

**UNITED STATES NUCLEAR REGULATORY COMMISSION  
PRESSURIZED WATER REACTOR GENERIC FUNDAMENTALS EXAMINATION  
DECEMBER 2009 -- FORM A**

**Please Print**

Name: \_\_\_\_\_

Docket No.: \_\_\_\_\_

Facility: \_\_\_\_\_

Start Time: \_\_\_\_\_ Stop Time: \_\_\_\_\_

**INSTRUCTIONS TO APPLICANT**

Answer all the test items using the answer sheet provided, ensuring a single answer is marked for each test item. Each test item has equal point value. A score of at least 80 percent is required to pass this portion of the NRC operator licensing written examination. All examination materials will be collected 3.0 hours after the examination begins. This examination applies to a typical U.S. pressurized water reactor (PWR) nuclear power plant.

SECTION	QUESTIONS	% OF TOTAL	SCORE
COMPONENTS	1 - 22		
REACTOR THEORY	23 - 36		
THERMODYNAMICS	37 - 50		
TOTALS	50		

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

\_\_\_\_\_  
Applicant's Signature

**RULES AND INSTRUCTIONS FOR THE NRC  
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.

NOTE: Numerical answers are rounded to the nearest whole number unless otherwise indicated.

1. Print your name in the blank provided on the cover sheet of the examination.
2. Fill in your individual docket number.
3. Fill in the name of your facility.
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 and Mollier Diagram 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. Either pencil or pen may be used.
11. Turn in your examination materials, answer sheet on top, followed by the examination copy and the examination aids, e.g., steam tables, handouts, and scrap paper.
12. After turning in your examination materials, leave the examination area, as defined by the proctor. If after leaving you are found in the examination area while the examination is in progress, your examination may be forfeited.

**GENERIC FUNDAMENTALS EXAMINATION**  
**EQUATIONS AND CONVERSIONS HANDOUT SHEET**

**EQUATIONS**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$A = \pi r^2$$

$$F = PA$$

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

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

$$E = IR$$

$$\text{Thermal Efficiency} = \text{Net Work Out}/\text{Energy In}$$

$$\frac{g(z_2 - z_1)}{g_c} + \frac{(\bar{v}_2^2 - \bar{v}_1^2)}{2g_c} + v(P_2 - P_1) + (u_2 - u_1) + (q - w) = 0$$

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

**CONVERSIONS**

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

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

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

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

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

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

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

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

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

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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QUESTION: 1

A main steam system uses a combination of safety and relief valves for overpressure protection. Which one of the following describes a major design consideration for installing both types of valves in the same system?

- A. The safety valves are installed to prevent chattering of the relief valves during normal power operation.
- B. The safety valves are installed to prevent unnecessary opening of the relief valves during a steam pressure transient.
- C. The relief valves are installed to prevent chattering of the safety valves during normal power operation.
- D. The relief valves are installed to prevent unnecessary opening of the safety valves during a steam pressure transient.

QUESTION: 2

A typical motor-operated valve (MOV) has just been opened from the main control room, and the breaker for the MOV has been opened. A plant operator has been directed to close the MOV locally for a surveillance test.

If the operator attempts to turn the MOV handwheel in the clockwise direction without first operating the clutch lever, which one of the following will occur?

- A. The handwheel will not turn, and the valve stem will not move.
- B. The handwheel will turn, but the valve stem will not move.
- C. The handwheel will turn, and the valve stem will move toward the closed position because the clutch is automatically engaged when the handwheel is turned.
- D. The handwheel will turn, and the valve stem will move toward the closed position because the clutch is automatically engaged when the breaker is opened.

