UNITED STATES NUCLEAR REGULATORY COMMISSION
PRESSURIZED WATER REACTOR GENERIC FUNDAMENTALS EXAMINATION
FEBRUARY 2001--FORM A

Please Print

Name: _____

Facility: _____

Docket No.: _____

Start Time: _____ Stop Time: _____

INSTRUCTIONS TO APPLICANT

Answer all the test items using the answer sheet provided. Each item has equal point value. A score of at least 80% is required to pass this portion of the written licensing examination. All examination papers will be collected 3.0 hours after the examination starts. This examination applies to a typical pressurized water reactor (PWR) power plant.

SECTION	QUESTIONS	% OF TOTAL	SCORE
COMPONENTS	1 - 44		
REACTOR THEORY	45 - 72		
THERMODYNAMICS	73 - 100		
TOTALS	100		

All work done on this examination is my own. I have neither given nor received aid.

))))))))))))))))))))))))))))))))))))

Applicant's Signature

RULES AND GUIDELINES FOR THE GENERIC FUNDAMENTALS EXAMINATION

During the administration of this examination the following rules apply:

NOTE: The generic term "control rod" refers to the length of neutron absorber material that can be positioned by the operator to change core reactivity.

1. Print your name in the blank provided on the cover sheet of the examination.

2. Fill in the name of your facility.

3. Fill in your individual docket number.

4. Fill in your start and stop times at the appropriate time.

5. Two aids are provided for your use during the examination:

   (1) An equations and conversions sheet contained within the examination copy, and

   (2) Steam tables provided by your proctor.

6. Place your answers on the answer sheet provided. Credit will only be given for answers properly marked on this sheet. Follow the instructions for filling out the answer sheet.

7. Scrap paper will be provided for calculations.

8. Cheating on the examination will result in the automatic forfeiture of this examination. Cheating could also result in severe penalties.

9. Restroom trips are limited. Only **ONE** examinee may leave the room at a time. In order to avoid the appearance or possibility of cheating, avoid all contact with anyone outside of the examination room.

10. After you have completed the examination, sign the statement on the cover sheet indicating that the work is your own and you have neither given nor received any assistance in completing the examination.

11. Turn in your examination materials, answer sheet on top, followed by the examination booklet, then examination aids - steam table booklets, handouts, and scrap paper used during the examination.

12. After turning in your examination materials, leave the examination area, as defined by the proctor. If after leaving you are found in the examination area while the examination is in progress, your examination may be forfeited.

GENERIC FUNDAMENTALS EXAMINATION
EQUATIONS AND CONVERSIONS HANDOUT SHEET

EQUATIONS

$\dot{Q} = \dot{m}c_p\Delta T$

$\dot{Q} = \dot{m}\Delta h$

$\dot{Q} = UA\Delta T$

$\dot{Q} \propto \dot{m}^3_{Nat\ Circ}$

$\Delta T \propto \dot{m}^2_{Nat\ Circ}$

$K_{eff} = 1/(1 - \rho)$

$\rho = (K_{eff} - 1)/K_{eff}$

$SUR = 26.06/\tau$

$\tau = \dfrac{\overline{\beta} - \rho}{\lambda_{eff}\ \rho}$

$\rho = \dfrac{\ell^*}{\tau} + \dfrac{\overline{\beta}}{1 + \lambda_{eff}\tau}$

$\ell^* = 1 \times 10^{-4}$ seconds

$\lambda_{eff} = 0.1\ seconds^{-1}$

$DRW \propto \varphi^2_{tip}/\varphi^2_{avg}$

$P = P_o 10^{SUR(t)}$

$P = P_o e^{(t/\tau)}$

$A = A_o e^{-\lambda t}$

$CR_{S/D} = S/(1 - K_{eff})$

$CR_1(1 - K_{eff1}) = CR_2(1 - K_{eff2})$

$1/M = CR_1/CR_X$

$A = \pi r^2$

$F = PA$

$\dot{m} = \rho A\vec{v}$

$\dot{W}_{Pump} = \dot{m}\Delta P\upsilon$

$E = IR$

Eff. = Net Work Out/Energy In

$\upsilon(P_2 - P_1) + \dfrac{(\vec{v}_2^{\,2} - \vec{v}_1^{\,2})}{2g_c} + \dfrac{g(z_2 - z_1)}{g_c} = 0$

$g_c = 32.2$ lbm-ft/lbf-sec^2

CONVERSIONS

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1 Mw = 3.41×10^6 Btu/hr

1 hp = 2.54×10^3 Btu/hr

1 Btu = 778 ft-lbf

°C = (5/9)(°F - 32)

°F = (9/5)(°C) + 32

1 Curie = 3.7×10^{10} dps

1 kg = 2.21 lbm

1 gal_{water} = 8.35 lbm

1 ft^3_{water} = 7.48 gal

QUESTION: 1

Which one of the following statements describes the throttling characteristics of a typical globe valve?

A. The first third of valve disk travel in the open direction will result in approximately one-third of full flow rate.

B. The first third of valve disk travel in the open direction will produce a smaller increase in flow rate than the last third of valve disk travel.

C. The first third of valve disk travel in the open direction will produce a greater increase in flow rate than the last third of valve disk travel.

D. The first two-thirds of valve disk travel in the open direction will produce approximately the same increase in flow rate as the last third of valve disk travel.

QUESTION: 2

When manually closing a motor-operated valve, why must the operator avoid using excessive valve seating force?

A. The valve actuator clutch may be damaged and disable subsequent automatic operation.

B. The valve may bind and cause the valve motor to trip on overload during subsequent remote operation.

C. The valve stem limit switches may be damaged and cause inaccurate remote valve position indication.

D. The valve actuator position indicator may be damaged and cause inaccurate local valve position indication.

QUESTION: 3

Check valves are used to prevent:

A. pump runout by providing a constant backpressure.

B. pump cavitation by keeping nonoperating systems filled.

C. backflow through nonoperating components or flowpaths.

D. overpressurization of nonoperating system piping and components.

QUESTION: 4

In a comparison of butterfly valves with ball valves, _____ valves are generally more leak tight in high pressure applications, and _____ valves generally exhibit the lowest system pressure drop when fully open.

A. ball; ball

B. ball; butterfly

C. butterfly; ball

D. butterfly; butterfly

QUESTION: 5

A plant is operating at 100% power. A main steam flow measuring instrument uses density compensation and square root extraction to convert the D/P sensed by the steam flow detector to main steam mass flow rate.

If the steam pressure sensed by the density compensation circuit decreases, indicated flow rate will _____ and if square root extraction is bypassed, indicated flow rate will _____.

A. decrease; decrease

B. decrease; increase

C. increase; decrease

D. increase; increase

QUESTION: 6

A differential pressure detector is being used with an orifice plate to measure water flow rate through a pipe. When the flow detector was last calibrated, the following parameters were observed:

Upstream Pressure:	125 psig	Actual Flow Rate:	100 gpm
Downstream Pressure:	116 psig	Indicated Flow Rate:	100 gpm

Significant erosion of the orifice hole has occurred since the calibration such that actual flow rate through the orifice has increased to 120 gpm while the upstream and downstream pressures have changed to 110 psig and 106 psig respectively.

What is the approximate flow rate that is currently indicated?

A. 44 gpm

B. 67 gpm

C. 81 gpm

D. 120 gpm

QUESTION: 7

Refer to the drawing of two tank differential pressure (D/P) level indicators (see figure below).

Two D/P level indicators are installed on a large water storage tank. Indicator No. 1 was calibrated at 200°F water temperature and indicator No. 2 was calibrated at 100°F water temperature.

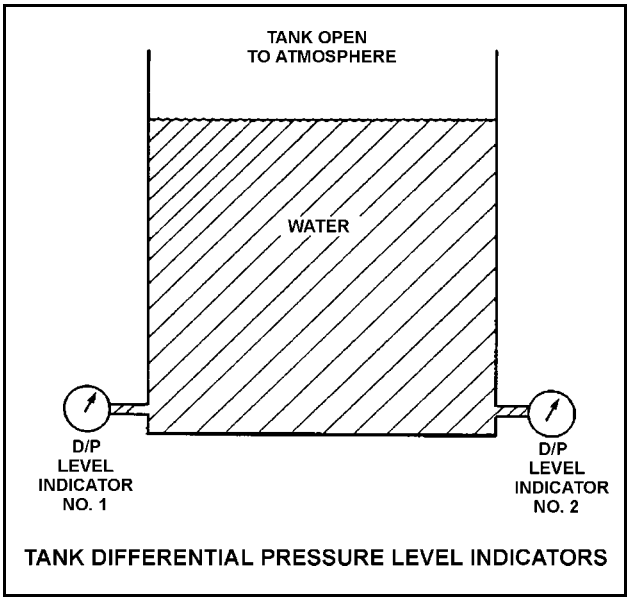
Assuming both indicators are on scale at a given temperature, which indicator will indicate the lower level?

