

# FULL-LENGTH PRACTICE TESTS

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## Practice Test 21: Full-Length Simulated Exam 3 – All Systems

### Questions 1–50

1. A building's BAS trend data shows supply air temperature from a cooling AHU gradually rising over several weeks despite no change in setpoint. What condition is most likely developing?

- A. The outdoor air damper actuator has been replaced with a new model
- B. The fire alarm system has activated duct smoke detectors intermittently
- C. The return air filter has been recently replaced
- D. The chilled water coil is fouling with scale or debris, reducing heat transfer capacity and degrading cooling performance

2. A fire alarm system's annual smoke detector sensitivity test reveals that several detectors have drifted below their listed sensitivity range. What risk does this create?

- A. The detectors will produce excessive nuisance alarms
- B. The detectors may fail to detect actual smoke conditions because they require a higher smoke concentration to activate than originally designed
- C. The fire alarm panel will display a power supply trouble signal
- D. The notification appliances connected to those detectors will produce lower sound output

3. What is the primary purpose of a trap primer installed on a commercial floor drain?

- A. Automatically replenishing the trap seal with periodic water additions to prevent sewer gas entry through infrequently used drains

- B. Increasing water pressure at the floor drain location
- C. Filtering debris from the drainage water before it enters the sewer
- D. Heating the trap water to prevent bacterial growth

4. A commercial building's rooftop unit short-cycles on high head pressure during hot summer afternoons. What is the most likely cause?

- A. The unit's supply air temperature sensor is out of calibration
- B. The economizer damper is stuck in the fully closed position
- C. The condenser coil is dirty, restricting airflow and preventing adequate heat rejection to the atmosphere
- D. The return air filter is a higher efficiency rating than specified

5. What is the primary reason the NEC requires a dedicated electrical room for the main switchgear in a commercial building?

- A. Providing adequate working clearances, environmental protection, and secure access for safe operation, maintenance, and emergency response
- B. Minimizing the distance between the switchgear and the rooftop HVAC units
- C. Reducing the building's overall construction cost
- D. Allowing the fire alarm panel to be mounted on the switchgear

6. A building's wet-pipe sprinkler system has a corroded pipe fitting that develops a pinhole leak. What NFPA 25 action is required?

- A. Only documenting the leak in the maintenance log for future reference
- B. Monitoring the leak monthly to track its progression rate
- C. Coating the fitting with waterproof sealant as a permanent repair
- D. Repairing or replacing the corroded fitting promptly and investigating the piping system for additional corrosion that may indicate a systemic problem

7. During commissioning, the BAS point-to-point verification reveals that a supply air temperature sensor reads 8 degrees higher than an independent reference measurement. What is the impact if this error is not corrected?

- A. The fire alarm system will display a trouble signal
- B. The AHU will overcool the supply air because the controller believes the air is warmer than it actually is, wasting cooling energy and causing comfort complaints
- C. The emergency generator will start on false demand
- D. The hot water system temperature will decrease proportionally

8. A plumbing engineer designs a domestic water system for a 12-story building with a single pressure zone. The ground floor static pressure measures 75 psi. What concern exists for upper floors?

- A. The ground floor pressure exceeds the 80 psi code maximum
- B. The upper floors will experience excessive water pressure
- C. Upper floors will have progressively lower pressure due to elevation loss, potentially falling below the minimum required for proper fixture operation
- D. The water heater will produce excessive hot water temperatures

9. What is the primary function of a fire alarm system annunciator located at the building's main entrance?

- A. Displaying system status and alarm locations in a graphic or text format for responding fire department personnel to quickly identify the fire location
- B. Controlling the building's HVAC shutdown sequence remotely
- C. Providing manual activation of the sprinkler system
- D. Resetting the fire alarm system after testing is complete

10. A building's lighting power density in the open office area measures 0.95 watts per square foot. The ASHRAE 90.1 allowance for open office is 0.79 watts per square foot. What action is required?

- A. No action because the installed LPD is within acceptable tolerance
- B. Only reducing the operating hours to compensate for the excess wattage
- C. Only adding daylight harvesting controls to offset the excess power
- D. Reducing the installed lighting power through higher-efficacy fixtures, delamping, or fixture replacement to meet the 0.79 watts per square foot code allowance

11. A building's geothermal heat pump system uses a closed-loop ground heat exchanger. What is the primary advantage of this ground source compared to air-source systems?

- A. Ground temperatures remain relatively constant year-round, providing a more stable and efficient heat source in winter and heat sink in summer
- B. Ground loops require no antifreeze protection in any climate
- C. Ground source systems eliminate the need for any supplemental heating
- D. Ground loops are less expensive to install than air-source equipment

12. A fire marshal inspection reveals that combustible storage has been placed in a fire pump room. Why does this violate the fire code?