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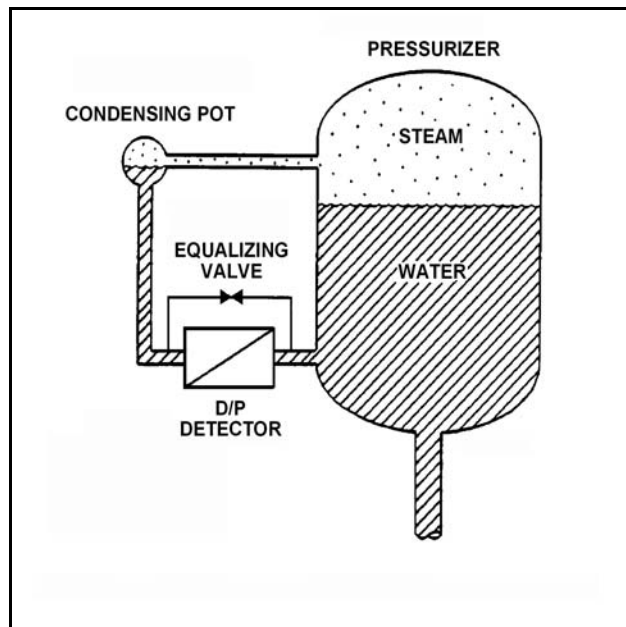
QUESTION: 3

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

With the pressurizer containing saturated water and steam at 2,250 psia, pressurizer level indication is 20 feet. Assume that reference leg level and temperature do not change. Also, ignore the effect of steam density changes on level indication.

With no change in actual pressurizer level, what will level indication be at 600 psia (saturated)?

- A. 14.9 feet
- B. 18.3 feet
- C. 22.4 feet
- D. 26.8 feet



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QUESTION: 4

Unlike a resistance temperature detector, a typical thermocouple...

- A. uses a single type of metal in the sensing element
- B. requires a temperature-controlled reference junction.
- C. can provide temperature input to a valve controller in a cooling water system.
- D. requires an external power supply to provide indication of temperature.

QUESTION: 5

A nuclear reactor is shut down at 100 cps in the source/startup range when a loss of coolant accident occurs. Which one of the following describes excore source/startup range count rate indication as homogeneous core voiding increases from 20 to 40 percent?

- A. Increases because more neutron leakage is occurring.
- B. Decreases because less neutron leakage is occurring.
- C. Increases because  $K_{\text{eff}}$  is increasing.
- D. Decreases because  $K_{\text{eff}}$  is decreasing.

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QUESTION: 6

Which one of the following types of radiation detectors is typically the least accurate in determining the dose rate to a human body from an unspecified source of radiation?

- A. Geiger-Mueller
- B. Ion chamber
- C. Proportional counter
- D. Scintillation

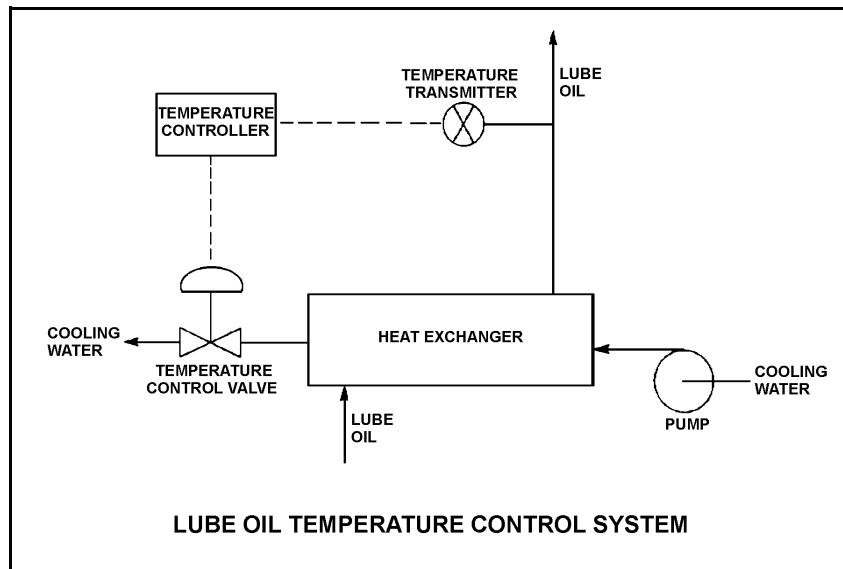
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QUESTION: 7

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

The temperature controller is a direct-acting proportional controller with a gain of 1.0. Which one of the following describes the effect of changing the gain to 2.0?

