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DEA 3500: HUMAN FACTORS: THE AMBIENT ENVIRONMENT (Fall 2017)

NAME:_____

HOMEWORK I
PRINT THIS OUT AND HAND IT IN BY THE DUE DATE

Due Date: September 14 in class

NOTE: You will need to consult the course texts and class notes to complete this homework. Note: for some answers you can only make an approximation. For calculations give your answers to no more than 2 decimal places.

1. Indicate whether each of the following statements is True (T) or False (F):

a. warm air can contain less moisture than cold air	T	F
b. cold air is always less humid than warm air	T	F
c. dry warm air is always heavier than moist cold air	T	F
d. moisture condense above 100% SVP of the air	T	F
e. moving air is always less humid than still air	T	F
f. An air temperatures of 91.4°F marks the onset of cardiac disturbances	T	F
g. The lungs are a principal source of body heat	T	F
h. The energy equivalent of metabolizing 2L oxygen is ~38-42 kJ	T	F
i. Air at the dew point can absorb 10% water	T	F
j. The saturated vapor pressure of air decreases as temperature increases	T	F
k. Peripheral vasomotor tone helps to balance body heat production and heat loss	T	F
l. The skin has ~16 million eccrine glands	T	F
m. Around 4% body weight is the maximum allowable sweat loss	T	F
n. Sports drinks are always the best fluid for rehydration	T	F
o. Acclimatization can allow for a doubling of the sweat rate	T	F
p. Heat acclimatization naturally occurs when the core temperature is 88.7°F	T	F

2. Indicate whether each of the following statements is True (T) or False (F):

a. at an air temperature of 85°F and a radiant temperature of 29.4°C most body heat is lost to the environment through radiation processes	T	F
b. at an air temperature of 73°F and radiant temperature of 22.8°C most body heat is radiated to the environment through convection processes	T	F
c. at an air temperature of 85.0°F and radiant temperature of 52.2°C most body heat is lost to the environment through sweat evaporation	T	F
d. at an air temperature of 17.2°C and radiant temperature of 66 °F most body heat is lost to the environment through radiation processes	T	F
e. at an air temperature of 35.6°C and radiant temperature of 98.0°F all body heat is lost to the environment through evaporation processes	T	F

3. Name the instrument that you would use to measure the following thermal variables:
   a. absolute humidity or relative humidity_____
   b. air temperature_____
   c. radiant temperature_____
   d. air velocity_____

4. Clothing plays a major role in determining thermal comfort. Using the table (Appendix A), what is the clothing insulation value in clo's for each of the clothing ensembles listed? DO NOT USE THE FORMULA IN SANDERS & MCCORMICK.
   For passive clothing insulation you can add clo values.
   For an active person the clo value must be adjusted: I_{cl}, active = I_{cl} x (0.6 + 0.4/M)
   a. indoor summer clothes for a sedentary man (M=1) comprising a short-sleeve knit sports-shirt, briefs, thin trousers, ankle socks, shoes= _____
   b. outdoor summer clothes for a seated woman (M=1) comprising T-shirt, bra, panties, thin skirt, bare legs and sandals = _____
   c. outdoor summer clothes for a man who is walking briskly (M=2) comprising T-shirt, walking shorts, bare legs, and sandals = _____
   d. standing (M=1.2) male worker wearing overalls, briefs, long sleeve flannel shirt, thick knee socks, boots =_____
   e. indoor clothes for a standing man (M=1.2) comprising thick single breasted suit, thick long sleeve sweater, long-sleeve dress shirt, calf-length socks, shoes briefs = _____
   f. indoor clothes for a seated woman (M=1) comprising sweatpants, long sleeve sweatshirt, bra, panties, ankle socks, slippers = _____
   g. light industrial assembly worker (M=1.6) wearing briefs, calf-length socks, boots, long-sleeve flannel shirt, coveralls= _____

5. Convert the following temperatures to either °C or °F (to 1 decimal place). Show your calculation:
   a.11.5°F = °C _____
   b.40.3°C = _____°F _____
   c.-20.2°C = _____°F _____
   d. 91.4°F = _____°C _____
   e.37.0°C = _____°F _____
   f. -40.0°F = _____°C _____

