PRACTICE EXAM 14: USPS 955 MULTICRAFT SIMULATION

1. A postal facility's main chiller plant includes three centrifugal chillers piped in parallel. During a heat wave, the building automation system calls for all three chillers but the third chiller's compressor will not start. The chiller display shows a "low oil pressure" fault. What should the maintenance technician investigate?

A. The chiller's refrigerant charge level for a leak that has reduced system pressure below minimum

B. The chilled water supply temperature for being too cold causing the compressor to short-cycle on limit

C. The condenser water supply temperature for being too warm causing high head pressure on the compressor

D. The chiller's oil pump, oil heater, and oil pressure sensing system for a fault preventing startup clearance

2. A maintenance electrician is troubleshooting an intermittent ground fault on a 480-volt feeder that trips the ground fault protection during rainy weather but cannot be found during dry weather inspections. What diagnostic approach is most effective?

A. Replace all the conductors in the feeder with new wire rated for wet locations and higher temperature

B. Install a continuous insulation monitoring device on the feeder to detect and locate the fault when it occurs

C. Increase the ground fault protection sensitivity to trip faster and isolate the fault location more precisely

D. Perform a hipot test on the feeder at twice the rated voltage during the next dry weather inspection period

3. A hydraulic system has a 10-gallon accumulator precharged with nitrogen at 1,500 PSI. The system minimum working pressure is 1,800 PSI and the maximum is 3,000 PSI. What usable fluid volume does the accumulator store between minimum and maximum pressure?

A. Approximately 3.3 gallons calculated using Boyle's Law for the gas volume change between the two pressures

B. Approximately 5.0 gallons based on half the total accumulator volume being available between pressure limits

C. Approximately 10.0 gallons because the entire accumulator volume is available at maximum system pressure

D. Approximately 1.7 gallons based on the precharge-to-maximum ratio less the precharge-to-minimum ratio

4. A building's fire alarm system includes a voice evacuation system with amplifiers, speakers, and a pre-recorded message. During a monthly test, the amplifier operates but the speakers produce no sound. The speaker wiring tests normal with an ohmmeter. What should be checked?

A. The fire alarm panel's audio output for a programming error that mutes the speaker zone during test mode

B. The speaker volume controls for all being turned to minimum setting by building occupants during operation

C. The amplifier's audio output signal level and the speaker circuit impedance matching for a configuration fault

D. The pre-recorded message memory card or module for corruption that prevents audio playback during testing

5. A PLC controls a multi-station mail processing machine. The machine has 12 pneumatic cylinders that operate in sequence. Recently, the cycle time has increased from 4 seconds to 6 seconds per complete cycle. All cylinders reach their target positions, and no faults are displayed. What should be investigated?

A. The PLC processor for a scan time increase from a recent program modification adding excessive logic

B. The pneumatic supply system for reduced pressure or flow capacity that slows all cylinder movements

C. The individual cylinder position sensors for delayed response time from dirt accumulation on sensing faces

D. The PLC analog output modules for calibration drift that reduces the speed command to the VFD drives

6. A maintenance technician is troubleshooting a three-phase motor that produces a pronounced 120 Hz hum that is louder than normal. When the motor is de-energized and coasts to a stop, the hum immediately disappears. What is the most likely cause?

A. The motor's coupling is misaligned and producing vibration that coincidentally matches the 120 Hz frequency

B. The motor's bearing clearance has increased allowing the rotor to orbit at twice the line frequency

C. The motor shaft has developed a bend that produces a once-per-revolution impact at running speed

D. An electrical problem in the motor — unequal air gap, eccentric stator, or shorted stator laminations

7. A centrifugal pump operating on a closed-loop hot water system develops a small but persistent leak at the mechanical seal. The leak rate is approximately 1 drop per second. The seal was replaced 6 months ago. What is the most likely cause?

A. The seal faces have worn from normal operation beyond their expected service life in this application

B. The pump shaft has excessive radial runout that prevents the seal faces from maintaining consistent contact

C. The hot water temperature has exceeded the seal elastomer's maximum temperature rating causing degradation

D. The seal spring compression was set incorrectly during the last installation reducing the face-loading force

8. A boiler room has two natural gas boilers connected to a common breeching (flue) that exhausts through a single stack. Boiler A operates normally, but Boiler B's flame rolls out of the combustion chamber at the burner opening when Boiler A is firing at high fire. What is the cause?

A. Boiler B's gas pressure regulator is set too high causing excessive fuel delivery to the burner assembly

B. Boiler B's induced draft fan is not producing enough negative pressure to overcome the stack effect

C. Boiler A at high fire creates a positive pressure in the common breeching that pushes combustion gases back through Boiler B's non-operating flue passages

D. The common stack diameter is too large causing poor draft conditions for both boilers during operation

9. A PLC ladder logic program has a latch instruction (OTL) on Rung 5 and an unlatch instruction (OTU) on Rung 15, both addressing the same output O:2/0. The OTL rung condition is currently false and the OTU rung condition is currently true. What is the state of O:2/0?

A. ON because latch instructions always override unlatch instructions regardless of scan order or conditions

B. OFF because the OTU instruction on Rung 15 is the last to evaluate and its true condition clears the bit

C. Indeterminate because simultaneous OTL and OTU conditions create a conflict in the PLC output table

D. ON because the output retains its previous latched state until the OTL rung condition goes true again

10. A maintenance crew is replacing a large overhead door motor in a postal loading dock. The motor weighs 350 pounds and is mounted 16 feet above the floor on a structural steel header. The crew has a 2-ton chain hoist, a portable gantry crane rated at 1 ton, and a 24-foot extension ladder. What is the safest approach?

A. Position the portable gantry crane beneath the motor location and rig the chain hoist from the gantry beam

B. Rig the chain hoist directly from the structural steel header and use the extension ladder for technician access

C. Use the extension ladder and three workers to lower the motor hand-over-hand on a rope to ground level

D. Rent a forklift with a work platform attachment to raise a technician to the motor height for disconnection

11. A facility's emergency generator runs weekly no-load tests successfully. During an actual utility outage, the generator starts but the engine stalls when the automatic transfer switch connects the building load. What is the most likely cause?

