

**UNITED STATES NUCLEAR REGULATORY COMMISSION  
BOILING WATER REACTOR GENERIC FUNDAMENTALS EXAMINATION  
SEPTEMBER 2011--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 hours after the examination begins. This examination applies to a typical U.S. boiling water reactor (BWR) 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 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 times.
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**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$A = \pi r^2$$

$$F = PA$$

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

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

$$P = IE$$

$$P_A = \sqrt{3} IE$$

$$P_T = \sqrt{3} IE \text{ pf}$$

$$P_R = \sqrt{3} IE \sin \theta$$

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

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

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

**CONVERSIONS**

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

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

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

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

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

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

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

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

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

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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QUESTION: 1

Subcooled water is flowing through a throttled valve with the following initial parameters:

- Inlet pressure = 60 psia
- Outlet pressure = 50 psia
- Flow rate = 800 gpm

The valve is opened fully and the following parameters currently exist:

- Inlet pressure = 60 psia
- Outlet pressure = 55 psia

What is the approximate flow rate through the fully open valve?

- A. 400 gpm
- B. 566 gpm
- C. 635 gpm
- D. Cannot be determined without additional information.

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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QUESTION: 2

A surveillance test procedure is being performed on a typical Limitorque motor-operated valve (MOV) used in an emergency core cooling system (ECCS) application. The declutch lever has been operated and released and the valve is being manually/locally opened by a technician. The MOV breaker is closed as required by the surveillance test procedure. During operation of the valve handwheel, an ECCS actuation signal is received that normally energizes the valve motor and closes the valve.

How will the valve be affected by the actuation signal?

- A. The handwheel will disengage and the valve will automatically close.
- B. The handwheel will disengage and the valve will remain in the current position.
- C. The handwheel will remain engaged and the valve will automatically close.
- D. The handwheel will remain engaged and the technician can continue to open the valve.

QUESTION: 3

Which one of the following is a disadvantage associated with using a gate valve, versus a globe valve, to throttle flow in a cooling water system?

- A. The tortuous flow path through a throttled gate valve body makes flow control difficult.
- B. A gate valve will experience stem leakage unless it is fully opened and backseated.
- C. The turbulent flow created by a throttled gate valve will cause erosion damage to the valve seat.
- D. A fully open gate valve will produce a greater system head loss than a fully open globe valve.

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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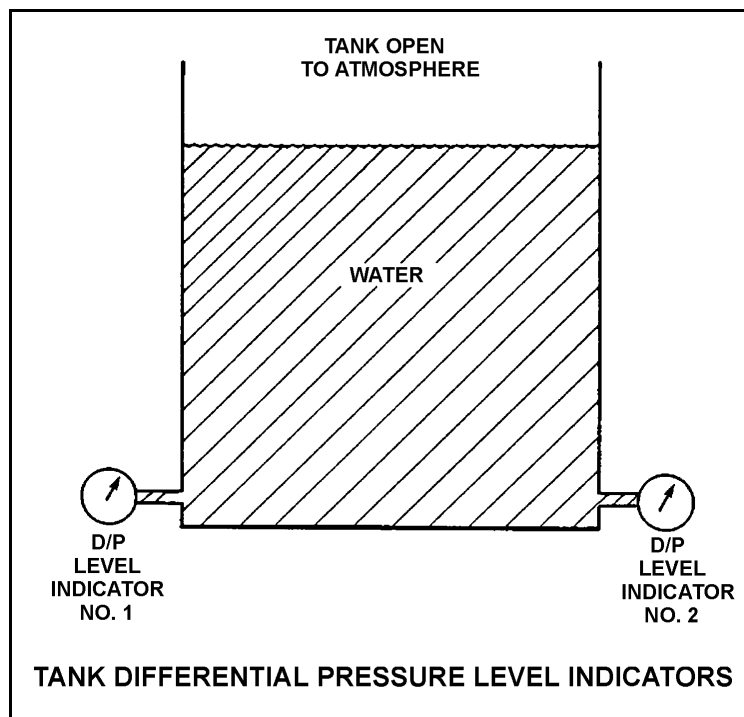
QUESTION: 4

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

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

Assuming both indicators are on scale, which indicator will indicate the lower level?

