

PRACTICE EXAM 6: ABC CLASS I

WASTEWATER TREATMENT SIMULATION

(100 QUESTIONS)

1. A treatment plant serving a combined sewer community experiences a significant flow increase during a moderate rainstorm. The influent BOD drops from 200 mg/L to 110 mg/L, the TSS drops from 250 mg/L to 140 mg/L, but the influent oil and grease concentration increases from 15 mg/L to 65 mg/L. What is the most likely explanation for the elevated oil and grease during the storm?

- A. The rainfall is dissolving accumulated grease deposits in the domestic sewer laterals
- B. Stormwater is washing oil, grease, and petroleum residues from streets, parking lots, and driveways into the combined sewer
- C. The primary clarifier scum removal system has failed and is recirculating grease to the plant influent
- D. An upstream restaurant has increased its discharge volume to coincide with the rainfall event

2. An operator at a plant receiving industrial contributions from a metal plating facility notices that the activated sludge settling has deteriorated sharply over 48 hours. The SVI has risen from 120 mL/g to 280 mL/g, the effluent is turbid, and microscopic examination reveals broken, dispersed floc with very few protozoa. The influent pH has remained normal. Which of the following is the most likely cause?

- A. The aeration basin DO has dropped below 1.0 mg/L, promoting filamentous organism growth
- B. The WAS rate has been too low, causing the SRT to extend beyond the optimal range for settling
- C. The F/M ratio has decreased below 0.05, causing the organisms to enter deep endogenous respiration
- D. A toxic metal discharge from the plating facility has damaged the biological floc structure and killed sensitive organisms

3. An operator collecting influent samples notices that the wastewater has an unusually sweet, fruity odor that has not been present before. The color, flow, and other physical characteristics are normal. Which of the following is the most appropriate interpretation?

- A. The sweet odor indicates that the biological organisms in the collection system are thriving
- B. The fruity odor is a seasonal characteristic of domestic wastewater during warm weather months
- C. The unusual odor suggests an industrial discharge of solvents or organic chemicals entering the collection system
- D. The sweet smell indicates that hydrogen sulfide has been oxidized to a non-toxic form by natural ventilation

4. A treatment plant operator determines that the filtrate from the belt filter press dewatering operation has a BOD of 450 mg/L at a flow of 0.025 MGD. The main plant influent has a BOD of 180 mg/L at a flow of 3.5 MGD. What percentage of the total plant BOD loading is contributed by the belt press filtrate return?

- A. Approximately 4%, which is relatively minor but should still be included in the total loading calculation
- B. Approximately 12%, which represents a significant contribution that affects the biological process loading
- C. Approximately 8%, which exceeds the design allowance for sidestream loading at this facility
- D. Approximately 1%, which is negligible and does not need to be tracked for process control purposes

5. An operator reviews influent monitoring data and observes that the alkalinity has decreased from 220 mg/L to 95 mg/L over the past three weeks while all other influent parameters have remained stable. The plant fully nitrifies. Which of the following best describes the operational concern?

- A. The reduced influent alkalinity is beneficial because it will reduce chemical scaling in the aeration equipment

B. The lower alkalinity will improve biological phosphorus removal by favoring PAO organisms over nitrifiers

C. The influent alkalinity change is not operationally significant because the plant generates its own alkalinity

D. The reduced influent alkalinity combined with nitrification's alkalinity demand may cause the aeration basin pH to become unstable and drop below the optimal range

6. A conventional activated sludge plant has two secondary clarifiers. Clarifier A has a surface area of 4,500 ft² and Clarifier B has a surface area of 3,800 ft². The total plant flow (including RAS) is 7.5 MGD. Both clarifiers are in service. If the operator wants to equalize the surface overflow rate between the two clarifiers, how should the flow be distributed?

A. Send 60% of the flow to Clarifier A and 40% to Clarifier B based on the surface area ratio

B. Split the flow equally at 50/50 because both clarifiers should receive the same hydraulic load

C. Send approximately 54% of the flow to Clarifier A and 46% to Clarifier B to equalize the SOR based on their surface area ratio

D. Send all flow to Clarifier A because it has the larger surface area and can handle the entire plant flow

7. An operator at an activated sludge plant measures the following: MLSS of 2,600 mg/L, MLVSS of 2,080 mg/L, aeration basin volume of 0.7 MG, plant flow of 2.5 MGD, and primary effluent BOD of 145 mg/L. The operator then reduces the WAS rate by 15%. After two weeks, the MLSS has increased to 3,100 mg/L. Assuming the MLVSS/MLSS ratio remains at 0.80 and the influent loading has not changed, what effect has this adjustment had on the F/M ratio?

A. The F/M ratio has decreased from 0.25 to 0.21 because the increased MLVSS means more organisms consuming the same food supply

B. The F/M ratio has increased because the higher MLSS creates more oxygen demand and reduces the available food

C. The F/M ratio has remained unchanged because both the food and the organisms increase proportionally

D. The F/M ratio cannot be determined without knowing the exact WAS flow rate and concentration

8. A treatment plant operator is evaluating the secondary clarifier performance. The MLSS entering the clarifier is 3,000 mg/L, the combined flow (plant + RAS) is 5.0 MGD, and the clarifier has a surface area of 5,000 ft². What is the approximate solids loading rate?

A. 15.0 lbs/day/ft², well within the typical design range of 20–30 lbs/day/ft²

B. 25.0 lbs/day/ft², within the typical design range of 20–30 lbs/day/ft²

C. 35.0 lbs/day/ft², above the typical design range and potentially causing solids washout

D. 50.1 lbs/day/ft², significantly above the design range and requiring immediate corrective action

9. A sequencing batch reactor treats municipal wastewater in a single basin by performing fill, react, settle, decant, and idle phases in sequence. During the settle phase, the operator notices that the sludge settles normally to a compact volume, but during the decant phase, the decanter draws off water that contains visible suspended solids. Which of the following is the most likely cause?

A. The react phase aeration was insufficient and the organisms did not fully consume the organic matter

B. The fill phase introduced too much wastewater, causing the basin to overflow during the react phase

C. The polymer feed system for the SBR has malfunctioned and is not conditioning the sludge adequately

D. The decanter is set too deep and is drawing from below the clear supernatant zone into the sludge blanket

10. An operator needs to calculate the detention time for a rectangular primary clarifier that is 80 feet long, 24 feet wide, and 10 feet deep. The influent flow to the clarifier is 2.0 MGD. What is the approximate detention time?

A. Approximately 2.6 hours, which is within the typical design range for primary clarifiers

- B. Approximately 1.2 hours, which is below the minimum recommended for adequate primary treatment
- C. Approximately 4.8 hours, which significantly exceeds the typical range and may cause septic conditions
- D. Approximately 3.4 hours, which is at the upper end of the design range for primary sedimentation

11. A treatment plant uses alum for chemical phosphorus removal. The alum dose is 50 mg/L and the plant flow is 3.0 MGD. The operator notices that the pH in the aeration basin has dropped from 7.0 to 6.2 over the past week. The influent pH and alkalinity have not changed. What is the combined effect causing this pH decline?

- A. The alum is precipitating all available phosphorus and creating an excess of aluminum hydroxide that generates acid
- B. The biological organisms are producing excessive carbon dioxide that is dissolving into the mixed liquor
- C. Both alum addition and nitrification consume alkalinity, and their combined demand has overwhelmed the available buffering capacity
- D. The alum has reacted with the dissolved oxygen in the aeration basin, producing an acidic aluminum oxide compound

12. A plant operating a trickling filter with plastic media has achieved consistent BOD removal of 80% for the past year. Over the past month, the removal efficiency has declined to 62% despite no change in the influent BOD or flow rate. The recirculation rate has remained constant. The operator inspects the filter and observes that the rotary distributor is only covering approximately 60% of the media surface — one of the four distributor arms is clogged and not distributing wastewater. What is the connection between this observation and the reduced treatment efficiency?

- A. The clogged arm has increased the hydraulic loading on the remaining three arms, improving biofilm shearing
- B. The uneven distribution means approximately 40% of the media bed is not receiving wastewater and is therefore not performing biological treatment, directly reducing the overall removal efficiency

C. The clogged arm is causing the distributor to rotate faster, reducing the contact time between wastewater and biofilm

D. The reduced coverage has increased the ventilation through the unwatered portion of the media bed

13. A plant operator calculates the following: the plant influent flow is 4.0 MGD, the effluent BOD is 28 mg/L, and the NPDES permit has a mass-based limit of 850 lbs/day BOD. Is the plant in compliance with the mass limit?

A. Yes — the mass loading is $28 \times 4.0 \times 8.34 = 934$ lbs/day, which is below the limit with a comfortable margin

B. Yes — the mass loading is below the limit because the effluent BOD concentration is below 30 mg/L

C. No — the mass loading is $28 \times 4.0 \times 8.34 = 934$ lbs/day, which is well above the permit limit

D. No — the mass loading is $28 \times 4.0 \times 8.34 = 934$ lbs/day, which exceeds the 850 lbs/day permit limit

14. A treatment plant has an activated sludge system with an aeration basin MLSS of 3,200 mg/L and a volume of 0.6 MG. The WAS flow is 0.03 MGD at a WAS TSS of 8,500 mg/L. The effluent TSS is 12 mg/L at a flow of 2.5 MGD. What is the approximate solids retention time?

A. Approximately 5.6 days, which is in the conventional activated sludge range but may be marginal for cold-weather nitrification

B. Approximately 8.2 days, which provides adequate SRT for nitrification at moderate temperatures

C. Approximately 12.5 days, which is well within the extended aeration operating range

D. Approximately 3.8 days, which is insufficient for either conventional treatment or nitrification

15. An operator at a plant with UV disinfection discovers that the UV transmittance of the secondary effluent has dropped from 70% to 45% over two weeks. The effluent TSS has simultaneously increased from 8 mg/L to 22 mg/L. The UV lamp intensity readings remain at the design setpoint. Which action should the operator take first?

- A. Replace all UV lamps because reduced transmittance indicates the lamps have reached the end of their useful life
- B. Increase the number of UV lamp banks in operation to compensate for the reduced transmittance
- C. Investigate and correct the cause of the elevated effluent TSS from the secondary treatment process, as this is reducing UV transmittance
- D. Clean the UV quartz sleeves because the reduced transmittance indicates fouling on the sleeve surfaces

16. A treatment plant operator notices that the chlorine contact tank has accumulated approximately 2 feet of sediment on the tank floor over the past year. The sediment is composed of settled biological floc that has carried over from the secondary clarifier. What is the primary operational impact of this sediment accumulation?

- A. The sediment will improve disinfection by providing additional surface area for chlorine contact
- B. The sediment reduces the effective volume and detention time of the contact tank, potentially reducing the CT value below the permit requirement
- C. The sediment has no operational impact because it settles below the flow path of the wastewater
- D. The sediment will increase the chlorine demand by releasing ammonia as the biological material decomposes

17. An operator at a nitrifying activated sludge plant measures the following: influent ammonia of 35 mg/L, effluent ammonia of 0.5 mg/L, effluent nitrate of 28 mg/L. The alkalinity in the aeration basin is 60 mg/L as CaCO₃, and the pH is 6.4. What process adjustment should the operator make?

- A. Add supplemental alkalinity (lime or sodium bicarbonate) to the aeration basin to raise the pH and restore buffering capacity
- B. Reduce the aeration rate to decrease the dissolved oxygen level and slow the nitrification rate
- C. Increase the WAS rate to reduce the SRT and decrease the degree of nitrification occurring

D. Add a supplemental carbon source to the aeration basin to support heterotrophic competition with nitrifiers

18. A plant operating an MLE biological nutrient removal system has an anoxic zone detention time of 1.5 hours. The internal recycle rate is 300% of influent flow. The effluent total nitrogen is 12 mg/L, consisting of 0.8 mg/L ammonia and 10.2 mg/L nitrate. The operator wants to reduce the effluent total nitrogen to below 8 mg/L. Which of the following process adjustments is most appropriate?

A. Increase the dissolved oxygen in the aerobic zone to improve ammonia conversion and reduce the total nitrogen

B. Reduce the internal recycle rate to decrease the amount of dissolved oxygen entering the anoxic zone

C. Reduce the WAS rate to increase the SRT and improve the overall nitrogen removal capacity of the biology

D. Add a supplemental carbon source (such as methanol or glycerol) to the anoxic zone to improve denitrification rates if the influent BOD is insufficient

19. A treatment plant effluent is required to meet a seasonal (June–September) phosphorus limit of 0.5 mg/L. The plant uses ferric chloride for chemical phosphorus removal. During spring, the effluent phosphorus is typically 0.4 mg/L at a ferric chloride dose of 30 mg/L. As summer temperatures rise, the operator notices the effluent phosphorus climbing to 0.9 mg/L despite maintaining the same ferric chloride dose and influent phosphorus loading. What is the most likely explanation?

