

**UNITED STATES NUCLEAR REGULATORY COMMISSION  
PRESSURIZED WATER REACTOR GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003--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 pressurized water reactor (PWR) nuclear 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**

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

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

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

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

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

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

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

$$\text{SUR} = 26.06/\tau$$

$$\tau = \frac{\bar{\beta} - \rho}{\lambda_{\text{eff}} \rho}$$

$$\rho = \frac{\ell^*}{\tau} + \frac{\bar{\beta}}{1 + \lambda_{\text{eff}}\tau}$$

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

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

$$\text{DRW} \propto \phi_{\text{tip}}^2 / \phi_{\text{avg}}^2$$

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

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

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

$$\text{CR}_{\text{S/D}} = S/(1 - K_{\text{eff}})$$

$$\text{CR}_1(1 - K_{\text{eff1}}) = \text{CR}_2(1 - K_{\text{eff2}})$$

$$1/M = \text{CR}_1/\text{CR}_X$$

$$A = \pi r^2$$

$$F = PA$$

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

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

$$E = IR$$

$$\text{Eff.} = \text{Net Work Out/Energy In}$$

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

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

**CONVERSIONS**

---

$$1 \text{ Mw} = 3.41 \times 10^6 \text{ Btu/hr}$$

$$1 \text{ hp} = 2.54 \times 10^3 \text{ Btu/hr}$$

$$1 \text{ Btu} = 778 \text{ ft-lbf}$$

$$^\circ\text{C} = (5/9)(^\circ\text{F} - 32)$$

$$^\circ\text{F} = (9/5)(^\circ\text{C}) + 32$$

$$1 \text{ Curie} = 3.7 \times 10^{10} \text{ dps}$$

$$1 \text{ kg} = 2.21 \text{ lbm}$$

$$1 \text{ gal}_{\text{water}} = 8.35 \text{ lbm}$$

$$1 \text{ ft}^3_{\text{water}} = 7.48 \text{ gal}$$

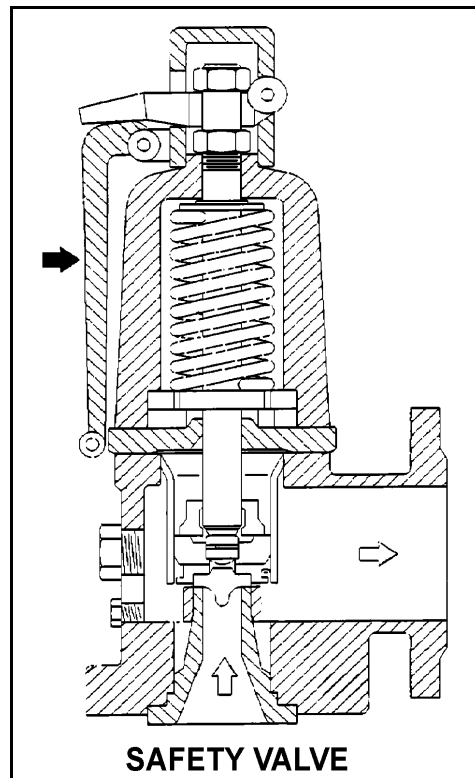
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QUESTION: 1

Refer to the drawing of a typical safety valve (see figure below).

The component indicated by the solid arrow is used by the operator to manually...

- A. ratchet open the safety valve.
- B. pop open the safety valve.
- C. gag shut the safety valve.
- D. determine the position of the safety valve.



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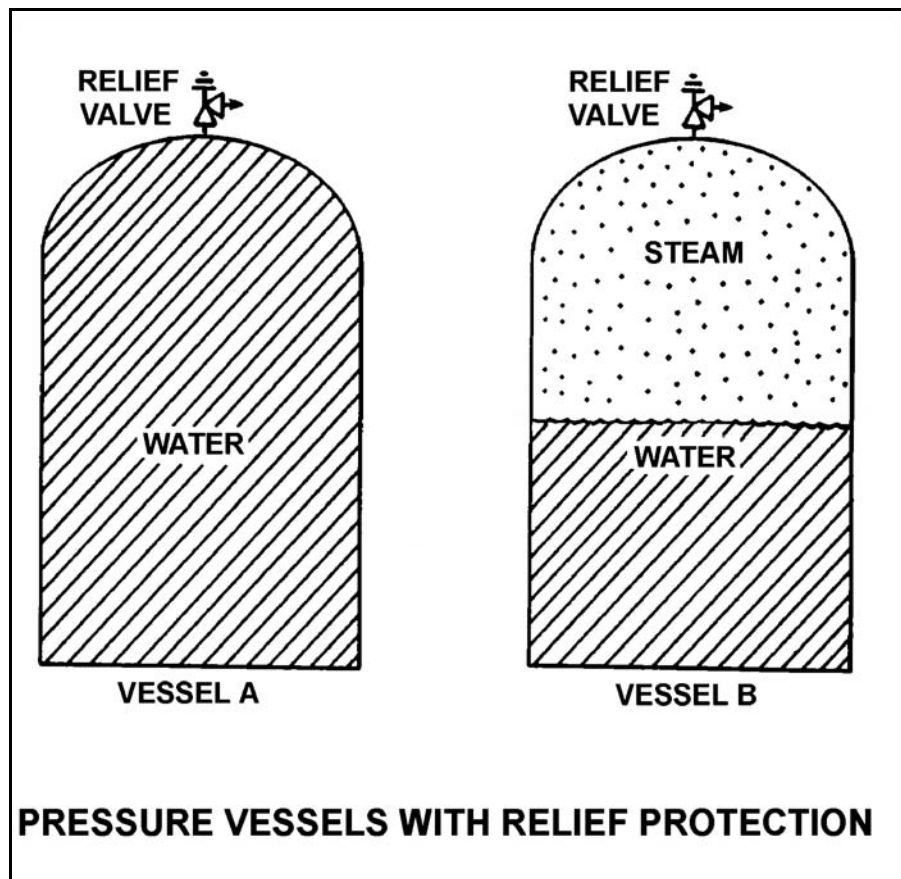
QUESTION: 2

Refer to the drawing of two identical pressure vessels with identical relief valve 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



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QUESTION: 3

Two common types of check valves used in nuclear power plants are...

- A. globe and gate.
- B. ball and plug.
- C. swing and lift.
- D. needle and angle.

QUESTION: 4

In a comparison between ball valves and butterfly valves in the same liquid process system application, the valves that typically are more leak-tight when fully closed and under high differential pressure are \_\_\_\_\_ valves; and the valves that typically result in the higher system pressure drop when fully open are \_\_\_\_\_ valves.

- A. ball; butterfly
- B. ball; ball
- C. butterfly; butterfly
- D. butterfly; ball

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QUESTION: 5

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: 6

A properly calibrated water flow detector is located several feet below a horizontal pipe containing the detector's sensing element. The detector is removed for inspection and then reconnected to the sensing element with its low-pressure sensing line filled with air and its high-pressure sensing line filled with water.

If the water system is operating, indicated flow rate will be...

- A. zero.
- B. equal to actual flow rate but greater than zero.
- C. lower than actual flow rate.
- D. higher than actual flow rate.

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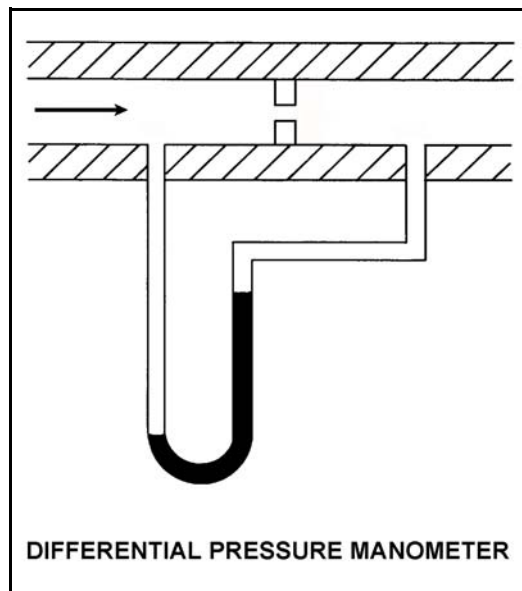
QUESTION: 7

Refer to the drawing of a differential pressure manometer (see figure below).

The manometer is filled with water and installed across an orifice in a ventilation duct to determine the rate of air flow. The manometer is currently indicating a water level difference of 16 inches at an air flow rate of 300 ft<sup>3</sup>/min.

Which one of the following will be the approximate rate of air flow when the manometer indicates a water level difference of 4 inches?