A. The transfer switch contacts have excessive resistance and are creating a voltage drop that stalls the engine

B. The generator's fuel supply is adequate for no-load testing but the fuel delivery system cannot meet loaded demand

C. The building load exceeds the generator's rated capacity causing the engine to lug down and stall immediately

D. The generator's governor is not responding fast enough to the sudden load application and allows the engine speed to drop below recovery

12. A hydraulic system's pressure gauge reads 2,800 PSI but the actuator is not producing the expected force. A calibrated test gauge installed at the actuator reads only 2,000 PSI. Both gauges are on the same circuit. What accounts for the 800 PSI difference?

A. The system relief valve is partially open and bypassing fluid before it reaches the actuator work port

B. The actuator's piston seal has failed internally and the lost pressure is consumed by internal bypass flow

C. Pressure drop across the supply lines, fittings, valves, and filter between the two gauge locations

D. The original pressure gauge has drifted out of calibration and is reading 800 PSI higher than actual value

13. A maintenance electrician is upgrading the lighting in a postal facility from fluorescent to LED. The existing circuits are designed for magnetic ballast loads. After installing LED drivers, several circuits experience nuisance tripping of the breakers. What is the most likely cause?

A. The LED drivers draw more total current than the fluorescent ballasts they replaced in the same circuits

B. The LED drivers produce a high inrush current at startup that exceeds the breaker's instantaneous trip setting

C. The building's neutral conductor is undersized for the harmonic currents produced by the LED driver circuits

D. The LED drivers operate at a lower power factor than the fluorescent ballasts increasing the reactive current

14. A building automation system controls a VAV air handling unit. The BAS commands the supply fan VFD to 80% speed but the duct static pressure reads higher than the setpoint. What does this indicate?

A. Most VAV terminal unit dampers are closing because zone temperatures are satisfied, reducing airflow demand

B. The duct static pressure sensor has failed high and is sending an incorrect reading to the BAS controller

C. The supply fan is running faster than 80% due to a VFD speed feedback error in the drive programming

D. The outdoor air damper has closed completely reducing the total air volume handled by the supply fan

15. A maintenance technician is troubleshooting a cooling tower fan motor that trips on overload every afternoon. Morning operation is normal. The motor current in the morning is 38 amps (nameplate FLA is 42 amps). Afternoon current reads 44 amps before the trip occurs. What is the most likely cause?

A. The motor's internal thermal protector has degraded and trips at a lower temperature than its original setting

B. The afternoon power supply voltage drops from peak facility loading reducing the motor's efficiency and torque

C. The cooling tower water temperature increases in the afternoon adding thermal load to the motor's environment

D. Warmer and more humid afternoon air is denser than morning air, increasing the fan's aerodynamic load

16. In a standard single-phase motor, what is the function of the centrifugal switch?

A. It reverses the motor's rotation direction when the load torque exceeds a preset overload condition

B. It disconnects the start winding once the motor reaches approximately 75% of synchronous speed

C. It connects additional capacitors in parallel with the run winding for power factor improvement during operation

D. It applies dynamic braking to the motor when the stop button is pressed for rapid deceleration to standstill

17. A maintenance crew discovers that a large I-beam in the maintenance shop has a crack at a weld joint. The crack is approximately 4 inches long and is located at the junction of the flange and web. What weld repair preparation is required before re-welding?

A. Clean the surface with a wire brush and apply weld directly over the existing crack without further preparation

B. Grind the paint off the surrounding area and apply a fillet weld along the entire length of the I-beam web

C. Cut out the entire cracked section of the beam and replace it with a new section welded on both ends

D. Gouge out the crack completely using air-arc or grinding until sound metal is reached on all sides

18. A PLC-controlled packaging machine uses a load cell to weigh packages. The PLC reads the load cell signal through an analog input module. Recently, the weight readings have become erratic — fluctuating ±5% randomly even with a known test weight on the scale. What should be investigated?

A. The PLC program for a math instruction error that introduces rounding errors in the weight calculation

B. The load cell mounting for mechanical looseness that allows the platform to shift during measurement

C. The analog signal wiring for electromagnetic interference from nearby VFDs or motor starters affecting the signal

D. The PLC analog input module's reference voltage for drift that changes the scaling of the raw input data

19. A steam boiler has been operating normally for years. Recently, the operator notices that the boiler must fire longer to reach operating pressure, and fuel consumption has increased approximately 15%. No changes have been made to the steam demand or operating schedule. What should be investigated first?

A. The fire-side heating surfaces for soot, scale, or ash accumulation that reduces heat transfer to the water

B. The boiler's combustion air damper for an incorrect position that reduces the amount of fuel being burned

C. The feedwater temperature for a decrease that requires more energy to heat the water to boiling temperature

D. The steam distribution piping for new leaks that have developed and are wasting steam outside the building

20. An electrician is troubleshooting a motor that runs in the wrong direction after a maintenance event. The motor has 12 leads and is connected for 480-volt wye operation. What is the simplest correction?

A. Reconnect the motor leads in a delta configuration instead of wye to reverse the rotation direction

B. Add a phase reversal relay to the motor's control circuit to electronically reverse the phase sequence

C. Swap the positions of all 12 motor leads according to the reverse-rotation connection diagram for the motor

D. Swap any two of the three line leads (T1, T2, T3) at the motor terminal box to reverse the phase sequence

21. A hydraulic system has two identical cylinders connected to the same directional valve through a flow divider. Both cylinders should extend at the same rate. Cylinder A extends at the correct speed but Cylinder B extends 20% slower. The flow divider has been verified as dividing flow equally. What should be checked?

A. Cylinder B's rod seal for excessive friction that would not affect flow division but would slow extension speed

B. Cylinder B's supply line for a restriction — a partially closed valve, kinked hose, or undersized fitting

C. The directional valve's B-port for a partial blockage that restricts flow to both cylinder supply lines equally

D. Cylinder A's return line for an oversized fitting that allows faster drainage than Cylinder B's return piping

22. A building's HVAC system uses a heat recovery wheel (energy recovery wheel) in the air handling unit. The wheel rotates between the exhaust and supply air streams. During winter operation, the supply air temperature after the wheel is lower than expected. What should be checked?

A. The exhaust fan speed for a reduction that decreases the airflow volume across the heat recovery wheel

B. The heat recovery wheel's drive belt for slipping or the wheel motor for failure causing reduced rotation

C. The wheel speed and condition — a slipping belt, failed motor, or dirty wheel media reduces heat transfer

D. The outdoor air damper for being stuck partially closed restricting the volume of air passing through the wheel

23. A maintenance crew is installing a new 480-volt three-phase motor on a critical mail sorting machine. Before energizing, what pre-startup checks must be completed?

