UNITED STATES NUCLEAR REGULATORY COMMISSION
BOILING WATER REACTOR GENERIC FUNDAMENTALS EXAMINATION
OCTOBER 2002--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 4.0 hours after the examination starts. This examination applies to a typical boiling water reactor (BWR) 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

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

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

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

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

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

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

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

$SUR = 26.06/\tau$

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

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

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

$\lambda_{eff} = 0.1\ sec^{-1}$ (for small positive ρ)

$DRW \propto \varphi_{tip}^2 / \varphi_{avg}^2$

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

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

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

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

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

$1/M = CR_1/CR_X$

$A = \pi r^2$

$F = PA$

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

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

$E = IR$

Eff. = Net Work Out/Energy In

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

$g_c = 32.2\ lbm\text{-}ft/lbf\text{-}sec^2$

CONVERSIONS

|			
1 Mw	= 3.41×10^6 Btu/hr	1 Curie	= 3.7×10^{10} dps
1 hp	= 2.54×10^3 Btu/hr	1 kg	= 2.21 lbm
1 Btu	= 778 ft-lbf	1 gal$_{water}$	= 8.35 lbm
°C	= (5/9)(°F - 32)	1 ft$^3_{water}$	= 7.48 gal
°F	= (9/5)(°C) + 32		

QUESTION: 1

Refer to the drawing of two identical pressure vessels with identical relief protection (see figure below).

Both vessels have been pressurized to 50 psig and then isolated. Vessel A is completely filled with water at 150°F. Vessel B is in a saturated condition with one-half steam (100% quality) and one-half water (0% quality) by volume.

If both relief valves fully open simultaneously, the faster pressure reduction will occur in vessel _____; and if both relief valves close at 40 psig, the greater mass loss will have occurred in vessel _____.

A. A; A

B. A; B

C. B; A

D. B; B

PRESSURE VESSELS WITH RELIEF PROTECTION
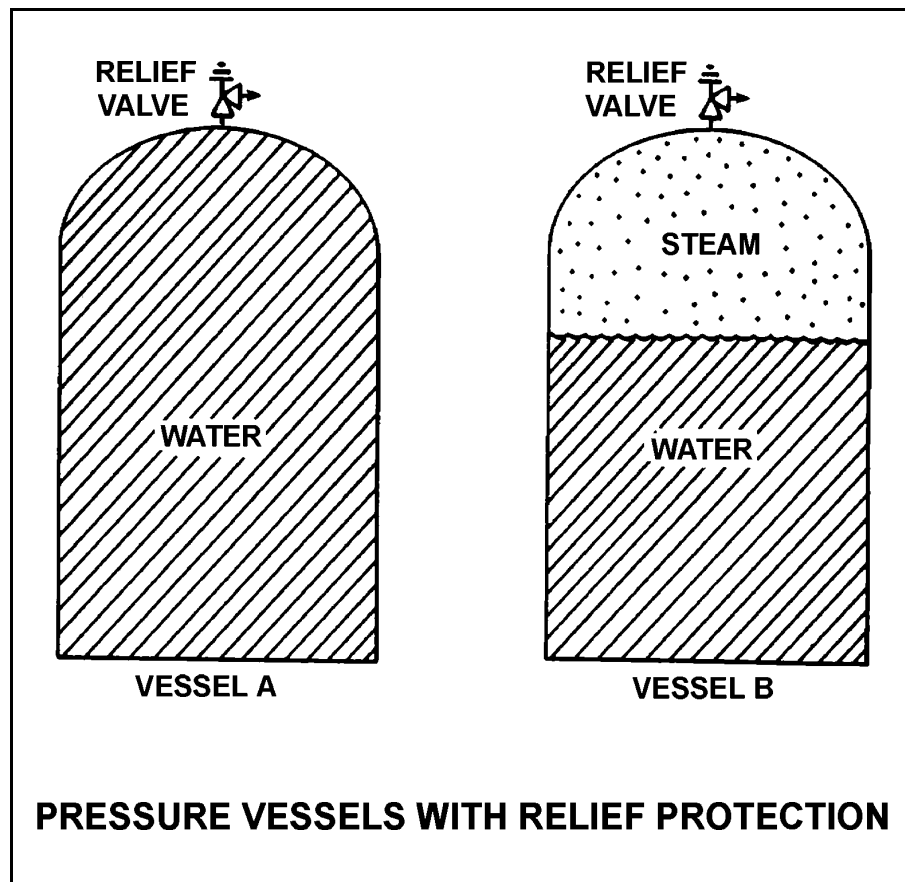
QUESTION: 2

Refer to the drawing of a spring-loaded air-operated valve (see figure below) in which the solenoid is shown energized.

Which one of the following will be the final valve position following a loss of electrical power to the solenoid?

A. Midposition

B. Closed

C. As is

D. Open

SPRING-LOADED AIR-OPERATED VALVE
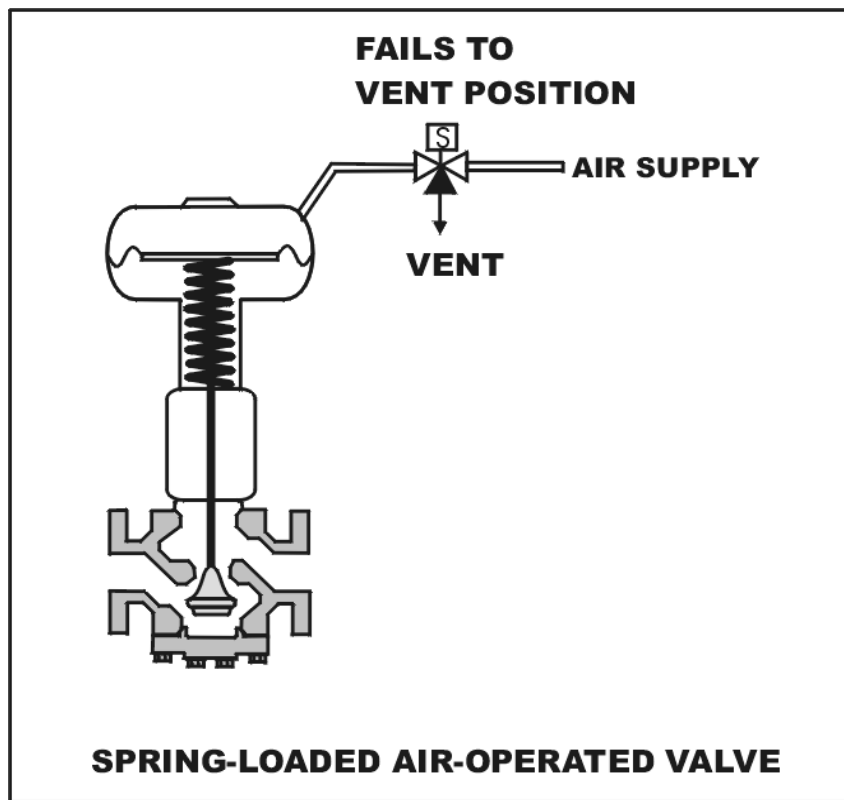
QUESTION: 3

Refer to the drawing of a water supply pump with two suction sources (see figure below). All motor-operated valves (MOVs) are currently closed.

Which one of the following MOV interlocks will permit the pump to take a suction on either the building sump or the water storage tank, while preventing the two sources from being cross-connected?

A. Neither MOV-1 nor MOV-2 can be opened unless MOV-3 is fully closed.

B. None of the MOVs can be opened unless at least one MOV remains fully closed.

C. None of the MOVs can be opened unless at least two MOVs remain fully closed.

D. Neither MOV-1 nor MOV-2 can be opened unless the other source MOV is fully closed.
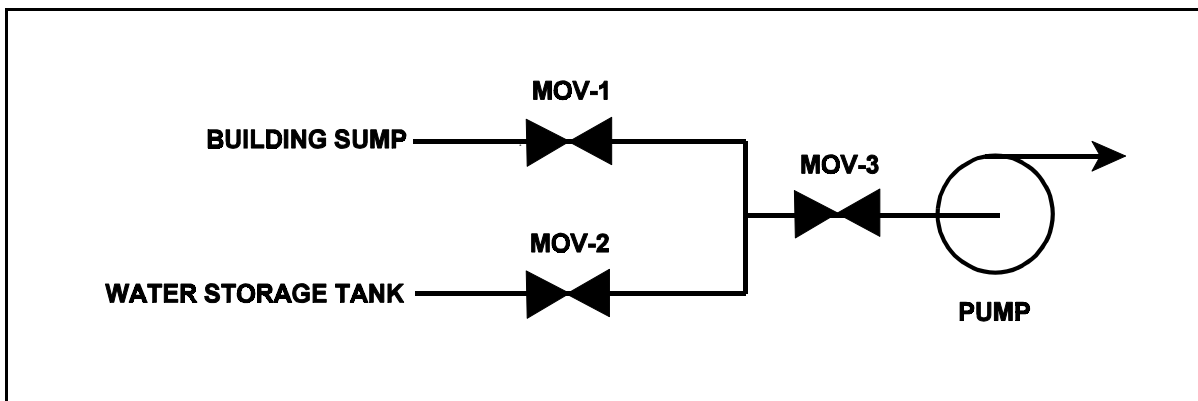
QUESTION: 4

Emergency core cooling systems (ECCSs) typically have check valves in the discharge lines from the ECCS pumps to the reactor vessel. How does the check valve operate?

A. The valve is opened by flow and pressure from the discharge of the associated ECCS pump.

B. Instrument air is supplied to the valve operator when the associated ECCS pump is stopped to close the valve and ensure no leakage across the seat.

C. The valve will begin to modulate when the associated ECCS pump is started to ensure adequate recirculation flow.

D. Instrument air is supplied to the valve upon ECCS pump start to ensure that the valve opens.

QUESTION: 5

In a comparison between a typical gate valve and a typical globe valve in the same application with both valves fully open, the gate valve has a _____ pressure drop and is normally used in _____ flow applications.