A. Indicator 1 at all water temperatures

B. Indicator 2 at all water temperatures

C. Indicator 1 below 150°F, indicator 2 above 150°F

D. Indicator 2 below 150°F, indicator 1 above 150°F



TANK DIFFERENTIAL PRESSURE LEVEL INDICATORS

QUESTION: 8

Refer to the drawing of a tank with differential pressure (D/P) level detector (see figure below). Assume the initial temperature of the reference leg and the water in the tank is 100°F, and that reference leg temperature does not change.

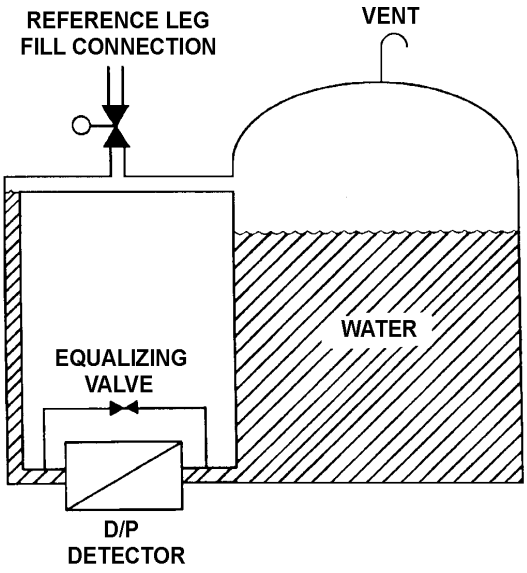
If the temperature of the water in the tank increases by 20°F, the D/P sensed by the detector will _____ as long as the water _____ is maintained constant.

A. increase; level

B. decrease; level

C. increase; mass

D. decrease; mass



TANK DIFFERENTIAL PRESSURE LEVEL DETECTOR

QUESTION: 9

A bourdon tube works on the principle that when the pressure sensed by the tube decreases, the tube tends to: (Assume detected pressure remains above atmospheric pressure.)

A. coil due to the greater pressure-induced force on the outside of the tube.

B. straighten due to the greater pressure-induced force on the outside of the tube.

C. coil due to the spring action of the metal overcoming the pressure-induced force on the inside of the tube.

D. straighten due to the spring action of the metal overcoming the pressure-induced force on the inside of the tube.

QUESTION: 10

Refer to the drawing of a bellows-type differential pressure (D/P) detector (see figure below).

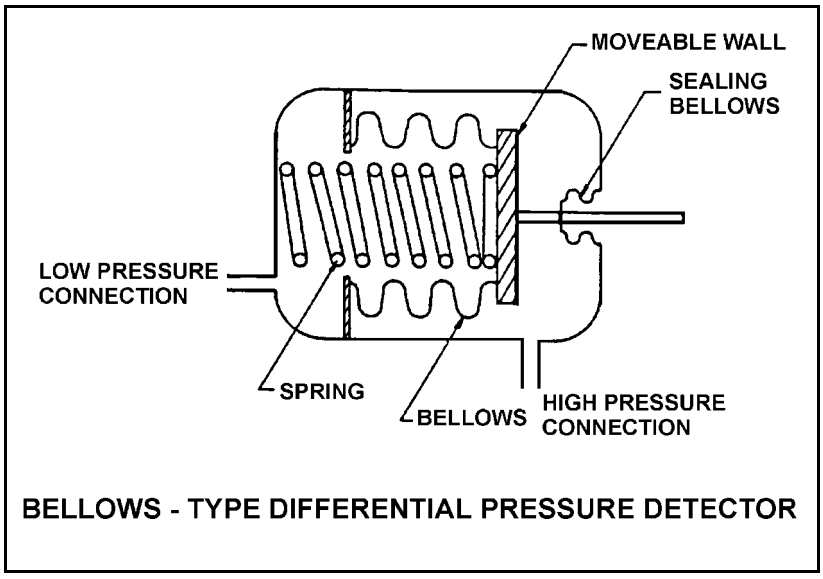
The spring in this detector (shown in a compressed state) has weakened from long-term use. If the actual D/P is constant, how will indicated D/P respond as the spring weakens?

A. Increase, because the spring will expand more.

B. Decrease, because the spring will expand more.

C. Increase, because the spring will compress more.

D. Decrease, because the spring will compress more.



BELLOWS - TYPE DIFFERENTIAL PRESSURE DETECTOR

QUESTION: 11

Refer to the drawing of a simple thermocouple circuit (see figure below).

Thermocouple temperature indication is 410°F with the reference (cold) junction at 125°F. If an ambient temperature decrease lowers reference junction temperature to 110°F, the new thermocouple temperature indication will be:

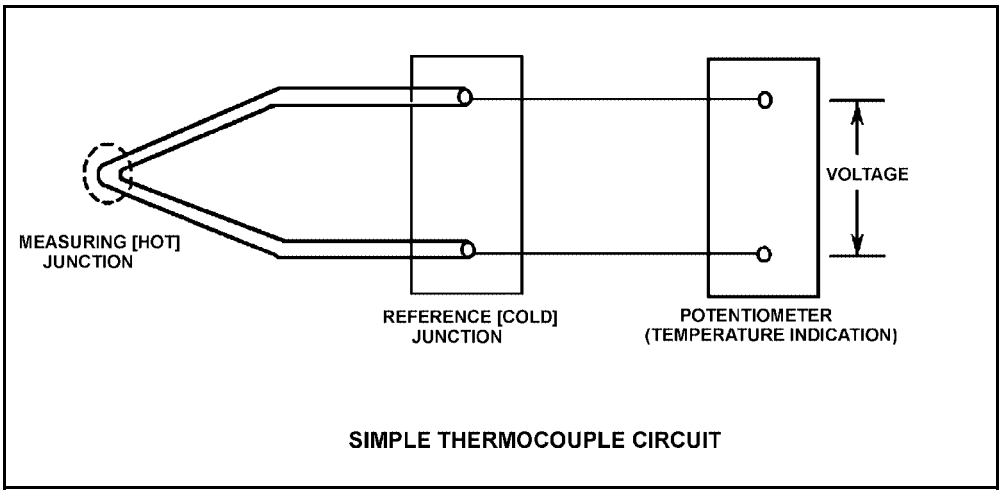
(Assume measuring junction temperature remains constant.)

A. 380°F.

B. 395°F.

C. 410°F.

D. 425°F.



SIMPLE THERMOCOUPLE CIRCUIT

QUESTION: 12

A plant startup is in progress immediately following a reactor refueling. The external nuclear instrumentation (NI) was calibrated just prior to the refueling shutdown and has not been readjusted.

If power level is stabilized at 90%, NI power level will be _____ than actual power level because, compared to pre-shutdown 90% power level operation, _____.

A. lower; total core neutron production rate has decreased

B. higher; total core neutron production rate has increased

C. lower; power production in the outer portion of the core has decreased

D. higher; power production in the outer portion of the core has increased

QUESTION: 13

Most of the electrons collected in a fission chamber are released as a result of ionizations caused directly by:

A. fission betas.

B. fission gammas.

C. fission neutrons.

D. fission fragments.

QUESTION: 14

Which one of the following describes the ion collection that occurs in a proportional counter, such as a BF_3 detector?

A. A fraction of the ions created by primary ionizations are collected. No secondary ionizations take place.

B. Virtually all of the ions created by primary ionizations are collected. No secondary ionizations take place.

C. Virtually all of the ions created by primary ionizations along with a fraction of the ions created by secondary ionizations are collected.

D. Virtually all of the ions created by primary and secondary ionizations are collected.

QUESTION: 15

Refer to the drawing of a pressure bistable in an alarm circuit (see figure below).

Assume the orientation of the bistable symbol indicates the characteristics of the bistable. The bistable turns on to actuate an alarm at a system pressure of 100 psig. The bistable has a 5 psig dead band, or neutral zone.