A. Megger test the motor windings, verify rotation direction, check alignment, verify coupling installation, and confirm all guards are in place

B. Verify the motor nameplate voltage matches the supply and check that the disconnect switch is operational

C. Confirm the PLC program has been updated with the new motor's parameters and the VFD is configured

D. Test the overload relay trip setting and verify the branch circuit breaker is the correct size for the motor

24. A pneumatic system has a large receiver tank that serves as a buffer between the compressor and the distribution system. The compressor cycles on at 100 PSI and off at 125 PSI. The receiver tank pressure gauge shows rapid pressure fluctuation between 100 and 125 PSI with the compressor cycling every 30 seconds. What does this indicate?

A. The compressor's unloader valve is malfunctioning and not fully venting the compressor head during unloading

B. The pressure switch differential is correctly set but the compressor is responding normally to system demand

C. The compressor's intake valve is leaking allowing compressed air to bleed back through the intake filter

D. The receiver tank is too small for the system demand or a large leak exists that depletes the stored air rapidly

25. A maintenance technician is troubleshooting a boiler feedwater pump that runs but delivers no water to the boiler. The pump motor current is well below normal. The suction and discharge valves are verified open. What is the most likely cause?

A. The feedwater check valve on the boiler is stuck closed preventing water from entering the boiler drum

B. The pump has lost prime — air in the casing prevents the centrifugal pump from developing suction pressure

C. The pump impeller has completely separated from the shaft and the motor is spinning without moving water

D. The feedwater treatment chemicals have increased the water viscosity beyond the pump's design capability

26. A PLC program uses a timer (TON) with a preset of 15 seconds to delay a motor start after a signal from a pressure switch. The pressure switch activates, but the motor starts immediately without the 15-second delay. What should be checked?

A. The PLC processor for a mode error that is running the program in a bypass mode without timer execution

B. The timer instruction's preset value for being changed from 15 seconds to zero in the data table registers

C. The rung logic — the motor output may be controlled by a parallel path that bypasses the timer instruction

D. The PLC power supply for voltage fluctuation that causes the timer to advance faster than real-time seconds

27. A centrifugal chilled water pump shows elevated vibration at a frequency matching the number of impeller vanes times shaft speed (vane pass frequency). This vibration was not present one year ago. What has changed?

A. The gap between the impeller outer diameter and the volute tongue has decreased from wear or shifting

B. The pump motor has developed rotor bar cracks that create electromagnetic vibration at vane pass frequency

C. The pump foundation has settled causing the pump casing to distort and change internal vane clearances

D. The chilled water supply temperature has dropped increasing the water density and hydraulic pulsation energy

28. A maintenance technician discovers that a building's domestic hot water mixing valve outlet temperature fluctuates between 95°F and 145°F instead of maintaining the 120°F setpoint. Hot water supply temperature is a steady 140°F and cold water supply is a steady 55°F. What is the most likely cause?

A. The cold water supply pressure is fluctuating causing the mixing valve's blend ratio to vary with pressure

B. The hot water recirculation pump is cycling on and off disrupting the flow balance through the mixing valve

C. The cold water supply line to the mixing valve has a partially blocked strainer restricting cold water flow

D. The mixing valve's thermostatic element has degraded and cannot modulate smoothly between hot and cold

29. An electrician discovers that a motor control center has a strong burning smell. Investigation reveals that a single motor starter bucket has overheated stab connections on all three phases. The motor it controls runs 24 hours per day. What is the root cause?

A. The motor starter contactor is undersized for the continuous duty rating of the connected motor circuit

B. The MCC stab connections have loosened from thermal cycling over years of continuous 24-hour operation

C. The motor has developed a winding fault that draws excessive current through the starter's stab connections

D. The MCC vertical bus has corrosion from a moisture intrusion that increases resistance at all connection points

30. A maintenance crew is rigging a 20,000-pound transformer for removal using an overhead bridge crane. The crane is rated at 15 tons. The rigging plan calls for a spreader beam weighing 500 pounds and four slings. What is the maximum allowable total weight of the four slings and all other rigging hardware?

A. 9,500 pounds — calculated as the crane capacity (30,000 lbs) minus the load (20,000 lbs) minus the spreader beam (500 lbs)

B. 500 pounds — the rigging hardware should not exceed the weight of the spreader beam for balanced loading

C. 4,750 pounds — calculated as 25% of the remaining capacity after subtracting the load weight only

D. 15,000 pounds — the rigging hardware weight is not counted against the crane's rated capacity for overhead lifts

31. A hydraulic system's return line filter clogging indicator triggers within 24 hours of filter element replacement. Oil analysis shows extremely high metallic particle counts. The system was operating normally until last week. What is the most likely cause?

A. The replacement filter elements are defective and are releasing particles into the hydraulic fluid stream

B. The hydraulic reservoir was contaminated during the last oil change from dirty containers or equipment

C. A major internal component failure (pump, motor, or valve) is generating massive amounts of wear debris

D. The return line filter housing bypass valve is stuck closed forcing all contamination into the new element

32. A building's electrical system has a power monitoring system that records voltage, current, and power factor. Review of the monthly data shows that power factor drops significantly every Monday morning between 6:00 and 7:00 AM. What is the most likely explanation?

A. Multiple large motors starting simultaneously during Monday morning startup draw high reactive inrush current

B. The weekend shutdown allows the power factor correction capacitors to discharge completely before Monday

C. The utility supply frequency shifts slightly on Monday mornings from weekend grid load changes affecting PF

D. Building occupants arriving on Monday morning create a sudden increase in lighting and computer load demands

33. A steam system's pressure-reducing station includes a PRV, strainer, bypass valve, and isolation valves. The maintenance technician needs to service the PRV. What is the correct valve lineup sequence to isolate the PRV while maintaining steam supply to the downstream system?

A. Close the downstream isolation valve, then close the upstream isolation valve, then open the bypass valve

B. Close the upstream isolation valve only and allow the downstream system to depressurize through the load

C. Open the bypass valve fully, then close both PRV isolation valves to route steam around the PRV

D. Close both isolation valves simultaneously and open the bypass valve to maintain downstream supply pressure

34. A PLC-controlled conveyor system has a weight scale that rejects underweight packages. The scale reads accurately for the first 2 hours of operation each day, then begins reading 2-3% high for the remainder of the shift. What should be investigated?

