

**UNITED STATES NUCLEAR REGULATORY COMMISSION  
BOILING 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 boiling water reactor (BWR) 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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$$\dot{Q} = \dot{m}c_p\Delta T$$

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

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

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

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

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

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

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

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

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

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

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

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

$$P = P_0 10^{\text{SUR}(t)}$$

$$P = P_0 e^{(t/\tau)}$$

$$A = A_0 e^{-\lambda t}$$

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

$$\text{CR}_1(1 - K_{\text{eff}1}) = \text{CR}_2(1 - K_{\text{eff}2})$$

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

$$A = \pi r^2$$

$$F = PA$$

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

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

$$E = IR$$

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

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

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

**CONVERSIONS**

---

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

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

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

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

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

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

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

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

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

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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QUESTION: 1

Given the following pressure specifications for operation of a main steam safety valve (MSSV):

Setpoint pressure (MSSV starts to open): 1200 psia  
Maximum pressure (MSSV will be fully open): 1230 psia  
Reseat pressure (MSSV will be fully closed): 1140 psia

Which one of the following is the percent blowdown for the MSSV?

- A. 2.5%
- B. 5.0%
- C. 7.5%
- D. 10.0%

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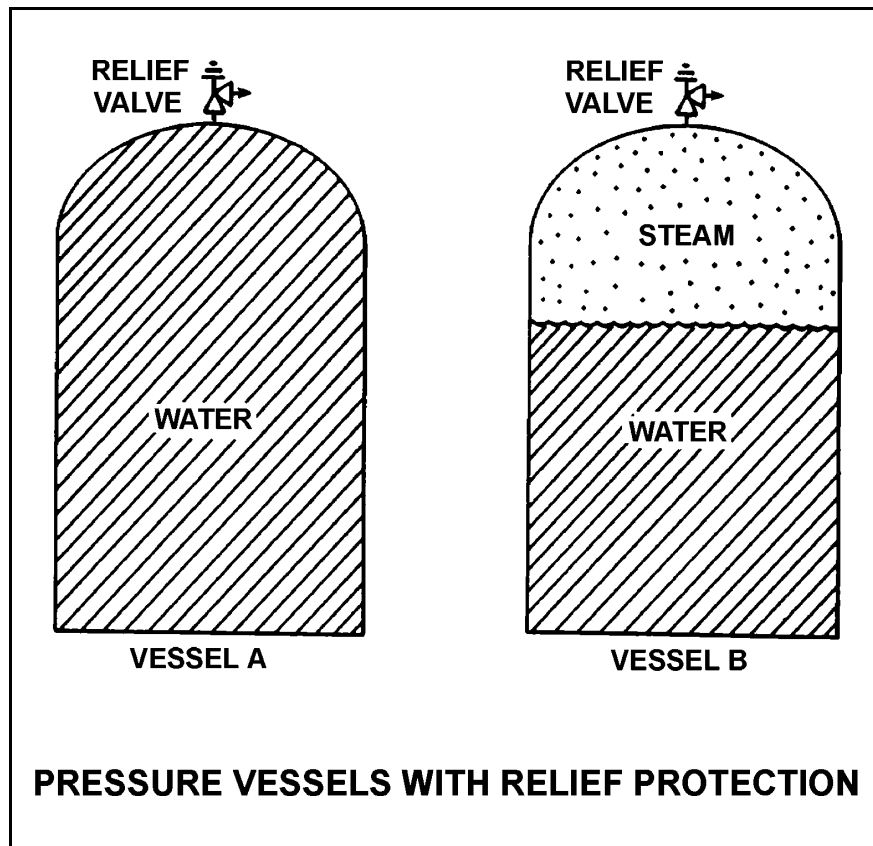
QUESTION: 2

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

Vessel A is completely filled with subcooled water at 80°F and vessel B is in a saturated, two-phase condition. Both vessels are currently pressurized to 50 psig and isolated.

If both relief valves fully open simultaneously, the faster pressure reduction will initially occur in vessel \_\_\_\_\_ and the faster mass loss will initially occur in vessel \_\_\_\_\_.

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



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QUESTION: 3

Which one of the following statements describes the flow rate characteristics of a typical globe valve in an operating water system?

- A. The first 25% of valve disk travel in the open direction will produce a smaller change in flow rate than the last 25% of valve disk travel.
- B. The first 25% of valve disk travel in the open direction will produce a greater change in flow rate than the last 25% of valve disk travel.
- C. The first 25% of valve disk travel in the open direction will produce approximately the same change in flow rate as the last 25% of valve disk travel.
- D. A globe valve that has been opened to 25% of valve disk travel will result in approximately 25% of full flow rate.

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

After an adjustment of the packing gland on a valve that had a minor packing leak, the operator attempts to operate the valve but finds that the valve is stuck. What is the most probable cause?

- A. The disk separated from the valve stem as a result of overtightening the packing gland.
- B. The operator placed the valve in the wrong position for adjusting the packing gland.
- C. The valve was overtorqued in the closed direction during the packing gland adjustment.
- D. The maintenance technician overtightened the packing gland, causing the stem to bind.

QUESTION: 6

A cooling water system uses a horizontal venturi with a differential pressure flow detector to provide cooling water flow rate indication. Water enters and leaves the venturi at 70°F, 120 psig and 20 ft/sec. Water velocity at the throat of the venturi is 45 ft/sec. Assume water is incompressible and the venturi experiences no unrecoverable head loss.

What is the approximate pressure of the water at the throat of the venturi?

- A. 109 psig
- B. 98 psig
- C. 86 psig
- D. 71 psig

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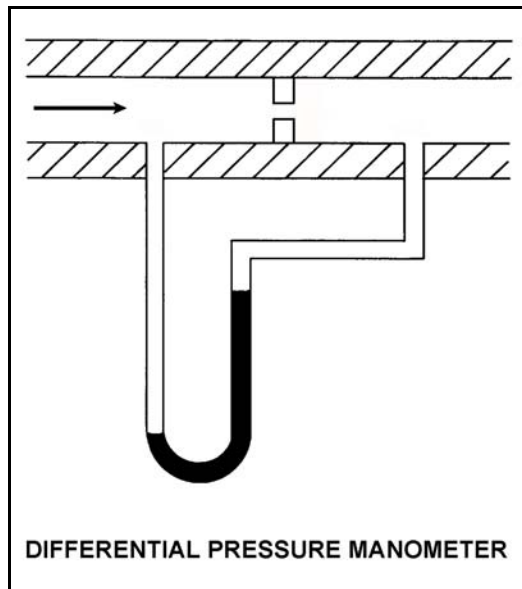
QUESTION: 7

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 reactor vessel (RV) differential pressure (D/P) level detector (see figure below).

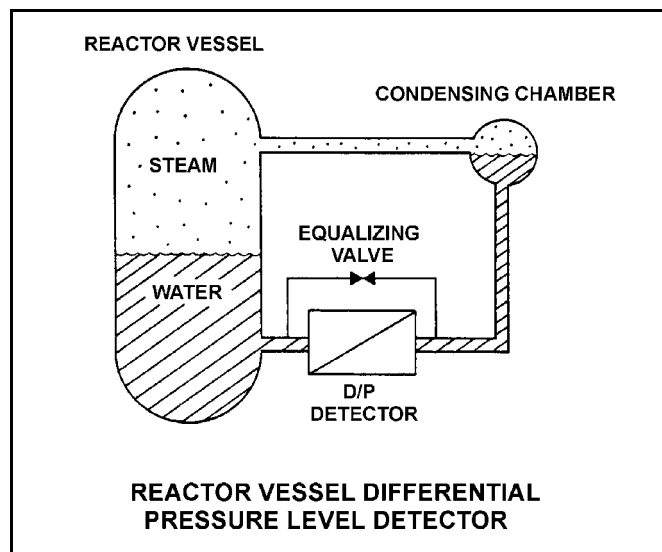
A reactor is shutdown with the reactor coolant system being maintained at 100 psia. The level detector has just been calibrated. Suddenly a rupture in the condensing chamber of the level detector results in a rapid drop of the condensing chamber pressure to atmospheric pressure.