A. larger; throttling

B. larger; on/off

C. smaller; throttling

D. smaller; on/off

QUESTION: 6

Density input is normally used in steam flow instruments to convert _____ into _____.

A. mass flow rate; volumetric flow rate

B. volumetric flow rate; mass flow rate

C. mass flow rate; differential pressure

D. differential pressure; volumetric flow rate

QUESTION: 7

Refer to the drawing of a horizontal pipe elbow (top view) in an operating water system (see figure below).

Three separate bellows-type differential pressure flow detectors are connected to taps A, B, C, and D as follows:

DETECTOR	TAPS
AD	A and D
BD	B and D
CD	C and D

Assuming zero head loss in this section of pipe, how will the detectors be affected if tap B experiences a significant leak? (Assume water system pressure does not change.)

A. All detectors will fail low.

B. All detectors will fail high.

C. Only one detector will fail, and it will fail low.

D. Only one detector will fail, and it will fail high.
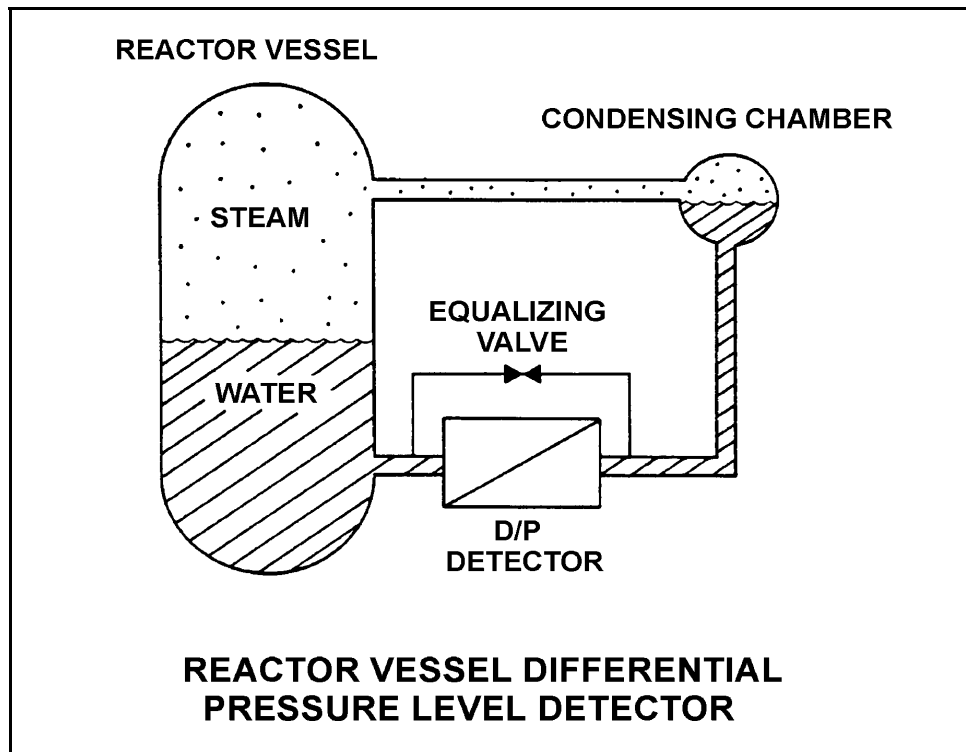

PIPE ELBOW - TOP VIEW
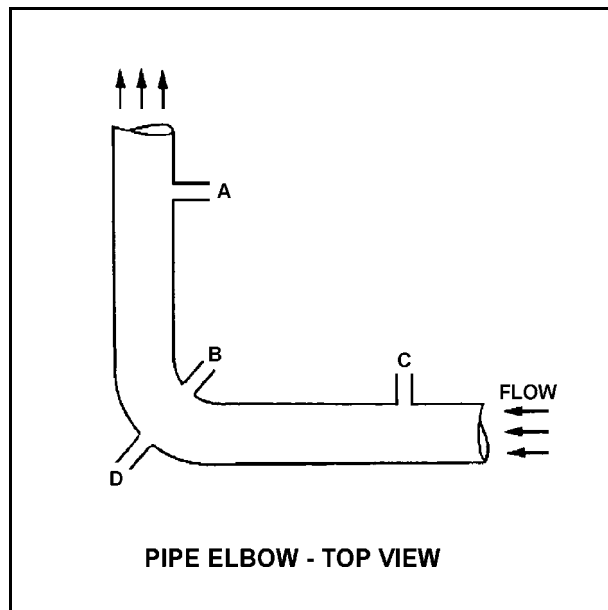
QUESTION: 8

Refer to the drawing of a reactor vessel (RV) differential pressure level detector (see figure below) that was recently calibrated at normal operating conditions.

With the reactor shut down, RV pressure was inadvertently decreased from 1,000 psig to 500 psig in 5 minutes due to operator error. RV pressure was stabilized at 500 psig, but during the pressure decrease a small amount of water in the condensing chamber flashed to steam. Assume the reference leg water remains subcooled, except for the small amount of water that flashes to steam in the condensing chamber.

As a result of the small loss of condensing chamber water, RV level will indicate _____ than actual level; and as the condensing chamber refills, indicated level will _____.

A. higher; decrease and stabilize above the actual level

B. higher; decrease and stabilize below the actual level

C. lower; increase and stabilize above the actual level

D. lower; increase and stabilize below the actual level

REACTOR VESSEL

CONDENSING CHAMBER

STEAM

EQUALIZING
VALVE

WATER

D/P
DETECTOR

REACTOR VESSEL DIFFERENTIAL
PRESSURE LEVEL DETECTOR

QUESTION: 9

A properly calibrated 0 to 100 psia diaphragm pressure detector is connected to a pressurized system; the low pressure side of the detector is vented to the atmosphere. The detector is currently producing a system pressure indication of 75 psia.

If the detector diaphragm ruptures, indicated pressure will be approximately:

A. 0 psia.

B. 15 psia.

C. 60 psia.

D. 90 psia.

QUESTION: 10

Which one of the following parameters requires square root compensation when measured by a differential pressure detector?

A. Reactor vessel level

B. Condenser vacuum

C. Reactor vessel pressure

D. Recirculation pump flow rate

QUESTION: 11

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

Thermocouple temperature indication is currently 150°F. Reference junction temperature is currently 90°F. Indicator range is from 0°F to 2000°F.

If one of the thermocouple extension wires loosens and becomes dislodged from its terminal in the reference junction panel, which one of the following temperature indications will occur?

A. Minimum instrument reading (0°F)

B. 60°F

C. 90°F

D. Maximum instrument reading (2000°F)

MEASURING [HOT]
JUNCTION

VOLTAGE

REFERENCE [COLD]
JUNCTION

POTENTIOMETER
(TEMPERATURE INDICATION)

SIMPLE THERMOCOUPLE CIRCUIT
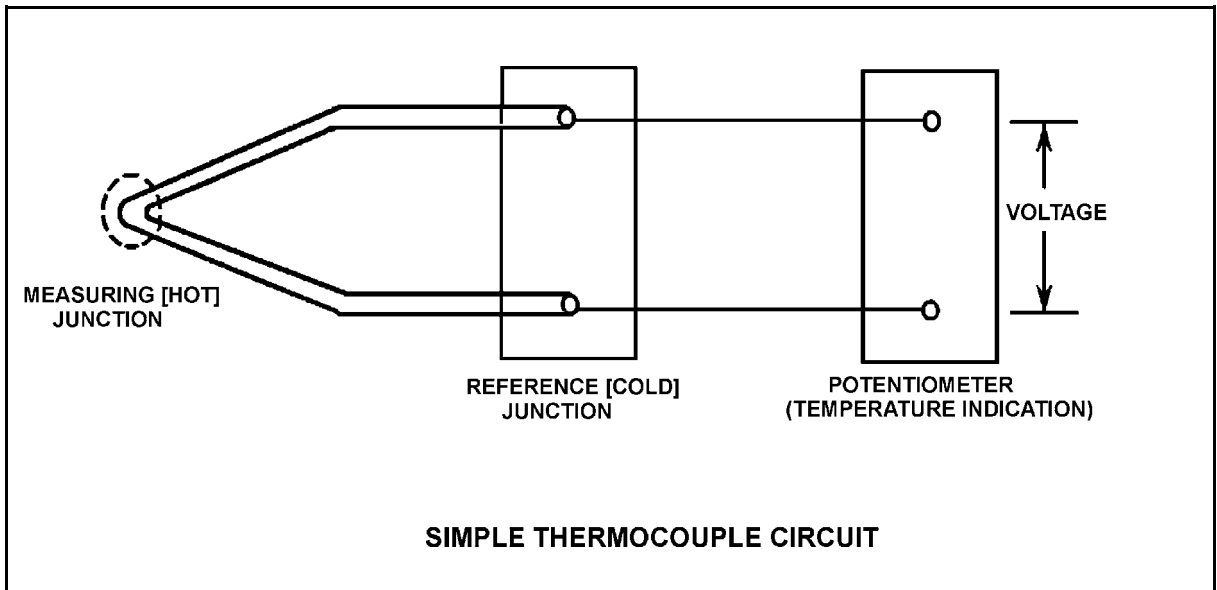
QUESTION: 12

Fission chamber detectors are used to monitor reactor power/neutron level in a shutdown reactor as well as a reactor operating at full power (and all power levels in between). At what power levels and why is it necessary to compensate the output of the detectors for gamma interactions with the fission chambers?

A. At all power levels, because gamma interactions produce larger detector pulses than neutron interactions.

B. At all power levels, because gamma interactions produce smaller detector pulses than neutron interactions.

C. Only when shutdown or at low power levels, because gamma flux is <u>not</u> proportional to reactor power at low power levels.

