Ch. 14 Active climate control

Sizing of cooling equipment

EXAMPLE 14.1 Find the total heat to be removed, and thus the required cooling capacity, for a dance hall. The design conditions are:

Room conditions (summer):	75°F DB (24°C), 50% RH
Number of occupants:	80 people
Activity:	Dancing
Ventilation provided:	35 cfm (18 L/s) per person
Outdoor air conditions:	90°F DB, 75°F WB (32.2 and 23.9°C)

Heat Gains in the Room 80 people dancing (see Table G.8)	**Sensible Heat, SH (Btu/h)**	**Latent Heat, LH (Btu/h)**
80 @ 305 Btu/h	24,400	
80 @ 545 Btu/h		43,600
Total transmission and solar gain, lights, equipment, etc.	67,600	None
	Room sensible heat (RSH) = 92,000	Room latent heat (RLH) = 43,600
Total heat gains in room: 135,600 Btu/h (RSH + RLH)		

Table G.8 from Ch.12

- Calculate SHF
- Calculate SA flow rate
- Determine SA duct size
- Calculate OA
- Locate SA, OA, RA and MA on the psychrometric chart
- Draw a line parallel to SHF, and locate a point of SA
- Locate points of OA and MA (=OA+RA)
- Find ΔI and GTH

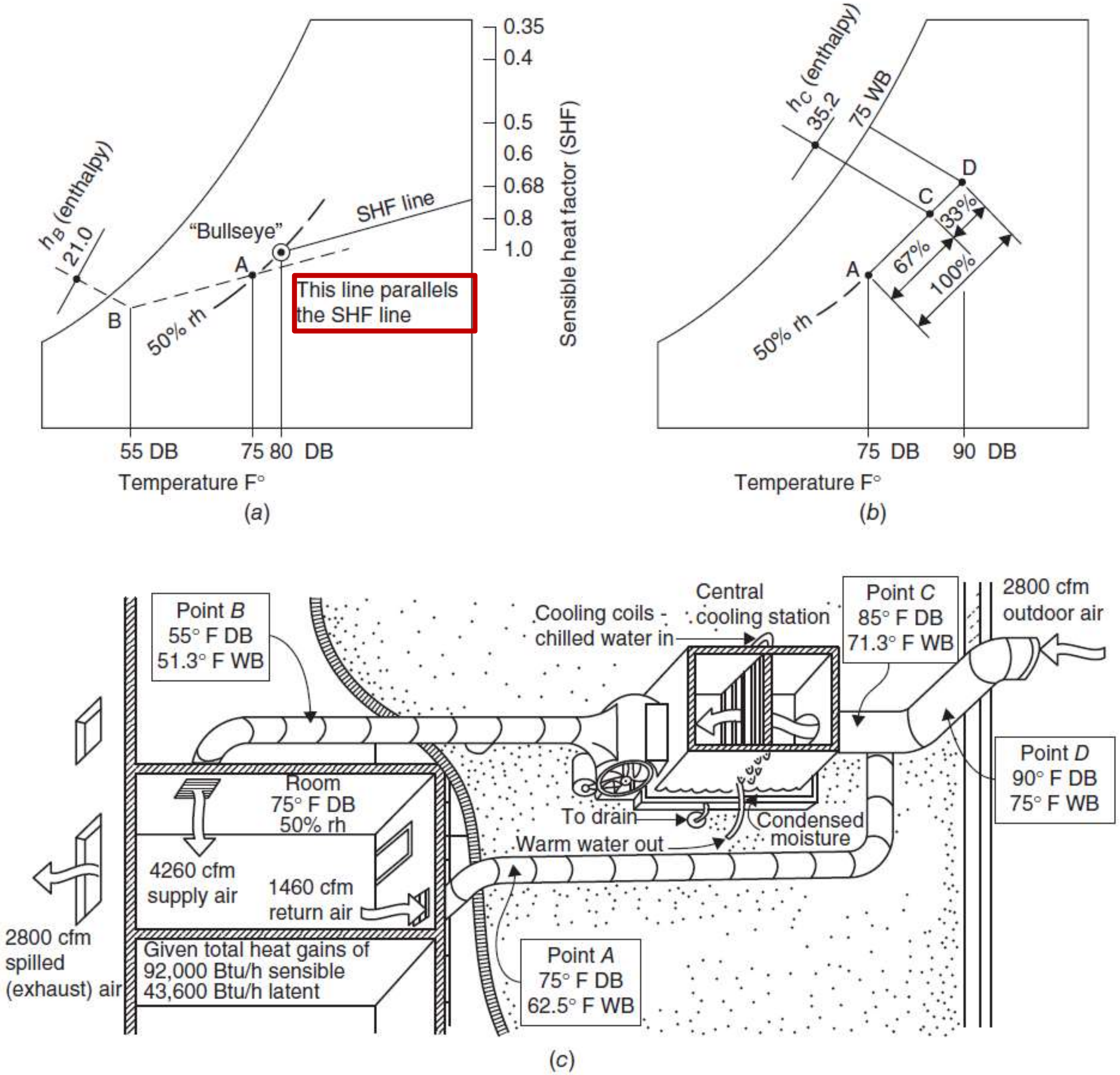
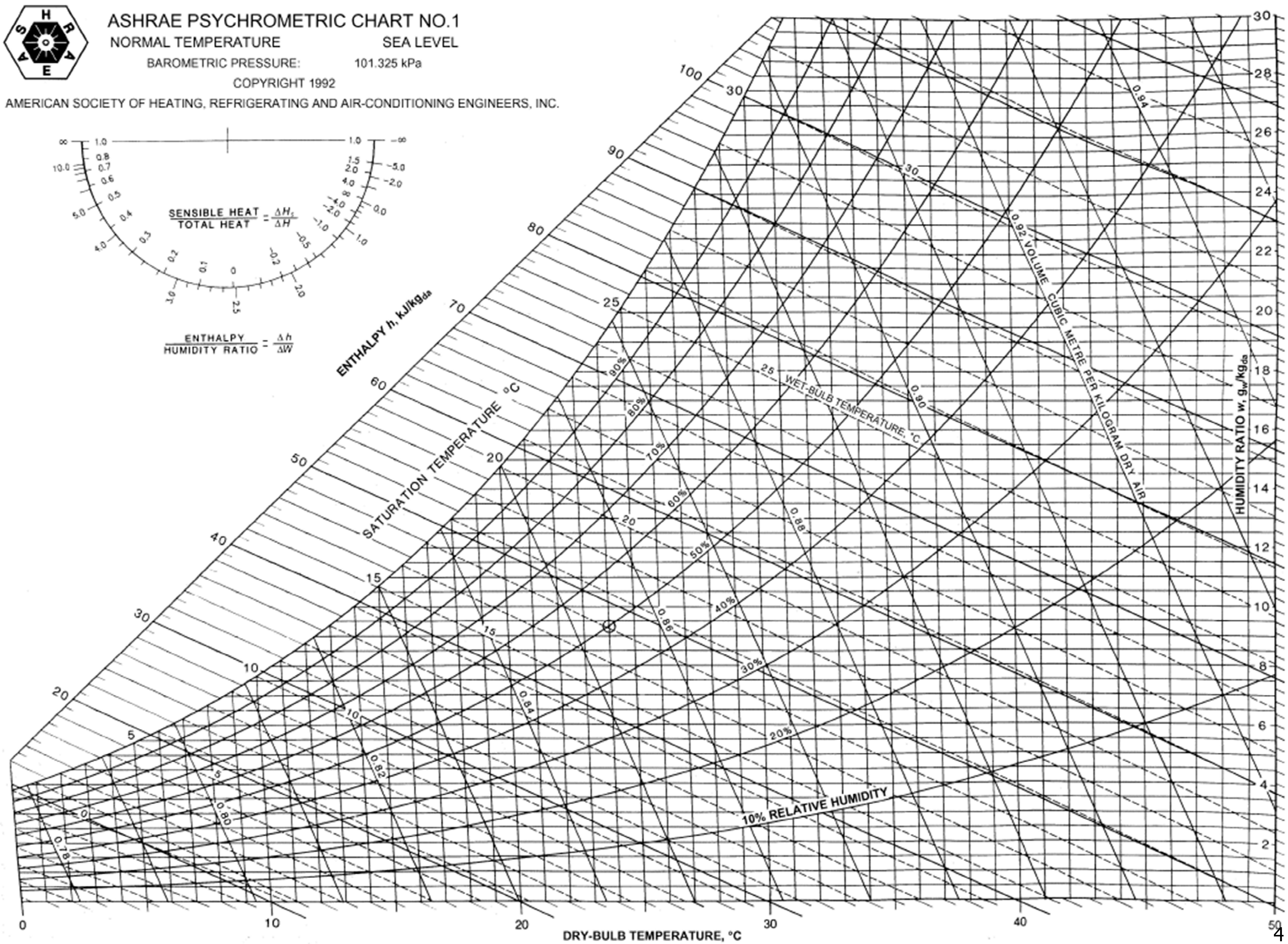