Given the following current conditions:

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

Which one of the following describes the current RV 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 RV.
- D. Offscale high because the static pressure on the reference leg is much less than the static pressure in the RV.



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QUESTION: 9

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.

QUESTION: 10

A nuclear power plant is operating at 100% power. A steam flow measuring instrument that uses density compensation and square root extraction is being used to measure main steam flow rate.

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

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

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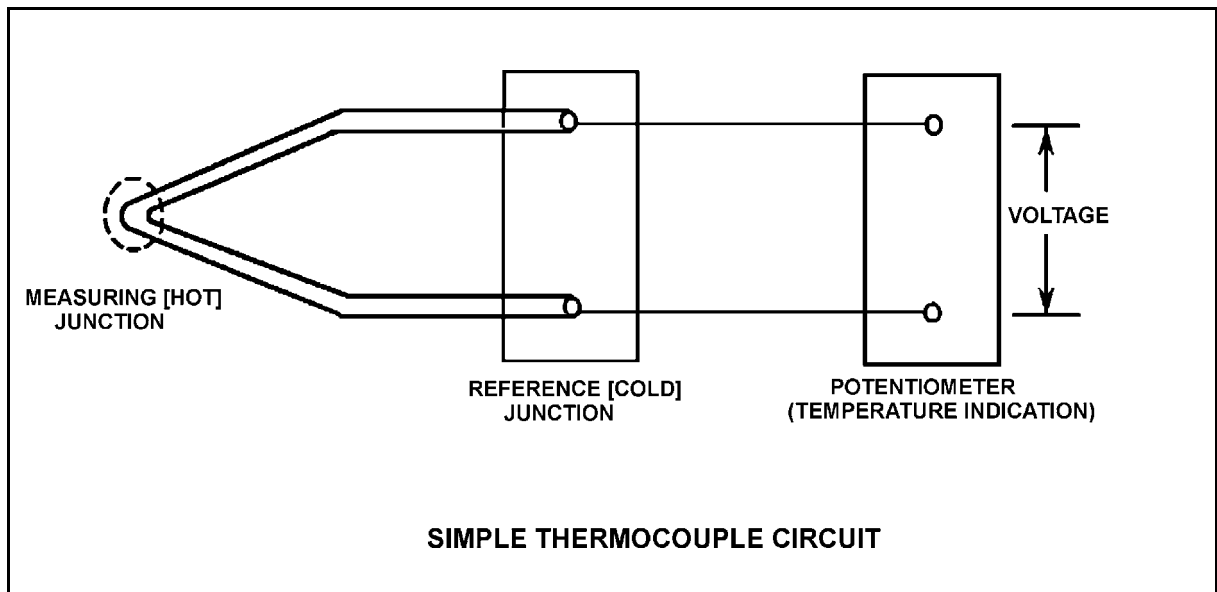
QUESTION: 11

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)



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QUESTION: 12

Which one of the following devices is commonly used to provide remote indication of valve position on an analog meter in units of "percent of full open"?

- A. Limit switch
- B. Reed switch
- C. Linear variable differential transformer
- D. Resistance temperature detector

QUESTION: 13

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

- A. fission fragments.
- B. fission gammas.
- C. fission betas.
- D. fissionable materials.

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QUESTION: 14

What is the effect on a proportional neutron detector if it is operated at a voltage near the high end of the proportional (true proportional) region on the gas-filled detector characteristic curve?

- A. Neutron-induced pulses will become so large that gamma pulse discrimination is no longer needed, yielding a more accurate neutron count rate.
- B. The positive space charge effect will increase and prevent collection of both gamma- and neutron-induced pulses, yielding a less accurate neutron count rate.
- C. A high rate of incident gamma radiation will result in multiple small gamma-induced pulses that combine to form larger pulses. The larger combined pulses will be counted as neutron-induced pulses, yielding a less accurate neutron count rate.
- D. Detection of any single ionizing event will result in ionizing nearly the entire detector gas volume. The resulting large pulses will prevent the detector from differentiating between radiation types, yielding a less accurate neutron count rate.

QUESTION: 15

The difference between the setpoint in an automatic controller and the steady-state value of the controlled parameter is called...

- A. offset.
- B. gain.
- C. deadband.
- D. feedback.

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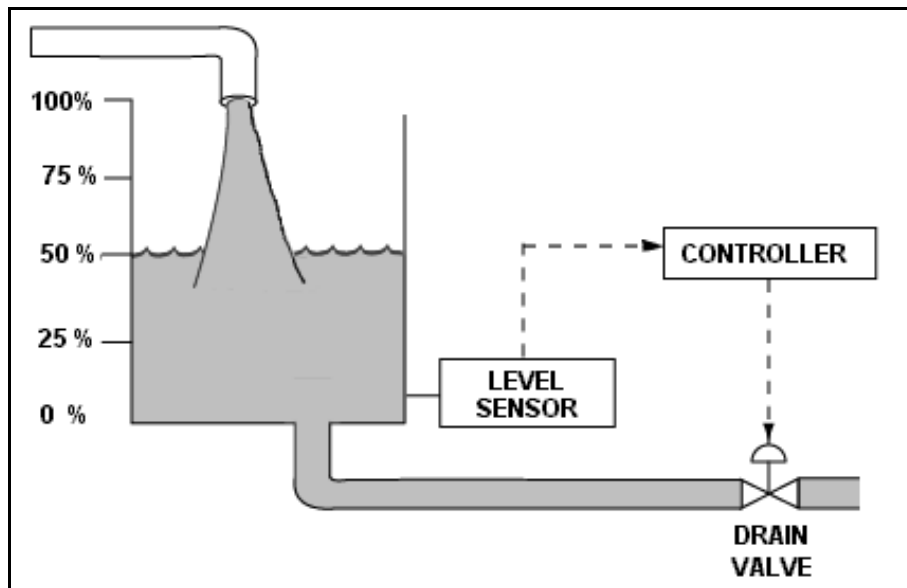
QUESTION: 16

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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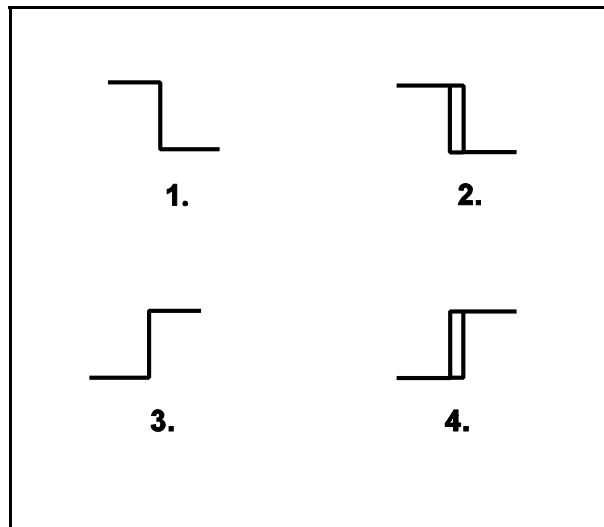
QUESTION: 17

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: 18

If a centrifugal pump is started with the discharge valve fully open (versus throttled), the possibility of pump runout will \_\_\_\_\_ and the possibility of pump cavitation will \_\_\_\_\_.