6. Indicate whether each of the following statements about insulation is true or false: (circle answer)

a. high clo value fabric always have high moisture permeability	T	F
b. clothing can absorb radiant heat from the body	T	F
c. light colors are good heat absorbers	T	F
d. heat is synonymous with temperature	T	F
e. moving air has a higher thermal resistance than still air	T	F
f. the clo value is always different for men and women	T	F
g. the fabric weave affect the moisture permeability of clothing	T	F

7. The effective temperature combines air temperature, humidity, and air movement to create a scale of equal sensations of warmth or cold. Use the chart in Appendix B to complete the following to obtain the ~ answer. (t_a = air temperature; t_w = wet bulb temperature; v = air velocity, m/s = meters/sec ; fpm = feet per min.,; ET = effective temperature):
   a. t_a = 80.1°F, t_w =75.2°F, v = 197 fpm ET= _____°F
   b. t_a = 89.6°F, t_w =77.0°F, v = 492 fpm, ET =_____°F
   c. t_a = 75.2°F, t_w =73.0°F, v = 2.5 m/s, ET= _____°F

d. v=1.0 m/s ET = 68°F, t_w = 69.8°F, t_a = _____ °F
e. t_a = 100.4°F, ET = 84.2°F, t_w = 78.8°F, v= _____ fpm
f. t_a = 95.0°F, v = 3.0 m/s, ET = 78.8°F, t_w = ____ °F
g. t_a = 78.8°F, t_w = 72.5°F, ET =73.4°F, v = _____ m/s

8. the operative temperatures for the following situations:
($t_{op} = At_a + (1-A)t_r$)
a. t_a = 25.8°C, t_r = 24.2°C, A = 0.5, t_{op} = ____ °F
b. t_a = 21.8°C, t_r = 21.2°C, A = 0.6, t_{op} = ____ °F
c. t_a = 78.4°F, t_r = 72.5°F, A = 0.7, t_{op} = ____ °C
d. t_a = 89.6°F, t_r = 82.4°F, A = 0.5, t_{op} = ____ °C
e. t_a = 68°F, A = 0.5, t_{op} = 67.1°F, t_r = _____ °F
f. t_r = 23.4°C, A = 0.5, t_{op} = 76.1°F, t_a = _____ °F
g. t_a = 71.6°F, t_r = 59.8°F, t_{op} = 70.52°F, A= _____
h. t_r = 81.68°F, t_a = 88.52°F, t_{op} = 86.81°F, A= _____

9. Using the chart in Appendix C Indicate whether each of the following statements is True (T) or False (F):
A person will be comfortable with:

a. t_{op}=25°C, RH = 60%, 0.5 clo, 0.1 m/s	T	F
b. t_{op}=29°C, RH = 40%, 0.5 clo, 0.1 m/s	T	F
c. t_{op}=23°C, RH = 20%, 1.0 clo, 0.1 m/s	T	F
d. t_{op}=20°C, RH = 60%, 1.0 clo, 1.2 m/s	T	F
e. t_{op}=27°C, RH = 50%, 1.0 clo, 0.1 m/s	T	F
f. t_{op}=22°C, RH = 35%, 1.0 clo, 0.1 m/s	T	F

10. For the following values of natural wet bulb temperature (NWB), globe temperature (dry bulb temperature - DB), and air temperature (t_a) calculate the wet-bulb globe temperatures (WBGT) and the Botsball index all in degrees C:
a. Indoors NWB = 28.7°C, GT = 26.9°C BB = _____ °F
b. Outdoors NWB =78.2°F, t_a = 83.6°F, GT = 80.8°F, WBGT = _____ °F
c. BB = 84.2°F, WBGT = _____ °F
d. Indoors WBGT = 31.5°C, BB = _____ °F
e. Indoors GT = 79.8°F BB = 72.9°F, NWB = _____ °F
f. Outdoors NWB =104.5°F, GT = 104°F, WBGT = 101.5°F , t_a = _____ °F
g. Outdoors NWB =78.2°F, WBGT = 79.0°F , t_a = 82.7°F, GT = _____ °F