- A. 75 ft<sup>3</sup>/min.
- B. 125 ft<sup>3</sup>/min.
- C. 150 ft<sup>3</sup>/min.
- D. 175 ft<sup>3</sup>/min.





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QUESTION: 8

Refer to the drawing of a pressurizer differential pressure (D/P) level detector (see figure below).

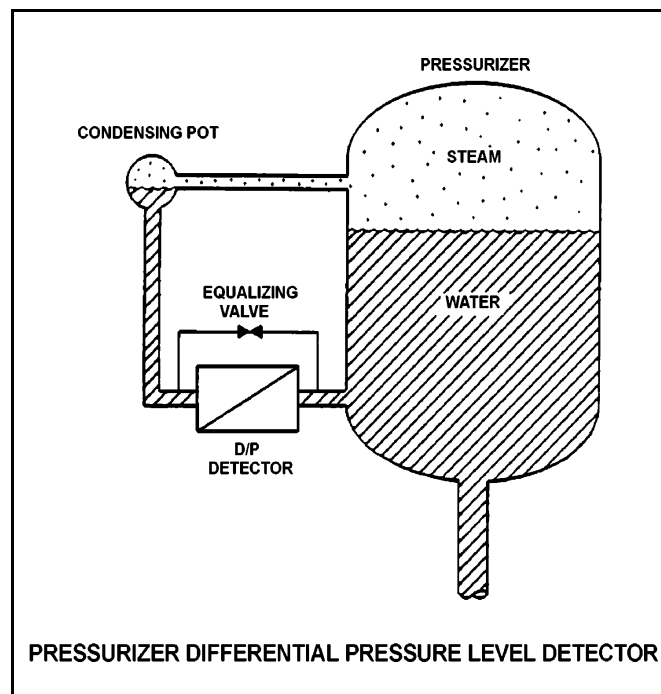
A reactor is shutdown with the reactor coolant system being maintained at 100 psia. The level detector has just been calibrated. Suddenly a rupture in the condensing pot of the level detector results in a rapid drop of the condensing pot pressure to atmospheric pressure.

Given the following current conditions:

- The condensing pot is at atmospheric pressure.
- Pressurizer pressure is 98 psia and slowly decreasing.
- Bulk reference leg temperature is 120°F.
- Actual pressurizer level has not changed significantly.

Which one of the following describes the current pressurizer level indication from the detector?

- A. Offscale low because the bulk of the water in the reference leg has flashed to steam.
- B. Offscale high because the bulk of the water in the reference leg has flashed to steam.
- C. Offscale low because the static pressure on the reference leg is much less than the static pressure in the pressurizer.
- D. Offscale high because the static pressure on the reference leg is much less than the static pressure in the pressurizer.



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QUESTION: 9

In a diaphragm type pressure detector, pressure is measured using the \_\_\_\_\_ of the diaphragm.

- A. rotational movement
- B. axial deflection
- C. change in circumference
- D. change in diameter

QUESTION: 10

The water pressure within a cooling water system is 100 psig, as indicated by a bourdon tube pressure detector. The cooling water system and the detector are located inside a reactor containment building. The pressure detector case is vented to the containment building, which is currently at atmospheric pressure.

If a steam line rupture raises the containment building pressure by 20 psig, the cooling water system pressure indication will: (Disregard any temperature effect on the detector.)

- A. increase to 120 psig.
- B. increase by a small, but indeterminate amount.
- C. decrease by a small, but indeterminate amount.
- D. decrease to 80 psig.

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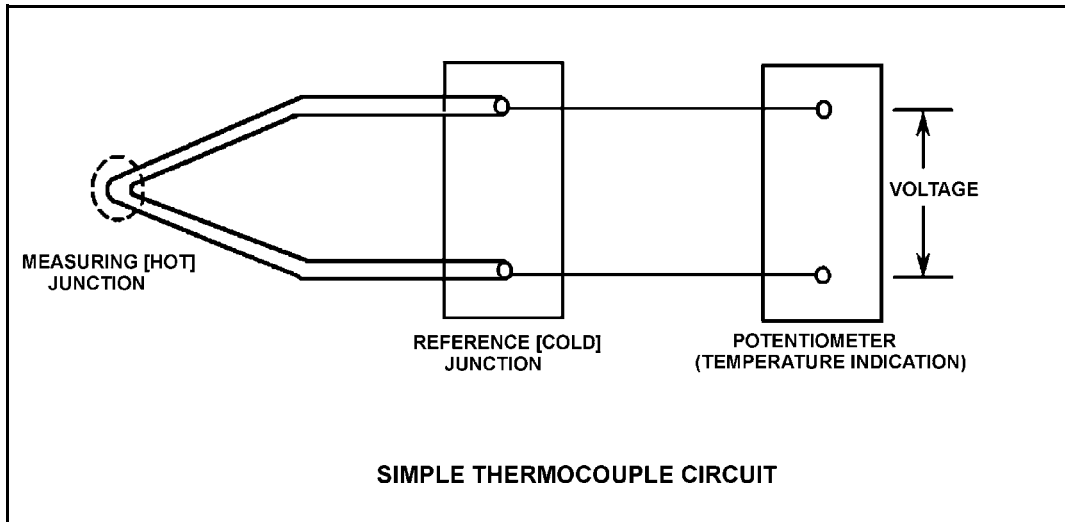
QUESTION: 11

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

Thermocouple temperature indication is currently  $150^{\circ}\text{F}$ . Reference junction temperature is currently  $90^{\circ}\text{F}$ . Indicator range is from  $0^{\circ}\text{F}$  to  $2000^{\circ}\text{F}$ .

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 ( $0^{\circ}\text{F}$ )
- B.  $60^{\circ}\text{F}$
- C.  $90^{\circ}\text{F}$
- D. Maximum instrument reading ( $2000^{\circ}\text{F}$ )



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QUESTION: 12

Reed switches are being used in an electrical measuring circuit to monitor the position of a control rod in a reactor. The reed switches are mounted in a column above the reactor vessel such that the control rod drive shaft passes by the reed switches as the control rod is withdrawn.

Which one of the following describes the action that causes the electrical output of the measuring circuit to change as the control rod is withdrawn?

- A. An ac coil on the control rod drive shaft induces a voltage into each reed switch as the drive shaft passes by.
- B. A metal tab on the control rod drive shaft mechanically closes each reed switch as the drive shaft passes by.
- C. The primary and secondary coils of each reed switch attain maximum magnetic coupling as the drive shaft passes by.
- D. A permanent magnet on the control rod drive shaft attracts the movable contact arm of each reed switch as the drive shaft passes by.

QUESTION: 13

A plant startup is in progress immediately following a reactor refueling outage. The external nuclear instrumentation (NI) was calibrated at 90% power just prior to the refueling outage and has not been readjusted.

If actual reactor power level is stabilized at 90%, NI power level will be \_\_\_\_\_ than actual reactor power level because, when compared to pre-outage 90% power level operation, \_\_\_\_\_.

- A. lower; the total core fission rate has decreased.
- B. higher; the total core fission rate has increased
- C. lower; the fission rate in the outer portion of the core has decreased
- D. higher; the fission rate in the outer portion of the core has increased

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QUESTION: 14

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

- A. decrease because fewer secondary ionizations are occurring in the detector.
- B. decrease because more primary ions are recombining in the detector prior to reaching the electrodes.
- C. stay approximately the same because the ion chamber is still operating at saturated conditions.
- D. stay approximately the same because all of the primary ions were already being collected at the higher voltage.

QUESTION: 15

If the turbine shaft speed signal received by a typical turbine governor control system fails low during turbine startup, the turbine governor will cause turbine speed to...

- A. decrease to a minimum speed setpoint.
- B. increase, until the mismatch with demanded turbine speed is nulled.
- C. decrease, until the mismatch with demanded turbine speed is nulled.
- D. increase, until an upper limit is reached or the turbine trips on overspeed.

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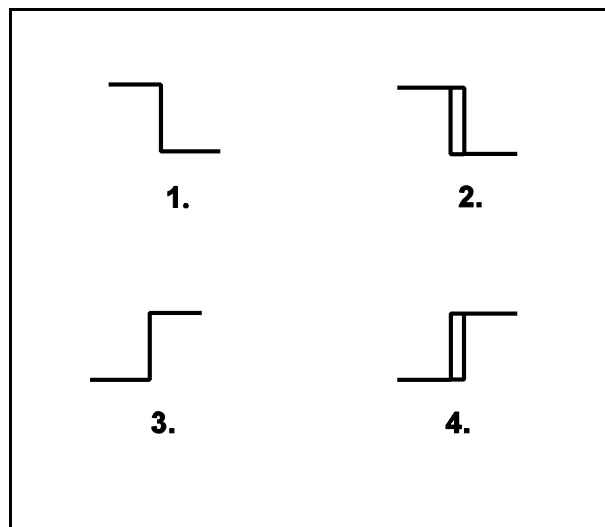
QUESTION: 16

Refer to the drawing of four bistable symbols (see figure below).

