PRACTICE EXAM 10: BOILER OPERATOR LICENSE SIMULATION

QUESTIONS 1–100

1. The saturation temperature of water at atmospheric pressure (14.7 psia) is:

A. 100°F matching typical room temperature for operations

B. 180°F matching typical feedwater temperature conditions

C. 212°F at standard sea-level atmospheric conditions

D. 240°F matching elevated pressure conditions for most boilers

2. An operator discovers the previous shift bypassed the low water fuel cutoff with a jumper wire. The boiler is currently firing. The first action is:

A. Shut off the fuel immediately and remove the jumper wire

B. Document the finding and continue operation until shift relief

C. Report to supervision and finish the current shift safely

D. Leave the jumper in place and monitor water level carefully

3. A boiler producing 6,900 lbs/hr of steam from and at 212°F has a rating of approximately:

A. 100 BHP based on halved divisor calculation directly

B. 200 BHP using the standard 34.5 divisor calculation

C. 300 BHP based on increased steam capacity calculation

D. 500 BHP based on alternative rating standards used

4. A cast-iron sectional heating boiler is classified under which ASME code section?

A. Section I for power boilers with high pressure operation

B. Section VIII for pressure vessels other than boilers

C. Section VII for recommended care of power boilers

D. Section IV for heating boilers at 15 psig steam pressure

5. The term "MAWP" on a boiler code plate stands for:

A. Maximum Allowable Working Pressure as stamped on plate

B. Minimum Acceptable Water Pressure during operations daily

C. Mandatory Alarm Warning Point on control panels

D. Maximum Applied Wall Pressure for piping calculations

6. A gauge glass water line that is rising rapidly during high steam demand and stable firing indicates most likely:

A. Normal operation during typical load transitions daily

B. Improved boiler efficiency showing higher water levels

C. Priming or foaming with water carryover developing

D. Reduced steam demand affecting apparent water level

7. Over 3 months, a boiler's fuel consumption rises 3% with steam demand unchanged. Stack temperature has risen 20°F. The most likely cause is:

A. Normal seasonal variation in boiler efficiency patterns

B. Progressive fouling of heat transfer surfaces over time

C. Improved feedwater treatment reducing combustion efficiency

D. Reduced ambient temperature affecting combustion air quality

8. An operator observes combustion analysis: 3% O_2, 50 ppm CO, stack at 400°F. This represents:

A. Combustion with insufficient oxygen producing excess CO emissions

B. Excessive air diluting combustion and reducing efficiency significantly

C. Normal operation at acceptable efficiency targets typically

D. Well-tuned combustion within typical natural gas targets

9. ASME CSD-1 applies specifically to boilers with what input rating?

A. 12.5 million Btu/hr or less input rating

B. 25 million Btu/hr or less input rating

C. 50 million Btu/hr or less input rating

D. 100 million Btu/hr or less input rating

10. During an LWCO slow-drain test, water drops but the burner continues firing past the expected cutoff point. The correct action is:

A. Continue the test to verify at what point cutoff occurs

B. Shut off fuel manually and investigate the LWCO failure

C. Reset the test and try again with faster drain rate

D. Document normal operation and continue with rounds

11. An operator is asked by supervision to falsify chemistry logs. The appropriate response is:

A. Follow supervision's instructions without question for cooperation

B. Ask coworkers for advice before making a decision today

C. Complete partial falsification as a compromise for harmony

D. Refuse because falsification is unethical and potentially illegal

12. A feedwater pump delivering 100 gpm against 200 psi differential at 70% efficiency requires approximately:

A. 16.7 BHP based on the standard pump formula

B. 25.0 BHP based on adjusted parameters for calculation

C. 50.0 BHP based on doubled parameter estimation

D. 100.0 BHP at full loading of the motor continuously

13. A "wetback" firetube boiler configuration has:

A. Water flowing through tubes around a combustion chamber design

B. Refractory lining the rear of the boiler at turnaround area

C. Water cooling the rear turnaround chamber instead of refractory

D. Multiple drums connected by bent tubes for construction strength

14. The "combustion triangle" consists of fuel, heat, and:

A. Water vapor as a reaction product during combustion

B. Oxygen supplied through combustion air to the burner

C. Carbon dioxide from the chemical reaction process

D. Nitrogen as an inert atmospheric gas during combustion

15. A boiler safety valve is set at 150 psig with 3% blowdown. The valve reseats at:

A. 145.5 psig matching the setpoint minus typical margin

B. 153 psig matching setpoint plus additional pressure

C. 100 psig matching operating pressure control setting

D. 145.5 psig (150×0.97) from the blowdown calculation

16. During operation, a flame scanner shows strong signal while no actual flame exists. This failure mode is:

A. Failed in a dangerous mode allowing continued fuel supply

B. Normal operation during modulating burner operation

C. Failed in a safe mode causing immediate burner shutdown

D. Properly functioning during standard combustion conditions

17. An operator discovers expired fire extinguishers in the boiler room. The appropriate action is:

A. Use them anyway since they probably still work today

B. Remove them completely until new units arrive next week

C. Report the condition and arrange prompt re-inspection

D. Leave them in place with warning labels applied

18. A boiler using natural gas at 5% excess air typically achieves:

A. 60-70% combustion efficiency at typical operating conditions

B. 80-85% combustion efficiency at optimal tuning points

C. 95-100% combustion efficiency as theoretical maximum

D. 40-50% combustion efficiency at reduced loads typically

19. An operator observes over 2 hours: sulfite 45 ppm → 35 ppm → 25 ppm → 15 ppm with pump running normally. The most likely cause is:

A. Developing oxygen ingress consuming sulfite faster than feed

B. Normal variation during standard operation periods daily

C. Chemical feed pump working harder than usual today

D. Improved boiler water treatment naturally occurring performance

20. The ASME "H" stamp on a boiler plate indicates:

A. Power boiler construction under Section I requirements

B. Pressure vessel construction under Section VIII rules

C. Welding qualification under Section IX standards

D. Heating boiler construction under Section IV rules

21. An operator discovers the boiler has not been internally inspected in 14 months. The appropriate response is:

A. Remove the boiler from service until inspection is completed

B. Continue operation since the boiler is performing well currently

C. Perform a quick visual check through the manway for safety

D. Wait for the jurisdictional inspector to arrive at some point

22. A boiler operator is handling No. 6 fuel oil. The required preheat temperature is approximately:

A. 70°F matching typical ambient storage temperature conditions

B. 110°F for proper handling and movement through pipes

C. 140°F at intermediate temperature for transfer operations

D. 185°F for proper atomization at burner inlet during firing

23. A three-element feedwater control uses which three signals?

A. Temperature, pressure, and combustion air as inputs

B. Fuel flow, combustion air, and steam pressure feedback

C. Water level, steam flow, and feedwater flow feedback

D. Chemistry, level, and stack temperature all combined

24. During a severe storm, plant power is lost and emergency generator fails to start. The first priority is:

A. Continue operation using any residual power available to plant

B. Secure the boiler safely and evacuate if necessary quickly

C. Wait for power restoration before taking any action at all

D. Evacuate personnel from the plant immediately upon failure

25. A boiler's operating pressure control is at 130 psig. The high-pressure limit setpoint should typically be:

A. Below the operating control for nuisance prevention daily

B. Matching the operating control for efficient operation

C. Matching the safety valve setpoint for pressure relief

D. 10-25 psig above operating control setpoint

26. An operator observes that bottom blowdown produces black flakes in the discharge. This indicates:

A. Iron scale detaching from waterside surfaces during blowdown

B. Normal sediment removal during routine boiler operations

C. Combustion deposits reaching the boiler through air intake

D. Proper chemistry maintenance from recent treatment changes

27. A boiler operating at 150 psig has approximate saturation temperature of:

A. 212°F matching atmospheric pressure condition always

B. 300°F matching twice atmospheric pressure roughly

C. 366°F matching 150 psig saturation condition

D. 450°F matching 500 psig saturation temperature

28. Multiple acceptable approaches exist for steam trap surveys. The BEST practice for an industrial plant is:

A. Annually matching internal inspection schedule for convenience

B. Semi-annually or quarterly for optimal detection of failures

C. Only when operators report obvious trap problems during rounds

D. Every 5 years matching major maintenance outages for efficiency

29. The standard "pre-purge" requirement before burner ignition is:

A. Two furnace-volume air changes for minimum safety standards

B. One furnace-volume air change for efficiency of operation

C. Six furnace-volume air changes for maximum safety precaution

D. Four furnace-volume air changes to clear combustibles

30. A licensed operator is asked to operate a boiler above their license class. The correct response is:

A. Refuse because operating outside license scope is illegal activity

B. Agree if supervision provides written authorization explicitly

C. Operate the boiler at reduced capacity for compliance marginally

D. Consult with fellow operators before making final decision today

31. During operation, the operator measures feedwater flow at 20% higher than steam flow output. The most likely cause is:

A. Normal variation between different measurement instruments calibrated

B. Significant blowdown rate above typical operation routine

C. Measurement error on one of the flow meters installed

D. Steam leak in downstream distribution piping somewhere

32. A boiler's feedwater pump has developed noisy bearings but continues to operate. The most appropriate action is:

A. Ignore the noise since pump is working correctly now

B. Increase pump speed to mask the bearing noise temporarily

C. Schedule bearing replacement at the next planned maintenance outage

D. Shut down the pump immediately for complete inspection now

33. 1 BHP expressed in Btu/hr equals approximately:

A. 33,475 Btu/hr based on 34.5 × 970.3 calculation

B. 2,545 Btu/hr matching mechanical horsepower equivalence

C. 746 Btu/hr matching electrical horsepower approximation

D. 1,000 Btu/hr matching natural gas per cubic foot

34. An operator on a plant with condensate containing visible yellow discoloration tests finds elevated iron content. The most likely cause is:

A. Normal aging of condensate producing color variations

B. Chemistry treatment producing iron compounds intentionally added

C. Improved boiler efficiency affecting condensate color measurements

D. Corrosion in condensate return piping due to acidic conditions

35. A safety valve lifting at its set pressure but reseating only 2 psi below the setting represents:

A. Excessive blowdown requiring adjustment to widen differential

B. Insufficient blowdown requiring adjustment to provide differential

C. Normal operation requiring no action on the valve system

D. Failed valve requiring immediate replacement before further use

36. The "stoichiometric" air-fuel ratio for combustion represents:

A. 25% excess air for safety margin during operations daily

B. The minimum air for visible flame formation during firing

C. Exactly theoretical air for complete fuel combustion chemistry

D. 50% excess air for complete combustion under all conditions

37. An operator observes cascading alarms in this sequence: (1) Low feedwater flow; (2) Low water level; (3) Burner trip on LWCO. The initiating event was:

A. Low feedwater flow starting the cascade sequence downward

B. Low water level activating the alarm cascade automatically

C. Burner trip initiating the downstream alarm sequence upward

D. All three alarms tripping simultaneously at the event time

38. The ASME BPVC section covering the care of power boilers is:

A. Section VIII for pressure vessels other than boilers

B. Section I for power boiler construction requirements only

C. Section VI for heating boiler care and operation

D. Section VII for power boiler care and operation

39. An operator finds boiler water pH at 10.8, sulfite at 40 ppm, conductivity at 2,500 µS/cm. The chemistry assessment is:

A. All parameters significantly out of specification requiring adjustment

B. All parameters within typical specification range operation

C. Only pH requiring adjustment for proper boiler protection

D. Only sulfite requiring adjustment for oxygen removal

40. Among acceptable approaches to combustion tuning, the BEST practice is:

A. Visual flame observation combined with stack temperature readings

B. Manual adjustment based on operator experience and judgment

C. Continuous oxygen trim with periodic comprehensive tune-ups

D. Periodic tune-ups with portable combustion analyzer annually

41. A boiler's main steam stop valve is found leaking during shutdown. The most likely symptom is:

A. Reduced steam flow to downstream loads during operation

B. Pressure in the boiler rising while offline from header

C. Feedwater flow exceeding steam production temporarily briefly

D. Stack temperature rising without corresponding firing rate increase

42. An operator receiving a chemical splash on the skin should immediately:

A. Wipe the area with a clean cloth or paper towel

B. Apply first aid cream and continue with task work

C. Cover the area with a bandage to protect from air

D. Flush the affected area with water for at least 15 minutes

43. The primary purpose of a water column's try cocks is to:

A. Verify water level by direct discharge observation independently

B. Adjust the feedwater regulator setpoint precisely during operation

C. Isolate the gauge glass for maintenance access during shutdowns

D. Test the safety valve for free lifting operation verification

44. A boiler operating at 180 psig has latent heat of vaporization of approximately: (At atmospheric it's 970 Btu/lb; at higher pressures it's lower.)