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

QUESTION: 19

Which one of the following describes gas binding of a centrifugal pump?

- A. Pump capacity is reduced due to the presence of steam or air in the pump impeller.
- B. Pump capacity is reduced due to windage losses between the pump impeller and pump casing.
- C. Pump motor current increases due to the compression of gases in the pump volute.
- D. Pump motor current increases due to the high head requirements for pumping a fluid saturated with dissolved gases.



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QUESTION: 20

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.

QUESTION: 21

A centrifugal firewater pump is operating 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.
- A fire hose connected to the fire main is being used to suppress an elevated fire.

At which one of the following elevations (referenced to sea level) will the fire hose spray nozzle first be unable to provide flow? (Disregard head loss in the fire main and fire hose.)

- A. 86 feet
- B. 101 feet
- C. 116 feet
- D. 135 feet

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QUESTION: 22

An ideal (no slip) reciprocating positive displacement pump is operating in an open system to provide makeup water to a coolant system that is being maintained at 800 psig. The discharge valve of the pump is full open.

If the pump discharge valve is subsequently throttled to 80% open, pump flow rate will \_\_\_\_\_ and pump head will \_\_\_\_\_.

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

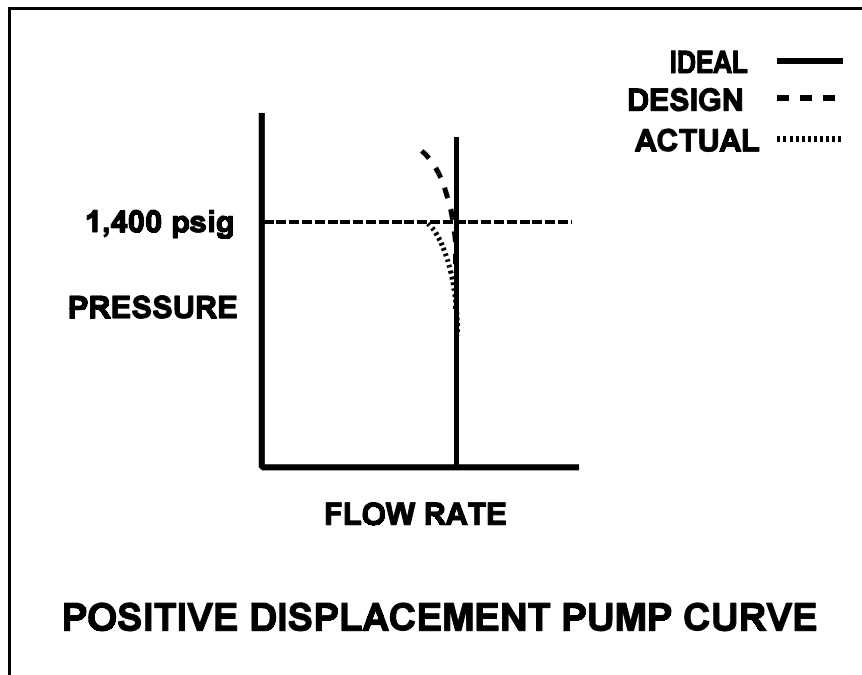
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QUESTION: 23

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, design, and actual pump performance during the test.

Which one of the following could have caused the observed difference between the design 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 setpoint of 1,400 psig.
- D. A relief valve on the pump discharge piping opened prior to its setpoint of 1,400 psig.



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QUESTION: 24

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

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

- A. Axial flow centrifugal
- B. Radial flow centrifugal
- C. Rotary positive displacement
- D. Reciprocating positive displacement

QUESTION: 25

A positive displacement pump should be started with its suction valve \_\_\_\_\_ and its discharge valve \_\_\_\_\_.

- A. closed; closed
- B. closed; open
- C. open; closed
- D. open; open

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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QUESTION: 26

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

QUESTION: 27

Which one of the following describes the relationship between the current supplied to an ac induction motor and the amount of heat generated (kW) in the motor windings?

- A. Heat generation is directly proportional to the current.
- B. Heat generation is proportional to the cube of the current.
- C. Heat generation is proportional to the square of the current.
- D. Heat generation is proportional to the square root of the current.

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QUESTION: 28

Which one of the following causes starting current to be greater than running current for a typical ac induction motor?

- A. The rotor does not develop maximum induced current flow until it has achieved synchronous speed.
- B. After the motor starts, resistors are added to the electrical circuit to limit the running current.
- C. A large amount of starting current is required to initially establish the rotating magnetic field.
- D. The rotor field induces an opposing voltage in the stator that is proportional to rotor speed.

QUESTION: 29

The force that causes electrons to flow in an electrical circuit is called...

- A. power.
- B. current.
- C. voltage.
- D. resistance.

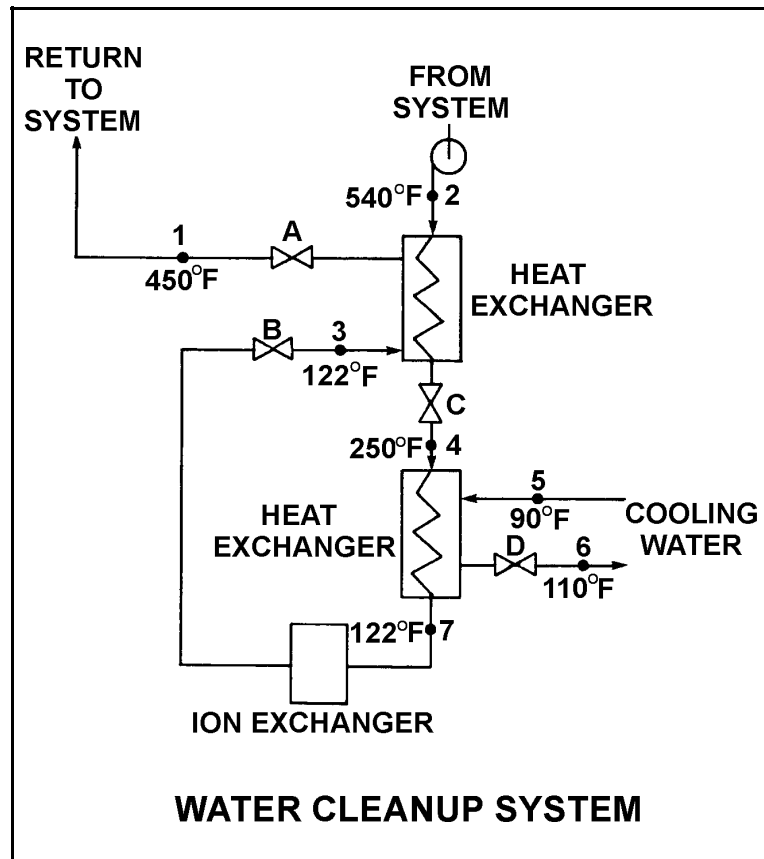
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QUESTION: 30

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 4, the operator can adjust valve \_\_\_\_\_ in the \_\_\_\_\_ direction.

