

**UNITED STATES NUCLEAR REGULATORY COMMISSION
BOILING WATER REACTOR GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 – FORM A**

Please Print

Name: _____

Docket No.: _____

Facility: _____

Start Time: _____ Stop Time: _____

INSTRUCTIONS TO EXAMINEE

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.

Examinee'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 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 SHEET

EQUATIONS

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

$$A = A_0e^{-\lambda t}$$

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

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

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

$$CR_1(1 - K_{\text{eff}_1}) = CR_2(1 - K_{\text{eff}_2})$$

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

$$1/M = CR_1/CR_x$$

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

$$A = \pi r^2$$

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

$$F = PA$$

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

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

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

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

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

$$P = IE$$

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

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

$$P_T = \sqrt{3}IEpf$$

$$\ell^* = 1.0 \times 10^{-4} \text{ sec}$$

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

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

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

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

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

$$P = P_0e^{t/\tau}$$

$$g = 32.2 \text{ ft/sec}^2$$

$$P = P_010^{\text{SUR}(t)}$$

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

CONVERSIONS

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

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

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

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

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

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

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

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

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

**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 1

A cooling water system uses a conventional relief valve (not pilot-operated) with a bench-tested setpoint of 60 psig. The relief valve discharges to a collection tank that is maintained at 5 psig. At what system pressure will the relief valve begin to open?

- A. 55 psig
- B. 60 psig
- C. 65 psig
- D. 80 psig

QUESTION: 2

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

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

The valve was 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
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 3

A surveillance test procedure is being performed on a typical motor-operated valve (MOV) with a declutch lever that is 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: 4

Two differential pressure level transmitters are installed on a large water storage tank. Transmitter I was calibrated at 100°F and transmitter II was calibrated at 200°F water temperature.

Which transmitter will indicate a higher level?

- A. Transmitter I below 150°F, transmitter II above 150°F.
- B. Transmitter II below 150°F, transmitter I above 150°F.
- C. Transmitter I at all water temperatures.
- D. Transmitter II at all water temperatures.

**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 5

A simple two-wire resistance temperature detector (RTD) is being used to measure the temperature in a water system. Copper extension wires run from the RTD to a temperature measuring instrument 40 feet away. If the temperature of the extension wires increases, 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

A loss-of-coolant accident resulted in a reactor scram. The source range monitors (SRMs) were fully inserted and are currently located in a voided section of the core.

If the SRMs are subsequently repositioned below the core water level, the SRM count rate will...

- A. decrease due to decreased neutron migration length.
- B. decrease due to decreased thermal neutron flux.
- C. increase due to increased neutron migration length.
- D. increase due to increased thermal neutron flux.

**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 7

Radiation interacting with a gas-filled radiation detector produces primary ion pairs. A primary ion pair consists of an electron and the ion formed by its removal. If the detector voltage is high enough, a primary ion pair can produce secondary ion pairs.

When secondary ion pairs are formed, they are typically caused by interactions between the primary _____ and the _____ in the detector.

- A. ion; gas
- B. ion; electrodes
- C. electron; gas
- D. electron; electrodes

**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

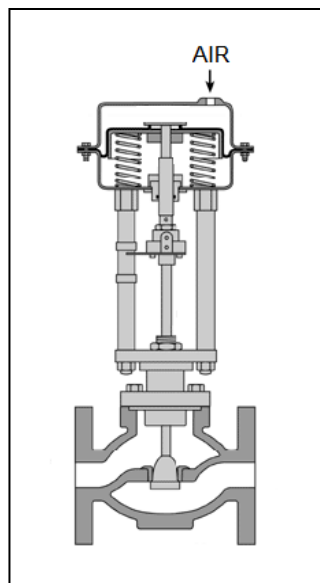
QUESTION: 8

Refer to the drawing of a flow control valve (see figure below) that is located in the drain line from a water storage tank.