A. 1,150 Btu/lb at increased operating pressure uniformly

B. 970 Btu/lb matching atmospheric pressure value

C. 837 Btu/lb at 180 psig (lower than atmospheric value)

D. 500 Btu/lb at increased pressure condition routinely

45. During operation, the operator observes boiler room temperature rising steadily without change in outdoor conditions. The most likely cause is:

A. Normal operation during heating seasons with variations daily

B. Heat loss from equipment, piping, or boiler into the room

C. Combustion air reduction limiting heat transfer efficiently

D. Reduced firing rate producing more heat retention inside

46. An operator notes a coworker sleeping on duty during night shift. The appropriate response is:

A. Wake the coworker quietly and let them continue work

B. Cover for them because shift work causes fatigue naturally

C. Take over their duties silently until they wake up eventually

D. Report the finding to supervision as a safety concern

47. A boiler's total dissolved solids have climbed from 2,800 ppm to 3,900 ppm over 2 weeks with no change in blowdown rate. The most likely cause is:

A. Excessive chemical treatment overdosing the boiler water gradually

B. Failure of the surface blowdown control valve to open

C. Reduced condensate return requiring increased makeup water volume

D. Improved deaerator performance reducing dissolved gases gradually

48. The "Hartford loop" piping arrangement is installed on:

A. High-pressure power boilers for redundancy during operation

B. Electric electrode boilers for electrical isolation purposes

C. Low-pressure steam heating boilers for water loss protection

D. Cast-iron modular boilers for section separation during assembly

49. A boiler operating at 83% efficiency with 5,000 lbs/hr steam and feedwater/steam enthalpies of 180 and 1,195 Btu/lb requires fuel input of approximately:

A. 5,075,000 Btu/hr matching output calculation directly

B. 4,200,000 Btu/hr at reduced fuel demand estimate

C. 10,000,000 Btu/hr at doubled input estimation values

D. 6,114,000 Btu/hr based on efficiency calculation

50. During operation, the operator notices the feedwater regulator valve progressively opens over hours. Steam demand is unchanged. The most likely cause is:

A. Normal operation with minor load variations during the day

B. Developing steam or water loss requiring increased makeup rate

C. Improved boiler efficiency reducing feedwater demand over time

D. Chemistry changes affecting feedwater flow measurement accuracy

51. A safety valve's try-lever is operated by hand when pressure is below 75% of setpoint. The expected result is:

A. No audible discharge because pressure is below test threshold

B. Full lift and discharge matching normal operation conditions

C. Partial discharge proving the valve mechanism works properly

D. Complete valve failure requiring immediate replacement effort

52. An operator observes the following deaerator operation: vent temperature 225°F, feedwater temperature 218°F, storage level 75%, dissolved oxygen 5 ppb. The deaerator performance is:

A. Significantly below specification requiring immediate investigation

B. At specification limits but acceptable during operations

C. Operating within typical specifications for good performance

D. Above specification indicating excessive steam consumption daily

53. Operator log shows over 1 week: Day 1 stack O_2 3.5%; Day 3 3.8%; Day 5 4.5%; Day 7 5.8%. No tuning was performed. The most likely cause is:

A. Improved combustion from natural system optimization over time

B. Drifting combustion control allowing excess air to increase gradually

C. Reduced firing rate requiring less combustion air during operation

D. Normal variation in combustion measurements during weekly cycles

54. An operator's BEST response to a supplier offering gifts in exchange for product recommendations is:

A. Accept the gifts and recommend the products as requested

B. Ask for larger gifts before making any recommendations firmly

C. Accept gifts but recommend only products the operator truly likes

D. Decline the gifts and evaluate products on technical merit only

55. The operator observes feedwater oxygen progressing: 0600 at 5 ppb; 1000 at 15 ppb; 1400 at 35 ppb; 1800 at 75 ppb. The most likely cause developing is:

A. Deaerator performance degradation requiring immediate investigation

B. Normal chemistry variation during standard daily operation

C. Improved chemical treatment reducing oxygen measurement readings

D. Reduced firing rate affecting feedwater oxygen content readings

56. A "non-return valve" combines the functions of:

A. A pressure regulator and bypass valve in one body assembly

B. A blowdown valve and drain valve in combination design

C. A stop valve and check valve in a single body

D. A safety valve and pressure relief valve together

57. During a cold startup, the operator is warming the boiler from ambient temperature. The correct practice is:

A. Bring to full operating pressure immediately to save time

B. Follow manufacturer's gradual warmup schedule for thermal protection

C. Increase firing rate to maximum to accelerate warming process

D. Stop warming periodically to check for any leaks present

58. A boiler has two safety valves set at 150 psig and 153 psig respectively. During accumulation test, maximum allowable pressure is:

A. 150 psig matching the lowest valve setting for safety

B. 153 psig matching the highest valve setting for safety

C. 165 psig as operating pressure margin above MAWP

D. 162 psig (6% above highest valve setting of 153)

59. The operator's "first-out annunciation" function identifies:

A. Which alarm condition occurred first in a cascade sequence

B. The most recent alarm received by the panel display

C. The highest-severity alarm regardless of sequence

D. Only alarms originating from control power failures automatically

60. An operator is asked by a contractor to approve work that was not completed. The response should be:

A. Accept the money if the work was close enough to complete

B. Accept the payment and do not approve the work actually

C. Refuse the offer and report the request to supervision

D. Ignore the offer and avoid the contractor going forward

61. A feedwater pump suction pressure drops from 5 psig to −2 psig. The most likely cause is:

A. Excessive pump discharge pressure demand from the boiler

B. Normal operation during reduced feedwater demand periods

C. Improved feedwater treatment reducing suction requirements daily

D. Clogged suction strainer or low feedwater tank level

62. The "Seebeck effect" is the physical principle behind:

A. Thermocouple temperature measurement at metal junctions

B. Capacitive pressure measurement using electrical fields

C. Conductivity measurement in boiler water samples always

D. Oxygen content measurement in flue gas streams constantly

63. During operation, the operator observes that combustion air fan amperage rises steadily over 8 hours while firing rate and damper position are unchanged. The most likely cause is:

A. Normal variation during the operating period typically

B. Improved fan efficiency from recent maintenance activities

C. Developing fan impeller fouling increasing aerodynamic load

D. Reduced firing rate affecting fan amperage over time

64. An operator should read a chemical's Safety Data Sheet:

A. Only after any incident occurs involving the chemical

B. Before handling the chemical for the first time always

C. Only when required by the annual compliance review

D. Only when specifically instructed by a supervisor during use

65. A feedwater pump running continuously for 6 months should:

A. Be rotated periodically with the standby pump for wear distribution

B. Continue running until failure then switch to backup pump

C. Be shut down for scheduled maintenance immediately today

D. Be run at higher speed for better reliability overall

66. An operator finds that emergency exits in the boiler room are blocked by stored materials. The appropriate response is:

A. Request the storage be moved during the next scheduled cleaning

B. Document the blocked exits in the log for future reference

C. Identify alternative exits and continue normal operations daily

D. Clear the exits immediately and report the violation

67. A boiler's steam flow exceeds nameplate rating by 5%. This condition:

A. Is normal operation below maximum capacity typically designed

B. Must be investigated and corrected to prevent damage

C. Indicates improved efficiency from recent tuning activities

D. Represents design margin that can be used operationally

68. A boiler's saturation temperature at 300 psig is approximately:

A. 212°F matching atmospheric pressure conditions typically

B. 300°F matching the gauge reading directly uniformly

C. 417°F matching 300 psig saturation temperature

D. 546°F matching 1,000 psig saturation value approximately

69. During a process upset, steam pressure drops from 150 psig to 100 psig in 90 seconds. The operator's correct response includes:

A. Verify steam demand cause, confirm max firing rate, monitor water level

B. Continue normal operation since pressure will naturally recover soon

C. Shut down the boiler immediately to prevent further pressure loss

D. Call supervision before taking any action during the upset

70. An operator's BEST practice for gauge glass cleaning frequency is:

A. Whenever the glass appears difficult to read from operator view

B. Monthly during preventive maintenance rounds scheduled for compliance

C. Annually during internal inspection and testing procedures only

D. Daily as part of routine blowdown verification activity

71. A deaerator's primary function is to:

A. Preheat feedwater using flue gas heat before the boiler

B. Soften feedwater by removing calcium and magnesium hardness

C. Remove dissolved oxygen and non-condensable gases from feedwater

D. Chemically treat feedwater with oxygen scavenger chemicals

72. A boiler operator notices the stack damper opens progressively over days while firing rate is steady. The most likely cause is:

A. Progressive restriction in gas flow requiring increased damper opening

B. Normal stack damper variation during standard firing operations daily

C. Improved combustion reducing stack damper position normally

D. Reduced steam demand affecting stack damper automatically

73. An operator is asked to train a person who lacks the required state license. The appropriate response is:

A. Train the person informally until supervision verifies credentials

B. Refuse unauthorized training and report to supervision immediately

C. Train on basic procedures while the license is processed

D. Allow hands-on training with close personal supervision daily

74. The "ASME BPVC Section I" governs:

A. Heating boilers below 15 psig steam pressure always

B. Pressure vessels other than boilers in plant service

C. Refrigeration systems with pressure vessel applications

D. Power boilers above 15 psig steam pressure

75. A boiler's heat absorbed equals (steam flow) × (h_steam − h_feedwater). For 4,500 lbs/hr steam, 1,200 Btu/lb steam enthalpy, 200 Btu/lb feedwater enthalpy, heat absorbed is:

A. 1,500,000 Btu/hr at moderate operating conditions

B. 2,000,000 Btu/hr at intermediate operation levels

C. 4,500,000 Btu/hr from the standard calculation

D. 6,000,000 Btu/hr at elevated operation conditions

76. An operator receives a fire alarm in the boiler room. The first action is:

A. Evacuate along designated routes to the assembly area

B. Call 911 before doing anything else immediately

C. Attempt to locate and extinguish the fire manually

D. Retrieve personal belongings before exiting the area safely

77. A "chemical" SDS must be consulted:

A. Only after an incident involving the chemical has occurred

B. Only during annual compliance reviews of safety procedures

C. Whenever the chemical appears to be causing problems

D. Before handling any chemical for the first time always

78. Over 3 months, the operator has observed blowdown rate climbing from 2.1% to 3.5% of steam production. The most likely cause is:

A. Normal seasonal variation in blowdown requirements over time

B. Reduced condensate return increasing makeup and solids loading

C. Improved chemical treatment affecting blowdown rate patterns

D. Feedwater chemistry improvements reducing solids accumulation gradually

79. The operator observes that water surface in the gauge glass has frothy white foam on top. This symptom is consistent with:

A. Foaming from chemistry contamination or high TDS levels

B. Normal operation during steady-state load conditions regularly

C. Low-pressure boiler operating at reduced firing rate efficiently

D. Adequate feedwater treatment maintaining boiler health routinely

80. A boiler's operating pressure control is cycling with 5 psig differential (125-130 psig). Most likely cause:

A. Normal operation at rated firing across all settings

B. High-pressure limit setpoint needs reduction to prevent nuisance

C. Operating control differential is too narrow at current setting

D. Safety valve setpoint needs adjustment to match operating range

81. The first action upon detecting a significant gas leak in the boiler room is:

A. Evacuate the affected area and isolate fuel supply at source

B. Investigate the source of the leak while maintaining operation

C. Increase ventilation to disperse the gas before further action

D. Continue operation while the leak is being located for repair

82. During operation, the operator observes that chemistry logs have been filled in for tomorrow's date. The appropriate response is:

A. Ignore the pre-dated entries since they may become accurate tomorrow

B. Continue using the records since they were written by a licensed operator

C. Report the falsified records to supervision for proper investigation

D. Correct the dates without notifying anyone about the discrepancy

83. A boiler's maximum allowable temperature for hot water service under Section IV is:

A. 200°F at typical hot water heating conditions always

B. 250°F as the upper temperature limit under Section IV

C. 300°F for higher-temperature hot water applications typically

D. 400°F at elevated pressure and temperature service ratings

84. A steam header should be sloped:

A. Level horizontally without any slope for uniform distribution

B. Upward toward outlets to promote gravity return overall

C. Random depending on available building space during construction

D. Downward in direction of steam flow for condensate drainage

85. Over 6 months, fuel consumption per pound of steam has increased from 900 Btu/lb steam to 950 Btu/lb steam. Steam output is unchanged. The efficiency change is approximately:

A. Negligible, about 1% decline in overall boiler efficiency only

B. About 5% efficiency decline from progressive heat transfer degradation

C. About 20% efficiency decline requiring major boiler maintenance now

D. No change since the fuel quantity is unchanged consistently

86. A steam trap that has failed open passes live steam to the return. The typical annual cost of one failed-open trap at 30 lbs/hr loss, 8,000 operating hours, and $12/1,000 lbs steam is approximately:

A. $288/year at reduced operating conditions total throughout year

B. $1,000/year at the standard operating rate typically used

C. $2,880/year from the direct calculation of losses annually

D. $10,000/year at elevated operating conditions used rarely

87. An operator's license is restricted to low-pressure service but supervision asks them to operate a high-pressure boiler. The operator should:

A. Agree if supervision provides written authorization explicitly

B. Refuse because operating outside license scope is illegal activity

C. Operate at reduced pressure only for compliance marginally

D. Consult fellow operators before making the decision today

88. The "boiler horsepower" reference standard is:

A. 100 lbs/hr of steam at operating pressure conditions

B. 30 lbs/hr of steam at standard conditions typically

C. 746 Btu/hr matching electrical horsepower exactly

D. 34.5 lbs/hr of steam from and at 212°F

89. A feedwater pump's shutoff head is the:

A. Maximum discharge pressure at zero flow condition

B. Normal operating discharge pressure during flow conditions

C. Zero discharge pressure during pump startup routine

D. Pressure at which the pump initially begins to flow

90. An operator's BEST response to recurring near-miss incidents that have not caused injury is:

A. Accept near-misses as inevitable given boiler operation complexity

B. Wait for a serious incident before changing any plant procedures

C. Conduct a systematic root-cause analysis across all incidents

D. Investigate each event as isolated without pattern analysis

91. During hydrostatic testing, the test pressure is applied at:

A. Equal to the MAWP value without any additional margin

B. 1.5 times the MAWP value for standard code testing

C. Half the MAWP value for conservative testing approaches

D. 4 times the MAWP value for maximum safety verification

92. An operator on a plant with untreated wastewater being discharged to a local river should:

A. Ignore the situation since it is not the operator's responsibility

B. Document the practice but take no further action initially

C. Attempt to treat the wastewater personally with available materials

D. Report the violation to environmental authorities and management

93. The primary cause of oxygen pitting in boiler tubes is:

A. Dissolved oxygen in feedwater from inadequate deaeration

B. Improper combustion producing tube wall oxidation externally

C. High pH causing caustic attack on tube surfaces internally

D. Excessive boiler pressure causing stress-induced corrosion chronic

94. A boiler with 1.5% blowdown rate at 5,000 lbs/hr steam production has blowdown flow of:

A. 35 lbs/hr matching reduced blowdown calculation directly

B. 50 lbs/hr at moderate flow conditions typically applied

C. 75 lbs/hr from standard calculation (5,000 × 0.015)

D. 125 lbs/hr at elevated flow conditions during operation

95. An operator finds a coworker who appears impaired during shift. The appropriate response is:

A. Confront the coworker directly without involving anyone else

B. Report the safety concern to supervision immediately without delay

C. Cover for the coworker to protect their job security today

D. Wait until the coworker makes a mistake before acting

96. A boiler's combustion air fan trips on motor overload during startup but operates normally on restart. The most likely cause is:

A. Normal starting behavior during cold startup periods daily

B. Bearing failure on the fan shaft requiring replacement soon

C. Motor winding issue developing over operating hours gradually

D. Damper restricting airflow at startup from frozen position

97. The "operating pressure control" on a boiler:

A. Cycles the burner on and off based on pressure setpoints

B. Shuts off the fuel supply at high-pressure limit condition

C. Provides relief during overpressure events automatically opening

D. Controls the feedwater flow based on level measurements only

98. During operation, the operator observes: Week 1 conductivity 2,400 µS/cm; Week 2 2,700; Week 3 3,100; Week 4 3,500. Other parameters stable. The most likely cause is:

A. Chemistry changes affecting conductivity measurements uniformly

B. Normal weekly variation in chemistry measurements routinely

C. Reduced condensate return increasing makeup water supply

D. Improved chemical treatment affecting conductivity patterns

99. A "flame scanner" detects flame through:

A. Audio signals from the combustion sound pattern analysis

B. Light emission in visible, infrared, or ultraviolet bands

C. Pressure variations in the combustion chamber during firing

D. Temperature measurement at the burner throat continuously

100. An operator's professional ethical obligation includes:

A. Following supervisor's instructions without question always

B. Maintaining confidentiality about all plant information forever

C. Protecting employer interests above public safety concerns

D. Upholding public safety, professional integrity, and legal compliance

PRACTICE EXAM 10: ANSWER KEY AND FULL EXPLANATIONS (QUESTIONS 1–100)

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1. C — Saturation temperature at atmospheric pressure (14.7 psia) is 212°F. This value is the reference for boiler horsepower calculations ("from and at 212°F") and the foundation of every steam table lookup. Understanding this pressure-temperature relationship is fundamental to boiler operation.

2. A — A bypassed LWCO is a life-safety violation that must be corrected immediately. Shutting off fuel removes the immediate combustion hazard; removing the jumper restores the intended protection. Continued firing with a defeated safety device has produced fatal boiler incidents historically.

3. B — 6,900 lbs/hr ÷ 34.5 = 200 BHP. The 34.5 divisor is the defining ratio of pounds of steam per hour to boiler horsepower "from and at 212°F." This is the most routinely tested BHP calculation on licensing examinations.

4. D — Cast-iron sectional heating boilers operate at or below 15 psig steam pressure under ASME Section IV. Section I covers power boilers; Sections VII and VIII cover different equipment. Correct code section identification determines all construction and operation requirements.

5. A — MAWP stands for Maximum Allowable Working Pressure as stamped on the code data plate. It defines the highest pressure at which the boiler may safely operate. Every decision about safety valve settings and operating pressure references this fundamental value.

6. C — Priming or foaming with water carryover causes water level to rise rapidly despite stable firing. Chemistry contamination, high water level, or TDS issues typically drive this behavior. Correction requires addressing the underlying cause, not the apparent level.

7. B — Progressive fouling of heat transfer surfaces causes rising fuel consumption and rising stack temperature over time. The pattern is diagnostic: heat not absorbed leaves through the stack, and more fuel is needed to produce the same steam. Tube cleaning typically restores efficiency.

8. D — 3% O_2 and 50 ppm CO at 400°F stack temperature represents well-tuned combustion within typical natural gas targets. Modern natural gas boilers target 3-5% O_2 with CO below 100 ppm. Efficiency at these conditions is typically 80-85%.

9. A — ASME CSD-1 covers controls and safety devices for automatically fired boilers of 12.5 million Btu/hr input or less. This covers the commercial package-boiler range. Larger units fall under NFPA 85 coverage.

10. B — Shutting off fuel manually and investigating the LWCO failure is the correct response when the cutoff fails during testing. The test has identified a safety-critical failure requiring immediate correction. Continuing or resetting without investigation is never acceptable for safety systems.

11. D — Falsification of chemistry logs is both unethical and illegal — a criminal offense and violation of professional licensing. Refusing the request is the only acceptable response regardless of supervisory pressure. Operators have both legal and professional obligations to refuse such requests.

12. A — Pump BHP = (gpm × psi × SG) / (1,714 × efficiency) = (100 × 200 × 1.0) / (1,714 × 0.70) = 20,000/1,200 ≈ 16.7 BHP. This standard pump-sizing formula applies to centrifugal pump applications. Understanding pump BHP is essential for electrical load and efficiency calculations.