- A. A; shut
- B. B; shut
- C. C; open
- D. D; open



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QUESTION: 31

A main generator that is connected to an infinite power grid has the following indications:

100 MWe  
100 MVAR (VARs out)  
2,800 amps

If main generator excitation is reduced slightly, amps will \_\_\_\_\_ and MWe will \_\_\_\_\_.

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



**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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QUESTION: 32

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.

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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QUESTION: 33

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

Given the following:

Cooling water pressure entering and leaving the heat exchanger is 10 psig.

Cooling water inlet temperature is 90°F.

Cooling water outlet temperature is 160°F.

Heat exchanger inlet and outlet piping have the same diameter.

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

- A. 496 gpm
- B. 500 gpm
- C. 504 gpm
- D. 509 gpm

QUESTION: 34

A condenser absolute pressure of 4 inches Hg is equivalent to...

- A. 11 inches Hg vacuum.
- B. 13 inches Hg vacuum.
- C. 26 inches Hg vacuum.
- D. 28 inches Hg vacuum.

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QUESTION: 35

A reactor is shut down at 400 psia during a maintenance outage when all forced decay heat removal is lost. Which one of the following will enhance natural circulation within the reactor vessel?

- A. Increasing reactor vessel pressure to 500 psia
- B. Increasing reactor vessel water level above the steam separators
- C. Decreasing reactor vessel pressure to 300 psia
- D. Decreasing reactor vessel water level to just above the top of the core

QUESTION: 36

During normal nuclear power plant operation, why does air entry into the main condenser reduce the thermodynamic efficiency of the steam cycle?

- A. The rate of steam flow through the main turbine increases.
- B. The condensate subcooling in the main condenser increases.
- C. The enthalpy of the low pressure turbine exhaust increases.
- D. The air mixes with the steam and enters the condensate.

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QUESTION: 37

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: 38

A demineralizer that is continuously exposed to flowing water with high concentrations of suspended solids will first develop an increase in the...

- A. conductivity at the demineralizer outlet.
- B. decontamination factor of the demineralizer.
- C. differential pressure across the demineralizer.
- D. pH at the demineralizer outlet.

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QUESTION: 39

Which one of the following is an indication of resin exhaustion in a demineralizer:

- A. An increase in suspended solids in the effluent
- B. A decrease in the flow rate through the demineralizer
- C. An increase in the conductivity of the effluent
- D. An increase in the differential pressure across the demineralizer

QUESTION: 40

Which one of the following describes a thermal overload device?

- A. A balanced bridge circuit that compares actual current to a fixed overcurrent signal which, when exceeded, actuates a tripping relay.
- B. An in-line heater coil that, when subjected to a sustained high current, overheats and actuates a circuit-interrupting device.
- C. A temperature monitor that senses the temperature of the operating equipment and trips the circuit breaker if the temperature exceeds preset limits.
- D. An in-line induction coil that generates a secondary current proportional to the primary current, closing the trip circuit contacts for a sustained overcurrent condition.

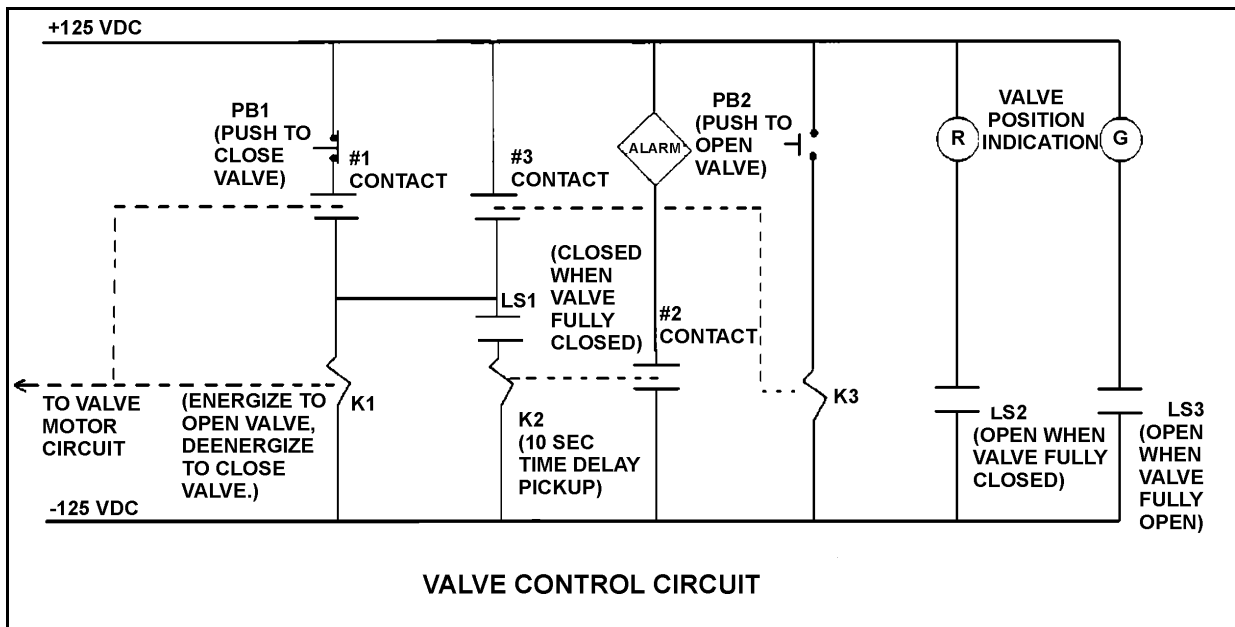
**USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 BWR--FORM A**

QUESTION: 41

Refer to the drawing of a valve control circuit (see figure below). Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts follow the standard convention for control circuit drawings.

Pushbutton PB2 has been momentarily depressed and then released, and the valve is currently at mid-stroke and moving to the open position. Under these conditions, which one of the following describes the position of contacts #1, #2, and #3?

- A. #1 closed; #2 open; #3 open
- B. #1 open; #2 closed; #3 closed
- C. #1 open; #2 open; #3 open
- D. #1 closed; #2 closed; #3 closed



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QUESTION: 42

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.

QUESTION: 43

When a typical 4160 volt breaker is racked to the "test" position, control power is \_\_\_\_\_ the breaker and the breaker is \_\_\_\_\_ the load.

- A. removed from; isolated from
- B. removed from; connected to
- C. available to; isolated from
- D. available to; connected to

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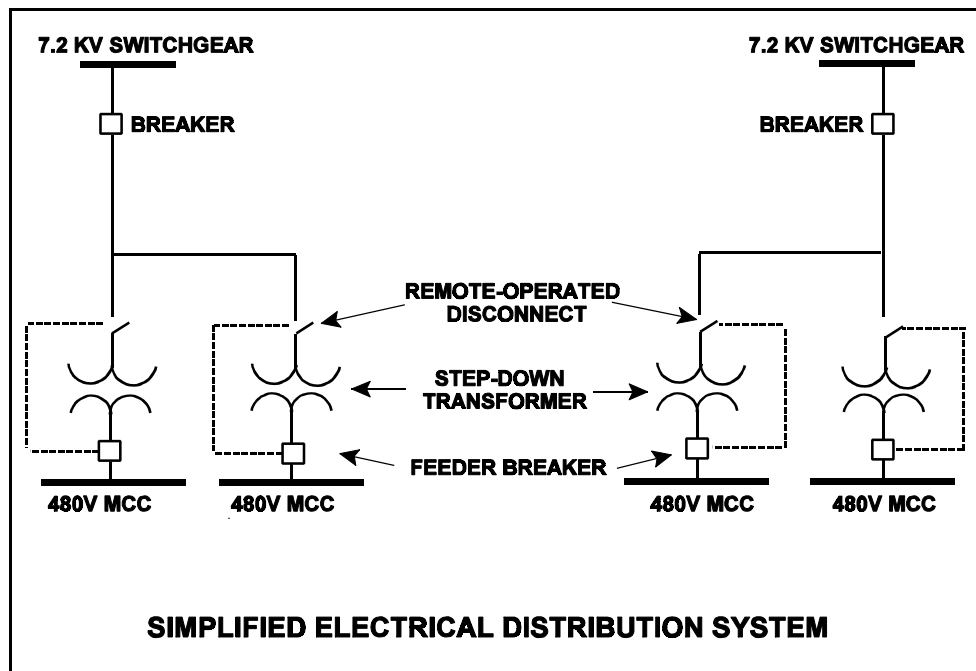
QUESTION: 44

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.