A temperature controller uses a bistable that turns on to actuate a warning light when controlled temperature reaches a low setpoint. The warning light extinguishes immediately after temperature increases above the low setpoint.

Which one of the following bistable symbols indicates the characteristics of the bistable?

- A. 1.
- B. 2.
- C. 3.
- D. 4.



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QUESTION: 17

Which one of the following describes the operation of a typical pneumatic valve positioner?

- A. Compares the valve controller demand signal with actual valve position and sends an error signal to the valve controller for adjustment of the demand signal.
- B. Compares the valve controller automatic and manual setpoints and sends an error signal to the valve controller to ensure the manual demand signal is tracking the automatic demand signal.
- C. Receives a valve position error signal from the valve controller and positions the valve as necessary to null the valve position error signal.
- D. Receives a demand signal from the valve controller and supplies the appropriate air pressure to the valve actuator to move the valve to the demanded position.

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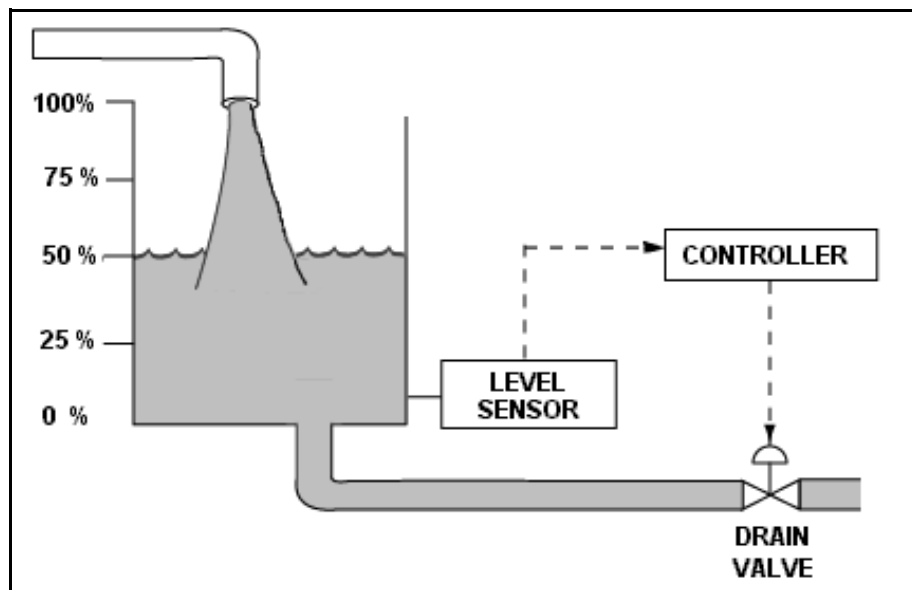
QUESTION: 18

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 level 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 input flow rate suddenly increases to 700 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%; 50% open
- C. above 50%; more than 50% open
- D. above 50%; 50% open





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QUESTION: 19

Prior to shifting a valve controller from automatic to manual control, why should the automatic and manual controller output signals be matched?

- A. To ensure the valve will operate in manual control upon demand.
- B. To ensure valve position indication is accurate in manual control.
- C. To move the valve to the new position prior to the transfer.
- D. To prevent a sudden valve repositioning during the transfer.

QUESTION: 20

Which one of the following contains indications of a gas/vapor bound motor-operated centrifugal pump that is operating in a cooling water system?

- A. Fluctuating pump discharge pressure, reduced system flow rate, and increased pump motor current
- B. Reduced system flow rate, increased pump motor current, and increased pump noise level
- C. Increased pump motor current, increased pump noise level, and fluctuating pump discharge pressure
- D. Increased pump noise level, fluctuating pump discharge pressure, and reduced system flow rate

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QUESTION: 21

A centrifugal pump is taking suction on an open storage tank that has been filled to a level of 40 feet with 10,000 gallons of 60°F water. The pump is located at the base of the tank, takes a suction from the bottom of the tank, and discharges through a fire hose.

Given:

- The pump is currently operating at its design flow rate of 200 gpm and a total developed head of 150 feet.
- The pump requires 4 feet of net positive suction head (NPSH).

How will the centrifugal pump flow rate be affected as the water storage tank level decreases?

- A. Flow rate will remain constant until the pump begins to cavitate at a tank level of about 4 feet.
- B. Flow rate will remain constant until the pump becomes air bound when the tank empties.
- C. Flow rate will gradually decrease until the pump begins to cavitate at a tank level of about 4 feet.
- D. Flow rate will gradually decrease until the pump becomes air bound when the tank empties.

QUESTION: 22

An ac motor-driven centrifugal water pump was just started. During the start, motor current remained peaked for 2 seconds, and then decreased and stabilized at about one-fifth the standard running current. Normally, the starting current peak lasts about 4 seconds.

Which one of the following could have caused the abnormal start indications above?

- A. The pump shaft was seized and the motor breaker opened.
- B. The pump was initially rotating slowly in the reverse direction.
- C. The pump was initially air bound, and then primed itself after 2 seconds of operation.
- D. The coupling between the motor and pump shafts was left unfastened after maintenance.

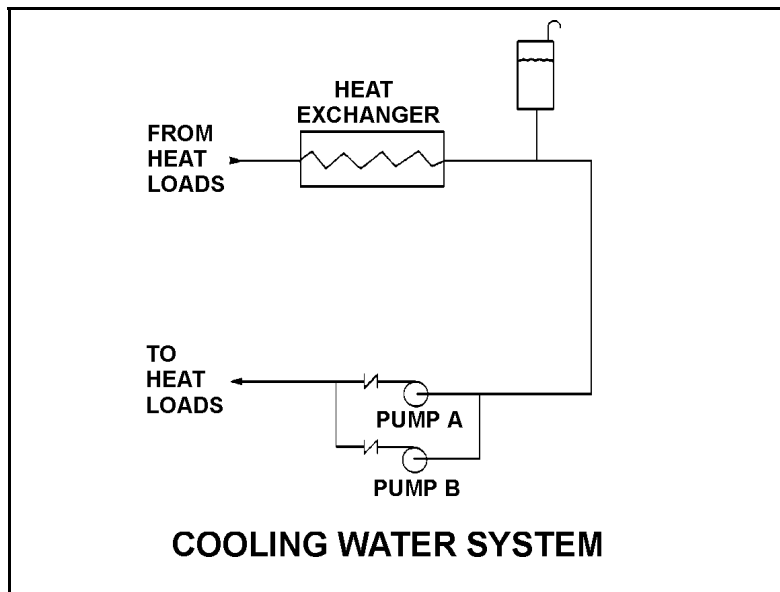
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QUESTION: 23

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

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

- A. more than one-half the original flow.
- B. one-half the original flow.
- C. the same; only the pump head will change.
- D. less than one-half the original flow.



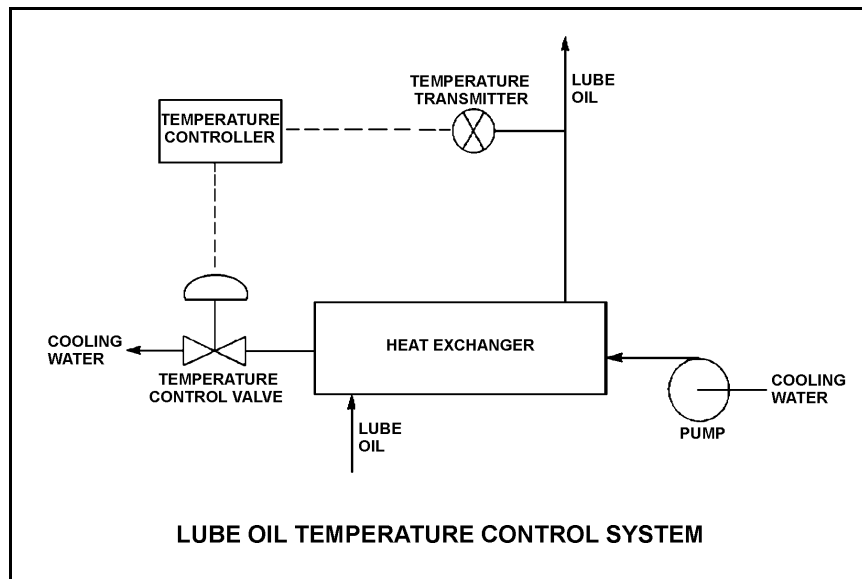
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QUESTION: 24

Refer to the drawing of a lube oil temperature control system (see figure below).