The flow control valve is positioned by a tank level controller that can maintain a stable water level anywhere between 10 percent above and 10 percent below the controller setpoint.

Which one of the following describes the characteristics of the tank level controller?

- A. Direct-acting with proportional only control.
- B. Direct-acting with proportional plus integral control.
- C. Reverse-acting with proportional only control.
- D. Reverse-acting with proportional plus integral control.



**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

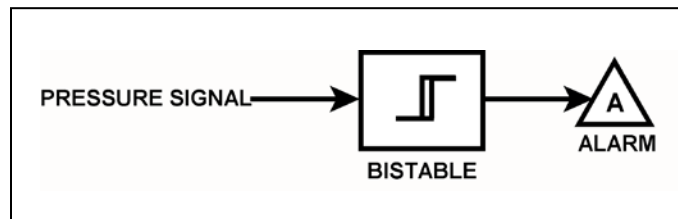
QUESTION: 9

Refer to the drawing of a pressure alarm circuit (see figure below). The orientation of the bistable symbol indicates the characteristics of the bistable, as is normal for a control circuit diagram.

The bistable turns on to actuate an alarm at a system pressure of 100 psig. The bistable has a 5 psig deadband, or neutral zone.

If system pressure is currently 90 psig, which one of the following describes the alarm circuit response as system pressure slowly increases to 110 psig?

- A. The alarm is currently actuated and will turn off at 95 psig.
- B. The alarm will actuate at 100 psig and will not turn off.
- C. The alarm is currently actuated and will turn off at 105 psig.
- D. The alarm will actuate at 100 psig and will turn off at 105 psig.



**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 10

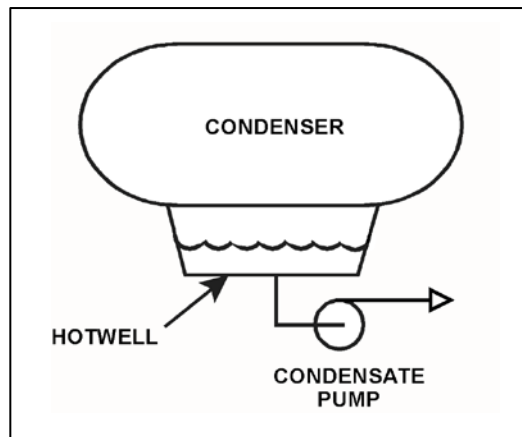
Refer to the drawing of a steam condenser, hotwell, and condensate pump (see figure below).

Given the following:

- The eye of the pump impeller is located 6.0 feet below the bottom of the hotwell.
- Hotwell water level is 6.0 feet.
- Hotwell water temperature is 90°F.
- Condenser pressure is 1.3 psia.
- Fluid velocity and friction head losses are zero.

What is the net positive suction head available to the condensate pump?

- A. 6.0 feet
- B. 7.4 feet
- C. 12.0 feet
- D. 13.4 feet



**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 11

Which one of the following specifies the proper pump discharge valve position and the basis for that position when starting a large motor-driven radial-flow centrifugal pump?

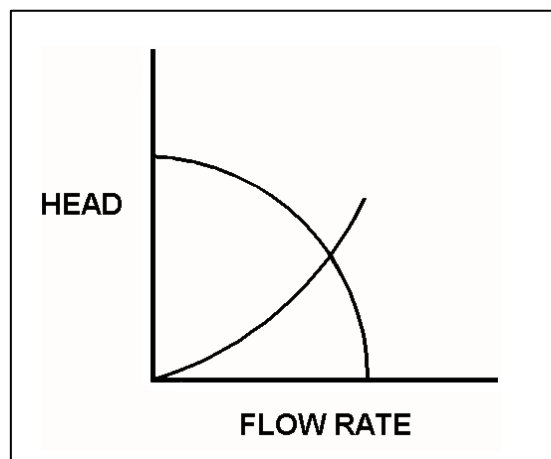
- A. Discharge valve fully open to reduce motor starting power requirements.
- B. Discharge valve throttled to reduce motor starting power requirements.
- C. Discharge valve fully open to ensure adequate pump net positive suction head.
- D. Discharge valve throttled to ensure adequate pump net positive suction head.