- A. Half the temperature deviation from setpoint will produce a given controller output.
- B. Twice the temperature deviation from setpoint will produce a given controller output.
- C. The temperature control valve will move half as far for a given change in controller output.
- D. The temperature control valve will move twice as far for a given change in controller output.





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QUESTION: 8

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

- A. increase, then decrease and stabilize below the initial value.
- B. increase, then decrease and stabilize above the initial value.
- C. decrease, then increase and stabilize below the initial value.
- D. decrease, then increase and stabilize above the initial value.

QUESTION: 9

An outside water storage tank is equipped with submerged heaters. The heaters energize at minimum power when water temperature decreases to 48°F. If water temperature continues to decrease, heater power will increase directly with the temperature deviation from 48°F until maximum power is reached at 40°F. If water temperature decreases faster than 1°F/min, the heaters will reach maximum power at a higher water temperature.

Which one of the following types of control is used in the heater control circuit to produce these characteristics?

- A. Proportional only
- B. Proportional plus integral
- C. Proportional plus derivative
- D. Proportional plus integral plus derivative

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QUESTION: 10

A centrifugal pump is initially operating at rated flow rate in an open system. Which one of the following moderate changes will cause the pump to operate in closer proximity to cavitation?

- A. Increase pump inlet temperature.
- B. Decrease pump speed.
- C. Increase pump suction pressure.
- D. Decrease pump recirculation flow rate.

QUESTION: 11

A centrifugal pump is taking suction on a water storage tank and discharging through a flow control valve. The pump will have the highest net positive suction head requirement if the pump is operated at a \_\_\_\_\_ speed with a \_\_\_\_\_ discharge flow control valve.

- A. high; fully open
- B. high; throttled
- C. low; fully open
- D. low; throttled

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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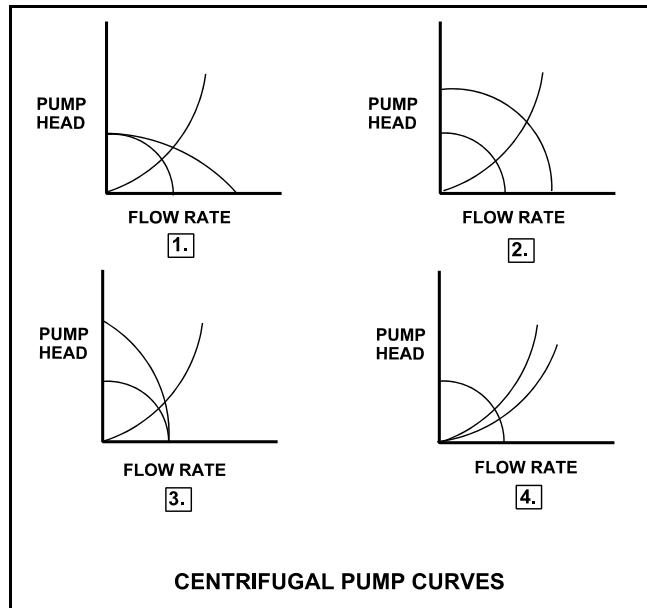
QUESTION: 12

Refer to the drawing of four sets of centrifugal pump operating curves (see figure below). Each set of curves shows the results of a change in pump/system operating conditions.

Initially, a single centrifugal pump is operating in a cooling water system. Another identical centrifugal pump is started in series with the first.

Which set of operating curves depicts the "before" and "after" conditions described above?

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



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QUESTION: 13

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

- A. Protect the pump and suction piping from overpressure if the discharge valve is open during system startup.
- B. Protect the pump and suction piping from overpressure if the suction valve is closed during pump operation.
- C. Protect the pump and discharge piping from overpressure if the discharge valve is closed during pump operation.
- D. Protect the pump and discharge piping from overpressure due to thermal expansion of pump contents when the pump is stopped with its suction valve closed.