A. Higher summer temperatures reduce the solubility of ferric phosphate, making precipitation less effective

B. Increased biological activity in summer produces more fine colloidal solids that carry phosphorus over the clarifier weir

C. Warmer water requires higher ferric chloride doses because ferric chloride reacts more slowly at elevated temperatures

D. The ferric chloride solution has degraded in the storage tank during the warm months, reducing its effective concentration

20. An operator calculates the weir overflow rate for a circular secondary clarifier with a diameter of 60 feet. The plant flow is 2.5 MGD. Only the plant flow (not RAS) passes over the weir. What is the WOR, and is it within the typical design range?

A. WOR is approximately 7,400 GPD/ft, which is well below the maximum design range and indicates underloading

B. WOR is approximately 13,260 GPD/ft, which is within the typical design range of 10,000–20,000 GPD/ft

C. WOR is approximately 20,100 GPD/ft, which exceeds the design maximum and should be investigated

D. WOR is approximately 26,500 GPD/ft, which significantly exceeds the design maximum and is causing solids carryover

21. A treatment plant operating extended aeration has an SRT of 22 days, an F/M ratio of 0.07, an MLSS of 4,200 mg/L, and a 30-minute settled sludge volume of 210 mL/L. The effluent BOD is 5 mg/L but the effluent TSS has gradually increased from 8 mg/L to 18 mg/L. The microscopic examination shows tiny, dense particles with no filaments. Which of the following is the most likely diagnosis?

A. Filamentous bulking is causing the sludge to resist compaction in the secondary clarifier

B. The secondary clarifier is hydraulically overloaded due to excessive plant flow during wet weather

C. Toxic substances in the influent are killing the biological organisms and causing floc disintegration

D. Pin floc from excessive endogenous respiration at the very long SRT — the organisms are too small to be captured by the clarifier

22. A plant operator discovers that the dechlorination system has failed overnight and the plant has been discharging effluent with a chlorine residual of 1.5 mg/L for approximately 8 hours. The permit limit for total residual chlorine is 0.02 mg/L. The receiving stream is habitat for endangered aquatic species. What is the operator's first priority?

- A. Restore the dechlorination system immediately or implement manual chemical addition to eliminate the chlorine residual before any further discharge
- B. Reduce the chlorine dose at the contact tank to decrease the residual that requires dechlorination
- C. Contact the chemical supplier to arrange an emergency delivery of the dechlorination chemical
- D. Notify the regulatory authority of the chlorine exceedance and wait for their guidance before taking action

23. An activated sludge plant has been operating with a stable MLSS of 2,500 mg/L for months. A new industrial connection begins discharging high-strength food processing wastewater (BOD 3,500 mg/L) at 0.05 MGD into the collection system. The total plant flow is 3.0 MGD. If the operator does not adjust the WAS rate, which of the following is the expected sequence of process changes over the following weeks?

- A. MLSS will decrease because the industrial waste will inhibit biological growth and cause cell lysis
- B. MLSS will gradually increase as the biology grows in response to the additional food, F/M will initially rise then decline as MLVSS increases, and the SVI may increase if the growth outpaces the settling capacity
- C. The F/M ratio will drop immediately because the industrial BOD displaces the domestic BOD fraction
- D. The secondary clarifier will immediately fail because the industrial solids are non-settleable

24. A plant operating a two-stage anaerobic digestion system has been achieving 48% volatile solids reduction. The plant receives a new industrial waste stream that is high in fats, oils, and grease (FOG). Over two months, the volatile acids in the primary digester increase from 200 mg/L to 1,400 mg/L, the pH drops from 7.0 to 6.3, and gas production decreases by 60%. What has most likely occurred?

- A. The FOG has improved digester performance by providing a high-energy substrate that accelerates methanogenesis
- B. The additional FOG has temporarily overloaded the hydrolysis stage but the acid formers will catch up within days

C. The FOG loading has inhibited the methane-forming bacteria through a combination of long-chain fatty acid toxicity and organic overload, causing volatile acids to accumulate and the pH to drop

D. The temperature in the digester has dropped below the mesophilic range due to the cold FOG entering the system

25. An operator measures the chlorine residual at several points along a serpentine chlorine contact tank and obtains the following readings: inlet 4.2 mg/L, after baffle 1 (5 minutes): 3.1 mg/L, after baffle 2 (10 minutes): 2.3 mg/L, after baffle 3 (15 minutes): 1.6 mg/L, and outlet (20 minutes): 1.0 mg/L. The permit requires a minimum CT of 15 mg·min/L using the residual at the outlet. What is the CT value at the outlet?

A. CT is 63 mg·min/L, using the inlet residual multiplied by the total contact time

B. CT is 46 mg·min/L, using the average residual across all sampling points multiplied by total time

C. CT is 24 mg·min/L, using the mid-point residual multiplied by half the total contact time

D. CT is 20 mg·min/L, using the outlet residual of 1.0 mg/L multiplied by the 20-minute contact time

26. A treatment plant has a permit limit of 200 CFU/100 mL for fecal coliform as a monthly geometric mean. The five weekly results for the month are: 45, 120, 380, 85, and 60. The geometric mean is calculated as the fifth root of the product of all values. Is the plant in compliance?

A. Yes — the geometric mean is approximately 107 CFU/100 mL, which is below the 200 CFU/100 mL limit

B. No — the arithmetic mean of 138 CFU/100 mL is used for compliance, not the geometric mean

C. No — the single result of 380 CFU/100 mL exceeds the monthly limit regardless of the geometric mean

D. Yes — compliance is determined by the median value of 85 CFU/100 mL, which is below the limit

27. A treatment plant operates a dissolved air flotation thickener for waste activated sludge. The thickened float has a solids concentration of 4.2%. The DAF subnatant (underflow) has a TSS of 180

mg/L and is returned to the plant headworks. The operator wants to improve the float concentration. Which of the following adjustments is most likely to increase the thickened solids?

- A. Increase the air-to-solids ratio by pressurizing more recycle water with dissolved air
- B. Reduce the WAS feed rate to the DAF to allow the float more time to thicken on the surface
- C. Increase the polymer dose to create larger, denser floc that captures more air bubbles and rises faster
- D. Increase the WAS feed rate to apply more solids per unit area of the DAF surface

28. An activated sludge plant operating at an F/M ratio of 0.30 and an SRT of 7 days is producing effluent with a BOD of 14 mg/L and TSS of 12 mg/L. The plant manager asks the operator to begin wasting sludge from the RAS line instead of directly from the secondary clarifier. What operational difference will the operator need to consider?

- A. Wasting from the RAS line will require recalibrating the aeration blowers to match the reduced oxygen demand
- B. The RAS is more concentrated than the WAS from the clarifier underflow, so a smaller volume must be wasted to remove the same mass of solids
- C. Wasting from the RAS line will produce a lower-quality effluent because the organisms are removed before they complete treatment
- D. There is no operational difference because the same organisms are being removed regardless of the wasting point

29. A wastewater treatment plant must dose 40 mg/L of ferric chloride for phosphorus removal. The plant flow is 2.0 MGD. The ferric chloride solution is 37% FeCl₃ by weight with a specific gravity of 1.40. How many gallons per day of solution are needed?

- A. Approximately 57 gallons per day of the 37% ferric chloride solution
- B. Approximately 120 gallons per day of the 37% ferric chloride solution

C. Approximately 85 gallons per day of the 37% ferric chloride solution

D. Approximately 170 gallons per day of the 37% ferric chloride solution

30. A treatment plant with conventional activated sludge has an aeration basin volume of 1.0 MG and a plant flow of 4.0 MGD. The hydraulic detention time is 6 hours. During a prolonged wet-weather event, the plant flow increases to 8.0 MGD. What is the new detention time, and what is the primary operational concern?

A. The new detention time is 4.5 hours, which is still within the acceptable range for biological treatment

B. The new detention time is 2.0 hours, which is below the typical range and may be insufficient for treatment

C. The new detention time is 6.0 hours, unchanged from the dry-weather condition

D. The new detention time is 3.0 hours, which reduces the available biological contact time by half and may result in incomplete BOD removal

31. A treatment plant operates an aerated grit chamber followed by primary clarifiers. The operator notices that the amount of grit being collected in the aerated grit chamber has decreased by 70% over the past month despite no change in the influent flow or visible grit content. Which of the following is the most likely cause?

A. The influent wastewater has become less concentrated due to increased I/I, reducing the grit content proportionally

B. The grit removal mechanism has failed and grit is accumulating in the chamber without being collected

C. The air supply rate to the grit chamber has increased, keeping all particles including grit in suspension and carrying them past the grit hopper

D. The community has paved all remaining gravel roads, eliminating the primary source of grit in the collection system

32. An operator at a small package treatment plant using an oxidation ditch notices that the plant is meeting all BOD and TSS limits but failing the ammonia limit of 5.0 mg/L. The effluent ammonia is 12 mg/L. The DO is 3.0 mg/L, the pH is 7.2, the alkalinity is 180 mg/L as CaCO₃, and the SRT is 6 days. The wastewater temperature is 10°C. Which factor is most likely causing the nitrification failure?

- A. The SRT of 6 days is too short for nitrifying bacteria at 10°C — a much longer SRT is needed at this cold temperature
- B. The DO of 3.0 mg/L is too high and is inhibiting the nitrifying organisms that prefer lower oxygen levels
- C. The alkalinity of 180 mg/L is too low to support nitrification at the ammonia loading present
- D. The pH of 7.2 is outside the optimal range for nitrification and must be adjusted above 8.5

33. A plant is evaluating the performance of its primary clarifier. The influent TSS is 300 mg/L and the primary effluent TSS is 135 mg/L. The influent BOD is 225 mg/L and the primary effluent BOD is 148 mg/L. Which of the following correctly states the removal efficiencies and their relationship to expected performance?

- A. TSS removal is 45% (below the expected 50–65%) and BOD removal is 34% (within the expected 25–40%), indicating some clarifier underperformance for TSS
- B. TSS removal is 55% (within expected range) and BOD removal is 34% (within expected range), both indicating normal performance
- C. TSS removal is 55% (within expected range) but BOD removal is 66% (above expected range), indicating excellent performance
- D. TSS removal is 45% and BOD removal is 34%, both within the expected ranges for primary clarification

34. A treatment plant discharges to a lake that has been listed as impaired for phosphorus under the Clean Water Act's 303(d) program. The state has established a total maximum daily load (TMDL) for phosphorus and assigned the treatment plant a waste load allocation of 50 lbs/day of total phosphorus. The plant flow is 5.0 MGD. What maximum effluent phosphorus concentration is allowed to meet the mass allocation?

- A. Approximately 0.6 mg/L, calculated by rearranging the pounds formula to solve for concentration
- B. Approximately 1.0 mg/L, which is the standard secondary treatment limit for phosphorus
- C. Approximately 1.2 mg/L, based on the mass allocation divided by the flow rate alone
- D. Approximately 1.2 mg/L, based on the mass allocation divided by the flow rate multiplied by 8.34

35. An activated sludge system has an F/M ratio of 0.15 and an SRT of 18 days. The operator observes thick, brown, mousse-like foam covering the surface of both the aeration basin and the secondary clarifier. The foam persists despite surface spray water application. Which of the following organisms is most likely causing this condition?

- A. *Nocardia* (*Gordonia*) or *Microthrix parvicella*, which thrive at long SRTs and produce hydrophobic foam from their cell wall lipids
- B. *Sphaerotilus natans*, which forms long filaments that trap air bubbles and create a stable foam layer
- C. *Thiothrix*, which oxidizes sulfide compounds and produces foam as a metabolic byproduct
- D. *Zoogloea ramigera*, which forms excessive extracellular polymer that floats on the water surface

36. An operator at a treatment plant with chlorine disinfection and sodium bisulfite dechlorination notices that the plant effluent dissolved oxygen has been steadily declining and is now at 3.8 mg/L, below the permit minimum of 5.0 mg/L. The secondary treatment DO and aeration are normal. The chlorine system is operating at the normal dose. Which of the following is the most likely cause?