- A. Indicator 1 at all water temperatures.
- B. Indicator 2 at all water temperatures.
- C. Indicator 1 below 150°F, indicator 2 above 150°F.
- D. Indicator 2 below 150°F, indicator 1 above 150°F .



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QUESTION: 5

A simple two-wire resistance temperature detector (RTD) is being used to measure the temperature of a water system. Copper extension wires run from the RTD to a temperature instrument 40 feet away. If the temperature of the extension wires decreases, the electrical resistance of the extension wires will \_\_\_\_\_, and the temperature indication will \_\_\_\_\_ unless temperature compensation is provided.

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

QUESTION: 6

In which usable region(s) of the gas-filled detector ionization curve is the pulse height resulting from the detection of a 1 MeV beta particle the same as a 5 MeV alpha particle?

- A. Geiger-Mueller only.
- B. Geiger-Mueller and Ionization Chamber.
- C. Proportional only.
- D. Proportional and Ionization Chamber.

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QUESTION: 7

Which one of the following describes a characteristic of a self-reading pocket dosimeter?

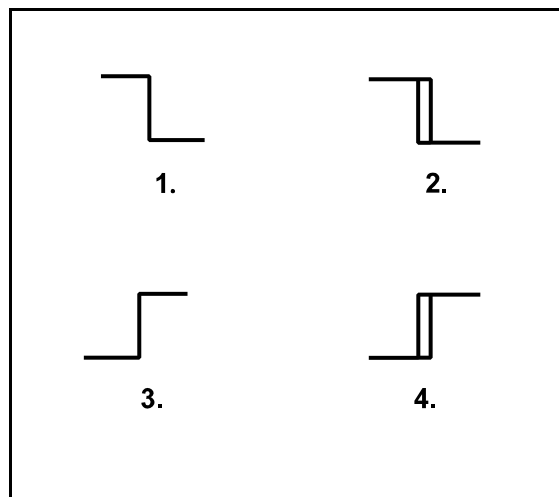
- A. Provides dose rate indication in mR/hr.
- B. More sensitive to gamma radiation than beta radiation.
- C. Contains crystals that luminesce when exposed to ionizing radiation.
- D. Can be stored as an accurate record of lifetime radiation exposure.

QUESTION: 8

The water level in a water storage tank is being controlled by an automatic bistable level controller. If water level increases to 70 percent, the controller bistable turns off to open a tank drain valve. When water level decreases to 60 percent, the controller bistable turns on to close the drain valve.

Which one of the following bistable symbols indicates the characteristics of the bistable used in the level controller?

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





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QUESTION: 9

A direct-acting proportional controller is being used to control the temperature of lube oil exiting a heat exchanger. The controller's proportional band is 80°F to 130°F.

Which one of the following will be the controller's output percentage when the measured lube oil temperature is 92°F?

- A. 12 percent
- B. 24 percent
- C. 38 percent
- D. 76 percent

QUESTION: 10

The discharge valve for a radial flow centrifugal cooling water pump is closed in preparation for starting the pump.

After the pump is started, the following stable pump pressures are observed:

Pump discharge pressure: 30 psig  
Pump suction pressure: 10 psig

With the discharge valve still closed, if the pump speed is doubled, what will be the new pump discharge pressure?

- A. 80 psig
- B. 90 psig
- C. 120 psig
- D. 130 psig

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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QUESTION: 11

A centrifugal pump is taking suction on an open water storage tank. The pump is located at the base of the tank, takes a suction from the bottom of the tank, and discharges to a pressurized system.

Given:

- The tank is filled to a level of 26 feet with 60°F water.
- The pump is currently operating at 50 gpm.
- The pump requires 30 feet of net positive suction head.

Which one of the following describes the current pump status, and how the pump flow rate will be affected as the level in the storage tank decreases?