- A. Combustible storage increases the fire pump's fuel consumption
- B. Combustible storage prevents the fire pump from achieving rated speed
- C. The fire pump room must be kept clear of combustible materials to prevent a fire from disabling the pump that the building depends on for fire suppression
- D. Combustible storage reduces the electrical capacity available to the pump

13. A building's emergency generator exercises weekly per the manufacturer's schedule. During the most recent exercise, the generator fails to start. What immediate action is required?

- A. Only scheduling the repair for the next available maintenance window
- B. Only documenting the failure in the generator maintenance log
- C. Only testing the fire alarm system to verify alarm transmission
- D. Initiating emergency repairs immediately because the building's life safety systems have no backup power, and notifying the AHJ if required by the impairment management program

14. A plumbing inspector finds that a cleanout is missing at a change of direction on a horizontal sanitary drain. What operational consequence does this create?

- A. The vent system connected to that branch will not function correctly
- B. Future blockages at or near the direction change will be difficult to clear because there is no access point for drain cleaning equipment
- C. The drainage pipe material will corrode at an accelerated rate
- D. The trap seals on connected fixtures will evaporate

15. What is the primary benefit of an enthalpy wheel energy recovery system on a dedicated outdoor air unit?

- A. Boosting the supply fan static pressure for longer duct runs
- B. Providing supplemental cooling during peak summer conditions
- C. Transferring both heat and moisture between exhaust and outdoor air streams, reducing the energy required to heat, cool, and dehumidify ventilation air
- D. Filtering particulate matter from the outdoor air intake

16. A building's access control system fails to release magnetically held doors upon fire alarm activation. What life safety hazard does this create?

- A. Occupants may be unable to evacuate through access-controlled doors on egress paths, potentially trapping them during a fire emergency
- B. The fire alarm notification appliances will not sound
- C. The sprinkler system will not receive adequate water pressure
- D. The emergency generator will not start on demand

17. A chiller's integrated part-load value has degraded significantly compared to its original rating. What does this indicate?

- A. The chiller's refrigerant type needs to be changed to a different formulation
- B. The chiller's nameplate data was incorrectly recorded at installation
- C. The chiller's condenser water pump is oversized for the system
- D. The chiller's efficiency has deteriorated across its typical operating range, consuming more energy than designed to produce the same cooling output

18. What is the primary purpose of a building's secondary roof drainage system?

- A. Providing filtered water for the building's cooling tower makeup
- B. Providing emergency overflow protection that prevents structural roof overload if the primary drainage system becomes blocked or overwhelmed
- C. Supplying rainwater to the building's irrigation system
- D. Draining condensate from rooftop HVAC equipment

19. A commissioning agent tests the fire alarm system's elevator recall sequence and finds that elevators travel to the fire floor when the designated recall floor lobby detector activates. What must be corrected?

- A. The smoke detector in the lobby must be replaced with a heat detector
- B. The elevator cab lighting must be connected to the emergency circuit
- C. The elevator recall programming must be corrected to send elevators to an alternate floor when the designated recall floor itself is the location of the alarm
- D. The elevator doors must be held open during all fire alarm conditions

20. An energy audit reveals that a building's constant-volume AHUs operate at full airflow regardless of occupancy or load. What retrofit would provide the greatest energy savings?

- A. Converting to variable air volume operation with VFDs on supply fans and adding zone-level VAV boxes for independent temperature control
- B. Replacing all air filters with higher-efficiency MERV 16 filters
- C. Adding additional return air grilles in each zone
- D. Installing a new building automation system without changing the AHU configuration

21. A fire protection system's quarterly main drain test shows a 15 psi decrease in residual pressure compared to the original acceptance test. What does this indicate?

- A. The fire alarm waterflow switch has been disconnected
- B. A significant obstruction or partially closed valve exists between the water supply and the sprinkler system that must be investigated immediately
- C. The fire pump needs a new diesel engine
- D. The inspector's test connection orifice size has changed

22. What is the primary purpose of demand-controlled ventilation using CO<sub>2</sub> sensors in a conference room?

- A. Modulating outdoor air volume based on actual occupancy, increasing ventilation when the room is heavily occupied and reducing it when the room is empty or lightly occupied
- B. Detecting carbon monoxide from combustion equipment in the room
- C. Measuring the room's relative humidity for comfort control
- D. Controlling the conference room's lighting levels based on occupancy

23. A building's fire-rated stairwell door has been propped open by building occupants. What fire protection function is compromised?

- A. The sprinkler system's water supply pressure
- B. The fire alarm notification appliance sound levels
- C. The stairwell's fire compartmentation and pressurization, allowing smoke to enter the primary vertical egress path during a fire
- D. The emergency generator's starting sequence

24. A facility manager wants to reduce the building's water consumption. The water audit shows that cooling tower makeup is the largest consumer. What strategy addresses this?

- A. Increasing the domestic water heater temperature setpoint
- B. Adding more plumbing fixtures throughout the building
- C. Increasing the cooling tower fan speed to maximum at all times
- D. Increasing cooling tower cycles of concentration through improved water treatment, reducing the blowdown volume and total makeup water required

25. What is the primary advantage of grooved mechanical couplings over welded connections for fire sprinkler piping installation?