QUESTION: 14

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

- A. Decreases due to decreased pump work.
- B. Decreases due to decreased counter electromotive force.
- C. Increases due to increased pump work.
- D. Increases due to increased counter electromotive force.

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QUESTION: 15

A 4,160 VAC three-phase induction motor is connected to a radial-flow centrifugal pump in a cooling water system. When the pump is started, the time period required to reach a stable running current will be shorter if the pump discharge valve is fully \_\_\_\_\_; and the stable running current will be lower if the pump discharge valve is fully \_\_\_\_\_.

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

QUESTION: 16

Which one of the following will reduce the rate of heat transfer between two liquids in a heat exchanger? (Assume single-phase conditions and a constant specific heat for both liquids.)

- A. The inlet temperatures of both liquids are decreased by 20°F.
- B. The inlet temperatures of both liquids are increased by 20°F.
- C. The inlet temperature of the hotter liquid is increased by 20°F.
- D. The inlet temperature of the colder liquid is increased by 20°F.

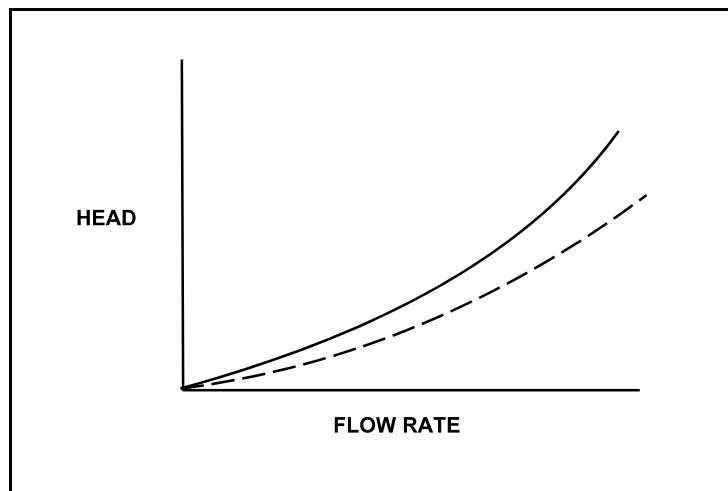
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QUESTION: 17

Refer to the drawing of two system curves for a typical main condenser cooling water system (see figure below).

Which one of the following will cause the system curve to shift from the solid curve toward the dashed curve?

- A. The main condenser tubes are cleaned.
- B. The main condenser tubes become increasingly fouled.
- C. Cooling water flow rate is increased by 25% by starting an additional cooling water pump.
- D. Cooling water flow rate is decreased by 25% by stopping one of the operating cooling water pumps.



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QUESTION: 18

A condensate demineralizer differential pressure (D/P) gauge indicates 4.0 psid at 50% flow rate. Over the next two days plant power changes have caused condensate flow rate to vary between 25% and 100%.

Which one of the following combinations of condensate flow and demineralizer D/P, observed during the power changes, indicates an increased accumulation of corrosion products in the demineralizer?

	<u>Condensate Flow Rate</u>	<u>Demineralizer D/P (psid)</u>
A.	100%	15.0
B.	75%	9.0
C.	40%	3.0
D.	25%	1.0

QUESTION: 19

The demineralization factor of a demineralizer can be expressed as...

- A. Inlet Conductivity minus Outlet Conductivity.
- B. Outlet Conductivity minus Inlet Conductivity.
- C. Inlet Conductivity divided by Outlet Conductivity.
- D. Outlet Conductivity divided by Inlet Conductivity.

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QUESTION: 20

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: 21

Which one of the following results from a loss of control power to a breaker supplying a motor?

- A. Motor ammeter indication will be zero regardless of actual breaker position.
- B. Breaker position will remotely indicate closed regardless of actual position.
- C. Breaker will trip open due to the actuation of its protective trip device.
- D. Charging motor will not recharge the closing spring after the breaker closes.



