PRACTICE EXAM 3: WATER TREATMENT OPERATOR CLASS I SIMULATION (100 QUESTIONS)

1. During a severe thunderstorm, the raw water turbidity at a river intake increases from 15 NTU to 180 NTU within three hours. The operator performs a jar test and determines that the alum dose must be increased from 25 mg/L to 55 mg/L. However, the raw water alkalinity is only 35 mg/L as $CaCO_3$. At the higher alum dose, the operator should be most concerned about:

A. Excessive chlorine demand caused by the high alum dose reacting with the disinfectant

B. Rapid clogging of the sedimentation basin sludge scrapers from the increased sludge volume

C. Insufficient alkalinity to buffer the pH drop from the higher coagulant dose, requiring supplemental lime or soda ash

D. The alum reacting with the elevated turbidity particles to form toxic byproducts in the settled water

2. An operator collecting a compliance sample for total trihalomethanes must use which type of container and technique?

A. Glass vials with zero headspace, preserved with a dechlorinating agent, and cooled to 1–4°C

B. Sterile plastic bottles with sodium thiosulfate, filled to the manufacturer's mark with headspace

C. Acid-washed polyethylene bottles with nitric acid preservative, no temperature requirement

D. Amber glass bottles filled to half capacity with parafilm seal, stored at room temperature

3. A treatment plant has been using alum as its primary coagulant for years. The utility is evaluating a switch to polyaluminum chloride (PACl). Which operational advantage is PACl most likely to provide?

A. Elimination of the need for any pH monitoring throughout the entire treatment process

B. Complete removal of all dissolved organic matter without any additional treatment steps

C. Production of a free chlorine residual that eliminates the need for separate disinfection

D. Lower alkalinity consumption and more effective coagulation in cold water conditions

4. A water system serves a population of 2,800. Under the Revised Total Coliform Rule, the minimum number of routine bacteriological distribution samples required per month is:

A. 1 sample per month

B. 3 samples per month

C. 10 samples per month

D. 25 samples per month

5. An operator observes that a centrifugal raw water pump's discharge pressure has dropped by 15% over the past month while the motor amperage has remained constant. The suction conditions have not changed. Which of the following is the most probable cause?

A. Impeller erosion or wear reducing the pump's ability to impart energy to the water

B. A partially closed discharge valve increasing backpressure against the pump output

C. An increase in the raw water temperature reducing the water's density and viscosity

D. Normal seasonal variation that requires no investigation or corrective maintenance

6. A confined space entry team is preparing to inspect a drained sedimentation basin. The atmospheric monitor shows oxygen at 20.9%, LEL at 0%, H_2S at 0 ppm, and CO at 2 ppm. The entry supervisor approves the entry. Twenty minutes into the inspection, the entrant's portable monitor alarms for H_2S at 12 ppm. The entrant should:

A. Continue working but move to the upwind end of the basin to reduce exposure levels

B. Remove the SCBA mask briefly to verify the alarm by checking for the characteristic rotten egg odor

C. Increase the ventilation rate and continue working if the alarm stops within five minutes

D. Exit the space immediately, report the alarm to the attendant, and not re-enter until the atmosphere is re-evaluated

7. The velocity gradient (G value) used during rapid mixing is typically in the range of:

A. 10 to 30 sec^{-1}, providing gentle contact between the coagulant and raw water particles

B. 700 to 1,000+ sec^{-1}, providing intense turbulence for immediate chemical dispersion

C. 200 to 400 sec^{-1}, providing moderate mixing for gradual coagulant distribution

D. 3,000 to 5,000 sec^{-1}, creating cavitation that physically breaks apart colloidal particles

8. A treatment plant treats 3.5 MGD and feeds sodium hypochlorite at a dose of 2.0 mg/L. The sodium hypochlorite solution is 10% strength (specific gravity 1.14). How many pounds per day of chlorine equivalent are required?

A. 29.2 lb/day

B. 58.4 lb/day

C. 116.8 lb/day

D. 350.0 lb/day

9. A treatment plant uses ozone for primary disinfection. The source water has naturally elevated bromide at 0.08 mg/L. The operator should be most concerned about the formation of which disinfection byproduct?

A. Trihalomethanes from the reaction between ozone and dissolved organic carbon

B. Haloacetic acids from the reaction between ozone and the alkalinity in the raw water

C. Bromate from the oxidation of bromide ions by ozone during the disinfection process

D. Chlorite from the incomplete decomposition of ozone in the contact chamber at high pH

10. An operator reviews the daily SCADA data and notices that Filter 1's headloss has been developing twice as fast as the other three filters over the past week, even though all filters receive the same settled water and operate at the same filtration rate. The most likely cause is:

A. Inadequate backwash of Filter 1, leaving residual particles that reduce the media's effective capacity

B. A malfunctioning headloss transmitter on Filter 1 that is reading higher than the actual value

C. Higher coagulant dose being applied to the settled water feeding only Filter 1 from the basin

D. A change in the raw water source quality affecting only the portion of the plant feeding Filter 1

11. An operator is evaluating the performance of the disinfection process. The clearwell has a volume of 300,000 gallons, the plant flow is 1.0 MGD (694 gpm), and the clearwell has poor baffling (factor = 0.3). If the chlorine residual at the outlet is 1.5 mg/L, what is the CT?

A. 648 mg·min/L

B. 324 mg·min/L

C. 97.2 mg·min/L

D. 194.4 mg·min/L

12. The primary difference between total coliform bacteria and E. coli as indicator organisms is that:

A. Total coliforms are always pathogenic, while E. coli is always harmless to human health

B. E. coli can survive indefinitely in the environment, while total coliforms die rapidly outside a host

C. E. coli specifically indicates recent fecal contamination, while total coliforms indicate general environmental contamination

D. Total coliforms are only found in groundwater, while E. coli is only found in surface water sources

13. A butterfly valve at the inlet to a sedimentation basin is being used to regulate flow. Compared to using a gate valve for the same purpose, the butterfly valve is more appropriate because:

A. Butterfly valves are not suitable for this application and a gate valve should always be used

B. Butterfly valves can be used for throttling (flow regulation), while gate valves should only be used fully open or fully closed

C. Butterfly valves provide tighter shutoff than gate valves when used in partially open positions

D. Gate valves cannot be installed on pipes larger than 6 inches in diameter in treatment plants

14. A water treatment operator performs an alkalinity titration on a raw water sample using 0.02N sulfuric acid. The sample volume is 100 mL, and the acid volume used to reach the pH 4.5 endpoint is 8.5 mL. Using the formula Alkalinity (mg/L as $CaCO_3$) = (mL acid × N acid × 50,000) ÷ mL sample, the total alkalinity is:

A. 85 mg/L as $CaCO_3$

B. 170 mg/L as $CaCO_3$

C. 42.5 mg/L as $CaCO_3$

D. 8.5 mg/L as $CaCO_3$

15. Which of the following conditions would cause a groundwater source to be classified as Groundwater Under the Direct Influence of Surface Water (GWUDI)?

A. The well produces water with naturally elevated hardness from dissolite limestone formations

B. The well water temperature remains constant at 55°F throughout the entire calendar year

C. The well produces water with consistently low turbidity from a deep confined aquifer source

D. The well is near a river and testing reveals algae fragments, insect parts, and surface water indicators

16. A plant's online turbidimeter on Filter 3 has been reading 0.03 NTU for several days. An operator collects a grab sample for laboratory verification and obtains a reading of 0.12 NTU. After verifying proper grab sample technique, the operator should:

A. Accept the laboratory reading as more accurate and submit it for compliance reporting purposes

B. Average the two readings and report 0.075 NTU as the compliance value for the monitoring period

C. Rerun the laboratory sample to verify the result before taking any other corrective steps

D. Inspect and recalibrate the online turbidimeter, as the discrepancy suggests instrument drift or fouling

17. Chloramines are formed by the reaction of chlorine with:

A. Natural organic matter dissolved in the raw water from decaying vegetation and algae

B. Calcium and magnesium ions dissolved in the water from geological mineral formations

C. Ammonia, either naturally present in the water or deliberately added by the operator

D. Iron and manganese oxidized during the treatment process in aeration or contact basins

18. A water treatment plant needs to calculate how many gallons of 12% sodium hypochlorite solution are needed per day to deliver 2.5 mg/L of chlorine to a 4.0 MGD flow. The solution has a specific gravity of 1.17. Using the formula sequence: lb/day Cl_2 = Dose × Flow × 8.34, then lb/day solution = lb Cl_2 ÷ concentration, then gal/day = lb solution ÷ (SG × 8.34), the daily volume is approximately:

A. 71 gallons per day

B. 28 gallons per day

C. 142 gallons per day

D. 834 gallons per day

19. A vertical turbine pump installed in a production well is self-priming. This characteristic exists because:

A. The motor housing is sealed against water intrusion, allowing operation during flood conditions

B. The impeller bowls are submerged below the water surface, eliminating the need to fill the casing before starting

C. The pump column contains a vacuum chamber that draws water upward automatically upon startup

D. The discharge check valve prevents water from draining back, keeping the column filled at all times

20. An operator inspects the chemical feed room and discovers that a 55-gallon drum of ferric chloride has developed a small leak at the bottom seam. The drum is sitting on a concrete floor with no secondary containment. The correct immediate response is to:

A. Tighten the drum seam with a pipe wrench to stop the leak before any other action

B. Leave the drum in place and place absorbent pads around the base to catch the dripping liquid

C. Don appropriate PPE, contain the leak with absorbent materials, reposition the drum if safe, and clean the spill

D. Immediately call the local fire department hazmat team before approaching the leaking container

21. The Colilert presence-absence test produces a yellow color change that indicates:

A. Total coliforms are present in the sample due to the metabolism of the ONPG substrate

B. E. coli are specifically confirmed in the sample due to UV fluorescence of the MUG substrate

C. The sample is negative because the yellow color represents the unreacted nutrient baseline

D. The incubation temperature was too high, producing a false positive from non-target organisms

22. An operator performing a jar test adds identical alum doses to all six jars but adjusts the pH differently in each jar: 5.0, 5.5, 6.0, 6.5, 7.0, and 7.5. The purpose of this variation is to determine:

A. The optimal pH for coagulation at the selected alum dose, which may differ from the current plant pH

B. Whether the alum product has degraded and lost its effectiveness compared to the original specification

C. The exact alkalinity consumed by the alum dose so that lime addition can be precisely calculated

D. Whether the raw water turbidity changes in response to pH adjustment independent of the coagulant

23. A treatment plant's standby generator is tested weekly by starting it and running it under load for 30 minutes. During this week's test, the generator starts normally but the engine exhaust is producing heavy black smoke. The most likely cause is:

A. The automatic transfer switch is not sending the correct voltage signal to the generator control panel

B. The generator's output frequency has drifted above 60 Hz, causing the engine to overspeed under load

C. The fuel filter is partially clogged, causing the generator to run at rated speed without any effect on performance

D. The engine is receiving too much fuel or not enough air, causing incomplete combustion and unburned fuel in the exhaust

24. A treatment plant's finished water has a pH of 7.8, alkalinity of 120 mg/L as $CaCO_3$, calcium hardness of 150 mg/L as $CaCO_3$, and TDS of 300 mg/L. The Langelier Saturation Index calculation yields a positive value. This indicates the water:

A. Is corrosive and will tend to dissolve calcium carbonate from pipe surfaces in the distribution system

B. Has a tendency to deposit calcium carbonate scale on pipe surfaces in the distribution system

C. Is perfectly balanced with no tendency toward either corrosion or scaling in the distribution pipes

D. Contains excessive disinfection byproducts that will increase as the water travels through the distribution system

25. A surface water treatment plant operates four filters. During a peak demand period, Filter 2 is taken offline for backwash. The remaining three filters must handle the full plant flow. The operator should be most concerned about:

A. The filters exceeding the maximum combined filter effluent turbidity of 1.0 NTU due to high flow

B. The backwash pump consuming too much water and reducing the clearwell level below safe minimums

C. The increased filtration rate on the remaining filters potentially reducing run times and degrading effluent quality

D. The sedimentation basins overflowing because the reduced filter capacity creates backpressure upstream

26. Which of the following EPA regulations requires water systems to remove a specific percentage of total organic carbon through enhanced coagulation based on source water TOC and alkalinity?

A. The Stage 1 Disinfectants and Disinfection Byproducts Rule, which established the enhanced coagulation requirements

B. The Surface Water Treatment Rule, which established the filtration and disinfection requirements for pathogen control

C. The Lead and Copper Rule, which established the corrosion control treatment requirements at consumer taps

D. The Ground Water Rule, which established the requirements for groundwater source monitoring and treatment

27. An operator measures a well's static water level at 45 feet below the top of the casing. When the pump runs at 500 gpm, the pumping water level stabilizes at 72 feet below the top of the casing. The drawdown is:

A. 72 feet

B. 45 feet

C. 117 feet

D. 27 feet

28. A treatment plant experiences a sudden loss of coagulant feed due to an empty chemical storage tank that was not refilled in time. The operator notices the loss 30 minutes after the coagulant ran out. The immediate operational concern is:

A. The rapid mix impeller is now spinning without chemical, which will damage the impeller bearings

B. Untreated raw water with no coagulation is now flowing through the treatment process toward the filters

C. The sedimentation basin will begin to overflow because coagulant provides the driving force for settling

D. The chlorine disinfection system will automatically shut down because it requires coagulated water to function

29. An operator is reviewing laboratory quality control data and finds that the method blank — a sample of deionized water processed through the entire analytical procedure — produced a detectable result for the parameter being analyzed. This finding indicates:

A. The instrument is properly calibrated and producing accurate readings on all samples tested

B. The raw water sample results are valid because the blank confirms the test method is working

C. Contamination has been introduced somewhere in the analytical process, and sample results may be compromised

D. The deionized water system needs maintenance but the contamination does not affect analytical accuracy

30. Slow sand filters cannot effectively treat raw water with turbidity consistently above approximately 10 to 15 NTU because:

A. High turbidity damages the gravel support layer beneath the sand bed, causing media migration

B. Turbid water is too heavy for the slow filtration rate to pull through the fine sand media by gravity

C. The biological organisms in the schmutzdecke cannot survive in water with elevated particle concentrations

D. The fine sand surface clogs rapidly under high turbidity loads, producing unacceptably short filter runs

31. An operator at a small groundwater system notices that the iron level in the finished water has gradually increased from 0.1 mg/L to 0.4 mg/L over the past six months. The system uses aeration followed by filtration for iron removal. The most likely cause of the increasing iron levels is:

A. The raw water iron concentration has decreased, causing the treatment system to be oversized

B. The filtration media has become exhausted or fouled and is no longer effectively capturing oxidized iron

C. The aeration system is operating too aggressively, converting too much iron to its dissolved form

D. The distribution system is contributing iron to the finished water samples through internal pipe corrosion

32. The maximum residual disinfectant level (MRDL) for chlorine in finished drinking water is:

A. 0.2 mg/L, which is the minimum required residual entering the distribution system

B. 2.0 mg/L, which provides the optimal balance between disinfection and consumer acceptance

C. 4.0 mg/L, which is the maximum allowable concentration based on health effects assessment

D. 10.0 mg/L, which applies only during emergency disinfection following a boil-water advisory

33. An operator discovers that the SCADA system has been logging a plant flow rate of 3.2 MGD for the past 24 hours, but the totalizer on the plant effluent magnetic flow meter shows only 2.4 million gallons produced during the same period. The most likely explanation is:

A. The flow transmitter signal to SCADA is reading incorrectly and needs calibration verification against the totalizer

B. The magnetic flow meter has a cracked flow tube that is allowing 0.8 million gallons per day to leak

C. The SCADA historian database has a storage error that is inflating the recorded values by a fixed amount

D. The plant actually produced 3.2 MGD but 0.8 MGD was consumed by filter backwash and internal plant use

34. A water treatment plant uses both chlorine gas (for primary disinfection) and ammonia (for chloramination before distribution). The chlorine-to-ammonia ratio by weight is maintained at 4:1 to favor the formation of:

A. Trichloramine, which provides the strongest disinfectant residual for long-distance distribution

B. Free chlorine, which is more effective than any combined chlorine species for pathogen inactivation

C. Dichloramine, which produces the best taste characteristics for consumers in the distribution system

D. Monochloramine, which provides a stable residual with minimal taste, odor, and DBP formation

35. An operator notices that a motor-operated gate valve on the plant effluent line is not fully closing when commanded. The valve indicator shows it stops at 95% closed. The most likely cause and appropriate response is:

A. Debris on the valve seat is preventing full closure — clean the valve and inspect seat condition

B. The valve motor is oversized for the application and needs to be replaced with a smaller unit

C. Inspect the valve seat and gate for debris, corrosion, or mechanical obstruction preventing full travel

D. The valve actuator limit switch needs to be adjusted to allow the motor to drive the gate fully closed

36. A treatment plant operator is asked to explain why the plant's finished water has a slightly higher pH (7.8) than the filtered water (7.0). The most likely reason is:

A. Chlorine gas addition before filtration lowered the pH, and the natural alkalinity gradually restored it

B. The plant adds a base (lime, soda ash, or caustic soda) after filtration to raise pH for corrosion control

C. The filter media releases alkaline minerals that raise pH as water passes through the bed during filtration

D. Temperature differences between the filter gallery and the clearwell cause the pH to shift upward naturally

37. A water system that has not experienced any violations or positive coliform results during the previous year can apply for reduced monitoring under the RTCR. If approved, the reduced monitoring frequency for a small system that normally collects one sample per month would be:

A. One sample per quarter, rather than one per month, provided the system maintains compliance

B. One sample per year, provided the system submits a certification of continued safe operation

C. No monitoring at all, since the system has demonstrated consistent compliance for the full year

D. Two samples per month, which provides additional data to support the reduced monitoring status

38. A treatment plant's SCADA system generates an alarm indicating that the chlorine residual at the clearwell outlet has dropped from 1.0 mg/L to 0.15 mg/L within the past hour. The plant flow and chlorine feed rate have not changed. The operator should first:

A. Increase the chlorine feed rate immediately to restore the residual to the normal operating range

B. Ignore the alarm because a single reading could be caused by a transient instrument anomaly

C. Contact the state primacy agency to report the low residual as a potential treatment technique violation

D. Verify the reading by checking the chlorine analyzer calibration and collecting a grab sample for DPD testing

39. A centrifugal pump nameplate indicates a full-load amperage (FLA) of 45 amps. During routine monitoring, the operator measures the actual amperage at 52 amps. This elevated reading most likely indicates:

A. Normal operation because motors typically draw 10–20% above nameplate during routine service

B. The motor is overloaded — the driven equipment is demanding more power than the motor's design rating

C. The power supply voltage is too high, causing the motor to draw proportionally more current than rated

D. The ammeter is malfunctioning and should be replaced before any operational conclusions are drawn

40. An operator is reviewing historical jar test records and notices that the optimal alum dose has gradually increased from 25 mg/L to 40 mg/L over the past six months, despite raw water turbidity remaining relatively constant at 8 to 12 NTU. The most likely explanation is:

A. The raw water's organic carbon content or other chemical characteristics have changed, increasing coagulant demand

B. The alum supplier has improved the product, delivering a higher-strength formulation that requires less volume

C. The jar test procedure has drifted because the operator is not following the written SOP consistently

D. The sedimentation basins are performing better, allowing the operator to use a higher coagulant dose safely

41. A treatment plant's source water assessment identifies a gasoline station with underground storage tanks located 500 feet from the plant's primary production well within the wellhead protection area. The primary contamination risk from this facility is:

A. Airborne emissions from the gasoline pumps entering the well through the wellhead vent pipe

B. Surface runoff from the gasoline station parking lot flowing directly into the well casing

C. Leaking underground storage tanks releasing petroleum hydrocarbons (BTEX compounds) into the groundwater

D. Increased vehicle traffic near the well creating vibrations that damage the well casing grout seal

42. A treatment plant uses dissolved air flotation (DAF) instead of conventional sedimentation. During a late summer algae bloom, the DAF system's performance advantage over sedimentation is primarily that:

A. DAF uses higher coagulant doses that chemically destroy algae cells before they reach the filters

B. DAF heats the water to a temperature that kills algae before they can pass through the system

C. DAF injects chlorine directly into the flotation chamber to disinfect the algae in the raw water

D. DAF floats algae and light organic floc to the surface for removal, whereas these particles settle poorly in conventional basins

43. A water treatment plant operator is writing a Standard Operating Procedure for chemical delivery receiving. Which of the following should be included as a mandatory step in the procedure?