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

QUESTION: 45

In a comparison between a delayed neutron and a prompt neutron born from the same fission event, the prompt neutron is more likely to...

- A. cause fast fission of a U-238 nucleus.
- B. be captured by a U-238 nucleus at a resonant energy between 1 eV and 1000 eV.
- C. be captured by a Xe-135 nucleus.
- D. cause thermal fission of a U-235 nucleus.

QUESTION: 46

The ideal moderator has a \_\_\_\_\_ macroscopic absorption cross section for thermal neutrons and a \_\_\_\_\_ average logarithmic energy decrement.

- A. large; small
- B. large; large
- C. small; small
- D. small; large

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

QUESTION: 47

With core  $K_{\text{eff}}$  equal to 0.987, how much reactivity must be added to make a reactor exactly critical? (Answer options are rounded to the nearest 0.01%  $\Delta K/K$ .)

- A. 1.01%  $\Delta K/K$
- B. 1.03%  $\Delta K/K$
- C. 1.30%  $\Delta K/K$
- D. 1.32%  $\Delta K/K$

QUESTION: 48

A reactor scram from 100% steady-state power occurred 36 hours ago due to an instrument malfunction. All systems operated normally.

Given the following absolute values of reactivities added since the scram, assign a (+) or (-) as appropriate and choose the current value of core reactivity.

Xenon	= ( ) 1.0% $\Delta K/K$
Fuel temperature	= ( ) 2.0% $\Delta K/K$
Control rods	= ( ) 14.0% $\Delta K/K$
Voids	= ( ) 3.0% $\Delta K/K$

- A. -8.0%  $\Delta K/K$
- B. -10.0%  $\Delta K/K$
- C. -14.0%  $\Delta K/K$
- D. -20.0%  $\Delta K/K$

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

QUESTION: 49

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: 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

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

QUESTION: 51

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 0.007. The operator adds positive reactivity to establish a stable positive 60-second reactor period.

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 reactor period after the addition of the same amount of positive reactivity?

- A. 28 seconds
- B. 32 seconds
- C. 36 seconds
- D. 40 seconds

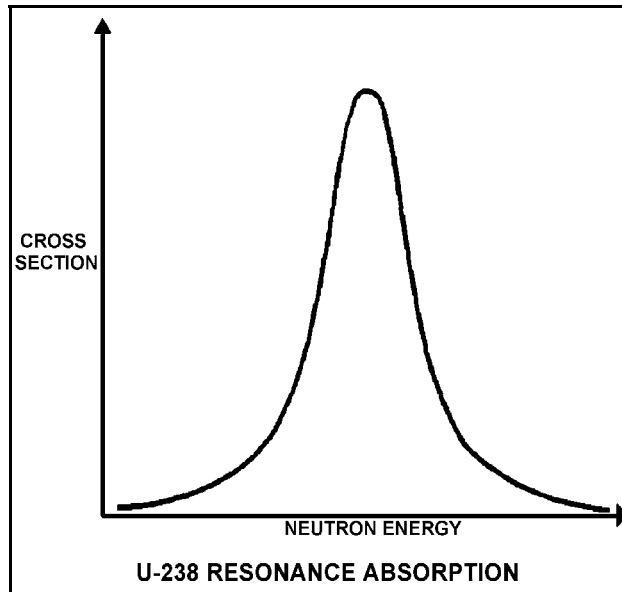
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OCTOBER 2003 BWR--FORM A**

QUESTION: 52

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 BWR--FORM A**

QUESTION: 53

For a normal reactor power increase from 20% to 100%, the smallest change in negative reactivity at steady-state conditions will be caused by...

- 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

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

QUESTION: 55

Which one of the following materials is used in control rods primarily for thermal neutron absorption?

- A. B-10.
- B. C-12.
- C. Xe-135.
- D. U-235.

QUESTION: 56

Criticality has been achieved during a xenon-free reactor startup. The core neutron flux level is low in the intermediate range and a stable positive 60-second reactor period 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 reactor period indicates infinity.

Immediately after the operator stops inserting the control rods, the reactor period 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 BWR--FORM A**

QUESTION: 57

The reactor is operating at 85% power with control rod X-Y inserted 20%. Which one of the following will cause the differential control rod worth of control rod X-Y to become more negative? (Assume that control rod X-Y remains 20% inserted for each case.)

- A. Fuel temperature increases as fission product gases accumulate in nearby fuel rods.
- B. Reactor vessel pressure drifts from 900 psig to 880 psig.
- C. Core Xe-135 builds up in the lower half of the core.
- D. An adjacent control rod is fully withdrawn from the core.

QUESTION: 58

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

- A. Uranium-235
- B. Boron-10
- C. Samarium-149
- D. Xenon-135



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

QUESTION: 59

A reactor has been operating at 100% power for one week when power is ramped in 4 hours to 50%. Which one of the following describes the new equilibrium core xenon-135 concentration?

- A. Remains the same because it is independent of power
- B. More than one-half the 100% value
- C. Less than one-half the 100% value
- D. One-half the 100% value

QUESTION: 60

A reactor has been operating at 70% power for 26 hours following a one-hour power reduction from steady-state 100% power. Which one of the following describes the current core xenon-135 concentration?

- A. Increasing toward a peak
- B. Decreasing toward an upturn
- C. Decreasing toward equilibrium
- D. At equilibrium

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

QUESTION: 61

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

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 scram and if criticality is rescheduled for \_\_\_\_\_ hours after the scram.

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

QUESTION: 62

A reactor has been operating at 100% power for several weeks. Following a reactor scram the reactor first will be considered xenon-free after...

- A. 40 to 50 hours.
- B. 70 to 80 hours.
- C. 100 to 110 hours.
- D. 130 to 140 hours.

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

QUESTION: 63

A nuclear power plant has been operating at steady-state 100% reactor power for three weeks when the operator slowly adds negative reactivity to the core over a period of 15 minutes to lower power level to 90%. Which one of the following describes reactor power 60 minutes later if no additional operator action is taken?

- A. Higher than 90% and increasing slowly.
- B. Higher than 90% and decreasing slowly.
- C. Lower than 90% and increasing slowly.
- D. Lower than 90% and decreasing slowly.

