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Revisions are shown in red.

Question 11, p. 13:

☐ C. PVC pipe with less than 20% plasticizer

Question 15, p. 14:

○ A. 0

○ B. 1

○ C. 5

○ D. 10

Question 25, p. 21:

○ A. –635

○ B. –1,270

○ C. –1,446

○ D. –2,018

Question 34, p. 25:

○ A. 0.41

○ B. 1.48

○ C. 2.20

○ D. 2.71

Question 47, p. 32:

A foam monitor system is designed per requirements of NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, and per applicable risk analysis parameters to protect a 60-ft-diameter fixed-roof storage tank containing a Class IB flammable liquid. The minimum required quantity (gal) of 3% AFFF foam liquid concentrate required to protect this hazard is most nearly:

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Question 57, p. 36:

A fire alarm notification horn is mounted at the center of a room's ceiling. The ceiling is 8.5 m high. What is the sound pressure level (dBA) for a 1.5-m-tall person standing 8 m off-center from a horn with a rated sound power level of 95 dB?

Question 61, p. 37:

- ○ A. 0.14
- ○ B. 0.74
- ○ C. 3.41
- ○ D. 80.88

Question 67, p. 40:

- ○ A. Type I (443)
- ○ B. Type I (442)
- ○ C. Type I (332)
- ○ D. Type II (222)

Question 68, p. 42:

Which of the following occupancies require smoke barriers, forming smoke compartments?

- ☐ A. Existing health care occupancies on floors with 31 or more inpatient sleeping
- ☐ B. Existing ambulatory health care occupancies where the area is less than 5,000 ft^2 and provided with automatic smoke detection throughout the area
- ☐ C. New detention and correctional occupancies on any story not used for resident sleeping where the occupant load is ≥ 50
- ☐ D. Every floor of new health care occupancies
- ☐ E. Every floor of new high-rise hotel occupancies

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Solution Table, p. 52

No. 15—B
No. 25—A
No. 52—C
No. 61—A
No. 84—C, D

Solution 4, p. 54:

According to NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2020 ed., Section 15.5.2, the precautions listed in A, B, and C are necessary. Precaution D would be necessary only if the impairment would last over 10 hours.

Solution 10, p. 55:

Refer to NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2019 ed., Section 20.3.2.2.2.1.

Solution 11, p. 55:

Refer to NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2019 ed., Section 20.4 (including Annex A of 20.4 for all tables).

Beer, PVC pipe with less than 20% plasticizer, and small arms ammunition are all acceptable to store in an area designed for Group IV commodities. However, only small arms ammunition is explicitly a Group IV commodity. Beer is either a Group I or a Group II, depending upon packaging, and PVC pipe with less than 20% plasticizer is a Group III commodity.

Solution 15, p. 56:

NFPA 13, *Standard for the Installation of Sprinkler Systems*, Section 20.4, correctly identifies gypsum board as a Class I commodity and oil-based paint in a metal container as a Class IV commodity. All requirements of 20.4.14.3 must be met. While 20.4.13.3(3) allows up to five pallets, it should meet the requirement of 20.4.13.3(2). For one location, the maximum number of pallet loads of paint is one.

THE CORRECT ANSWER IS: B

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Solution 25, p. 59:

$\Sigma\Delta H_f$ (Products) – $\Sigma\Delta H_f$ (Reactants) = –1,270 kJ/mol

Heat of combustion can be calculated by subtracting the summation of heats of formation of the reactants from the summation of heats of formation of the products, as shown: $\Delta H_c = \Sigma\Delta H_f$ (Products) – $\Sigma\Delta H_f$ (Reactants). Heats of formation can be found in the Fire Dynamics Fundamentals chapter in the *PE Fire Protection Reference Handbook*.