11. Indicate whether the following statements are True (T) or False (F).
A person will be comfortable:

a. at 40% humidity, sedentary, and light clothing at 17.5°C	T	F
b. at 60% humidity, with medium activity and light clothing, at 23°C	T	F
c. at 40% humidity, medium, with light clothing, at 60°F	T	F
d. at 20% humidity, high activity, medium clothing, at 8°C	T	F
e. at 60% humidity, high activity, light clothing, 13.5°C	T	F
f. at 80% humidity, medium activity, medium clothing, 20°C	T	F

g. at 100% humidity, high activity, medium clothing, 10°C T F
h. at 80% humidity, sedentary, light clothing, 7°F T F

12. Air velocity and air temperature affect the percentage of people dissatisfied with feeling a draught around their head region. Using this knowledge complete the following:
(v = mean air velocity in m/s; T_a = air temperature; %D = percent dissatisfied) :
    a. t_a = 73°F, v = 1 ft/s, %D = _____ %
    b. t_a = 26°C, v = 0.33 ft/s, %D = _____ %
    c. v = 0.4 m/s, %D =60%, t_a = _____ °C
    d. t_a = 23°C, %D = 10%, v = _____ m/s

13. Heat stress produces a number of physiological changes in core (rectal) temperature. Using the information in the textbooks complete the following to illustrate some of these changes:
    a. ET = 21°C, work activity = 300 k cal/hr, core temperature = _____ °C
    b. ET = 29°C, work activity = 420 k cal/hr, core temperature = _____ °C
    c. core temperature = 37.8°C, work activity = 180 k cal/hr, ET = _____ °C
    d. air temperature = 26°C, heart rate (white females) = _____ bpm
    e. air temperature = 90°F, heart rate (black males) = _____ bpm
    f. air temperature = 20°C, heart rate (white males) = _____ bpm
    g. air temperature = 100°F, heart rate (black males) = _____ bpm
    h. the pulse rate for men working at 300 k cal/hr in a hot climate (48.9°C, 17% RH) for 7 days = _____ bpm
    i. when the mean core temperature of men working at 300 k cal/hr in a hot climate (48.9°C, 17% RH) is 38.3°C , the approx. mean pulse rate = _____ bpm
    j. the sweat loss rate for men working at 300 k cal/hr in a hot climate (48.9°C, 17% RH) for 3 days = _____ kg per _____ kg/hr
    k. 9 days acclimation for men working at 300 k cal/hr in a hot climate (48.9°C, 17% RH) results in an adaptive fall in core temperature of around _____ °F

14. Indicate whether each of the following statements is True (T) or False (F).
    a. In extreme heat skin blood flow can be 20% cardiac output T F
    b. heat acclimatization improves linearly with time T F
    c. heat stress depresses cardiac output T F
    d. people who work in cold environments can be at risk for heat stress T F
    e. metabolism increases 10% for each a 2ºC rise in skin temperature T F
    f. excess body fat degrades heat tolerance T F
    g. heat stroke is potentially fatal T F
    h. at 34ºC ET work productivity is 70% of pre-stress levels T F

15. Indicate whether each of the following statements is True (T) or False (F):
    i. heat stress can increase heart rate T F
    j. recovery from physical work is slower in hot environments T F
    k. heat stress sweating can exceed 8L per hour T F
    l. in a hot environment drinking 25 oz. of water/hour is recommended T F
    m. in a hot environment all body heat is lost through skin conduction T F
    n.

16. Indicate whether each of the following statements is True (T) or False (F):
    a. hyperpyrexia is the first stage of heat illness T F
    a. women are less prone to heat stress than men T F
    b. heat stress tolerance improves with increased fitness T F
    c. elderly adults can suffer from heat stress more than young adults T F
    d. hyperhydration can result from excessive sweating T F

17. Indicate whether each of the following statements is True (T) or False (F):
    a. the heat index measures heat-humidity combinations T F
    b. moderate work ability diminishes above 26ºC WBGT T F
    c. light work ability in still air diminishes above 30ºC WBGT T F
    d. heavy work ability in still air diminishes below 25ºC WBGT T F
    e. moderate thermal stress greatly improves visual reaction times T F
    f. >38ºC WBGT impairs cognitive task performance T F

18. Indicate whether each of the following statements is True (T) or False (F):
    a. frequent rest breaks help to reduce the effects of heat stress T F
    b. children are better able to regulate their temperature than adults T F
    c. heat acclimatization is a psychological process T F
    d. an ice-bag vest can work better than a fan to reduce heat stress T F
    e. physical fitness improves heat tolerance T F

