



WELL v2

Concept summary

**THERMAL
COMFORT**



Thermal comfort is a state of mind which expresses satisfaction with the thermal environment.¹

1. American Society of Heating, Refrigeration and Air Conditioning Engineers. ANSI/ASHRAE Standard 55-2013: Thermal Environmental Conditions for Human Occupancy. Atlanta: ASHRAE; 2013.

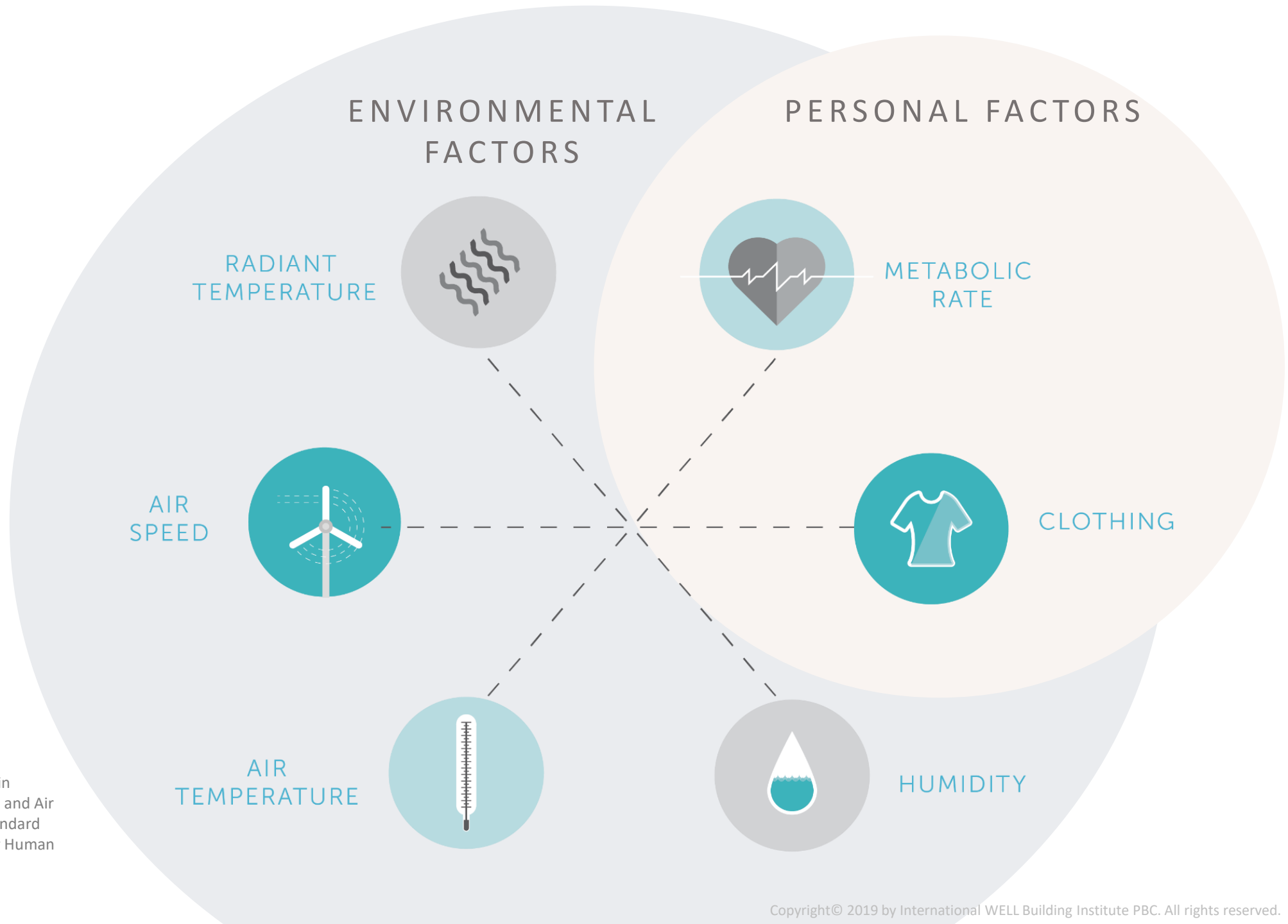


THERMAL COMFORT

IMPACT

Thermal comfort greatly influences our experiences in the places where we live and work.³ It is one of the highest contributing factors influencing overall human satisfaction in buildings,⁴⁻⁶ impacting individual levels of motivation, alertness, focus and mood.⁶