The pump is operating with the temperature control valve one-half open. If the temperature control valve modulates farther closed, system head loss will \_\_\_\_\_ and pump head will \_\_\_\_\_.

- A. increase, decrease
- B. increase, increase
- C. decrease, decrease
- D. decrease, increase



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QUESTION: 25

If the speed of a positive displacement pump is increased, the available net positive suction head will \_\_\_\_\_ and the probability of cavitation will \_\_\_\_\_.

- A. increase; increase
- B. decrease; decrease
- C. increase; decrease
- D. decrease; increase

QUESTION: 26

When starting a positive displacement pump, why must the pump discharge valve be fully open?

- A. Ensures integrity of the pump and system piping
- B. Prevents pump cavitation
- C. Reduces motor starting current
- D. Minimizes the potential for water hammer

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QUESTION: 27

If a motor bearing seizes on an operating motor, which one of the following breaker trip signals will trip the motor breaker?

- A. Instantaneous overcurrent
- B. Time-delayed overcurrent
- C. Underfrequency
- D. Undervoltage

QUESTION: 28

A diesel generator (D/G) is supplying an electrical bus that is connected to an infinite power grid. Assuming D/G terminal voltage and bus frequency do not change, if the D/G governor set point is increased from 60.0 Hz to 60.1 Hz, D/G kVAR load 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

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QUESTION: 29

A multi-speed motor-driven centrifugal pump is operating with the following parameters:

Motor current = 27 amps  
Pump head = 50 psi  
Pump flow rate = 880 gpm

Which one of the following will be the approximate new value of pump head if pump speed is increased such that the motor current is now 64 amperes?

- A. 89 psi
- B. 119 psi
- C. 211 psi
- D. 281 psi

QUESTION: 30

A main turbine-generator is operating in parallel with an infinite power grid. If the turbine control valves (or throttle valves) slowly fail open, the generator will experience high current primarily due to: (Assume no generator protective actuations occur.)

- A. excessive generator MWe.
- B. excessive generator KVAR (VARs out).
- C. excessive generator KVAR (VARs in).
- D. generator reverse power.

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QUESTION: 31

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



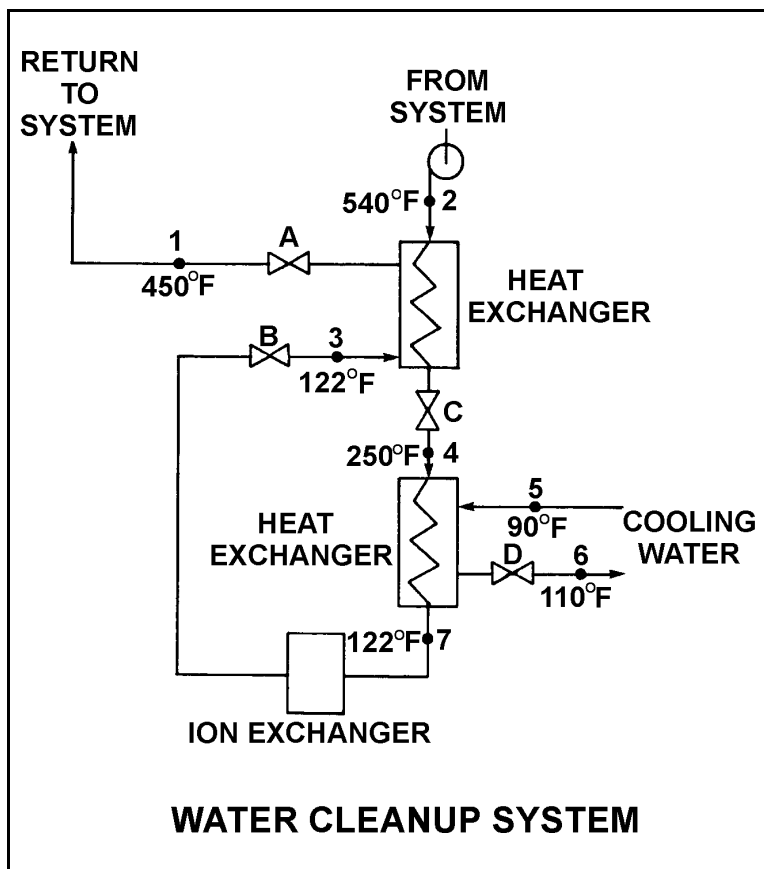
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QUESTION: 32

Refer to the drawing of an operating water cleanup system (see figure below). All valves are identical and are initially 50% open.

To raise the temperature at point 7, the operator should adjust valve \_\_\_\_\_ in the close direction.

- A. A
- B. B
- C. C
- D. D



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QUESTION: 33

A main turbine-generator was operating at 80% load with the following initial steady-state cooling water and lube oil temperatures for the main turbine lube oil heat exchanger:

$$\begin{aligned}T_{\text{oil in}} &= 174^{\circ}\text{F} \\T_{\text{oil out}} &= 114^{\circ}\text{F} \\T_{\text{water in}} &= 85^{\circ}\text{F} \\T_{\text{water out}} &= 115^{\circ}\text{F}\end{aligned}$$

Six months later, the following current steady-state heat exchanger temperatures are observed:

$$\begin{aligned}T_{\text{oil in}} &= 177^{\circ}\text{F} \\T_{\text{oil out}} &= 111^{\circ}\text{F} \\T_{\text{water in}} &= 85^{\circ}\text{F} \\T_{\text{water out}} &= 115^{\circ}\text{F}\end{aligned}$$

Assume that the total heat exchanger heat transfer coefficient and the cooling water flow rate do not change, and that the specific heat values for the cooling water and lube oil do not change.

Which one of the following could be responsible for the differences between the initial and current steady-state heat exchanger temperatures?

- A. The current main turbine-generator load is lower than the initial load.
- B. The current main turbine-generator load is higher than the initial load.
- C. The current main turbine lube oil flow rate is less than the initial flow rate.
- D. The current main turbine lube oil flow rate is greater than the initial flow rate.

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QUESTION: 34

A nuclear power plant is operating at 100% power when air leakage results in the buildup of noncondensable gases in the main condenser. Which one of the following will decrease as a result of this air leakage?

- A. Condensate temperature
- B. Pressure in the main condenser
- C. Suction pressure at the condensate pumps
- D. Condenser cooling water outlet temperature

QUESTION: 35

A lower than expected differential pressure across a demineralizer is an indication of...

- A. depletion of the cation resin.
- B. channeling through the resin bed.
- C. improper resin regeneration.
- D. excessive accumulation of suspended solids.

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QUESTION: 36

A PWR nuclear power plant has two identical mixed resin bed reactor coolant ion exchangers, A and B, which were each conditioned and placed in parallel service continuously for about two weeks with the plant at full power after a refueling outage. Then, ion exchanger A was isolated for standby use while ion exchanger B remained in service. After 10 months of continuous operation at full power, it is necessary to place ion exchanger A in service and isolate ion exchanger B.

Which one of the following describes why the effluent from ion exchanger A is initially drained to a collection facility prior to placing the ion exchanger in service?

- A. To avoid an undesired increase in reactor coolant pH.
- B. To avoid an undesired decrease in reactor coolant pH.
- C. To avoid an undesired increase in reactor coolant boron concentration.
- D. To avoid an undesired decrease in reactor coolant boron concentration.

QUESTION: 37

After 12 months of operation at 100% power, a reactor is shutdown with a plant cooldown in progress. An operator reports that the general area radiation levels around the operating shutdown cooling pumps have increased significantly since the cooldown started several hours ago.

Which one of the following is a typical cause of these indications, resulting from the cooldown?

- A. Increased radioactive tritium in the reactor coolant
- B. Increased radioactive nitrogen-16 in the reactor coolant
- C. Increased radioactive oxygen dissolved in the reactor coolant
- D. Increased radioactive corrosion products suspended in the reactor coolant

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 38

Which one of the following describes the normal operation of a local breaker overcurrent trip flag indicator?

- A. Actuates when no lockout is present; satisfies an electrical interlock to remotely close a breaker.
- B. Actuates when a breaker overcurrent trip has occurred; can be manually reset when the overcurrent condition clears.
- C. Actuates when a breaker has failed to trip on an overcurrent condition; can be manually reset when the overcurrent condition clears.
- D. Actuates to cause a breaker trip when the overcurrent trip setpoint is reached; can be remotely reset when the overcurrent condition clears.

QUESTION: 39

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:

<u>Generator A</u>	<u>Generator B</u>
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.