19. Indicate whether each of the following statements is True (T) or False (F):
    a. a skin temperature of 30°C is perceived as comfortable T F
    b. peripheral vasoconstriction is a body defense against cold stress T F
    c. shivering helps to warm the body's core temperature T F
    d. unfit people shiver less efficiently than fitter people T F
    e. the 'dive reflex' instantly protects the lungs against cold stress T F
    f. cold water can reduce swimming efficiency T F
    g. frosting is a mild form of frostbite T F
    h. appropriate headgear should be worn in air temperatures <14°F T F

20. Indicate whether each of the following statements is True (T) or False (F):
    a. at 19°C mean-hand temperature the hands can be uncomfortably cold T F
    b. at 13°C manual dexterity is impaired compared with 24°C T F
    c. in air at 41°F bare hands are always painfully cold T F
    d. tracking task performance shows impairment at 4°C T F
    e. skin temperature affects skin sensitivity T F

21. Indicate whether each of the following statements is True (T) or False (F):
    a. people wearing 4 clo of insulation can tolerate a cold environment at 0°C about twice as long as people wearing 2 clo T F
    b. men always have colder hands than women T F
    c. Trucking workers have a higher risk of cold injury than heavy construction workers T F
    d. gloves are preferable to mittens below 32°F T F

e. a manual assembly task (Purdue Pegboard Test) performed after 60 minutes exposure to -18°C conditions can be completed half as quickly with auxiliary heat than with no heat T F

f. immersing the hands and forearms in cold water reduces heat stress T F

APPENDIX A

TABLE B2
Garment Insulation*

Garment Description†	I_{clu}, clo	Garment Description‡	I_{clu}, clo
Underwear		**Dress and Skirts****	
Bra	0.01	Skirt (thin)	0.14
Panties	0.03	Skirt (thick)	0.23
Men's briefs	0.04	Sleeveless, scoop neck (thin)	0.23
T-shirt	0.08	Sleeveless, scoop neck (thick), i.e., jumper	0.27
Half-slip	0.14	Short-sleeve shirtdress (thin)	0.29
Long underwear bottoms	0.15	Long-sleeve shirtdress (thin)	0.33
Full slip	0.16	Long-sleeve shirtdress (thick)	0.47
Long underwear top	0.20	**Sweaters**	
Footwear		Sleeveless vest (thin)	0.13
Ankle-length athletic socks	0.02	Sleeveless vest (thick)	0.22
Pantyhose/stockings	0.02	Long-sleeve (thin)	0.25
Sandals/thongs	0.02	Long-sleeve (thick)	0.36
Shoes	0.02	**Suit Jackets and Vests††**	
Slippers (quilted, pile lined)	0.03	Sleeveless vest (thin)	0.10
Calf-length socks	0.03	Sleeveless vest (thick)	0.17
Knee socks (thick)	0.06	Single-breasted (thin)	0.36
Boots	0.10	Single-breasted (thick)	0.44
Shirts and Blouses		Double-breasted (thin)	0.42
Sleeveless/scoop-neck blouse	0.12	Double-breasted (thick)	0.48
Short-sleeve knit sport shirt	0.17	**Sleepwear and Robes**	
Short-sleeve dress shirt	0.19	Sleeveless short gown (thin)	0.18
Long-sleeve dress shirt	0.25	Sleeveless long gown (thin)	0.20
Long-sleeve flannel shirt	0.34	Short-sleeve hospital gown	0.31
Long-sleeve sweatshirt	0.34	Short-sleeve short robe (thin)	0.34
Trousers and Coveralls		Short-sleeve pajamas (thin)	0.42
Short shorts	0.06	Long-sleeve long gown (thick)	0.46
Walking shorts	0.08	Long-sleeve short wrap robe (thick)	0.48
Straight trousers (thin)	0.15	Long-sleeve pajamas (thick)	0.57
Straight trousers (thick)	0.24	Long-sleeve long wrap robe (thick)	0.69
Sweatpants	0.28		
Overalls	0.30		
Coveralls	0.49		

* Data are from Chapter 9 in the *2009 ASHRAE Handbook—Fundamentals*[3].
† "Thin" refers to garments made of lightweight, thin fabrics often worn in the summer; "thick" refers to garments made of heavyweight, thick fabrics often worn in the winter.
‡‡ Knee-length dresses and skirts.
†† Lined vests.