Graphic adapted from a figure presented in American Society of Heating Refrigeration and Air Conditioning Engineers. ANSI/ASHRAE Standard 55: Thermal Environmental Conditions for Human Occupancy. Atlanta, GA: ASHRAE; 2013.



THERMAL COMFORT

THE IMPACT

In a laboratory setting, personal thermal comfort devices have been shown to improve self-reported productivity rates and increase thermal comfort.¹

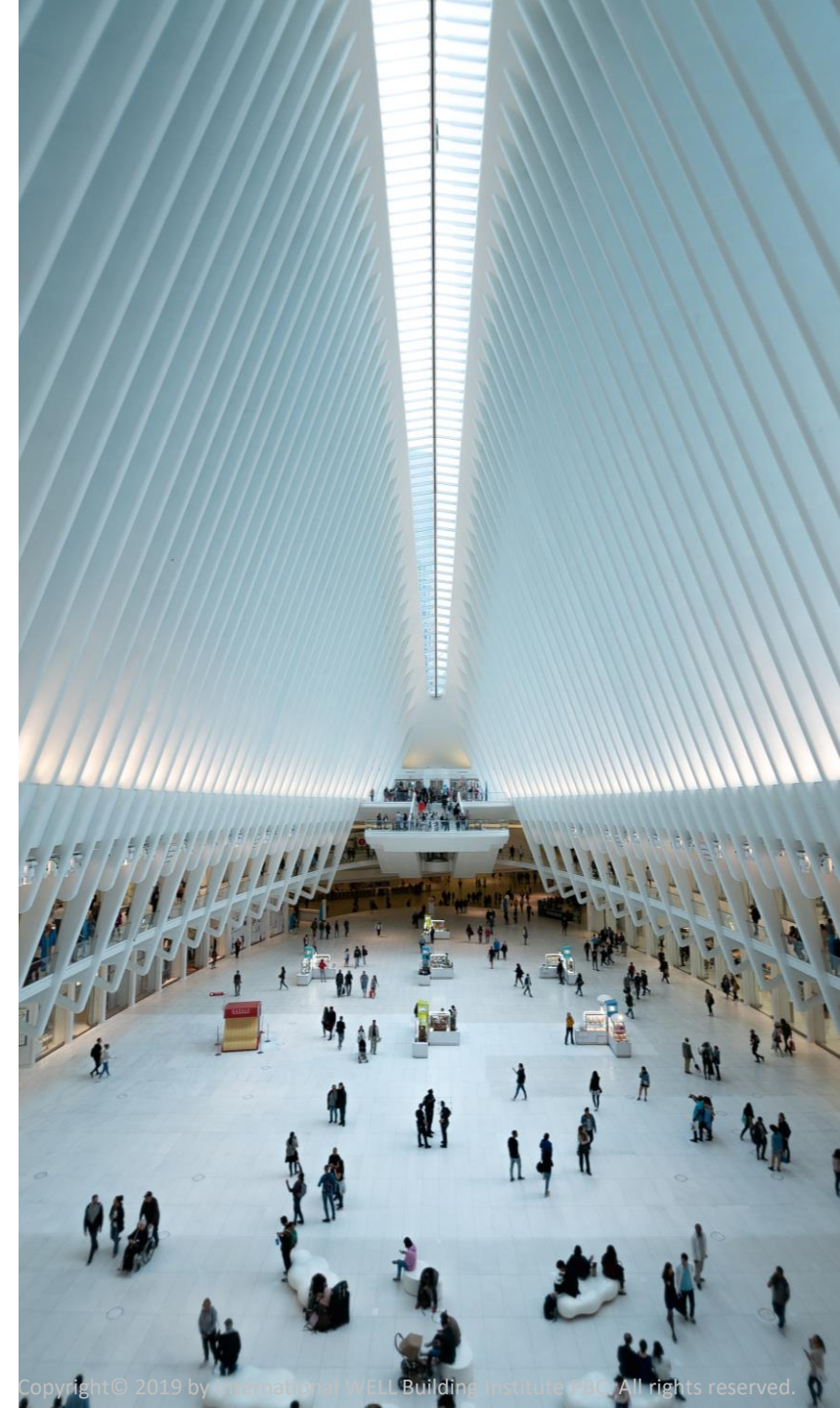
1. Boerstra AC, te Kulve M, Toftum J, Loomans MGLC, Olesen BW, Hensen JLM. Comfort and performance impact of personal control over thermal environment in summer: Results from a laboratory study. *Build Environ.* 2015;87:315-326. doi:10.1016/J.BUILDENV.2014.12.022.