$\Sigma\Delta H_f$ (Products) $= 2CO_2 + 4H_2O$
$= 2(-393.52) + 4(-241.83) = -1{,}754.36$ kJ/mol

$\Sigma\Delta H_f$ (Reactants) $= 2CH_3OH + 3O_2$
$= 2(-242.1) + 3(0) = -484.2$ kJ/mol

$$\Delta H_c = \frac{-1{,}754.36 - (-484.2)}{2}$$
$$= -635 \text{ kJ/mol}$$

A value of 0 is used for O_2 since the oxygen is in its elemental form and does not release energy during the combustion process.

THE CORRECT ANSWER IS: A

Solution 28, p. 60:

$$\Delta T_0 = 9.1\left(\frac{T_\infty}{g c_\rho^2 \rho_\infty^2}\right)^{1/3} \dot{Q}_c^{2/3} (z - z_0)^{-5/3}$$

$$\dot{Q}_c = 0.70\ \dot{Q} = 0.70\ (3{,}000\,\text{kW})$$
$$= 2{,}100\,\text{kW}$$

$z_0 = 0.5\,\text{m},\ Z = 6\ \text{m}$

$g = 9.81\,\text{m/s}^2$

$c_\rho = 1.00\,\text{kJ/kgK}$

$\rho_\infty = 1.2\,\text{kg/m}^3$

$T_\infty = 293\,\text{K}$ (for normal atmospheric conditions)

$$\Delta T = 25.0\,\text{Km}^{5/3}\ \text{kW}^{-2/3}\,(2{,}100\,\text{kW})^{2/3}\,(6 - 0.5)^{-5/3}$$
$$= 25.0\,(163.99)\,(0.058)$$
$$\Delta T = 239\,\text{K}$$
$$T = T_\infty + \Delta T = 293\,\text{K} + 239\,\text{K} = 532\,\text{K}$$

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Solution 35, p. 62:
Refer to NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2019 ed., Section 16.9.3.3.1.

Solution 36, p. 63:
Table 20.12.2.6 in NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2019 ed., requires a water supply duration of 2 hours. Using the system overage indicated, the corresponding water volume (excluding hose stream) is:

Solution 40, p. 63:
According to NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2020 ed., Table 13.1.1.2, Exception 1 and Section 13.3.2.1.2, electrically supervised valves may be inspected quarterly.

Solution 41, p. 64:
Maximum area per extra hazard Group 2 is 40,000 ft^2 per NFPA 13, *Standard for the Installation of Sprinkler Systems*, Section 4.5.1.

Solution 42, p. 64:
Per NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2019 ed., Section 27.2.4.2

Solution 43, p. 64:
Refer to NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2019 ed., Table A.18.5.9.

Solution 47, p. 66:
NFPA 11, *Standard for Low Expansion Foam*, 2021 ed., is the appropriate reference. Paragraph 5.2.4.1.1 permits the use of foam monitors for fixed-roof tanks over 30 ft in diameter and per risk analysis.

Solution 52, p. 67:
Per NFPA 72, *National Fire Alarm and Signaling Code*, 2019 ed., Table 14.4.3.2, Item 17(6), the testing frequency for radiant energy fire detectors (i.e., a category that includes flame detectors) is semiannually.

THE CORRECT ANSWER IS: C

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Solution 53, p. 67:
NFPA 72, *National Fire Alarm and Signaling Code*, 2019 ed., Section 18.4.4.1, requires a minimum 15 dBA over ambient.

Solution 54, p. 68:
Refer to NFPA 72, *National Fire Alarm and Signaling Code*, 2016 ed., Section 18.5.5.6.1 and 18.5.5.6.5.

Solution 55, p. 68:
Per NFPA 72, *National Fire Alarm and Signaling Code*, 2019 ed., Section 10.6.7.2.1, power supply shall have capacity to operate under quiescent load (standby) for 24 hours and alarm load for 5 min.

Solution 56, p. 68:
New detectors plus 10% of existing detectors are required per NFPA 72, *National Fire Alarm and Signaling Code*, 2019 ed., Section 14.4.2.4.