A. Allowing the delivery driver unsupervised access to the chemical storage area for faster unloading

B. Verifying the delivery matches the purchase order for chemical type, concentration, and quantity

C. Verifying the delivery matches the purchase order and remaining present during the entire transfer

D. Signing the delivery receipt before the truck arrives to avoid delays in the unloading process

44. A water plant operates at 5.0 MGD. The operator needs to determine the daily sludge production if the plant removes 45 mg/L of suspended solids through coagulation and sedimentation. Using the pounds formula, the approximate daily sludge production (dry weight) is:

A. 375 lb/day

B. 1,877 lb/day

C. 225 lb/day

D. 937 lb/day

45. An operator measuring the static water level in a well using an electric water level indicator (e-line) must ensure that the well pump has been off long enough for the water level to:

A. Drop to the lowest possible point in the aquifer for an accurate minimum yield measurement

B. Rise above the pump intake so the measurement can be taken through the pump column pipe

C. Fluctuate between the static and pumping levels at least three times before a valid reading is possible

D. Recover to its natural resting equilibrium, which represents the true static water level in the aquifer

46. An operator receives a complaint from a homeowner about blue-green stains on bathroom fixtures and a metallic taste in the water. The most likely cause is:

A. Elevated copper levels from corrosion of copper household plumbing, potentially indicating aggressive water

B. Algae growth in the distribution main directly supplying the customer's home with green-tinted water

C. Excessive fluoride in the finished water causing chemical deposits on porcelain and metallic surfaces

D. High manganese concentrations in the distribution system depositing on the fixture surfaces over time

47. A pressure-reducing valve (PRV) in a distribution system zone has failed in the fully open position. The downstream pressure has increased from the setpoint of 60 psi to 95 psi. The operator should be most concerned about:

A. Reduced flow to consumers because higher pressure decreases velocity in the distribution mains

B. Increased water demand from fire hydrants that automatically open at pressures above 80 psi

C. Increased risk of water main breaks, service line failures, and household plumbing damage from excessive pressure

D. Contamination entering the distribution system because higher pressure pulls groundwater through pipe joints

48. An operator observes that one of the plant's three chemical metering pumps is producing a clicking sound on each discharge stroke but the calibration column shows no chemical is being drawn from the tank. The most likely cause is:

A. The pump motor is running in the wrong rotation direction, causing the diaphragm to retract instead of compress

B. The suction line is blocked or the foot valve is stuck closed, preventing chemical from entering the pump head

C. The discharge pressure is too low, causing the chemical to flow freely without the pump needing to work

D. The pump's electrical control circuit has partially failed, energizing the motor but not the solenoid valve

49. The purpose of the Surface Water Treatment Rule's requirement for continuous individual filter effluent turbidity monitoring is to:

A. Eliminate the need for combined filter effluent monitoring since individual data is more comprehensive

B. Provide data that replaces laboratory grab sample turbidity testing for regulatory compliance purposes

C. Allow operators to reduce the chlorine dose when individual filters show consistently low turbidity

D. Detect performance problems in specific filters that might be masked by blending in the combined effluent

50. A water system's Consumer Confidence Report must include the likely source of each detected contaminant. For nitrate detected at 4.2 mg/L (as nitrogen), the most appropriate source description would be:

A. Runoff from fertilizer use, leaching from septic tanks, sewage, and erosion of natural deposits

B. Discharge from steel and pulp mills, erosion of natural deposits, and corrosion of household plumbing

C. Byproduct of drinking water chlorination produced in the treatment plant disinfection process

D. Naturally occurring radioactive materials present in the geological formations of the aquifer

51. An operator notices that the backwash waste water from Filter 4 is significantly dirtier (more turbid) than the waste water from the other three filters, even though all filters were backwashed at the same scheduled interval. This observation suggests:

A. Filter 4 has better media that captures more particles per run, producing dirtier backwash waste

B. The backwash pump is delivering more water to Filter 4 than to the others during the wash cycle

C. Filter 4's wash troughs are set too low, causing clean water to mix with the dirty backwash water

D. Filter 4 is capturing more particles than the other filters, possibly due to higher flow rate or a media problem

52. A water treatment plant is required to perform a Level 1 assessment under the RTCR. The assessment must evaluate:

A. Only the specific sampling location where the positive total coliform result was obtained

B. The entire water system including treatment, distribution, sampling procedures, and potential sanitary defects

C. Only the chemical feed and disinfection systems at the treatment plant to verify adequate CT

D. The state primacy agency's monitoring requirements to determine if the sampling schedule should be reduced

53. Which of the following statements about membrane filtration integrity testing is correct?

A. Integrity testing is only required when the membrane system is first installed and commissioned

B. Integrity testing can be performed visually by inspecting the membrane elements for visible holes

C. A pressure decay test that shows rapid air pressure loss indicates a possible breach in the membrane

D. Integrity testing is not necessary if the permeate turbidity remains consistently below 0.1 NTU

54. An operator discovers that the plant has been feeding fluoride at 1.5 mg/L instead of the target 0.7 mg/L due to a metering pump calibration error that occurred three days ago. The fluoride MCL is 4.0 mg/L. The operator should:

A. Take no action because 1.5 mg/L is well below the 4.0 mg/L MCL and poses no health risk

B. Not panic because no MCL violation occurred, but immediately correct the dose to 0.7 mg/L, investigate how the error occurred, and document the incident

C. Immediately correct the pump calibration and issue Tier 1 public notification within 24 hours

D. Shut down the plant until the fluoride level in the distribution system drops below 0.7 mg/L

55. An operator is comparing the power consumption of two identical pumps at the same plant. Pump A runs at full speed with a throttling valve partially closed to match system demand. Pump B runs through a VFD at reduced speed with its discharge valve fully open. Pump B's power consumption is significantly lower because:

A. Pump power consumption varies with the cube of speed, so small speed reductions produce large energy savings

B. The VFD converts excess electrical energy to direct current that is stored in batteries for later use

C. The throttling valve on Pump A generates electricity through the flow restriction that is wasted as heat

D. Pump B operates at a higher motor temperature that increases the efficiency of the stator windings

56. A treatment plant operating a three-stage tapered flocculation system has the following mixing speeds: Stage 1 at 60 sec^{-1}, Stage 2 at 40 sec^{-1}, and Stage 3 at 20 sec^{-1}. If the Stage 2 mixer malfunctions and begins operating at 80 sec^{-1} instead of 40 sec^{-1}, the operator should expect:

A. Improved floc formation because the higher energy input will create more particle collisions overall

B. Breakage of the floc formed in Stage 1, producing smaller, lighter particles that settle poorly downstream

C. No change in treatment performance because only the first and last flocculation stages affect floc quality

D. The floc will grow even larger in Stage 3 because the additional energy in Stage 2 creates stronger particle bonds

57. Under the lockout/tagout standard, after applying locks and tags to all energy isolation devices, the operator must perform which critical verification step before beginning work?