TOO COLD IN SUMMER, TOO HOT IN WINTER

The overcooling of buildings in summer is a commonly observed and persistent problem in offices and other commercial buildings. Similarly, these spaces can feel too hot in winter months.

What health implications might arise from this?

Thermal discomfort is known to play a role in sick building syndrome [SBS] symptoms.





THERMAL COMFORT

ISSUE

Leading research indicates employees perform 15% poorer when the office is overheated and 14% poorer when the office is cold.¹ Thermal discomfort is also known to play a role in sick building syndrome symptoms, which will similarly cause decreases in productivity.²





THERMAL COMFORT

Maximize your comfort and productivity through improved HVAC system design and by meeting thermal preferences.

- T01 Thermal Performance*
- T02 Verified Thermal Comfort
- T03 Thermal Zoning
- T04 Individual Thermal Control
- T05 Radiant Thermal Comfort
- T06 Thermal Comfort Monitoring
- T07 Humidity Control
- T08 Enhanced Operable Windows
- T09 Outdoor Thermal Comfort



T01 THERMAL PERFORMANCE

Provide a thermal environment that the majority of building users find acceptable.

1. Provide An Acceptable Thermal Environment
2. Monitor Thermal Parameters

T06 THERMAL COMFORT MONITORING

Inputs

Select method: PMV method

Operative temperature
 °C

Air speed
 m/s

Relative humidity
 %

Metabolic rate
 met

Clothing level
 clo

No local control

Relative humidity

Seated, quiet: 1.0

Trousers, long-sleeve sh

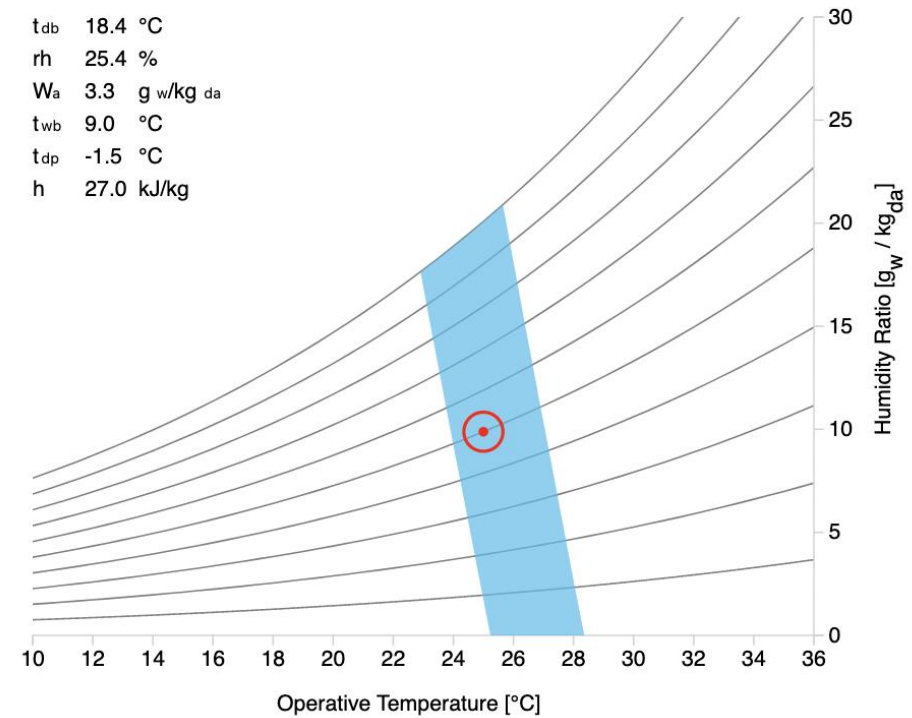
✓ Complies with ASHRAE Standard 55-2020

PMV = -0.16
Sensation = Neutral

PPD = 6 %
SET = 24.8 °C

Psychrometric (operative temperature)

t_{db} 18.4 °C
 rh 25.4 %
 W_a 3.3 g w/kg da
 t_{wb} 9.0 °C
 t_{dp} -1.5 °C
 h 27.0 kJ/kg





T02 VERIFIED THERMAL COMFORT

Verify building design elements have translated into occupant comfort and satisfaction by ensuring a substantial majority of building users (above 80%) perceive their environment as thermally acceptable.

1. Survey for Thermal Comfort
 1. Sample survey in Appendix T1



T07 HUMIDITY CONTROL

Limit the growth of pathogens, reduce off-gassing and maintain thermal comfort by providing the appropriate level of humidity.

1. Manage Relative Humidity
 1. The mechanical system has the capability of maintaining relative humidity between 30% and 60% at all times.