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QUESTION: 22

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

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

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

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

QUESTION: 23

During a brief time interval in a typical commercial nuclear reactor operating near the beginning of a fuel cycle,  $1.0 \times 10^3$  delayed neutrons were emitted.

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

- A.  $1.5 \times 10^5$
- B.  $6.5 \times 10^6$
- C.  $1.5 \times 10^7$
- D.  $6.5 \times 10^8$

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QUESTION: 24

Nuclear reactors A and B are identical except that reactor A is operating near the beginning of a fuel cycle (BOC) and reactor B is operating near the end of a fuel cycle (EOC). Both reactors are operating at 100 percent power with all control rods fully withdrawn.

If the total reactivity worth of the control rods is the same for both reactors, which reactor will have the greater core  $K_{\text{eff}}$  five minutes after a reactor trip, and why?

- A. Reactor A, because the pre-trip reactor coolant boron concentration is lower near the BOC.
- B. Reactor A, because the power coefficient adds less positive reactivity after a trip near the BOC.
- C. Reactor B, because the pre-trip reactor coolant boron concentration is higher near the EOC.
- D. Reactor B, because the power coefficient adds more positive reactivity after a trip near the EOC.

QUESTION: 25

Two identical reactors, A and B, are critical at  $1.0 \times 10^{-8}$  percent power near the beginning of a fuel cycle. Simultaneously, positive 0.001  $\Delta K/K$  is added to reactor A, and negative 0.001  $\Delta K/K$  is added to reactor B. One minute later, which reactor, if any, will have the shorter period and why?

- A. Reactor A, because delayed neutrons are less effective at slowing down power changes when the fission rate is increasing.
- B. Reactor B, because delayed neutrons are less effective at slowing down power changes when the fission rate is decreasing.
- C. The periods in both reactors will be the same because their effective delayed neutron fractions are the same.
- D. The periods in both reactors will be the same because the absolute values of the reactivity additions are the same.

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QUESTION: 26

As the reactor coolant boron concentration increases, the moderator temperature coefficient becomes less negative. This is because a 1°F increase in reactor coolant temperature at higher boron concentrations results in a larger increase in the...

- A. fast fission factor.
- B. thermal utilization factor.
- C. total nonleakage probability.
- D. resonance escape probability.

QUESTION: 27

If the average temperature of a fuel pellet decreases by 50°F, the microscopic cross-section for absorption of neutrons at a resonance energy of U-238 will \_\_\_\_\_; and the microscopic cross-sections for absorption of neutrons at energies that are slightly higher or lower than a U-238 resonance energy will \_\_\_\_\_.

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

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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QUESTION: 28

Consider a nuclear reactor core with four quadrants: A, B, C, and D. The reactor is operating at steady state 90 percent 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 percent.

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

- 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.

QUESTION: 29

Why are the control rod insertion limits power dependent?

- A. Power defect increases as power increases.
- B. Control rod worth decreases as power increases.
- C. Doppler (fuel temperature) coefficient decreases as power increases.
- D. Equilibrium core xenon-135 negative reactivity increases as power increases.

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QUESTION: 30

Reactor power is increased from 50 to 60 percent in 1 hour. The most significant contributor to the initial change in core xenon-135 reactivity is the increase in xenon-135...

- A. production from iodine decay.
- B. production from fission.
- C. absorption of neutrons.
- D. decay to cesium.

QUESTION: 31

Twenty four hours after a reactor trip from a long-term, steady-state, 100 percent power run, the core xenon-135 concentration will be approximately...

- A. the same as at the time of the trip and decreasing.
- B. the same as at the time of the trip and increasing.
- C. 50% lower than at the time of the trip and decreasing.
- D. 50% higher than at the time of the trip and increasing.

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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QUESTION: 32

Compared to adding boric acid to the RCS during forced circulation, adding boric acid during natural circulation requires \_\_\_\_\_ time to achieve complete mixing in the RCS; and, once completely mixed at a given coolant temperature, a 1 ppm increase in RCS boron concentration during natural circulation will cause a/an \_\_\_\_\_ change in core reactivity.