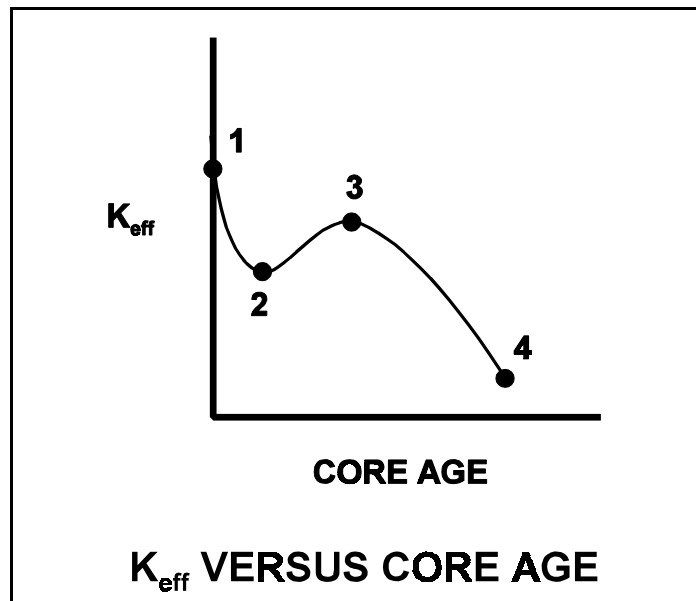
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QUESTION: 64

Refer to the drawing of  $K_{\text{eff}}$  versus core age (see figure below).

The major cause for the change in  $K_{\text{eff}}$  from point 3 to point 4 is...

- A. depletion of U-235.
- B. depletion of U-238.
- C. burnout of burnable poisons.
- D. buildup of fission product poisons.



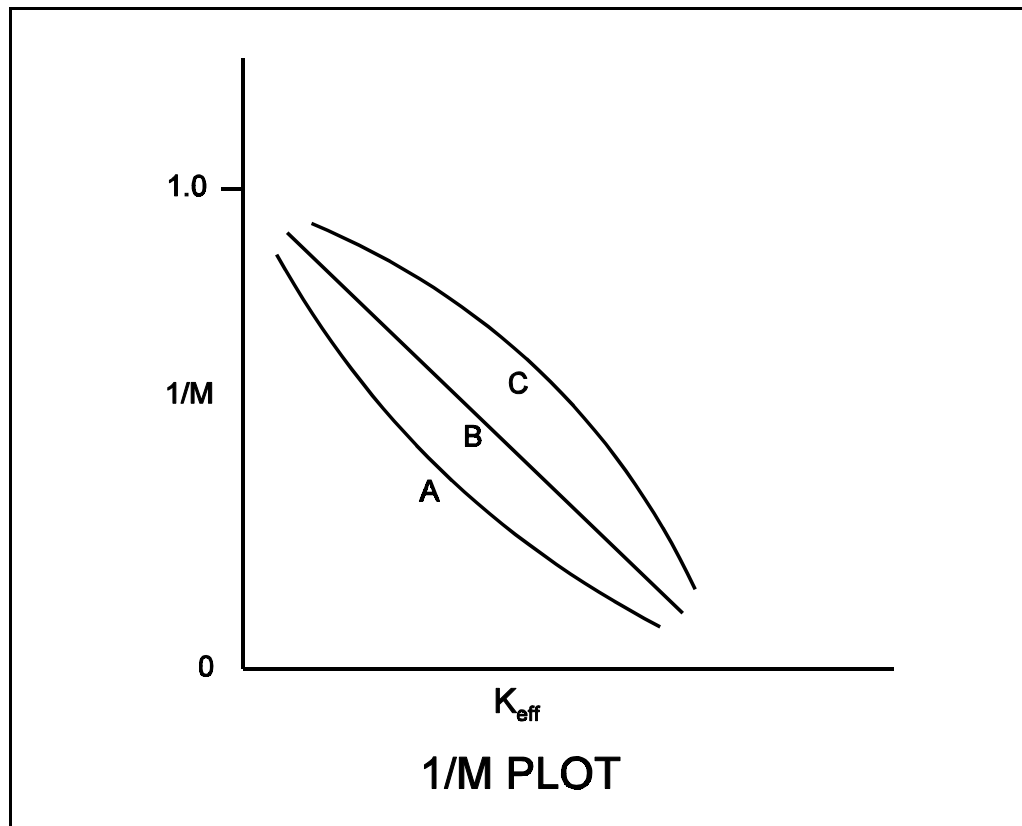
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QUESTION: 65

Refer to the drawing of three 1/M plots labeled A, B, and C (see figure below).

The least conservative approach to criticality is represented by plot \_\_\_\_\_ and could possibly be the result of recording count rates at \_\_\_\_\_ time intervals after incremental fuel loading steps compared to the situations represented by the other plots.

- A. A; shorter
- B. A; longer
- C. C; shorter
- D. C; longer



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

QUESTION: 66

A reactor is critical at  $10^{-6}\%$  power. Control rods are withdrawn for 5 seconds and then stopped, resulting in a stable reactor period of positive 100 seconds.

If control rods had been inserted (instead of withdrawn) for 5 seconds with the reactor initially critical at  $10^{-6}\%$  power, the stable reactor period would have been: (Assume equal absolute values of reactivity are added in both cases.)

- A. longer than negative 100 seconds because, compared to power increases, reactor power decreases are more limited by delayed neutrons.
- B. shorter than negative 100 seconds because, compared to power increases, reactor power decreases are less limited by delayed neutrons.
- C. longer than negative 100 seconds because, compared to power increases, reactor power decreases result in smaller delayed neutron fractions.
- D. shorter than negative 100 seconds because, compared to power increases, reactor power decreases result in larger delayed neutron fractions.

QUESTION: 67

A reactor is critical at  $10^{-3}\%$  power during a cold reactor startup at the beginning of core life. Reactor period is stable at positive 60 seconds. Assuming no operator action, no reactor scram, and no steam release, what will be reactor power 10 minutes later?

- A. Below the point of adding heat (POAH)
- B. At the POAH
- C. Approximately 22%
- D. Greater than 100%

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

QUESTION: 68

A reactor is critical and a reactor coolant heat-up is in progress with coolant temperature currently at 140°F. If the point of adding heat is 1% reactor power, and reactor power is held constant at 3% during the heat-up, which one of the following describes the coolant heat-up rate (HUR) from 140°F to 200°F?

- A. HUR will initially decrease and then increase.
- B. HUR will slowly decrease during the entire period.
- C. HUR will slowly increase during the entire period.
- D. HUR will remain the same during the entire period.

QUESTION: 69

Which one of the following will add the most positive reactivity during a power decrease from 100% to 65% over a 1 hour period? (Assume the power change is performed only by changing core recirculation flow rate.)

- A. Fuel temperature change
- B. Moderator temperature change
- C. Fission product poison change
- D. Core void fraction change

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

QUESTION: 70

A reactor is operating at 100% power and core flow rate. Reactor power is reduced to 90% by inserting control rods. (Recirculating pump speed remains constant.)

What is the effect on core flow rate?

- A. Core flow rate will decrease due to an increase in core voiding.
- B. Core flow rate will increase due to the decrease in recirculation ratio.
- C. Core flow rate will increase due to the decrease in two-phase flow resistance.
- D. Core flow rate will decrease due to an increase in two-phase flow resistance.

QUESTION: 71

A plant is operating at 85% power when a failure of the steam pressure control system opens the turbine control valves to admit 10% more steam flow to the main turbine. No operator actions occur and no protective system actuations occur.

How will reactor power respond? (Assume the control valves remain in the failed position.)

- A. Increase until power level matches the new steam demand.
- B. Increase continuously and exceed reactor protection set points.
- C. Decrease and stabilize at a lower power level above the point of adding heat.
- D. Decrease and stabilize at a critical power level below the point of adding heat.