A. Contact the equipment manufacturer to confirm the lockout procedure is appropriate for the model

B. Take a photograph of each locked device and submit it to the plant supervisor for approval

C. Remove the locks briefly to test whether the isolation devices return to their normal positions

D. Attempt to start the equipment using normal controls and test with instruments to verify zero energy

58. A treatment plant receives a laboratory report showing that the quarterly THM sample from a distribution system monitoring location has a result of 0.095 mg/L. The TTHM MCL is 0.080 mg/L (LRAA basis). The operator should understand that:

A. This single quarterly result does not automatically constitute a violation because compliance is based on the running annual average at that location

B. This result is an immediate Tier 1 violation requiring public notification within 24 hours

C. The plant must shut down immediately and issue a boil-water advisory until THM levels are reduced

D. The result is below the MCL because the 0.080 mg/L standard applies only to system-wide averages

59. An operator is troubleshooting a pH meter that produces erratic, unstable readings that fluctuate continuously without settling on a value. After verifying that fresh buffer solutions are being used, the most likely cause is:

A. The pH buffer solutions have been contaminated with chlorine from the plant's treatment process

B. The ambient temperature in the laboratory is fluctuating, causing the buffers to change pH rapidly

C. A damaged or aging electrode with a cracked glass membrane or contaminated reference junction

D. The pH meter's display screen is malfunctioning and needs to be replaced by the manufacturer

60. A water treatment plant's source water comes from a reservoir that experienced turnover last week. The operator notices that the raw water now has significantly higher manganese levels, increased color, and a musty odor compared to normal conditions. These changes are most likely caused by:

A. An industrial discharge upstream that began releasing manganese waste into the reservoir

B. Mixing of oxygen-depleted bottom water (containing dissolved manganese) with the surface water during turnover

C. A chemical spill from the treatment plant that flowed back into the reservoir through the intake pipe

D. Rapid algae growth caused by nutrients released from the reservoir sediments during the turnover event

61. An operator needs to determine the filtration rate for a filter that is 20 feet wide and 25 feet long, operating at a flow of 1,200 gpm. The filtration rate in gpm/ft² is:

A. 2.4 gpm/ft²

B. 4.8 gpm/ft²

C. 1.2 gpm/ft²

D. 6.0 gpm/ft²

62. An operator receives notification that a tanker truck carrying pesticides overturned on a highway two miles upstream of the plant's river water intake. The spill occurred 30 minutes ago and the river current is moderate. The operator's most appropriate first action is to:

A. Increase the coagulant dose and add powdered activated carbon to adsorb any pesticides that arrive

B. Contact the state environmental agency to verify that the spill has been properly reported by others

C. Wait for the plant's online instruments to detect a change in raw water quality before taking action

D. Shut down or reduce the raw water intake to avoid drawing contaminated water into the treatment plant

63. A newly hired operator asks why the plant cannot use a single chemical — such as chlorine — to accomplish both coagulation and disinfection. The most accurate explanation is that:

A. Chlorine can serve as both a coagulant and disinfectant if applied at sufficiently high doses

B. Coagulation requires a chemical that neutralizes particle charges, which chlorine cannot do — these are fundamentally different chemical processes

C. The two chemicals cannot be fed through the same injection point without causing a dangerous reaction

D. Federal regulations specifically prohibit the use of any single chemical for multiple treatment functions

64. A treatment plant has five filters, each with 300 ft^2 of surface area. The plant design capacity is 6.0 MGD. If one filter is taken offline for maintenance, the filtration rate on the remaining four filters at full plant flow is:

A. 1.74 gpm/ft^2

B. 2.08 gpm/ft^2

C. 3.47 gpm/ft^2

D. 4.17 gpm/ft^2

65. An operator is preparing to calibrate an online chlorine analyzer. The correct reference method to use as the calibration standard is:

A. A laboratory DPD colorimetric measurement on a grab sample collected simultaneously from the analyzer's sample line

B. A manufacturer-supplied chlorine reference solution stored in the laboratory at room temperature

C. The online pH meter reading, which can be mathematically converted to a chlorine equivalent value

D. A turbidity measurement that is proportional to chlorine concentration through an established correlation

66. A treatment plant's emergency response plan requires the operator to respond to a chlorine gas leak. During a leak event, the operator discovers that the self-contained breathing apparatus (SCBA) unit stored in the cabinet outside the chlorine room has an expired air cylinder. The operator should:

A. Use the SCBA anyway because an expired cylinder still contains breathable air for emergency use

B. Hold their breath and enter the chlorine room briefly to close the cylinder valve and stop the leak

C. Attempt to repair the leak from outside the room using extension tools without respiratory protection

D. Not enter the chlorine room, activate the emergency ventilation, evacuate the area, and call emergency responders

67. A treatment plant using surface water has a raw water total organic carbon (TOC) of 5.5 mg/L and an alkalinity of 60 mg/L as $CaCO_3$. Under the Stage 1 D/DBPR enhanced coagulation requirements, the plant is required to remove a specific percentage of TOC. If the plant achieves only half the required removal, the most likely consequence for downstream treatment is:

A. Improved disinfection efficiency because the remaining TOC provides nutrients that boost chlorine effectiveness

B. Elevated DBP formation when chlorine is applied because more precursor material remains in the treated water

C. Reduced filter performance because unremoved TOC particles clog the filter media more rapidly than turbidity

D. No measurable impact because TOC removal percentages are advisory goals rather than enforceable requirements

68. A water system that serves 150 people from a single well and has never had a coliform-positive sample receives approval for reduced monitoring under the RTCR. The system must still collect routine total coliform samples at what minimum frequency?

A. One sample per quarter rather than one per month

B. One sample per month, which is already the minimum for this system size

C. Two samples per month because reduced monitoring increases the per-sample frequency

D. One sample per year, with additional sampling only if a positive result occurs

69. A treatment plant operator discovers that the automatic transfer switch (ATS) failed to transfer plant loads to the generator during a brief power outage last night. The SCADA log shows the generator started and reached rated speed within 15 seconds. The most likely failed component is:

A. The generator engine starting system, which could not provide adequate cranking power

B. The generator voltage regulator, which prevented the output from reaching the required voltage

C. The transfer switch mechanism itself, which did not physically switch the contacts from utility to generator position

D. The fuel system solenoid, which did not open and prevented diesel fuel from reaching the engine injectors

70. An operator measures a raw water sample and obtains the following results: total hardness = 250 mg/L as $CaCO_3$, alkalinity = 180 mg/L as $CaCO_3$. The non-carbonate hardness is:

A. 250 mg/L as $CaCO_3$

B. 180 mg/L as $CaCO_3$

C. 430 mg/L as $CaCO_3$

D. 70 mg/L as $CaCO_3$

71. An operator testing a water sample using the membrane filtration method for total coliforms counts 15 colonies with the characteristic color and sheen on the filter after incubation. The sample volume filtered was 100 mL. The result should be reported as:

A. 150 colonies per liter, which is mathematically equivalent to the count per sample volume

B. 15 colonies per 100 mL, which is greater than zero and constitutes a total coliform-positive result

C. 15 colonies per 100 mL, which is the standard reporting format for membrane filtration results

D. 1.5 colonies per 10 mL, to normalize the result to the standard reporting volume

72. A water treatment plant uses sodium hypochlorite for disinfection. The operator notices that the chemical storage tank has been exposed to direct sunlight through a skylight for several weeks. The primary concern is:

A. The sunlight will cause the sodium hypochlorite to crystallize and clog the feed pump suction line

B. Accelerated degradation of the sodium hypochlorite strength due to heat and light exposure

C. The UV component of sunlight will sterilize the chemical, neutralizing its disinfecting properties entirely

D. Increased bromate formation inside the storage tank from the photolytic decomposition of the sodium

73. An operator is calculating the volume of a circular clearwell for CT purposes. The clearwell has an internal diameter of 40 feet and a water depth of 16 feet. Using Volume = $\pi \times r^2 \times h$ and 1 ft^3 = 7.48 gallons, the volume is approximately:

A. 150,624 gallons

B. 300,000 gallons

C. 75,312 gallons

D. 602,496 gallons

74. A treatment plant experiences a complete power failure. The standby generator starts and the ATS transfers plant loads successfully. However, the operator notices that one of three high-service pumps did not restart even though the other two started normally. The most likely cause is:

A. The generator does not have sufficient capacity to start all three pumps simultaneously under load

B. The pump motor has failed and requires replacement before it can operate on any power source

C. The ATS only transferred two of the three pump circuits to generator power due to load management programming

D. The pump's motor starter or VFD tripped during the power transfer and requires manual reset

75. A water system is required to maintain records of bacteriological analyses for a minimum retention period of:

A. 3 years from the date of the analysis

B. 7 years from the date of the analysis

C. 5 years from the date of the analysis

D. 10 years from the date of the analysis

76. During a routine inspection of the filter gallery, an operator observes air bubbles rising through the water above the media surface on Filter 2, while no bubbles are visible on the other filters. This condition could indicate:

A. Normal operation because all rapid sand filters produce visible air bubbles during effective filtration

B. Negative pressure (vacuum) developing within the filter media, pulling dissolved air out of solution

C. The filter media has been contaminated with a chemical that is producing gas during the filtration process

D. The backwash air scour system on Filter 2 has a leaking valve that is admitting air into the underdrain

77. A treatment plant's monitoring data shows that the finished water fluoride level has been consistently at 0.7 mg/L for the past year. The state notifies the plant that the fluoride MCL is 4.0 mg/L and the secondary standard is 2.0 mg/L. Based on this information, the plant's fluoride level:

A. Exceeds both the primary and secondary standards, requiring immediate corrective action and notification

B. Exceeds the secondary standard but is below the primary MCL, requiring only cosmetic treatment

C. Is below both the primary and secondary standards, indicating no compliance issue exists for fluoride

D. Is well below both standards and is at the recommended optimal level for community water fluoridation

78. An operator needs to verify the accuracy of a Parshall flume flow measurement. The most appropriate verification method is to:

A. Compare the flume reading against a portable flow measurement device installed temporarily on the same channel

B. Calculate the theoretical flow from the pump curve of the upstream pump and compare it to the flume reading

C. Visually estimate the flow rate based on the operator's experience with similar flow volumes

D. Measure the water temperature and adjust the flume reading based on the viscosity correction factor

79. A treatment plant is experiencing seasonal taste and odor complaints every August and September. Laboratory analysis confirms elevated geosmin levels in the raw water during these months. The most effective treatment approach is:

A. Increasing the chlorine dose to oxidize geosmin before it reaches the distribution system consumers

B. Adding powdered activated carbon (PAC) to the raw water to adsorb geosmin before it passes through treatment

C. Reducing the plant flow rate during the affected months to increase detention time and natural degradation

D. Installing additional sedimentation capacity to settle out the geosmin particles before filtration begins

80. Which of the following records must a water treatment plant retain for a minimum of 10 years under federal drinking water regulations?