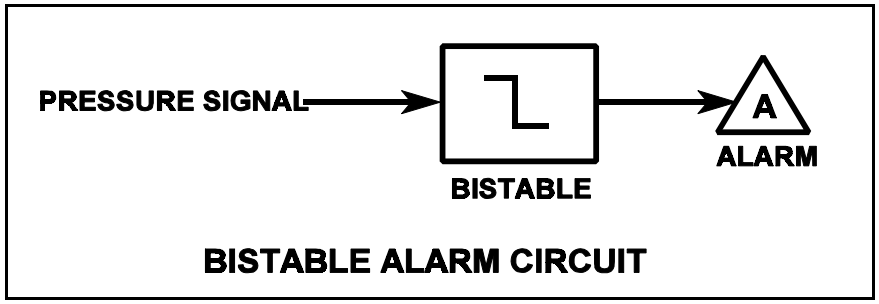
If current system pressure is 90 psig, which one of the following describes the alarm response as system pressure is slowly increased to 110 psig?

A. The alarm is currently actuated and will turn off at 95 psig.

B. The alarm is currently actuated and will turn off at 105 psig.

C. The alarm will actuate at 100 psig and will NOT turn off.

D. The alarm will actuate at 100 psig and will turn off at 105 psig.



QUESTION: 16

Refer to the drawing of a pneumatic control system (see figure below).

An increasing steam generator (S/G) level will decrease the S/G level control signal and reduce the control air pressure applied to the actuator of the feed control valve.

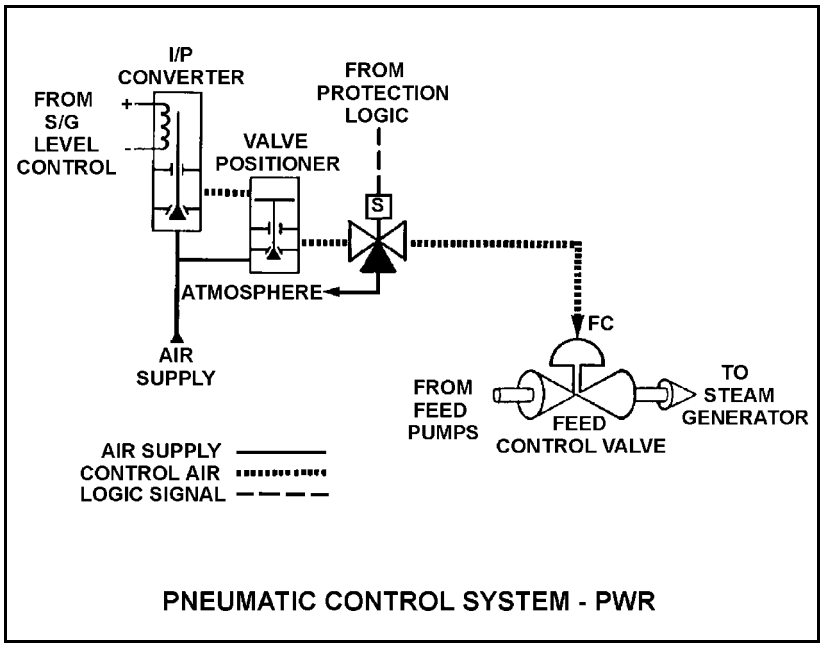
If the level control signal fails high, S/G level will _____ because the control air pressure to the valve positioner will _____.

A. increase; increase

B. increase; decrease

C. decrease; increase

D. decrease; decrease



PNEUMATIC CONTROL SYSTEM - PWR

QUESTION: 17

A diesel generator (DG) is supplying an isolated electrical bus with the governor operating in the speed droop mode. Assuming the DG does not trip, if a large electrical bus load trips, generator frequency will:

A. remain constant during and after the load trip.

B. initially increase, then decrease and stabilize below the initial value.

C. initially increase, then decrease and stabilize at the initial value.

D. initially increase, then decrease and stabilize above the initial value.

QUESTION: 18

What may be damaged if an operator attempts to manually disengage the motor on a motor-operated valve while the motor is operating?

A. Motor

B. Clutch

C. Limit switches

D. Torque switches

QUESTION: 19

Which one of the following describes the response of a direct-acting derivative controller, operating in automatic, to an increase in the controlled parameter above the controller setpoint?

A. The controller will develop an output signal that will remain directly proportional to the rate of change of the controlled parameter.

B. The controller will develop an output signal that will remain directly proportional to the difference between the controlled parameter and the controller setpoint.

C. The controller will develop an output signal that continues to increase until the controlled parameter equals the controller setpoint, at which time the output signal becomes zero.

D. The controller will develop an output signal that continues to increase until the controlled parameter equals the controller setpoint, at which time the output signal becomes constant.

QUESTION: 20

A centrifugal pump is needed to take suction on a hot water storage tank and deliver high pressure hot water to a water spray system. To minimize axial thrust on the pump shaft, the pump should have _____ stage(s); and to maximize the available NPSH at the impeller inlet, the pump should be _____ suction.

A. a single; single

B. a single; double

C. multiple opposed; single

D. multiple opposed; double

QUESTION: 21

Refer to the drawing of a cooling water system and the associated centrifugal pump operating curve (see figure below).

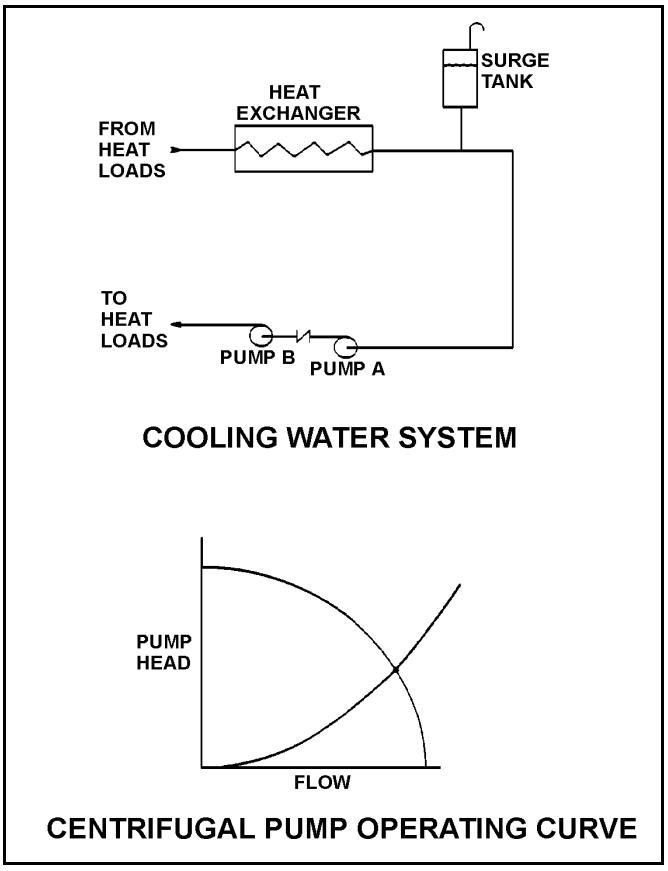
Pumps A and B are identical single-speed centrifugal pumps and only pump A is operating. If pump B is started, after the system stabilizes system flow rate will be:

A. twice the original flow.

B. the same as the original flow.

C. less than twice the original flow.

D. more than twice the original flow.



QUESTION: 22

A centrifugal pump is operating at maximum design flow rate, delivering water through two parallel valves. Valve "A" is half open, and valve "B" is one quarter open.

Which one of the following will occur if both valves are fully opened?

A. The pump will operate at shutoff head.

B. The pump will operate at runout conditions.

C. The pump required net positive suction head will decrease.

D. The pump available net positive suction head will increase.

QUESTION: 23

Minimum required net positive suction head for an ideal positive displacement pump will increase if the pump:

A. motor speed increases.

B. discharge pressure decreases.

C. suction temperature increases.

D. discharge valve is positioned from 90% open to fully open.

QUESTION: 24

A pump is needed to supply fuel oil from a day tank to a diesel fuel injection system. The pump must maintain a nearly constant flow rate with a minimum of discharge pressure fluctuations as system pressure varies between 200 psig and 1900 psig.

Which one of the following types of pumps would typically be used in this application?

A. Axial flow centrifugal

B. Radial flow centrifugal

C. Rotary positive displacement

D. Reciprocating positive displacement

QUESTION: 25

A plant is operating at full power when a 200 gpm reactor coolant leak occurs, which results in a reactor scram and initiation of emergency coolant injection. Reactor coolant system pressure stabilizes at 1000 psia and all injection pumps are operating with their pump recirculation lines isolated. The shutoff heads for the pumps are as follows:

High pressure injection (HPI) pumps:	2500 psia
Low pressure injection (LPI) pumps:	200 psia

Which pumps must be stopped quickly and why?

A. HPI pumps to prevent pump overheating caused by low flow

B. LPI pumps to prevent pump overheating caused by low flow

C. HPI pumps to prevent motor overheating caused by high flow

D. LPI pumps to prevent motor overheating caused by high flow

QUESTION: 26

What is the purpose of the safety/relief valve located between the pump outlet and discharge isolation valve of most positive displacement pumps?