- A. The pump is currently cavitating; pump flow rate will decrease continuously as tank level decreases.
- B. The pump is currently cavitating; pump flow rate will remain about the same until the tank empties.
- C. The pump is currently not cavitating; pump flow rate will gradually decrease with tank level and then rapidly decrease when cavitation begins at a lower tank level.
- D. The pump is currently not cavitating; pump flow rate will gradually decrease with tank level and then rapidly decrease as the pump becomes air bound when the tank empties.

QUESTION: 12

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

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QUESTION: 13

A centrifugal fire water pump takes a suction on an open storage tank and discharges through a fire hose. Which one of the following will cause the pump to operate at shutoff head?

- A. The fire hose nozzle is raised to an elevation that prevents any flow.
- B. Suction temperature is increased to the point that gas binding occurs.
- C. Pump speed is adjusted to the value at which cavitation occurs.
- D. Suction pressure is adjusted until available net positive suction head is reduced to zero feet.

QUESTION: 14

Two identical 4,160 VAC three-phase induction motors are connected to identical radial-flow centrifugal pumps in identical but separate cooling water systems. Each motor is rated at 200 hp. The discharge valve for motor/pump A is fully open and the discharge valve for motor/pump B is fully closed.

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

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

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QUESTION: 15

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

100 MW  
0 MVAR  
2,625 amps  
22 KV

If the main generator excitation current is decreased, the main generator amps will initially \_\_\_\_\_ and MW will initially \_\_\_\_\_.

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

QUESTION: 16

Which one of the following describes the proper sequence for placing a steam (shell) and water (tube) heat exchanger into service?

- A. The water side is valved in before the steam side to minimize thermal shock.
- B. The water side is valved in before the steam side to ensure adequate venting.
- C. The steam side is valved in before the water side to minimize scale buildup on the heat exchanger tubes.
- D. The steam side is valved in before the water side to ensure that the cooldown rate does not exceed 100°F/hr.

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QUESTION: 17

A main turbine-generator is operating at 80 percent load with the following initial steady-state temperatures for the main turbine lube oil heat exchanger:

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

After six months of main turbine-generator operation, the following final steady-state lube oil heat exchanger temperatures are observed:

$$\begin{array}{ll} T_{\text{oil in}} & = 179^{\circ}\text{F} \\ T_{\text{oil out}} & = 119^{\circ}\text{F} \\ T_{\text{water in}} & = 85^{\circ}\text{F} \\ T_{\text{water out}} & = 115^{\circ}\text{F} \end{array}$$

Assume that the final cooling water and lube oil flow rates are the same as the initial flow rates, 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 final heat exchanger steady-state temperatures?

- A. The heat exchanger tubes have become fouled with scale.
- B. The temperature of the cooling water source has increased.
- C. The final main turbine-generator load is higher than the initial load.
- D. The final main turbine-generator load is lower than the initial load.

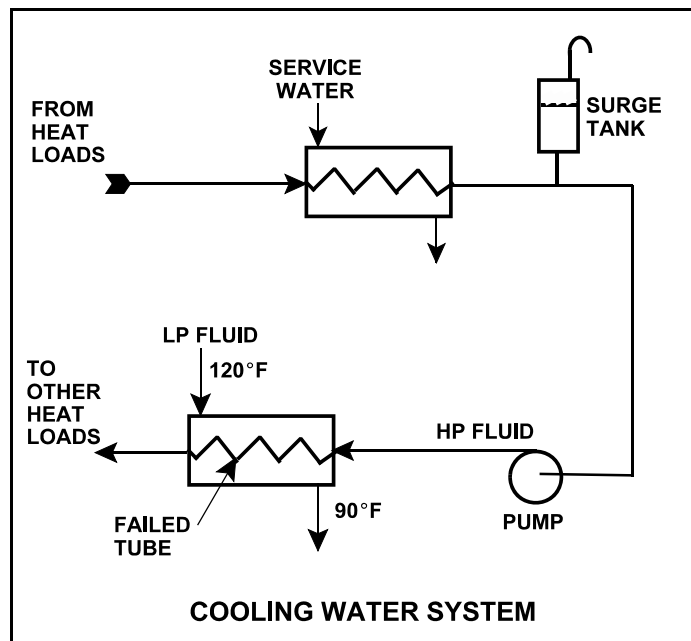
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QUESTION: 18

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

Which one of the following will occur as a result of the indicated tube failure in the heat exchanger?