- A. more; smaller
- B. more; equal
- C. less; smaller
- D. less; equal

QUESTION: 33

Which one of the following describes the change in neutron count rate resulting from a short control rod withdrawal with  $K_{\text{eff}}$  at 0.95 as compared to an identical control rod withdrawal with  $K_{\text{eff}}$  at 0.99? (Assume the reactivity additions are equal, and the reactor remains subcritical.)

- A. The prompt jump in count rate will be the same, and the increase in count rate will be the same.
- B. The prompt jump in count rate will be greater with  $K_{\text{eff}}$  at 0.99, but the increase in count rate will be the same.
- C. The prompt jump in count rate will be the same, but the increase in count rate will be greater with  $K_{\text{eff}}$  at 0.99.
- D. The prompt jump in count rate will be greater, and the increase in count rate will be greater with  $K_{\text{eff}}$  at 0.99.

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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QUESTION: 34

The following data were obtained during a nuclear reactor startup:

<u>Control Rod Units Withdrawn</u>	<u>Source Range Count Rate (cps)</u>
0	20
10	25
15	28
20	33
25	40
30	50

Assuming a uniform differential control rod worth, at what approximate control rod position will criticality occur?

- A. 66 to 75 units withdrawn
- B. 56 to 65 units withdrawn
- C. 46 to 55 units withdrawn
- D. 35 to 45 units withdrawn

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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QUESTION: 35

A nuclear power plant is operating at 60 percent power in the middle of a fuel cycle with manual rod control when a turbine control system malfunction closes the turbine steam inlet valves an additional 5 percent. Which one of the following is mostly 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 by the moderator initially increases.
- C. The rate of neutron absorption at U-238 resonance energies initially increases.
- D. The rate of neutron absorption by the boron in the reactor coolant initially increases.

QUESTION: 36

After one month of operation at rated thermal power, the fraction of rated thermal power being produced from the decay of fission products in the operating nuclear reactor is...

- A. greater than 10 percent.
- B. greater than 5 percent, but less than 10 percent.
- C. greater than 1 percent, but less than 5 percent.
- D. less than 1 percent.



**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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QUESTION: 37

Assuming a standard atmospheric pressure of 15.0 psia, 5.0 inches of mercury (Hg) vacuum is equivalent to...

- A. 2.5 psia.
- B. 5.0 psia.
- C. 10.0 psia.
- D. 12.5 psia.

QUESTION: 38

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

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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QUESTION: 39

Which one of the following changes will result in increased subcooling of the condensate in the condenser hotwell?

- A. Isolate one bay of the condenser circulating water system.
- B. Increase circulating water temperature.
- C. Decrease circulating water flow.
- D. Decrease the main turbine steam flow rate.

QUESTION: 40

A pressurizer safety valve is leaking by, allowing the 100% quality steam from the pressurizer to enter the discharge pipe, which remains at a constant pressure of 30 psig. Initial safety valve discharge pipe temperature is elevated but stable. Assume no heat loss from the safety valve discharge pipe.

Upon discovery of the leak, the reactor is shut down and a plant cooldown and depressurization are commenced. With the leak still present, as pressurizer pressure slowly decreases from 2,000 psig to 1,800 psig, the safety valve discharge pipe temperature will...

- A. decrease, because the entropy of the safety valve discharge will be decreasing.
- B. decrease, because the enthalpy of the safety valve discharge will be decreasing.
- C. increase, because the safety valve discharge will become more superheated as pressurizer pressure decreases.
- D. remain the same, because the safety valve discharge will remain a saturated steam-water mixture at 30 psig.

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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QUESTION: 41

A nuclear power plant is operating at 100 percent power with 0°F of condensate subcooling. If main condenser cooling water inlet temperature increases by 3°F, the overall plant thermal efficiency will...