A. Protect the pump and suction piping from overpressure if the discharge valve is open during system startup.

B. Protect the pump and suction piping from overpressure if the suction valve is closed during pump operation.

C. Protect the pump and discharge piping from overpressure if the discharge valve is closed during pump operation.

D. Protect the pump and discharge piping from overpressure due to thermal expansion of pump contents when the pump is shutdown with its suction valve closed.

QUESTION: 27

If the generator bearings on a motor-generator begin to overheat from excessive friction, which one of the following will occur next?

A. Generator current will begin to increase.

B. Generator windings will begin to overheat.

C. Motor current will begin to decrease.

D. Motor windings will begin to overheat.

QUESTION: 28

A diesel generator (D/G) is supplying both kW and kVAR to an electrical bus in parallel with the grid. Assuming D/G and bus voltage do not change, if the D/G voltage regulator set point is increased slightly, then D/G kW will _____ and D/G amps will _____.

A. increase; increase

B. increase; remain the same

C. remain the same; increase

D. remain the same; remain the same

QUESTION: 29

The starting current in an ac motor is significantly higher than the full-load running current because:

A. motor torque production is highest during motor start.

B. work performed by the motor is highest during motor start.

C. little counter electromotive force is induced onto the rotor during motor start.

D. little counter electromotive force is induced onto the stator during motor start.

QUESTION: 30

Two identical 4160 Vac induction motors are connected to identical centrifugal pumps being used to provide cooling water flow in separate systems in a power plant. Each motor is rated at 1000 hp. The discharge valve for pump A is fully open and the discharge valve for pump B is fully shut.

If each motor is then started, the longest time period required to stabilize motor current will be experienced by motor _____ and the higher stable motor current will be experienced by motor _____.

A. A; A

B. A; B

C. B; A

D. B; B

QUESTION: 31

Which one of the following is the basis for restricting the number of starts that a large ac motor may be subjected to within a one-hour period?

A. Prevent excessive wear of motor thrust bearings

B. Prevent excessive torsional stresses on the motor shaft

C. Prevent excessive heat buildup within the motor windings

D. Prevent excessive arcing and degradation of motor breaker contacts

QUESTION: 32

Refer to the drawing of a water cleanup system (see figure below).

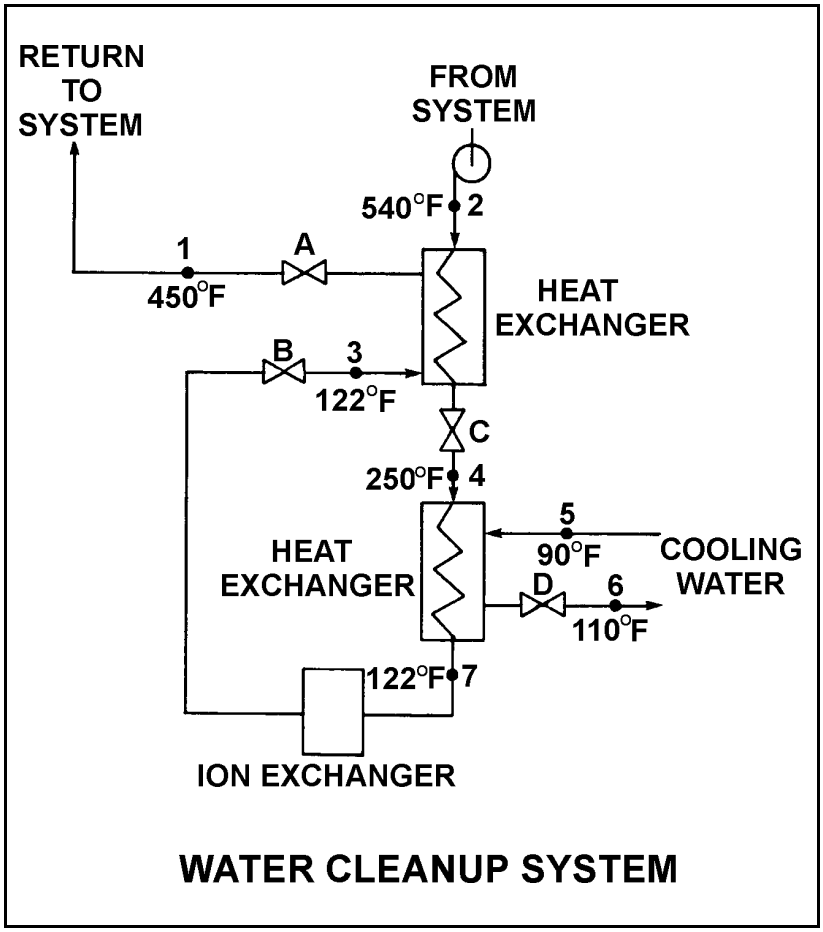
All valves are identical and are initially 50% open. To raise the temperature at point 1, the operator can adjust valve _____ in the _____ direction.

A. A; shut

B. B; open

C. C; shut

D. D; open



QUESTION: 33

A counter-flow lube oil cooler is located inside a machinery room that is maintained at 80°F. The cooler has been isolated for several days. When the cooler is returned to service, it will be supplied with seawater at 45°F to cool lube oil from 125°F to 105°F.

To minimize the thermal shock experienced by the cooler when it is returned to service, the lube oil flow rate should be _____ increased to design flow rate, while the cooling water flow rate is _____ increased to design flow rate.

A. quickly; subsequently

B. quickly; simultaneously

C. gradually; subsequently

D. gradually; simultaneously

QUESTION: 34

Refer to the drawing of a lube oil heat exchanger (see figure below).

Given the following lube oil cooling system conditions:

- The lube oil flow rate in the lube oil heat exchanger is 200 lbm/min.
- The lube oil enters the heat exchanger at 140ºF.
- The lube oil leaves the heat exchanger at 100ºF.
- The specific heat of the lube oil is 0.8 Btu/lbm-ºF.
- The cooling water flow rate is 400 lbm/min.
- The cooling water enters the lube oil heat exchanger at 60ºF.
- The specific heat of the cooling water is 1.0 Btu/lbm-ºF.

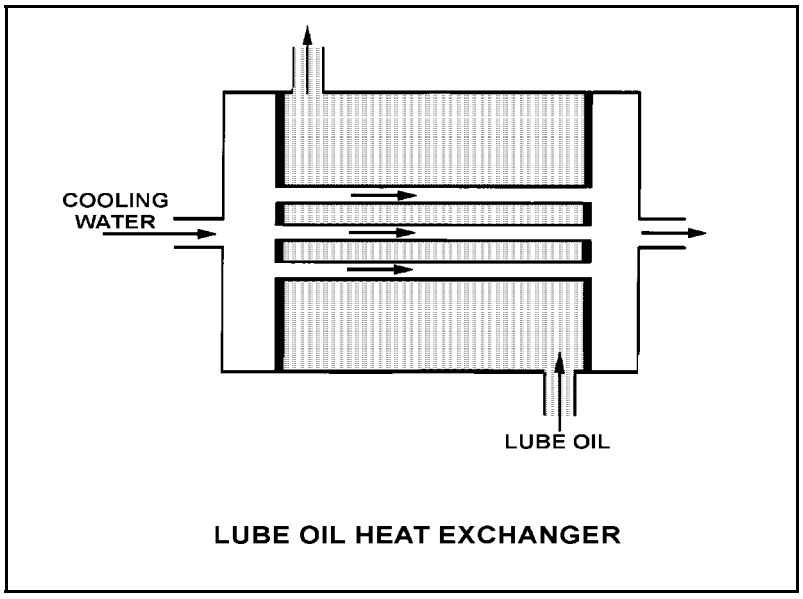
What is the approximate temperature of the cooling water leaving the lube oil heat exchanger?

A. 76ºF

B. 85ºF

C. 92ºF

D. 124ºF



LUBE OIL HEAT EXCHANGER

QUESTION: 35

The ion exchange efficiency of a condensate demineralizer is determined by performing a calculation using the:

A. demineralizer inlet and outlet pH.

B. demineralizer inlet and outlet conductivity.

C. change in pH at the outlet of the demineralizer over a period of time.

D. change in conductivity at the outlet of the demineralizer over a period of time.

QUESTION: 36

Refer to the drawing of a parallel demineralizer loop that is currently aligned for normal flow direction through the demineralizer (see figure below).