- A. High pressure (HP) fluid inventory increases.
- B. Pressure in the low pressure (LP) system decreases.
- C. Temperature in the low pressure (LP) system increases.
- D. Level in the surge tank decreases.



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QUESTION: 19

The decontamination factor (or demineralization factor) of a condensate demineralizer has just been determined to be 10, based on conductivity measurements.

If condensate having a conductivity of 20  $\mu\text{mho/cm}$  is flowing into this demineralizer, which one of the following is the conductivity of the condensate at the outlet of the demineralizer?

- A. 0.5  $\mu\text{mho/cm}$
- B. 2.0  $\mu\text{mho/cm}$
- C. 5.0  $\mu\text{mho/cm}$
- D. 10.0  $\mu\text{mho/cm}$

QUESTION: 20

Which one of the following describes the process of backwashing a mixed-resin deep bed demineralizer?

- A. Alternating the flow of dilute acidic and caustic solutions through the demineralizer to remove suspended solids and colloidal matter.
- B. Alternating the flow of dilute acidic and caustic solutions through the demineralizer to remove ionic impurities.
- C. Reversing flow of pure water through the demineralizer to remove suspended solids and colloidal matter.
- D. Reversing flow of pure water through the demineralizer to remove ionic impurities.

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QUESTION: 21

Given the following indications for an open 4,160 VAC breaker:

- All phase overcurrent trip flags are reset.
- The control power fuses indicate blown.
- The line-side voltmeter indicates 4,160 VAC.
- The load-side voltmeter indicates 0 volts.

Assuming no operator actions were taken since the breaker opened, which one of the following could have caused the breaker to open?

- A. A ground fault caused an automatic breaker trip.
- B. A loss of control power caused an automatic breaker trip.
- C. An operator tripped the breaker manually at the breaker cabinet.
- D. An operator tripped the breaker manually from a remote location.

QUESTION: 22

A main generator is about to be connected to an infinite power grid. Which one of the following conditions will cause the main generator to immediately supply reactive power (MVAR) to the grid when the generator output breaker is closed?

- A. Generator voltage is slightly higher than grid voltage.
- B. Generator voltage is slightly lower than grid voltage.
- C. The synchroscope is turning slowly in the clockwise direction.
- D. The synchroscope is turning slowly in the counterclockwise direction.



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QUESTION: 23

A fast neutron will lose the greatest amount of energy during a scattering reaction in the moderator if it interacts with...

- A. an oxygen nucleus.
- B. a hydrogen nucleus.
- C. a deuterium nucleus.
- D. an electron surrounding a nucleus.

QUESTION: 24

Which one of the following is a reason for installing excess reactivity ( $K_{\text{excess}}$ ) in a reactor core?

- A. To compensate for the conversion of U-238 to Pu-239 over core life.
- B. To compensate for burnout of Xe-135 and Sm-149 during power changes.
- C. To ensure the fuel temperature coefficient remains negative throughout core life.
- D. To compensate for the negative reactivity added by the power coefficient during a power increase.

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QUESTION: 25

Which one of the following is the intrinsic source that produces the greatest neutron flux for the first few days following a reactor scram from extended high power operations?

- A. Spontaneous neutron emission from control rods.
- B. Photo-neutron reactions in the moderator.
- C. Spontaneous fission in the fuel.
- D. Alpha-neutron reactions in the fuel.

QUESTION: 26

Which one of the following 10 percent power level changes produces the largest amount of negative reactivity from the fuel temperature coefficient? (Assume that each power level change produces the same increase/decrease in fuel temperature.)