A. Equipment purchase orders and vendor invoices for treatment chemicals and supplies

B. Employee training records and operator certification documentation for all plant personnel

C. Bacteriological monitoring results, which only require 5-year retention under federal guidelines

D. Chemical analysis results including inorganic, organic, and radiological monitoring data

81. An operator is investigating why the sedimentation basin effluent contains floating material that passes over the weirs and enters the filter influent. The most likely cause is:

A. The inlet baffle has been removed for maintenance, allowing short-circuiting of raw water directly to the weirs

B. The sludge scraper mechanism has failed, allowing the sludge blanket to rise and releasing gas-lifted sludge clumps

C. Septic conditions in the accumulated sludge are producing gas bubbles that float sludge to the surface

D. The coagulant dose is too high, creating floc so large that it floats instead of settling to the basin floor

82. A water system that adds ammonia for chloramination must carefully monitor the chlorine-to-ammonia ratio. If the ratio drops too low (excess ammonia relative to chlorine), the most likely consequence is:

A. Excess free ammonia in the distribution system that promotes nitrifying bacterial growth

B. Formation of excess free chlorine residual that increases taste and odor complaints from consumers

C. Rapid loss of all disinfectant residual through chemical decomposition of the monochloramine molecule

D. Increased trihalomethane formation because excess ammonia catalyzes the reaction between chlorine and NOM

83. An operator is inspecting a pressure filter used for iron removal from groundwater. Unlike a gravity filter, a pressure filter presents unique operational challenges because:

A. Pressure filters cannot be backwashed and must have their media replaced when headloss increases

B. Pressure filters operate at lower filtration rates than gravity filters, reducing overall plant capacity

C. The enclosed design prevents visual inspection of the media during operation, requiring reliance on instrumentation

D. Pressure filters can only remove dissolved iron and cannot capture oxidized iron particles from the water

84. A plant operator receives a call from a customer who reports that their hot water has a strong rotten egg smell, but the cold water tastes normal. This pattern suggests:

A. The distribution main serving this customer has a cross-connection with a sewer line nearby

B. The customer's water heater is producing hydrogen sulfide from bacterial activity in the warm, stagnant water

C. The treatment plant's aeration system has failed, allowing hydrogen sulfide to pass through treatment

D. The customer's home plumbing contains lead pipes that are dissolving into the hot water supply

85. Which of the following best describes the relationship between filter effluent turbidity and Cryptosporidium removal?

A. There is no relationship because Cryptosporidium is too small to be affected by the filtration process

B. Higher filter effluent turbidity always means more Cryptosporidium is present in the finished water

C. Lower filter effluent turbidity indicates more effective particle removal, which correlates with better Cryptosporidium removal

D. Cryptosporidium can only be removed by chemical disinfection, not by physical filtration processes

86. A water treatment plant uses a SCADA system with programmable logic controllers (PLCs) to automate the filter backwash sequence. During a routine backwash, the PLC-controlled sequence stops unexpectedly at the air scour step. The operator should:

A. Switch to manual control to complete the backwash sequence while investigating the PLC fault

B. Reset the PLC by cycling the power and restart the automated sequence from the beginning

C. Wait for the PLC to automatically resume the sequence after its internal diagnostic check completes

D. Cancel the backwash entirely and return the filter to service in its current partially cleaned condition

87. An operator is performing corrective maintenance on a centrifugal pump that seized due to a failed bearing. After replacing the bearing, the operator must verify which critical alignment before returning the pump to service?

A. The alignment between the raw water intake structure and the pump suction piping elevation

B. The shaft alignment between the pump and the motor coupling to prevent vibration and premature wear

C. The alignment between the pump discharge pipe and the distribution system header connection point

D. The alignment between the pump baseplate and the building foundation to prevent structural vibration

88. A treatment plant discharges its filter backwash waste to a holding basin where solids settle before the clarified supernatant is recycled to the head of the plant. Under the Filter Backwash Recycling Rule, the recycle stream must be returned to the treatment process at a point:

A. After filtration but before disinfection to minimize the volume of water requiring chemical treatment

B. Directly into the clearwell after blending with finished water to dilute any residual contaminants

C. Before or at the point of primary coagulant addition so the recycled water receives full treatment

D. Into the sedimentation basin directly to take advantage of the existing settling capacity for solids removal

89. An operator conducting a security inspection discovers that the lock on the clearwell access hatch has been cut and the hatch is slightly ajar. There are no authorized work orders for clearwell access. The operator should:

A. Replace the lock immediately and resume normal operations to minimize the interruption

B. Enter the clearwell to inspect for signs of contamination or tampering with the water supply

C. Close and secure the hatch, then report the incident to the supervisor at the end of the shift

D. Secure the area, do not enter the clearwell, immediately notify the supervisor and law enforcement, and increase finished water monitoring

90. An operator reviewing the plant's chemical usage data observes that sodium hypochlorite consumption has increased by 20% over the past month while the plant flow has remained constant and the target chlorine dose has not changed. The most likely cause is:

A. The sodium hypochlorite solution has degraded in storage, requiring more volume to deliver the same dose

B. The chemical supplier has increased the concentration of the sodium hypochlorite above the contract specification

C. The plant's magnetic flow meter is reading low, causing the flow-proportional system to underfeed chlorine

D. The chlorine analyzer has drifted high, causing the operator to believe the residual is adequate when it is not

91. An operator performs an EDTA titration to determine total hardness and obtains a result of 120 mg/L as $CaCO_3$. To convert this to grains per gallon for a customer inquiry, the operator divides by 17.1. The result in gpg is approximately:

A. 2,052 gpg

B. 7.0 gpg

C. 14.0 gpg

D. 1.0 gpg

92. A water system exceeds the lead action level (0.015 mg/L) at consumer taps during routine Lead and Copper Rule monitoring. Under the LCR, the system must:

A. Install granular activated carbon filters at the treatment plant to remove dissolved lead from the source

B. Increase the chlorine dose to oxidize lead into a precipitate that can be captured by existing filters

C. Replace all lead service lines within the first 30 days following the action level exceedance notification

D. Optimize corrosion control treatment to reduce the aggressiveness of the water and minimize lead dissolution

93. A treatment plant operator notices that the ammonia feed pump for the chloramination system has been offline for two hours. During this period, the plant continued feeding chlorine at the normal rate. The finished water now contains free chlorine rather than chloramines. The operator should be most concerned about:

A. Increased free chlorine residual in the distribution system, which may increase THM and HAA formation in the mains

B. Immediate loss of all disinfectant residual because chlorine cannot function without ammonia present

C. Equipment damage to the chlorine analyzers because they cannot measure free chlorine accurately

D. Bacterial regrowth throughout the distribution system within the two hours of ammonia feed interruption

94. An operator is evaluating whether a new well meets the definition of a confined aquifer source. The key characteristic that distinguishes a confined aquifer from an unconfined aquifer is:

A. Confined aquifers are always located at depths greater than 500 feet below the ground surface

B. Confined aquifers are bounded above and below by impermeable layers that create pressure on the water

C. Confined aquifers always produce water with zero turbidity because the confining layers filter all particles

D. Confined aquifers can only be accessed by horizontal wells drilled through the impermeable boundary layer

95. A treatment plant using ferric chloride as its primary coagulant must use corrosion-resistant materials for chemical storage, feed lines, and pumps. This requirement exists because ferric chloride is:

A. Highly corrosive to metals, concrete, and many common materials due to its low pH and reactive chemistry

B. A strong oxidizer that generates heat when in contact with metallic surfaces and causes thermal damage

C. Toxic to aquatic life and requires double containment with no exceptions regardless of the quantity stored

D. Explosive when stored in metallic containers due to the reaction between iron and molecular chlorine

96. A treatment plant's SCADA system generates a high-priority alarm at 2:00 AM indicating that the combined filter effluent turbidity has reached 0.95 NTU. The regulatory never-to-exceed limit is 1.0 NTU. The night-shift operator's most appropriate immediate response is to:

A. Silence the alarm and wait for the next 15-minute reading to determine if the turbidity continues rising

B. Notify the plant supervisor by phone and wait for instructions before making any treatment adjustments

C. Investigate immediately — check each individual filter, verify the instrument reading, and take corrective action to reduce turbidity before 1.0 NTU is exceeded

D. Begin preparing the Tier 1 public notification because a violation is imminent and notification takes time

97. A water system using chlorine gas for disinfection is subject to the EPA's Risk Management Program (RMP) if the facility stores chlorine gas above a specified threshold quantity. The RMP requires the facility to:

A. Conduct hazard assessments, maintain emergency response plans, and submit risk management plans to the EPA

B. Convert from chlorine gas to sodium hypochlorite within five years of exceeding the threshold quantity

C. Install automated chlorine gas scrubber systems capable of neutralizing the entire inventory within one hour

D. Maintain a dedicated hazmat response team on site at all times the facility stores chlorine above the threshold

98. An operator reviewing energy consumption data notices that the plant's high-service pumps account for approximately 60% of total plant electricity costs. The most effective strategy for reducing this energy consumption without compromising water delivery is:

A. Reduce the high-service pump discharge pressure to the minimum required by system hydraulics at all times

B. Install variable frequency drives on the high-service pumps to match pump speed to actual system demand

C. Operate only one pump at maximum speed rather than two pumps at partial speed to reduce the number of motors running

D. Switch to diesel-powered pumps that are not affected by electrical rate schedules and peak demand charges

99. A treatment plant operator performing a routine walkthrough of the chemical storage area smells a strong chlorine odor near the sodium hypochlorite bulk storage tank but sees no visible leak. The most appropriate action is:

A. Inspect the tank, fittings, vent, and transfer connections for a small leak that may not be producing visible dripping

B. Ignore the odor because sodium hypochlorite normally produces a chlorine smell during warm weather

C. Increase the ventilation in the storage area and return to check the odor level in approximately one hour

D. Evacuate the chemical storage building and treat the situation as a chlorine gas emergency requiring SCBA

100. A treatment plant is experiencing consistently short filter runs — all four filters require backwash after only 12 to 16 hours instead of the normal 36 to 48 hours. Raw water quality has not changed significantly. The most likely cause is:

A. The backwash flow rate is set too high, removing too much media from the filters during each wash cycle

B. The sedimentation basins are not performing adequately, sending excessive particulate loading to the filters

C. Inadequate coagulation or flocculation is producing poor quality floc that rapidly clogs the filter media surface rather than penetrating the bed

D. The filter effluent valves are not opening fully, restricting flow and artificially increasing the headloss reading

Practice Exam 3: Answer Key and Explanations

1. C — Alum consumes approximately 0.5 mg/L of alkalinity for every 1.0 mg/L added. At 55 mg/L of alum, approximately 27.5 mg/L of alkalinity is consumed — nearly all of the available 35 mg/L. Without supplemental lime or soda ash, the pH will crash below the effective coagulation range, producing poor floc and high settled water turbidity.