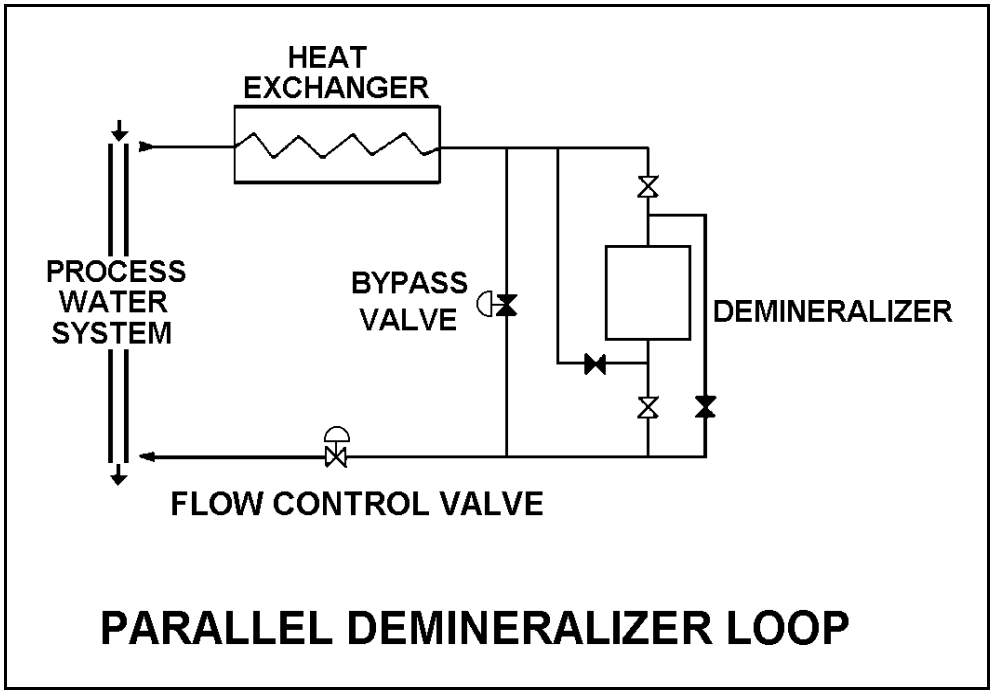
A minor seawater leak has occurred into the process water system, which is a closed system. Which one of the following will decrease the time required for the demineralizer loop to reduce the concentration of ionic impurities in the process water system?

A. Reverse the flow direction through the demineralizer.

B. Divert 50% of the loop flow to bypass the demineralizer.

C. Increase the flow rate in the loop from 95 gpm to 105 gpm.

D. Decrease the temperature in the loop from 110°F to 100°F.



QUESTION: 37

A demineralizer that has been exposed to _____ should be bypassed because the resin beads may release unwanted ions.

A. low flow

B. high flow

C. low temperature

D. high temperature

QUESTION: 38

Which one of the following capabilities would remain functional following a loss of control power to a typical 480 Vac bus feeder breaker?

A. Remote breaker control

B. Remote bus voltage indication

C. Remote breaker position indication

D. Breaker closing spring automatic recharging

QUESTION: 39

Which one of the following indicating devices must be manually reset after breaker actuation on an electrical fault to ensure proper breaker operation?

A. OPEN/CLOSED flag

B. OPEN/CLOSED lights

C. OVERCURRENT trip flag

D. CHARGED/DISCHARGED flag

QUESTION: 40

A typical 120 Vac manual circuit breaker has tripped due to overload. To close this circuit breaker, the breaker handle must be moved from the:

A. OFF position directly to the ON position; trip latch reset is not required.

B. OFF position to the midposition to reset the trip latch, and then to the ON position.

C. midposition directly to the ON position; trip latch reset is not required.

D. midposition to the OFF position to reset the trip latch, and then to the ON position.

QUESTION: 41

Refer to the drawing of a valve motor control circuit (see figure below) for a valve that is currently fully closed and has a 10-second stroke time. (Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts follow the standard convention for control circuit drawings.)

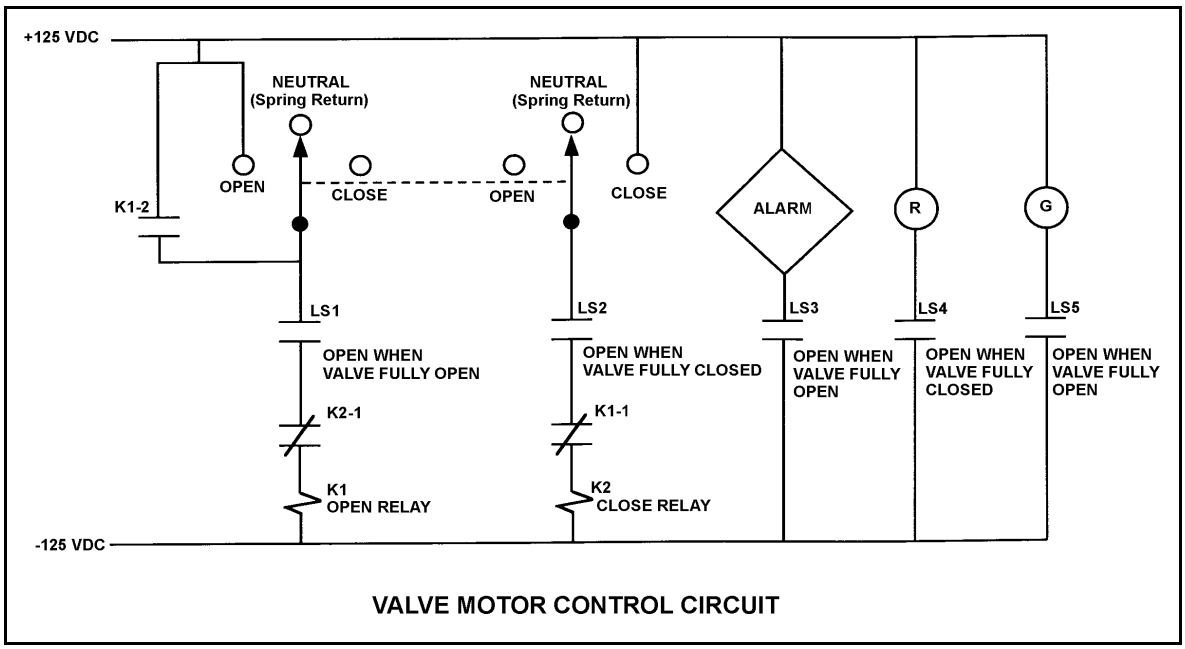
The operator takes the control switch to "Open" momentarily and the valve begins to open. Five seconds later, the operator takes the switch to "Close" momentarily and then releases the switch. Which one of the following describes the valve response after the switch is released?

A. The valve will stop opening and remain partially open.

B. The valve will stop opening and then go fully closed.

C. The valve will open fully and remain fully open.

D. The valve will open fully and then go fully closed.



VALVE MOTOR CONTROL CIRCUIT

QUESTION: 42

Refer to the simplified drawing of an electrical distribution system showing 7.2 KV switchgear, step-down transformers, and 480V motor control centers (MCCs) (see figure below).

The high voltage side of each step-down transformer has a remote-operated disconnect to allow transformer maintenance while keeping the other transformers in service. The control circuit for each disconnect is position-interlocked with the associated MCC feeder breaker.

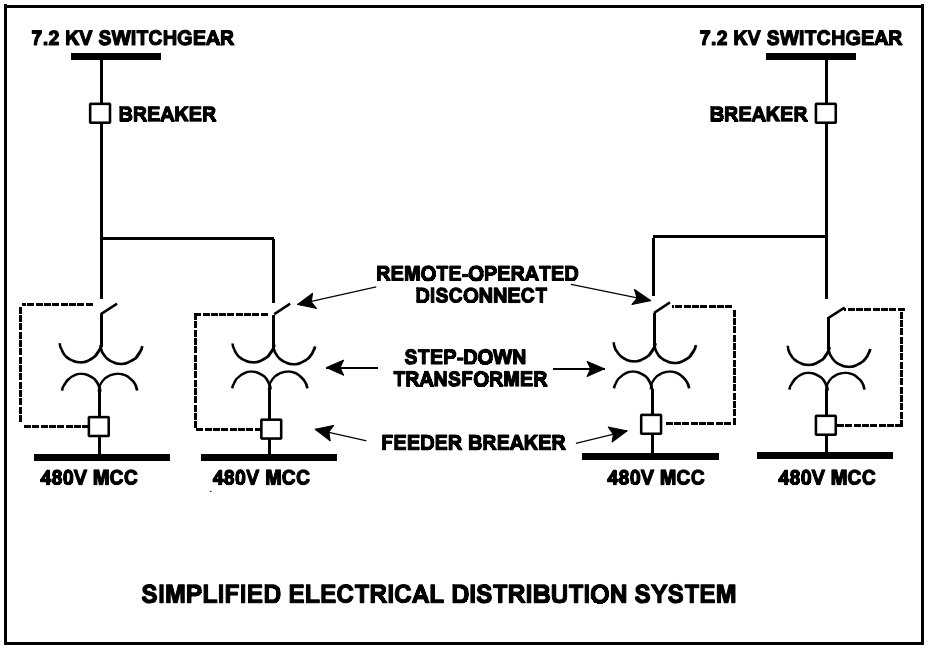
Which one of the following describes the purpose served by the interlock?