T03 THERMAL ZONING

- Smaller thermal control zones
- Occupant controllable thermostats

T04 INDIVIDUAL THERMAL COMFORT

- Personal cooling + heating options
- Allowing flexible dress code

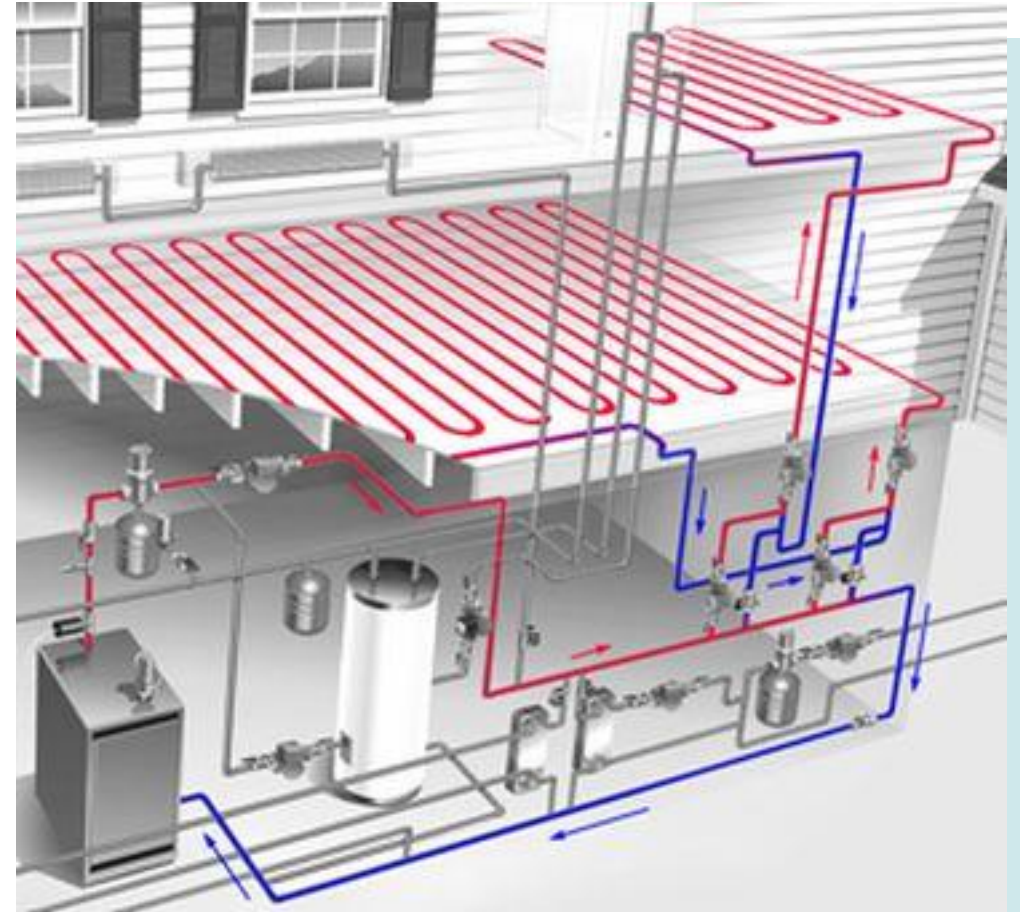
T08 β ENHANCED OPERABLE WINDOWS

T05 RADIANT

THERMAL COMFORT

Conventional "all-air" mechanical systems have a higher risk of draft discomfort may lead to decreased thermal comfort for occupants.

1. Implement Radiant Heating
2. Implement Radiant Cooling



T09 β OUTDOOR THERMAL COMFORT

Address the thermal comfort needs of project occupants in the exterior spaces of the project.

- Adding vegetation
- Providing shading structures
- Increasing reflectance of building materials
- Introducing water features