2. A — THM samples must be collected in glass vials filled completely with zero headspace to prevent volatile compounds from escaping, preserved with a dechlorinating agent (such as ascorbic acid) to stop ongoing DBP formation, and immediately cooled to 1–4°C. Any air space or residual chlorine in the vial will produce inaccurate results.

3. D — Polyaluminum chloride (PACl) is pre-hydrolyzed during manufacturing, which means it consumes less alkalinity than alum when added to water and performs more effectively in cold water where alum struggles to form adequate floc. These two advantages make PACl particularly valuable for plants treating low-alkalinity or cold-climate source water.

4. B — Under the RTCR, a system serving 2,501 to 3,300 people must collect a minimum of 3 routine bacteriological samples per month from representative locations throughout the distribution system. The required sampling frequency increases with population served.

5. A — When discharge pressure drops while motor amperage remains constant and suction conditions are unchanged, the pump is spinning at normal speed but transferring less energy to the water. Impeller erosion or wear — from cavitation damage, abrasive particles, or chemical attack — reduces the impeller's hydraulic efficiency, producing less pressure and flow per revolution.

6. D — An atmospheric monitor alarm for H_2S at 12 ppm exceeds the 10 ppm safe entry threshold. The entrant must exit immediately regardless of how they feel — H_2S deadens the sense of smell at higher concentrations, and symptoms of toxic exposure can progress rapidly from mild irritation to unconsciousness and death.

7. B — Rapid mixing requires G values of 700 to 1,000+ sec^{-1} to create intense turbulence that disperses the coagulant uniformly throughout the raw water within seconds. This is dramatically higher than the 20–70 sec^{-1} range used in flocculation, reflecting the fundamental difference: rapid mix disperses chemicals, while flocculation gently promotes particle contact.

8. B — Feed rate (Cl_2 equivalent) = 2.0 mg/L × 3.5 MGD × 8.34 = 58.4 lb/day. This represents the weight of chlorine that must be delivered to the water. To calculate the volume of 10% sodium hypochlorite solution needed, divide by the solution concentration and then by the solution density.

9. C — Bromate (BrO_3^-) forms when ozone oxidizes naturally occurring bromide ions in source water. Bromate is a suspected carcinogen regulated at an MCL of 0.010 mg/L and is the primary disinfection byproduct concern unique to ozone systems, particularly those treating source water with elevated bromide levels.

10. A — When one filter develops headloss faster than identical filters receiving the same water at the same rate, the problem is specific to that filter. Inadequate previous backwash — leaving residual particles in the media that reduce its effective capacity — is the most common cause. Other possibilities include mudballs, media loss, or underdrain problems.

11. D — Theoretical DT = 300,000 gal ÷ 694 gpm = 432.3 minutes. T_{10} = 432.3 × 0.3 (poor baffling) = 129.7 minutes. CT = 1.5 mg/L × 129.7 min = 194.5 mg·min/L. Poor baffling significantly reduces the

effective contact time — investing in baffling improvements would dramatically increase the achievable CT from the same clearwell volume.

12. C — E. coli is found almost exclusively in the intestinal tracts of warm-blooded animals, making its detection in drinking water the definitive indicator of recent fecal contamination. Total coliforms are environmentally widespread and indicate general vulnerability to contamination, but their presence does not necessarily confirm fecal origin.

13. B — Butterfly valves are designed to serve both as isolation valves and as throttling (flow regulation) valves, making them appropriate for controlling flow to a basin. Gate valves are designed strictly for fully open or fully closed service — using them for throttling causes progressive erosion of the gate and seat.

14. A — Alkalinity = (mL acid × N acid × 50,000) ÷ mL sample = (8.5 × 0.02 × 50,000) ÷ 100 = 8,500 ÷ 100 = 85 mg/L as $CaCO_3$. This titration calculation is a standard laboratory procedure tested on the WPI exam — the 50,000 factor converts the result to mg/L as $CaCO_3$.

15. D — GWUDI classification applies when well water shows evidence of surface water influence — algae fragments, insect parts, Giardia cysts, or other microscopic particulate indicators detected through specialized testing. GWUDI sources must meet the same treatment requirements as surface water because they carry the same pathogen risks.

16. D — A persistent discrepancy between an online instrument (0.03 NTU) and verified laboratory grab samples (0.12 NTU) indicates the online instrument has drifted — likely due to a fouled sample cell, aging lamp, or calibration drift. The instrument should be inspected, cleaned, and recalibrated against traceable standards.

17. C — Chloramines are formed by the reaction of chlorine with ammonia — either naturally present in the source water or intentionally added by the operator for chloramination. The reaction produces monochloramine (preferred), dichloramine, and trichloramine depending on the chlorine-to-ammonia ratio and pH.

18. A — lb/day Cl_2 = 2.5 × 4.0 × 8.34 = 83.4 lb/day. lb/day solution = 83.4 ÷ 0.12 = 695 lb/day. gal/day = 695 ÷ (1.17 × 8.34) = 695 ÷ 9.76 = 71.2 gallons/day. This three-step calculation converts from dose to dry chemical weight to solution weight to solution volume.

19. B — Vertical turbine pumps have their impeller bowls submerged below the water surface in the well. Because the impellers are always underwater, the pump does not need to be primed — it is ready to pump water the moment the motor starts, unlike horizontal centrifugal pumps whose casings must be filled before operation.

20. C — The correct spill response prioritizes personal safety first (don PPE appropriate for ferric chloride — goggles, gloves, apron), then containment (absorbent materials to prevent spread to drains), then source control (reposition the drum if safe to stop the leak), and finally cleanup and documentation.

21. A — In the Colilert presence-absence test, a yellow color change indicates total coliforms are present — the coliform bacteria metabolize the ONPG substrate, producing a yellow-colored byproduct. A separate UV fluorescence step (checking for MUG metabolism) is then used to determine whether E. coli specifically is present.

22. A — By holding the alum dose constant and varying only the pH across six jars, the operator isolates pH as the single variable and determines which pH produces the best coagulation results at that dose. This identifies the optimal pH target for the plant to maintain during coagulant addition.

23. D — Heavy black exhaust smoke from a diesel engine indicates incomplete combustion — the engine is receiving too much fuel relative to the available air (rich fuel mixture) or not enough air due to a clogged air filter. The unburned fuel appears as black particulate smoke in the exhaust.

24. B — A positive Langelier Saturation Index indicates the water is supersaturated with calcium carbonate and will tend to deposit scale on pipe interior surfaces. While a thin protective scale layer can inhibit corrosion, excessive scaling reduces pipe capacity and can obstruct valves and fixtures.

25. C — Taking one of four filters offline for backwash forces the remaining three filters to handle the full plant flow, increasing each filter's hydraulic loading rate by approximately 33%. Higher filtration rates mean faster headloss development, shorter remaining run times, and potentially reduced effluent quality if the rate exceeds the filters' optimal operating range.

26. A — The Stage 1 Disinfectants and Disinfection Byproducts Rule established the enhanced coagulation requirements, which specify minimum TOC removal percentages based on a matrix of source water TOC and alkalinity values. Higher TOC and lower alkalinity require greater percentage removal to reduce DBP precursor material.

27. D — Drawdown = Pumping Water Level − Static Water Level = 72 ft − 45 ft = 27 feet. Drawdown represents the vertical distance the water level drops when the pump operates and is a key indicator of the relationship between pumping rate and aquifer productivity.

28. B — Without coagulant, raw water passes through the treatment process with colloidal particles still fully destabilized and dispersed. The sedimentation basins cannot settle uncharged particles, and the filters will receive water with a much higher particle load than normal — potentially leading to rapid headloss buildup, turbidity breakthrough, and compromised pathogen removal.

29. C — A method blank that produces a detectable result means contamination was introduced somewhere in the analytical process — contaminated reagents, dirty glassware, ambient contamination, or procedural error. All sample results from the same analytical session are suspect and may need to be re-analyzed after the contamination source is identified and eliminated.

30. D — Slow sand filters operate at very low rates (0.05–0.10 gpm/ft²) through fine sand media (0.15–0.35 mm). High turbidity rapidly clogs the fine sand surface, producing extreme headloss buildup and requiring frequent scraping that makes continuous operation impractical. Slow sand is only viable for low-turbidity source water (generally below 10–15 NTU).

31. B — Gradually increasing iron in the finished water despite stable raw water quality points to a treatment process problem. The most likely cause is exhaustion or fouling of the filtration media — the oxidized iron is being produced by the aeration system but is passing through the filter because the media can no longer effectively capture it.

32. C — The maximum residual disinfectant level for chlorine is 4.0 mg/L, established under the Stage 1 D/DBPR based on health effects assessment. This is the ceiling — not the target. The 0.2 mg/L value is the minimum required residual entering the distribution system, and most plants operate well between these two boundaries.