- A. Faster assembly, easier disassembly for maintenance, ability to accommodate thermal movement, and reduced fire hazard during installation compared to welding
- B. Higher pressure rating than any welded connection method
- C. Elimination of the need for pipe hangers and supports
- D. Lower material cost than standard threaded fittings

26. A building's electrical system experiences frequent voltage sags that disrupt sensitive computer equipment. What device should be installed?

- A. A larger emergency generator to provide more backup power
- B. An uninterruptible power supply that provides clean, conditioned power during voltage sags and momentary outages
- C. Additional circuit breakers on the affected panels
- D. A higher-rated grounding electrode system

27. A building's HVAC system uses outdoor air reset control on the hot water boiler. What does this strategy accomplish?

- A. Shutting down the boiler when outdoor temperature drops below freezing
- B. Increasing the boiler firing rate as outdoor temperature increases
- C. Maintaining a constant hot water temperature regardless of outdoor conditions
- D. Reducing the hot water supply temperature as outdoor temperature rises, improving efficiency and reducing distribution losses when full heating capacity is not needed

28. A fire alarm system serves a high-rise building with phased evacuation. What notification method does this strategy require?

- A. A voice evacuation system capable of delivering different messages to different zones, instructing the fire floor and adjacent floors to evacuate while directing other floors to stand by
- B. A single horn signal at uniform volume throughout all floors
- C. Only visual strobe notification with no audible component
- D. Manual bullhorn announcements from the fire command center only

29. A plumbing engineer specifies acid-resistant piping and a neutralization tank for a laboratory building's drainage. What hazard does this specialized system address?

- A. Preventing sewage backups during heavy rainfall events
- B. Filtering radioactive materials from the laboratory waste stream
- C. Protecting the sanitary sewer infrastructure from corrosive chemical waste that would damage standard piping and interfere with wastewater treatment
- D. Increasing the drainage flow velocity for faster waste removal

30. During electrical commissioning, the automatic transfer switch is tested and the retransfer from generator to utility power occurs immediately when utility is restored. What must be adjusted?

- A. The fire alarm panel's utility power monitoring circuit
- B. A time delay must be added to the retransfer sequence to verify utility power is stable before transferring back, preventing repeated transfers from unstable utility power
- C. The generator's voltage regulator output setting
- D. The emergency panelboard's main breaker trip setting

31. A building's fire protection risk assessment identifies that the sprinkler system was designed for light hazard but the space is now used for high-pile storage. What concern does this raise?

- A. The fire alarm notification appliances are incorrectly spaced
- B. The exit signs need to be upgraded to higher-output models
- C. The existing sprinkler design density, head spacing, and water supply may be completely inadequate for the significantly higher hazard classification of high-pile storage
- D. The emergency lighting duration must be extended

32. What is the primary purpose of a measurement and verification plan for an HVAC energy conservation project?

- A. Selecting the HVAC equipment manufacturers for the project
- B. Establishing the construction project's general conditions
- C. Scheduling the HVAC contractor's maintenance visits
- D. Quantifying actual energy savings compared to the pre-retrofit baseline to confirm that the projected savings from each conservation measure are being achieved

33. A building's lighting control system includes occupancy sensors in private offices. During commissioning, lights remain on for 30 minutes after occupants leave. What should be adjusted?

- A. The fire alarm integration with the lighting control system
- B. The occupancy sensor timeout period, reducing the delay to an appropriate duration such as 15 to 20 minutes to minimize wasted energy while avoiding premature shutoff during brief periods of low motion
- C. The emergency lighting battery charging circuit
- D. The daylight harvesting photosensor calibration

34. A building's fire department connection is a single Siamese fitting with two 2½-inch inlets. During a fire marshal inspection, one inlet cap is missing and debris has accumulated inside. What is the concern?

- A. Debris inside the FDC could obstruct water flow when the fire department connects, and the missing cap has allowed contamination to enter the fire protection piping
- B. The FDC needs to be repainted to match the building exterior
- C. The FDC signage needs to be updated with current building information
- D. The FDC pressure gauge needs to be recalibrated

35. A building automation system monitors the differential pressure across a chilled water filter. The trend data shows the pressure drop increasing over time. What does this indicate?

- A. The chiller's compressor is losing efficiency
- B. The condenser water pump is operating at excessive speed
- C. The cooling tower fill media is deteriorating
- D. The filter is accumulating debris and will eventually require cleaning or replacement to maintain design flow

36. What is the primary advantage of a DALI lighting control system for a building that undergoes frequent tenant space reconfigurations?

- A. Higher light output from each fixture during reconfigurations
- B. Lower electricity rates from the utility during construction
- C. Fixture zones and groups can be reprogrammed through software without physical rewiring, accommodating new tenant layouts quickly and cost-effectively
- D. Automatic fire alarm integration at each fixture location

37. A building's sewage ejector pump has been running continuously instead of cycling on and off. What does this indicate?