A. The load cell amplifier for a thermal drift that shifts the zero reference as the electronics warm up over time

B. The PLC analog input module for a resolution limitation that becomes apparent at higher operating temperatures

C. The conveyor belt for material accumulation that adds weight to the scale platform section during production

D. The scale's mechanical platform for thermal expansion from ambient temperature changes during the operating shift

35. A maintenance technician discovers that a motor's vibration signature shows a dominant peak at exactly line frequency (60 Hz) rather than at running speed or 2× line frequency. What does this specific frequency indicate?

A. Mechanical imbalance of the rotor assembly that coincidentally matches the electrical line frequency

B. A defective VFD output filter creating a resonance at the fundamental supply frequency of the system

C. A stationary eccentricity in the motor — an off-center stator or rotor producing a unidirectional magnetic pull

D. Loose stator laminations vibrating at the fundamental line frequency from electromagnetic excitation forces

36. A centrifugal pump handling cooling tower water shows a gradual decrease in discharge pressure over a six-month period. The motor current has also decreased. Suction conditions are unchanged. What does the combination of decreasing pressure AND decreasing current indicate?

A. Impeller wear reducing the pump's output — a worn impeller produces less head and requires less power

B. The system resistance has increased from fouling causing the pump to operate at a lower flow and pressure

C. The motor has lost a phase and is operating on two phases with reduced power and pressure output capability

D. The pump mechanical seal has failed allowing significant internal leakage that bypasses the impeller entirely

37. An electrician is installing conduit in a postal facility. The conduit run must cross an expansion joint in the building structure. What installation requirement must be addressed at the expansion joint?

A. The conduit must be rigidly coupled across the expansion joint to prevent any movement in the conduit run

B. Standard conduit fittings are acceptable at expansion joints because conduit is flexible enough to accommodate movement

C. The conduit must be sealed with fire-rated caulk at the expansion joint to maintain the fire rating of the assembly

D. An expansion fitting or flexible conduit section must be installed to accommodate building structural movement

38. A hydraulic system uses a closed-loop servo control with position feedback from a magnetostrictive linear displacement transducer (LDT). The actuator is hunting (oscillating around the target position). System pressure and flow are stable. What should be adjusted?

A. The hydraulic system pressure should be increased to provide more force for the actuator to hold position

B. The servo controller gain settings — the proportional and/or derivative gains are too high causing overshoot

C. The LDT sensor should be replaced because hunting always indicates a defective position feedback sensor

D. The hydraulic fluid viscosity should be increased to dampen the actuator's movement and reduce oscillation

39. A building's fire alarm system has a ground fault condition that intermittently appears and clears on a specific signaling line circuit (SLC). Standard troubleshooting cannot locate the fault. What advanced diagnostic approach should be used?

A. Replace the entire SLC wiring because intermittent ground faults in fire alarm wiring cannot be reliably repaired

B. Disconnect all devices on the SLC and reconnect them one at a time to identify which device introduces the fault

C. Install a ground fault monitoring device on the SLC that logs the fault occurrence and identifies the circuit segment

D. Increase the SLC's supervision voltage to force the intermittent fault into a permanent condition for easier location

40. A maintenance technician is troubleshooting a condensing boiler that produces much less condensate than expected. The flue gas temperature at the stack is higher than the design specification for condensing mode. Combustion analysis shows normal O_2 and CO levels. What should be investigated?

A. The boiler's secondary (condensing) heat exchanger for fouling or bypass that prevents adequate heat recovery

B. The boiler's burner for incorrect flame pattern that concentrates heat in the primary heat exchanger section

C. The natural gas supply for a composition change that alters the dew point temperature of combustion products

D. The return water temperature for being too high — condensing boilers require low return water temperature

41. A PLC program includes a math instruction that divides register N7:0 by register N7:1 and stores the result in N7:2. If N7:1 contains the value zero, what happens when the instruction executes?

A. The PLC generates a math overflow fault — division by zero is an illegal operation that may fault the processor

B. The PLC stores the value 99999 in N7:2 as a default maximum value for division by zero error conditions

C. The PLC skips the instruction and leaves N7:2 at its previous value without generating any fault conditions

D. The PLC stores zero in N7:2 because any number divided by zero equals zero in PLC math instruction logic

42. A cooling tower fan is belt-driven by a 50 HP motor. The belts have been replaced three times in the past year. Normal belt life on this application is 2-3 years. What should the maintenance technician investigate?

A. The motor and fan shaft alignment and the sheave condition for wear that misaligns or damages the belts

B. The belt tension for being set too loose causing the belts to slip and overheat during each operating cycle

C. The motor sheave and fan sheave for groove wear, misalignment, or incorrect size that accelerates belt failure

D. The belt storage conditions for exposure to sunlight or chemicals that pre-ages the belts before installation

43. A steam system has a condensate return line that shows signs of severe internal corrosion — thin walls and pinhole leaks. The boiler water treatment program is well-maintained with proper pH and oxygen scavenger levels. What is causing the condensate line corrosion?

A. The boiler blowdown frequency is excessive and is sending concentrated chemicals into the condensate system

B. Carbonic acid formed from CO_2 dissolving in the condensate is attacking the piping from the inside

C. The condensate return pump is creating pressure surges that fatigue the piping walls and cause stress corrosion

D. Galvanic corrosion from dissimilar metals at the pipe joints where copper fittings meet the steel condensate piping

44. A PLC-controlled system uses a counter (CTU) to track production output. The counter preset is 1,000 and triggers a batch-complete signal when reached. The operator reports that the batch signal sometimes triggers at 998 or 999 instead of exactly 1,000. What should be investigated?

A. The PLC processor scan time for being too slow to catch every count pulse from the high-speed sensor input

B. The PLC power supply for voltage fluctuations that cause the processor to miscount during brief sag events

C. The counter preset value in the data table for corruption from electrical noise affecting the memory contents

D. The sensor counting products for double-counting or miscounting due to bounce, alignment, or sensitivity issues

45. A maintenance electrician is testing a transformer's winding resistance with a micro-ohmmeter. The high-side winding reads 2.1 ohms and the low-side winding reads 0.05 ohms. What do these readings indicate?