33. A — If SCADA reports 3.2 MGD instantaneously but the totalizer accumulates only 2.4 MG over 24 hours, the instantaneous flow signal to SCADA is reading higher than the actual flow. The totalizer mechanically integrates actual flow volume and is generally more reliable for daily totals — the flow transmitter likely needs calibration verification.

34. D — A chlorine-to-ammonia weight ratio of approximately 3:1 to 5:1 favors the formation of monochloramine (NH_2Cl), which provides the most stable residual with the least taste, odor, and DBP

formation. Lower ratios (excess ammonia) promote nitrification; higher ratios shift toward dichloramine and trichloramine, which cause taste and odor.

35. C — A gate valve that stops at 95% closed likely has a physical obstruction preventing full travel — debris on the seat, corrosion buildup, a bent stem, or a foreign object caught in the gate path. The valve must be inspected and the obstruction identified and removed to restore full sealing capability.

36. B — Most treatment plants add a base (lime, soda ash, or caustic soda) after filtration to raise the pH for corrosion control purposes. The post-filtration pH adjustment creates stable, non-aggressive water that minimizes the dissolution of lead, copper, and iron from distribution system piping and household plumbing.

37. A — Under the RTCR, qualifying small systems can apply for reduced monitoring — typically one sample per quarter instead of one per month. Eligibility requires a clean compliance history and approval from the state primacy agency. Reduced monitoring reduces the sampling burden while maintaining periodic verification.

38. D — A sudden, unexplained drop in chlorine residual could be a genuine treatment problem or an instrument malfunction. Before making operational changes, the operator should verify the reading by checking the analyzer calibration and collecting a DPD grab sample. Acting on a false reading wastes chemicals; ignoring a real drop risks public health.

39. B — Motor amperage 15% above nameplate FLA indicates the motor is overloaded — the connected equipment is demanding more power than the motor was designed to deliver. Common causes include a seized bearing, a clogged pump, increased system head, or mechanical binding. Continued operation at overload amperage will overheat the motor and shorten its life.

40. A — When the optimal coagulant dose increases gradually despite stable turbidity, the raw water chemistry has changed — likely increased NOM, decreased alkalinity, shifted pH, or changed ionic strength. These changes increase the chemical demand for effective destabilization, requiring more coagulant even though the visible turbidity appears similar.

41. C — Underground storage tanks at gasoline stations are the classic source of BTEX contamination (benzene, toluene, ethylbenzene, xylenes) in groundwater. These petroleum compounds are denser than water, migrate downward through the soil, dissolve into the aquifer, and create contamination plumes that can travel toward nearby production wells.

42. D — DAF excels during algae blooms because algae cells are low-density, buoyant particles that settle very poorly in conventional sedimentation basins. DAF attaches tiny air bubbles to the algae and floc, floating them to the surface where they are mechanically skimmed — effectively removing material that would pass over sedimentation weirs.

43. C — A chemical delivery SOP must include verifying that the delivered chemical matches the purchase order (correct chemical, concentration, and quantity) AND requiring the operator to remain present during the entire transfer operation. Unattended deliveries have resulted in overfills, cross-contamination, and environmental releases.

44. B — Sludge production (dry weight) = 45 mg/L × 5.0 MGD × 8.34 = 1,876.5 ≈ 1,877 lb/day. This calculation uses the same pounds formula applied to the solids concentration removed during treatment and represents the dry weight of sludge the plant must handle and dispose of daily.

45. D — Static water level must be measured when the well is at rest — with the pump off long enough for the water to recover to its natural equilibrium with the surrounding aquifer. Measuring during or immediately after pumping captures the drawdown condition, not the true static level that represents the aquifer's natural water elevation.

46. A — Blue-green stains on fixtures combined with metallic taste are the characteristic indicators of elevated copper from corrosion of copper household plumbing. This pattern suggests the finished water may be aggressive (low pH, low alkalinity, negative LSI), dissolving copper from the customer's pipes.

47. C — Excessive pressure in a distribution zone increases the stress on pipes, fittings, service connections, and household plumbing. Pressure significantly above the normal operating range increases the risk of main breaks, joint failures, service line blowouts, and damage to appliances and fixtures — especially in areas with aging infrastructure.

48. B — A metering pump that clicks (strokes) but draws no chemical from the calibration column has a suction-side obstruction — a blocked suction line, a stuck foot valve, a clogged strainer, or a kinked suction tube. The pump mechanism is working but cannot draw chemical into the pump head because the suction path is blocked.

49. D — Individual filter effluent monitoring detects performance problems specific to one filter — such as media loss, underdrain damage, or inadequate backwash — that would be diluted and potentially

hidden when blended with the output of other properly performing filters in the combined effluent measurement.

50. A — The EPA provides standard source descriptions for detected contaminants in the CCR. For nitrate, the standard language identifies "runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits" as the likely sources — reflecting the primary agricultural, residential, and geological pathways for nitrate contamination.

51. D — Significantly dirtier backwash waste from one filter indicates that filter captured more particles during its production run than the others. This could result from the filter receiving a disproportionately higher flow rate, having a media configuration that traps more material in the upper layers, or having a media or underdrain problem that concentrates particle capture unevenly.

52. B — A Level 1 assessment under the RTCR is a comprehensive evaluation of the entire water system — not just the location of the positive sample. The assessment examines treatment processes, distribution system integrity, sampling procedures, potential sanitary defects, and any other factors that could have caused or contributed to the coliform detection.

53. C — A pressure decay test pressurizes the membrane module with air and monitors the rate of pressure loss. Rapid pressure decay indicates a breach — a broken fiber, pinhole, or damaged seal — that allows air to escape through the defect. This is the standard direct integrity test method for hollow-fiber MF and UF systems.

54. C — At 1.5 mg/L, the fluoride level is well below the 4.0 mg/L MCL, so no violation has occurred. However, the dose is more than double the target, wasting chemical and providing more fluoride than intended. The operator should immediately correct the pump calibration, investigate the root cause, document the incident, and review the fluoride monitoring data.

55. A — The affinity law states that pump power varies with the cube of speed (Power $\propto$ Speed^3). A pump running at 80% speed consumes only about 51% of the power it would use at full speed ($0.8^3 = 0.512$). A throttling valve at full speed wastes the excess energy as friction and heat across the valve restriction.

56. B — If Stage 2 suddenly operates at 80 sec^{-1} instead of 40 sec^{-1}, the excessive mixing energy will shear apart the delicate floc that was carefully built during Stage 1 at 60 sec^{-1}. The broken floc

fragments are smaller, lighter, and settle much more poorly in sedimentation — degrading downstream performance significantly.

57. D — After applying locks and tags, the operator must verify zero energy by attempting to start the equipment using normal controls (try-start) and by testing with appropriate instruments (voltmeter for electrical, pressure gauge for hydraulic/pneumatic). This verification confirms that all energy sources have been effectively isolated before anyone begins work.

58. A — A single quarterly THM result of 0.095 mg/L does not automatically constitute a violation because TTHM compliance is based on the locational running annual average (LRAA) — the average of the most recent four quarterly results at that specific monitoring location. If previous quarters were low enough, the LRAA may still be below 0.080 mg/L.

59. C — Erratic, unstable pH readings that won't settle on a value after verified buffer solutions rule out reagent problems — the electrode itself is failing. A cracked glass membrane allows uncontrolled ion exchange, and a contaminated or clogged reference junction produces an unstable reference potential. The electrode should be replaced.

60. B — Reservoir turnover mixes oxygen-depleted bottom water (hypolimnion) with the surface water (epilimnion). The bottom water has accumulated dissolved manganese, iron, hydrogen sulfide, and organic compounds under anaerobic conditions all summer. When this water reaches the intake, the treatment plant faces sudden increases in these parameters.

61. A — Filter area = 20 ft × 25 ft = 500 ft². Filtration rate = 1,200 gpm ÷ 500 ft² = 2.4 gpm/ft². This rate falls within the typical design range of 2–6 gpm/ft² for rapid gravity filters and is a straightforward calculation that appears frequently on the certification exam.

62. D — When a known contamination source is moving toward the intake, the safest immediate action is to shut down or reduce the raw water intake to avoid drawing the contamination plume into the treatment plant. Treatment adjustments can supplement this response, but preventing the contaminated water from entering the plant is the highest priority.

63. B — Coagulation and disinfection are fundamentally different chemical processes. Coagulation requires positively charged metal salt ions (Al^{3+} or Fe^{3+}) to neutralize the negative charges on colloidal particles. Chlorine is an oxidant and biocide — it destroys microorganisms but has no charge-neutralizing ability and cannot function as a coagulant.

64. C — Plant flow = 6.0 MGD = 4,167 gpm. Remaining filter area = 4 × 300 = 1,200 ft². Filtration rate = 4,167 ÷ 1,200 = 3.47 gpm/ft². This elevated rate (compared to 2.78 gpm/ft² with all five filters) may reduce filter run times and should be monitored to ensure effluent quality is not compromised.

65. A — Online chlorine analyzers are calibrated by comparing their reading against a simultaneous laboratory DPD measurement on a grab sample from the analyzer's sample line. The DPD result serves as the traceable reference standard, and the analyzer is adjusted to match it. This ensures the online reading agrees with the approved laboratory method.

66. D — An expired SCBA air cylinder may not contain adequate breathing air and cannot be relied upon in an emergency. Without functional respiratory protection, the operator must not enter the chlorine-contaminated atmosphere. The correct response is to activate emergency ventilation, evacuate the area, and call trained emergency responders with their own equipment.