- A. 30 percent to 40 percent.
- B. 30 percent to 20 percent.
- C. 80 percent to 90 percent.
- D. 80 percent to 70 percent.

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QUESTION: 27

Which one of the following is the primary reason the void coefficient becomes less negative toward the end of a fuel cycle?

- A. The thermal neutron flux increases.
- B. The thermal diffusion length decreases.
- C. The fuel centerline temperature increases.
- D. The control rod density decreases.

QUESTION: 28

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

- A. increase and stabilize above the original level.
- B. increase, then decrease and stabilize at the original level.
- C. increase, then decrease and stabilize above the original level.
- D. remain the same during and after the withdrawal.

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QUESTION: 29

If the void fraction surrounding several centrally located fuel bundles increases, the worth of the associated control rod(s) will...

- A. decrease, because the average neutron energy in the fuel bundles decreases, resulting in fewer neutrons traveling from within the fuel bundles to the affected control rod(s).
- B. decrease, because more neutrons are resonantly absorbed in the fuel while they are being thermalized, resulting in fewer thermal neutrons available to be absorbed by the affected control rod(s).
- C. increase, because the diffusion length of the thermal neutrons increases, resulting in more thermal neutrons traveling from within the fuel bundles to the affected control rod(s).
- D. increase, because neutrons will experience a longer slowing down length, resulting in a smaller fraction of thermal neutrons being absorbed by the fuel and more thermal neutrons available to be absorbed by the affected control rod(s).

QUESTION: 30

A nuclear power plant was operating at 100 percent power for 3 months near the end of a fuel cycle when a reactor scram occurred. Eighteen hours later, the reactor is critical at the point of adding heat with normal operating reactor vessel temperature and pressure. Power level will be raised to 100 percent over the next 3 hours.

During this power level increase, most of the positive reactivity added by the operator will be required to overcome the negative reactivity from...

- A. fuel burnup.
- B. xenon-135 buildup.
- C. fuel temperature increase.
- D. moderator temperature increase.

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QUESTION: 31

A nuclear reactor had been operating at 70 percent power for two weeks when power was increased to 100 percent over a 2-hour period. To offset core Xe-135 reactivity changes during the next 12 hours, which one of the following incremental control rod manipulations will be required?

- A. Insert rods slowly during the entire period.
- B. Insert rods slowly at first, then withdraw rods slowly.
- C. Withdraw rods slowly during the entire period.
- D. Withdraw rods slowly at first, then insert rods slowly.

QUESTION: 32

Just prior to a refueling outage the control rod density at 100 percent power is relatively low. However, immediately following the outage the control rod density at 100 percent power is much higher.

Which one of the following contributes to the need for a much higher 100 percent power control rod density at the beginning of a fuel cycle (BOC) compared with the end of a fuel cycle (EOC)?

- A. The negative reactivity from burnable poisons is greater at BOC than at EOC.
- B. The negative reactivity from fission product poisons is smaller at BOC than at EOC.
- C. The positive reactivity from the fuel in the core is smaller at BOC than at EOC.
- D. The positive reactivity from a unit withdrawal of a typical control rod is greater at BOC than at EOC.

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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QUESTION: 33

A nuclear reactor has just achieved criticality during a xenon-free reactor startup. Instead of stabilizing reactor power at  $1.0 \times 10^3$  cps per the startup procedure, the operator inadvertently allows power to increase to  $1.0 \times 10^4$  cps.

Assuming reactor vessel coolant temperature and pressure do not change, the critical rod height at  $1.0 \times 10^4$  cps will be \_\_\_\_\_ the critical rod height at  $1.0 \times 10^3$  cps. (Neglect any effects of changes in fission product poisons.)

- A. different but unpredictable compared to
- B. less than
- C. greater than
- D. equal to

QUESTION: 34

After taking critical data during a reactor startup, the operator establishes a stable 50-second reactor period to increase power to the point of adding heat (POAH). Which one of the following is the approximate amount of reactivity that must be added to stabilize reactor power at the POAH? (Assume  $\bar{\beta}_{\text{eff}} = 0.006$ .)