QUESTION: 12

Refer to the drawing of pump and system operating curves (see figure below). The drawing shows the operating point for a single-speed centrifugal pump operating in a closed cooling water system using 6-inch diameter piping.

If the cooling water system 6-inch diameter piping were replaced with 8-inch diameter piping, the new operating point would occur at a _____ pump head and a _____ pump flow rate.

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



**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 13

An ideal (no slip) reciprocating positive displacement pump is operating to provide makeup water to a reactor coolant system that is being maintained at 1,000 psig. The discharge valve of the pump was found to be throttled to 80 percent open.

If the valve is subsequently fully opened, pump flow rate will _____; and pump head will _____.

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

QUESTION: 14

Which one of the following will result from prolonged operation of an AC induction 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.

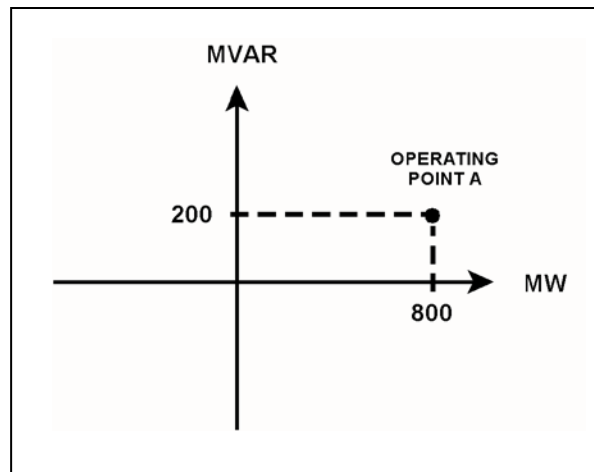
**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 15

Refer to the drawing of an electrical system power curve (see figure below).

If the system is operating at point A, which one of the following is the power factor for this system?

- A. 0.80
- B. 0.88
- C. 0.93
- D. 0.97



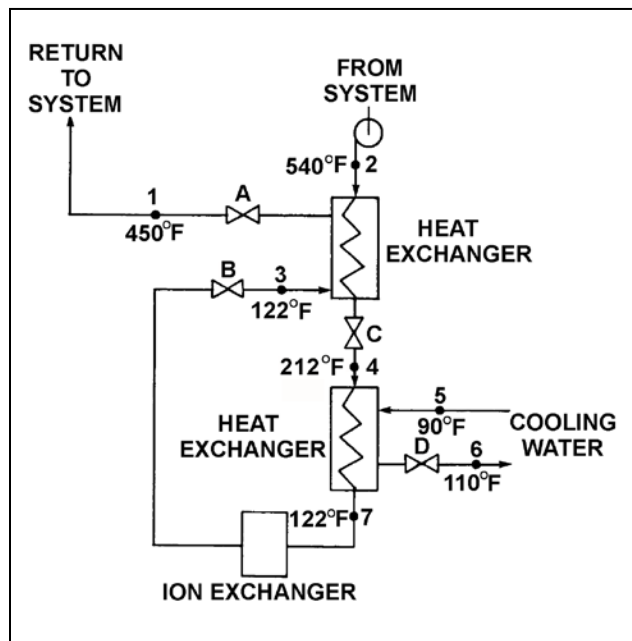
**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 16

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

All valves are identical and are initially 50 percent open. To lower the temperature at point 4, the operator can adjust valve _____ in the _____ direction.