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

QUESTION: 72

During continuous reactor power operation, rod pattern exchanges are performed periodically to...

- A. ensure some control rods remain inserted as deep control rods until late in the fuel cycle.
- B. allow the local power range monitoring nuclear instruments to be asymmetrically installed in the core.
- C. increase the rod worth of control rods that are nearly fully withdrawn.
- D. prevent the development of individual control rods with very high reactivity worths.

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

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

QUESTION: 74

Consider a saturated water/steam mixture at 500°F with a quality of 90%. If the pressure of the mixture is decreased with no heat gain or loss, the temperature of the mixture will \_\_\_\_\_ and the quality of the mixture will \_\_\_\_\_. (Assume the mixture remains saturated.)

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

QUESTION: 75

A nuclear power plant is shutdown at normal operating temperatures and pressures. Reactor coolant temperature is being controlled by dumping main steam (100% quality) to the main condenser.

Given the following:

- Main steam pressure: 1000 psia
- Main condenser vacuum: 28"Hg

Which one of the following is the approximate temperature of the steam as it enters the main condenser?

- A. 102°F
- B. 212°F
- C. 295°F
- D. 358°F

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

QUESTION: 76

During jet pump operation, high pressure and low velocity fluid flow is supplied through a \_\_\_\_\_ where the pressure drops and the velocity increases, creating a low pressure area in the \_\_\_\_\_ section of the jet pump.

- A. nozzle; throat
- B. nozzle; diffuser
- C. diffuser; throat
- D. diffuser; nozzle

QUESTION: 77

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

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

QUESTION: 78

A steam plant main turbine consists of a high-pressure (HP) unit and several low-pressure (LP) units. The main turbine is most likely to experience stress-related failures of the rotor blades in the \_\_\_\_\_ stages of the \_\_\_\_\_ unit(s).

- A. inlet; HP
- B. inlet; LP
- C. outlet; HP
- D. outlet; LP

QUESTION: 79

The major concern with starting a main feedwater pump with downstream fluid in a saturated condition is...

- A. cavitation.
- B. water hammer.
- C. thermal shock.
- D. positive reactivity addition.

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

QUESTION: 80

An ideal positive displacement pump is pumping to a system operating at 100 psig. Assume pump speed is constant, zero pump slip, and pump backpressure remains within normal pump operating limits.

If system pressure increases to 200 psig, the pump head will \_\_\_\_\_ and pump flow rate will \_\_\_\_\_.

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

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

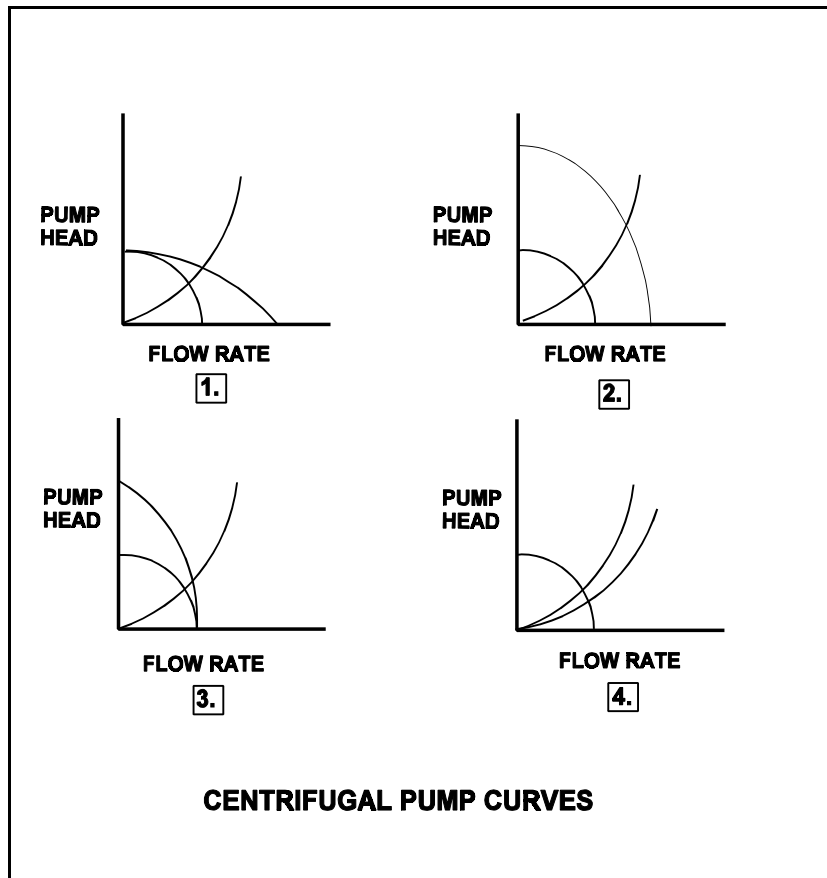
QUESTION: 81

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 pump operating conditions?

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



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

QUESTION: 82

The order of reactor coolant heat transfer mechanisms, from the most efficient to the least efficient, is...

- A. nucleate boiling, transition boiling, stable film boiling.
- B. stable film boiling, nucleate boiling, transition boiling.
- C. nucleate boiling, stable film boiling, transition boiling.
- D. stable film boiling, transition boiling, nucleate boiling.

QUESTION: 83

Given the following data for a typical steam condenser:

Total tube area	= 500,000 ft <sup>2</sup>
Cooling water flow rate	= 200,000 gpm
Condenser pressure	= 1 psia
Specific heat of cooling water ( $c_p$ )	= 1 Btu/lbm-°F
Cooling water inlet temperature	= 60°F
Cooling water outlet temperature	= 80°F
Steam condensing rate	= 3,000,000 lbm/hr
Mass of cooling water	= 8.34 lbm/gal

What is the condenser heat load in megawatts thermal (MWt)?

- A. 587 MWt
- B. 629 MWt
- C. 671 MWt
- D. 733 MWt

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

QUESTION: 84

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

- A. The feedwater temperature used in the heat balance calculation was 20°F higher than actual feedwater temperature.
- B. The reactor recirculation pump heat input term was omitted from the heat balance calculation.
- C. The steam and feedwater flow rates used in the heat balance calculation were 10% lower than actual flow rates.
- D. The ambient heat loss term was omitted from the heat balance calculation.

QUESTION: 85

A reactor is currently shutdown after several months of operation at full power. The shutdown cooling system is in operation, maintaining an average reactor coolant temperature of 280°F. A pressure control malfunction causes RCS pressure to slowly and continuously decrease from 100 psia while reactor coolant temperature remains constant. (Assume a normal reactor coolant flow direction through the core.)

Which one of the following describes where nucleate boiling will first occur?

- A. At a scratch on the surface of a fuel rod near the top of a fuel assembly.
- B. At a scratch on the surface of a fuel rod near the bottom of a fuel assembly.
- C. In the bulk fluid of a coolant channel near the top of a fuel assembly.
- D. In the bulk fluid of a coolant channel near the bottom of a fuel assembly.



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

QUESTION: 86

A reactor is operating at full power with a fuel coolant channel that is experiencing each of the following heat transfer mechanisms somewhere along the length of the coolant channel.

Which of the following causes the first reduction in the local fuel clad heat transfer rate as the coolant flows upward through the coolant channel?