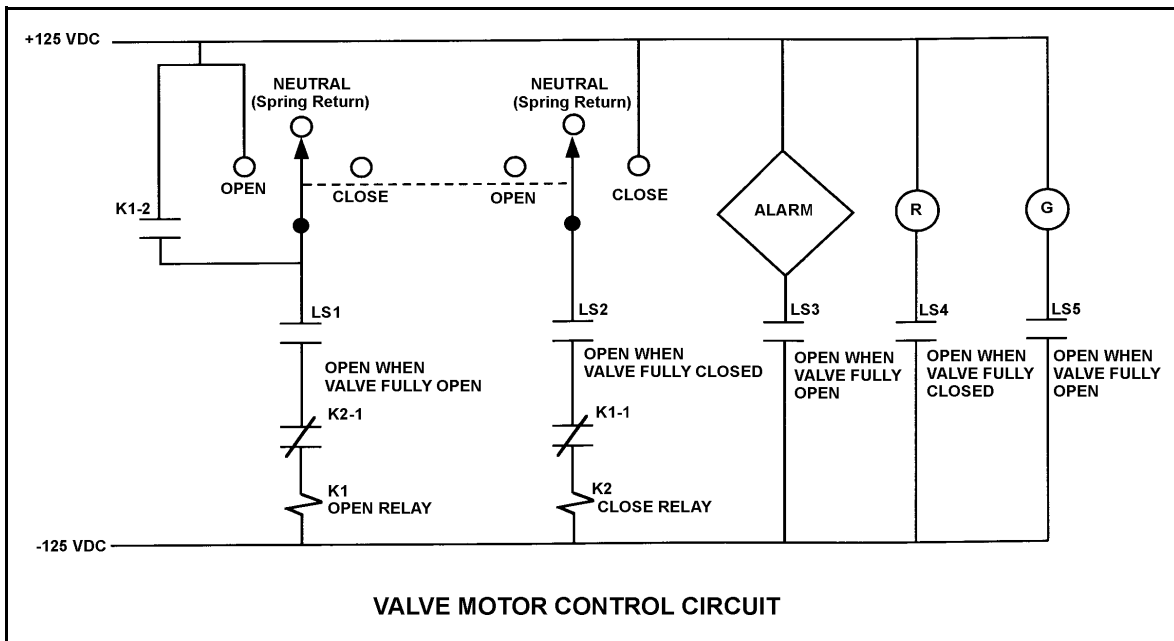
**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 40

Refer to the drawing of a valve motor control circuit (see figure below) for a valve that is currently fully open 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.)

Which one of the following describes the valve response if the control switch is taken to the “Close” position for two seconds and then released?

- A. The valve will not move.
- B. The valve will close fully.
- C. The valve will begin to close and then stop moving.
- D. The valve will begin to close and then open fully.



**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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QUESTION: 41

Which one of the following will cause the most damage to the contact surfaces of a main generator output breaker?

- A. An operator attempts to close the main generator breaker with the generator and power grid frequencies matched but with voltages 180 degrees out of phase.
- B. An operator attempts to close the main generator breaker with the generator and power grid voltages in phase but with generator frequency 0.5% higher than power grid frequency.
- C. The main generator breaker automatically trips open on a loss of offsite power while the main generator is operating at its minimum rated load.
- D. The main generator breaker automatically trips open on a loss of offsite power while the main generator is operating at its maximum rated load.

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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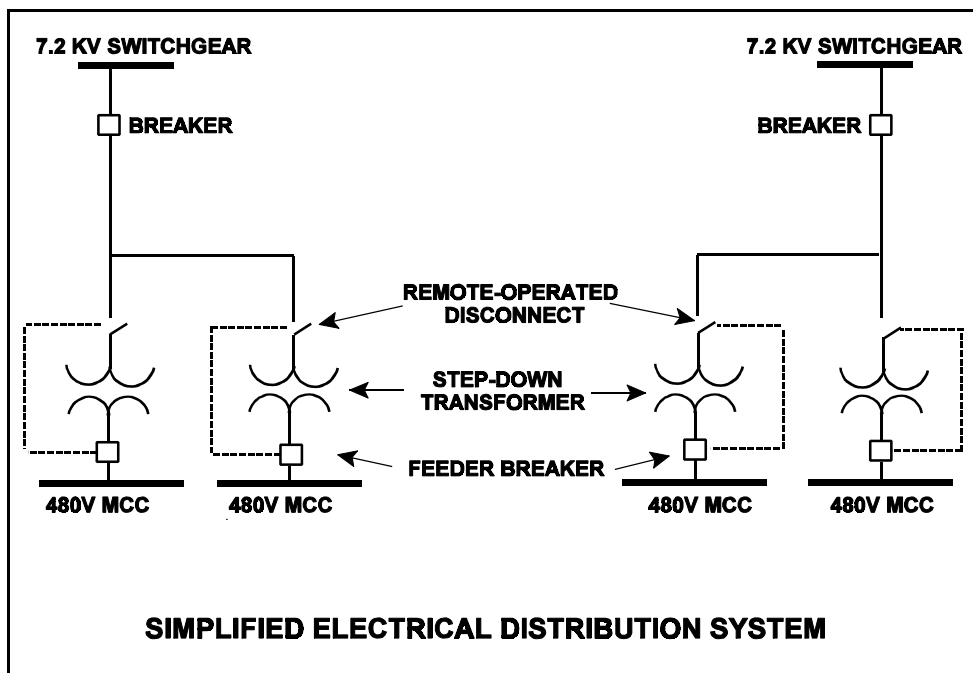
QUESTION: 42

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.





**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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QUESTION: 43

While remotely investigating the condition of a normally-open 480 Vac 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 480 Vac voltage.
- MCC ammeter indicates zero amperes.

Based on these indications, the operator should report that the feeder breaker is \_\_\_\_\_ and racked \_\_\_\_\_.

- A. open; in
- B. closed; in
- C. open; to the test position
- D. closed; to the test position

QUESTION: 44

A thermal overload device for a large motor protects the motor from...

- A. sustained overcurrent by opening the motor breaker or motor line contacts.
- B. sustained overcurrent by opening contacts in the motor windings.
- C. instantaneous overcurrent by opening the motor breaker or motor line contacts.
- D. instantaneous overcurrent by opening contacts in the motor windings.

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 45

A neutron that is born  $10^{-2}$  seconds after the associated fission event is a \_\_\_\_\_ neutron.

- A. capture
- B. prompt
- C. delayed
- D. thermal

QUESTION: 46

A reactor is operating at full power at the beginning of a fuel cycle. A neutron has just been absorbed by a U-238 nucleus at a resonance energy of 6.7 electron volts.

Which one of the following describes the most likely reaction for the newly formed U-239 nucleus and the effect of this reaction on  $K_{\text{excess}}$ ?

- A. Decays over several days to Pu-239, which increases  $K_{\text{excess}}$ .
- B. Decays over several days to Pu-240, which increases  $K_{\text{excess}}$ .
- C. Immediately undergoes fast fission, which decreases  $K_{\text{excess}}$ .
- D. Immediately undergoes thermal fission, which decreases  $K_{\text{excess}}$ .

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 47

A reactor was operating at steady-state 100% power with all control rods fully withdrawn and RCS  $T_{ave}$  at 588°F when a reactor trip occurred.

After the trip  $T_{ave}$  stabilized at 557°F and all control rods were verified to be fully inserted.

Given the following information, select the post-trip value of shutdown margin. (Assume no operator actions and disregard any reactivity effects of xenon.)

Power coefficient	= -0.015% $\Delta K/K/\%$ power
Control/regulating rod worth	= -2.788% $\Delta K/K$
Shutdown/safety rod worth	= -4.130% $\Delta K/K$
Moderator temperature coefficient	= -0.0012% $\Delta K/K$ per °F

- A. -5.381%  $\Delta K/K$
- B. -5.418%  $\Delta K/K$
- C. -8.383%  $\Delta K/K$
- D. -8.418%  $\Delta K/K$

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 48

A reactor is shutdown with a  $K_{\text{eff}}$  of 0.8. The source range count rate is stable at 800 cps. What percentage of the core neutron population is being contributed directly by neutron sources other than neutron-induced fission?

- A. 10%
- B. 20%
- C. 80%
- D. 100%

QUESTION: 49

A reactor is critical in the source range during the initial reactor startup immediately following a refueling outage. The core average delayed neutron fraction is 0.0062. The operator adds positive reactivity to establish a stable 0.5 dpm startup rate.

If the reactor had been at the end of core life with a core average delayed neutron fraction of 0.005, what would be the approximate stable startup rate after the addition of the same amount of positive reactivity?