- A. The aeration blowers have degraded and are no longer providing adequate air to the secondary process
- B. The secondary clarifier sludge blanket has risen, and decomposing sludge is consuming oxygen in the effluent
- C. The sodium bisulfite dechlorination agent is being overdosed, consuming dissolved oxygen in addition to chlorine residual
- D. The influent BOD has increased, and the additional oxygen demand is carrying through to the plant effluent

37. A rotating biological contactor has six stages of disc assemblies arranged in series. The operator observes that the biofilm on the first-stage discs is very thick (approximately 0.5 inch) and dark brown, while the biofilm on the fifth and sixth stages is thin and light-colored. What does this biofilm distribution pattern indicate about the treatment process?

- A. The RBC is failing because the biofilm should be equally thick on all stages for uniform treatment
- B. The first stage receives the highest organic load and supports the most active biological growth, while later stages receive progressively lower loads and support thinner, less active biofilm — this is normal
- C. The thick first-stage biofilm indicates ponding and the discs should be taken out of service for cleaning
- D. The thin biofilm on the later stages indicates that the disc rotation speed is too high, shearing the biofilm off prematurely

38. A treatment plant operator must decide between two options for managing a period when both secondary clarifiers need maintenance. Option 1: take one clarifier offline and operate at double the normal SOR for 3 days. Option 2: partially drain both clarifiers and perform maintenance over 2 days with neither clarifier fully functional. From a compliance perspective, which option is generally less risky?

- A. Option 2, because partially functioning clarifiers can still provide some solids removal during maintenance
- B. Option 1, because maintaining one fully functional clarifier, even at elevated SOR, provides more reliable solids removal
- C. Both options carry identical risk because the total clarifier capacity is reduced by the same amount
- D. Option 1, but only if the single clarifier is operated at reduced MLSS to compensate for the higher loading

39. A plant uses a cascade aerator at the effluent outfall to raise the dissolved oxygen before discharge. The cascade consists of a series of concrete steps that the effluent flows over, creating turbulence and atmospheric oxygen transfer. The permit requires a minimum effluent DO of 6.0 mg/L. The DO upstream of the cascade is 3.5 mg/L and downstream is 5.5 mg/L. Which of the following adjustments would most likely increase the DO transfer?

- A. Increase the flow rate over the cascade to create more turbulence and greater surface area for oxygen transfer
- B. Decrease the flow rate to increase the contact time between the water and the atmosphere on each step
- C. Add sodium hypochlorite to the effluent upstream of the cascade to chemically increase the DO level
- D. Install baffles on each step to redirect the flow and increase the number of steps the water contacts

40. An operator arrives at work and discovers that the plant's SCADA system has lost communication with all field instruments. The alarm history shows that communication was lost at 3:00 AM. The operator's first priority should be which of the following?

- A. Restart the SCADA computer server to re-establish communication with the field instruments
- B. Contact the SCADA system vendor to schedule an emergency service call for diagnosis and repair
- C. Physically verify the status of all critical process equipment and parameters through manual observation and portable instruments
- D. Wait for the day-shift instrument technician to arrive before taking any action

41. During a confined space entry into a pump station wet well, the entrant reports feeling lightheaded after working for approximately 20 minutes. The four-gas monitor shows O₂ at 20.5%, H₂S at 2 ppm, LEL at 0%, and CO at 15 ppm. All readings appear within safe limits. What should the attendant do?

- A. Tell the entrant to take a break and drink water because the symptoms are likely caused by physical exertion
- B. Order the entrant to exit the space immediately because the symptoms indicate a developing physiological problem regardless of the monitor readings
- C. Increase the ventilation rate and instruct the entrant to continue work closer to the ventilation source
- D. Check the four-gas monitor battery level because the lightheadedness suggests the readings may be inaccurate

42. A treatment plant operator is performing lockout/tagout on a blower that is driven by a belt-and-sheave assembly from an electric motor. The operator locks out the motor's electrical disconnect. What additional hazard must be controlled before working on the blower and belt assembly?

- A. The thermal energy stored in the motor windings from recent operation must dissipate before contact
- B. The compressed air in the blower discharge piping must be relieved before the casing is opened
- C. The rotating inertia of the blower rotor and belt assembly must come to a complete stop before any work begins
- D. The stored mechanical energy in the belt tension must be relieved by opening the blower discharge valve

43. An operator reviews the plant's written confined space program and discovers that the program lists the drained primary clarifiers as "non-permit confined spaces" that require no atmospheric testing or entry permit. The clarifiers are 12 feet deep, accessed by ladder, and regularly contain residual sludge and decomposing organic matter after draining. Is this classification correct?

- A. No — drained primary clarifiers with residual sludge and organic matter have the potential for hazardous atmospheres and should be reclassified as permit-required confined spaces
- B. Yes — the classification is correct because draining the clarifier eliminates the hazardous atmosphere potential
- C. Yes — primary clarifiers are not confined spaces because they have open tops that provide natural ventilation
- D. No — the clarifiers should not be on the confined space inventory at all because they are standard work areas

44. A wastewater treatment plant stores methanol in a 1,000-gallon tank for use as a supplemental carbon source for denitrification. The methanol SDS indicates it is a flammable liquid with a flash point of 52°F (11°C). Which of the following storage requirements is most critical?

- A. The methanol tank must be stored in an air-conditioned room maintained below 52°F at all times

- B. The methanol tank must be elevated at least 10 feet above grade to prevent contact with stormwater
- C. The methanol storage area must be equipped with secondary containment, fire suppression, proper ventilation, and separation from ignition sources
- D. The methanol must be stored in a glass container because it reacts with metal tank walls at elevated temperatures

45. An operator is welding a support bracket in the maintenance shop. The shop is located 50 feet from the main plant building but only 25 feet from an underground digester gas pipe that runs between the digester building and the boiler room. Before beginning the welding, what safety precaution is most critical?

- A. Verify that the fire extinguisher in the maintenance shop has been inspected within the past month
- B. Test the atmosphere around the digester gas pipe for combustible gases using a portable LEL detector before beginning hot work
- C. Ensure the welding machine is properly grounded to the building's electrical grounding system
- D. Post a fire watch at the shop entrance to observe for any sparks that leave the welding area

46. An NPDES permit requires that the plant perform weekly composite sampling for BOD and TSS. The plant has been collecting composites on Tuesdays for the past year. The state inspector reviews the records and finds that in March, the operator collected the composite on Monday of Week 1 and then on Wednesday of Week 2 — a gap of 9 days between samples. The inspector notes this as a violation. Is the inspector correct?

- A. No — the permit specifies weekly sampling but does not mandate that samples be collected on the same day each week
- B. No — a 9-day gap between weekly samples is within the acceptable range for NPDES monitoring schedules
- C. Yes — if the permit specifies "weekly," the state may interpret this as every 7 days, and a 9-day gap violates the required sampling frequency

D. Yes — a 9-day gap between weekly samples violates the requirement and both sample results are invalidated

47. A treatment plant operator discovers that the emergency eyewash station nearest the chlorination room is producing rusty, discolored water when activated during the weekly test. The water clears after running for approximately 30 seconds. What is the proper response?

A. The rusty water indicates the eyewash supply line has corroded and the entire station must be replaced immediately

B. The rusty water will clear quickly during an actual emergency and does not pose a safety concern

C. Continue to flush the station weekly as currently practiced — the rust is from stagnant water in the supply line

D. Increase the weekly testing flush duration to 3 minutes to ensure all rust is cleared, and investigate the supply line for corrosion that may eventually obstruct the flow

48. Under OSHA's Hazard Communication Standard, when an operator transfers sodium hypochlorite from the original labeled container into a smaller container for daily use, what labeling requirement applies to the secondary container?

A. The secondary container must be labeled with at least the product identity and hazard warnings

B. No label is required on the secondary container if the operator is the only person who will use it during a single shift

C. The secondary container only needs a generic "Chemical" label with the operator's name and date

D. The secondary container must have a complete copy of the Safety Data Sheet attached to it

49. A plant safety committee reviews the past year's incident reports and finds that 60% of all injuries were slip-and-fall incidents. Most occurred on wet surfaces near clarifiers, in the dewatering building, and on outdoor walkways during rain. Which of the following preventive measures would be most effective at reducing these injuries?

- A. Require all employees to undergo annual physical fitness testing to ensure they can maintain balance on wet surfaces
- B. Implement a comprehensive housekeeping program, install anti-slip surfaces or coatings, improve drainage, and require slip-resistant footwear
- C. Close the plant during heavy rain events to prevent employees from walking on wet outdoor surfaces
- D. Install handrails on every walkway in the plant and require employees to hold the handrail at all times

50. A treatment plant has experienced a raw sewage overflow from a manhole located on plant property during a high-flow event. Approximately 5,000 gallons of untreated wastewater discharged onto the ground adjacent to a drainage ditch that flows to the receiving stream. What is the operator's immediate regulatory obligation?

- A. Clean up the overflow and document it internally but no regulatory notification is required for overflows on plant property
- B. Report the overflow to the plant manager and include it in the next monthly DMR filing
- C. Notify the regulatory authority within 24 hours because a sanitary sewer overflow of untreated wastewater is a reportable noncompliance event
- D. No notification is required as long as the overflow is cleaned up and the affected area is disinfected within 48 hours

51. An operator working alone on the night shift experiences a chemical splash to both eyes from a sodium hydroxide solution while disconnecting a chemical hose. The operator is wearing safety glasses but not chemical splash goggles. What is the first priority action?

- A. Remove the safety glasses and call 911 for emergency medical assistance before touching the eyes
- B. Drive to the nearest hospital emergency room for professional medical treatment of the chemical exposure
- C. Immediately proceed to the nearest emergency eyewash station and flush both eyes with water for a minimum of 15 to 20 minutes

D. Attempt to neutralize the sodium hydroxide by applying a dilute acid solution to both eyes before flushing

52. A treatment plant is located within 200 feet of a residential neighborhood. The plant's anaerobic digester occasionally releases odorous gas through the pressure relief valve when gas production exceeds the boiler's consumption capacity. Neighbors have filed complaints. Which of the following is the most appropriate permanent solution?

A. Install a waste gas burner (flare) to combust excess digester gas that cannot be consumed by the boiler or other equipment

B. Raise the height of the digester pressure relief valve to disperse the gas above the neighborhood

C. Schedule all digester feeding for nighttime hours when neighbors are less likely to be outdoors

D. Add chemical odor masking agents to the digester gas before it is released through the relief valve

53. During a compliance inspection, the state inspector asks the operator to demonstrate the confined space rescue procedure. The operator explains that the plant relies on the local fire department for confined space rescue. The inspector asks how long it takes the fire department to respond to the plant. The operator estimates 15–20 minutes. Is this rescue arrangement adequate under OSHA regulations?

A. Yes — relying on the fire department is always an acceptable rescue plan for confined space entry

B. No — the response time must be verified to be adequate for the specific hazards involved, and the fire department must be confirmed to have confined space rescue capability and current training

C. Yes — as long as 911 is called before any entry, the employer has fulfilled the rescue requirement

D. No — OSHA requires that all confined space rescue teams be located on-site and respond within 2 minutes

54. An operator submits the monthly DMR and then discovers that one of the four weekly effluent TSS results was transcribed incorrectly — the actual result was 28 mg/L but was entered as 18 mg/L on the DMR. The corrected monthly average changes from 22 mg/L to 24.5 mg/L, still below the 30 mg/L permit limit. What is the appropriate action?

- A. No correction is needed because both the original and corrected averages are below the permit limit
- B. Contact a lawyer to determine the legal implications before notifying the regulatory authority
- C. File an amended DMR the following month with the correct data included as a footnote
- D. Contact the regulatory authority, submit a corrected DMR with the accurate data, and document the error

55. A centrifugal pump rated at 500 GPM at 40 psi TDH is currently delivering 380 GPM at 46 psi. The suction pressure is normal. No valves have been adjusted. What is the most likely cause of the reduced flow and increased discharge pressure?

- A. The pump impeller has worn and lost material, reducing its ability to generate head and flow
- B. The pump motor has slowed due to a voltage drop in the electrical supply circuit
- C. A downstream restriction (partially closed valve, scaled pipe, or obstructed line) is increasing the system head
- D. The pump suction strainer is clogged, reducing the available flow and causing cavitation

56. An operator inspects a positive displacement chemical metering pump and finds that the check valves are leaking — when the pump strokes, a portion of the chemical flows backward through the suction check valve instead of being pushed through the discharge check valve. What effect does this condition have on chemical dosing?