D. Only when operating at high power levels, because gamma flux is <u>not</u> proportional to reactor power at high power levels.

QUESTION: 13

A gas-filled radiation detector operating in the proportional region is exposed to a constant gamma radiation field. If the applied voltage is increased but maintained within the proportional region, the rate of ion collection will:

A. increase because more secondary ionizations are occurring in the detector.

B. increase because fewer primary ions are recombining in the detector prior to reaching the electrodes.

C. stay approximately the same because the ion chamber is operating at saturated conditions.

D. stay approximately the same because all of the primary ions were already being collected at the lower voltage.

QUESTION: 14

A Geiger-Mueller radiation detector is located in a radiation field consisting of beta, gamma, and fast neutron radiation. Assuming each type of radiation enters the detector gas chamber and ionizes the detector gas, which one of the following describes the resulting detector pulse sizes?

A. Beta radiation will produce a larger pulse size than either gamma or fast neutron radiation.

B. Gamma radiation will produce a larger pulse size than either beta or fast neutron radiation.

C. Fast neutron radiation will produce a larger pulse size than either beta or gamma radiation.

D. Beta, gamma, and fast neutron radiation will produce pulse sizes that are equal in magnitude.
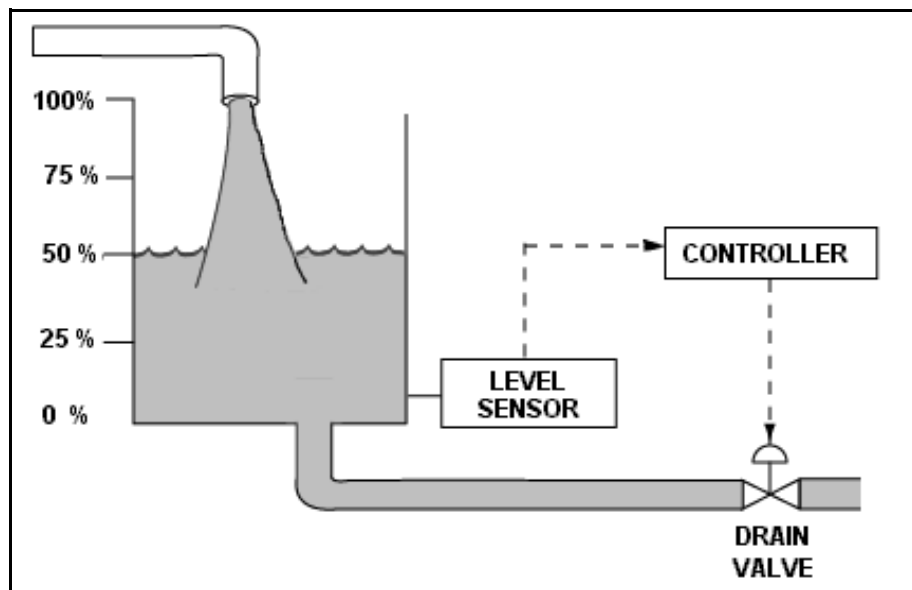
QUESTION: 15

Refer to the drawing of a water storage tank with a level control system (see figure below).

The tank water level is being automatically controlled by a proportional-only controller with a setpoint of 50%. Tank water level is currently stable at 50% with 500 gpm entering the tank and the drain valve 50% open.

The tank suddenly develops a constant 200 gpm leak, while the input flow rate remains constant at 500 gpm. After the tank water level stabilizes, level will be _____, and the drain valve position will be _____.

A. 50%; more than 50% open

B. 50%; less than 50% open

C. below 50%; more than 50% open

D. below 50%; less than 50% open
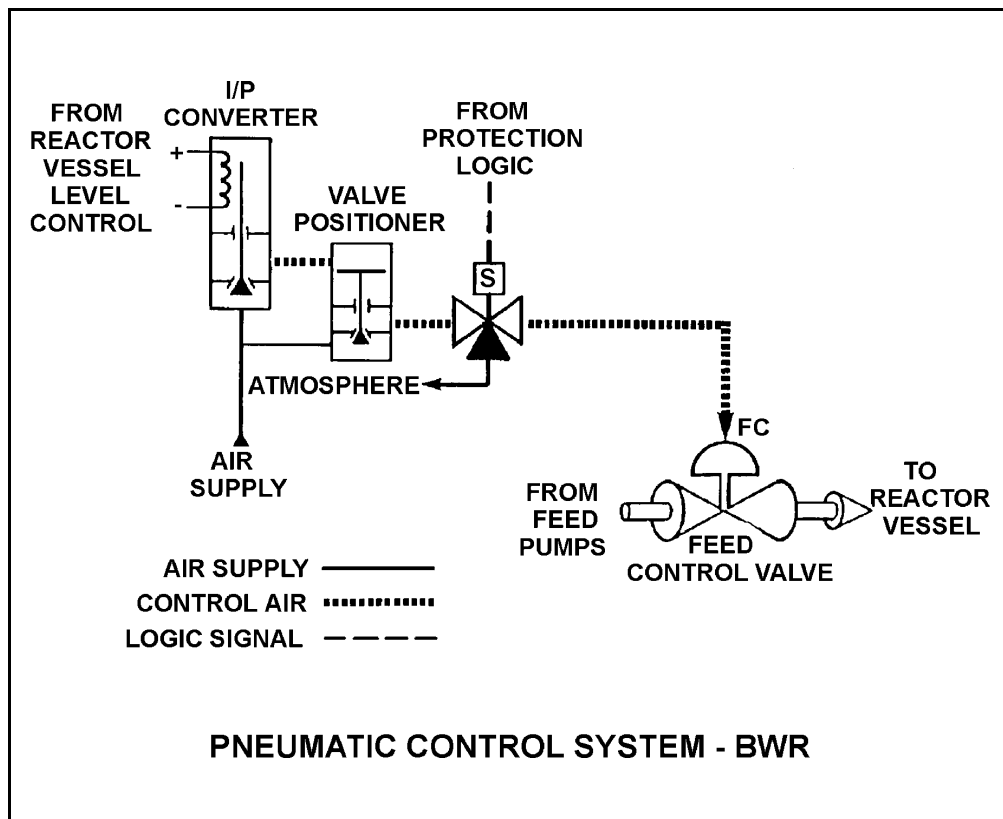
QUESTION: 16

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

The purpose of the valve positioner is to convert:

A. a small control air pressure into a proportionally larger air pressure to adjust valve position.

B. a large control air pressure into a proportionally smaller air pressure to adjust valve position.

C. pneumatic force into mechanical force to adjust valve position.

D. mechanical force into pneumatic force to adjust valve position.

PNEUMATIC CONTROL SYSTEM - BWR

QUESTION: 17

If the turbine shaft speed signal received by a typical turbine governor control system fails <u>high</u> during turbine startup, the turbine governor will cause turbine speed to:

A. increase, until an upper limit is reached or the turbine trips on overspeed.

B. decrease, until the mismatch with the turbine speed demand signal is nulled.

C. increase, until the mismatch with the turbine speed demand signal is nulled.

D. decrease, until a lower limit is reached or turbine steam flow is isolated.

QUESTION: 18

A centrifugal pump with no recirculation flow path must be stopped when discharge pressure reaches the pump shutoff head to prevent:

A. overheating of the pump.

B. overheating of the motor.

C. bursting of the pump casing.

D. water hammer in downstream lines.

QUESTION: 19

A multispeed centrifugal pump is operating with a flow rate of 3,000 gpm. Which one of the following approximates the new flow rate if the speed is decreased from 3,600 rpm to 2,400 rpm?

A. 1,000 gpm

B. 1,500 gpm

C. 2,000 gpm

D. 2,500 gpm

QUESTION: 20

A motor-driven centrifugal pump is operating in an open system. If the pump discharge valve is fully opened from a throttled position, available net positive suction head (NPSH) will _____ and required NPSH will _____.

A. increase; increase

B. increase; remain the same

C. decrease; increase

D. decrease; remain the same

QUESTION: 21

A centrifugal firewater pump is operating normally to pressurize a fire main. The pump takes suction on a water reservoir. The reservoir water level and the pump are both at sea level.

Given:

- The pump has a shutoff head of 100 feet.
- The required net positive suction head (NPSH) for the pump is 15 feet.
- The reservoir water temperature is 60°F.

What is the highest elevation (referenced to sea level) of a fire hose nozzle at which the firewater pump will be able to provide flow? (Disregard head loss in the fire main and fire hose.)

A. 115 feet

B. 100 feet

C. 85 feet

D. 67 feet

QUESTION: 22

A single-speed centrifugal pump is needed to supply river water to a storage facility. The pump must be capable of providing a very high flow rate at a low discharge pressure. Which one of the following types of centrifugal pumps is best suited for this application?

A. Single-stage, axial flow

B. Single-stage, radial flow

C. Multiple-stage, axial flow

D. Multiple-stage, radial flow

QUESTION: 23

A centrifugal pump is operating at rated conditions in an open system with all valves fully open. If the pump suction valve is throttled to 50% closed, pump suction pressure will _____ and pump flow rate will _____.

A. increase; decrease

B. decrease; remain the same

C. increase; remain the same

D. decrease; decrease

QUESTION: 24

A section of reactor coolant piping is being hydrostatically tested to 1,400 psig using a positive displacement pump. The operating characteristics of the positive displacement pump are shown below, identifying ideal, expected, and actual pump performance during the test.

Which one of the following could have caused the observed difference between the expected and the actual pump performance?