13. C — Wetback firetube boilers have water cooling the rear turnaround chamber area instead of refractory. This contrasts with dryback designs where refractory lines the rear turnaround. Wetback is more efficient but more expensive to construct.

14. B — The combustion triangle requires fuel, heat (ignition), and oxygen through combustion air. Removing any of the three stops combustion. This is the fundamental mental model for every combustion safety decision an operator makes.

15. D — Blowdown of 3% on 150 psig means the valve reseats at 150 × 0.97 = 145.5 psig. Blowdown is the pressure differential between opening and reseating, typically 2-4% of set pressure, adjustable via the blowdown ring.

16. A — A flame scanner reporting flame when no flame exists is "failed in a dangerous mode" — the BMS continues fuel supply without ignition, allowing unburned fuel to accumulate for potential furnace explosion. This is the dangerous failure mode distinct from safe failures.

17. C — Expired fire extinguishers may not function when needed. Reporting the condition and arranging prompt re-inspection is the only responsible action. Removing leaves the area unprotected; using without verification assumes functionality.

18. B — Natural gas combustion at 5% excess air typically achieves 80-85% efficiency — within the optimal range for well-tuned modern boilers. Higher excess air wastes efficiency; lower risks incomplete combustion. This is a target efficiency for natural gas operation.

19. A — Developing oxygen ingress consuming sulfite faster than feed rate explains declining sulfite from 45 to 15 ppm with normal pump operation. The sulfite is being consumed by dissolved oxygen. Investigation of the oxygen source addresses the root cause.

20. D — The ASME "H" stamp indicates heating boiler construction under Section IV (below 15 psig steam). "S" indicates Section I power boilers; "U" indicates Section VIII pressure vessels. Code stamps are essential for identifying applicable requirements.

21. A — Overdue annual internal inspection (14 months overdue in this case, with the required interval being 12 months) requires removing the boiler from service. Operating beyond inspection is a code violation. The inspection must be performed before authorized operation continues.

22. D — No. 6 residual fuel oil requires preheating to approximately 185°F to reduce viscosity for proper atomization. Lower preheat produces coarse droplets and smoky combustion. Each fuel grade has specific preheat requirements based on viscosity.

23. C — Three-element feedwater control uses water level (primary controlled variable), steam flow (anticipatory), and feedwater flow (verification) signals. This configuration is standard on larger industrial and utility boilers for optimal level control during transients.

24. B — Securing the boiler safely and evacuating if necessary is the correct priority during simultaneous power and emergency generator loss. Continued operation without power is unsafe; waiting for restoration ignores the immediate risk. Safe securing protects pressure parts and personnel.

25. D — Limit controls typically operate 10-25 psig above the operating setpoint. For 130 psig operation, 140-155 psig is typical limit range. Too narrow causes nuisance trips; too wide allows dangerous overpressure. This gap balances protection with operational stability.

26. A — Iron scale detaching from waterside surfaces appears as black flakes in bottom blowdown. This typically indicates chemistry changes reducing the scale-forming tendency, releasing previously-deposited scale. Continued blowdown removes the released scale until stabilization.

27. C — At 150 psig (164.7 psia), saturation temperature is approximately 366°F. Memorizing representative pressure-temperature pairs (100 psig → 338°F, 150 psig → 366°F, 300 psig → 417°F) helps with calculations and operating decisions.

28. B — Semi-annually or quarterly trap surveys optimize the balance between detection speed and survey cost. Annual is acceptable minimum; problem-based is reactive; every 5 years allows years of waste. Semi-annual or quarterly catches failures before substantial fuel waste accumulates.

29. D — Four furnace-volume air changes during pre-purge sweep residual fuel-air mixture below the lower explosive limit. Without adequate pre-purge, accumulated fuel from prior operation could ignite explosively. This is the most critical safety element of burner startup.

30. A — Operating outside license scope is illegal and exposes the operator to civil and criminal liability. Refusing protects both the operator's license and the plant. Written authorization does not cure a licensing violation.

31. B — Significant blowdown rate above typical operation produces 20% difference between feedwater flow and steam production. The difference is explained by water leaving as hot blowdown rather than steam. This is expected when blowdown is excessive.

32. C — Scheduling bearing replacement at the next planned maintenance outage balances safety with operational continuity. The pump is working but showing developing failure; immediate replacement might not be feasible, continued operation indefinitely risks sudden failure. Planned maintenance is appropriate.

33. A — 1 BHP = 34.5 lb/hr × 970.3 Btu/lb ≈ 33,475 Btu/hr. This is the universal Btu-equivalent of boiler horsepower. Mechanical horsepower (2,545 Btu/hr) and electrical horsepower (746 watts) are different conventions.

34. D — Corrosion in condensate return piping due to acidic conditions (carbonic acid from CO_2 dissolving in condensate) produces the yellow-brown iron discoloration. Proper amine treatment prevents this by neutralizing the acid. Iron color is a visual indicator of the corrosion process.

35. B — Insufficient blowdown explains a 2 psi reseat differential on a safety valve — typical blowdown should be 2-4% of set pressure. A too-narrow differential can cause rapid cycling or valve damage. Blowdown ring adjustment widens the differential appropriately.

36. C — Stoichiometric combustion represents exactly theoretical air for complete fuel combustion chemistry — the molecular ratio required for complete fuel oxidation. Real boilers use 5-15% more air (excess air) to ensure complete combustion. This defines the reference for combustion calculations.

37. A — Low feedwater flow starting the cascade explains the subsequent low water level and LWCO trip. First-out annunciation identifies the initiating event at the top of the cascade. Feedwater supply issues precede water level issues before triggering burner shutdown.

38. D — Section VII provides recommended guidelines for the care of power boilers. Section VI covers heating boilers; Section I covers power boiler construction; Section VIII covers pressure vessels. Operators use Section VII as the authoritative guide for power-boiler operating practice.

39. B — pH 10.8, sulfite 40 ppm, conductivity 2,500 µS/cm are all within typical specification ranges for industrial boiler water. Operating targets are pH 10.5-11.5, sulfite 30-60 ppm, and conductivity 2,000-3,500 µS/cm for most applications.

40. C — Continuous oxygen trim with periodic comprehensive tune-ups combines real-time combustion optimization with calibrated deep adjustments. This captures both real-time performance and calibrated accuracy. Manual and visual methods alone lack the precision of continuous monitoring with periodic verification.

41. B — A leaking main steam stop valve allows pressure to rise while the boiler is offline from header pressure. Normal operation would maintain the pressure differential, not equalize it. This is diagnostic of internal seat damage requiring repair or replacement.