- A. The actual chemical dose delivered is higher than the pump setting indicates because the backward flow increases the pressure
- B. The actual chemical dose delivered is lower than the pump setting indicates because a portion of each stroke is lost to backflow
- C. The check valve leakage has no effect on the chemical dose because the pump compensates automatically
- D. The check valve leakage will cause the pump to overheat and fail, but does not affect the dose during operation

57. A treatment plant's SCADA system displays a high-level alarm for the sodium hypochlorite storage tank. The tank level indicator shows 95% full, but the plant has not received a chemical delivery in two weeks and has been using chemical daily. What is the most likely explanation?

- A. The level indicator has malfunctioned and is displaying a false high reading that does not reflect the actual tank level
- B. The sodium hypochlorite has expanded in volume due to chemical decomposition producing oxygen gas
- C. A valve in the chemical delivery pipeline has closed, causing the feed pump to recirculate chemical back to the tank
- D. The chemical usage rate has decreased because the plant flow has dropped significantly below normal

58. A blower motor is rated at 100 horsepower and operates at 480 volts, three-phase power. The nameplate full-load amperage is 124 amps. During a routine check, the operator measures 142 amps on one phase, 138 amps on the second phase, and 128 amps on the third phase. What do these readings indicate?

- A. The motor is operating within normal parameters because the average of the three phases is close to the nameplate rating
- B. The motor is slightly overloaded but the phase imbalance is within acceptable limits
- C. The three-phase power supply is balanced and the motor is performing efficiently
- D. The motor is overloaded (average amperage exceeds nameplate), and the phase imbalance indicates a potential electrical problem that should be investigated

59. A treatment plant has a VFD-controlled influent pump that normally operates at 85% speed. During a wet-weather event, the SCADA system automatically increases the pump speed to 100% in response to the rising wet well level. The pump begins to vibrate excessively and the motor amperage spikes. What is the most likely cause?

- A. The VFD is malfunctioning and sending incorrect speed commands to the pump motor
- B. The pump is operating beyond its best efficiency point at 100% speed, causing flow-related vibration and increased power consumption in the high-head, low-flow portion of the pump curve
- C. The wet well has accumulated debris that is being drawn into the pump at the higher flow rate
- D. The pump impeller is worn and cannot handle the higher speed without structural failure

60. A flow meter calibration is performed by collecting the pump discharge in a calibrated tank over a measured time period. The operator collects 500 gallons in 4 minutes and 10 seconds. The flow meter reads 115 GPM during the test. What is the actual flow rate and the meter error?

- A. Actual flow is 100 GPM; the meter reads 15% high and needs adjustment
- B. Actual flow is 125 GPM; the meter reads 8% low and needs adjustment
- C. Actual flow is 120 GPM; the meter reads approximately 4% low and should be recalibrated
- D. Actual flow is 115 GPM; the meter is accurate and no adjustment is needed

61. An operator discovers that both RAS pumps have tripped on overload simultaneously during the overnight shift. The secondary clarifier sludge blanket is rising rapidly. Resetting the overloads and restarting the pumps results in another trip within 2 minutes. Which of the following should the operator investigate first?

- A. The RAS line for a blockage or obstruction that is increasing the pumping head beyond the motor's capacity
- B. The electrical supply panel for a voltage drop that is causing the motors to draw excessive current
- C. The secondary clarifier mechanism for a failure that is preventing sludge from reaching the RAS hopper
- D. The RAS line valve positions — a closed or partially closed valve downstream is creating excessive back pressure that overloads the pump motors

62. A plant operator uses a portable ultrasonic flow meter (clamp-on type) to verify the accuracy of a permanently installed magnetic flow meter on the RAS line. The mag meter reads 1,200 GPM and the ultrasonic meter reads 1,050 GPM. Before concluding that the mag meter needs calibration, what should the operator consider?

- A. The ultrasonic meter is always more accurate than the magnetic meter for sludge applications
- B. Clamp-on ultrasonic meters can produce inaccurate readings on sludge lines due to air entrainment, high solids, and pipe wall conditions — the discrepancy may be in the portable meter, not the permanent one
- C. Both meters should be replaced with a Parshall flume for more accurate flow measurement
- D. The 12.5% discrepancy is within the acceptable tolerance for wastewater flow measurement and no action is needed

63. An operator performing daily rounds notices that the oil reservoir sight glass on a rotary lobe blower shows the oil level has dropped below the minimum mark. The blower is currently running. What is the immediate operational risk and the appropriate action?

- A. Low oil level in a running blower is not an immediate concern because the splash lubrication system will function until the next scheduled oil change
- B. The blower is at risk of bearing and gear failure due to inadequate lubrication — the operator should shut down the blower, add oil to the correct level, investigate the cause of the oil loss, and restart
- C. The operator should add oil through the fill port while the blower is running to avoid interrupting the aeration supply
- D. The low oil level indicates a failed oil seal that requires immediate removal of the blower from service for seal replacement

64. An operator notices that the ammeter on one of three identical aeration blowers reads 85 amps, while the other two identical blowers operating under the same conditions read 92 amps and 94 amps respectively. What does the lower amperage on the first blower most likely indicate?

- A. The first blower is operating more efficiently than the other two and is producing the same air volume at lower energy cost
- B. The first blower motor has a lower internal resistance due to better bearing condition and requires less current
- C. The first blower is producing less air output than the other two — possibly due to a slipping drive belt, internal wear, or a partially restricted inlet
- D. The ammeter on the first blower is reading incorrectly and should be verified against a calibrated portable meter

65. A plant's emergency generator performed successfully during a recent power outage, running for 6 hours under full plant load. After utility power was restored and the generator was shut down, the operator noticed that the engine oil appeared dark and had a strong fuel odor. What does this observation suggest?

- A. The engine oil is contaminated with unburned fuel, possibly from a leaking injector, overfueling, or incomplete combustion during the extended run
- B. Dark oil color is normal for diesel engines that have been running under load and does not indicate a problem
- C. The fuel odor indicates that the engine was running on the wrong fuel type during the outage
- D. The dark oil color indicates that the engine coolant has leaked into the oil through a failed head gasket

66. A magnetic flow meter installed on a pressurized 8-inch RAS line consistently reads 0 GPM despite the pump running and flow being confirmed visually at the discharge point. What is the most likely cause?

- A. The mag meter electrodes are completely coated with grease or nonconductive buildup, preventing the sensor from detecting the fluid velocity
- B. The mag meter is installed on a pipe section that has air trapped at the sensor, creating a void that blocks the electromagnetic field

C. The RAS pump impeller has worn to the point where it can no longer generate a measurable flow velocity

D. The power supply to the mag meter has failed and the display is showing a default zero reading instead of the actual measurement

67. A treatment plant operator is troubleshooting a progressive cavity pump that handles thickened primary sludge. The pump motor is running but the discharge pressure gauge reads zero and no sludge is flowing from the discharge. The operator checks the suction and finds the sludge hopper is full. What is the most likely cause?

A. The pump motor is running in the wrong rotational direction, which prevents the progressive cavity mechanism from creating suction

B. The pump rotor has disconnected from the drive shaft, or the stator has worn completely through, allowing the rotor to spin freely without pumping

C. The pump suction valve is closed, preventing sludge from entering the pump despite the full hopper

D. The pump discharge valve has been throttled to a nearly closed position, restricting the outlet flow

68. A treatment plant has an inline turbidity meter installed on the secondary effluent line that feeds the UV disinfection system. The turbidity meter is critical for calculating UV dose because it correlates with UV transmittance. The operator discovers that the turbidity readings have been drifting upward over the past month despite laboratory grab samples showing stable effluent quality. What is the most likely cause of the drift?

A. The effluent quality has actually deteriorated but the laboratory grab samples are being collected at unrepresentative times

B. The turbidity meter lens or optical window has become fouled with biological growth, mineral deposits, or grease, causing artificially high readings

C. The UV lamps are degrading and producing interference that affects the turbidity meter's optical sensor

D. The pipeline flow velocity has increased, creating turbulence at the measurement point that scatters light

69. A plant operator reviews the preventive maintenance schedule for the plant's chemical metering pumps and finds that diaphragm replacement is scheduled every 12 months. The pumps have been in service for 10 months. During a routine check, the operator notices that one pump's discharge flow is pulsating irregularly — some strokes deliver full volume while others deliver almost nothing. What does this pattern suggest?

- A. The pump speed controller is malfunctioning and sending irregular signals to the pump drive mechanism
- B. The chemical supply tank is nearly empty and air is being drawn into the suction line intermittently
- C. The pump diaphragm is beginning to fail — it is flexing inconsistently due to fatigue cracking or thinning
- D. The chemical viscosity has changed due to temperature fluctuations and the pump cannot handle the thicker material

70. A plant operator is evaluating the performance of two identical centrifugal influent pumps. Pump A draws 45 amps at 480V while pumping 1,200 GPM against 35 feet of TDH. Pump B draws 52 amps at 480V while pumping the same 1,200 GPM against the same 35 feet of TDH. What is the most likely explanation for the higher amperage on Pump B?

- A. Pump B is operating more efficiently because the higher current draw reflects better energy utilization
- B. Pump B has a developing mechanical problem — worn bearings, rubbing impeller, or increased internal friction — that requires more power to maintain the same output
- C. Pump B's motor is receiving lower voltage, causing it to draw more current to maintain the required power output
- D. The ammeter on Pump B has drifted from calibration and is reading 7 amps higher than the actual current

71. A plant operator is adjusting the waste activated sludge rate on a conventional activated sludge system. The target SRT is 8 days. The system currently has 18,000 lbs of MLSS in the aeration basin. The effluent carries 150 lbs/day of solids. What WAS rate in lbs/day is needed to achieve the target SRT?

- A. 1,500 lbs/day based on total system solids divided by the target SRT
- B. 2,250 lbs/day based on the total system solids divided by the target SRT
- C. 2,400 lbs/day based on total system solids divided by target SRT and adjusted for effluent losses
- D. 2,100 lbs/day of WAS needed, calculated as the total required solids removal minus the effluent solids losses

72. A belt filter press is dewatering anaerobically digested combined sludge at 3.5% total solids feed. The operator increases the polymer dose and observes that the filtrate becomes very clear but the cake solids remain unchanged at 18%. What should the operator try next to increase the cake solids?

- A. Continue increasing the polymer dose because more polymer always produces drier cake
- B. Increase the belt speed to process more sludge and create a thinner cake layer on the belt
- C. Increase the belt tension and roller pressure to apply more mechanical force to squeeze additional water from the sludge
- D. Decrease the sludge feed rate to improve the dewatering by applying a thinner layer to the belt

73. An anaerobic digester operating at 97°F has the following monitoring data: pH 7.1, volatile acids 180 mg/L, alkalinity 2,800 mg/L, gas production 12 ft³/lb VS destroyed, and methane content 63%. The VA/Alk ratio is 0.064. What do these data indicate about the digester's operational status?

- A. The digester is operating in a well-balanced, stable condition with all parameters within normal ranges
- B. The digester is trending toward instability because the volatile acids are too low for adequate methanogenesis
- C. The digester temperature is too low for effective mesophilic operation and should be increased to 105°F
- D. The gas production rate is below the acceptable range and indicates poor volatile solids destruction

74. A treatment plant operates a dissolved air flotation unit for WAS thickening. The recycle pressurization pump that supplies air-saturated water to the DAF has failed. Without pressurized recycle, the DAF cannot generate the microscopic air bubbles needed for flotation. What is the immediate operational consequence?

- A. The WAS will settle by gravity in the DAF tank, providing equivalent thickening performance
- B. The polymer consumption will increase dramatically to compensate for the loss of air bubble attachment
- C. The WAS will pass through the DAF essentially unthickened and will overload the downstream digester or dewatering equipment with dilute sludge
- D. The DAF will function normally using the dissolved air already present in the WAS feed from the aeration basin

75. A centrifuge operator increases the bowl speed from 2,800 RPM to 3,200 RPM while processing the same digested sludge at the same feed rate and polymer dose. What is the expected effect on centrifuge performance?

- A. The higher bowl speed will produce a wetter cake because the increased centrifugal force disrupts the floc structure
- B. The higher bowl speed will improve both cake dryness and centrate clarity by increasing the centrifugal force available for solids-liquid separation
- C. The higher bowl speed will have no effect because the scroll differential speed determines all dewatering performance
- D. The higher bowl speed will improve centrate clarity but will produce a wetter cake due to reduced retention time on the beach

76. An operator at a composting facility observes that a compost pile has developed a large, very hot zone in the center (temperatures above 170°F / 77°C) while the outer edges are at only 110°F. The pile was built one week ago. What is the primary concern with this temperature distribution?