- A. Normal operation for a properly sized sewage ejector system
- B. The pump cannot keep up with incoming flow due to a stuck check valve, broken float switch, continuous water source, or pump impeller degradation
- C. The fire alarm system has triggered continuous pump operation
- D. The domestic water supply is flowing into the ejector basin at design rate

38. A fire alarm system's voice evacuation message is tested in a large atrium space and found to be unintelligible due to excessive echo. What must be addressed?

- A. The fire alarm battery backup capacity must be increased
- B. The smoke detector spacing in the atrium must be reduced
- C. The sprinkler head spacing in the atrium must be recalculated
- D. Speaker placement, directional speaker selection, volume adjustment, or acoustic treatment to reduce reverberation and achieve the required speech intelligibility rating

39. What is the primary purpose of thermal energy storage in a commercial building's cooling system?

- A. Producing and storing cooling capacity during off-peak nighttime hours for discharge during peak daytime hours, shifting electrical demand from peak to off-peak periods and reducing demand charges
- B. Storing hot water for the building's domestic heating needs
- C. Providing emergency cooling water during chiller maintenance
- D. Filtering the chilled water to remove mineral deposits

40. A plumbing code inspection reveals that a backwater valve has been installed upside down on a sanitary sewer lateral. What is the consequence?

- A. The backwater valve will not pass inspection cosmetically
- B. The valve's flow direction indicator is purely decorative
- C. The valve will fail to prevent municipal sewer backup because the check mechanism operates correctly only when installed in the proper orientation
- D. The valve will restrict normal outgoing drainage flow excessively

41. An existing building's fire alarm system uses a single communication pathway to the monitoring station. What vulnerability does this create?

- A. Higher sound output from notification appliances
- B. Increased smoke detector sensitivity throughout the building
- C. Faster elevator recall response during fire alarm activation
- D. Loss of the single pathway from cable damage, equipment failure, or network disruption would prevent alarm transmission to the monitoring station, delaying fire department notification

42. What must electrical commissioning verify regarding the building's surge protective devices?

- A. That SPDs are properly installed, connected, and indicated as functional at the main switchgear and critical branch panels to protect sensitive equipment from transient voltage events
- B. Only that the SPD manufacturer's warranty has been registered
- C. Only that the SPD enclosure matches the panel color
- D. Only that the SPD nameplate data matches the specification

43. A building's hot water system serves both domestic fixtures and a commercial kitchen. The kitchen requires 140-degree water for sanitizing while lavatories require tempered water. How should the system be configured?

- A. Two completely separate water heaters with no interconnection
- B. A single water heater set to 110 degrees with a booster heater for the kitchen
- C. A single water heater maintaining 140 degrees for storage and kitchen supply, with thermostatic mixing valves reducing temperature to safe levels at domestic fixture points of use
- D. A single water heater set to 140 degrees with no mixing valves at any location

44. A commissioning agent discovers that smoke dampers in the HVAC ductwork do not close when the fire alarm activates. What must be investigated?

- A. The sprinkler system's hydraulic calculations
- B. The fire alarm integration wiring to the smoke damper actuators, the damper control module programming, and the physical operation of each damper blade
- C. The emergency generator's transfer switch timing
- D. The chilled water system's control valve operation

45. A building's energy use intensity has decreased after a comprehensive retro-commissioning project. What ongoing practice ensures the savings persist?

- A. Only replacing the BAS controller hardware annually
- B. Only repainting the mechanical rooms every two years
- C. Only upgrading the fire alarm system software quarterly
- D. Continuous monitoring of BAS trend data, regular verification of setpoints and schedules, and periodic recommissioning to prevent operational drift from returning

46. A plumbing engineer sizes a commercial building's water service using the fixture unit method. The calculation yields a total of 500 fixture units. What does this number represent?

- A. A weighted demand value that accounts for the probable simultaneous use of all connected fixtures, converted to a peak flow rate using diversity tables for pipe sizing
- B. The exact number of plumbing fixtures installed in the building
- C. The total water pressure required at the most remote fixture
- D. The building's annual water consumption in gallons

47. What is the primary function of a fire pump controller in a commercial building?

- A. Regulating the domestic water pressure at each floor
- B. Controlling the fire alarm notification appliance circuits
- C. Monitoring conditions, starting the fire pump automatically on pressure drop, providing manual start capability, and monitoring pump performance including power, pressure, and alarm conditions
- D. Operating the building's elevator recall sequence

48. A building owner reports that the HVAC system provides adequate cooling in the morning but cannot maintain temperature by mid-afternoon. What should be investigated?

- A. The fire alarm system's afternoon testing schedule
- B. Whether the cooling system was sized for peak afternoon conditions including solar heat gain, and whether equipment performance has degraded below design capacity
- C. The plumbing system's afternoon water consumption pattern
- D. The emergency lighting battery discharge rate during afternoon hours

49. What is the primary purpose of listing and labeling requirements for fire protection equipment?

- A. Providing aesthetic coordination with the building's interior design
- B. Calculating the fire protection system's installation cost
- C. Establishing the fire protection contractor's warranty obligations
- D. Ensuring that all fire protection equipment has been independently tested, evaluated, and certified to meet applicable safety and performance standards

50. A building's commissioning plan identifies seasonal testing requirements. Why is testing during both heating and cooling seasons essential?