APPENDIX B

How to determine Basic Effective Temperature

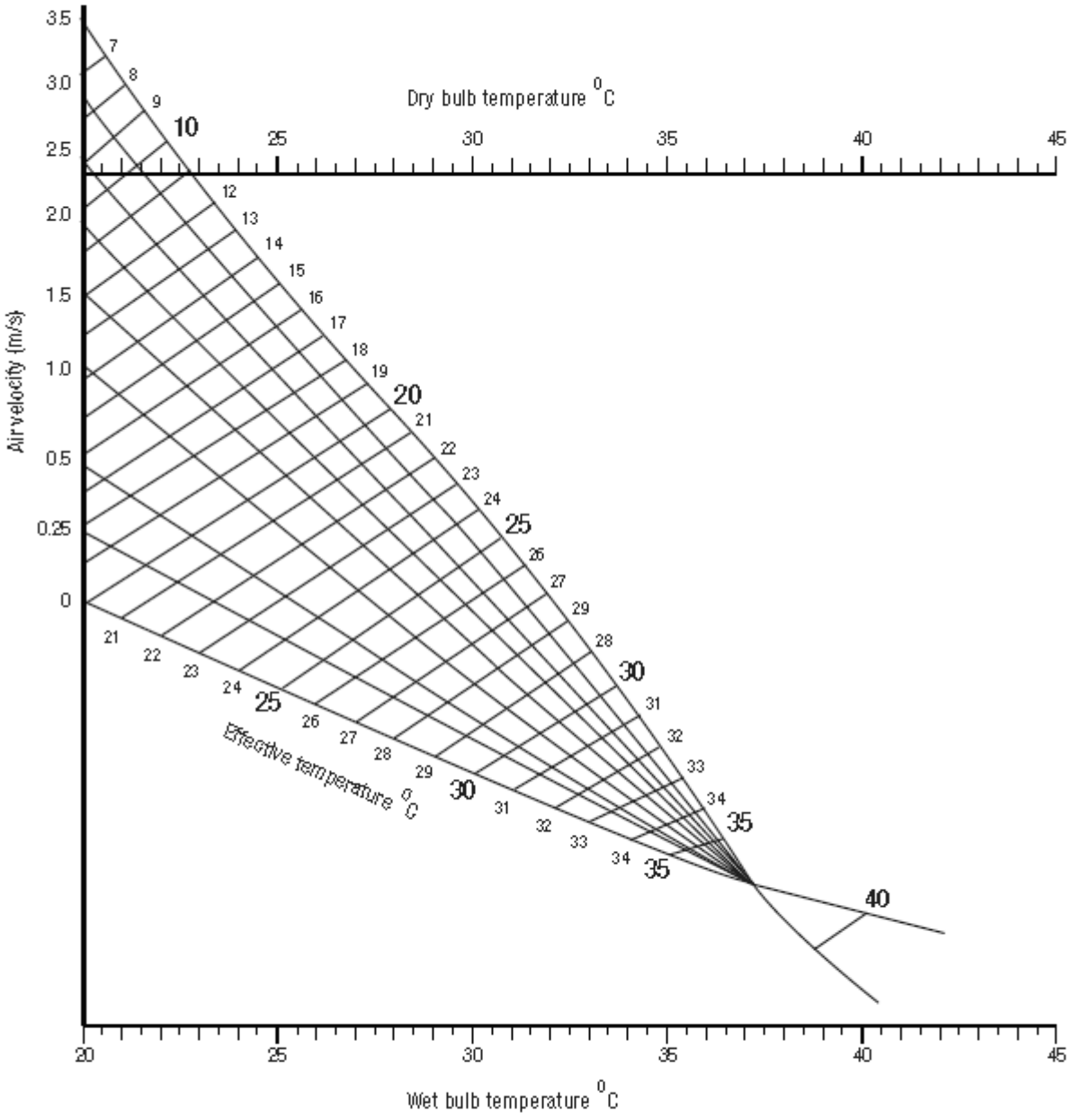

Chart of effective temperature °C (basic)