A. Available NPSH decreased to slightly above the required NPSH for the pump.

B. Available NPSH decreased to slightly below the required NPSH for the pump.

C. A relief valve on the pump discharge piping failed to open at its set point of 1,400 psig.

D. A relief valve on the pump discharge piping opened prior to its set point of 1,400 psig.
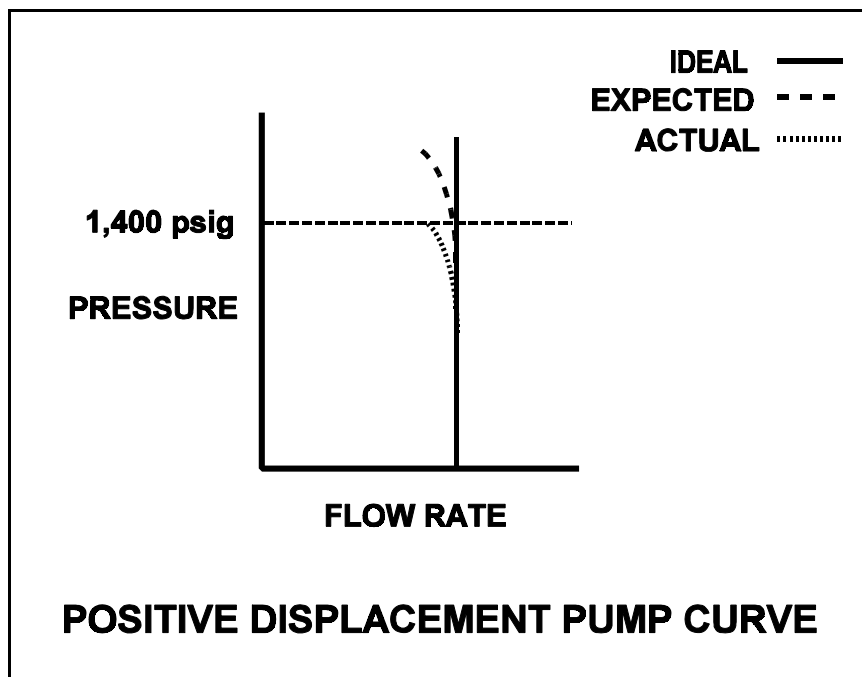
POSITIVE DISPLACEMENT PUMP CURVE

QUESTION: 25

Prior to starting a positive displacement pump, the discharge valve should be open to:

A. prevent rupturing the pump casing.

B. limit the pump motor starting time.

C. ensure the pump casing fills by backflow.

D. reduce pressure fluctuations in the discharge piping.

QUESTION: 26

A cooling water pump is being driven by an ac induction motor. Which one of the following describes how and why pump motor current will change if the pump shaft seizes?

A. Decreases due to decreased pump flow

B. Decreases due to increased counter electromotive force

C. Increases due to decreased pump flow

D. Increases due to decreased counter electromotive force

QUESTION: 27

Which one of the following will result from prolonged operation of an ac motor with excessively high stator temperatures?

A. Decreased electrical current demand due to reduced counter electromotive force

B. Increased electrical current demand due to reduced counter electromotive force

C. Decreased electrical ground resistance due to breakdown of winding insulation

D. Increased electrical ground resistance due to breakdown of winding insulation

QUESTION: 28

A main generator is operating on the power grid with the following indications:

    100 MWe
    0 MVAR
    2,900 amps
    20,000 volts

If MVAR does not change while real load is increased to 200 MWe, the current supplied by the generator will increase to approximately:

A. 11,600 amps

B. 8,200 amps

C. 5,800 amps

D. 4,100 amps

QUESTION: 29

Two identical 4160 Vac induction motors are connected to identical centrifugal pumps in identical but separate cooling water systems. Each motor is rated at 200 hp. The discharge valve for pump A is fully shut and the discharge valve for pump B is fully open.

When the motors are started under these conditions, the shorter time period required to reach a stable running current will be experienced by motor _____, and the higher stable running current will be experienced by motor _____.

A. A; A

B. A; B

C. B; A

D. B; B

QUESTION: 30

A large centrifugal pump is driven by a 200 horsepower 4.16 kV ac motor. The motor breaker control circuit contains the following protection devices: instantaneous overcurrent relay, motor thermal overload relay, control power fuses, and an anti-pumping device.

The pump had been manually started and stopped several times during a 5-minute period when the motor breaker unexpectedly tripped. In this situation, which one of the following is the most likely cause of the breaker trip?

A. Instantaneous overcurrent

B. Motor thermal overload

C. Blown control power fuse

D. Anti-pumping device actuation

QUESTION: 31

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

Increasing the oil flow rate through the heat exchanger will cause the oil outlet temperature to
_____ and the cooling water outlet temperature to _____.

A. increase; increase

B. increase; decrease

C. decrease; increase

D. decrease; decrease

LUBE OIL HEAT EXCHANGER
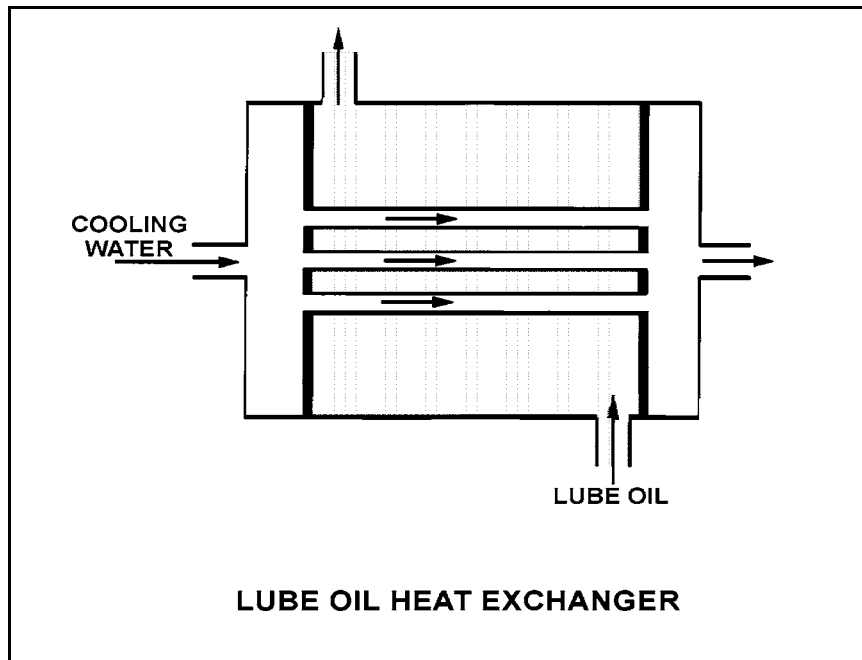
QUESTION: 32

Steam has been admitted to a condenser for 25 minutes with no cooling water during a condenser startup. Initiating full cooling water flow rate at this time will:

A. induce large thermal stresses on the condenser shell.

B. reduce the stress on the condenser tubes by gradually cooling the tubes.

C. reduce the stress on the condenser shell because the shell has been pre-warmed.

D. induce large thermal stresses on the junctions between the condenser tubes and the tubesheet.

QUESTION: 33

The discharge valve for a large operating centrifugal pump should be positioned slowly to minimize the:

A. change in available net positive suction head.

B. potential for causing water hammer.

C. differential pressure stress exerted on the valve disk and stem.

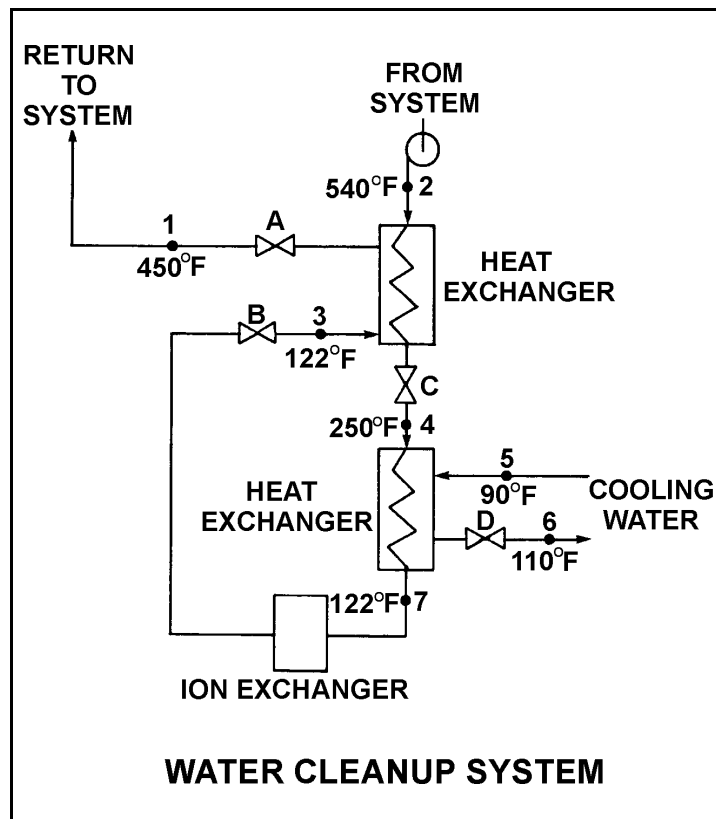D. mechanical wear on the valve seat and stem packing.

QUESTION: 34

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

Valves A, B, and C are fully open. Valve D is 20% open. All temperatures are as shown. Valve D is then quickly opened to 100%.

The temperature at point:

A. 3 will increase.

B. 4 will decrease.

C. 5 will decrease.

D. 7 will increase.

QUESTION: 35

Refer to the drawing of an operating cooling water system (see figure below).

Which one of the following effects would occur as a result of the failed tube in the heat exchanger?