- A. 0.55 dpm
- B. 0.65 dpm
- C. 0.75 dpm
- D. 0.85 dpm

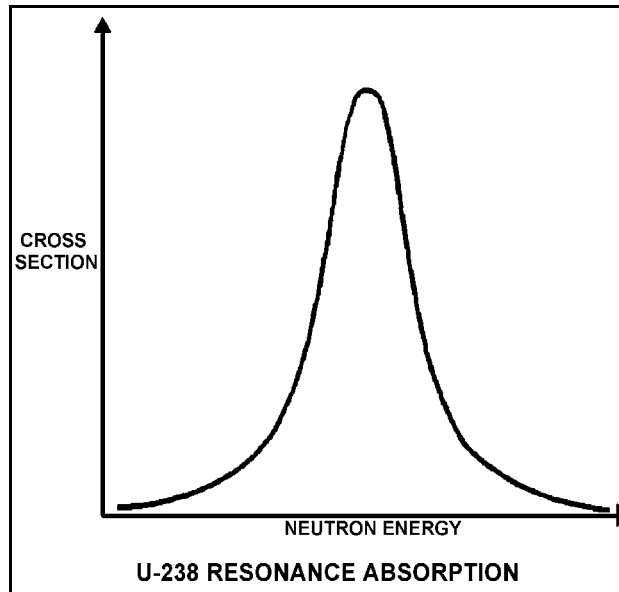
**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 50

Refer to the drawing of microscopic cross section for absorption versus neutron energy for a resonance peak in U-238 in a reactor operating at 80% power (see figure below).

If reactor power is decreased to 60%, the height of the curve will \_\_\_\_\_ and the area under the curve will \_\_\_\_\_.

- A. increase; increase
- B. increase; remain the same
- C. decrease; decrease
- D. decrease; remain the same



**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 51

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: 52

The amount of boric acid required to increase the reactor coolant boron concentration by 50 ppm at the beginning of core life (1200 ppm) is approximately \_\_\_\_\_ as the amount of boric acid required to increase boron concentration by 50 ppm at the end of core life (100 ppm).

- A. the same
- B. four times as large
- C. eight times as large
- D. twelve times as large

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 53

Given the following initial parameters:

Total power coefficient	= -0.016% $\Delta K/K/\%$
Boron worth	= -0.010% $\Delta K/K/ppm$
Rod worth	= -0.030% $\Delta K/K/inch$ inserted
Initial reactor coolant system (RCS) boron concentration	= 500 ppm

Which one of the following is the final RCS boron concentration required to support increasing plant power from 30% to 80% by boration/dilution with 10 inches of outward control rod motion. (Assume no change in xenon reactivity.)

- A. 390 ppm
- B. 420 ppm
- C. 450 ppm
- D. 470 ppm

QUESTION: 54

Criticality has been achieved during a xenon-free reactor startup. The core neutron flux level is low in the intermediate range and a stable 0.5 dpm startup rate (SUR) has been established. The operator begins inserting control rods in an effort to stabilize the core neutron flux level near its current value. The operator stops inserting control rods exactly when the SUR indicates 0.0 dpm.

Immediately after the operator stops inserting the control rods, the SUR will become \_\_\_\_\_ ; then the core neutron flux level will \_\_\_\_\_.

- A. positive; increase exponentially
- B. positive; increase linearly
- C. negative; decrease exponentially
- D. negative; decrease linearly

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 55

Which one of the following will cause group differential control rod worth to become less negative? (Assume the affected group of control rods remains 10% inserted for each case.)

- A. During long-term full power operation, fuel temperature decreases as the fuel pellets come into contact with the fuel clad.
- B. The reactor coolant system is cooled from 170°F to 120°F in preparation for a core refueling.
- C. Core Xe-135 builds up in the lower half of the core.
- D. Early in core life, the concentration of burnable poison decreases.

QUESTION: 56

Consider a reactor core with four quadrants: A, B, C, and D. The reactor is operating at steady state 90% power when a fully withdrawn control rod in quadrant C drops to the bottom of the core. Assume that no operator actions are taken and reactor power stabilizes at 88%.

How are the maximum upper and lower core power tilt values (sometimes called quadrant power tilt ratio or azimuthal power tilt) affected?

- A. Upper core value decreases while lower core value increases.
- B. Upper core value increases while lower core value decreases.
- C. Both upper and lower core values decrease.
- D. Both upper and lower core values increase.



**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 57

A reactor is operating at equilibrium full power when a single control rod fully inserts (from the fully withdrawn position). Reactor power is returned to full power with the control rod still fully inserted.

Compared to the initial axial neutron flux shape, the current flux shape will have a...

- A. minor distortion, because a fully inserted control rod has zero reactivity worth.
- B. minor distortion, because the fully inserted control rod is an axially uniform poison.
- C. major distortion, because the upper and lower core halves are loosely coupled.
- D. major distortion, because power production along the length of the rod drastically decreases.

QUESTION: 58

Fission product poisons can be differentiated from other fission products in that fission product poisons...

- A. have a longer half-life.
- B. are stronger absorbers of thermal neutrons.
- C. are produced in a larger percentage of fissions.
- D. have a higher fission cross section for thermal neutrons.

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 59

Xenon-135 undergoes radioactive decay to...

- A. iodine-135.
- B. cesium-135.
- C. tellurium-135.
- D. lanthanum-135.

QUESTION: 60

A reactor has been operating at 80% power for two months. A manual reactor trip is required for a test. The trip will be followed by a reactor startup with criticality scheduled to occur 24 hours after the trip.

The greatest assurance that xenon reactivity will permit criticality during the reactor startup will be attained if the reactor is operated at \_\_\_\_\_ power for 48 hours prior to the trip and if criticality is rescheduled for \_\_\_\_\_ hours after the trip.

- A. 60%; 18
- B. 60%; 30
- C. 100%; 18
- D. 100%; 30

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 61

A reactor has been operating at 80% power for several weeks with power production equally distributed axially above and below the core midplane. Reactor power is increased to 100% using boron dilution to control reactor coolant temperature while maintaining control rods fully withdrawn.

During the power increase, axial power distribution will...

- A. shift toward the top of the core.
- B. shift toward the bottom of the core.
- C. remain evenly distributed above and below the core midplane.
- D. peak at the top and the bottom of the core.

QUESTION: 62

A reactor that has been operating at rated power for two weeks is quickly reduced in power to 50%. Xenon-135 will reach a new equilibrium condition in \_\_\_\_\_ hours.

- A. 8 to 10
- B. 20 to 25
- C. 30 to 35
- D. 40 to 50

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 63

A reactor plant is initially operating at steady-state 100% reactor power in the middle of a fuel cycle. The operators then slowly decrease main generator load to 90% while adding boric acid to the RCS. After the required amount of boric acid is added, reactor power is 90% and average reactor coolant temperature is 582°F. All control rods remain fully withdrawn and in manual control.

Assuming no other operator actions are taken, which one of the following describes the average reactor coolant temperature after an additional 60 minutes?

- A. Higher than 582°F and increasing slowly.
- B. Higher than 582°F and decreasing slowly.
- C. Lower than 582°F and increasing slowly.
- D. Lower than 582°F and decreasing slowly.

QUESTION: 64

Instead of using a higher concentration of soluble boric acid, burnable poisons are installed in a new reactor core to...

- A. prevent boron precipitation during normal operation.
- B. develop a less positive moderator temperature coefficient.
- C. allow control rods to be withdrawn farther upon initial criticality.
- D. maintain reactor coolant pH above a minimum acceptable value.

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 65

A nuclear power plant was operating at steady-state 100% power near the end of a fuel cycle when a reactor trip occurred. Four hours after the trip, with reactor coolant temperature at normal no-load temperature, which one of the following will cause the fission rate in the reactor core to increase?

- A. The operator fully withdraws the shutdown control rods.
- B. Reactor coolant temperature is allowed to increase by 3°F.
- C. Reactor coolant boron concentration is increased by 10 ppm.
- D. An additional two hours is allowed to pass with no other changes in plant parameters.

QUESTION: 66

During a xenon-free reactor startup, critical data was inadvertently taken two decades below the required intermediate range (IR) level. The critical data was taken again at the proper IR level with the same reactor coolant temperatures and boron concentration.

The critical rod position taken at the proper IR level \_\_\_\_\_ the critical rod position taken two decades below the proper IR level.

- A. cannot be compared to
- B. is greater than
- C. is the same as
- D. is less than

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 67

A reactor is critical below the point of adding heat (POAH). The operator adds enough reactivity to attain a startup rate of 0.5 decades per minute. Which one of the following will decrease first when the reactor reaches the POAH?