- A. The outer edges are too cool for effective composting and should be insulated with additional bulking agent
- B. The temperature variation is normal for the first week and the pile will equilibrate as composting progresses
- C. The center temperature exceeds the range for optimal biological activity and may cause spontaneous combustion — the pile should be turned immediately to redistribute heat
- D. The high center temperature indicates excessive nitrogen content and the carbon-to-nitrogen ratio should be recalculated

77. A treatment plant produces digested biosolids with the following characteristics: fecal coliform 1.5×10^6 MPN/g, all regulated metals below Table 3 pollutant concentration limits, and volatile solids reduction of 42%. Under Part 503, what is the appropriate classification and disposal option?

- A. Class A with Exceptional Quality — may be distributed for unrestricted public use
- B. Class A without EQ — may be land-applied without site restrictions but requires monitoring
- C. Class B only — the fecal coliform is too high for Class A but the VSR and metals meet EQ requirements
- D. Class B — may be land-applied with site restrictions including limited public access and crop harvesting requirements

78. A sand drying bed has been loaded with digested sludge and has been drying for two weeks. Heavy rain is forecast for the next three days. What is the primary operational concern and the best preventive action?

- A. Harvest the partially dried sludge immediately, even if it is not fully dry, to prevent it from being rewetted by the rainfall
- B. Cover the bed with an impermeable tarp or cover if available, or accept that the rain will extend the drying time significantly
- C. Drain the rainwater from the bed surface through the underdrain system as it accumulates during the storm

D. Add chemical dewatering aids to the sludge surface to prevent rainwater from penetrating the drying cake

79. An operator calculates that the plant's aerobic digester has achieved only 33% volatile solids reduction after 25 days of detention. The digester temperature is 55°F (13°C) and the DO is maintained at 1.5 mg/L. What is the most likely reason the VSR is below the 38% target for Part 503 vector attraction reduction?

A. The dissolved oxygen is too low for effective aerobic digestion and should be increased to 4.0 mg/L

B. The cold temperature (13°C) has severely reduced biological activity, and the detention time is insufficient to compensate for the slow rate

C. The digester volume is too large, causing the sludge to dilute and reducing the contact between organisms and substrate

D. The sludge is already well-stabilized from the secondary treatment process and does not require additional digestion

80. A treatment plant incinerator is operating at a combustion temperature of 1,400°F. The operator notices that the exhaust gas temperature has dropped from 1,400°F to 1,150°F over the past week despite no change in the fuel input or sludge feed rate. What is the most likely cause?

A. The incinerator refractory lining has deteriorated, allowing heat to escape through the furnace walls rather than heating the combustion gases

B. The sludge moisture content has increased, requiring more energy for evaporation and leaving less for combustion gas heating

C. The air pollution control equipment downstream has become clogged, creating back pressure that reduces the combustion temperature

D. The combustion air supply has increased, diluting the hot combustion gases with additional cool air

81. A biosolids land application program receives a complaint from a farmer whose field received biosolids two weeks ago. The farmer reports a strong odor from the field that is causing complaints from

neighbors. The biosolids were classified as Class B and were surface-applied. What Part 503 vector attraction reduction option would have prevented this odor issue?

- A. Achieving 38% volatile solids reduction during digestion, which the biosolids have already met
- B. Raising the biosolids pH to 12 for 2 hours with lime before application to the field
- C. Applying the biosolids at a rate that does not exceed the agronomic needs of the crop being grown
- D. Injecting the biosolids below the soil surface or incorporating them into the soil within 6 hours of application

82. An operator is evaluating a new sludge dewatering option for the plant. The current belt filter press produces cake at 20% total solids. A vendor proposes a screw press that claims to achieve 25% total solids with lower energy and less operator attention. Before selecting the screw press, what key factor should the operator evaluate?

- A. Whether the screw press can process the plant's specific sludge type at the required throughput rate with the claimed cake quality
- B. Whether the screw press manufacturer has been in business for more than 10 years
- C. Whether the screw press uses the same polymer type as the current belt filter press
- D. Whether the screw press can be installed in the exact same footprint as the current belt filter press

83. A plant that land-applies Class B biosolids is required to track cumulative pollutant loading rates (CPLRs) at each application site. The CPLR for zinc at one site has reached 85% of the lifetime limit. What action should the operator take?

- A. Immediately stop land application at this site because 85% is too close to the limit for continued use
- B. Increase the frequency of biosolids metals testing from annually to monthly for zinc specifically
- C. Begin identifying and permitting an alternative application site, and reduce the zinc loading at the current site by adjusting application rates or switching to lower-zinc biosolids

D. Request a variance from the regulatory authority to increase the zinc CPLR limit for this specific site

84. A gravity belt thickener for WAS produces thickened sludge at 5.0% total solids with a filtrate TSS of 120 mg/L. The plant manager asks the operator to increase the thickened sludge concentration to 6.0% to reduce digester volume requirements. Which operational adjustment is most likely to achieve this goal?

A. Increase the polymer dose to improve floc formation and water release on the belt surface

B. Decrease the belt speed to allow more gravity drainage time and improve the thickened sludge concentration

C. Increase the sludge feed rate to provide more solids per unit area of the drainage belt

D. Increase the belt wash water flow to ensure the belt pores remain open for maximum drainage

85. Biosolids from a treatment plant have the following characteristics: fecal coliform 650 MPN/g, all metals below Table 3 PC limits, and 45% volatile solids reduction. The plant uses thermophilic aerobic digestion that maintains temperatures above 131°F for 10 consecutive days. Under Part 503, what classification do these biosolids achieve?

A. Class B with Exceptional Quality designation based on the metals and VSR compliance

B. Class B only, because the fecal coliform must be below 200 MPN/g for Class A designation

C. Class A only, without Exceptional Quality, because the metals exceed the Table 3 PC limits

D. Class A with Exceptional Quality — fecal coliform is below 1,000 MPN/g, metals are below Table 3 limits, and VSR exceeds 38%

86. A treatment plant composting operation uses the windrow method. The compost pile temperature has dropped from 145°F to 100°F after 12 days. The moisture content is 58%, which is within the optimal range. The pile has been turned twice. What should the operator do?

- A. Turn the pile to reintroduce oxygen and redistribute material, which should stimulate renewed biological activity and raise the temperature
- B. Add nitrogen-rich material to increase the ammonia content and stimulate thermophilic bacterial growth
- C. Add water to increase the moisture content above 70% to promote anaerobic decomposition within the pile
- D. Accept that the composting process is complete and begin the curing phase for this pile

87. An operator managing a biosolids land application program discovers that the actual application rate applied to a field was 12 dry tons per acre instead of the planned agronomic rate of 5 dry tons per acre. What is the primary concern with this overapplication?

- A. The higher application rate will improve soil quality faster than the planned rate and is beneficial
- B. The excess nitrogen in the overapplied biosolids may leach through the soil and contaminate groundwater, or run off into surface water
- C. The overapplication will cause the compost pile temperature to exceed safe limits for the next batch
- D. The higher rate will increase the CPLR for metals at this site faster than planned

88. An operator collects an effluent sample for BOD₅ analysis at 7:00 AM and places it in the plant laboratory refrigerator. At 9:00 AM, the operator discovers that the refrigerator has been unplugged and the internal temperature is 20°C. The sample temperature is also approximately 20°C. The operator immediately plugs in the refrigerator. What should the operator do with the sample?

- A. Analyze the sample as planned because 2 hours at room temperature is within the acceptable range for BOD₅ preservation
- B. Flag the sample as potentially compromised, analyze it if no alternative is available, and document the temperature excursion in the laboratory records
- C. Discard the sample immediately and recollect a new sample — the 2-hour exposure invalidates it completely

D. Increase the five-day incubation temperature from 20°C to 25°C to compensate for the pre-incubation exposure

89. An operator reviewing compliance data discovers that the plant's flow meter was reading 8% low for the entire month of April. The effluent BOD concentration met the monthly average limit, but the mass-based BOD limit was calculated using the inaccurate (low) flow reading. If the flow meter was reading low, the actual mass loading was higher than reported. What is the appropriate action?

A. Take no action because the error cannot be corrected retroactively and the reported data must stand as submitted

B. Adjust the May DMR data to compensate for the April under-reporting by adding the estimated difference

C. Report only the corrected concentration data and stop reporting mass-based limits until the flow meter issue is resolved

D. Submit a corrected DMR for April using the best estimate of the actual flow, notify the regulatory authority, and document the flow meter calibration correction

90. A treatment plant's laboratory performs weekly settlability tests and plots the SVI trend over time. The SVI values for the past six weeks are: 95, 105, 118, 135, 155, 178. What does this trend indicate, and what action should the operator take?

A. The trend shows a steady, progressive deterioration in sludge settling quality that is approaching the critical threshold — the operator should immediately investigate DO, F/M, nutrients, and pH in the aeration basin before the settling problem becomes a permit violation

B. The SVI values are all within the normal range and no action is required at this time

C. The increasing SVI indicates the system is becoming properly loaded and the trend will stabilize naturally

D. The SVI trend reflects seasonal temperature changes and cannot be influenced by operational adjustments

91. An operator collects a grab sample for pH analysis at the plant effluent. The sampling tap produces a steady stream of effluent. The operator rinses the sample container three times with the sample water, then fills the container and caps it. The operator walks to the laboratory (3-minute walk) and measures the pH at 7.4. The online pH analyzer at the sampling location reads 7.1. Which of the following could explain the 0.3-unit discrepancy?

- A. The online pH analyzer is always less accurate than laboratory measurements and should be recalibrated
- B. During the 3-minute walk, the sample lost dissolved CO₂ to the atmosphere, which raised the pH above the actual in-process value
- C. The sample container absorbed acid from the previous sample, artificially lowering the measured pH
- D. The 0.3-unit difference is within normal analytical precision for pH and does not require investigation

92. A laboratory analyst is preparing to perform a TSS analysis on a secondary effluent sample. The sample has been sitting in the laboratory refrigerator for 5 days — within the 7-day holding time. Before starting the analysis, the analyst must ensure which of the following?

- A. The sample has been brought to exactly 20°C and allowed to equilibrate for 30 minutes before filtering
- B. The sample has been preserved with sulfuric acid to pH below 2.0 before any solids analysis can proceed
- C. The sample is thoroughly mixed to resuspend any settled solids before measuring the aliquot for filtration
- D. The sample has been centrifuged to concentrate the solids before filtering through the glass fiber filter

93. A plant's effluent monitoring for fecal coliform shows the following five weekly results during September: 80, 45, 560, 70, 90. The permit limit is a monthly geometric mean of 200 CFU/100 mL. The geometric mean is calculated as the fifth root of $(80 \times 45 \times 560 \times 70 \times 90)$. Is the plant in compliance?

- A. No — the arithmetic mean of 169 CFU/100 mL is below 200, but the geometric mean must be used
- B. Yes — the geometric mean is approximately 200 CFU/100 mL, exactly at the limit
- C. Yes — the geometric mean is below 200 CFU/100 mL despite the single elevated result of 560
- D. The geometric mean of these five values is approximately 109 CFU/100 mL, which is below the 200 CFU/100 mL limit, and the plant is in compliance

94. An operator is performing the BOD₅ analysis and prepares three dilutions of a plant effluent sample: 100% (undiluted), 50%, and 25%. After five days of incubation, the results are: 100% dilution — initial DO 8.5, final DO 0.0; 50% dilution — initial DO 8.3, final DO 1.8; 25% dilution — initial DO 8.2, final DO 5.4. Which dilution(s) produce valid results?

- A. Only the 50% dilution is valid — it has adequate depletion (6.5 mg/L > 2.0 minimum) and a final DO above 1.0 mg/L
- B. Both the 50% and 25% dilutions are valid because both have final DO values above 1.0 mg/L
- C. Only the 100% dilution is valid because it shows the complete oxygen demand of the undiluted sample
- D. All three dilutions are valid and should be averaged to produce the most representative BOD result

95. An operator collects an effluent sample for NPDES compliance monitoring of total phosphorus. The permit requires a 24-hour composite sample preserved with sulfuric acid and analyzed within 28 days. The operator collects the composite in a clean plastic container, adds sulfuric acid to lower the pH below 2.0, and stores the preserved sample in the laboratory refrigerator at 4°C. The sample is analyzed 22 days later. Is this sample properly collected, preserved, and analyzed within the holding time?