- A.  $-0.01 \% \Delta K/K$
- B.  $-0.06 \% \Delta K/K$
- C.  $-0.10 \% \Delta K/K$
- D.  $-0.60 \% \Delta K/K$

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QUESTION: 35

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: 36

Nuclear reactors A and B are identical and have been operated at 100 percent power for six months when a reactor scram occurs simultaneously on both reactors. All control rods fully insert, except for one reactor B control rod that remains fully withdrawn.

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

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

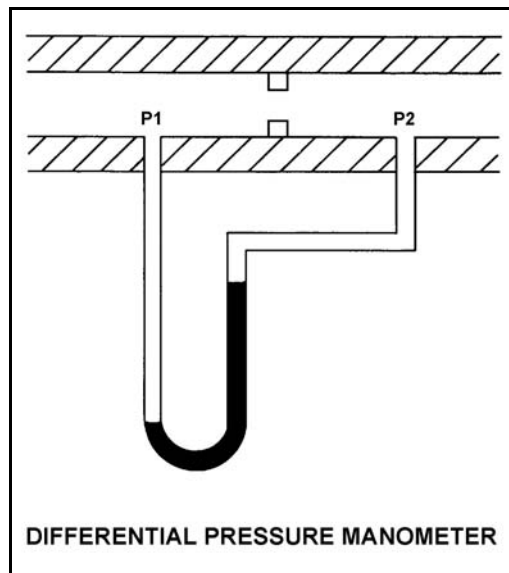
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QUESTION: 37

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

A differential pressure manometer filled with water is installed across an orifice in a ventilation duct to determine the direction of airflow. With the ventilation conditions as shown, the pressure at P1 is \_\_\_\_\_ than P2, and airflow is \_\_\_\_\_.

- A. greater; left to right
- B. greater; right to left
- C. less; left to right
- D. less; right to left





**USNRC GENERIC FUNDAMENTALS EXAMINATION  
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QUESTION: 38

A nuclear power plant experienced a loss of all AC electrical power due to a natural disaster. A few days later, there is turbulent boiling in the spent fuel pool. Average spent fuel temperature is elevated but stable. Assume that boiling is the only means of heat removal from the spent fuel pool.

Given the following stable current conditions:

Spent fuel decay heat rate: 4.8 MW  
Spent fuel building pressure: 14.7 psia  
Spent fuel pool temperature: 212°F

At what approximate rate is the mass of water in the spent fuel pool decreasing?

- A. 4,170 lbm/hr
- B. 4,950 lbm/hr
- C. 14,230 lbm/hr
- D. 16,870 lbm/hr

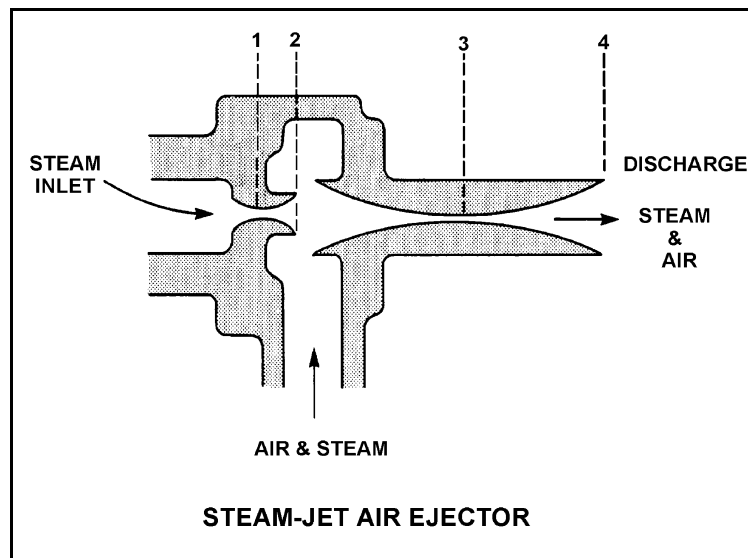
**USNRC GENERIC FUNDAMENTALS EXAMINATION  
SEPTEMBER 2011 BWR--FORM A**

QUESTION: 39

Refer to the drawing of a steam-jet air ejector (see figure below) in normal operation with supersonic steam velocities.

