



EXISTING BUILDING PERFORMANCE INNOVATION CHALLENGE

**Last Issue date:
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INN-2 CHALLENGE EBP - IEQ-3POINTS
AVAILABLE**1****AIM OF CREDIT**

To encourage and recognise project teams that achieve full points under EBP - IEQ-3 Thermal comfort.

CREDIT CRITERIA

One point is awarded where:

Innovation Challenge Criteria:

- Achieve full points under EBP - IEQ-3 Thermal Comfort.

***See EBP - IEQ-3 and EBP - INN-2 for compliance.**

For Mechanically Ventilated Spaces:

- Measure air speed at the same time as the temperature measurements above.
- Confirm predicted mean vote (PMV) levels, calculated in accordance with ISO7730 tables E.1 to E.9 (see below) using standard clothing and metabolic rates values, are within the following limits for at least 90% of the measurements during both measurement periods:
 - PMV levels between -1.0 and + 1.0 (inclusive)

For Naturally Ventilated Spaces:

- At least 90% of the measured internal operative temperatures are within the ASHRAE Standard 55-2004 80% Acceptability Limits (see below), OR
- The predicted mean vote (PMV) levels calculated in accordance with ISO7730 tables E.1 to E.9 (see below) using standard clothing and metabolic rate values, are within the following limits for at least 90% of the measurements during both measurement periods:
 - PMV levels between -1.0 and + 1.0 (inclusive)

DOCUMENTATION REQUIREMENTS / EVIDENCE

Criteria	Documentation
PMV Calculations	Short Report Containing: <ul style="list-style-type: none"> ▪ Summary of PMV calculations ▪ Table of measurements taken for typical spaces
ASHRAE Calculations	Short Report Containing: <ul style="list-style-type: none"> ▪ Summary of ASHRAE 55 Calculations

***See EBP - IEQ-3 and EBP- INN-2 for compliance.**

INN-2 CHALLENGE EBP - IEQ-3POINTS
AVAILABLE**1****Short Report must provide:**

- Confirmation that the assessor noted down the occupants activity and clothing levels at the time of taking the measurements. General activity and clothing level for a building / space can be used for the PMV calculation. It is not necessary to consider each individual separately.
- Total number of measurements taken.
- Total number of measurements below the limit.
- Indicate the percentage of the measurements below the limit.
- PMV Summary Result using collected data (temperatures, air speed, clothing levels and activity level) ISO 7730 tables E.1 to E.9. The PMV results shall indicate the total percentage of PMV values within the range of -1.0 to +1.0.
- ASHRAE 55 acceptability results. If the space is naturally ventilated then using only the monthly average outside temperature and the measured indoor temperature, determine if the measurement is within or out of the 80% acceptability range according to ASHRAE 55 figure 5.3. Alternatively the PMV results as indicated above can be used for naturally ventilated spaces.

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Below are example PMV values using ISO 7730 Tables E.1 to E.9 with 80% satisfaction rates highlighted for typical office activity levels and standard winter and summer clothing. Table E.3 relates to individuals with a metabolic rate of 1.2 (office work).

(PMV Values between -1.0 and +1.0)

Table E.3 — Activity level: 65,6 W/m² (1,2 met)

Clothing		Operative temperature °C	Relative air velocity:							
clo	m ² · kW		m/s							
			<0,10	0,10	0,15	0,20	0,30	0,40	0,50	1,00
0	0	25	-1,33	-1,33	-1,59	-1,92				
		26	-0,83	-0,83	-1,11	-1,40				
		27	-0,33	-0,33	-0,63	-0,88				
		28	0,15	0,12	-0,14	-0,36				
		29	0,63	0,56	0,35	0,17				
		30	1,10	1,01	0,84	0,69				
		31	1,57	1,47	1,34	1,24				
		32	2,03	1,93	1,85	1,78				
		23	-1,18	-1,18	-1,39	-1,61	-1,97	-2,25		
		24	-0,79	-0,79	-1,02	-1,22	-1,54	-1,80	-2,01	
		25	-0,42	-0,42	-0,64	-0,83	-1,11	-1,34	-1,54	-2,21
		26	-0,04	-0,07	-0,27	-0,43	-0,68	-0,89	-1,06	-1,65
0,25	0,039	27	0,33	0,29	0,11	-0,03	-0,25	-0,43	-0,58	-1,09
		28	0,71	0,64	0,49	0,37	0,18	0,03	-0,10	-0,54
		29	1,07	0,99	0,87	0,77	0,61	0,49	0,39	0,03
		30	1,43	1,35	1,25	1,17	1,05	0,95	0,87	0,58
		18	-2,01	-2,01	-2,17	-2,38	-2,70			
		20	-1,41	-1,41	-1,58	-1,76	-2,04	-2,25	-2,42	
		22	-0,79	-0,79	-0,97	-1,13	-1,36	-1,54	-1,69	-2,17
		24	-0,17	-0,20	-0,36	-0,48	-0,68	-0,83	-0,96	-1,35
		26	0,44	0,39	0,26	0,16	-0,01	-0,11	-0,21	-0,52
		28	1,05	0,98	0,88	0,81	0,70	0,61	0,54	-0,31
		30	1,64	1,57	1,51	1,46	1,39	1,33	1,29	1,14
		32	2,25	2,20	2,17	2,15	2,11	2,09	2,07	1,99
0,75	0,116	16	-1,77	-1,77	-1,91	-2,07	-2,31	-2,49		
		18	-1,27	-1,27	-1,42	-1,56	-1,77	-1,93	-2,05	-2,45
		20	-0,77	-0,77	-0,92	-1,04	-1,23	-1,36	-1,47	-1,82
		22	-0,25	-0,27	-0,40	-0,51	-0,66	-0,78	-0,87	-1,17
		24	0,27	0,23	0,12	0,03	-0,10	-0,19	-0,27	-0,51
		26	0,78	0,73	0,64	0,57	0,47	0,40	0,34	0,14
		28	1,29	1,23	1,17	1,12	1,04	0,99	0,94	0,80
		30	1,80	1,74	1,70	1,67	1,62	1,58	1,55	1,46
		16	-1,18	-1,18	-1,31	-1,43	-1,59	-1,72	-1,82	-2,12
		18	-0,75	-0,75	-0,88	-0,98	-1,13	-1,24	-1,33	-1,59
		20	-0,32	-0,33	-0,45	-0,54	-0,67	-0,76	-0,83	-1,07
		22	0,13	0,10	0,00	-0,07	-0,18	-0,26	-0,32	-0,52
1,00	0,155	24	0,58	0,54	0,46	0,40	0,31	0,24	0,19	0,02
		26	1,03	0,98	0,91	0,86	0,79	0,74	0,70	0,58
		28	1,47	1,42	1,37	1,34	1,28	1,24	1,21	1,12
		30	1,91	1,86	1,83	1,81	1,78	1,75	1,73	1,67