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



**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 17

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

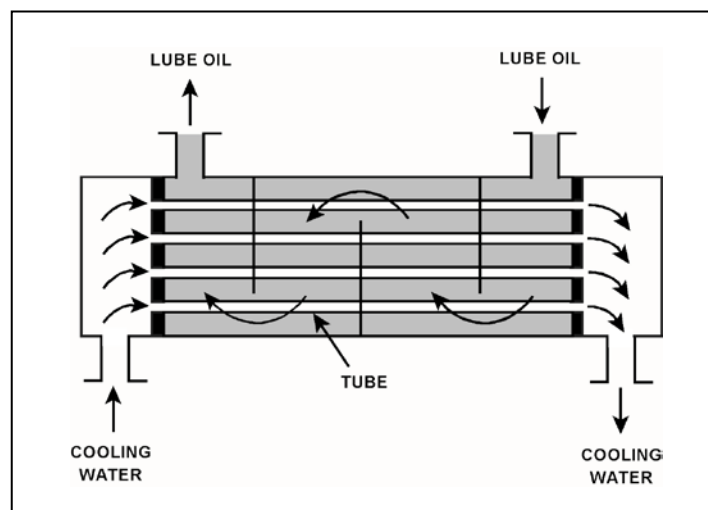
The heat exchanger was initially placed in continuous service 6 months ago. During the 6-month period of operation, mineral deposits have accumulated inside the heat exchanger tubes.

The following parameters are currently stable at their initial values:

- Cooling water mass flow rate
- Cooling water inlet temperature
- Cooling water outlet temperature
- Lube oil mass flow rate

Compared to their initial values, the current lube oil inlet temperature is _____; and the current lube oil outlet temperature is _____.

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



**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 18

With a nuclear power plant operating at 50 percent power, which one of the following will occur as a result of multiple tube leaks in the main condenser? (Assume that main condenser vacuum does not change.)

- A. Condensate depression will decrease.
- B. Condensate conductivity will increase.
- C. Condensate oxygen concentration will decrease.
- D. Condenser inlet cooling water flow rate will decrease.

QUESTION: 19

Water containing dissolved sodium (Na^+) and chloride (Cl^-) ionic impurities is passing through an ion exchanger that contains only anion exchange resin. How are the ionic impurities being affected as the water flows through the ion exchanger?

- A. Sodium ions are being exchanged, but the chloride ions are unaffected.
- B. Chloride ions are being exchanged, but the sodium ions are unaffected.
- C. Sodium ions are being exchanged, and chloride ions are being removed by filtration.
- D. Chloride ions are being exchanged, and sodium ions are being removed by filtration.

**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 20

Which one of the following describes a possible cause and effect associated with a lower-than-normal differential pressure across a demineralizer during otherwise normal system flow conditions?

- A. The resin has developed low resistance flow paths, which can decrease the decontamination factor for the demineralizer.
- B. The resin has developed low resistance flow paths, which can increase the decontamination factor for the demineralizer.
- C. The resin has become compacted, which can reduce the flow rate through the demineralizer and decrease the decontamination factor for the demineralizer.
- D. The resin has become compacted, which can reduce the flow rate through the demineralizer and increase the decontamination factor for the demineralizer.

QUESTION: 21

A main generator is about to be connected to an infinite power grid. Generator voltage equals grid voltage and the synchroscope is rotating slowly in the clockwise direction. The generator breaker is closed just as the synchroscope pointer reaches the 12 o'clock position.

Which one of the following will occur after the breaker is closed?

- A. The breaker will remain closed and the generator will supply only MW to the grid.
- B. The breaker will remain closed and the generator will supply both MW and MVAR to the grid.
- C. The breaker will trip open due to overcurrent.
- D. The breaker will trip open due to reverse power.