Steam flowing from 1 to 2 undergoes a pressure \_\_\_\_\_ and a velocity \_\_\_\_\_.

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



**USNRC GENERIC FUNDAMENTALS EXAMINATION  
SEPTEMBER 2011 BWR--FORM A**

QUESTION: 40

Given the following:

- A saturated steam-water mixture with an inlet quality of 40 percent is flowing through a moisture separator.
- The moisture separator is 100 percent efficient for removing water.

How much water will be removed by the moisture separator from 50 lbm of the steam-water mixture?

- A. 10 lbm
- B. 20 lbm
- C. 30 lbm
- D. 40 lbm

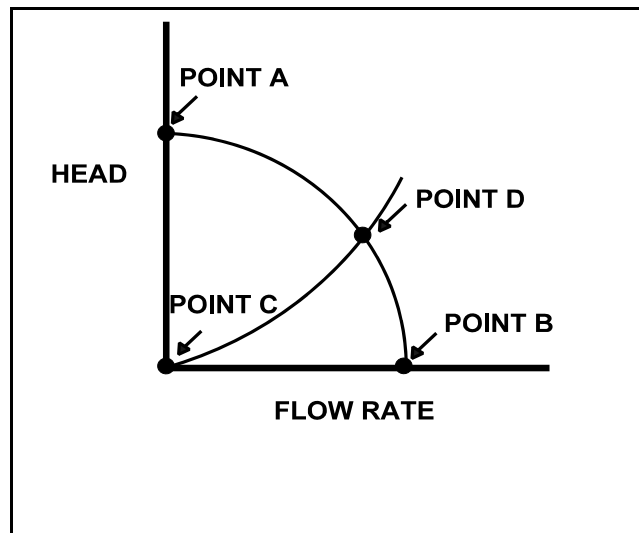
**USNRC GENERIC FUNDAMENTALS EXAMINATION  
SEPTEMBER 2011 BWR--FORM A**

QUESTION: 41

Refer to the drawing of centrifugal pump and system operating curves (see figure below).

Which one of the following determines the general shape of the curve from point C to point D?

- A. The frictional and throttling losses in the piping system as the system flow rate increases.
- B. The frictional losses between the pump impeller and its casing as the differential pressure (D/P) across the pump increases.
- C. The pump flow losses due to the decrease in available net positive suction head as the system flow rate increases.
- D. The pump flow losses due to back leakage through the clearances between the pump impeller and casing as the D/P across the pump increases.



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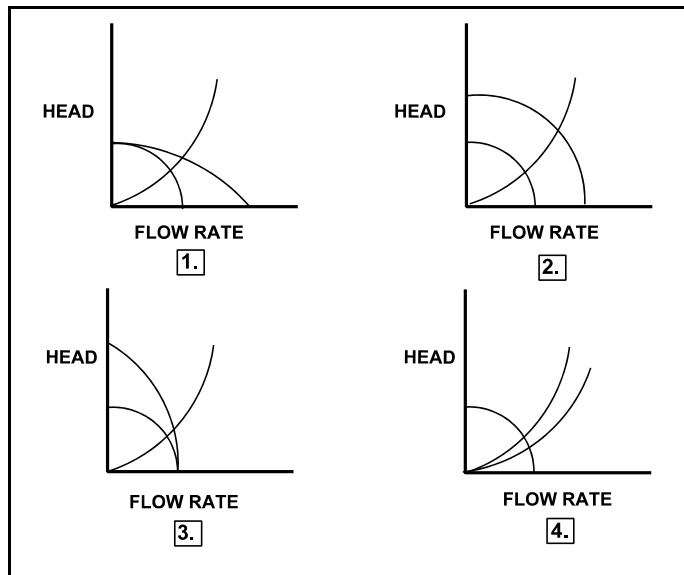
QUESTION: 42

Refer to the drawing of four sets of centrifugal pump and system 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.