A. Level in the surge tank increases.

B. Flow in the low pressure system reverses.

C. Pressure in the low pressure system decreases.

D. Low pressure fluid heat exchanger outlet temperature decreases.

COOLING WATER SYSTEM
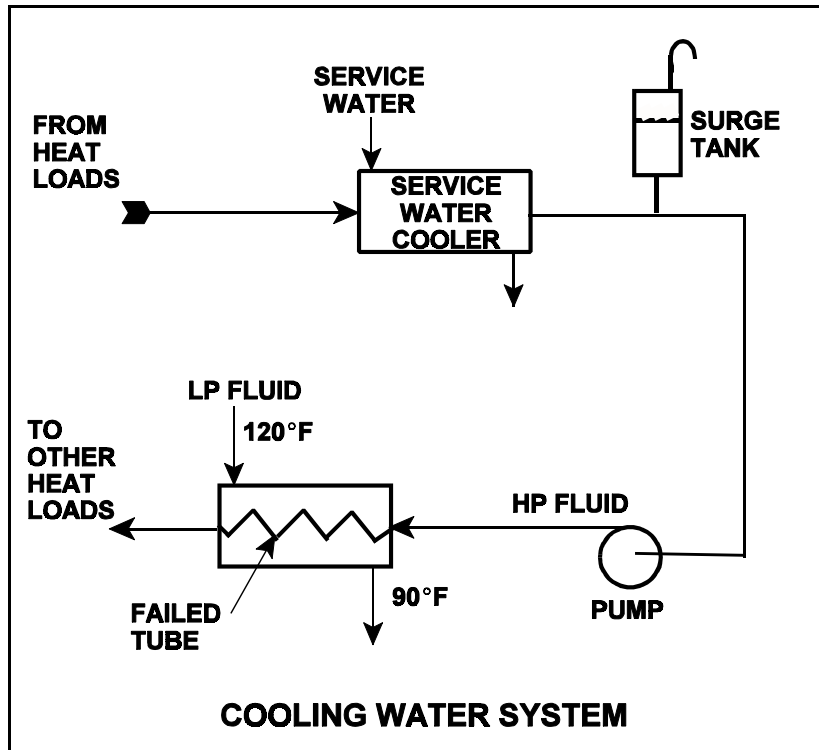
QUESTION: 36

A plant is operating at 100% power when air inleakage results in the buildup of noncondensible gases in the main condenser. Assume <u>no</u> operator or automatic actions occur that affect reactor power or turbine load.

Which one of the following will occur as a result of this air inleakage?

A. Decreased condensate temperature

B. Decreased pressure in the main condenser

C. Decreased suction pressure at the condensate pumps

D. Decreased condenser cooling water outlet temperature

QUESTION: 37

A demineralizer is being used in a water purification system. How will accumulation of suspended solids in the demineralizer affect performance of the demineralizer?

A. The rate of resin depletion will increase.

B. The flow rate of water through the demineralizer will increase.

C. The differential pressure across the demineralizer will decrease.

D. The rate of unwanted ion removal from the system will decrease.

QUESTION: 38

What percentage of impurities is being removed from the water passing through an ion exchanger if the ion exchanger has a decontamination factor of 25?

A. 99%

B. 96%

C. 88%

D. 75%

QUESTION: 39

Which one of the following conditions will lead to channeling in a demineralizer?

A. Suspended solids and insoluble particles forming a mat on the surface of the resin bed

B. A sudden $10°F$ decrease in the temperature of the influent to the demineralizer

C. Exhaustion of the resin bed due to high conductivity of the demineralizer influent

D. Operation of the demineralizer with influent flow rate at 10% below design flow rate

QUESTION: 40

While remotely investigating the condition of a normally-open motor control center (MCC) feeder breaker, an operator observes the following indications:

Green breaker position indicating light is out.
Red breaker position indicating light is lit.
MCC voltmeter indicates normal voltage.
MCC ammeter indicates zero amperes.

Based on these indications, the operator should report that the circuit breaker is _____ and racked _____.

A. open; in

B. closed; in

C. open; out

D. closed; out

QUESTION: 41

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

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

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

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

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

QUESTION: 42

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.)

An operator takes the control switch to "Open" momentarily and the valve begins to open. Five seconds later, the operator places and holds the switch in the "Close" position. Which one of the following describes the valve response with the switch held in the "Close" position?

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
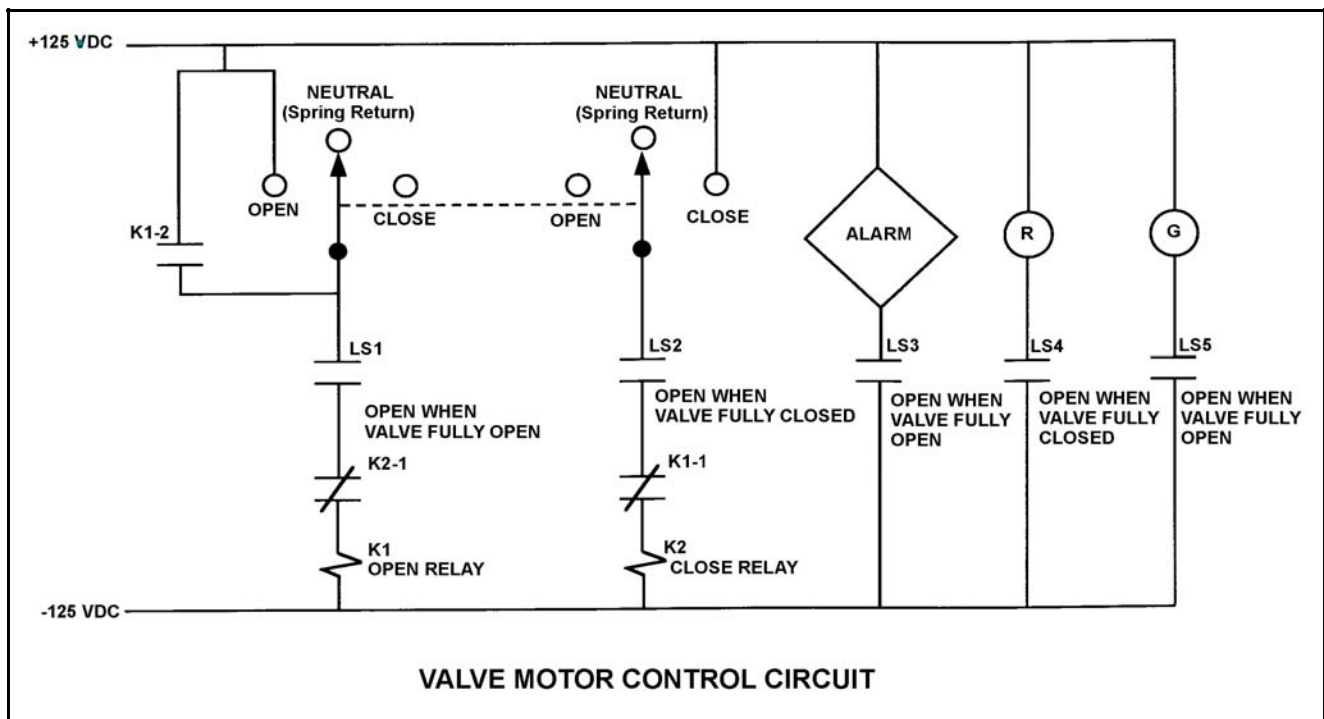
QUESTION: 43

Two identical 1000 MW electrical generators are operating in parallel supplying the same isolated electrical bus. The generator output breakers provide identical protection for the generators. Generator A and B output indications are as follows:

Generator A	Generator B
22 KV	22 KV
60.2 Hertz	60.2 Hertz
800 MW	800 MW
50 MVAR (out)	25 MVAR (in)

A malfunction causes the voltage regulator for generator B to slowly and continuously increase the terminal voltage for generator B. If no operator action is taken, generator B output current will:

A. increase continuously until the output breaker for generator A trips on overcurrent.

B. increase continuously until the output breaker for generator B trips on overcurrent.

C. initially decrease, and then increase until the output breaker for generator A trips on overcurrent.

D. initially decrease, and then increase until the output breaker for generator B trips on overcurrent.

QUESTION: 44

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
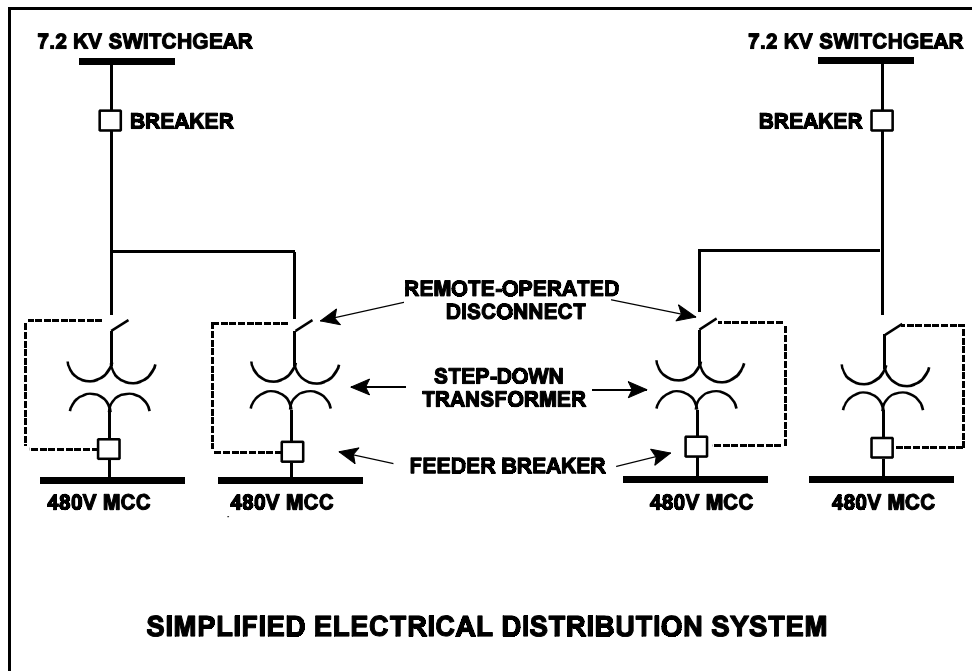
QUESTION: 45

During a brief time interval in a typical commercial nuclear reactor operating at the beginning of a fuel cycle, 10^5 delayed neutrons were emitted.