- A. decrease due to a degraded main condenser vacuum.
- B. increase due to an improved main condenser vacuum.
- C. decrease due to increased main condenser heat rejection.
- D. increase due to decreased main condenser heat rejection.

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
DECEMBER 2009 PWR--FORM A**

QUESTION: 42

Refer to the drawing of two lengths of 16-inch diameter pipe, each containing an identical automatic isolation valve. The actual pipe lengths are proportional to their symbols in the drawing.

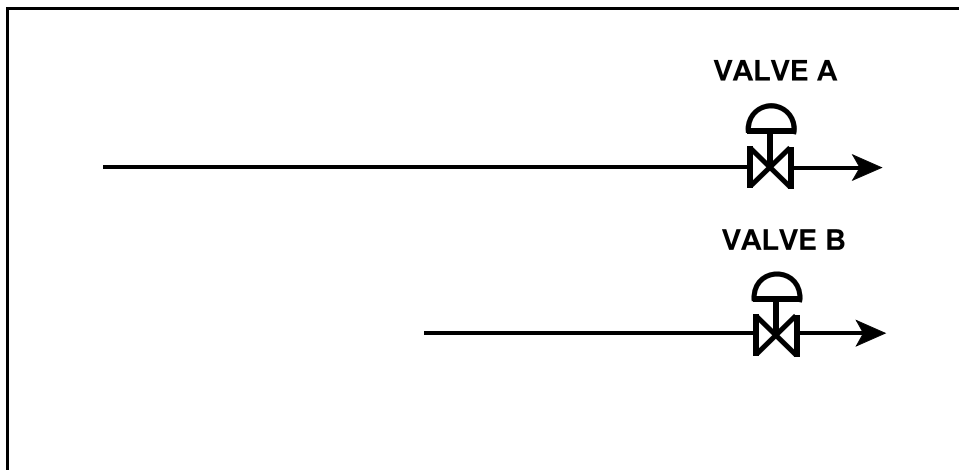
Water is flowing at 10,000 gpm through each pipe when both isolation valves instantly close. Consider two cases:

Case 1: The water temperature upstream of both valves is 65°F.

Case 2: The water temperature is 65°F upstream of valve A, and 85°F upstream of valve B.

For which case(s), if any, will valve A experience a pressure spike that is greater than the pressure spike at valve B?

- A. Case 1 only
- B. Case 2 only
- C. Both cases
- D. Neither case



**USNRC GENERIC FUNDAMENTALS EXAMINATION  
DECEMBER 2009 PWR--FORM A**

QUESTION: 43

Reactor coolant system (RCS) hot leg temperature is 552°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. 1,100 to 1,051 psig
- B. 1,050 to 1,001 psig
- C. 1,000 to 951 psig
- D. 950 to 901 psig

QUESTION: 44

Which one of the following describes a heat transfer process in which convection is the most significant mode of heat transfer?

- A. From the reactor fuel to the core barrel during core uncover.
- B. Through the tube walls in a steam generator during normal operation at 100 percent power.
- C. From the reactor fuel to the steam generators following a loss of all RCPs.
- D. From the fuel pellet centerline to the fuel clad during normal operation at 100 percent power.

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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QUESTION: 45

Subcooled reactor coolant flows into the bottom of a fuel assembly coolant channel and exits the top of the channel as a saturated steam-water mixture with a 98% moisture content. How does the overall heat transfer coefficient in the coolant channel change as the coolant travels upward along the channel?

- A. Increases only.
- B. Increases, then decreases.
- C. Decreases only.
- D. Decreases, then increases.

QUESTION: 46

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

- Reactor power is 55 percent 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 decrease the steady-state departure from nucleate boiling ratio?

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

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
DECEMBER 2009 PWR--FORM A**

QUESTION: 47

Refer to the drawing of a section of pipe that contains flowing water (see figure below).

Given:

Pressure at  $P_1$  is 24 psig.