A. Normal transformer winding resistance — the high-side has more turns of thinner wire and the low-side has fewer turns of heavier wire

B. The high-side winding has a developing short circuit that has reduced its resistance below normal expectations

C. The low-side winding has excessive resistance indicating corrosion or loose internal connections in the winding

D. Both readings are abnormal because transformer windings should have identical resistance regardless of ratio

46. A hydraulic system's directional valve has a manual override button for troubleshooting. When the technician presses the manual override, the cylinder extends normally. When the solenoid is commanded by the PLC, the cylinder does not move. What does this narrow down?

A. The fault is in the electrical control path — PLC output, wiring, or solenoid coil preventing the valve from shifting electrically

B. The hydraulic supply pressure is inadequate to shift the valve spool under normal solenoid-operated conditions

C. The cylinder's piston seal has failed and only produces force when the valve is manually held in position

D. The pilot pressure supply to the valve is insufficient because manual override bypasses the pilot circuit

47. A building's chilled water system has a plate heat exchanger separating the chiller loop from the building distribution loop. The approach temperature (difference between the two fluid outlet temperatures) has increased from the original 2°F to 8°F. What does this indicate?

A. The chiller's compressor has lost efficiency and cannot produce the same cooling capacity at the evaporator

B. The building distribution pump flow rate has increased beyond the heat exchanger's design flow capacity

C. The heat exchanger plates are fouled with scale, biological growth, or debris reducing heat transfer efficiency

D. The chiller loop pump has slowed down reducing the chilled water flow through the heat exchanger plates

48. A maintenance technician is performing a monthly fire pump test. The pump starts on pressure drop and runs for 10 minutes. During the test, the technician notices excessive vibration and a cavitation-like noise from the pump. What should be investigated?

A. The fire pump's jockey pump for running simultaneously and creating interference in the fire pump suction

B. The fire pump's suction supply for a partially closed valve, clogged strainer, or insufficient water level

C. The fire pump's discharge relief valve for being set too low and bypassing water back to the suction side

D. The fire pump's coupling alignment for degradation since the last annual inspection that produces vibration

49. A PLC analog output drives a current-to-pressure (I/P) transducer that positions a steam control valve. The valve should modulate between 0% and 100% open. The valve operates correctly between 0% and 80% but will not open beyond 80% regardless of the command signal. What should be checked?

A. The PLC analog output module for a defect that limits the maximum output current below 20 mA full scale

B. The steam control valve actuator for a mechanical travel stop that physically prevents full stroke travel

C. The I/P transducer for a span calibration error that limits the maximum output air pressure below full range

D. The valve positioner for a calibration error or mechanical limit preventing full stroke at maximum signal input

50. A centrifugal pump produces a cyclical surging sound and the discharge pressure oscillates approximately 10% above and below the average. The pump operates at approximately 25% of its BEP flow rate. What is this condition called?

A. Low-flow surge or recirculation — operating far below BEP causes unstable flow patterns at the impeller eye

B. Cavitation from insufficient NPSH at the low flow rate operating condition near pump minimum flow limit

C. Bearing resonance excited by the pump's natural frequency at the reduced flow and speed condition

D. Water hammer from a downstream check valve chattering at the reduced flow velocity in the discharge piping

51. A building automation system controls the building's lighting based on occupancy sensors and daylight harvesting. Several zones report that lights remain on even when the occupancy sensors show "unoccupied" status. What should be investigated?

A. The occupancy sensor wiring for a short that keeps the sensor permanently in the "occupied" detection state

B. The BAS programming for a time delay or override that keeps lights on for a period after vacancy is detected

C. The BAS lighting control relay outputs for welded contacts that keep the lighting circuit energized continuously

D. The occupancy sensors for a sensitivity setting that detects movement from the HVAC system air supply diffusers

52. An electrician is measuring the current on a three-phase motor feeder. Phase A reads 42 amps, Phase B reads 44 amps, and Phase C reads 28 amps. The motor nameplate FLA is 40 amps. What is the percentage of current imbalance?

A. 4.7% calculated using the difference between the highest and lowest readings divided by their average value

B. 31.6% calculated using the maximum deviation from average divided by the average of all three phase readings

C. 10.5% calculated using the standard deviation of the three readings divided by the mean current draw value

D. 16.0% calculated by dividing the difference between highest and lowest by the motor nameplate FLA rating

53. A hydraulic press cylinder must extend 24 inches in 4 seconds. The cylinder bore is 5 inches. What pump flow rate (GPM) is required?

A. 3.1 GPM based on cylinder volume displaced per minute using the bore area and stroke rate calculation

B. 12.3 GPM based on the total system volume divided by the cycle time including return stroke calculation

C. 6.2 GPM based on doubling the single-stroke volume to account for the return stroke fluid displacement

D. 5.1 GPM based on the cylinder bore area times the stroke length divided by the time converted to gallons per minute

54. A maintenance technician discovers that a building's sump pump runs much more frequently than normal during dry weather. The sump pit fills rapidly even though there has been no rain for two weeks. What should be investigated?

A. An underground water or sewer pipe leak in or near the building that is filling the sump with water continuously

B. The sump pump's float switch for a stuck condition that cycles the pump more frequently than necessary

C. The building's HVAC condensate drain for a disconnected line that is dumping water into the sump pit area

D. A seasonal rise in the groundwater table that increases water infiltration into the building's foundation drainage

55. A PLC-controlled sorting machine uses a network of photoelectric sensors to track packages through the system. One sensor has been causing intermittent false signals during the afternoon. Morning operation is normal. The sensor was cleaned and tested — it works correctly in the shop. What is the cause?

A. The sensor's internal electronics are temperature-sensitive and drift when the facility warms up in afternoon

B. Afternoon shift workers are wearing different colored uniforms that trigger the sensor's detection algorithm

C. Afternoon sunlight through a skylight or window reaches the sensor at certain times and causes interference

D. The PLC's scan time increases during afternoon peak production causing intermittent missed sensor signals

56. A maintenance electrician needs to install a 480-volt circuit for a new rooftop HVAC unit. The cable run from the electrical room to the roof is 250 feet through conduit exposed to direct sunlight. What additional factor must be considered in the conductor sizing?

A. The conduit fill percentage for the number of conductors to verify the conduit size is adequate for all wires

B. Ambient temperature derating — conductors exposed to sunlight in conduit may experience temperatures above the standard 30°C rating

C. The conductor insulation must be changed from THHN to a UV-rated type for direct sunlight exposure service

D. Surge protection must be installed at both ends of the run to protect against lightning-induced voltage spikes

57. A hydraulic system has a motor-driven pump that produces a rhythmic pressure pulsation at twice the pump shaft speed. The pulsation was not present when the system was new. What component is the most likely cause?

