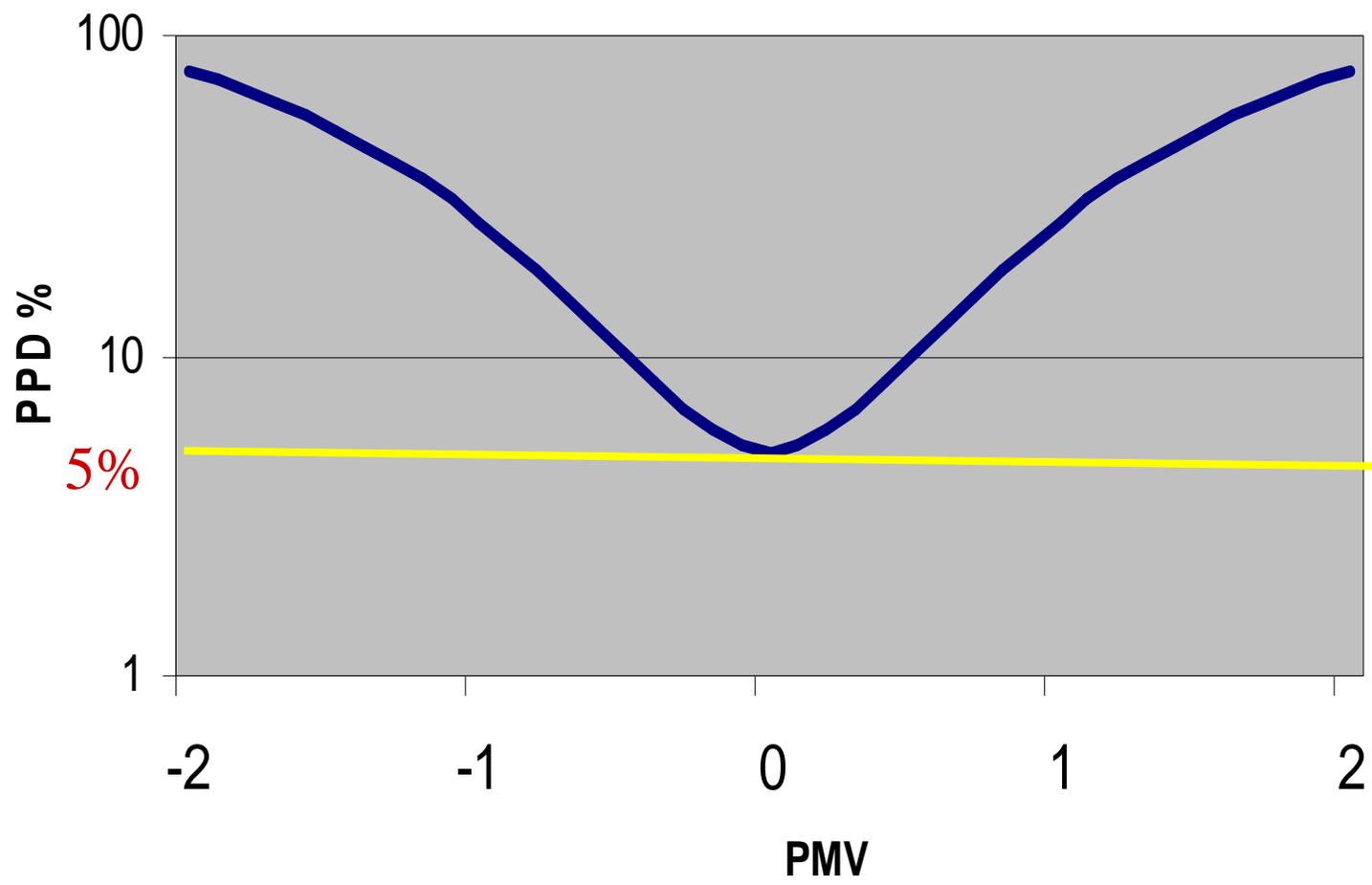
Predicted Percentage of Dissatisfied PPD

..an index that predicts the percentage of thermally dissatisfied people.

The percentage of a large group of people voting hot,warm,cool or cold on the following 7-point thermal sensation scale.

- +3 hot
- +2 warm
- +1 slightly warm
- 0 neutral
- 1 slightly cool
- 2 cool
- 3 cold

Predicted Percentage of Dissatisfied



PMV - ISO 7730

Model

Draught rating

Draught - unwanted local cooling of the body caused by air movement

Draught Rating DR = percentage of people dissatisfied due to draught.

$$DR = (34-t_a)(v-0.05)^{0.62}(0.37vT_u+3.14)$$

ISO TS 14415 (TR)

Ergonomics of the thermal environment: The application of International Standards for people with special requirements

Scope

to provide background information on the thermal responses and needs of persons with special requirement so that international standards concerned with the assessment of the thermal environment can be appropriately applied.