- A. Many HVAC deficiencies only manifest during their specific operating season, and heating system problems are invisible during summer testing while economizer and cooling sequence faults only appear during appropriate weather conditions
- B. Seasonal testing is required only to satisfy the architect's specifications
- C. Seasonal testing reduces the fire alarm system's annual testing costs
- D. Seasonal testing is only necessary for buildings in tropical climates

# ANSWER KEY 21: DETAILED EXPLANATIONS — PRACTICE TEST 21 FULL-LENGTH SIMULATED EXAM 3 — ALL SYSTEMS

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## Questions 1–50

1. **D. The chilled water coil is fouling with scale or debris, reducing heat transfer capacity and degrading cooling performance** — Gradually rising supply air temperature with an unchanged setpoint indicates progressive heat transfer degradation at the cooling coil. Scale, mineral deposits, or debris accumulating on the coil tubes insulates the heat transfer surface, reducing the coil's ability to cool the air passing through it even with adequate chilled water supply.
2. **B. The detectors may fail to detect actual smoke conditions because they require a higher smoke concentration to activate than originally designed** — Smoke detectors that drift below their listed sensitivity range become less responsive to smoke. During an actual fire, these detectors may not activate until smoke concentration reaches dangerous levels, delaying alarm notification and reducing the available evacuation time for building occupants.
3. **A. Automatically replenishing the trap seal with periodic water additions to prevent sewer gas entry through infrequently used drains** — Trap primers connect to the domestic water supply and periodically release small volumes of water into the floor drain trap as the seal evaporates. This automated approach ensures continuous sewer gas protection without relying on manual maintenance, which is particularly important for drains in mechanical rooms and storage areas.
4. **C. The condenser coil is dirty, restricting airflow and preventing adequate heat rejection to the atmosphere** — Dirty condenser coils reduce airflow across the heat exchange surface, preventing the refrigerant from rejecting its heat to the outdoor air. This causes condenser pressure to rise until the unit's high-pressure safety switch trips the compressor. When the compressor cools, it restarts and the cycle repeats, producing the short-cycling pattern.
5. **A. Providing adequate working clearances, environmental protection, and secure access for safe operation, maintenance, and emergency response** — The NEC requires specific working clearances in front of electrical equipment to protect personnel from electrical hazards during operation and maintenance. Dedicated electrical rooms provide controlled environments with

proper ventilation, lighting, and restricted access that meet these safety requirements for medium and high-voltage equipment.

6. **D. Repairing or replacing the corroded fitting promptly and investigating the piping system for additional corrosion** — NFPA 25 requires that system deficiencies be corrected when identified. A corroded fitting producing a leak indicates active corrosion that may exist elsewhere in the system. The immediate leak must be repaired, and the investigation should determine whether the corrosion is isolated or represents a systemic condition requiring more extensive assessment.
7. **B. The AHU will overcool the supply air because the controller believes the air is warmer than it actually is, wasting cooling energy and causing comfort complaints** — An 8-degree high reading causes the controller to believe the supply air is warmer than its setpoint, commanding more cooling than needed. The coil cools the air below the intended temperature, wasting chilled water energy and delivering uncomfortably cold air to occupied zones.
8. **C. Upper floors will have progressively lower pressure due to elevation loss, potentially falling below the minimum required for proper fixture operation** — Water pressure decreases approximately 0.433 psi per foot of elevation. In a 12-story building with approximately 120 feet of height, upper floors lose approximately 52 psi from elevation alone. Starting at 75 psi on the ground floor, upper floors may have insufficient pressure for adequate fixture operation.
9. **A. Displaying system status and alarm locations in a graphic or text format for responding fire department personnel to quickly identify the fire location** — The fire alarm annunciator at the building entrance provides responding firefighters with immediate visual information about the alarm condition, including which zone or device is in alarm. This enables the fire department to proceed directly to the fire location without first locating the main fire alarm panel.
10. **D. Reducing the installed lighting power through higher-efficacy fixtures, delamping, or fixture replacement to meet the 0.79 watts per square foot code allowance** — ASHRAE 90.1 establishes maximum lighting power density allowances by space type. At 0.95 watts per square foot, the installation exceeds the 0.79 allowance by 20 percent. The designer must select more efficient fixtures, reduce the number of fixtures, or use lower-wattage lamps to comply.
11. **A. Ground temperatures remain relatively constant year-round, providing a more stable and efficient heat source in winter and heat sink in summer** — Ground temperatures at the depths used for geothermal loops remain between 50 and 60 degrees Fahrenheit regardless of season. This stability provides a much more favorable operating condition than outdoor air temperatures that fluctuate widely, enabling higher coefficients of performance in both heating and cooling modes.
12. **C. The fire pump room must be kept clear of combustible materials to prevent a fire from disabling the pump that the building depends on for fire suppression** — The fire pump is the building's last line of defense when the municipal water supply cannot meet the sprinkler system's

hydraulic demand. A fire in the pump room could disable the pump at the exact moment it is needed most. Keeping the room clear of combustibles eliminates this risk.