A. The pump's suction strainer has partially clogged reducing the available flow on alternate pump strokes

B. A worn directional valve spool allowing intermittent bypass flow at the pump delivery frequency harmonic

C. The pump's discharge check valve has a weak spring that allows brief backflow on each pump discharge pulse

D. Worn pump components — gear teeth, vane tips, or piston rings — creating uneven displacement each revolution

58. A building's emergency egress lighting includes exit signs with internal batteries. During a power outage test, three exit signs in different locations fail to illuminate on battery power. Normal AC power illumination works on all three. What is the common fault?

A. The batteries in all three signs have reached end of life and need replacement with matching battery packs

B. The charging circuits inside all three signs have failed simultaneously from a power quality event or surge

C. The transfer relay inside each sign that switches from AC to battery power has failed on all three units

D. The building's emergency lighting inverter system has failed and is not providing battery power to the signs

59. A maintenance crew is performing a load test on an overhead crane. The test load is 12,500 pounds (125% of the 10-ton rated capacity). During the test, the hoist holds the load but the bridge structure shows visible deflection. What action should be taken?

A. The test is a failure — the bridge structure should be inspected by a structural engineer before returning to service

B. Visible deflection under load test conditions is normal as long as the deflection recovers when the load is removed

C. The crane structure has been overloaded beyond its capacity and must be immediately removed from service

D. Reduce the test load to 100% of rated capacity and retest to determine if the deflection is still visible

60. A PLC-controlled batch process uses a totalizing flow meter to measure the amount of fluid dispensed into a container. The PLC compares the totalized flow against a setpoint and closes the fill valve when the setpoint is reached. Recently, containers are being overfilled by approximately 2%. What should be investigated?

A. The flow meter for calibration drift that is reading lower than actual flow causing the PLC to overfill

B. The fill valve closure time — the valve takes a finite time to close during which additional fluid passes through

C. The PLC's comparison instruction for a rounding error that causes the setpoint to be evaluated incorrectly

D. The fill pump for increased output pressure that is delivering fluid faster than the flow meter can register

Practice Exam 14: Answer Key and Explanations

1. **D. Oil pump, oil heater, and oil pressure sensing system fault** — Centrifugal chillers require adequate oil pressure before the compressor is allowed to start. A failed oil pump, de-energized oil heater (oil too thick to circulate), or faulty pressure sensor triggers a low oil pressure lockout preventing startup.

2. **B. Install continuous insulation monitoring to detect and locate the fault when it occurs** — An intermittent weather-related ground fault requires real-time monitoring. A continuous insulation monitor detects the fault the moment it appears during rain and can identify the circuit segment where the insulation breakdown occurs.

3. **A. Approximately 3.3 gallons using Boyle's Law for gas volume change** — At 1,500 PSI precharge, gas volume = 10 gal. At 1,800 PSI min: V = 10 × (1,500/1,800) = 8.33 gal gas, so 1.67 gal fluid. At 3,000 PSI max: V = 10 × (1,500/3,000) = 5.0 gal gas, so 5.0 gal fluid. Usable = 5.0 − 1.67 = 3.33 gal.

4. **C. Amplifier audio output signal level and speaker circuit impedance matching configuration** — Speakers producing no sound despite normal wiring resistance suggests an impedance mismatch or zero audio signal from the amplifier. The amplifier may have a failed output stage or the speaker circuit impedance may exceed the amplifier's rated load.

5. **B. Pneumatic supply system for reduced pressure or flow slowing all cylinder movements** — All 12 cylinders complete their strokes but take longer. A system-wide slowdown affecting all actuators equally points to the common resource — the pneumatic air supply. Reduced compressor output, leaks, or regulator problems affect all cylinders.

6. **D. Electrical problem — unequal air gap, eccentric stator, or shorted laminations** — A pronounced 120 Hz hum (2× line frequency) that disappears when de-energized is definitively electrical. Mechanical vibration would continue during coastdown. Stator eccentricity, unequal air gap, or shorted laminations produce electromagnetic forces at 2× line frequency.

7. **A. Seal faces worn beyond service life from normal operation in this application** — A mechanical seal that develops a slow leak after 6 months of hot water service has reached the end of its service

life for these operating conditions. The seal face material, fluid temperature, and operating hours determine actual seal life.

8. **C. Boiler A creates positive pressure in common breeching pushing gases back through Boiler B** — When two boilers share a common flue and one fires at high capacity, the exhaust volume can create positive pressure in the breeching. This pressure pushes combustion gases backward through the idle boiler's flue passages and out the burner opening.

9. **B. OFF because OTU on Rung 15 evaluates last and its true condition clears the bit** — The PLC scans top to bottom. Rung 5 OTL is false (does not set the bit). Rung 15 OTU is true (clears the bit). The last instruction to write to the bit determines its state. OTU clears O:2/0 to OFF.

10. **A. Position portable gantry crane beneath motor and rig chain hoist from gantry beam** — The gantry crane provides a stable overhead lifting point beneath the motor. The chain hoist suspended from the gantry controls the lift. This eliminates the need for workers to handle a 350-pound motor on a ladder.

11. **D. Governor not responding fast enough to sudden load causing engine speed to drop fatally** — No-load tests do not stress the governor's ability to respond to sudden load. When the ATS connects the building load instantly, the governor must rapidly increase fuel to maintain speed. A sluggish governor allows the engine to stall.

12. **C. Pressure drop across supply lines, fittings, valves, and filter between gauge locations** — An 800 PSI difference between two gauges on the same circuit indicates friction loss in the components between them. The supply hoses, fittings, directional valve, and filter all contribute to the cumulative pressure drop.

13. **B. LED drivers produce high inrush current exceeding the breaker's instantaneous trip** — LED drivers with input capacitors draw a momentary high inrush current when first energized. When multiple drivers start simultaneously on the same circuit, the combined inrush can exceed the breaker's magnetic instantaneous trip threshold.

14. **A. VAV dampers closing as zones are satisfied reducing airflow demand from the system** — When zone temperatures are satisfied, VAV dampers close to reduce airflow. With the fan still running at 80% speed but less air being consumed, duct static pressure rises above the setpoint. This is normal VAV system behavior.

15. **D. Warmer and more humid afternoon air is denser increasing the fan's aerodynamic load** — Warm, humid air is denser than cool, dry morning air (at the same absolute conditions, humidity adds water vapor mass). The denser air increases the aerodynamic load on the fan, increasing motor current above the overload trip point.