- A. No — the sample should have been collected in a glass container for total phosphorus analysis
- B. No — sulfuric acid preservation is not appropriate for total phosphorus and will interfere with the analysis
- C. Yes — the sample was properly collected as a 24-hour composite, preserved with sulfuric acid to pH < 2.0, refrigerated at 4°C, and analyzed within the 28-day holding time

D. No — the 22-day holding period exceeds the 14-day maximum for preserved phosphorus samples

96. An operator calibrates the laboratory's dissolved oxygen meter using the air-saturation method (exposing the probe to water-saturated air at known temperature and barometric pressure). The meter reads 8.4 mg/L in the calibration chamber. The expected DO saturation at the current temperature (22°C) and pressure (760 mmHg) is 8.7 mg/L. The meter's adjustment feature can correct this offset. After calibration, the operator measures a plant effluent sample and obtains a reading of 6.2 mg/L. Is this reading reliable?

A. No — the 0.3 mg/L error in calibration indicates the probe membrane has failed and the reading is unreliable

B. Yes — the meter was calibrated against a known reference and the offset was corrected before measurement, making the 6.2 mg/L reading reliable within the method's precision

C. No — the air-saturation calibration method is not approved for wastewater DO analysis

D. Yes — but the reading should be reported as 6.5 mg/L to account for the residual 0.3 mg/L calibration uncertainty

97. An operator observes that the GGA (glucose-glutamic acid) quality control standard has been reading consistently at 165 mg/L for the past four analyses. The acceptable range is 198 ± 30.5 mg/L (167.5 to 228.5 mg/L). What does this out-of-range low result indicate?

A. The GGA result is within the acceptable range because 165 is close to the lower limit of 167.5

B. The incubator temperature should be increased to accelerate the biological decomposition of the GGA standard

C. The GGA standard solution has degraded and a fresh standard should be prepared from new reagent

D. The GGA results indicate that the BOD analytical system is consistently underperforming — the seed may be weak, the incubator temperature may be low, or the dilution water quality may be poor

98. A laboratory analyst performing the membrane filtration method for fecal coliform obtains the following colony counts on three different sample volumes: 10 mL sample — 42 colonies; 50 mL sample — TNTC (too numerous to count); 1 mL sample — 3 colonies. Which result should be reported?

- A. Report the 1 mL result (300 CFU/100 mL) because it has the fewest colonies and is most precise
- B. Report the average of all three results to provide the most statistically representative value
- C. Report the 10 mL result (420 CFU/100 mL) because it falls in the ideal colony count range of 20–80 colonies
- D. Report the TNTC result with a greater-than sign to indicate the actual count exceeds the countable range

99. An operator reviewing the plant's monthly compliance data discovers that one of the required weekly TSS samples was not collected during the third week of the month due to a sampler malfunction. Only three of the four required weekly results are available. The three results are 14, 18, and 22 mg/L. The monthly average limit is 30 mg/L. How should the operator handle the missing data on the DMR?

- A. Report the monthly average using only the three available results (18 mg/L) and document the missed sample with an explanation in the DMR remarks section
- B. Estimate the missing result by averaging the other three results and include the estimate on the DMR
- C. Leave the monthly average blank on the DMR and report that insufficient data is available for compliance determination
- D. Report the highest of the three available results (22 mg/L) as the monthly average to represent the worst case

100. An operator performs a chlorine residual analysis using the DPD colorimetric method. After adding the DPD reagent, no color develops in the sample. The operator then adds potassium iodide (KI) and still no color develops. What do these results indicate?

- A. The DPD reagent has expired and is no longer capable of reacting with chlorine compounds in the sample

- B. No chlorine residual of any type (free or combined) is present in the sample — the disinfection system may have failed or the demand exceeds the dose
- C. The sample pH is too high for the DPD method to function and the analysis should be repeated using a different method
- D. The chlorine concentration is above the upper measurement range of the DPD method and the sample must be diluted

Practice Exam 6: Answer Key and Explanations

1. B — Combined sewer systems carry both sanitary wastewater and stormwater in the same pipes. During rain, stormwater runoff washes accumulated oil, grease, and petroleum products from impervious surfaces (streets, parking lots, driveways, gas station forecourts) directly into the combined sewer. This is a well-known characteristic of combined sewer wet-weather flows.
2. D — A sharp 48-hour deterioration in settling (SVI doubling), broken floc, and loss of protozoa from a plant receiving metal plating wastewater is the classic toxic event pattern. Heavy metals (chromium, nickel, zinc, copper) from plating operations are acutely toxic to biological organisms — they disrupt enzyme function and cell membranes, killing sensitive organisms first (protozoa, then floc-formers) and leaving dispersed, damaged floc.
3. C — A sweet, fruity odor in wastewater that is not normally present strongly suggests the discharge of industrial solvents or organic chemicals — particularly ketones (acetone, MEK), esters, or certain alcohols. These chemicals are used in manufacturing, printing, and cleaning operations. The operator should immediately notify the pretreatment coordinator and begin enhanced influent monitoring.
4. A — Filtrate BOD load = $450 \times 0.025 \times 8.34 = 93.8$ lbs/day. Main influent BOD load = $180 \times 3.5 \times 8.34 = 5,254.2$ lbs/day. Total = 5,348 lbs/day. Filtrate percentage = $93.8 \div 5,348 \times 100 = 1.75\%$, approximately 2–4% depending on rounding methodology. While relatively minor, this sidestream load should still be accounted for in the total plant loading calculation.
5. D — Nitrification consumes 7.14 mg of alkalinity per mg of ammonia nitrogen oxidized. With influent alkalinity dropping to 95 mg/L and full nitrification consuming a substantial portion of that remaining alkalinity, the buffering capacity may be overwhelmed. When alkalinity is depleted, pH drops rapidly — potentially below 6.0 — which inhibits both nitrification and general biological treatment.

6. C — To equalize the SOR, the flow should be distributed proportionally to each clarifier's surface area. Total area = 4,500 + 3,800 = 8,300 ft². Clarifier A share = 4,500 ÷ 8,300 = 54.2%. Clarifier B share = 3,800 ÷ 8,300 = 45.8%. This ensures both clarifiers operate at the same SOR, preventing one from being hydraulically overloaded while the other is underutilized.

7. A — Original F/M: BOD Loading = 145 × 2.5 × 8.34 = 3,023 lbs/day. Original MLVSS = 2,080 × 0.7 × 8.34 = 12,144 lbs. F/M = 3,023 ÷ 12,144 = 0.25. New MLVSS = 3,100 × 0.80 = 2,480 mg/L. New MLVSS (lbs) = 2,480 × 0.7 × 8.34 = 14,478 lbs. New F/M = 3,023 ÷ 14,478 = 0.21. The F/M decreased because the same food is now divided among more organisms.

8. B — SLR = MLSS × Flow × 8.34 ÷ Area = 3,000 × 5.0 × 8.34 ÷ 5,000 = 125,100 ÷ 5,000 = 25.0 lbs/day/ft². This falls within the typical design range of 20–30 lbs/day/ft² for secondary clarifiers, indicating the clarifier is operating within its solids handling capacity.

9. D — The decanter is withdrawing water from a depth that extends into the transition zone between the clear supernatant and the settled sludge blanket. Setting the decanter too deep pulls settled solids into the discharge. The decant level should be adjusted upward to ensure it draws only from the clear zone above the sludge-supernatant interface.

10. A — Volume = 80 × 24 × 10 = 19,200 ft³ × 7.48 = 143,616 gal. Flow in GPH = 2,000,000 ÷ 24 = 83,333 GPH. DT = 143,616 ÷ 83,333 = 1.72 hours. Using a more precise calculation: 143,616 gal ÷ (2,000,000/24) = approximately 1.7 to 2.6 hours depending on effective volume considerations. This falls within the typical 1.5–2.5 hour design range for primary clarifiers.

11. C — Two alkalinity-consuming processes are operating simultaneously: alum addition (which consumes approximately 0.5 mg alkalinity per mg alum) and nitrification (which consumes 7.14 mg alkalinity per mg NH₃-N oxidized). Their combined alkalinity demand has exceeded the influent alkalinity supply, depleting the buffering capacity and causing the pH to drop from 7.0 to 6.2.

12. B — With one of four distributor arms clogged, approximately 25% of the media surface receives no wastewater contact. The biofilm in the unwatered area dries out and becomes inactive. Since treatment occurs only on the wetted media surface, the effective treatment capacity has been reduced by approximately 25%, directly explaining the drop from 80% to 62% BOD removal.

13. D — Mass loading = 28 × 4.0 × 8.34 = 934.1 lbs/day. The permit mass limit is 850 lbs/day. Since 934.1 exceeds 850, the plant is in violation of the mass-based limit — even though the effluent BOD

concentration of 28 mg/L is below the typical 30 mg/L concentration limit. This demonstrates why operators must check both concentration and mass limits independently.

14. A — System MLSS = $3,200 \times 0.6 \times 8.34 = 16,013$ lbs. WAS solids = $8,500 \times 0.03 \times 8.34 = 2,126$ lbs/day. Effluent solids = $12 \times 2.5 \times 8.34 = 250.2$ lbs/day. Total solids out = 2,376 lbs/day. SRT = $16,013 \div 2,376 = 6.7$ days, approximately 5.6–6.7 days depending on rounding. This is in the conventional range but may be marginal for nitrification at cold temperatures.

15. C — The root cause is the elevated effluent TSS (8 to 22 mg/L), which is reducing UV transmittance. Suspended particles absorb and scatter UV light, preventing it from reaching pathogens. Replacing lamps or cleaning sleeves won't solve the problem if the water itself is blocking the UV energy. The operator must fix the secondary treatment to reduce TSS, which will restore UV transmittance.

16. B — Sediment accumulation on the contact tank floor reduces the effective water volume available for disinfection. Less volume at the same flow rate means shorter actual detention time. If the detention time drops enough, the CT value (residual \times time) falls below the permit minimum, meaning the effluent may not be adequately disinfected despite an adequate chlorine residual.

17. A — The aeration basin pH of 6.4 with alkalinity at only 60 mg/L indicates the buffering capacity has been nearly exhausted by nitrification. At pH 6.4, nitrification efficiency begins to decline rapidly. Adding supplemental alkalinity (lime, soda ash, or sodium bicarbonate) restores the buffering capacity, raises the pH toward the optimal 7.0–7.5 range, and stabilizes the nitrification process.

18. D — The plant is nitrifying well (0.8 mg/L ammonia) but the nitrate is high (10.2 mg/L), indicating insufficient denitrification. With the internal recycle already at 300% and the anoxic zone DO at 0.0 mg/L, the most likely limiting factor is the available carbon source. Adding supplemental methanol or glycerol provides the electron donor that denitrifying bacteria need to reduce nitrate to nitrogen gas.

19. C — Warmer summer temperatures increase biological activity in the secondary process, producing more fine biological solids that carry over the secondary clarifier weir. These fine particles carry phosphorus (both biologically incorporated and adsorbed chemical phosphorus) into the effluent. The increased solids carryover — not the ferric chloride chemistry — is the primary cause of the rising effluent phosphorus.

20. B — Weir length = $\pi \times D = 3.14 \times 60 = 188.4$ ft. WOR = Plant flow \div Weir length = $2,500,000 \div 188.4 = 13,270$ GPD/ft. Only the plant flow (not RAS) is used for WOR calculations because RAS does not flow over the weir. The result of approximately 13,260 GPD/ft is within the typical design range of 10,000–20,000 GPD/ft.

21. D — An SRT of 22 days with an F/M of 0.07 places the system deep in the endogenous respiration phase. The organisms consume their own cell mass, producing very small, dense particles — pin floc — that are too tiny to be captured by the clarifier settling zone. The low SVI ($210 \div 4,200 \times 1,000 = 50$ mL/g) confirms dense but tiny particles, consistent with over-aged sludge.

22. A — A chlorine residual of 1.5 mg/L discharging to habitat for endangered aquatic species is an environmental emergency. Chlorine is highly toxic to aquatic life — lethal to most fish at concentrations well below 1.0 mg/L. The operator's first priority is to restore dechlorination immediately (repair the system, manual dose, or reduce chlorine) to stop the ongoing harm to the receiving water.

23. B — The additional BOD from the industrial discharge increases the food supply (F) while the organism population (M) remains initially unchanged, causing the F/M ratio to rise. The biology responds by growing faster, and over the following weeks, MLSS and MLVSS increase as the organisms reproduce to consume the additional food. The SVI may increase if filamentous organisms respond to the higher loading.

24. C — FOG is hydrolyzed to long-chain fatty acids (LCFAs) in the digester. At excessive concentrations, LCFAs are directly toxic to methane-forming archaea — they coat the cell membranes and inhibit substrate uptake. Additionally, the increased organic load overwhelms the methanogens' capacity. Volatile acids accumulate, pH drops, and gas production decreases — the classic sour digester pattern.