42. D — Chemical splash requires immediate flushing with water for at least 15 minutes — the OSHA-required response. This is why eyewash stations and deluge showers are standard boiler-room equipment. Wiping or covering without flushing can worsen chemical injury.

43. A — Try cocks on a water column verify water level by direct discharge observation. Code typically requires three try cocks on steam boiler water columns. They serve as independent backup to the gauge glass.

44. C — Latent heat of vaporization decreases as pressure rises. At atmospheric (0 psig) it's approximately 970 Btu/lb; at 180 psig it's approximately 837 Btu/lb. This inverse relationship means higher-pressure boilers recover less latent heat per pound of steam.

45. B — Heat loss from equipment, piping, or boiler into the room explains rising boiler room temperature without outdoor changes. Insulation degradation or increased heat release are typical causes. Investigation of insulation and equipment identifies the specific source.

46. D — Sleeping on duty is a serious safety violation that must be reported through supervision. Waking quietly, covering silently, or helping the colleague all leave the plant unattended by an alert operator — the condition that produces incidents. Supervisory involvement is required.

47. C — Reduced condensate return requires more makeup water, which carries dissolved solids raising boiler TDS over time. Over 2 weeks, this pattern is consistent with decreasing condensate return. Investigation of return rates identifies the root cause.

48. C — The Hartford loop is specific to low-pressure steam heating boilers for water loss protection against return line breaks. It's not used on power boilers, electric boilers, or cast-iron modular applications. The loop is standard on heating boilers and required by code in some jurisdictions.

49. D — Fuel input = $(5{,}000 \times (1{,}195 - 180)) / 0.83 = 5{,}075{,}000 / 0.83 \approx 6{,}114{,}000$ Btu/hr. Dividing useful heat output by efficiency gives required fuel input. This is the standard efficiency calculation applied to find fuel requirements.

50. B — Developing steam or water loss requiring increased makeup rate causes steadily climbing feedwater valve position with unchanged steam demand. Steam traps failing open, heat exchanger leaks, or other losses all produce this pattern. Investigation of downstream system identifies the loss.

51. A — Below 75% of setpoint, try-lever tests typically produce no audible discharge because the valve doesn't achieve full lift. Code specifies testing at least 75% of setpoint for valid verification. Testing at lower pressures doesn't properly verify valve function.

52. C — Vent temperature at 225°F (close to saturation for low-pressure deaeration), feedwater at 218°F (near saturation), level 75% (good), oxygen 5 ppb (within specification) all indicate deaerator operating within typical specifications for good performance.

53. B — Drifting combustion control allowing excess air to increase gradually explains steady rising O_2 from 3.5% to 5.8% over a week. Without tuning, combustion controls gradually drift. Recalibration typically restores the lost excess air control.

54. D — Declining gifts and evaluating products on technical merit is the professional standard. Accepting gifts creates conflicts of interest and biases technical decisions. This maintains objectivity in product evaluation regardless of supplier relationships.

55. A — Deaerator performance degradation allowing dissolved oxygen to reach feedwater produces this rising oxygen trend. The progression from 5 to 75 ppb over 12 hours indicates developing equipment issue. Investigation of deaerator steam supply, operation, and integrity identifies the cause.

56. C — A non-return valve combines stop valve (isolation) and check valve (reverse-flow prevention) functions in one body. Installed on boiler steam outlets in multi-boiler installations, it prevents reverse flow during upsets. This is specialized equipment for common-header arrangements.

57. B — Slow warmup per manufacturer's gradual schedule prevents thermal shock to boiler pressure parts. Rushing the warmup produces uneven expansion, potential tube damage, and refractory cracking. The schedule represents accumulated engineering experience with the specific design.

58. D — Maximum allowable pressure during accumulation = highest valve setting × 1.06 = 153 × 1.06 = 162 psig. The code-required 6% limit protects the pressure vessel from overpressure during an actual relief event. Exceeding the limit requires additional safety valve capacity.

59. A — First-out annunciation identifies which alarm condition occurred first when multiple alarms cascade. This is invaluable for troubleshooting because the initiating alarm often points to the root cause, while downstream alarms are consequences. First-out information drives root-cause analysis.

60. C — Refusing the offer and reporting the request to supervision is the professional response to bribery offers. Accepting or ignoring create additional problems; accepting with incomplete work adds fraud. This maintains professional integrity and plant interests.

61. D — Clogged suction strainer or low feedwater tank level typically causes feedwater pump suction pressure to drop from positive to vacuum. These are the most common causes of suction pressure issues. Verifying both is the standard diagnostic approach.

62. A — The Seebeck effect is the thermoelectric phenomenon where a voltage develops across the junction of two dissimilar metals at different temperatures. This is the operating principle of

thermocouples. Different thermocouple types use different metal pairs with characteristic voltage curves.

63. C — Developing fan impeller fouling increasing aerodynamic load explains steady amperage rise at constant firing rate and damper position. Something is making the fan work harder to move the same air. Inspection and cleaning typically restores normal current.

64. B — OSHA's Hazard Communication Standard requires reading the SDS before handling any chemical for the first time. Estimating, relying on verbal information, or using in small amounts first all fail to meet the legal requirement. SDS must be read and understood before use.

65. A — Rotating pumps periodically with the standby pump maintains both in serviceable condition. Letting one run continuously for 6 months risks backup failure; always running both wastes energy; rotating without verification misses backup issues. Rotation plus testing is complete management.

66. D — Blocked emergency exits must be cleared immediately. Delaying until next cleaning, documenting for later, or identifying alternatives all fail to address the immediate life-safety issue. Exits must be available at all times for evacuation scenarios.

67. B — Operating above rated capacity must be investigated — the boiler is outside its design envelope. The nameplate represents a design limit; routinely exceeding it stresses pressure parts and safety devices. This triggers immediate review of demand, equipment, and system integrity.

68. C — At 300 psig (approximately 314.7 psia), saturation temperature is approximately 417°F. Saturation temperature rises with pressure, and memorizing representative pairs (0 psig → 212°F, 300 psig → 417°F) helps with exam questions and operating decisions.

69. A — Verifying steam demand cause, confirming maximum firing rate, and monitoring water level covers the critical responses to rapid pressure drop. Three simultaneous actions address the cause, boiler response, and water supply necessary to recover. Shutting down or inaction are both inappropriate.

70. D — Daily gauge glass cleaning as part of routine blowdown verification serves multiple purposes: cleaning the glass, verifying connections are clear, and visual condition check. Less frequent cleaning allows deposits to accumulate. Daily practice is the industry norm for steam boilers.

71. C — Deaeration removes dissolved oxygen and non-condensable gases from feedwater to protect the boiler from oxygen pitting corrosion. Thermal deaerators accomplish this by heating feedwater to saturation and breaking it into droplets to release gases. This is the primary function.