16. **B. Disconnects start winding at approximately 75% of synchronous speed** — The centrifugal switch opens at about 75% speed, disconnecting the start winding (and start capacitor if present) that is only needed for initial rotation. The motor then runs on the run winding alone for normal operation.

17. **D. Gouge out the crack completely to sound metal on all sides before re-welding** — Welding over an existing crack without complete removal traps the defect beneath new weld metal. The crack must

be completely removed by air-arc gouging or grinding to sound base metal on all sides before repair welding begins.

18. **C. Analog signal wiring for EMI from nearby VFDs or motor starters affecting the signal** — Load cell signals are low-level analog signals highly susceptible to electromagnetic interference. VFDs and motor starters in proximity generate EMI that induces noise on unshielded or improperly routed signal wiring causing erratic readings.

19. **A. Fire-side heating surfaces for soot, scale, or ash accumulation reducing heat transfer** — Longer firing times and increased fuel consumption with no change in demand indicates reduced heat transfer efficiency. Soot or scale on the fire-side surfaces insulates them, requiring more firing time to transfer the same amount of heat to the water.

20. **D. Swap any two of the three line leads at the motor terminal box** — Reversing any two of the three line connections (T1, T2, T3) reverses the phase sequence and reverses motor rotation. This works regardless of the motor's internal winding configuration (wye, delta, or part-winding connection).

21. **B. Cylinder B's supply line for restriction reducing flow despite equal flow divider output** — The flow divider splits flow equally, confirmed by testing. Equal flow entering each supply line but different cylinder speeds means a restriction exists in Cylinder B's supply path — partially closed valve, kinked hose, or undersized fitting.

22. **C. Wheel speed and condition — slipping belt, failed motor, or dirty media reduces transfer** — A heat recovery wheel's effectiveness depends on rotation speed and media cleanliness. A slipping drive belt or failed motor reduces rotation speed, and dirty media reduces the heat exchange surface area, both lowering recovery performance.

23. **A. Megger test, rotation check, alignment verification, coupling installation, and guard placement** — A comprehensive pre-startup checklist includes insulation resistance verification, rotation direction confirmation (bump test), shaft alignment verification, coupling installation check, and safety guard installation before full energization.

24. **D. Receiver tank too small or large leak depleting stored air rapidly** — Rapid pressure cycling (every 30 seconds) between cut-in and cut-out means the stored air volume is consumed very quickly. Either the receiver tank is undersized for the system demand or a large leak is depleting the stored volume between compressor cycles.

25. **B. Pump has lost prime — air in casing prevents suction pressure development** — A centrifugal pump running with low current and zero discharge is the classic signature of a lost-prime condition. The pump spins freely in air, drawing minimal current, but cannot create the suction needed to draw water into the casing.

26. **C. Motor output controlled by a parallel path that bypasses the timer instruction** — If the motor starts immediately despite the timer, the output is being energized by a rung path that does not include the timer. A parallel branch in the logic provides an alternate path to the output that bypasses the time delay.

27. **A. Gap between impeller OD and volute tongue has decreased from wear or shifting** — Emerging vane pass frequency vibration indicates the impeller-to-volute clearance has changed. A smaller gap intensifies the pressure pulse each time an impeller vane passes the volute tongue (cutwater), producing the characteristic frequency.

28. **D. Mixing valve thermostatic element degraded and cannot modulate smoothly** — A steady hot supply (140°F) and steady cold supply (55°F) with fluctuating outlet temperature indicates the mixing valve itself is the problem. A degraded thermostatic element cannot maintain a stable blend ratio and hunts between extremes.

29. **B. MCC stab connections loosened from thermal cycling over years of continuous operation** — Continuous 24-hour motor operation subjects the stab connections to constant thermal cycling — heating under load and cooling during brief stops. Over years, this cycling loosens the connection, creating high resistance and overheating.

30. **A. 9,500 pounds remaining capacity for slings and rigging hardware** — Total crane capacity = 15 tons = 30,000 lbs. Load = 20,000 lbs. Spreader beam = 500 lbs. Remaining for slings and hardware = 30,000 − 20,000 − 500 = 9,500 lbs. All rigging hardware counts against the crane's rated capacity.

31. **C. Major internal component failure generating massive wear debris** — A filter that clogs in 24 hours with high metallic particle counts indicates a catastrophic wear event — a failing pump, motor, or valve is shedding metal at an extreme rate. The system should be shut down and the debris source identified immediately.

32. **A. Multiple large motors starting simultaneously draw high reactive inrush current** — Monday morning startup of multiple motors, compressors, and HVAC equipment after a weekend shutdown creates a spike in reactive power (motor magnetizing current during startup). This temporarily depresses the facility's power factor.

33. **C. Open bypass valve fully, then close both PRV isolation valves** — Opening the bypass first maintains downstream steam supply. Then closing both PRV isolation valves removes the PRV from the circuit while steam continues flowing through the bypass. The operator manually regulates bypass flow during PRV service.

34. **A. Load cell amplifier thermal drift shifting the zero reference as electronics warm up** — Electronic amplifiers can drift as their temperature changes. A consistent upward reading shift after warmup suggests the amplifier's zero reference or gain is temperature-sensitive, reading progressively higher as the electronics stabilize at operating temperature.

35. **C. Stationary eccentricity — off-center stator or rotor producing unidirectional pull** — Vibration at exactly 1× line frequency (60 Hz, not 120 Hz) indicates a static eccentricity creating a constant unidirectional magnetic pull that varies with the AC cycle. This is distinct from 2× line frequency which indicates dynamic eccentricity.

36. **A. Impeller wear reducing both output head and power consumption** — A worn impeller has reduced vane dimensions and increased clearances. It produces less head (lower discharge pressure)

and requires less power (lower motor current). Both decreasing together is the signature of impeller erosion.

37. **D. Expansion fitting or flexible conduit section to accommodate building structural movement** — Building expansion joints accommodate thermal and structural movement. Rigid conduit spanning an expansion joint without a flexible section will be stressed and eventually crack or pull apart as the building moves.

38. **B. Servo controller gain settings — proportional and/or derivative gains too high** — Hunting (oscillation around target) is the classic symptom of excessive loop gain in a servo control system. The controller overreacts to the position error, overshoots, corrects, overshoots again. Reducing the proportional and derivative gains stabilizes the response.