WE ARE WELL

wellcertified.com



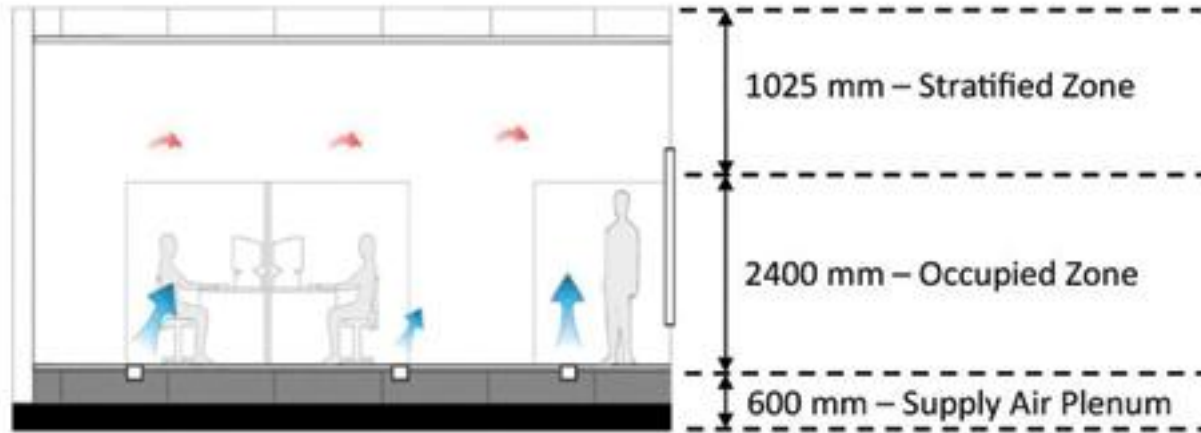
WELL IN PRACTICE

THERMAL COMFORT

METROPOLE HQ – TAIPEI, TAIWAN



Smart Cooling



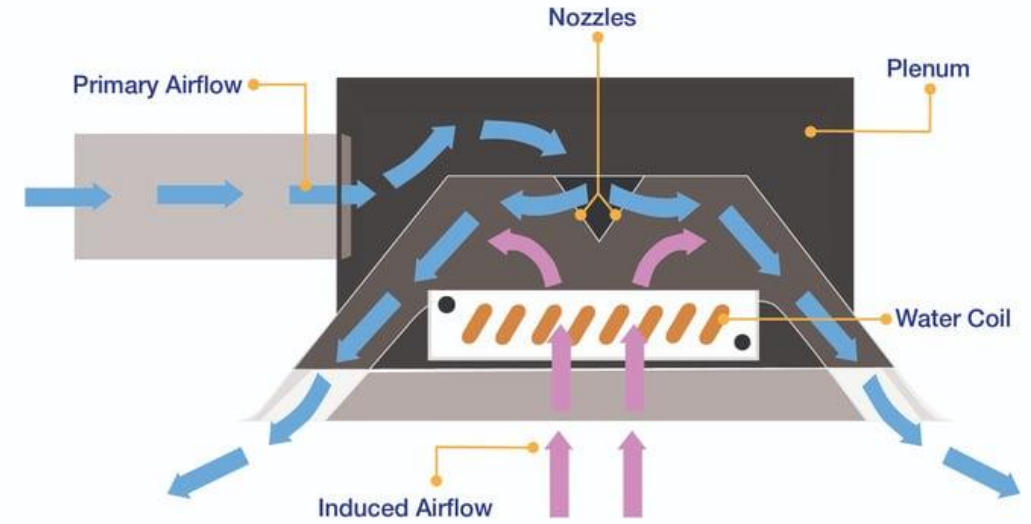
Occupied Zone:

1. Occupancy Load
2. Plug Load

Stratified Zone

1. Lighting Load

**Supply Temperature set-point for UFAD – 18
Deg C (Grille outlet temperature)**



REFERENCES

1. Vimalanathan K, Babu TR. The effect of indoor office environment on the work performance, health and well-being of office workers. *J Environ Heal Sci Eng*. 2014;12(1). doi:10.1186/s40201-014-0113-7
2. Boerstra AC, Kulve M te, Toftum J, Loomans MGLC, Olesen BW, Hensen JLM. Comfort and performance impact of personal control over thermal environment in summer: Results from a laboratory study. *Build Environ*. 2015;87:315-326. doi:10.1016/j.buildenv.2014.12.022
3. Nicol JF, Humphreys MA. Adaptive thermal comfort and sustainable thermal standards for buildings. *Energy Build*. 2002;34(6):563-572. doi:10.1016/S0378-7788(02)00006-3
4. Frontczak M, Wargocki P. Literature survey on how different factors influence human comfort in indoor environments. *Build Environ*. 2011;46(4):922-937. doi:10.1016/j.buildenv.2010.10.021
5. Frontczak M, Schiavon S, Goins J, Arens E, Zhang H, Wargocki P. Quantitative relationships between occupant satisfaction and satisfaction aspects of indoor environmental quality and building design. *Indoor Air*. 2012;22(2):119-131. doi:10.1111/j.1600-0668.2011.00745.x
6. Lamb S, Kwok KCS. A longitudinal investigation of work environment stressors on the performance and wellbeing of office workers. *Appl Ergon*. 2016;52:104-111. doi:10.1016/j.apergo.2015.07.010
7. Fanger PO. Assessment of man's thermal comfort in practice. *Br J Ind Med*. 1973;30(4):313-324.
8. Mendell MJ, Fisk WJ, Kreiss K, et al. Improving the health of workers in indoor environments: Priority research needs for a National Occupational Research Agenda. *Am J Public Health*. 2002;92(9):1430-1440. doi:10.2105/AJPH.92.9.1430
9. Stefano Schiavon RZ. *Indoor Climate and Productivity in Offices*. Berkeley, CA: Federatin of European Heating, Ventilation and Air Conditioning Associations; 2008. <https://www.rehva.eu/eshop/detail/no06-indoor-climate-and-productivity-in-offices>.
10. Huizenga C, Abbaszadeh S, Zagreus L, Arens EA. Air Quality and Thermal Comfort in Office Buildings: Results of a Large Indoor Environmental Quality Survey. In: *Proceedings of Healthy Buildings*. Vol III. ; 2006:393-397. <http://escholarship.org/uc/item/7897g2f8;jsessionid=CEA1E13173D8003D5F74BD638E71785C>.
11. Vimalanathan K, Babu TR. The effect of indoor office environment on the work performance, health and well-being of office workers. *J Environ Heal Sci Eng*. 2014;12(1). doi:10.1186/s40201-014-0113-7
12. American Society of Heating Refrigerating and Air-Conditioning Engineers. *ASHRAE 55-2013: Thermal Environmental Conditions for Human Occupancy*. 2013. https://www.techstreet.com/ashrae/standards/ashrae-55-2013?product_id=1868610.
13. American Society of Heating Refrigerating and Air-Conditioning Engineers. *ASHRAE Handbook: fundamentals*. 2017. <https://www.ashrae.org/technical-resources/ashrae-handbook/description-2017-ashrae-handbook-fundamentals>.