72. A — Progressive restriction in gas flow requiring increased damper opening explains steady damper position increase with constant firing rate. Something is increasing gas-path resistance (tube fouling, damper mechanism issues). Investigation of tube condition and flue path identifies the restriction.

73. B — Training a person without the required state license is a regulatory violation that must be refused and reported. Informal training, training on basic procedures only, or supervised training all fail to cure the compliance gap. Supervision must know immediately to arrange proper credentialing.

74. D — ASME BPVC Section I governs power boilers — those with steam pressure above 15 psig. Construction requirements, materials, welding, and inspection are all covered under this section. Correct section identification determines code compliance requirements.

75. C — Heat absorbed = $4{,}500 \times (1{,}200 - 200) = 4{,}500{,}000$ Btu/hr. This is the useful thermal output of the boiler. Dividing by fuel input gives efficiency. Simple to calculate but highly tested in the conversion between steam output and thermal energy.

76. A — Evacuation to the designated assembly area is the standard fire alarm response. Attempting to extinguish, retrieving belongings, or calling 911 first all delay evacuation and risk personal injury. Professional fire responders handle firefighting; operators evacuate and account for personnel.

77. D — OSHA's Hazard Communication Standard requires reading the SDS before handling any chemical for the first time. This is a fundamental chemical safety requirement. Relying on incident response, annual reviews, or problem indicators is insufficient.

78. B — Reduced condensate return increasing makeup and solids loading explains increased blowdown requirements to maintain TDS within specification. Over 3 months, gradual condensate return loss compounds. Investigation of return rates and loss sources addresses the root cause.

79. A — Frothy foam on the water surface indicates foaming from chemistry contamination or high TDS levels. Chemistry contamination or high TDS causes surface tension changes producing froth. This is a precursor to carryover and damages downstream equipment. Chemistry investigation and blowdown are typical corrective actions.

80. C — Operating control differential too narrow at current setting (5 psig cycle) causes frequent cycling between firing and standby. Widening the differential reduces cycling frequency. This is a tuning issue on the operating control, not a problem with limit or safety valve settings.

81. A — Evacuating the affected area and isolating fuel supply at the source is the safe and correct response to a detected gas leak. Continued operation, ventilation alone, or investigation during operation all risk explosion. Safety must precede investigation.

82. C — Reporting falsified records to supervision for proper investigation is the required professional response. Pre-dated entries indicate falsification, which is unethical and often illegal. Supervision has the authority to investigate and address the underlying issue.

83. B — ASME Section IV heating boilers for hot water service have a maximum allowable temperature of 250°F (and maximum pressure of 160 psig). Above either threshold, the boiler is classified as a power boiler under Section I.

84. D — Steam headers and mains are sloped downward in the direction of steam flow (typically one inch per forty feet) so that condensate travels with the steam toward drip legs at low points. Level or upward piping allows condensate accumulation and water hammer.

85. B — 950 vs. 900 Btu/lb represents approximately $(950-900)/900 \times 100 = 5.56\%$, so about a 5% efficiency decline. This corresponds to progressive heat transfer degradation (fouling, scale) over the 6-month period. Tube cleaning typically restores the lost efficiency.

86. C — Cost = (30 lbs/hr) × (8,000 hrs) × ($12/1000 lbs) = 30 × 8,000 × 0.012 = $2,880/year per trap. This calculation illustrates why trap surveys are so cost-effective — each failed-open trap costs meaningful money. Industry typical ROI for surveys is rapid.

87. B — License restrictions define the legal scope of operation. Operating outside scope is illegal even with supervisory authorization. Refusing the assignment protects both the operator's license and the plant. Written authorization does not cure a licensing violation.

88. D — Boiler horsepower is defined as 34.5 lb/hr of steam from and at 212°F, equivalent to approximately 33,475 Btu/hr. This standardized reference allows comparison of boilers across different operating conditions. The 34.5 divisor is fundamental to all BHP calculations.

89. A — Shutoff head is the maximum discharge pressure at zero flow — the pump's maximum pressure capability under static conditions. Dead-heading pumps for extended periods damages them by circulating the same water and overheating. Understanding this concept helps with pump sizing and protection.

90. C — A systematic root-cause analysis across all three events is the appropriate response to recurring near-misses. Individual analysis misses patterns; accepting or waiting for serious incidents both fail organizational safety. The pattern indicates systemic issues requiring systematic investigation.

91. B — Hydrostatic tests are performed at 1.5 times the MAWP per ASME code. The test verifies pressure boundary integrity using water to avoid explosion risk from compressible gas. This is a standard post-construction and post-major-repair verification requirement.

92. D — Untreated wastewater discharge violates environmental regulations and must be reported to both environmental authorities and management. The violation is too serious for the operator to address alone. The employer's interests do not override public environmental protection requirements.

93. A — Dissolved oxygen in feedwater from inadequate deaeration is the primary cause of oxygen pitting in boiler tubes. Oxygen attacks heated metal surfaces producing characteristic deep pits. Deaeration and oxygen scavenger treatment prevent this common corrosion mechanism.

94. C — Blowdown = 5,000 × 0.015 = 75 lbs/hr. The 1.5% rate represents the fraction of steam production lost as blowdown. This calculation matters for both chemistry control and fuel efficiency tracking in operating boilers.

95. B — Worker impairment is a safety issue requiring immediate supervisor notification. Covering, confronting directly, or waiting for a mistake all risk injury. Supervision has the tools and authority to address impairment through appropriate channels.

96. D — A damper restricting airflow at startup from a frozen position causes motor overload during initial draw. Once the damper breaks free, the motor operates normally. This pattern — overload only at startup, not during operation — is diagnostic.

97. A — The operating pressure control cycles the burner on and off based on pressure setpoints, modulating firing rate to maintain operating pressure. This is distinct from the high-pressure limit (safety trip) and the safety valve (mechanical relief). Understanding pressure control hierarchy is fundamental.

98. C — Reduced condensate return increasing makeup water supply explains steadily climbing conductivity with other parameters stable. Makeup water carries dissolved solids, so more makeup means higher conductivity. Investigation of condensate return rates identifies the root cause.

99. B — Flame scanners detect flame through light emission in visible, infrared, or ultraviolet bands. Different scanner types use different spectral bands depending on the fuel and application. Understanding detection principles helps troubleshoot scanner issues.

100. D — Professional ethical obligations include public safety, professional integrity, and legal compliance — all three together. Following instructions without question, confidentiality above safety, or employer interests over public safety all fail the professional standard. Public safety is paramount.