**USNRC GENERIC FUNDAMENTALS EXAMINATION  
SEPTEMBER 2011 BWR--FORM A**

QUESTION: 43

A condenser is operating at 28.5 inches of Hg vacuum with a condensate outlet temperature of 88°F. Which one of the following is the approximate value of condensate depression?

- A. 2°F
- B. 9°F
- C. 13°F
- D. 17°F

QUESTION: 44

Which one of the following conditions must occur to sustain natural convection in a fluid system?

- A. Subcooling of the fluid.
- B. A phase change in the fluid.
- C. A density change in the fluid.
- D. Radiative heat transfer to the fluid.

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
SEPTEMBER 2011 BWR--FORM A**

QUESTION: 45

If the fission rate in a nuclear reactor core steadily increases, the mode of heat transfer that occurs immediately after the critical heat flux is reached is called...

- A. transition boiling.
- B. subcooled nucleate boiling.
- C. saturated nucleate boiling.
- D. stable film boiling.

QUESTION: 46

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

- A. The core differential pressure is minimized at all power levels.
- B. The total core coolant flow rate remains the same at all power levels.
- C. The total core coolant flow rate is divided equally through all bundles at all power levels.
- D. The highest bundle coolant flow rates exist in core interior bundles at all power levels.

**USNRC GENERIC FUNDAMENTALS EXAMINATION  
SEPTEMBER 2011 BWR--FORM A**

QUESTION: 47

Maintaining the linear heat generation rate below the thermal limit ensures that...

- A. peak cladding temperature after the design basis loss of coolant accident will not exceed 2,200°F.
- B. during transients, more than 99.97 percent of the fuel rods will avoid transition boiling.
- C. plastic strain of the cladding will not exceed 1 percent.
- D. peaking factors will not exceed those assumed in the safety analysis.

QUESTION: 48

A nuclear power plant is operating at 90 percent power near the end of a fuel cycle when reactor recirculation flow rate suddenly decreases by 10 percent. Assuming the reactor does not scram immediately, critical power will initially \_\_\_\_\_ and reactor power will initially \_\_\_\_\_.

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



**USNRC GENERIC FUNDAMENTALS EXAMINATION  
SEPTEMBER 2011 BWR--FORM A**

QUESTION: 49

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 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.

QUESTION: 50

Two identical nuclear reactors are currently shut down for refueling. Reactor A has an average lifetime power capacity of 90 percent and has been operating for 16 years. Reactor B has an average lifetime power capacity of 80 percent and has been operating for 18 years.

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

- A. Reactor A due to the higher average lifetime power capacity.
- B. Reactor B due to the lower average lifetime power capacity.
- C. Both reactors will have approximately the same nil ductility transition temperature because each core has produced approximately the same number of fissions.
- D. Both reactors will have approximately the same nil ductility transition temperature because fast neutron irradiation in a shut down core is not significant.

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

**SEPTEMBER 2011 NRC GENERIC FUNDAMENTALS EXAMINATION  
BOILING 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	A
2	16	A	27	41	D
3	17	C	28	42	A
4	18	B	29	43	B
5	19	D	30	44	C
6	20	A	31	45	B
7	21	B	32	46	B
8	22	B	33	47	D
9	23	B	34	48	C
10	24	B	35	49	D
11	25	D	36	50	D
12	26	D	37	1	A
13	27	A	38	2	D
14	28	C	39	3	D
15	29	D	40	4	C
16	30	A	41	5	A
17	31	A	42	6	C
18	32	D	43	7	A
19	33	B	44	8	C
20	34	C	45	9	A
21	35	C	46	10	D
22	36	A	47	11	C
23	37	B	48	12	D
24	38	D	49	13	B
25	39	B	50	14	C