APPENDIX C

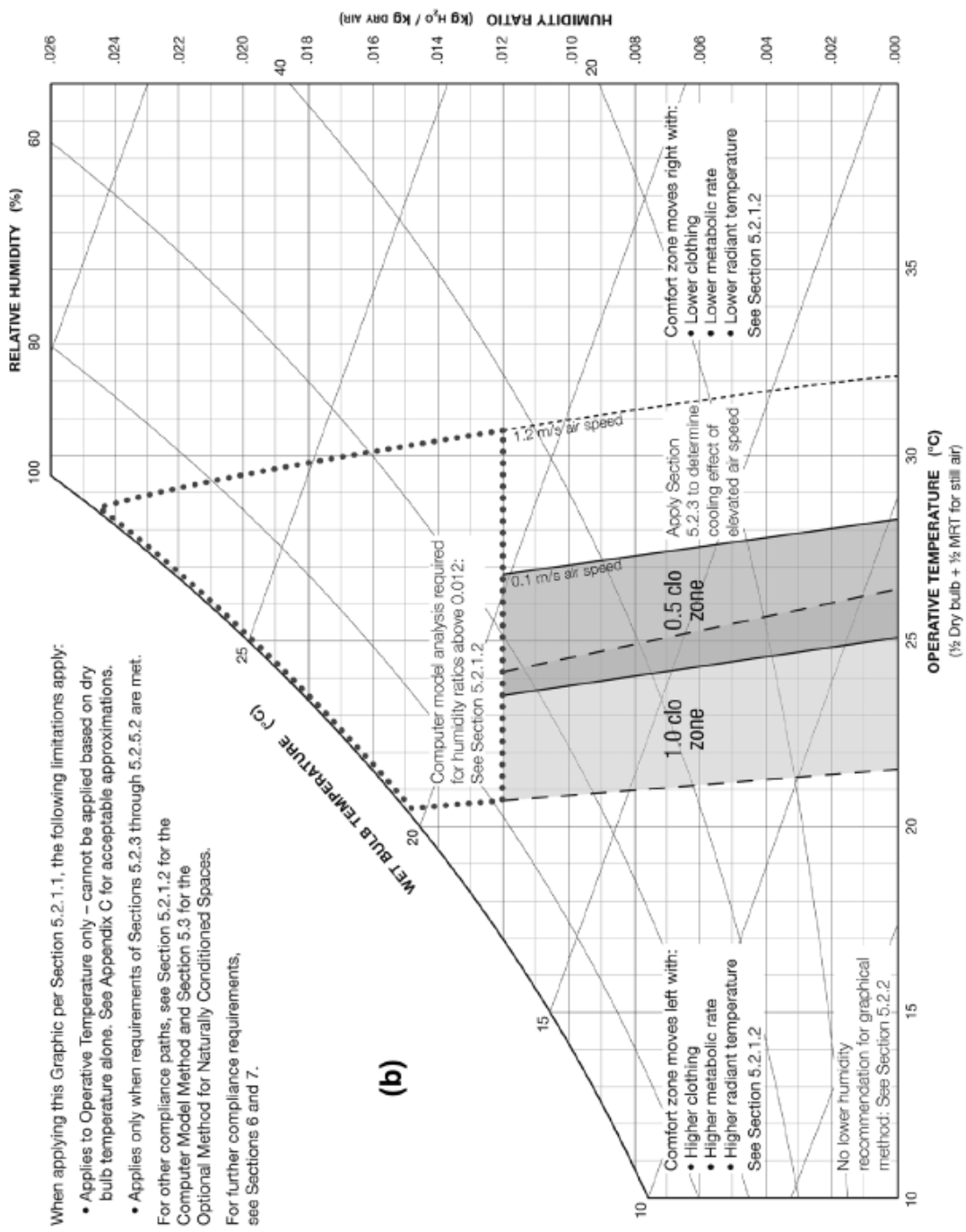

Figure 5.2.1.1 Graphic Comfort Zone Method: Acceptable range of operative temperature and humidity for spaces that meet the criteria specified in Section 5.2.1.1 (1.1 met; 0.5 and 1.0 clo)—(a) I-P and (b) SI.