- A. Pressurizer level
- B. Reactor coolant temperature
- C. Reactor power
- D. Startup rate

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 68

A reactor was operating with the following steady-state initial conditions:

Power level = 100%  
Coolant boron = 620 ppm  
Coolant temperature = 587°F

After a load decrease, steady-state reactor conditions were as follows:

Power level = 80%  
Coolant boron = 650 ppm  
Coolant temperature = 577°F

Given the following, how much reactivity was added by control rod movement during the load decrease? (Disregard any change in fission product poison reactivity.)

Differential boron worth =  $-1.0 \times 10^{-2}\% \Delta K/K/ppm$   
Total power coefficient =  $-1.5 \times 10^{-2}\% \Delta K/K/\%$   
Moderator temperature coefficient =  $-2.0 \times 10^{-2}\% \Delta K/K/^\circ F$

- A.  $-0.0\% \Delta K/K$
- B.  $-0.2\% \Delta K/K$
- C.  $-0.6\% \Delta K/K$
- D.  $-0.8\% \Delta K/K$

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

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 positive 1.0 dpm startup rate. One minute later (prior to the point of adding heat) the operator inserts the same control rods for 25 seconds. (Assume the control rod withdrawal and insertion rates are the same.)

During the rod insertion, the startup rate will become...

- A. negative during the entire period of control rod insertion.
- B. negative shortly 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 shortly before the control rods pass through the critical rod height.

QUESTION: 70

A nuclear power plant is operating at 60% power in the middle of a fuel cycle with manual rod control when a turbine control system malfunction closes the turbine stream inlet valves an additional 5 percent. Which one of the following is responsible for the initial reactor power decrease?

- A. The rate of neutron absorption by core Xe-135 initially increases.
- B. The rate of neutron absorption in the moderator initially increases.
- C. The rate of neutron absorption at U-238 resonant energies initially increases.
- D. The rate of neutron absorption by the boron in the reactor coolant initially increases.



**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 71

Reactors A and B are identical and have been operated at 100% power for six months when a reactor trip occurs simultaneously on both reactors. All reactor A control rods fully insert. One reactor B control rod sticks fully withdrawn.

Which reactor, if any, will have the longest reactor period five minutes after the scram?

- A. Reactor A due to the greater shutdown reactivity.
- B. Reactor B due to the smaller shutdown reactivity.
- C. Both reactors will have the same reactor period because, after five minutes, both reactors will be stable at a power level low in the source range.
- D. Both reactors will have the same reactor period because, after five minutes, only the longest-lived delayed neutron precursors will be releasing fission neutrons.

QUESTION: 72

A reactor was shut down one week ago following several months of operation at 100% power. Reactor coolant is being maintained at 500°F and all reactor coolant pumps are operating.

The principle source of heat input to the reactor coolant is from...

- A. reactor coolant pumps.
- B. subcritical thermal fission of U-235 and Pu-239.
- C. subcritical fast fission of U-238.
- D. fission product decay.

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 73

A water storage tank is vented to atmosphere. The tank is located at sea level and contains 100,000 gallons of water at 80°F. A pressure gauge at the bottom of the tank reads 7.3 psig. What is the approximate water level in the tank?

- A. 13 feet
- B. 17 feet
- C. 21 feet
- D. 25 feet

QUESTION: 74

A reactor is operating normally at 100% power. Reactor coolant enters the reactor vessel at a temperature of 556°F and a total flow rate of 320,000 gpm. The reactor coolant leaves the reactor vessel at 612°F.

What is the approximate flow rate of the reactor coolant leaving the reactor vessel?

- A. 320,000 gpm
- B. 331,000 gpm
- C. 342,000 gpm
- D. 353,000 gpm

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 75

A nuclear power plant was operating at full power when a station blackout occurred, resulting in a reactor trip and a complete loss of forced reactor coolant circulation. All means of reactor coolant injection are unavailable. Reactor coolant system (RCS) pressure is being maintained at approximately 2,100 psia by operation of the pressurizer relief valves.

The following conditions exist five minutes after the reactor trip:

RCS pressure:	2,100 psia
Core exit thermocouple (CET) temperature:	550°F

Assuming that core uncover eventually occurs, which one of the following describes the future response of the CET temperature indication?

- A. CET indication will remain stable at approximately 550°F until the core becomes uncovered; then, CET indication will become erratic.
- B. CET indication will remain stable at approximately 550°F until the core becomes uncovered; then, CET indication will increase to approximately 643°F where it will become erratic.
- C. CET indication will steadily increase to approximately 643°F and stabilize; then, as the core begins to uncover, CET indication will increase further until it becomes erratic.
- D. CET indication will steadily increase until it becomes erratic.

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 76

Main turbine exhaust enters a main condenser and condenses at 126°F. The condensate is cooled to 100°F before entering the main condenser hotwell. Assuming main condenser vacuum does not change, which one of the following would improve the thermodynamic efficiency of the steam cycle?

- A. Decrease main condenser hotwell level by 5%.
- B. Increase main condenser hotwell level by 5%.
- C. Decrease condenser cooling water flow rate by 5%.
- D. Increase condenser cooling water flow rate by 5%.

QUESTION: 77

Which one of the following is essentially a constant-enthalpy process?

- A. Throttling of main steam through main turbine steam inlet valves
- B. Condensation of turbine exhaust in a main condenser
- C. Expansion of main steam through the stages of an ideal turbine
- D. Steam flowing through an ideal convergent nozzle

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 78

A reactor plant was initially operating normally at 90% reactor power when heating steam (supplied from main turbine extraction steam) to the feedwater heaters was isolated. The plant was stabilized and reactor power was returned to 90%.

As compared to the initial main generator output (MW), the current generator output is...

- A. lower, because the steam cycle is less efficient.
- B. higher, because the steam cycle is less efficient.
- C. lower, because more steam heat energy is available to the main turbine.
- D. higher, because more steam heat energy is available to the main turbine.

QUESTION: 79

Which one of the following operating practices minimizes the possibility of water hammer?

- A. Change valve position as rapidly as possible.
- B. Start a centrifugal pump with the discharge valve throttled.
- C. Start a positive displacement pump with the discharge valve closed.
- D. Vent a system only after initiating system flow.

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 80

A 55 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 50 psig?

- A. 27.5 gpm
- B. 31.8 gpm
- C. 38.9 gpm
- D. 43.4 gpm

QUESTION: 81

Reactor coolant system (RCS) hot leg temperature is 568°F and RCS pressure is decreasing due to a small leak. Which one of the following pressure ranges includes the pressure at which two-phase flow will first occur in the hot leg?

- A. 1250 to 1201 psig
- B. 1200 to 1151 psig
- C. 1150 to 1101 psig
- D. 1100 to 1051 psig

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 82

A centrifugal water 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: 83

Two centrifugal pumps and two positive displacement pumps are able to be cross-connected to provide makeup water flow to a system. Each pump will produce 100 gpm at 1000 psig backpressure and has a maximum design pressure of 1500 psig.

If system pressure is 800 psig, which one of the following combinations will produce the greatest flow rate to the system?

- A. Two centrifugal pumps in parallel
- B. Two centrifugal pumps in series
- C. Two positive displacement pumps in parallel
- D. Two positive displacement pumps in series

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 84

A secondary heat balance calculation is being performed at 90% reactor power to calibrate reactor power instrumentation. Which one of the following will result in a calculated reactor power that is less than actual reactor power?

- A. Steam generator pressure is indicating 20 psi above actual steam generator pressure.
- B. Steam generator water level is indicating 3% below actual steam generator water level.
- C. Feedwater flow rate is indicating 3% above actual feedwater flow rate.
- D. Feedwater temperature is indicating 20°F below actual feedwater temperature.

QUESTION: 85

Which one of the following pairs of fluids undergoing heat transfer through comparable heat exchangers will yield the greatest heat exchanger overall heat transfer coefficient?

- A. Oil to water
- B. Air to water
- C. Steam to water
- D. Water to water



**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 86

A nuclear power plant is operating with the following initial conditions:

- Reactor power is 45% in the middle of a fuel cycle.
- Axial and radial power distributions are peaked in the center of the core.

Which one of the following will increase the steady-state departure from nucleate boiling ratio?

- A. Core Xe-135 decays with no change in the axial and radial power distributions.
- B. A reactor trip occurs and one control rod remains fully withdrawn from the core.
- C. The operator decreases reactor coolant boron concentration by 5 ppm with no control rod motion.
- D. A pressurizer malfunction decreases reactor coolant system pressure by 20 psig with no control rod motion.

QUESTION: 87

A reactor is operating at 100% steady-state power near the end of core life with all control rods fully withdrawn. At what axial location in a typical fuel assembly will the maximum departure from nucleate boiling ratio occur?