Fig. 14.1 *Sizing cooling equipment using the psychrometric chart. (a) Finding the conditions for the supply air. SI values are: 12.8, 23.9, and 26.7°C DB. (b) Finding the conditions for the return air–outdoor air mixture. SI values are: 23.9 and 32.2°C DB; 23.9°C WB. (c) Points A, B, C, and D are representative conditions within the cooling cycle. SI values are: Point A (23.9/16.9°C); Point B (12.8/10.7°C); Point C (29.4/21.8°C); Point D (32.2/23.9°C); outdoor air (1321 L/s); exhaust air (1321 L/s); supply air (2010 L/s); return air (689 L/s); room (23.9°C).*


ASHRAE PSYCHROMETRIC CHART NO.1
NORMAL TEMPERATURE
SEA LEVEL
BAROMETRIC PRESSURE: 101.325 kPa
COPYRIGHT 1992
AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC.
SENSIBLE HEAT / TOTAL HEAT = ΔHs / ΔH
ENTHALPY / HUMIDITY RATIO = Δh / ΔW
ENTHALPY h, kJ/kg da
SATURATION TEMPERATURE °C
WET-BULB TEMPERATURE, °C
VOLUME CUBIC METRE PER KILOGRAM DRY AIR
10% RELATIVE HUMIDITY
HUMIDITY RATIO w, gw/kg da
DRY-BULB TEMPERATURE, °C

Capacity of a refrigeration unit

- The roots for refrigeration are in the ice making industry, and the ice manufacturers wanted an easy way of understanding the size of a refrigeration system in terms of the production of ice.
- Refrigeration Ton (RT): It is a capacity to freeze 1 ton (1,000kg) of water at 0 °C in 24 hours. The latent heat of ice is 79.68 kcal/kg.

$$1\ (RT) = \frac{1{,}000\ (kg)\ \times 79.68\left(\frac{kcal}{kg}\right)}{24\ hr} = 3{,}320\ \left(\frac{kcal}{h}\right) = 3{,}861\ (Watt)$$

- USRT: It is a capacity to freeze 1 short ton (2,000 lb. 907kg) of water at 32 °F in 24 hours. The latent heat of ice is 144 btu/lb.

$$1\ USRT = \frac{2000\ (lbs)\ \times 144\left(\frac{BTU}{lb}\right)}{24\ hr} = 12{,}000\ \left(\frac{BTU}{h}\right) = 3{,}517\ (Watt) = 3{,}024\ \left(\frac{kcal}{h}\right)$$

http://www.onlineconversion.com/

Thermal zoning

- Why? To provide separate thermal control for thermal comfort.
- Thermal zoning typically driven by differences in the timing of loads from one room to another. (east-facing office vs. west-facing office)
- More thermal zones → higher first cost & better thermal comfort
- Fewer thermal zones → less first cost, higher thermal discomfort