A. Prevent damage to the disconnect.

B. Prevent damage to the transformer.

C. Prevent damage to the feeder breaker.

D. Prevent damage to the 480V MCC.



SIMPLIFIED ELECTRICAL DISTRIBUTION SYSTEM

QUESTION: 43

The main generator is being paralleled to the grid. Generator voltage has been properly adjusted and the synchroscope is rotating slowly in the clockwise direction. The generator output breaker must be closed just prior to the synchroscope pointer reaching the 12 o'clock position to prevent:

A. motoring of the generator due to unequal frequencies.

B. excessive current within the breaker due to out-of-phase voltages.

C. excessive MW load transfer to the generator due to unequal frequencies.

D. excessive MVAR load transfer to the generator due to out-of-phase voltages.

QUESTION: 44

The following indications are observed in the control room for a normally-open motor control center (MCC) breaker that directly starts/stops a 480 Vac motor:

Red position indicating light is on.
Green position indicating light is off.
Motor load current indicates 0 amps.
MCC voltage indicates 480 volts.

What is the condition of the breaker?

A. Open and racked in

B. Closed and racked in

C. Open and racked to "test" position

D. Closed and racked to "test" position

QUESTION: 45

As compared to prompt neutrons, delayed neutrons:

A. are more likely to leak out of the core.

B. are more likely to cause fission of U-238.

C. are more likely to become thermal neutrons.

D. are responsible for the majority of U-235 fissions.

QUESTION: 46

A reactor is currently operating at equilibrium 80% power near the middle of a fuel cycle. Reactor reactivity control systems are in manual. During the next 3 days no operator action is taken. Assume a reactor scram does not occur.

How will core K_{eff} be affected during the 3-day period?

A. K_{eff} will gradually increase during the entire period.

B. K_{eff} will gradually decrease during the entire period.

C. K_{eff} will tend to increase, but inherent reactivity feedback will maintain K_{eff} at 1.0.

D. K_{eff} will tend to decrease, but inherent reactivity feedback will maintain K_{eff} at 1.0.

QUESTION: 47

A plant malfunction requires a rapid reactor power decrease from 100% to 90%. The crew hurriedly performs the downpower transient using control rod insertion when necessary. Reactor coolant boron concentration is not changed.

If the initial shutdown margin was 3.5 %ΔK/K, which one of the following describes the shutdown margin at the lower power level? (Neglect any changes in core fission product reactivity.)

A. Less than 3.5 %ΔK/K due only to the power defect.

B. Greater than 3.5 %ΔK/K due only to the insertion of control rods.

C. Less than 3.5 %ΔK/K due to the combined effects of control rod insertion and power defect.

D. Equal to 3.5 %ΔK/K regardless of the reactivity effects of control rod insertion and power defect.

QUESTION: 48

A reactor startup is being commenced with initial source (startup) range count rate stable at 20 cps. After a period of control rod withdrawal, count rate stabilizes at 80 cps.

If the total reactivity added by the above control rod withdrawal is 4.5 %ΔK/K, how much additional positive reactivity must be inserted to make the reactor critical?

A. 1.5 %ΔK/K

B. 2.0 %ΔK/K

C. 2.5 %ΔK/K

D. 3.0 %ΔK/K

QUESTION: 49

Which one of the following percentages of fission, by fuel, occurring in a reactor will result in the smallest reactor core effective delayed neutron fraction?

	U-235	U-238	Pu-239
A.	60%	6%	34%
B.	70%	7%	23%
C.	80%	6%	14%
D.	90%	7%	3%

QUESTION: 50

A reactor startup is in progress with the reactor at normal operating temperature and pressure. With reactor power stable at the point of adding heat, a control rod malfunction causes an inadvertent rod withdrawal that results in adding 0.3 %ΔK/K reactivity.

Given:

All rod motion has been stopped.
No automatic system or operator actions occur to inhibit the power increase.
Power coefficient = -0.04 %ΔK/K / % power
Average effective delayed neutron fraction = 0.006

What is the approximate power level increase required to offset the reactivity added by the inadvertent rod withdrawal?

A. 3.0%

B. 5.0%

C. 6.7%

D. 7.5%

QUESTION: 51

Which one of the following will cause the Doppler power coefficient to become more negative?

A. Lower power level

B. Increased clad creep

C. Increased pellet swell

D. Higher coolant boron concentration

QUESTION: 52

Which one of the following adds the most positive reactivity following a reactor trip/scram from full power at the beginning of core life? (Assume reactor coolant system parameters stabilize at their normal post-trip values.)

A. Void coefficient

B. Pressure coefficient

C. Fuel temperature coefficient

D. Moderator temperature coefficient

QUESTION: 53

Differential boron reactivity worth will become _____ negative as moderator temperature increases because, at higher moderator temperatures, a 1 ppm increase in reactor coolant system boron concentration will add _____ boron atoms to the core.

A. more; fewer

B. more; more

C. less; fewer

D. less; more

QUESTION: 54

A reactor has been shut down for three weeks with all control rods fully inserted. If a center control rod is fully withdrawn from the core, neutron population will: (Assume the reactor remains subcritical.)

A. remain the same.

B. increase and stabilize at a new higher level.

C. increase temporarily then return to the original value.

D. increase exponentially until the operator inserts the control rod.

QUESTION: 55

The reactor is operating at 85% power with the controlling group of control rods inserted 10%. Which one of the following will cause group differential control rod worth to become more negative? (Assume reactor power and control rod position remain constant for each case.)

A. RCS boron concentration is increased by 5 ppm .

B. Core Xe-135 builds up in the lower half of the core.

C. RCS average temperature drifts from 580°F to 575°F.

D. Fuel temperature increases as fission product gasses accumulate in a fuel rod.

QUESTION: 56

The reactor is operating at 75% power at the middle of core life. Which one of the following actions will cause the greatest shift in reactor power distribution toward the top of the core? (Assume control rods remain fully withdrawn.)

A. Decrease reactor power by 25%.

B. Decrease average reactor coolant temperature by 5°F.

C. Decrease reactor coolant boron concentration by 10 ppm.

D. Decrease reactor coolant system operating pressure by 15 psia.

QUESTION: 57

A reactor is operating at 85% power with all control rods fully withdrawn. Assuming reactor power does not change, which one of the following compares the effects of partially inserting (50%) a single center control rod to the effects of dropping (full insertion) the same control rod?

A. A partially inserted rod causes a greater change in shutdown margin.

B. A partially inserted rod causes a smaller change in shutdown margin.

C. A partially inserted rod causes a smaller change in axial power distribution.

D. A partially inserted rod causes a smaller change in radial power distribution.

QUESTION: 58

Which one of the following exhibits the greatest microscopic cross section for absorption of a thermal neutron in an operating reactor?

A. Boron-10

B. Xenon-135

C. Samarium-149

D. Uranium-235

QUESTION: 59

A 3400 Mw reactor has been operating at 100% power for several months. Which one of the following describes the contributions of beta decay and neutron capture to Xe-135 removal from the reactor core?

A. Primary - beta decay; secondary - neutron capture

B. Primary - neutron capture; secondary - beta decay

C. Equally from beta decay and neutron capture

D. Not enough information given to make a comparison

QUESTION: 60

A reactor has been operating at full power for one month following a refueling outage with core axial neutron flux distribution peaked in the bottom half of the core. An inadvertent reactor scram occurs. The reactor is restarted, with criticality occurring 6 hours after the scram. Reactor power is increased to 60% over the next 4 hours and stabilized.

How will core axial neutron flux distribution be affected during the 1-hour period immediately following the return to 60% power?

The core axial neutron flux peak will be located _____ in the core than the pre-scram peak location, and the flux peak will be moving _____.

A. higher; downward

B. higher; upward

C. lower; downward

D. lower; upward

QUESTION: 61

Four hours after a reactor trip from equilibrium full power operation, a reactor is taken critical and power is immediately stabilized for critical data. To maintain a constant reactor power, the operator must add _____ reactivity because xenon concentration is _____.