39. **C. Install ground fault monitoring device to log fault occurrences and identify the circuit segment** — An intermittent fault that clears before manual troubleshooting can locate it requires automated monitoring. A ground fault logger records the fault timing and location data when the fault occurs, enabling targeted investigation.

40. **D. Return water temperature too high for condensing mode operation** — Condensing boilers require return water temperature below approximately 130°F to cool flue gases below the dew point. High return water temperature prevents condensation, reducing the boiler to non-condensing efficiency. Check the system delta-T and return temperature.

41. **A. PLC generates a math overflow fault from division by zero** — Division by zero is mathematically undefined. Most PLCs flag this as a major fault that can halt the processor. Programs should include a comparison instruction that checks for a zero divisor before executing the divide instruction.

42. **C. Motor and fan sheaves for groove wear, misalignment, or incorrect size** — Premature belt failure repeated three times points to the sheaves rather than the belts. Worn sheave grooves (too wide or irregular profile), misaligned sheaves, or incorrect sheave sizes all destroy belts rapidly regardless of belt quality.

43. **B. Carbonic acid from CO_2 dissolving in condensate attacking pipe walls** — CO_2 from the combustion process dissolves in condensate forming carbonic acid. This acid attacks carbon steel condensate piping from the inside even when boiler water treatment is correct — the treatment protects the boiler, not the condensate return lines.

44. **D. Sensor counting products for miscounting due to bounce, alignment, or sensitivity** — An occasional count of 998 or 999 instead of 1,000 indicates the sensor is missing 1-2 counts per batch. Sensor bounce, misalignment with the product stream, or marginal sensitivity causes intermittent missed detections.

45. **A. Normal winding resistance — more turns of thinner wire on high side** — The high-voltage winding has many turns of smaller gauge wire (higher resistance). The low-voltage winding has fewer turns of heavier gauge wire (lower resistance). The resistance ratio roughly corresponds to the square of the turns ratio.

46. **A. Fault is in the electrical control path — PLC output, wiring, or solenoid coil** — Manual override mechanically shifts the valve spool bypassing the solenoid. Normal operation works manually but not electrically. The hydraulic system is functional — the problem is isolated to the electrical signal path from PLC to solenoid.

47. **C. Heat exchanger plates fouled reducing heat transfer efficiency between loops** — Increased approach temperature (the difference between the two outlet streams) directly indicates reduced heat transfer effectiveness. Fouled plate surfaces insulate against heat transfer, requiring a greater temperature difference to transfer the same energy.

48. **B. Fire pump suction supply — partially closed valve, clogged strainer, or low water level** — Excessive vibration and cavitation noise from a fire pump indicate insufficient suction supply. A partially closed suction valve, fouled suction strainer, or low water level in the supply source reduces NPSHa below the pump's requirement.

49. **D. Valve positioner calibration error or mechanical limit preventing full stroke at maximum signal** — The valve operates correctly from 0-80% but stops at 80%. The PLC output and I/P transducer would need to produce 100% signal for the positioner to read. A positioner span calibration error or mechanical travel limit at the positioner prevents full valve travel.

50. **A. Low-flow surge or recirculation from operating far below BEP** — Operating at 25% of BEP is well into the unstable region of the pump curve. Flow patterns at the impeller eye become chaotic, causing pressure surges, noise, and cyclical flow variation. This condition accelerates impeller and bearing wear.

51. **C. BAS lighting relay outputs for welded contacts keeping lighting energized continuously** — Occupancy sensors show "unoccupied" (sensors working) but lights stay on. If the BAS programming is correct, the relay contacts that switch the lighting circuit may be welded closed from arcing, keeping lights on regardless of the command.

52. **B. 31.6% current imbalance from maximum deviation divided by average** — Average current = (42+44+28)/3 = 38 amps. Maximum deviation = 38 − 28 = 10 amps. Imbalance = (10/38) × 100 = 26.3%. Using the NEMA method: max deviation from average / average × 100. This severe imbalance requires immediate investigation.

53. **D. 5.1 GPM from cylinder volume per stroke time converted to GPM** — Bore area = $\pi \times 2.5^2$ = 19.63 sq in. Volume per stroke = 19.63 × 24 = 471.2 cubic inches. Strokes per minute = 60/4 = 15. Volume per minute = 471.2 × 15... Actually for a single stroke in 4 seconds: 471.2 cu in / 4 sec × 60 sec/min = 7,068 cu in/min ÷ 231 cu in/gal = 5.1 GPM.

54. **C. Disconnected HVAC condensate drain dumping water into the sump pit area** — Increased sump pump activity during dry weather with no rain eliminates groundwater and surface water as sources. An internal water source — a disconnected condensate drain from air conditioning equipment — can produce significant water volume.

55. **C. Afternoon sunlight through a skylight or window causing optical interference** — A sensor that works perfectly in the shop but fails in the afternoon at its installed location points to an environmental

factor at the installation site. Sunlight entering through skylights or windows at specific afternoon angles overwhelms photoelectric sensors.

56. **B. Ambient temperature derating for conduit exposed to direct sunlight above standard rating** — Conduit exposed to direct sunlight can reach temperatures well above the standard 30°C (86°F) ambient assumption. NEC requires conductor ampacity derating based on the actual ambient temperature to prevent insulation damage from overheating.

57. **D. Worn pump components creating uneven displacement each revolution** — A pressure pulsation at 2× pump speed that was not present when the system was new indicates internal wear. Worn gear teeth, vane tips, or piston rings produce uneven displacement, and the 2× frequency corresponds to the number of pumping elements per revolution.

58. **A. Batteries in all three signs have reached end of life requiring replacement** — Exit signs with functioning AC power illumination but failed battery operation have dead batteries. Batteries are the component with the shortest service life in exit signs (typically 3-5 years). Simultaneous failures across multiple signs of the same age is expected.

59. **A. Test failure — bridge structure must be inspected by structural engineer before returning to service** — Visible deflection during a load test is a serious finding that requires structural engineering evaluation. The deflection may indicate fatigue, overload damage, or section loss from corrosion. The crane must not return to service until cleared.

60. **B. Fill valve closure time — additional fluid passes during the time the valve takes to close** — All valves require a finite time to close. During this closing time, fluid continues flowing through the partially open valve. The overfill is consistent (2%) because the valve closure time is constant. Compensating the PLC setpoint by 2% corrects the overfill.