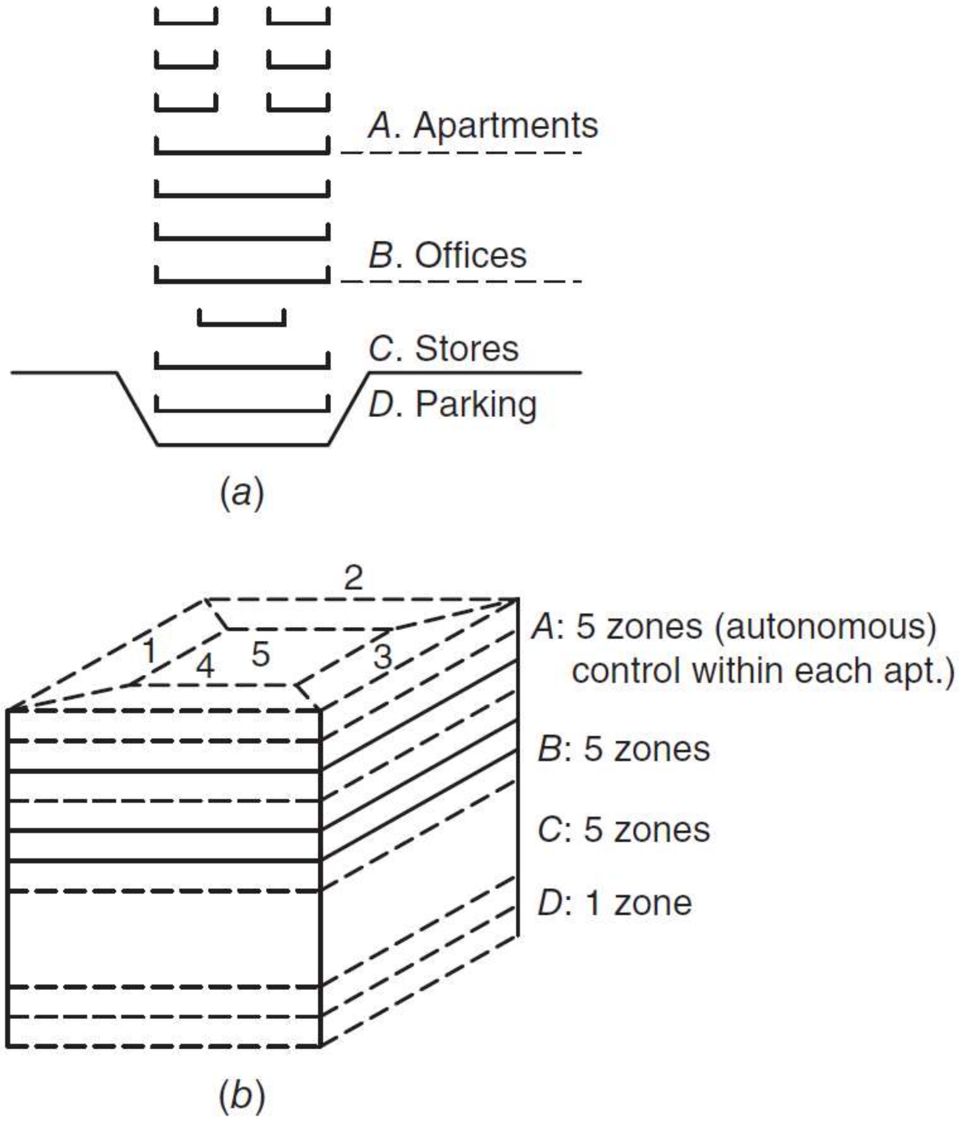


Fig. 14.5 *A reasonable minimum number of thermal zones for a large multipurpose building.*