ISO 7730 Example thermal comfort design criteria

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Table C.1 — Thermal insulation for typical combinations of garments

Work clothing	I_{cl}		Daily wear clothing	I_{cl}	
	clo	$m^2 \cdot K/W$		clo	$m^2 \cdot K/W$
Underpants, boiler suit, socks, shoes	0,70	0,110	Panties, T-shirt, shorts, light socks, sandals	0,30	0,050
Underpants, shirt, boiler suit, socks, shoes	0,80	0,125	Underpants, shirt with short sleeves, light trousers, light socks, shoes	0,50	0,080
Underpants, shirt, trousers, smock, socks, shoes	0,90	0,140	Panties, petticoat, stockings, dress, shoes	0,70	0,105
Underwear with short sleeves and legs, shirt, trousers, jacket, socks, shoes	1,00	0,155	Underwear, shirt, trousers, socks, shoes	0,70	0,110
Underwear with long legs and sleeves, thermo-jacket, socks, shoes	1,20	0,185	Panties, shirt, trousers, jacket, socks, shoes	1,00	0,155
Underwear with short sleeves and legs, shirt, trousers, jacket, heavy quilted outer jacket and overalls, socks, shoes, cap, gloves	1,40	0,220	Panties, stockings, blouse, long skirt, jacket, shoes	1,10	0,170
Underwear with short sleeves and legs, shirt, trousers, jacket, heavy quilted outer jacket and overalls, socks, shoes	2,00	0,310	Underwear with long sleeves and legs, shirt, trousers, V-neck sweater, jacket, socks, shoes	1,30	0,200
Underwear with long sleeves and legs, thermo-jacket and trousers, Parka with heavy quilting, overalls with heavy quilting, socks, shoes, cap, gloves	2,55	0,395	Underwear with short sleeves and legs, shirt, trousers, vest, jacket, coat, socks, shoes	1,50	0,230

ISO 7730 Example clothing levels for typical combinations

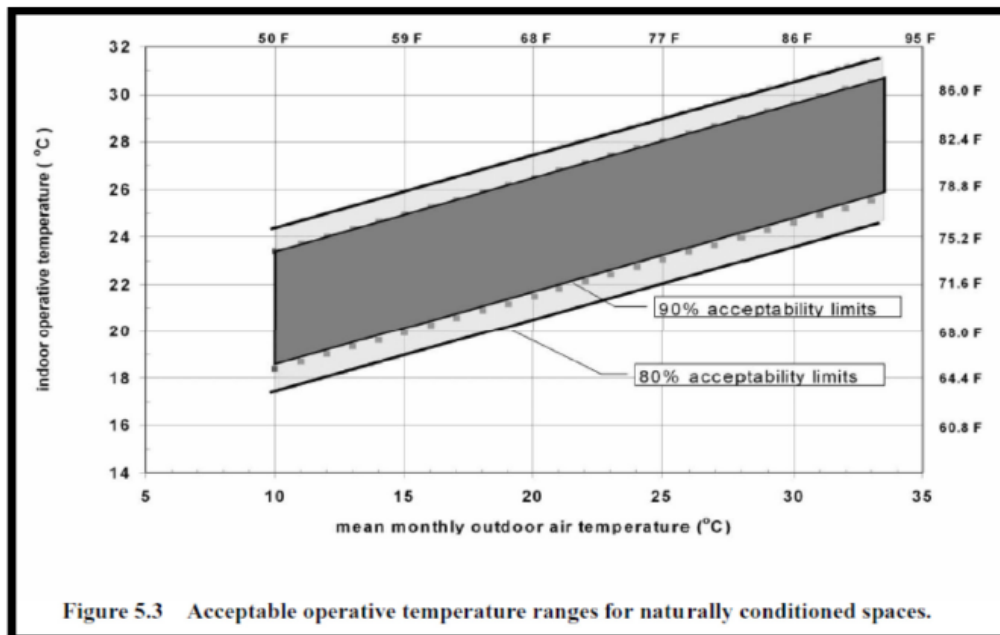
Table A.5 — Example design criteria for spaces in various types of building