ISO TR 14415: People with special requirements

Thermal responses and needs

Sensory impairment

Body shape

Impaired sweat secretion

Impaired vasomotor control

Differences in metabolic rate

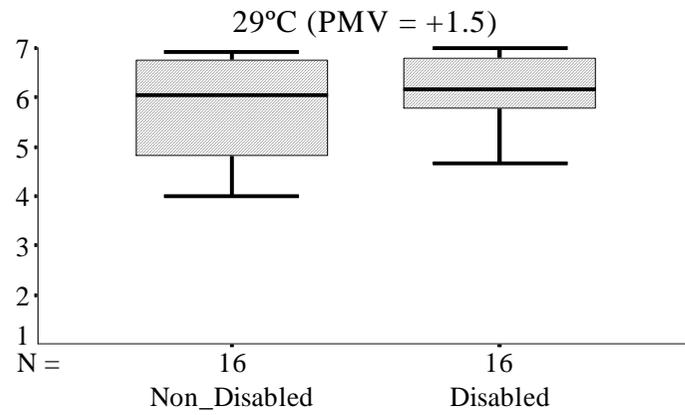
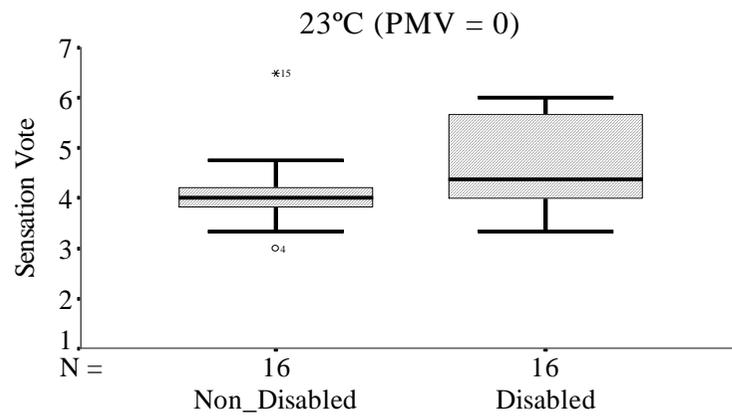
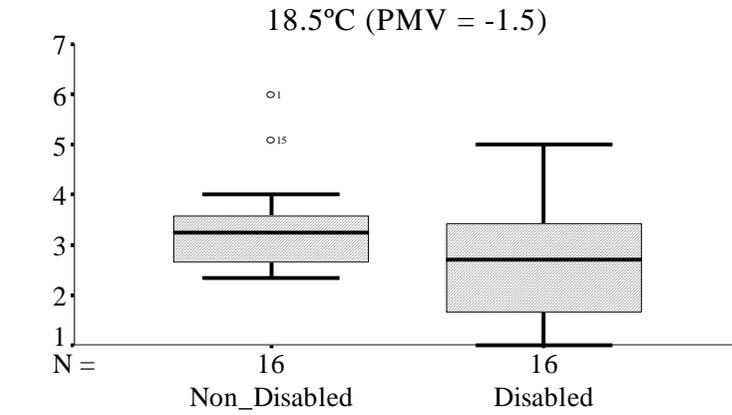
Disability, aged, pregnant and others

Four year EPSRC thermal comfort research programme

- Field surveys - 391 people with physical disabilities
38 carers of people with physical disabilities
- Laboratory studies- responses of 145 people with physical disabilities in warm, neutral and cool environments
- Software tool - Integrate the results in usable form to determine the thermal comfort requirements of people with physical disabilities.



What are thermal comfort conditions for people with physical disabilities?



Data base model

How can we design
for thermal comfort?

PMV - ISO 7730

Adaptive Approach ?



PMV - ISO 7730

Adaptive Model

Equivalent clothing
index

Equivalent Clothing Index (I_{EQUIV})

I_{EQUIV} is the clothing insulation that would give equivalent thermal comfort to people with no adaptation as the thermal comfort of people who adapt to their thermal conditions

Equivalent Clothing Index (I_{EQUIV})

$I_{EQUIV} = I_{START} - (I_{ADJ} \times I_{START})$ in Hot conditions

$I_{EQUIV} = I_{START} + (I_{ADJ} \times I_{START})$ in Cold conditions

Adaptive opportunity	I_{ADJ}
Minimum	0
Low	0.25
Medium	0.5
High	0.75
Maximum	1

PMV - ISO 7730 Adaptive Model

Equivalent clothing index

People in a building wear 1.0 Clo, perform sedentary activity in conditions with no radiant load and vapour pressure of 1.0 kPa in still air

Adaptive opportunities:

Can reduce clothing but not increase it.

Can move around.

Can open windows.

Conclude adaptive opportunity as high in the heat and low in the cold.

For $PMV = 0$ (Neutral): **24.0 °C for $I_{EQUIV} = I_{START} = 1.0$ Clo**

22.8 °C for $I_{EQUIV} = 1.25$ Clo

28.5 °C for $I_{EQUIV} = 0.25$ Clo

For environmental design therefore comfort range is 22.8 to 28.5 °C

PMV - ISO 7730 Adaptive Model - Equivalent clothing index

People in a building wear 1.0 Clo, perform sedentary activity in conditions with no radiant load and vapour pressure of 1.0 kPa in still air

People with disabilities:

Cannot reduce or increase clothing

Cannot move around

Cannot open windows

Conclude adaptive opportunity is minimum

For PMV = 0 (Neutral): 24.0 °C for IEQUIV = ISTART = 1.0 Clo

For environmental design therefore comfort range is 24 °C

New approach: Design the environment for adaptive opportunities.

Inclusive design - adaptive opportunities that a wide range of people can take.

Inclusive Design - If thermal comfort requirements for people with disabilities require different conditions for optimum, then design so that adaptive opportunities can accommodate all.

Total environments - Although the approach is presented in terms of thermal comfort, it applies to all environmental components. (Sound, light, air quality etc).

Adaptive opportunity for environmental design will depend upon job design and organizational culture (Do you have to wear a hat and tie?, Is it necessary to stay in one place?.....)

ISO TC 159 SC5

Ergonomics of the physical environment

NP - People with special requirements

Extend ISO TS 14515 to more environments.

*NP - The environmental Ergonomics
Survey*

K.C.Parsons@lboro.ac.uk