- A. Nucleate boiling
- B. Stable film boiling
- C. Partial film boiling
- D. Single-phase convection

QUESTION: 87

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 bundle to become closer to the onset of transition boiling? (Assume reactor power does not change unless stated.)

- A. Recirculation flow increases.
- B. Reactor pressure decreases.
- C. Feed water temperature increases.
- D. Associated bundle power decreases.

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

QUESTION: 88

Forced circulation through a reactor core is required at all times during power operation to prevent...

- A. the core from becoming prompt critical due to high fuel and coolant temperatures.
- B. exceeding reactor vessel and core design steaming rates.
- C. high fuel clad surface temperatures that would result in a crack or leak in the clad.
- D. jet pump cavitation which would reduce the power generated by the core.

QUESTION: 89

Reactors A and B are identical. Reactor A is operating at 75% power and reactor B is operating at 50% power with neutron flux radially and axially peaked in the center of each core. Recirculation mass flow rate through each core is the same.

Compared to the center fuel bundle in reactor A, the center fuel bundle in reactor B has the \_\_\_\_\_ critical power and the \_\_\_\_\_ coolant flow rate.

- A. lower; lower
- B. lower; higher
- C. higher; lower
- D. higher; higher

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

QUESTION: 90

Given:

- Reactors A and B are identical except that reactor A has no core orificing while reactor B is equipped with orifices.
- Both reactors always operate with identical recirculation system flow rates.
- Both reactors are currently operating at 80% of full power with the thermal neutron flux radially peaked in the center of both cores.

Compared to identical locations in the core of reactor A, the critical power ratio (CPR) in the central fuel bundles of reactor B is \_\_\_\_\_; and the peak power in the peripheral fuel bundles of reactor B is \_\_\_\_\_.

- A. larger; larger
- B. larger; smaller
- C. smaller; larger
- D. smaller; smaller

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

QUESTION: 91

A reactor was shutdown from steady-state 100% power operation 10 days ago. Five minutes ago, a station blackout occurred that caused the complete loss of forced coolant circulation through the core. The following conditions currently exist:

- Reactor pressure vessel (RPV) pressure indicates 0 psig.
- Main steam isolation valves are closed.
- Reactor head vents are open with no steam issuing.
- Average reactor coolant temperature is 150°F.
- Differential temperature between the upper and lower RPV heads is 20°F and increasing.

Over the next few hours, with no operator action, which one of the following would occur if natural circulation becomes established in the RPV?

- A. RPV pressure will remain near 0 psig, and the differential temperature between the upper and lower RPV heads will stabilize at a value greater than 0°F.
- B. RPV pressure will remain near 0 psig, and the differential temperature between the upper and lower RPV heads will stabilize at 0°F.
- C. RPV pressure will slowly increase to about 10 psig, and the differential temperature between the upper and lower RPV heads will stabilize at a value greater than 0°F.
- D. RPV pressure will slowly increase to about 10 psig, and the differential temperature between the upper and lower RPV heads will stabilize at 0°F.

QUESTION: 92

The axial peaking factor for a node of a fuel bundle is defined as...

- A.  $\frac{\text{core average bundle power}}{\text{peak nodal power}}$
- B.  $\frac{\text{peak nodal power}}{\text{core average bundle power}}$
- C.  $\frac{\text{bundle average nodal power}}{\text{nodal power}}$
- D.  $\frac{\text{nodal power}}{\text{bundle average nodal power}}$

USNRC GENERIC FUNDAMENTALS EXAMINATION  
OCTOBER 2003 BWR--FORM A

QUESTION: 93

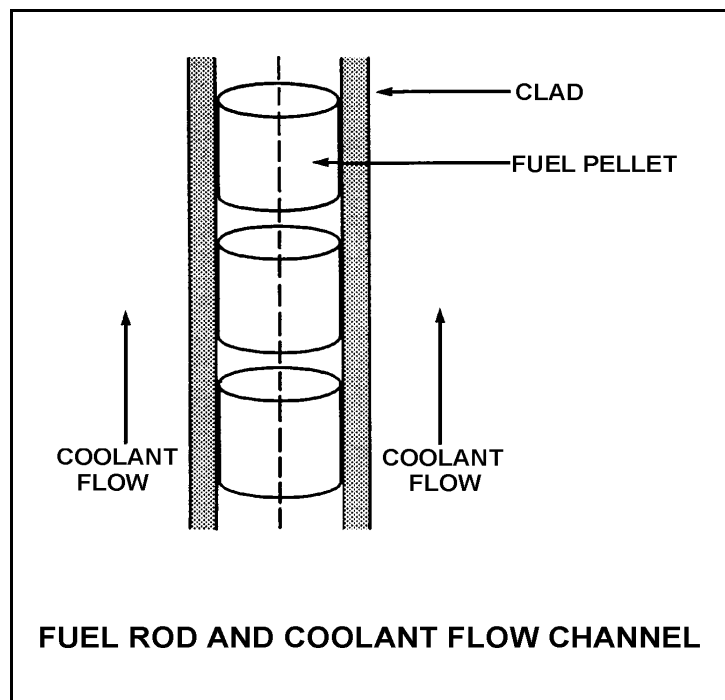
Refer to the drawing of a fuel rod and coolant flow channel (see figure below).

Given the following initial stable core parameters:

Reactor power = 50%  
 $T_{\text{coolant}} = 550^{\circ}\text{F}$   
 $T_{\text{fuel centerline}} = 1,250^{\circ}\text{F}$

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. 1,425°F
- B. 1,600°F
- C. 1,750°F
- D. 1,875°F



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

QUESTION: 94

Which one of the following is most likely to result in fuel clad damage?

- A. Operating at 110% of reactor vessel design pressure.
- B. An inadvertent reactor scram from 100% power.
- C. Operating with fuel bundle power greater than critical power.
- D. Operating with saturated nucleate boiling occurring in a fuel bundle.

QUESTION: 95

For a reactor operating at 100% power, which one of the following combinations of axial power distribution and recirculation system flow rate will result in the smallest critical power ratio in the limiting fuel bundle?

<u>AXIAL POWER DISTRIBUTION</u>	<u>RECIRCULATION SYSTEM FLOW RATE</u>
A. Top-peaked	Low
B. Top-peaked	High
C. Bottom-peaked	Low
D. Bottom-peaked	High

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

QUESTION: 96

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: 97

Why does the threshold power for pellet-clad interaction decrease as fuel burnup increases?

- A. The fuel pellet thermal conductivity is reduced significantly by irradiation.
- B. The buildup of a certain fission product gases causes chemical embrittlement of the cladding.
- C. Fuel pellet densification causes the center of the pellet to expand against the cladding as the pellet length shrinks.
- D. Zirconium hydriding increases significantly as the zirconium oxide layer builds up on the clad.

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

QUESTION: 98

What is the primary purpose of the gap between a fuel pellet and the surrounding cladding?

- A. To allow insertion of fuel pellets into the fuel rods.
- B. To provide a collection volume for fission product gases.
- C. To maintain the design fuel thermal conductivity throughout the fuel cycle.
- D. To accommodate different expansion rates of the fuel pellets and cladding.

QUESTION: 99

Brittle fracture of a low-carbon steel is more likely to occur when the temperature of the steel is \_\_\_\_\_ the nil ductility temperature, and will normally occur when the applied stress is \_\_\_\_\_ the steel's yield strength (or yield stress).

- A. greater than; greater than
- B. greater than; less than
- C. less than; greater than
- D. less than; less than



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

QUESTION: 100

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.

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

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

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