Type of building/space	Activity W/m ²	Category	Operative temperature °C		Maximum mean air velocity ^a m/s	
			Summer (cooling season)	Winter (heating season)	Summer (cooling season)	Winter (heating season)
Single office	70	A	24,5 ± 1,0	22,0 ± 1,0	0,12	0,10
Landscape office		B	24,5 ± 1,5	22,0 ± 2,0	0,19	0,16
Conference room						
Auditorium		C	24,5 ± 2,5	22,0 ± 3,0	0,24	0,21 ^b
Cafeteria/restaurant	81	A	23,5 ± 1,0	20,0 ± 1,0	0,11	0,10 ^b
Classroom		B	23,5 ± 2,0	22,0 ± 2,5	0,18	0,15 ^b
		C	23,5 ± 2,5	22,0 ± 3,5	0,23	0,19 ^b
Kindergarten		A	23,0 ± 1,0	19,0 ± 1,5	0,16	0,13 ^b
Department store	93	B	23,0 ± 2,0	19,0 ± 3,0	0,20	0,15 ^b
		C	23,0 ± 3,0	19,0 ± 4,0	0,23	0,18 ^b

^a The maximum mean air velocity is based on a turbulence intensity of 40 % and air temperature equal to the operative temperature according to 6.2 and Figure A.2. A relative humidity of 60 % and 40 % is used for summer and winter, respectively. For both summer and winter a lower temperature in the range is used to determine the maximum mean air velocity.

^b Below 20 °C limit (see Figure A.2).

ASHRAE 55 Example design criteria for space in various types of buildings.

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AVAILABLE**1****Naturally Ventilated spaces****ASHRAE 55-2004 Acceptability Criteria****ASHRAE 55-2004 Adaptive Comfort Temperatures**

The ASHRAE guide defines a range of temperatures which are deemed comfortable for a naturally ventilated space, where occupants have control over openings. These depend on the mean monthly outside air temperature, based on the fact that people living in warmer areas can tolerate higher internal temperatures than those living in cold areas. An approximate summary of the data is as follows:

Mean monthly outdoor temp °C	Min internal temp (80% acceptability) °C	Min internal temp (90% acceptability) °C	Max internal temp (90% acceptability) °C	Max internal temp (80% acceptability) °C
10	17.5	18.5	23.5	24.5
15	19	20	25	26
20	20.5	21.5	26.5	27.5
25	22	23	28	29
30	23.5	24.5	29.5	30.5

Table IEQ-9.1: Adaptive Comfort Temperatures as defined in ASHRAE 55-2004

These internal temperatures are 'operative' internal temperatures, defined in ASHRAE Fundamentals 2001. For occupants not sitting in direct sunlight, this can be approximated as the mean of the air temperature and the mean radiant temperature.

ASHRAE 55-2004 Adaptive Comfort Temperatures

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AVAILABLE**1****ADDITIONAL GUIDANCE / RESOURCES**

Refer to the GBCSA website at www.gbcsa.org.za

BACKGROUND

Thermal comfort is important for the occupants of a building to remain productive if they spend a significant amount of time in the space. The perception of thermal comfort is influenced through a variety of factors such as clothing, activity level, air and radiant temperature, relative humidity and air speed.

The first step in maintaining thermal comfort conditions are to have a process in place to monitor the major factors that influence thermal comfort such as temperature humidity and air speed. In order to ultimately determine if thermal comfort levels are achieved these measured values together with the activity and clothing levels are required to be used in a predicted mean vote (PMV) calculation in order to determine if the majority of the occupants will experience comfort levels. This credit aims at using occupant surveys and a simplified calculation methodology to determine if the thermal comfort is achieved in the building.

REFERENCES

- ISO7730 – PMV Levels (Predicted Mean Vote), http://www.iso.org/iso/catalogue_detail.htm?csnumber=39155 ASHRAE 55-2004 (and 2010),
- <https://www.ashrae.org/resources--publications/bookstore/standard-55>
- Green Star South Africa, Public & Education Building v1 Rating tool, <https://www.gbcsa.org.za/knowledge/publications/?cat=98>
- LEED EBO&M, 2009 Edition, <http://www.usgbc.org/resources/leed-ebom-2009-reference-guidesupplement-> Europe acps-global-acp
- Green Star Australia, Green Star Performance, <https://www.gbca.org.au/green-star/green-starperformance/>