Approximately how many prompt neutrons were emitted in the reactor during this same time interval?

A. 1.5×10^5

B. 6.5×10^6

C. 1.5×10^7

D. 6.5×10^8

QUESTION: 46

The best neutron moderator is _____ and is composed of _____ atoms.

A. dense; large

B. not dense; large

C. dense; small

D. not dense; small

QUESTION: 47

Which one of the following is a benefit of installing excess reactivity (K_{excess}) in a reactor core?

A. Ensures that sufficient control rod negative reactivity is available to shut down the reactor.

B. Ensures that the reactor can be made critical during a peak xenon condition after a reactor scram.

C. Ensures that positive reactivity additions result in controllable reactor power responses.

D. Ensures that the U-235 fuel enrichment is the same at the beginning and the end of a fuel cycle..

QUESTION: 48

When determining shutdown margin for an operating reactor, how many control rod assemblies are assumed to remain fully withdrawn?

A. A single control rod of the highest reactivity worth

B. A symmetrical pair of control rods of the highest reactivity worth

C. A single control rod of average reactivity worth

D. A symmetrical pair of control rods of average reactivity worth

QUESTION: 49

A reactor plant that has been operating at rated power for two months experiences a reactor scram. One month after the reactor scram, with all control rods still fully inserted, a stable count rate of 20 cps is indicated on the source range nuclear instruments.

The majority of the source range detector output is being caused by the interaction of _____ with the detector.

A. intrinsic source neutrons

B. fission gammas from previous power operation

C. fission neutrons from subcritical multiplication

D. delayed fission neutrons from previous power operation

QUESTION: 50

A refueling outage has just been completed in which one-third of the core was replaced with new fuel assemblies. A reactor startup has been performed to mark the beginning of the sixth fuel cycle and power is being increased to 100%.

Which one of the following pairs of reactor fuels will be providing the greatest contribution to core heat production when the reactor reaches 100% power?

A. U-238 and Pu-239

B. U-238 and Pu-241

C. U-235 and U-238

D. U-235 and Pu-239

QUESTION: 51

Reactors A and B are identical except that the reactor cores are at different times in core life. The reactor A effective delayed neutron fraction is 0.007, and the reactor B effective delayed neutron fraction is 0.005. Both reactors are currently subcritical and stable with neutron flux level in the source range.

Given:

    Reactor A K_{eff} = 0.999
    Reactor B K_{eff} = 0.998

If positive 0.003 $\Delta K/K$ is suddenly added to each reactor, how will the resulting stable periods compare? (Consider only the reactor response while power is below the point of adding heat.)

A. Reactor A stable period will be shorter because it will have the higher positive reactivity in the core.

B. Reactor B stable period will be shorter because it has the smaller effective delayed neutron fraction.

C. Reactors A and B will have the same stable period because both reactors will remain subcritical.

D. Reactors A and B will have the same stable period because both reactors received the same amount of positive reactivity.

QUESTION: 52

How does control rod withdrawal affect the moderator temperature coefficient in an undermoderated reactor core?

A. The initially negative MTC becomes more negative.

B. The initially negative MTC becomes less negative.

C. The initially positive MTC becomes more positive.

D. The initially positive MTC becomes less positive.

QUESTION: 53

During a normal power increase from 20% to 100% near the beginning of a fuel cycle, the <u>smallest</u> negative reactivity addition will be caused by the change in:

A. void content.

B. fuel temperature.

C. xenon concentration.

D. moderator temperature.

QUESTION: 54

A group of control rods, initially at position 06 are withdrawn three notches. After withdrawal, this group of rods is classified as _____ rods; and the blade tips for this group of rods are positioned 36 inches from the _____ of the reactor core.

A. shallow; top

B. shallow; bottom

C. deep; top

D. deep; bottom

QUESTION: 55

Rod density is a measure of the total number of control rod notches _____ the core divided by the total number of control rod notches _____ the core.

A. inserted into; available in

B. inserted into; withdrawn from

C. withdrawn from; available in

D. withdrawn from; inserted into

QUESTION: 56

Which one of the following expresses the relationship between differential rod worth (DRW) and integral rod worth (IRW)?

A. DRW is the area under the IRW curve at a given rod position.

B. DRW is the slope of the IRW curve at a given rod position.

C. DRW is the IRW at a given rod position.

D. DRW is the square root of the IRW at a given rod position.

QUESTION: 57

The main reason for designing and operating a reactor with a flattened neutron flux distribution is to:

A. provide even burnup of control rods.

B. reduce neutron leakage from the core.

C. allow a higher average power density.

D. provide more accurate nuclear power indication.

QUESTION: 58

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

A. Uranium-235

B. Boron-10

C. Samarium-149

D. Xenon-135

QUESTION: 59

A fission product poison can be differentiated from all other fission products in that a fission product poison will:

A. be produced in direct proportion to the fission rate in the core.

B. remain radioactive for thousands of years after the final reactor criticality.

C. depress the power production in some core locations and cause peaking in others.

D. migrate out of the fuel pellets and into the reactor coolant via pinhole defects in the clad.

QUESTION: 60

A reactor has been operating at 25% power for five days when a scram occurs. Core xenon-135 negative reactivity will peak in approximately:

A. 2 hours.

B. 5 hours.

C. 10 hours.

D. 20 hours.

QUESTION: 61

Which one of the following explains why core Xe-135 oscillations are a concern in a reactor?

A. They can adversely affect core power distribution and can require operation below full rated power.

B. They can adversely affect core power distribution and can prevent a reactor startup following a reactor scram.

C. They can cause excessively short reactor periods during power operation and can require operation below full rated power.

D. They can cause excessively short reactor periods during power operation and can prevent a reactor startup following a reactor scram.

QUESTION: 62

Which one of the following describes a reason for the direction of change in core xenon-135 reactivity immediately after a reactor shutdown from long-term power operation?

A. The production rate of Xe-135 from I-135 decay significantly decreases.

B. The production rate of Xe-135 from fission significantly decreases.

C. The removal rate of Xe-135 by decay to I-135 significantly decreases.

D. The removal rate of Xe-135 by neutron absorption significantly decreases.

QUESTION: 63

A plant had been operating at 100% power for two months when a reactor scram occurred. Soon afterward, a reactor startup was performed. Twelve hours after the scram, the startup has been paused with reactor power at 2%.

To maintain reactor power stable at 2% over the next hour, the operator must add _____ reactivity because core xenon-135 concentration will be _____.

A. positive; increasing.

B. negative; increasing.

C. positive; decreasing.

D. negative; decreasing.

QUESTION: 64

Just prior to refueling, control rods are nearly fully withdrawn at 100% power. After refueling, the control rods are inserted much farther into the core at 100% power.

Which one of the following is the primary reason for the change in full power control rod position?

A. Reactivity from power defect at beginning of core life (BOL) is much greater than at end of core life (EOL).

B. Reactivity from void coefficient at EOL is much greater than at BOL.

C. The excess reactivity in the core at BOL is much greater than at EOL.

D. The integral control rod worth at EOL is much greater than at BOL.

QUESTION: 65

During a reactor startup, source range monitors (SRMs) indicate a stable count rate of 100 cps, and K_{eff} is 0.95. After a number of rods have been withdrawn, SRM indication stabilizes at 270 cps. Which one of the following is the new K_{eff}? (Assume reactor period is infinity before and after the rod withdrawal.)

A. 0.963

B. 0.972

C. 0.981

D. 0.990

QUESTION: 66

A reactor startup is in progress for a reactor that is in the middle of a fuel cycle. The reactor is at normal operating temperature and pressure. The main steam isolation valves are open and the main turbine bypass (also called steam dump) valves are closed. The reactor is near criticality.

Reactor period is stable at infinity when, suddenly, a turbine bypass valve fails open and remains stuck open, dumping steam to the main condenser. The operator immediately ensures <u>no</u> control motion is occurring and takes <u>no</u> further action. Assume that the reactor vessel water level remains stable, the reactor does <u>not</u> scram, and <u>no</u> other protective actions occur.

As a result of the valve failure, reactor period will initially become _____; and reactor power will stabilize _____ the point of adding heat.

A. positive; at

B. positive; above

C. negative, but soon turn; at

D. negative, but soon turn; above

QUESTION: 67

A reactor has just achieved criticality during a xenon-free reactor startup. Instead of stabilizing power at 10^3 cps per the startup procedure, the operator inadvertently allows reactor power to increase to 10^4 cps as indicated on the source range monitors.

Assuming reactor vessel coolant temperature and pressure do not change, the critical rod height at 10^4 cps will be _____ the critical rod height at 10^3 cps. (Neglect any effects of changes in fission product poisons.)

A. different but unpredictable compared to

B. less than

C. greater than

D. equal to

QUESTION: 68

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 positive 30-second reactor period. One minute later (prior to the point of adding heat) the operator inserts the same control rods for 25 seconds.

During the insertion, the reactor period will become:

A. infinity 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 before the control rods pass through the critical rod height.

QUESTION: 69

After taking critical data during a reactor startup, the operator establishes a stable positive 48-second reactor period to increase power to the point of adding heat (POAH). Which one of the following is the approximate amount of reactivity needed to stabilize power at the POAH? (Assume $\overline{\beta}_{eff} = 0.00579$.)

A. -0.10% ΔK/K

B. -0.12% ΔK/K

C. -0.01% ΔK/K

D. -0.012% ΔK/K

QUESTION: 70

With a reactor on a constant period of 180 seconds, which one of the following power changes requires the <u>longest</u> amount of time to occur?