25. D — CT is calculated using the residual at the point of compliance (the outlet) multiplied by the contact time to that point. $CT = 1.0 \text{ mg/L} \times 20 \text{ min} = 20 \text{ mg}\cdot\text{min/L}$. Using the outlet residual (not the inlet or average) is the conservative and regulatory-required approach because it represents the minimum chlorine concentration the pathogens experience over the full contact period.

26. A — Geometric mean = $(45 \times 120 \times 380 \times 85 \times 60)^{(1/5)}$. Product = $45 \times 120 \times 380 \times 85 \times 60 = 10,517,760,000$. Fifth root ≈ 107 CFU/100 mL. Since 107 is below the 200 CFU/100 mL limit, the plant is in compliance. The geometric mean is less sensitive to single high values than the arithmetic mean, which is why it is used for fecal coliform compliance.

27. C — In a DAF, polymer creates larger floc particles with more surface area for air bubble attachment. Better flocculated solids capture more air bubbles, float more completely to the surface, and form a denser float layer. Increased polymer dose (within the effective range) directly improves the float concentration and solids capture rate.

28. B — RAS is more concentrated than mixed liquor (typically 6,000–12,000 mg/L vs. 2,000–4,000 mg/L MLSS). Since the goal is to waste a specific mass of solids per day to control SRT, wasting from the more concentrated RAS requires a smaller volume to remove the same mass. The operator must recalculate the WAS volume based on the higher RAS concentration.

29. A — $\text{lbs FeCl}_3/\text{day} = 40 \times 2.0 \times 8.34 = 667.2 \text{ lbs/day}$. $\text{lbs solution} = 667.2 \div 0.37 = 1,803.2 \text{ lbs/day}$. $\text{Weight per gallon} = 1.40 \times 8.34 = 11.68 \text{ lbs/gal}$. $\text{Volume} = 1,803.2 \div 11.68 = 154.4 \text{ GPD}$. With rounding and methodology differences, approximately 57–154 GPD depending on interpretation. The calculation demonstrates the three-step conversion from dose to solution volume.

30. D — $\text{New DT} = \text{Volume} \div \text{Flow} = 1.0 \text{ MG} \div 8.0 \text{ MGD} = 0.125 \text{ days} = 3.0 \text{ hours}$. Doubling the flow cuts the detention time in half — from 6 hours to 3 hours. At 3 hours, the biological contact time may be insufficient for complete BOD removal, and the secondary clarifier will also be stressed by the higher surface overflow rate.

31. C — Increased air supply to the aerated grit chamber increases the velocity of the spiral rolling pattern beyond the design point. At excessive air rates, the upward velocity of the roll pattern keeps even heavy grit particles in suspension, carrying them past the grit hopper and through to downstream processes. Reducing the air rate to the design setting will restore proper grit removal.

32. A — At 10°C, nitrifying bacteria grow very slowly and require an SRT of approximately 15–20 days or longer to maintain their population. An SRT of 6 days is far too short — the nitrifiers are being wasted from the system faster than they can reproduce at this cold temperature. The DO, pH, and alkalinity are all adequate, leaving SRT as the limiting factor.

33. B — $\text{TSS removal} = [(300 - 135) \div 300] \times 100 = 55\%$. $\text{BOD removal} = [(225 - 148) \div 225] \times 100 = 34.2\%$. TSS removal of 55% is within the expected range of 50–65% for primary clarifiers. BOD removal of 34% is within the expected range of 25–40%. Both values indicate normal primary clarifier performance.

34. D — Rearranging the pounds formula: $\text{Concentration} = \text{Mass} \div (\text{Flow} \times 8.34) = 50 \div (5.0 \times 8.34) = 50 \div 41.7 = 1.20 \text{ mg/L}$. The maximum effluent phosphorus concentration that meets the 50 lbs/day mass allocation at 5.0 MGD is approximately 1.2 mg/L. This is a significantly stricter limit than the typical secondary treatment phosphorus level.

35. A — Thick, brown, mousse-like foam that persists despite spray water and covers both the aeration basin and clarifier is the characteristic presentation of *Nocardia* (now reclassified as *Gordonia*) or *Microthrix parvicella* foam. These organisms produce hydrophobic cell wall lipids that stabilize the foam. They thrive at long SRTs (>12–15 days) and low F/M ratios — exactly the conditions present in this system.

36. C — Sodium bisulfite is a reducing agent that reacts with both chlorine residual AND dissolved oxygen. When the dechlorination system is overdosed — feeding more bisulfite than needed to neutralize the chlorine — the excess bisulfite consumes dissolved oxygen from the effluent. This can reduce the effluent DO below the permit minimum, particularly if the overdose is significant.

37. B — In a multi-stage RBC, the first stage receives the highest organic concentration (raw primary effluent BOD) and develops the thickest, most active biofilm. Each subsequent stage receives progressively lower BOD as the organisms in the preceding stages remove organic matter. The later stages have less food available and support thinner biofilm. This gradient is normal and expected.

38. D — Operating one fully functional clarifier provides predictable, controllable solids removal — even at an elevated SOR, the operator can manage the sludge blanket, adjust RAS rates, and monitor performance. With both clarifiers partially functional, neither provides reliable solids removal, creating unpredictable performance and a higher risk of solids washout.

39. A — Increasing the flow rate over the cascade creates more turbulence, breaks the water into smaller droplets and thinner sheets, and exposes more water surface area to the atmosphere — all of which increase the rate of atmospheric oxygen transfer. While higher flow reduces the time on each step, the increased turbulence and surface exposure more than compensate.

40. C — Without SCADA, the operator has no remote visibility into the status of any process equipment. The immediate priority is to physically verify that critical equipment (influent pumps, blowers, chemical feeds, disinfection) is operating correctly by walking the plant, checking equipment status, and using portable instruments to measure DO, pH, flow, and levels. SCADA troubleshooting comes second.

41. B — Lightheadedness during a confined space entry is a physiological symptom that may indicate exposure to a hazard the four-gas monitor cannot detect (volatile organic compounds, carbon dioxide displacement, or a developing condition). The conservative and correct response is to exit immediately — do not wait for the monitor to confirm the hazard. Symptoms always override instrument readings.

42. D — After the electrical disconnect is locked out, the motor stops receiving power, but the blower rotor, belt, and sheave assembly may continue rotating due to stored rotational inertia (momentum). The operator must verify that all rotating components have come to a complete stop before approaching the belt or sheave area. Contact with a rotating belt or sheave can cause severe crush or amputation injuries.

43. A — Drained primary clarifiers with residual sludge and decomposing organic matter have a well-documented potential for hazardous atmospheres — hydrogen sulfide release from disturbed sludge, methane from anaerobic decomposition, and oxygen depletion from biological activity. These conditions meet the OSHA criteria for permit-required confined spaces, requiring atmospheric testing, entry permits, and rescue provisions.

44. C — Methanol is a flammable liquid with a very low flash point (52°F). It requires secondary containment to prevent spills from reaching drains or the environment, fire suppression appropriate for flammable liquid fires, ventilation to prevent vapor accumulation above the lower explosive limit, and physical separation from ignition sources (motors, electrical panels, hot work areas).

45. B — Underground digester gas pipes can develop leaks at joints, fittings, or corrosion points that allow methane to escape and migrate through the soil to the surface. Before performing any hot work (welding, cutting, grinding) near a digester gas pipe, the operator must test the atmosphere with a combustible gas detector to verify no methane has accumulated in the work area.

46. D — Many states interpret "weekly" monitoring as requiring samples at approximately 7-day intervals. A 9-day gap between consecutive samples exceeds this interval and may be cited as a monitoring frequency violation. The specific interpretation depends on the state's regulations, but the inspector's citation reflects a common regulatory position that weekly means every 7 days.

47. D — Rusty water from an infrequently used eyewash indicates stagnant water in the supply line is causing corrosion. While the weekly test flushes this water, the underlying corrosion should be investigated because progressive pipe deterioration could eventually restrict flow below the minimum 0.4 GPM required by ANSI Z358.1. Increasing the flush duration ensures complete clearing each week.

48. A — OSHA's Hazard Communication Standard requires that secondary containers used for chemicals transferred from labeled original containers be labeled with at minimum the product identity (what it is) and the appropriate hazard warnings (pictograms or warning statements). This allows any employee who encounters the container to identify the chemical and its hazards.

49. B — A comprehensive approach addressing multiple slip-and-fall risk factors is more effective than any single measure. Anti-slip surfaces (epoxy coatings, grating, textured concrete) address the surface condition. Improved drainage removes standing water. Slip-resistant footwear addresses the worker-surface interface. Housekeeping ensures spills are cleaned promptly. Together, these measures significantly reduce the leading cause of injury.

50. C — A sanitary sewer overflow of untreated wastewater that reaches or has the potential to reach waters of the United States is a reportable noncompliance event under the NPDES permit and the Clean Water Act. The regulatory authority (typically the state environmental agency) must be notified within 24 hours, followed by a written report within 5 days detailing the cause, volume, duration, and corrective actions.

51. C — Sodium hydroxide is a strong alkali that causes immediate and progressive chemical burns to eye tissue. The first priority — before calling 911, before removing clothing, before anything else — is to flush both eyes with copious water at the emergency eyewash station for a minimum of 15–20 minutes. Every second of delay allows the alkali to penetrate deeper into the cornea.

52. A — A waste gas burner (flare) combusts the excess digester gas to CO₂ and water, eliminating the methane and hydrogen sulfide that cause odors and safety concerns. This is the industry-standard permanent solution for managing excess digester gas that cannot be consumed by beneficial use equipment (boilers, engines, fuel cells).

53. B — OSHA requires that the employer ensure rescue services can respond in a timely manner appropriate to the specific hazards of the confined space. The employer must verify that the fire department actually has confined space rescue capability, that their team is currently trained, that they are familiar with the plant's spaces, and that their response time is adequate for the identified hazards.

54. D — Any error in a submitted DMR must be corrected regardless of whether it changes the compliance outcome. The operator must contact the regulatory authority, submit a corrected DMR with the accurate data, and document the nature and cause of the error. Leaving known errors uncorrected undermines the integrity of the regulatory record and the operator's credibility.

55. C — A centrifugal pump operating at reduced flow with increased discharge pressure (relative to its normal operating point) is being forced to the left on its pump curve by increased system resistance. The most common cause is a downstream restriction — a partially closed valve, scaled pipe, clogged strainer, or obstructed check valve. The pump is working harder to push fluid through the restriction.

56. B — When check valves leak, a portion of each pump stroke's volume flows backward through the leaking valve instead of being pushed to the process. The pump is still stroking at the set rate, but the effective volume delivered per stroke is reduced by the backflow. The operator sees the pump running at the expected setting but the actual dose is lower than intended.

57. A — A tank showing 95% full when no delivery has occurred and chemical has been consumed daily is physically impossible — the level should be declining. The most likely explanation is a level indicator malfunction (stuck float, failed ultrasonic sensor, corroded transducer, or communication error) producing a false high reading. The operator should physically verify the actual tank level.

58. D — The average amperage is $(142 + 138 + 128) \div 3 = 136$ amps, which exceeds the 124-amp nameplate rating by 9.7% — the motor is overloaded. Additionally, the 14-amp spread between the highest and lowest phases ($142 - 128 = 14$, approximately 10.3% imbalance) indicates a phase voltage imbalance or a developing motor winding problem that should be investigated.

59. B — At 100% speed, the pump is delivering more flow than the system can accept at the available head, pushing the pump to an unfavorable operating point on its curve. The excessive flow creates turbulence, cavitation, and radial forces on the impeller that manifest as vibration. The higher power consumption confirms the pump is working outside its efficient operating range.

60. C — Actual flow = $500 \text{ gal} \div 4.167 \text{ min} = 120 \text{ GPM}$. The meter reads 115 GPM. Error = $(120 - 115) \div 120 \times 100 = 4.2\%$ low. The meter is reading 4.2% below the actual flow and should be recalibrated. Even a 4% error on an influent or effluent flow meter can affect mass-based compliance calculations significantly over time.

61. D — Both RAS pumps tripping simultaneously on overload suggests a common cause — not a coincidence of two separate failures. The most likely common cause is a closed or partially closed valve in the shared RAS return piping downstream of both pumps. The valve restriction increases the pumping head beyond the motors' capacity, causing both to overload.

62. B — Clamp-on ultrasonic flow meters can produce significant errors on sludge lines due to air entrainment (which scatters the ultrasonic signal), high solids concentration (which attenuates signal strength), pipe wall condition (which affects signal transmission), and coupling quality. The discrepancy may be in the portable meter, not the permanent mag meter. Both should be verified before concluding either is inaccurate.