13. **D. Initiating emergency repairs immediately because the building's life safety systems have no backup power, and notifying the AHJ if required** — A non-functional emergency generator means the building's exit signs, egress lighting, fire alarm system, and fire pump have no backup power during a utility outage. This is a critical life safety impairment requiring immediate repair, appropriate notifications, and implementation of compensating measures until the generator is restored.
14. **B. Future blockages at or near the direction change will be difficult to clear because there is no access point for drain cleaning equipment** — Cleanouts provide essential access for inserting mechanical drain cleaning equipment to clear blockages. Direction changes are particularly prone to accumulating solids, and without a cleanout at this location, the only option for clearing a blockage is opening walls or floors to access the pipe.
15. **C. Transferring both heat and moisture between exhaust and outdoor air streams, reducing the energy required to heat, cool, and dehumidify ventilation air** — Enthalpy wheels rotate through both the exhaust and outdoor air streams, exchanging both sensible heat and latent moisture. In winter, the wheel recovers warmth and humidity from exhaust air. In summer, it pre-cools and dehumidifies incoming outdoor air, significantly reducing the DOAS energy consumption.
16. **A. Occupants may be unable to evacuate through access-controlled doors on egress paths, potentially trapping them during a fire emergency** — Building codes require that access-controlled doors on egress paths unlock automatically upon fire alarm activation. When this integration fails, locked doors can block evacuation routes, creating a life-threatening situation where occupants cannot escape. This integration must be verified during both fire alarm and access control commissioning.
17. **D. The chiller's efficiency has deteriorated across its typical operating range, consuming more energy than designed to produce the same cooling output** — IPLV measures weighted efficiency across multiple part-load conditions reflecting typical annual operation. A degraded IPLV indicates the chiller consumes more energy per ton of cooling across all operating points, typically from compressor wear, refrigerant loss, heat exchanger fouling, or control system degradation.
18. **B. Providing emergency overflow protection that prevents structural roof overload if the primary drainage system becomes blocked or overwhelmed** — Secondary roof drainage systems activate only when the primary system fails or is overwhelmed by extreme rainfall. They discharge at visible exterior locations as an alert to building maintenance that the primary drains require immediate attention. Without secondary drainage, a blocked primary system could cause ponding and structural failure.

19. **C. The elevator recall programming must be corrected to send elevators to an alternate floor when the designated recall floor itself is the location of the alarm** — When the fire occurs on the designated recall floor, sending elevators there delivers occupants directly to the fire. The system must recognize this condition and automatically redirect elevators to a pre-programmed alternate floor, keeping occupants and firefighters away from the immediate danger.
20. **A. Converting to variable air volume operation with VFDs on supply fans and adding zone-level VAV boxes for independent temperature control** — Constant-volume systems deliver full airflow regardless of zone conditions, wasting significant fan energy. Converting to VAV reduces supply fan speed as zone demands decrease, and individual VAV boxes provide independent temperature control for each zone, addressing both energy waste and comfort simultaneously.
21. **B. A significant obstruction or partially closed valve exists between the water supply and the sprinkler system that must be investigated immediately** — The quarterly main drain test compares current pressure readings to the original acceptance baseline. A 15 psi residual pressure decrease is substantial and indicates a restriction in the water supply path, most commonly a partially closed control valve, pipe obstruction, or degraded municipal supply condition.
22. **A. Modulating outdoor air volume based on actual occupancy, increasing ventilation when the room is heavily occupied and reducing it when the room is empty or lightly occupied** — CO<sub>2</sub> sensors serve as a proxy for occupancy levels. When a conference room fills with people, CO<sub>2</sub> rises and the system increases outdoor air to maintain acceptable air quality. When the room empties, CO<sub>2</sub> drops and the system reduces outdoor air, saving the energy that would otherwise be spent conditioning unnecessary ventilation air.
23. **C. The stairwell's fire compartmentation and pressurization, allowing smoke to enter the primary vertical egress path during a fire** — Fire-rated stairwell doors maintain the stairwell as a protected fire compartment and enable pressurization systems to maintain positive pressure. A propped-open door breaches the fire compartment, allows smoke to enter the stairwell, and compromises pressurization by allowing air to escape, potentially making the stairwell unusable during evacuation.
24. **D. Increasing cooling tower cycles of concentration through improved water treatment, reducing the blowdown volume and total makeup water required** — Cycles of concentration represent how many times the dissolved minerals in the circulating water have been concentrated compared to the makeup water. Increasing cycles through better water treatment allows more evaporation before blowdown is needed, directly reducing the total makeup water required to maintain water quality.
25. **A. Faster assembly, easier disassembly for maintenance, ability to accommodate thermal movement, and reduced fire hazard during installation compared to welding** — Grooved couplings use a bolted housing over grooves rolled into the pipe ends, allowing rapid assembly without hot work. The mechanical connection accommodates thermal expansion and contraction,

enables easy disassembly for maintenance, and eliminates the fire hazard and permit requirements associated with welding in occupied buildings.