A.   3% power to 5% power

B.   5% power to 15% power

C. 15% power to 30% power

D. 30% power to 60% power

QUESTION: 71

A reactor has been operating at full power for several months. Following a normal reactor shutdown, steam production will continue for a period of time, with the rate (Btu/hr) of steam production dependent upon the:

A. rate of reactor power decrease from full power to the point of adding heat.

B. pressure being maintained in the reactor pressure vessel (RPV).

C. previous power history of the plant and the time elapsed since shutdown.

D. recirculation flow rate and the water level being maintained in the RPV.

QUESTION: 72

Which one of the following is the purpose of a rod sequence exchange?

A. Ensures proper rod coupling

B. Prevents rod shadowing

C. Promotes even fuel burnout

D. Minimizes water hole peaking

QUESTION: 73

Refer to the drawing of four identical tank differential pressure level detectors (see figure below).

The tanks are identical and are presently at 2 psig overpressure, the same constant water level, and a temperature of 60°F. They are surrounded by atmospheric pressure. All level detectors have been calibrated and are producing the same level indication. A leak in the top of each tank causes a complete loss of overpressure in both tanks.

Which level detector(s) will produce the lowest level indication?

A. No. 1 only

B. No. 2 only

C. No. 1 and 4

D. No. 2 and 3

TANK DIFFERENTIAL PRESSURE LEVEL DETECTORS
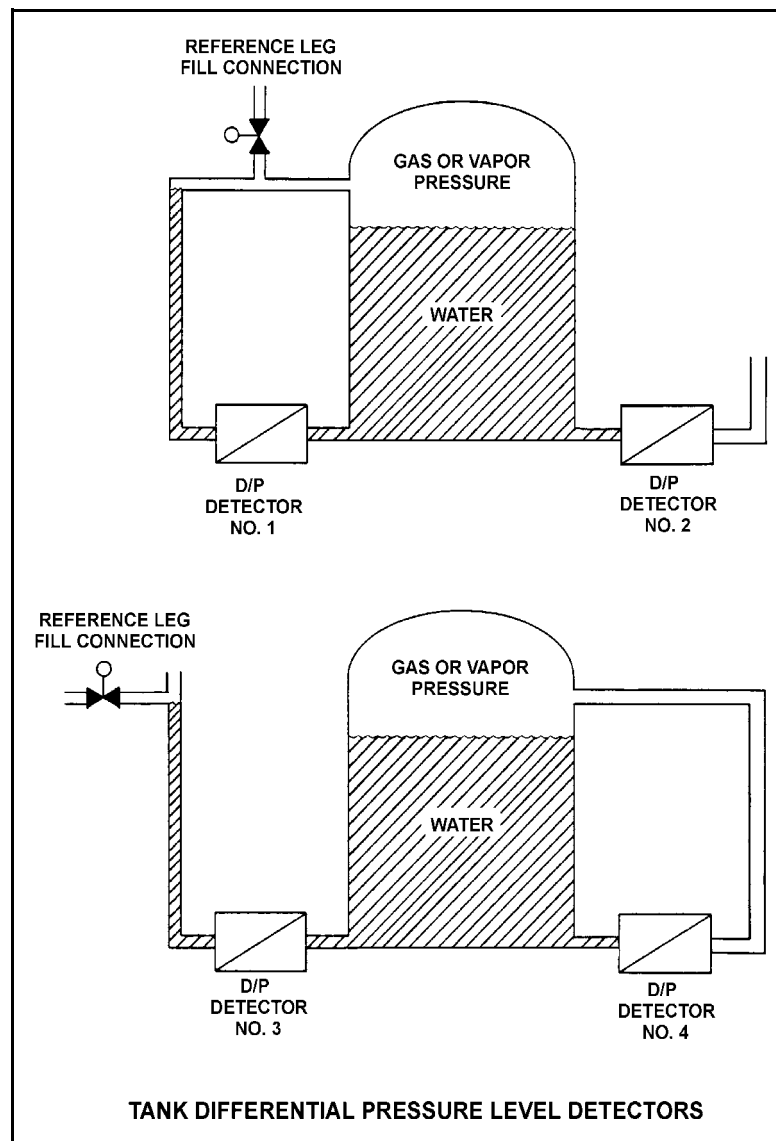
QUESTION: 74

A steam-water mixture is initially saturated with a quality of 50%, when a small amount of heat is added. Assuming pressure remains constant and the mixture remains saturated, mixture steam quality will _____ and mixture temperature will _____.

A. increase; increase

B. increase; remain the same

C. remain the same; increase

D. remain the same; remain the same

QUESTION: 75

Saturated steam (100% quality) at 1000 psia is being supplied to the inlet of a partially-open steam throttle valve on a main turbine. Pressure in the steam chest downstream of the throttle valve is 150 psia. Assume a typical throttling process with <u>no</u> heat gain or loss to/from the steam.

When compared to the conditions at the inlet to the throttle valve, which one of the following describes the conditions in the steam chest for specific enthalpy and entropy?

	Steam Chest Specific Enthalpy	Steam Chest Specific Entropy
A.	About the same	About the same
B.	About the same	Significantly higher
C.	Significantly lower	About the same
D.	Significantly lower	Significantly higher

QUESTION: 76

Steam entering an air ejector reaches sonic velocity in the throat of a convergent-divergent nozzle. Upon entering the divergent section of the nozzle, steam velocity will _____ and steam pressure will _____.

A. decrease; increase

B. increase; decrease

C. increase; increase

D. decrease; decrease

QUESTION: 77

A power plant is operating at 90% of rated power. Which one of the following describes the effect of increasing circulating water flow rate through the main condenser?

A. The saturation temperature in the main condenser decreases.

B. The enthalpy of the condensate leaving the main condenser increases.

C. The temperature of the circulating water leaving the main condenser increases.

D. The total rate of heat transfer from the turbine exhaust steam to the circulating water decreases.

QUESTION: 78

Steam turbines X and Y are identical 100% efficient turbines that exhaust to a condenser at 1.0 psia. Saturated steam at 250 psia enters turbine X. A moisture separator/reheater supplies turbine Y with superheated steam at 250 psia and 500°F.

Which one of the following lists the percentage of moisture in the exhaust of turbines X and Y?

	Turbine X	Turbine Y
A.	24.5%	20.5%
B.	26.3%	13.0%
C.	24.5%	13.0%
D.	26.3%	20.5%

QUESTION: 79
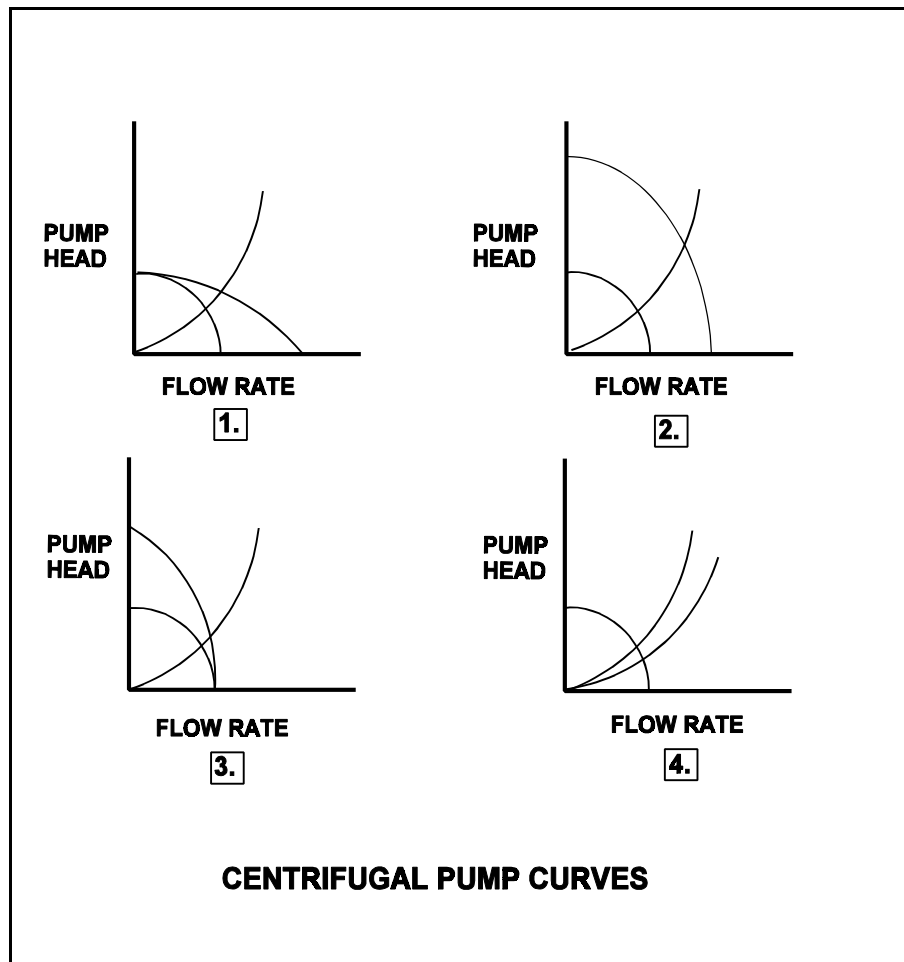
Refer to the drawing of four centrifugal pump operating curves (see figure below).

A two-speed centrifugal pump is operating at fast speed in a cooling water system and discharging through a heat exchanger. The pump is then switched to slow speed.

Which set of curves illustrates the initial and final operating conditions?

A. 1.

B. 2.

C. 3.

D. 4.

CENTRIFUGAL PUMP CURVES

QUESTION: 80

A reactor heatup is in progress. Which one of the following reactor temperatures will result in a main steam line pressure of approximately 530 psig?