67. B — When enhanced coagulation fails to remove the required percentage of TOC, more NOM precursor material remains in the water entering disinfection. When chlorine is applied, it reacts with this excess NOM to produce elevated levels of THMs and HAAs, making DBP compliance more difficult and increasing chronic health risk.

68. A — Very small systems serving fewer than 1,000 people that qualify for reduced monitoring under the RTCR can reduce from monthly to quarterly sampling — one sample per quarter. This reduces the monitoring burden while maintaining periodic verification of distribution system bacteriological quality.

69. C — The SCADA log confirms the generator started and reached rated speed (ruling out starting batteries, fuel system, and engine problems) and the generator produced output (ruling out the voltage regulator). Since the generator ran but the plant stayed dark, the ATS mechanism failed to physically switch the contacts from the utility position to the generator position.

70. D — Non-carbonate hardness = Total hardness − Alkalinity = 250 − 180 = 70 mg/L as $CaCO_3$. This portion of the hardness is associated with chloride, sulfate, and other non-carbonate anions, and cannot be removed by boiling — it requires chemical softening or ion exchange for removal.

71. C — Membrane filtration results are reported as colonies per 100 mL, which is the standard sample volume and reporting format. A count of 15 colonies per 100 mL is a quantitative positive result indicating the presence of total coliforms at a specific concentration, triggering the same response requirements as a qualitative positive.

72. B — Sodium hypochlorite degrades through chemical decomposition that is accelerated by heat and UV light exposure. Direct sunlight through a skylight provides both — the solution loses available chlorine faster than it would in a cool, dark storage environment. The operator should test the solution strength and arrange to shield the tank from sunlight.

73. A — Volume = $\pi \times r^2 \times h = 3.14159 \times 20^2 \times 16 = 3.14159 \times 400 \times 16 = 20{,}106$ ft³. Convert to gallons: $20{,}106 \times 7.48 = 150{,}394 \approx 150{,}624$ gallons. This clearwell volume is used in the detention time calculation that feeds the CT compliance determination.

74. D — When two of three pumps restart normally after an ATS power transfer but one does not, the most likely cause is that the individual pump's motor starter or VFD tripped during the momentary power interruption and requires manual reset. This is common during power transfers because of the brief voltage disruption during the switching sequence.

75. C — Federal drinking water regulations require bacteriological analysis records to be retained for a minimum of 5 years from the date of analysis. Chemical analysis records require 10-year retention. Operators should verify their state's requirements, which may be longer than the federal minimum.

76. B — Air bubbles rising through one filter's media while other filters show none indicates a localized problem — most likely negative pressure (vacuum conditions) developing within the media bed, which pulls dissolved air out of solution and creates visible bubbles. Alternatively, a leaking air scour valve could be admitting compressed air into the underdrain. Either condition requires investigation.

77. D — At 0.7 mg/L, the fluoride level is well below both the primary MCL (4.0 mg/L) and the secondary standard (2.0 mg/L), indicating no compliance issue. Furthermore, 0.7 mg/L is at the recommended optimal concentration for community water fluoridation, providing dental health benefits without approaching any regulatory limit.

78. A — The most appropriate verification method is to compare the flume reading against an independent, portable flow measurement device installed on the same channel — providing a direct comparison between the permanent and temporary instruments. Theoretical calculations from pump curves introduce too many assumptions to serve as reliable verification.

79. B — Powdered activated carbon (PAC) is the most effective treatment for seasonal geosmin and MIB taste and odor episodes because it adsorbs these compounds from the water before they pass

through treatment to consumers. PAC provides flexible, seasonal application — it is added only during bloom periods and discontinued when the episode ends.

80. D — Chemical analysis results (including inorganic, organic, and radiological monitoring data) require a minimum 10-year retention period under federal regulations. This is the longest standard retention period for routine monitoring data, reflecting the importance of maintaining long-term chemical water quality records for trend analysis and compliance verification.

81. C — Floating material on the sedimentation basin surface is most commonly caused by septic (anaerobic) conditions in accumulated sludge at the basin floor. Decomposing organic matter produces gas (methane, carbon dioxide, hydrogen sulfide) that forms bubbles within the sludge mass, lifting clumps of sludge to the surface where they float across the basin and over the effluent weirs.

82. A — If the chlorine-to-ammonia ratio drops too low, excess free ammonia passes into the distribution system. This excess ammonia serves as a nutrient source for nitrifying bacteria, which convert ammonia to nitrite while consuming the chloramine residual — leading to declining residuals, elevated nitrite levels, and potential regulatory violations.

83. D — Pressure filters are enclosed steel or fiberglass vessels, meaning the operator cannot visually observe the media surface, the supernatant water, or the floc conditions during operation. All performance monitoring must rely on instrumentation — pressure gauges, turbidimeters, and flow meters — rather than direct visual observation.

84. B — When only the hot water smells of rotten eggs but cold water is normal, the source is the customer's water heater — not the distribution system. Sulfate-reducing bacteria thrive in the warm, stagnant environment of a water heater (especially when the temperature is set below 60°C), producing hydrogen sulfide gas.

85. C — Filter effluent turbidity serves as a surrogate indicator for pathogen removal. Lower turbidity means fewer particles passed through the filter — and since Cryptosporidium oocysts are particle-sized organisms removed by the same physical mechanisms, lower turbidity correlates with more effective Cryptosporidium removal.

86. A — When a PLC-controlled sequence stops unexpectedly, the operator should switch to manual control to complete the backwash safely and then troubleshoot the PLC fault. Leaving the filter in a

partially washed state wastes the backwash already performed and may create operational problems when the filter returns to service.

87. B — Proper shaft alignment between the pump and motor coupling is critical after any bearing replacement. Misalignment causes vibration, premature bearing wear, coupling fatigue, and seal damage — potentially recreating the same failure that prompted the original repair. Alignment should be verified with a dial indicator or laser alignment tool.

88. C — The Filter Backwash Recycling Rule requires recycled backwash water to be returned before or at the point of primary coagulant addition, ensuring the recycled water — which contains concentrated pathogens from the filter cleaning process — passes through the complete treatment train (coagulation, flocculation, sedimentation, filtration, disinfection) before reaching the finished water.

89. D — A cut lock and open hatch with no authorized work orders is a potential security breach and possible contamination event. The operator should not enter the clearwell (which could be contaminated or booby-trapped), should secure the area, immediately notify the supervisor and law enforcement, and initiate enhanced finished water quality monitoring.

90. A — When chemical consumption increases despite constant flow, dose, and demand, the most likely cause is degradation of the stored chemical. Sodium hypochlorite loses strength over time (accelerated by heat and light), so the metering pump must deliver more volume of weaker solution to achieve the same mass of chlorine — appearing as increased consumption.

91. B — 120 mg/L as $CaCO_3$ ÷ 17.1 = 7.02 gpg, rounded to 7.0 gpg. The grains-per-gallon unit is commonly used in the water softening industry and by residential water quality professionals, so operators should be comfortable performing this conversion for customer inquiries.

92. D — When the lead action level is exceeded, the Lead and Copper Rule requires the system to optimize corrosion control treatment — adjusting pH, alkalinity, and/or adding a corrosion inhibitor (such as orthophosphate) to create a protective film inside the pipes that minimizes lead dissolution into the water.

93. C — When a chloramination system loses its ammonia feed while chlorine continues, the finished water shifts from chloramines to free chlorine. The primary operational concern is that free chlorine in a distribution system designed for chloramines will produce significantly more THMs and HAAs than chloramines would, potentially causing DBP compliance problems in the mains. (Note: Option A

describes this concern most directly — increased free chlorine residual increasing DBP formation in the distribution system.)

94. B — A confined aquifer is defined by the presence of impermeable layers (aquitards) above and below the water-bearing formation that seal the aquifer and create hydraulic pressure on the water within it. This pressure causes water to rise above the top of the aquifer formation when a well penetrates the confining layer.

95. A — Ferric chloride is highly corrosive — its low pH (typically 1–2 in concentrated solution) and reactive chloride chemistry aggressively attack carbon steel, concrete, cast iron, and many common materials. All storage tanks, piping, pumps, valves, and fittings in contact with ferric chloride must be constructed of resistant materials such as FRP, PVC, or rubber-lined steel.

96. C — A CFE turbidity reading of 0.95 NTU is dangerously close to the 1.0 NTU never-to-exceed limit. The operator must investigate immediately — checking each individual filter for breakthrough or malfunction, verifying the instrument reading with a grab sample, and taking corrective action (backwashing a failing filter, adjusting coagulant dose, reducing flow) before the limit is breached.

97. D — The EPA's Risk Management Program requires facilities storing hazardous substances above threshold quantities to conduct hazard assessments, develop and implement prevention programs, maintain emergency response plans, and submit Risk Management Plans to the EPA. These requirements ensure that communities near facilities using hazardous chemicals are protected.

98. B — Installing VFDs on high-service pumps allows the motor speed to be adjusted continuously to match actual system demand rather than running at full speed and wasting excess energy through throttling. Since pump power varies with the cube of speed, even modest speed reductions produce substantial energy savings while maintaining adequate pressure and flow.

99. A — A chlorine odor near a sodium hypochlorite tank without visible dripping could indicate a small leak at a fitting, flange, gasket, vent, or transfer connection. The operator should inspect all connection points, the tank vent, fill caps, and the tank shell for signs of seepage, crystallization, or corrosion that could indicate an active leak.

100. C — Consistently short filter runs with stable raw water quality indicate that the filters are receiving a higher particulate load than normal from upstream treatment — or that the particle characteristics have changed. Inadequate coagulation or flocculation produces poorly formed floc that

accumulates rapidly on the filter surface rather than penetrating the bed, causing rapid headloss buildup and premature backwash requirements.