**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

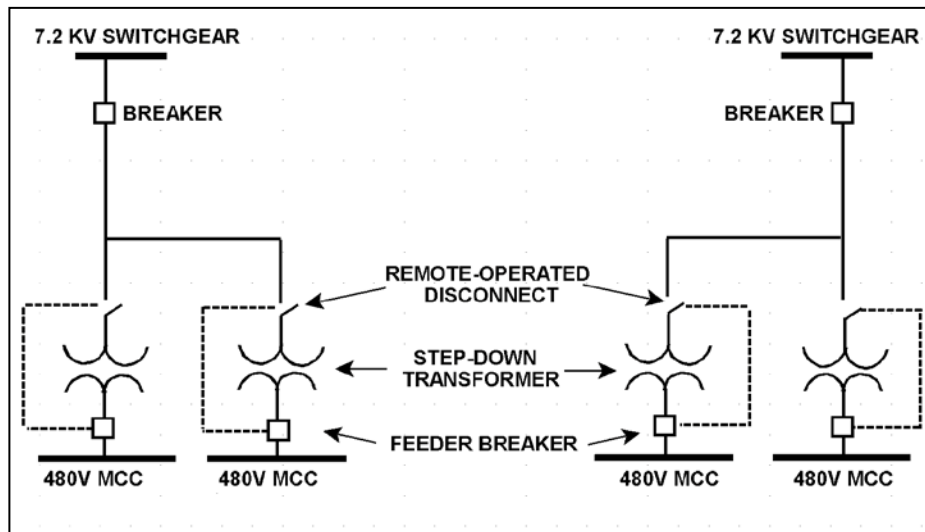
QUESTION: 22

Refer to the simplified drawing of an electrical distribution system showing 7.2 KV switchgear, step-down transformers, and 480 V 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
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 23

In a comparison between a delayed neutron and a prompt neutron produced from the same fission event, the delayed neutron is more likely to... (Assume that each neutron remains in the core unless otherwise stated.)

- A. cause fission of a U-238 nucleus.
- B. travel to an adjacent fuel assembly.
- C. be absorbed in a B-10 nucleus.
- D. leak out of the core.

QUESTION: 24

Before a fission neutron could migrate out of a fuel pellet, the neutron was absorbed by the nucleus of a uranium atom. The absorption occurred at a neutron energy of 1.5 MeV. If the neutron was absorbed by a U-235 nucleus, the most likely outcome would be _____; if the neutron was absorbed by a U-238 nucleus, the most likely outcome would be _____.

- A. fission; fission
- B. fission; capture
- C. capture; fission
- D. capture; capture

**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 25

Which one of the following is the neutron 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 the control rods.
- B. Photo-neutron reactions in the moderator.
- C. Spontaneous fission in the fuel.
- D. Alpha-neutron reactions in the fuel.

QUESTION: 26

A nuclear power plant is operating at steady-state 70 percent power. Which one of the following will result in a less negative fuel temperature coefficient? (Consider only the direct effect of the change in each listed parameter.)

- A. Increase in Pu-240 inventory in the core.
- B. Increase in moderator temperature.
- C. Increase in fuel temperature.
- D. Increase in void fraction.

**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 27

Which one of the following describes how and why the void coefficient of reactivity changes as void fraction increases during a control rod withdrawal at 80 percent power?

- A. Becomes less negative, due to the increased absorption of neutrons by U-238.
- B. Becomes less negative, due to a greater fraction of neutrons lost to leakage from the core.
- C. Becomes more negative, due to the reduction in the fast fission contribution to the neutron population.
- D. Becomes more negative, due to a greater fractional loss of moderator for a 1 percent void increase at higher void fractions.

QUESTION: 28

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

- A. DRW is the area under the IRW curve at a given rod position.
- B. DRW is the slope of the IRW curve at a given rod position.
- C. DRW is the IRW at a given rod position.
- D. DRW is the square root of the IRW at a given rod position.

**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 29

A reactor is operating at steady-state 100 percent power when a single control rod fully inserts from the fully withdrawn position. After the initial transient, the operator returns the reactor to 100 percent power with the control rod still fully inserted.