A. 462°F

B. 468°F

C. 476°F

D. 484°F

QUESTION: 81

A reactor shutdown has been performed because of leakage from the main condenser cooling water system into the main condenser through a tube leak.

Given the following initial conditions:

    Main condenser pressure is 1.0 psia.
    Main condenser cooling water system pressure is 10 psig.
    Main condenser cooling water inlet temperature is 60°F.
    Cooling water leak rate into the main condenser is 100 gpm.

If the main condenser is brought to atmospheric pressure, with <u>no</u> changes to the main condenser cooling water system parameters, what will be the approximate rate of cooling water leakage into the main condenser?

A. 17 gpm

B. 28 gpm

C. 42 gpm

D. 65 gpm

QUESTION: 82

Which one of the following is the order of core heat transfer mechanisms, from the <u>least</u> desirable to the <u>most</u> desirable?

A. Film boiling, single-phase convection, nucleate boiling

B. Film boiling, nucleate boiling, single-phase convection

C. Single-phase convection, nucleate boiling, film boiling

D. Single-phase convection, film boiling, nucleate boiling

QUESTION: 83

Which one of the following actions will increase plant efficiency?

A. Increasing turbine inlet steam moisture content

B. Increasing condensate depression

C. Decreasing turbine exhaust pressure

D. Decreasing temperature of feed water entering the reactor vessel

QUESTION: 84

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 feedwater temperature used in the heat balance calculation was lower than actual feed water temperature.

B. The reactor recirculation pump heat input term was omitted from the heat balance calculation.

C. The feed flow rate used in the heat balance calculation was lower than actual feed flow rate.

D. The steam pressure used in the heat balance calculation was lower than actual steam pressure.

QUESTION: 85

A reactor is operating at steady state 90% power. Which one of the following will cause the two-phase coolant flowing upward in a fuel channel to become closer to the onset of transition boiling? (Assume reactor power does <u>not</u> change unless stated.)

A. Reactor pressure increases.

B. Recirculation flow increases.

C. Feedwater temperature decreases.

D. Associated bundle power decreases.

QUESTION: 86

Core inlet subcooling is defined as the difference between the temperature of the fluid _____ and the saturation temperature of the fluid in the core inlet plenum.

A. in the core inlet plenum

B. at the feedwater pump discharge

C. in the downcomer area

D. in the lower fuel channel area

QUESTION: 87

A reactor is operating at 70% power. Recirculation flow rate is increased by 5%.

Which one of the following statements describes the initial response of the boiling boundary within the core?

A. It physically moves up the fuel rods, because fewer Btus per pound mass of water are now being transferred.

B. It physically moves up the fuel rods, because more Btus per pound mass of water are now being transferred.

C. It physically moves down the fuel rods, because more Btus per pound mass of water are now being transferred.

D. It physically moves down the fuel rods, because fewer Btus per pound mass of water are now being transferred.

QUESTION: 88

Refer to the drawing of a fuel rod and coolant flow channel at the beginning of core life (see figure below).

At 100% reactor power, the <u>greatest</u> temperature difference in a typical fuel channel radial temperature profile will occur across the:

A. fuel centerline to fuel surface.

B. fuel-to-clad gap.

C. zircaloy cladding.

D. flow channel boundary (laminar) layer.

FUEL ROD AND COOLANT FLOW CHANNEL
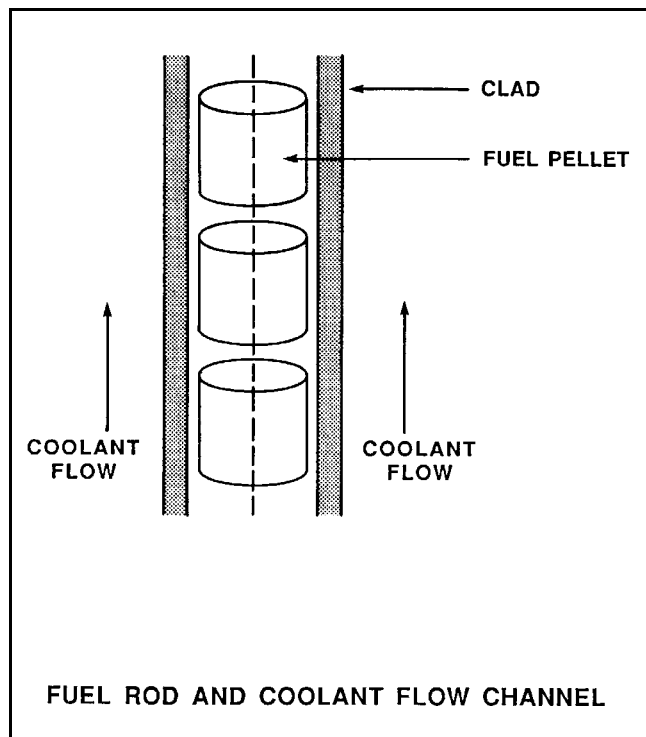
QUESTION: 89

Single-phase coolant flow resistance (head loss) in a reactor core is directly proportional to the square of coolant _____ and inversely proportional to _____.

A. velocity; fuel assembly length

B. temperature; fuel assembly length

C. velocity; coolant channel cross-sectional area

D. temperature; coolant channel cross-sectional area

QUESTION: 90

Which one of the following occurs as a result of reactor core orifices?

A. The core differential pressure is minimized at all power levels.

B. The total core coolant flow rate remains the same at all power levels.

C. The total core coolant flow rate is divided equally through all bundles at all power levels.

D. The highest bundle coolant flow rates exist in core interior bundles at all power levels.

QUESTION: 91

Which one of the following statements describes natural circulation in a shut down reactor? (Assume <u>no</u> isolation condenser.)

A. The moisture separators return the liquid portion of the coolant mixture exiting the core to the downcomer where it cools and increases in density.

B. The jet pump diffusers establish a thermal driving head by increasing the velocity of the coolant as it flows downward through the diffuser.

C. Coolant flows from the downcomer into a reactor recirculation loop and is returned to the core.

D. Emergency coolant injection establishes a thermal driving head by providing cold coolant to the downcomer.

QUESTION: 92

The linear heat generation rate (LHGR) for a reactor core is acceptable if _____ is being maintained at _____.

A. LHGR-limit/LHGR-actual; 0.95

B. LHGR-actual/LHGR-limit; 1.05

C. LHGR-limit/LHGR-actual; 1.10

D. LHGR-actual/LHGR-limit; 1.15

QUESTION: 93

If the linear heat generation rate (LHGR) limiting condition for operation is exceeded, the most probable type of fuel failure is cladding:

A. cracking due to high stress.

B. gross failure due to a lack of cooling.

C. embrittlement due to excessive oxidation.

D. distortion due to inadequate cooling of the clad.

QUESTION: 94

Which one of the following describes the basis for the 2,200°F maximum fuel clad temperature limit?

A. 2,200°F is approximately 500°F below the fuel clad melting temperature.

B. The rate of the zircaloy-steam reaction increases significantly above 2,200°F.

C. If fuel clad temperature reaches 2,200°F, the onset of transition boiling is imminent.

D. The differential expansion between the fuel pellets and the fuel clad becomes excessive above 2,200°F.

QUESTION: 95

If a reactor is being operated with the minimum critical power ratio (MCPR) at its transient limit, which one of the following is indicated?

A. None of the fuel rods are experiencing critical heat flux.

B. A small fraction of the fuel rods may be experiencing critical heat flux.

C. All radioactive fission products are being contained within the reactor fuel.

D. All radioactive fission products are being contained within either the reactor fuel or the reactor vessel.

QUESTION: 96

For what operational condition does the flow biasing correction factor (K_f) adjust the minimum critical power ratio?

A. Operation at less than rated steam flow

B. Operation at greater than rated steam flow

C. Operation at less than rated core flow

D. Operation at greater than rated core flow

QUESTION: 97

A step increase in reactor power results in a fuel cladding surface temperature increase from 550°F to 580°F at steady state conditions. The fuel thermal time constant is 6 seconds.

Which one of the following is the approximate fuel cladding surface temperature 6 seconds after the power change?

A. 571°F

B. 569°F

C. 565°F

D. 561°F

QUESTION: 98

Select the cause for the reduction in the size of the gap between the fuel pellet and the clad over core life.

A. Contraction of the clad due to zirconium hydriding

B. Expansion of the fuel pellets due to fission product buildup

C. Contraction of the clad due to fuel rod internal vacuum

D. Expansion of the fuel pellets due to densification

QUESTION: 99

Which one of the following will prevent brittle fracture failure of a reactor vessel?

A. Manufacturing the reactor vessel from low carbon steel

B. Maintaining reactor vessel pressure below the maximum design limit

C. Operating above the reference temperature for nil-ductility transition (RT_{NDT})

D. Maintaining the number of reactor vessel heatup/cooldown cycles within limits

QUESTION: 100

A reactor is shut down for refueling following 18 months of operation at an average power level of 85%. During the shutdown, a reactor vessel metal specimen is removed from the reactor vessel for testing. The testing indicates that the nil-ductility transition (NDT) temperature of the specimen has decreased from 44°F to 32°F since the last refueling.

Which one of the following conclusions is warranted?

A. The test results are credible and the reactor vessel is <u>more</u> likely to experience brittle fracture now than after the last refueling.

B. The test results are credible and the reactor vessel is <u>less</u> likely to experience brittle fracture now than after the last refueling.

C. The test results are questionable because the actual specimen NDT temperature would <u>not</u> decrease during the described 18-month period of operation.

D. The test results are questionable because the actual specimen NDT temperature would decrease by much <u>less</u> than indicated by the test results.

*** FINAL ANSWER KEY ***

OCTOBER 2002 NRC GENERIC FUNDAMENTALS EXAMINATION
BOILING WATER REACTOR - ANSWER KEY

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