- A. At the top of the fuel assembly
- B. At the bottom of the fuel assembly
- C. Between the bottom and midplane of the fuel assembly
- D. Between the midplane and the top of the fuel assembly

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 88

Increasing coolant flow rate through the reactor core improves heat transfer from the fuel because it \_\_\_\_\_ the laminar film thickness and \_\_\_\_\_ the temperature of the coolant adjacent to the fuel.

- A. increases; increases
- B. increases; decreases
- C. decreases; increases
- D. decreases; decreases

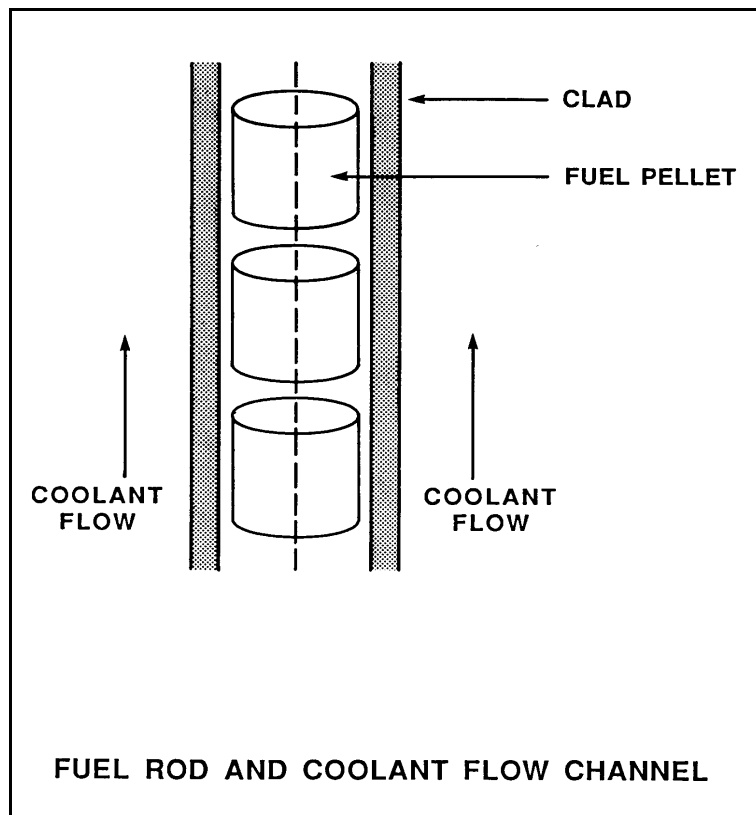
**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 89

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

At 100% reactor power, the greatest temperature difference in a fuel channel radial temperature profile will occur across the: (Assume the temperature profile begins at the fuel centerline.)

- A. fuel pellet centerline to pellet surface.
- B. fuel-to-clad gap.
- C. zircaloy cladding.
- D. flow channel boundary (laminar) layer.



**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 90

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: 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. Provides cooling to various reactor vessel internal components
- D. Prevents excessive reactor vessel wall differential temperature

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 92

A reactor had been operating at steady state 100% power when a loss of offsite power occurred, thereby causing a reactor trip and a complete loss of forced reactor coolant flow. Natural circulation reactor coolant flow developed and stabilized approximately 30 minutes after the trip.

Which one of the following combinations of reactor power history and post-trip steam generator pressure will result in the highest stable natural circulation flow rate?

- |    | <u>DAYS AT</u><br><u>FULL</u><br><u>POWER</u> | <u>POST-TRIP</u><br><u>STEAM GENERATOR</u><br><u>PRESSURE</u> |
|----|---|---|
| A. | 12  | 1100 psia   |
| B. | 100   | 1100 psia   |
| C. | 12  | 1000 psia   |
| D. | 100   | 1000 psia   |

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 93

A reactor coolant system cooldown is in progress on natural circulation via the steam generator (S/G) atmospheric steam relief valves (operated in manual control). If high point voiding interrupts natural circulation, which one of the following will occur? (Assume feed flow rate, relief valve position, and decay heat level are constant.)

- A. S/G level increases and S/G pressure increases.
- B. S/G level increases and S/G pressure decreases.
- C. S/G level decreases and S/G pressure increases.
- D. S/G level decreases and S/G pressure decreases.

QUESTION: 94

A reactor is operating at 80% power near the beginning of a fuel cycle. All control rods are fully withdrawn and in manual control. The moderator temperature coefficient is negative. Core axial power distribution is peaked below the core midplane.

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

- A. One bank of control rods is inserted 10%.
- B. One control rod fully inserts into the core.
- C. Turbine load/reactor power is reduced by 20%.
- D. Reactor coolant system boron concentration is reduced by 50 ppm.

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 95

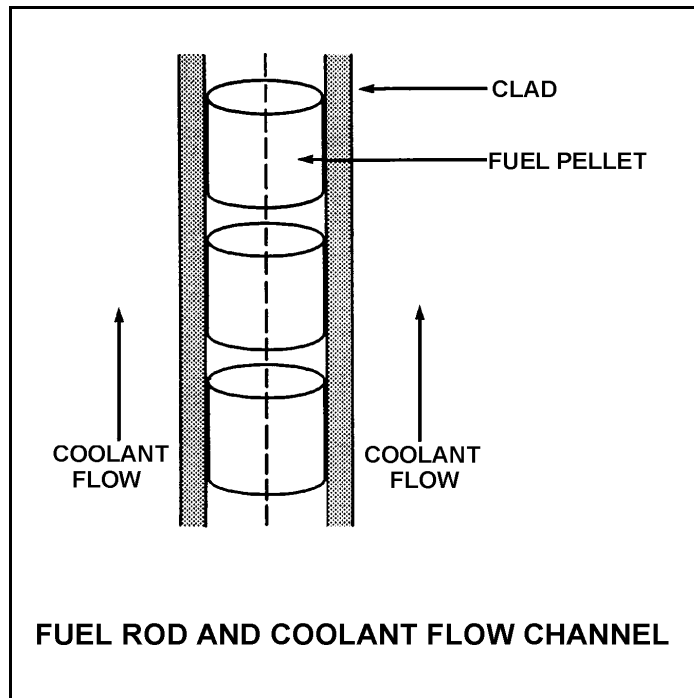
Refer to the drawing of a fuel rod and coolant flow channel (see figure below).

Given the following initial stable core parameters:

Reactor power = 50%  
 $T_{\text{coolant}} = 550^{\circ}\text{F}$   
 $T_{\text{fuel centerline}} = 2,250^{\circ}\text{F}$

Assume that the total heat transfer coefficient and the reactor coolant temperature do not change.  
What will the approximate stable fuel centerline temperature be if reactor power is increased to 75%?

- A. 2,550°F
- B. 2,800°F
- C. 2,950°F
- D. 3,100°F



**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 96

The reference temperature for nil-ductility transition ( $RT_{NDT}$ ) is the temperature above which...

- A. a metal exhibits more ductile tendencies.
- B. the probability of brittle fracture increases.
- C. no appreciable deformation occurs prior to failure.
- D. a large compressive stress can result in brittle fracture.

QUESTION: 97

Which one of the following operating limitations is designed to prevent brittle fracture of the reactor vessel?

- A. Maximum setpoint for the pressurizer safety valves
- B. Maximum differential pressure between the RCS and the steam generators
- C. Maximum RCS pressure vs. RCS temperature for a given RCS heatup rate
- D. Maximum differential temperature between the RCS and the pressurizer



**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

QUESTION: 98

Two identical reactors are currently shut down for refueling. Reactor A has an average lifetime power capacity of 90% and has been operating for 10 years. Reactor B has an average lifetime power capacity of 80% and has been operating for 15 years.

Which reactor will have the higher reactor vessel nil ductility transition temperature and why?

- A. Reactor A because it has the higher average lifetime power capacity.
- B. Reactor B because it has the lower average lifetime power capacity.
- C. Reactor A because it has produced significantly less fissions.
- D. Reactor B because it has produced significantly more fissions.

QUESTION: 99

A nuclear power plant is shut down with the reactor coolant system at 1,200 psia and 350°F. Which one of the following would be most likely to cause pressurized thermal shock of the reactor vessel?

- A. A rapid depressurization followed by a rapid heatup
- B. A rapid depressurization followed by a rapid cooldown
- C. A rapid cooldown followed by a rapid pressurization
- D. A rapid heatup followed by a rapid pressurization

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 PWR--FORM A**

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 \*\*\***

**OCTOBER 2003 NRC GENERIC FUNDAMENTALS EXAMINATION  
PRESSURIZED WATER REACTOR - ANSWER KEY**

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