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

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

QUESTION: 30

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

- A. They can adversely affect core power distribution, and they can require operation below full rated power.
- B. They can adversely affect core power distribution, and they can prevent reactor criticality during a reactor startup.
- C. They can cause excessively short reactor periods during power operation, and they can require operation below full rated power.
- D. They can cause excessively short reactor periods during power operation, and they can prevent reactor criticality during a reactor startup.

**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 31

A reactor had been operating at 100 percent power for 2 months when a reactor scram occurred. Four hours later with a startup in progress, reactor power is currently stable at 10 percent. Which one of the following operator actions is required to maintain reactor power at 10 percent over the next 18 hours?

- A. Incremental control rod withdrawals throughout the entire period.
- B. Incremental control rod insertions throughout the entire period.
- C. Incremental control rod withdrawals for several hours, then incremental insertions for the rest of the period.
- D. Incremental control rod insertions for several hours, then incremental withdrawals for the rest of the period.

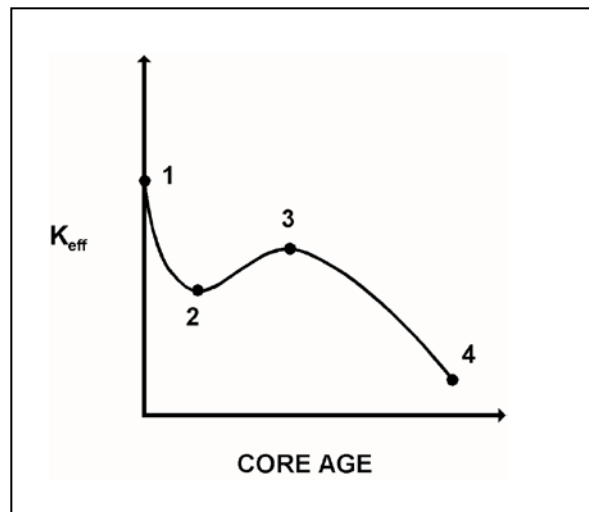
**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 32

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

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

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



**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 33

After recording critical data during a cold reactor startup with main steam isolation valves open, the operator withdraws the control rods to continue the startup. Which one of the following pairs of parameters will provide the first indications of reaching the point of adding heat?

- A. Reactor pressure and reactor water level
- B. Reactor power and reactor period
- C. Reactor pressure and turbine load
- D. Reactor water level and core flow rate

QUESTION: 34

Ignoring the effects of changes in fission product poisons, which one of the following reactor power changes requires the greatest amount of positive reactivity addition?

- A. 3 percent to 10 percent
- B. 10 percent to 25 percent
- C. 25 percent to 65 percent
- D. 65 percent to 100 percent

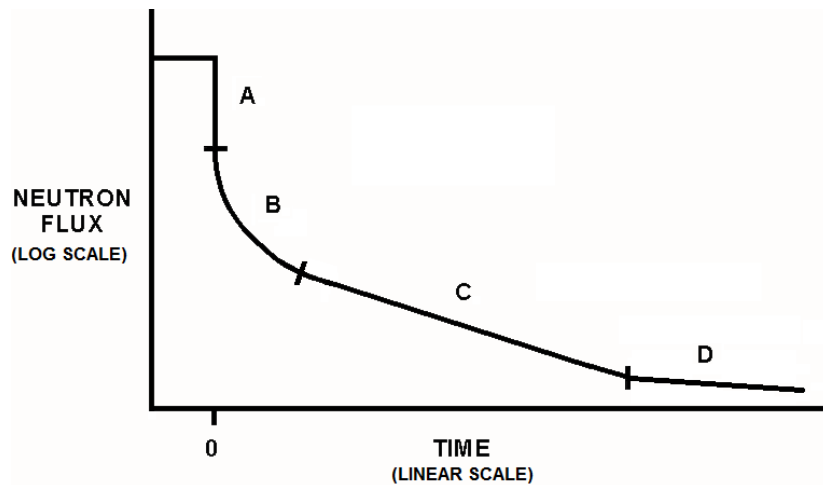
**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 35

Refer to the graph of neutron flux versus time (see figure below) for a nuclear power plant that experienced a reactor scram from steady-state 100 percent power at time = 0 seconds.