26. **B. An uninterruptible power supply that provides clean, conditioned power during voltage sags and momentary outages** — UPS systems use batteries, rectifiers, and inverters to provide continuously conditioned power that bridges voltage sags, momentary outages, and the transfer gap between utility failure and generator startup. The double-conversion UPS topology isolates sensitive equipment from all power quality disturbances.
27. **D. Reducing the hot water supply temperature as outdoor temperature rises, improving efficiency and reducing distribution losses when full heating capacity is not needed** — Outdoor air reset proportionally reduces the boiler supply temperature as heating demand decreases with warmer outdoor conditions. Lower supply temperatures improve condensing boiler efficiency, reduce heat losses from distribution piping, prevent overheating at terminal units, and improve occupant comfort.
28. **A. A voice evacuation system capable of delivering different messages to different zones, instructing the fire floor and adjacent floors to evacuate while directing other floors to stand by** — Phased evacuation requires zone-specific messaging that standard horn signals cannot provide. Voice evacuation systems deliver targeted instructions to each floor zone, enabling prioritized evacuation of the fire floor and adjacent floors while preventing mass simultaneous evacuation that could overwhelm stairwells.
29. **C. Protecting the sanitary sewer infrastructure from corrosive chemical waste that would damage standard piping and interfere with wastewater treatment** — Laboratory facilities generate acidic and alkaline waste that would corrode standard drainage piping materials and damage municipal sewer infrastructure. Acid-resistant piping systems convey waste safely to neutralization tanks that adjust the pH to acceptable levels before discharge into the standard sanitary sewer.
30. **B. A time delay must be added to the retransfer sequence to verify utility power is stable before transferring back** — Immediate retransfer risks repeated transfers if the utility power is unstable, cycling loads between the generator and an unreliable utility source. A programmed time delay, typically 5 to 30 minutes, ensures the utility power has stabilized before the ATS transfers loads back, preventing harmful repeated switching.
31. **C. The existing sprinkler design density, head spacing, and water supply may be completely inadequate for the significantly higher hazard classification of high-pile storage** — Light hazard sprinkler design uses lower water densities, wider head spacing, and smaller design areas than required for high-pile storage. The existing system likely cannot deliver the water volume and density needed to control a fire in high-pile commodity, requiring significant system modification or replacement.

32. **D. Quantifying actual energy savings compared to the pre-retrofit baseline to confirm that the projected savings from each conservation measure are being achieved** — M&V plans establish a documented pre-retrofit baseline and define the methodology for measuring post-retrofit performance. Comparing actual consumption against the baseline quantifies real savings, verifies investment returns, and identifies measures that may need adjustment to achieve projected performance.
33. **B. The occupancy sensor timeout period, reducing the delay to an appropriate duration such as 15 to 20 minutes** — A 30-minute timeout keeps lights on for half an hour after the last detected motion, wasting energy in spaces that may be unoccupied for the majority of the workday. Reducing the timeout to 15 to 20 minutes balances energy savings with occupant convenience, avoiding premature shutoff while minimizing unnecessary illumination.
34. **A. Debris inside the FDC could obstruct water flow when the fire department connects, and the missing cap has allowed contamination to enter the fire protection piping** — The FDC must be immediately accessible and free of obstructions for the fire department to connect pumper hoses during an emergency. Debris accumulated inside the connection can block water flow into the system, and without caps, dirt, insects, and moisture enter the piping system.
35. **D. The filter is accumulating debris and will eventually require cleaning or replacement to maintain design flow** — Increasing differential pressure across a filter indicates progressive debris accumulation on the filter media. As the filter loads, resistance to flow increases, reducing the chilled water flow rate through the system. Monitoring this trend enables proactive filter maintenance before flow restriction affects cooling capacity.
36. **C. Fixture zones and groups can be reprogrammed through software without physical rewiring, accommodating new tenant layouts quickly and cost-effectively** — DALI's individual fixture addressability allows complete flexibility in zone assignments through software changes. When tenant spaces are reconfigured, lighting zones, schedules, and dimming profiles are updated through the management system without any physical rewiring, saving significant time and cost during tenant improvements.
37. **B. The pump cannot keep up with incoming flow due to a stuck check valve, broken float switch, continuous water source, or pump impeller degradation** — Normal sewage ejector operation involves cycling on when the basin fills and off when it empties. Continuous operation indicates the pump cannot lower the basin level, either because water enters faster than the pump can remove it or because the pump's discharge capacity has degraded from a stuck check valve, worn impeller, or failed float control.
38. **D. Speaker placement, directional speaker selection, volume adjustment, or acoustic treatment to reduce reverberation and achieve the required speech intelligibility rating** — Large atrium spaces with hard reflective surfaces create reverberation that degrades speech intelligibility. Corrections may include repositioning speakers, using directional speakers that

focus sound toward occupied areas, adjusting volume to reduce reflected energy, or applying acoustic treatment to reduce reverberation time.