14. Bluysen PM, Roda C, Mandin C, et al. Self-reported health and comfort in "modern" office buildings: First results from the European OFFICAIR study. *Indoor Air*. 2016;26(2):298-317. doi:10.1111/ina.12196
15. Jing S, Li B, Tan M, Liu H. Impact of relative humidity on thermal comfort in a warm environment. *Indoor Built Environ*. 2013;22(4):598-607. doi:10.1177/1420326X12447614
16. Nematchoua MK, Orosa JA. Building construction materials effect in tropical wet and cold climates: A case study of office buildings in Cameroon. *Case Stud Therm Eng*. 2016;7:55-65. doi:10.1016/j.csite.2016.01.007
17. Petrofsky JS, Berk L, Alshammari F, et al. The interrelationship between air temperature and humidity as applied locally to the skin: The resultant response on skin temperature and blood flow with age differences. *Med Sci Monit*. 2012;18(4):CR201-CR208. doi:10.12659/MSM.882619
18. Burge S, Hedge A, Wilson S, Bass JH, Robertson A. Sick building syndrome: A study of 4373 office workers. *Ann Occup Hyg*. 1987;31(4 A):493-504. doi:10.1093/annhyg/31.4A.493
19. Horr, A., Kaushik, A., Mazroei, A., Katafygiotou, A. & Elsarrag E. Occupant productivity and office indoor environment quality : a review of the literature *Occupant Productivity and Office Indoor Environment Quality : A Review of the Literature*. 2016. http://usir.salford.ac.uk/39106/3/BAE-D-16-00533_final%2520manuscript%5B1%5D.pdf.
20. Brager GS. Benefits of Improving Occupant Comfort and Well-being in Buildings. In: *Proceedings of the 4th International Holcim Forum for Sustainable Construction: The Economy of Sustainable Construction*. Mumbai; 2013:181-194. https://src.lafargeholcim-foundation.org/dnl/93603859-d59e-498a-b056-405d16e39171/F13_OrangeWS_Brager.pdf.
21. Environmental Protection Agency. *Heat Island Cooling Strategies | Heat Island Effect | US EPA*.
22. UCAR Center for Science Education. *Urban Heat Islands | UCAR Center for Science Education*.

INTERNATIONAL WELL BUILDING INSTITUTE, IWBI, WELL BUILDING STANDARD, WELL COMMUNITY STANDARD, WELL CERTIFIED, WELL PORTFOLIO, WELL PORTFOLIO SCORE, WELL AP, THE WELL CONFERENCE, WELL HEALTH-SAFETY RATING, WELL PERFORMANCE, WELL EP, WELL ENTERPRISE, WELL™, and others and their related logos are trademarks or certification marks of the International WELL Building Institute pbc in the United States and other countries.

Although the information contained in this presentation is believed to be reliable and accurate, all materials set forth within are provided without warranties of any kind, either express or implied, including but not limited to warranties of the accuracy or completeness of information or the suitability of the information for any particular purpose. IWBI's WELL offerings and resources related thereto are intended to educate and assist organizations, building stakeholders, real estate owners, tenants, occupants; and neither this presentation and nor any related materials should be considered, or used as a substitute for, quality control, safety analysis, legal compliance, financial or investment advice, comprehensive urban planning, medical advice, diagnosis or treatment.