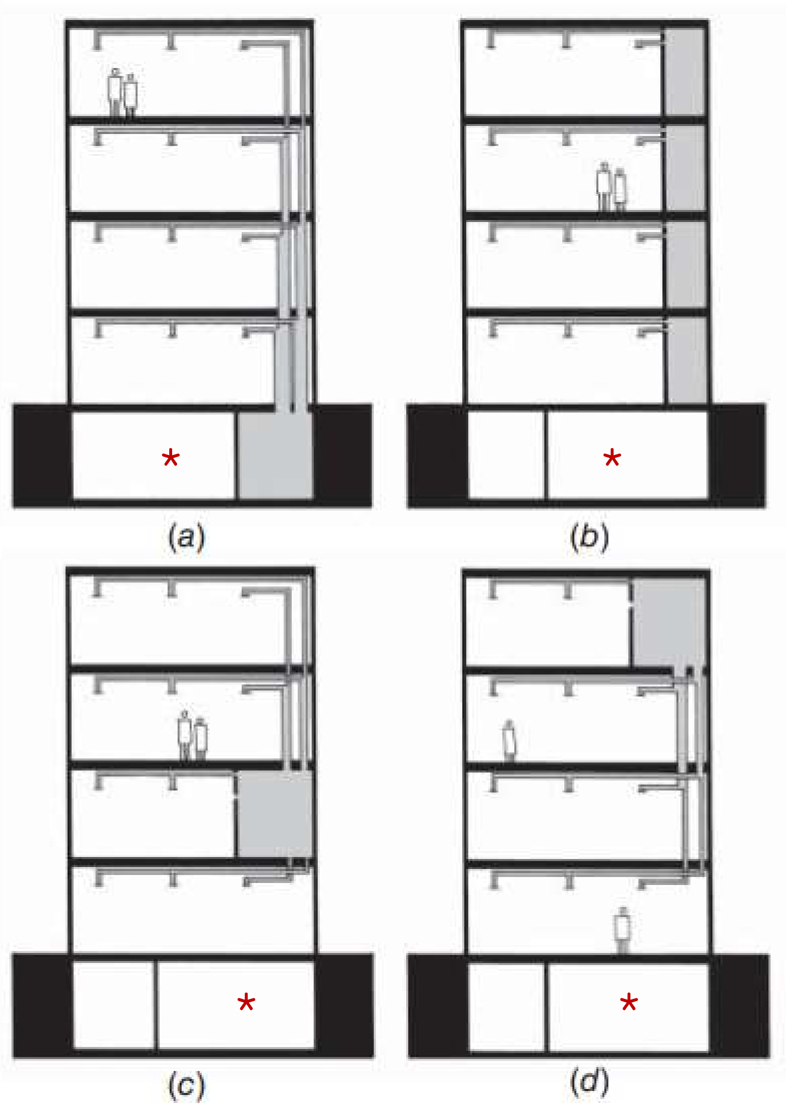
Central vs. local

- Central systems
  - Large mechanical spaces (basement, roof)
  - Easy control of noise, heat, etc. with the machinery concentrated in a few locations
  - Easy maintenance
  - Breakdowns in central equipment paralyze the entire building
  - Difficult to handle a difference in a zone scheduling
  - Size and length of distribution trees
- Local systems
  - Attractive as differences in scheduling, function or comfort expectations increase
  - Large and centralized equipment spaces not required
  - Minimal size of distribution trees
  - Simplified control systems
  - System breakdowns affect only small portions of the building
  - Noise and other byproducts of multiple machines become threats to occupied spaces
  - Demanding maintenance
- Central heat/cool + local air distribution: a central boiler/chiller + fan rooms in each floor

Central heat/cool, local air distribution

- A central boiler/chiller space located + fan rooms on each floor (Fig. 14.61(b))
  - Gray spaces → fan rooms
  - Minimize the bulky distribution tree for air
  - From the central equipment, only heated and chilled water are delivered.

Fig. 14.61 Fan rooms (gray spaces) can either be combined with or separated from boiler/chiller "plant" rooms. (a) Common location for a central combined equipment room. (b) Increasingly common arrangement of a small fan room on each floor, with a plant room in the basement. (c) An intermediate floor may be able to provide space for a central fan room, while heavier and noisier equipment remains in the basement. (d) With a top-floor central fan room, plant equipment may be located either on the roof or in a mechanical penthouse, or it may remain in the basement. (Adapted by permission from E. Allen and J. Iano, The Architect's Studio Companion, *6th edition; © 2017, John Wiley & Sons, Inc.)*



*: boiler and chiller equipment room