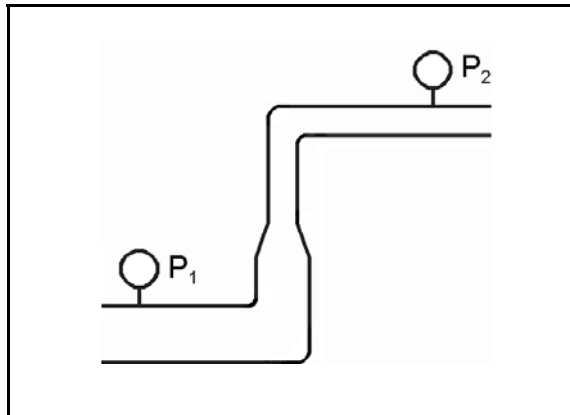
Pressure at  $P_2$  is 16 psig.

Pressure change due to change in velocity is 2 psig.

Pressure change due to change in elevation is 10 psig.

The pressure decrease due to friction head loss between  $P_1$  and  $P_2$  is \_\_\_\_\_; and the direction of flow is from \_\_\_\_\_.

- A. 2 psig; left to right
- B. 2 psig; right to left
- C. 4 psig; left to right
- D. 4 psig; right to left



**USNRC GENERIC FUNDAMENTALS EXAMINATION  
DECEMBER 2009 PWR--FORM A**

QUESTION: 48

A reactor coolant system natural circulation cooldown is in progress using the steam generator (SG) atmospheric steam relief valves (operated in manual control).

If voids interrupt natural circulation, which one of the following will occur? (Assume feed flow rate, relief valve position, and decay heat level are constant.)

- A. SG pressure decreases and core exit thermocouple (CETC) temperature increases.
- B. SG pressure decreases and CETC temperature remains constant.
- C. SG pressure increases and CETC temperature increases.
- D. SG pressure increases and CETC temperature remains constant.

QUESTION: 49

A nuclear reactor is operating at steady state conditions in the power range with the following average temperatures in a core plane:

$$\begin{aligned} T_{\text{coolant}} &= 550^{\circ}\text{F} \\ T_{\text{fuel centerline}} &= 1,680^{\circ}\text{F} \end{aligned}$$

Assume that the fuel rod heat transfer coefficients and reactor coolant temperatures are equal throughout the core plane. If the maximum total peaking factor in the core plane is 2.1, what is the maximum fuel centerline temperature in the core plane?

- A. 2,923 °F
- B. 3,528 °F
- C. 4,078 °F
- D. 4,683 °F



**USNRC GENERIC FUNDAMENTALS EXAMINATION  
DECEMBER 2009 PWR--FORM A**

QUESTION: 50

Which one of the following comparisons will result in a higher probability of brittle fracture of the reactor vessel?

- A. A high reactor gamma flux rather than a high neutron flux.
- B. A high reactor vessel material strength rather than a high material ductility.
- C. A high reactor coolant oxygen content rather than a low oxygen content.
- D. A rapid 100°F reactor cooldown at a high temperature rather than a low temperature.

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

**DECEMBER 2009 NRC GENERIC FUNDAMENTALS EXAMINATION  
PRESSURIZED WATER REACTOR - ANSWER KEY**

<u>FORM A</u>	<u>FORM B</u>	<u>ANS.</u>	<u>FORM A</u>	<u>FORM B</u>	<u>ANS.</u>
1	15	D	26	40	B
2	16	B	27	41	B
3	17	D	28	42	D
4	18	B	29	43	A
5	19	A	30	44	C
6	20	A	31	45	A
7	21	A	32	46	B
8	22	B	33	47	D
9	23	C	34	48	C
10	24	A	35	49	C
11	25	A	36	50	B
12	26	C	37	1	D
13	27	C	38	2	B
14	28	A	39	3	D
15	29	D	40	4	D
16	30	D	41	5	A or C
17	31	A	42	6	B
18	32	C	43	7	B
19	33	C	44	8	C
20	34	B	45	9	A
21	35	D	46	10	D
22	36	B	47	11	D
23	37	A	48	12	A
24	38	D	49	13	A
25	39	A	50	14	B