39. **A. Producing and storing cooling capacity during off-peak nighttime hours for discharge during peak daytime hours, shifting electrical demand from peak to off-peak periods and reducing demand charges** — Thermal storage shifts the chiller's electrical demand from expensive peak daytime hours to lower-cost nighttime hours. Ice or chilled water produced overnight is stored and discharged during afternoon peak periods, directly reducing the building's measured peak demand and associated utility charges.
40. **C. The valve will fail to prevent municipal sewer backup because the check mechanism operates correctly only when installed in the proper orientation** — Backwater valves use gravity-operated flap mechanisms designed to allow forward flow while blocking reverse flow. Installed upside down, the flap mechanism cannot function as designed, leaving the building unprotected against municipal sewer surcharges that could cause raw sewage to back up into below-grade spaces.
41. **D. Loss of the single pathway from cable damage, equipment failure, or network disruption would prevent alarm transmission to the monitoring station, delaying fire department notification** — A single communication pathway creates a single point of failure. If that pathway is interrupted by any cause, alarm signals cannot reach the monitoring station and the fire department will not be dispatched automatically. NFPA 72 requires redundant communication pathways for this reason.
42. **A. That SPDs are properly installed, connected, and indicated as functional at the main switchgear and critical branch panels** — Surge protective device commissioning verifies correct installation at specified locations, proper connection to the electrical system, functional status indicators showing the devices are operational, and appropriate coordination with the building's overcurrent protection scheme to ensure sensitive equipment is protected from transient voltage events.
43. **C. A single water heater maintaining 140 degrees for storage and kitchen supply, with thermostatic mixing valves reducing temperature to safe levels at domestic fixture points of use** — This configuration efficiently serves both requirements from a single heat source. The 140-degree storage temperature prevents Legionella colonization and satisfies the kitchen's sanitizing needs. Thermostatic mixing valves at domestic fixtures blend hot and cold water to safe delivery temperatures, preventing scalding.
44. **B. The fire alarm integration wiring to the smoke damper actuators, the damper control module programming, and the physical operation of each damper blade** — Smoke damper failure to close upon fire alarm activation can result from disconnected or miswired integration wiring, incorrect control module programming that does not assign the dampers to the correct fire

alarm zones, or physical problems with the damper blade, linkage, or actuator mechanism preventing closure.

45. **D. Continuous monitoring of BAS trend data, regular verification of setpoints and schedules, and periodic recommissioning to prevent operational drift** — Energy savings achieved through retro-commissioning degrade over time as setpoints are overridden, schedules are modified, and control sequences drift from their optimized settings. Continuous monitoring identifies drift early, regular verification catches manual overrides, and periodic recommissioning restores optimized operation.
46. **A. A weighted demand value that accounts for the probable simultaneous use of all connected fixtures, converted to a peak flow rate using diversity tables** — Fixture units assign weighted values to each fixture type based on flow rate and probability of simultaneous use. The total fixture unit count is converted to an estimated peak demand flow rate using diversity curves that account for the statistical improbability that all fixtures operate simultaneously.
47. **C. Monitoring conditions, starting the fire pump automatically on pressure drop, providing manual start capability, and monitoring pump performance** — The fire pump controller continuously monitors system pressure and starts the pump automatically when pressure drops below the activation setpoint. It also provides manual start capability, monitors pump performance parameters including power and pressure, and transmits alarm and supervisory signals to the fire alarm system.
48. **B. Whether the cooling system was sized for peak afternoon conditions including solar heat gain, and whether equipment performance has degraded below design capacity** — Afternoon cooling failures typically result from solar heat gain that peaks in mid to late afternoon. The investigation should verify whether the original design accounted for peak solar loads and whether current equipment capacity has degraded from refrigerant loss, compressor wear, coil fouling, or condenser performance decline.
49. **D. Ensuring that all fire protection equipment has been independently tested, evaluated, and certified to meet applicable safety and performance standards** — Listed and labeled equipment has been evaluated by an independent testing laboratory such as UL or FM and found to meet the applicable safety and performance standards. This certification provides assurance that the equipment will perform as expected when needed during a fire emergency.
50. **A. Many HVAC deficiencies only manifest during their specific operating season, and heating system problems are invisible during summer testing while economizer and cooling sequence faults only appear during appropriate weather conditions** — Commissioning performed in only one season misses deficiencies that only appear under opposite conditions. Boiler sequencing, heating valve operation, and winter economizer lockout cannot be verified in summer. Similarly, chiller staging, cooling tower operation, and economizer engagement cannot be fully tested in winter.