A. positive; increasing

B. positive; decreasing

C. negative; increasing

D. negative; decreasing

QUESTION: 62

Compare a reactor that has been operating at 50% power for several days when a reactor trip occurs, to a reactor that had been operating at full power prior to the trip. For the 50% power reactor, xenon would peak _____ and the peak xenon reactivity would be _____.

A. earlier; the same

B. earlier; less negative

C. at the same time; the same

D. at the same time; less negative

QUESTION: 63

A reactor is initially operating at 100% power with equilibrium core xenon-135. Power is decreased to 75% over a 1-hour period using the control rods and then stabilized. The operator then adjusts control rod height as necessary to maintain average reactor coolant temperature constant.

What will be the rod position and directional trend 30 hours after the power change?

A. Above the initial 75% position and inserting slowly

B. Above the initial 75% position and withdrawing slowly

C. Below the initial 75% position and inserting slowly

D. Below the initial 75% position and withdrawing slowly

QUESTION: 64

Why are burnable poisons installed in a reactor core?

A. To compensate for control rod depletion that occurs over core life

B. To shield reactor fuel from thermal neutron flux until later in core life

C. To flatten the radial thermal neutron flux distribution at the end of core life

D. To ensure that the control rods will be above the rod insertion limit when the reactor is critical

QUESTION: 65

As criticality is approached during a reactor startup, equal insertions of positive reactivity result in a _____ absolute change in equilibrium count rate and a _____ time to reach each new equilibrium.

A. smaller; shorter

B. smaller; longer

C. greater; shorter

D. greater; longer

QUESTION: 66

A reactor is subcritical by 1.0 %ΔK/K when the operator dilutes the reactor coolant system by 30 ppm boron. Assuming boron worth is -0.025 %ΔK/K per ppm and that no other reactivity changes occur, the reactor is:

A. subcritical.

B. critical.

C. supercritical.

D. prompt critical.

QUESTION: 67

A reactor is critical at a stable power level below the point of adding heat (POAH) when a small amount of positive reactivity is added. Which one of the following reactivity coefficient(s) will stabilize reactor power at the POAH?

A. Fuel temperature only

B. Moderator temperature only

C. Fuel temperature and voids

D. Moderator temperature and fuel temperature

QUESTION: 68

After taking critical data during a reactor startup, the operator establishes a stable 3/4 dpm startup rate to increase power to the point of adding heat (POAH). Which one of the following is the approximate amount of reactivity that must be added to stabilize reactor power at the POAH? (Assume $\overline{\beta}_{eff} = 0.0066$.)

A. -0.10 %ΔK/K

B. -0.12 %ΔK/K

C. -0.15 %ΔK/K

D. -0.28 %ΔK/K

QUESTION: 69

A reactor startup is in progress and criticality has just been achieved. After recording critical rod height, the operator withdraws control rods for 20 seconds to establish a 1 dpm startup rate. One minute later (prior to the point of adding heat) the operator inserts the same control rods for 30 seconds.

During the insertion, the startup rate will become:

A. zero during the entire period of control rod insertion.

B. negative after the control rods pass through the critical rod height.

C. negative just as the control rods pass through the critical rod height.

D. negative prior to control rods passing through the critical rod height.

QUESTION: 70

A plant is operating at 90% power at the end of core life with manual rod control when a turbine control system malfunction opens the turbine control valves an additional 5 percent. Reactor power will initially:

A. increase due to reduced neutron leakage out of the core.

B. decrease due to increased neutron leakage out of the core.

C. increase due to reduced neutron absorption in the moderator.

D. decrease due to increased neutron absorption in the moderator.

QUESTION: 71

Which one of the following describes the process for inserting control rods during a normal reactor shutdown?

A. Control rods are inserted in reverse order one bank at a time to maintain acceptable power distribution.

B. Control rods are inserted in reverse order one bank at a time to maintain a rapid shutdown capability from the remainder of the control rods.

C. Control rods are inserted in reverse order in a bank overlapping sequence to maintain a relatively constant differential control rod worth.

D. Control rods are inserted in reverse order in a bank overlapping sequence to limit the amount of positive reactivity added during a rod ejection accident.

QUESTION: 72

Following a reactor shutdown from long-term operation at full power, core heat production will continue for a period of time. The rate of core heat production will depend on the:

A. intrinsic neutron source strength following shutdown.

B. amount of time that has elapsed since K_{eff} decreased below 1.0.

C. rate at which the reactor was brought subcritical during shutdown.

D. amount of time required for the reactor pressure vessel to cool down.

QUESTION: 73

Which one of the following is arranged from the highest pressure to the lowest pressure?

A. 2 psig, 12 inches Hg absolute, 8 psia

B. 2 psig, 18 inches Hg absolute, 8 psia

C. 12 psia, 20 inches Hg absolute, 2 psig

D. 12 psia, 30 inches Hg absolute, 2 psig

QUESTION: 74

The temperature of a saturated steam-water mixture is 467°F.

Which one of the following additional parameter values, when paired with the temperature, provides <u>insufficient</u> data to determine the approximate steam quality of the mixture?

A. Pressure at 499.96 psia

B. Enthalpy at 977.33 Btu/lbm

C. Entropy at 1.17 Btu/lbm -°R

D. Specific volume at 0.817 ft^3/lbm

QUESTION: 75

If 1 pound-mass of liquid water is in a saturated condition at a constant pressure, the addition of 1 Btu will:

A. result in 1°F of superheat.

B. vaporize a portion of the water.

C. increase the density of the water.

D. raise the temperature of the water by 1°F.

QUESTION: 76

A plant is operating near full rated power. Condensate is collecting in the main condenser hotwell at 90°F with a condenser pressure of 28" Hg vacuum. Which one of the following will improve steam cycle efficiency?

A. Main condenser cooling water flow decreases by 5% with no change in condenser vacuum.

B. Main condenser cooling water inlet temperature decreases by 10°F with no change in condenser vacuum.

C. Main condenser vacuum decreases to 27" Hg due to buildup of noncondensible gases.

D. Steam flow through the turbine decreases by 10% with no change in condenser vacuum.

QUESTION: 77

A reactor plant is operating at 100% rated power. Steam is escaping to atmosphere through a flange leak in a steam supply line to the low pressure section of the main turbine.

Given:

- Steam line pressure is 300 psia.
- Steam line temperature is 440°F.

What is the approximate temperature of the steam as it reaches atmospheric pressure?

A. 212°F

B. 268°F

C. 322°F

D. 358 °F

QUESTION: 78

Which one of the following will be caused by a <u>decrease</u> in main condenser vacuum (higher absolute pressure) on a plant operating at full power? (Assume main steam flow rate and condenser circulating water flow rate are unchanged.)

A. Decrease in the condensate temperature

B. Decrease in the ideal steam cycle efficiency

C. Decrease in the condensate pump required NPSH

D. Decrease in the mass of noncondensable gas in the condenser

QUESTION: 79

The possibility of water hammer in a liquid system is minimized by:

A. venting systems prior to starting centrifugal pumps.

B. maintaining temperature above the saturation temperature.

C. starting centrifugal pumps with the casing vent valve fully open.

D. starting positive displacement pumps with the discharge valve closed.

QUESTION: 80

A 75 gpm leak to atmosphere has developed from a cooling water system that is operating at 100 psig. Which one of the following will be the approximate leak rate when system pressure has decreased to 80 psig?

A. 26.5 gpm

B. 38.9 gpm

C. 56.4 gpm

D. 68.2 gpm

QUESTION: 81

The volumetric flow rate of cooling water entering a heat exchanger is 500 gpm.

Given the following:

Cooling water pressure entering and leaving the heat exchanger is 10 psig.
Cooling water inlet temperature is 90°F.
Cooling water outlet temperature is 160°F.
Heat exchanger inlet and outlet piping have the same diameter.

What is the approximate volumetric flow rate of the cooling water exiting the heat exchanger?

A. 496 gpm

B. 500 gpm

C. 504 gpm

D. 509 gpm

QUESTION: 82

A plant is recovering from a loss of offsite power that caused all reactor coolant pumps (RCPs) to be lost. Pressurizer level indication is off-scale high.

Prior to restarting an RCP, the steam generator (S/G) temperatures should be equal to or less than the associated reactor coolant system (RCS) loop temperature to avoid:

A. localized water hammer in the RCS.

B. pressurized thermal shock to the S/Gs.

C. a large pressure spike throughout the RCS.

D. inadvertently lifting a S/G atmospheric relief valve.

QUESTION: 83

A centrifugal pump is being returned to service after maintenance. However, the operator fails to vent the pump.