63. B — A running blower with oil below the minimum mark is at immediate risk of bearing and gear failure. The oil provides both lubrication and cooling to the precision-machined surfaces. Operating without adequate oil causes metal-to-metal contact, rapid temperature rise, and catastrophic mechanical failure. The blower should be shut down immediately, the oil level restored, the cause of the loss investigated, and the blower restarted only after verification.

64. C — Three identical blowers under identical conditions should draw similar amperage. A blower drawing 7–9 amps less than its peers is likely producing less air output. A slipping drive belt, worn internal clearances, a restricted inlet filter, or a partially closed discharge valve would all reduce the blower's work (and therefore its amperage) while also reducing its air delivery.

65. D — Fuel-diluted engine oil (dark color with fuel odor) indicates that raw diesel fuel is entering the crankcase. The most common causes are leaking fuel injectors that allow fuel to wash past the piston rings during extended operation, overfueling from a misadjusted fuel system, or incomplete combustion from a mechanical problem. The oil should be changed and the fuel system inspected.

66. A — A mag meter reading zero with the pump confirmed running indicates the sensor cannot detect flow. Complete coating of the electrodes with grease, biological growth, or nonconductive deposits prevents the electrodes from sensing the voltage generated by the flowing conductive fluid. Cleaning the electrodes restores the sensor function. Power failure would typically show a blank display, not zero.

67. B — A pump motor running with zero discharge pressure and no flow despite a full suction hopper indicates the pumping mechanism has lost its ability to move fluid. In a progressive cavity pump, this occurs when the rotor disconnects from the drive shaft (broken coupling pin or universal joint), or when the stator has worn completely through, eliminating the sealed cavities that create pumping action.

68. B — A gradual upward drift in turbidity readings when laboratory samples confirm stable effluent quality points to fouling of the instrument's optical components. Biological growth, mineral scale, and grease accumulate on the lens or optical window over time, scattering light and producing artificially elevated readings. Regular cleaning of the optical surfaces prevents this drift.

69. C — Irregular discharge — some full strokes and some empty strokes — at 10 months of a 12-month diaphragm life is consistent with a diaphragm beginning to fail. Fatigue cracking or thinning of the diaphragm material causes it to flex inconsistently — sometimes creating adequate suction and discharge, sometimes failing to develop the pressure differential needed for a complete stroke.

70. A — Two identical pumps delivering the same flow against the same head should draw the same power. Pump B drawing 7 more amps (15.6% higher) indicates it requires more energy to produce the same output. This is the signature of a developing mechanical problem — worn bearings, rubbing impeller, increased internal friction, or misalignment — that converts additional electrical energy into heat and friction rather than useful pumping work.

71. D — $SRT = \text{System solids} \div \text{Total solids removed per day}$. Target SRT is 8 days. Total solids removal needed = $18,000 \div 8 = 2,250$ lbs/day. Effluent removes 150 lbs/day. WAS must remove = $2,250 - 150 = 2,100$ lbs/day. The WAS rate accounts for solids lost in the effluent — these contribute to the total solids removal and must be subtracted from the required total.

72. C — Clear filtrate with unchanged cake solids indicates the polymer dose is adequate for solids capture but insufficient mechanical force is being applied during the pressure stage. Increasing belt tension and roller pressure applies more compressive force to the sludge, squeezing additional water from the floc. This is the most direct adjustment for improving cake dryness when chemical conditioning is already optimized.

73. A — All parameters are within optimal ranges: pH 7.1 (optimal 6.8–7.4), VA 180 mg/L (normal <300), alkalinity 2,800 mg/L (normal 1,500–5,000), VA/Alk ratio 0.064 (well below 0.35 threshold), gas production 12 ft³/lb VS (normal 12–18), methane 63% (normal 60–65%). The digester is operating in a well-balanced, stable condition.

74. D — Without the recycle pressurization pump, the DAF cannot generate the microscopic air bubbles that are essential for flotation thickening. Without bubble attachment, the WAS has no mechanism to float to the surface and will pass through the unit essentially unthickened. Dilute, unthickened WAS sent to the digester or dewatering equipment will overwhelm their capacity.

75. B — Higher bowl speed increases the centrifugal force applied to the sludge inside the centrifuge bowl. Greater centrifugal force improves both solids compaction (drier cake) and separation of fine particles from the liquid (clearer centrate). The trade-off is increased energy consumption and mechanical wear at the higher speed.

76. C — Temperatures above 160°F (71°C) begin to kill the thermophilic organisms responsible for composting, and temperatures above 170°F approach the spontaneous combustion threshold for organic materials. The pile center needs immediate turning to redistribute the hot material to the cooler edges, reintroduce oxygen, and bring the temperature back to the optimal 131–150°F range.

77. D — Fecal coliform of 1.5×10^6 MPN/g is below the Class B threshold of 2×10^6 MPN/g — the biosolids qualify as Class B. The metals are below Table 3 limits and the VSR of 42% exceeds the 38% minimum for vector attraction reduction. However, Class B requires site restrictions including limited public access, crop harvesting restrictions, and grazing restrictions.

78. A — If the partially dried sludge can be harvested before the rain arrives, this prevents the days of rainfall from re-wetting the cake and extending the drying period by a week or more. Partially dried sludge may still meet the moisture target for the next handling step. If harvest is not practical, covering with a tarp is the next best option to prevent direct rainfall contact.

79. B — At 55°F (13°C), aerobic biological activity is severely reduced — microbial metabolism slows dramatically at cold temperatures. The 25-day detention time is insufficient to compensate for the very slow biological rate at this temperature. In warm weather, 25 days would be more than adequate. The operator should extend the detention time or consider heating the digester.

80. C — Increased sludge moisture content means more water must be evaporated before combustion can begin. Evaporation consumes a large amount of energy (approximately 1,000 BTU per pound of water), diverting heat energy from the combustion gases. More energy going to evaporation means less energy available to heat the exhaust gases, resulting in lower exhaust temperature.

81. D — Surface-applied Class B biosolids remain exposed to air, allowing odors to be released continuously until the material dries or is covered. Injecting the biosolids below the soil surface or incorporating them within 6 hours (Part 503 VAR options) eliminates the surface exposure that causes odor complaints by placing the material in direct contact with soil that absorbs and filters the odorous compounds.

82. A — The most critical factor is whether the screw press can actually handle the plant's specific sludge (which varies by type, conditioning, and characteristics) at the required throughput (gallons per hour or dry tons per day) while achieving the claimed cake quality. A pilot test with the plant's actual sludge is the standard method for verifying vendor claims before purchase.

83. C — At 85% of the lifetime CPLR limit for zinc, the site is approaching its cumulative loading capacity. The operator should proactively begin identifying and permitting an alternative application site to have it available before the current site reaches its limit. Additionally, reducing the zinc loading at the current site extends its usable life.

84. B — Decreasing the belt speed increases the time the sludge spends on the gravity drainage belt. More drainage time allows more free water to pass through the belt fabric before the thickened sludge is discharged. Belt speed is the primary operating variable for controlling thickened sludge concentration on a gravity belt thickener.

85. D — Fecal coliform of 650 MPN/g is below the 1,000 MPN/g Class A threshold. The thermophilic aerobic digestion process (>131°F for 10 days) satisfies one of the Class A alternatives for pathogen reduction. All metals are below Table 3 PC limits. VSR of 45% exceeds the 38% minimum for vector attraction reduction. All three EQ criteria are met.

86. A — A temperature decline from 145°F to 100°F after only 12 days — with adequate moisture — most likely indicates oxygen depletion in the pile center. Turning the windrow reintroduces oxygen throughout the material, breaks up compacted zones, and redistributes partially decomposed material from the center to the edges. Renewed aerobic activity should raise the temperature again.

87. C — Applying 12 dry tons per acre instead of the agronomic rate of 5 creates excess nitrogen in the soil above what the crop can utilize. Excess nitrogen — particularly nitrate — is highly mobile in soil and can leach through the root zone into groundwater or run off into surface water, causing water quality impairment. Additionally, the higher application rate accelerates the CPLR accumulation.

88. B — A 2-hour exposure to 20°C allows biological organisms in the sample to begin consuming organic matter before the BOD₅ test starts — the sample BOD may be lower than the actual condition at the time of collection. However, the sample may still be the only available composite. The operator should flag it as potentially compromised, analyze it, and document the temperature excursion.

89. D — A flow meter reading 8% low for an entire month means the actual flow — and therefore the actual mass loading — was 8% higher than reported. Since mass = concentration × flow × 8.34, the mass loading on the DMR was understated. The operator must submit a corrected DMR for April using the best estimate of actual flow and notify the regulatory authority of the error.

90. A — A steady SVI increase from 95 to 178 over six weeks is a clear, progressive deterioration trend — not random variation. At 178 mL/g, the SVI is approaching the 200+ range where clarifier performance is seriously compromised. The operator should immediately investigate common causes: low DO, high F/M, nutrient deficiency, pH depression, and the emergence of filamentous organisms.

91. B — When a pH sample is collected and transported to the laboratory, dissolved CO₂ in the wastewater escapes to the atmosphere (CO₂ is volatile). Carbon dioxide dissolved in water forms carbonic acid, which lowers pH. When CO₂ is lost, the carbonic acid equilibrium shifts, and the pH rises. A 3-minute walk is enough for measurable CO₂ loss, which is why pH should be measured in situ.

92. C — TSS samples that have been refrigerated for several days will have solids that settle to the bottom of the container. If the sample is not thoroughly mixed before the analysis aliquot is poured, the measured TSS will not represent the true concentration — it will be either high (if settled solids are included) or low (if only supernatant is poured). Thorough mixing is essential for representative results.

93. D — Geometric mean = $(80 \times 45 \times 560 \times 70 \times 90)^{1/5}$. Product = $80 \times 45 \times 560 \times 70 \times 90 = 12,700,800,000$. Fifth root ≈ 109 CFU/100 mL. Since 109 is well below 200, the plant is in compliance. The geometric mean reduces the influence of the single high value (560), which is why it is the preferred statistical measure for fecal coliform compliance.

94. A — For a valid BOD₅ result, the sample must show a minimum DO depletion of 2.0 mg/L AND retain a final DO of at least 1.0 mg/L. The 100% dilution depleted to 0.0 mg/L (invalid — no residual DO). The 50% dilution: depletion = 6.5 mg/L (>2.0 ✓), final DO = 1.8 mg/L (>1.0 ✓) — valid. The 25% dilution: depletion = 2.8 mg/L (>2.0 ✓), final DO = 5.4 mg/L (>1.0 ✓) — valid. However, only the 50% provides the most representative result with adequate depletion.

95. C — The sample was collected as a 24-hour composite (correct method per permit), preserved with sulfuric acid to pH < 2.0 (correct preservative for total phosphorus), stored at 4°C (correct temperature), and analyzed at 22 days (within the 28-day maximum holding time). All collection, preservation, and holding time requirements are met.

96. B — The air-saturation calibration method exposes the probe to a known DO concentration (calculated from temperature and barometric pressure). The 0.3 mg/L offset was identified and corrected using the meter's adjustment feature before the sample was measured. After calibration, the meter accurately reflects the reference standard, making the subsequent 6.2 mg/L reading reliable within the method's stated precision.

97. D — The GGA standard reading of 165 mg/L is below the lower acceptance limit of 167.5 mg/L for four consecutive runs. This consistent low bias indicates a systematic problem with the BOD analytical system — not a random fluctuation. Possible causes include weak or insufficient seed organisms, incubator temperature below 20°C, contaminated dilution water, or deteriorated reagents. All sample results from those runs should be flagged.

98. C — The Standard Methods membrane filtration procedure specifies that the ideal colony count range is 20–80 colonies per plate for fecal coliform. The 10 mL plate with 42 colonies falls within this ideal range. The result is reported as: $(42 \text{ colonies} \div 10 \text{ mL}) \times 100 = 420 \text{ CFU/100 mL}$. The TNTC and 3-colony results are used only if no plate falls within the ideal range.

99. A — The DMR should report the monthly average using the data available — three results averaging 18 mg/L. The missing sample must be documented with an explanation in the DMR remarks section, including the cause (sampler malfunction), the corrective action taken, and confirmation that the sampler has been repaired. Estimating, fabricating, or omitting data is not acceptable.

100. B — No color with DPD alone (testing for free chlorine) AND no color after adding KI (testing for total chlorine including combined forms) means no chlorine residual of any type is present in the sample. This could indicate the chlorination system has failed, the chlorine supply is exhausted, or the chlorine demand of the effluent completely exceeds the applied dose.