Solution 58, p. 69:
Refer to NFPA 72, *National Fire Alarm Code*, 2019 ed., Table 17.7.6.3.3.2

Solution 59, p. 69:
Maximum make-up air velocity is 200 ft/min per NFPA 92, *Standard for Smoke Control Systems*, 2021 ed., Section 4.4.4.1.4.

Solution 60, p. 70:
Refer to NFPA 92, *Standard for Smoke Control Systems,* 2021 ed.

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Solution 61, p. 70:
Refer to the Smoke Control chapter in the *PE Fire Protection Reference Handbook*.

$$F = F_{DC} + \frac{k_d W A \Delta P}{2(W - d)}$$

Convert N to lb

$$11.24 \text{ lb} = 1.12 \text{ lb} + \frac{(5.2)(4 \text{ ft})(24 \text{ ft}^2)\Delta P}{2(4 \text{ ft} - 0.5 \text{ ft})}$$

$$\Delta P = 0.14 \text{ in. } H_2O$$

THE CORRECT ANSWER IS: A

Solution 63, p. 71:
Refer to NFPA 92, *Standard for Smoke Control Systems*, 2021 ed., Table 4.4.2.1.1, for a building with automatic sprinkler protection (AS).

THE CORRECT ANSWER IS: A

Solution 68, p. 73:
In NFPA 101, *Life Safety Code*, 2021 ed., Sections 19.3.7.1 and 22.3.7.1 require smoke barriers.

Solution 70, p. 73:
Refer to NFPA 101, *Life Safety Code*, 2021 ed., Section 7.2.2.5.2 and Section 7.2.2.6.3.

Solution 71, p. 73:
Refer to NFPA 101, *Life Safety Code*, 2021 ed., Table 8.3.3.2.2.

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Solution 73, p. 74:
Refer to NFPA 101, *Life Safety Code*, 2021 ed., Sections 7.6.

As shown in the figure, the various segments of exit travel are the distance to the hallway, the distance from the hallway to the stairs, the distance down the stairs, and the distance across the landing to outside. Since there are doors at either end of the room, the most remote point to an exit will be from the center of the balcony. Because of the pews, the travel to the center of the hallway is 25 ft + 20 ft + 2.5 ft. The travel distance down the hallway to the top of the stairs is 45 ft + 2.5. The travel distance down the stairs is taken along the nose of the tread of the stairs. That makes 22 ft the travel distance.

Since the two sets of exit stairs are equidistant in either direction, the remote point of the room is at the center front. The total distance to either exit is thus 25 + 20 + 2.5 + 45 + 2.5 + 3 + 22 + 6 = 126 ft. The actual travel distance would be slightly less than this as the natural path of travel would not be perpendicular.

THE CORRECT ANSWER IS: B

Solution 74, p. 75:
Per NFPA 101, *Life Safety Code*, 2021 ed., Section 7.2.1.4.3.1, door encroachment cannot exceed 50% of required corridor width (40 in.).

Solution 75, p. 75:
Refer to NFPA 101, *Life Safety Code*, 2021 ed., Section 7.1.3.2.1 (9).

Solution 78, p. 75:
7,000 ft^2/100 ft^2/person = 70 persons
18,000 ft^2/300 ft^2/person = 60 persons
120,000 ft^2 – 7,000 ft^2 – 18,000 ft^2 = 95,000 ft^2
95,000 ft^2/30 ft^2/person = 3,167 persons
3,167 + 70 + 60 = 3,297 persons
3,297 persons × 0.2 in./person = 659.4 in.

THE CORRECT ANSWER IS: C

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Solution 79, p. 76:

Refer to NFPA 101, *Life Safety Code*, 2021 ed., Section 18.1.7, Table 7.3.1.2, which says to use 120 ft^2/person gross area.

Solution 84, p. 78:

Pre-evacuation time is the interval between the time at which a general alarm signal or warning is given and the time at which the first deliberate evacuation movement is made. It consists of two components: recognition time and response time.

THE CORRECT ANSWERS ARE: C, D