Compared to normal operations, after the pump is started, the operator will see _____ flow rate and _____ discharge head.

A. higher; lower

B. higher; higher

C. lower; lower

D. lower; higher

QUESTION: 84

A reactor plant is operating at 100% rated power. Main turbine extraction steam is being supplied to a feedwater heater. Extraction steam parameters are as follows:

Steam pressure: 750 psia
Steam flow rate: 7.5×10^5 lbm/hr
Steam enthalpy: 1150 Btu/lbm

Saturated liquid condensate at 448°F leaves the feedwater heater via a drain line.

What is the approximate heat transfer rate from the extraction steam to the feedwater in the feedwater heater?

A. 3.8×10^7 Btu/hr

B. 8.6×10^7 Btu/hr

C. 5.4×10^8 Btu/hr

D. 7.2×10^8 Btu/hr

QUESTION: 85

The power range nuclear instruments have been adjusted to 100% based on a calculated heat balance. Which one of the following will result in indicated reactor power being lower than actual reactor power?

A. The reactor coolant pump heat input term was omitted from the heat balance calculation.

B. The feed water flow rate used in the heat balance calculation was 10% higher than actual flow rate.

C. The steam pressure used in the heat balance calculation was 50 psi lower than actual steam pressure.

D. The feed water temperature used in the heat balance calculation was 20°F higher than actual feed water temperature.

QUESTION: 86

Convection heat transfer improves when nucleate boiling begins on the surface of a fuel rod because:

A. a steam blanket begins to form along the surface of the fuel rod.

B. steam bubble formation increases coolant flow along the fuel rod.

C. steam bubble formation decreases coolant flow along the fuel rod.

D. the motion of the steam bubbles causes rapid mixing of the coolant.

QUESTION: 87

Which one of the following will be the initial cause of fuel damage if a fuel rod exceeds the critical heat flux at 100% power?

A. Excessive fuel clad temperature

B. Excessive fuel pellet temperature

C. Excessive fuel rod thermal stress

D. Excessive fuel rod internal pressure

QUESTION: 88

A small increase in ΔT (at the fuel clad-to-coolant interface) causes increased steam blanketing and a reduction in heat flux. This describes which type of boiling?

A. Nucleate boiling

B. Subcooled boiling

C. Partial film boiling

D. Total film boiling

QUESTION: 89

Which one of the following will directly increase the reactor coolant system (RCS) subcooling margin with the reactor operating at full power?

A. Increased coolant flow rate

B. Decreased RCS hot leg temperature

C. Decreased RCS cold leg temperature

D. Increased concentration of soluble gases in the RCS

QUESTION: 90

During a plant cooldown and depressurization with forced circulation, reactor coolant system (RCS) loop flow and reactor coolant pump (RCP) current indications become erratic. This is most likely caused by:

A. RCP runout.

B. RCP cavitation.

C. RCS hot leg saturation.

D. RCS loop water hammer.

QUESTION: 91

Which one of the following describes a function of core bypass flow?

A. Provides a means of measuring core flow

B. Prevents boron precipitation in the core baffle area

C. Prevents excessive reactor vessel wall differential temperature

D. Provides cooling to various reactor vessel internal components

QUESTION: 92

A reactor is shut down with natural circulation core cooling. Decay heat generation is equivalent to 1.0% rated thermal power. Core ΔT has stabilized at 13 °F.

When decay heat generation decreases to 0.5% rated thermal power, core ΔT will be approximately:

A. 4 °F.

B. 6 °F.

C. 8 °F.

D. 10 °F.

QUESTION: 93

Which one of the following describes the mechanism for core heat removal during reflux cooling?

A. Forced coolant flow

B. Natural circulation coolant flow

C. Radiation with total core voiding

D. Conduction with stagnant coolant flow

QUESTION: 94

A reactor is operating at 75% power at the middle of a fuel cycle with radial power distribution peaked in the center of the core. All control rods are fully withdrawn and in manual control.

Assuming all control rods remain fully withdrawn, except as noted, which one of the following will cause the maximum steady-state radial peaking (or hot channel) factor to decrease?

A. Turbine load/reactor power is reduced by 20%.

B. A control rod located at the edge of the core drops into the core.

C. Reactor coolant system boron concentration is reduced by 10 ppm.

D. The reactor is operated continuously at 75% power for three months.

QUESTION: 95

A reactor is operating steady-state at 80% power at the beginning of a fuel cycle. All control rods are fully withdrawn and in manual control. Moderator temperature coefficient is negative.

Which one of the following will increase the maximum core axial peaking factor? (Assume no subsequent operator action is taken and that turbine load and core xenon distribution do not change unless stated.)

A. One bank of control rods is inserted 10%.

B. Power is maintained constant for one month.

C. Turbine load/reactor power is reduced by 20%.

D. Reactor coolant system boron concentration is increased by 50 ppm.

QUESTION: 96

Brittle fracture of a low-carbon steel reactor vessel can only occur when the temperature of the vessel is _____ the nil ductility temperature, and will normally occur when the applied stress is _____ the steel's yield strength (or yield stress).

A. less than; less than

B. less than; greater than

C. greater than; less than

D. greater than; greater than

QUESTION: 97

The likelihood of brittle fracture failure of the reactor vessel is reduced by:

A. increasing vessel age.

B. reducing vessel pressure.

C. reducing vessel temperature.

D. reducing gamma flux exposure.

QUESTION: 98

Two identical reactors are currently shut down for refueling. Reactor A has an average lifetime power capacity of 60% and has been operating for 15 years. Reactor B has an average lifetime power capacity of 75% and has been operating for 12 years.

Which reactor, if any, will have the lowest reactor vessel nil ductility transition temperature?

A. Reactor A due to the lower average lifetime power capacity

B. Reactor B due to the higher average lifetime power capacity

C. Both reactors will have approximately the same nil ductility transition temperature because each core has produced approximately the same number of fissions.

D. Both reactors will have approximately the same nil ductility transition temperature because fast neutron irradiation from a shut down core is not significant.

QUESTION: 99

Which one of the following would be most likely to cause pressurized thermal shock of the reactor vessel?

A. Continuous emergency coolant injection to the RCS during and after a complete and unisolable rupture of a main steam line.

B. Starting a reactor coolant pump in an idle loop with the associated steam generator temperature less than RCS loop temperature.

C. Starting a reactor coolant pump in an idle loop with the associated steam generator temperature greater than RCS loop temperature.

D. Continuous emergency coolant injection to the RCS during and after a complete and unisolable rupture of a reactor vessel coolant outlet nozzle.

QUESTION: 100

Which one of the following describes the thermal stress placed on the reactor vessel during a cooldown of the reactor coolant system?

A. Tensile across the entire wall

B. Compressive across the entire wall

C. Tensile at the inner wall, compressive at the outer wall

D. Compressive at the inner wall, tensile at the outer wall

***** FINAL ANSWER KEY *****

FEBRUARY 2001 NRC GENERIC FUNDAMENTALS EXAMINATION
PRESSURIZED WATER REACTOR - ANSWER KEY

FORM A	FORM B	ANS	FORM A	FORM B	ANS	FORM A	FORM B	ANS	FORM A	FORM B	ANS
1	29	C	26	54	C	51	79	A	76	4	A
2	30	B	27	55	D	52	80	C	77	5	D
3	31	C	28	56	C	53	81	C	78	6	B
4	32	A	29	57	D	54	82	B	79	7	A
5	33	B	30	58	A	55	83	B	80	8	D
6	34	B	31	59	C	56	84	A	81	9	D
7	35	B	32	60	B	57	85	D	82	10	C
8	36	A	33	61	D	58	86	B	83	11	C
9	37	C	34	62	A	59	87	B	84	12	C
10	38	C	35	63	B	60	88	A	85	13	D
11	39	D	36	64	C	61	89	A	86	14	D
12	40	C	37	65	D	62	90	B	87	15	A
13	41	D	38	66	B	63	91	C	88	16	C
14	42	D	39	67	A/C	64	92	B/D	89	17	B
15	43	B	40	68	D	65	93	D	90	18	B
16	44	A	41	69	C	66	94	A	91	19	D
17	45	D	42	70	A	67	95	D	92	20	C
18	46	B	43	71	B	68	96	C	93	21	B
19	47	A	44	72	D	69	97	D	94	22	D
20	48	D	45	73	C	70	98	A	95	23	A
21	49	C	46	74	D	71	99	C	96	24	A
22	50	B	47	75	D	72	100	B	97	25	B
23	51	A	48	76	A	73	1	B	98	26	C
24	52	C	49	77	A	74	2	A	99	27	A
25	53	B	50	78	D	75	3	B	100	28	C