The shape of section A on the graph is primarily determined by a rapid decrease in the production rate of...

- A. intrinsic source neutrons.
- B. prompt fission neutrons.
- C. delayed fission neutrons.
- D. delayed fission neutron precursors.



**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 36

A nuclear reactor initially has a K_{eff} of 0.999 and a stable source range count rate. Control rods are inserted until K_{eff} decreases to 0.998, resulting in a negative reactor period. After the control rod insertion stops, reactor period will...

- A. gradually lengthen until the neutron population reaches equilibrium, then stabilize at infinity.
- B. gradually lengthen until the neutron population reaches equilibrium, then stabilize at an unknown negative value.
- C. quickly stabilize at approximately negative 80 seconds until the neutron population approaches equilibrium, then gradually lengthen and stabilize at infinity.
- D. quickly stabilize at an unknown negative value until the neutron population approaches equilibrium, then gradually lengthen and stabilize at an unknown negative value.

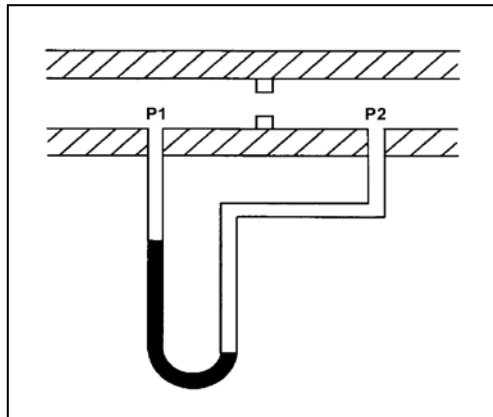
**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 37

Refer to the drawing of a water-filled manometer (see figure below).

The manometer is installed across an orifice in a ventilation duct to determine the direction of airflow. With the manometer conditions as shown, the pressure at P1 is _____ than P2; and the direction of airflow is _____.

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



**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 38

Consider a sealed vessel containing 1,000 lbm of a saturated steam-water mixture at 500°F. The vessel is perfectly insulated with no heat gain or loss occurring.

If a leak near the bottom of the vessel results in a loss of 10 percent of the liquid volume from the vessel, the temperature of the mixture will _____; and the overall quality of the mixture will _____. (Assume the mixture remains saturated.)

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

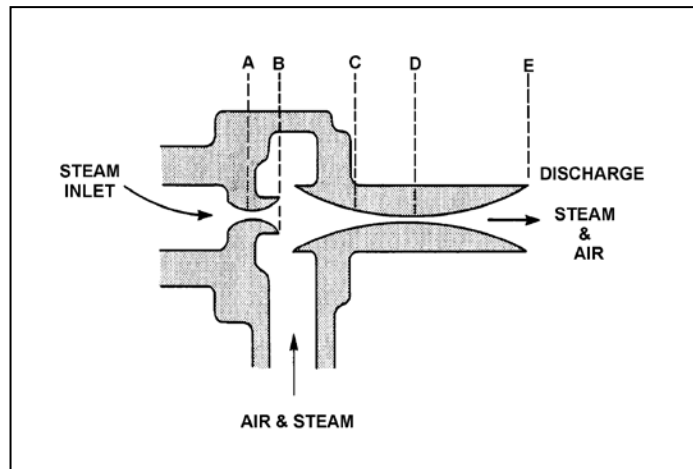
**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 39

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

Steam flowing from D to E undergoes a pressure _____ and a velocity _____.

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



**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 40

A nuclear power plant has a thermal power rating of 3,200 MW. When the plant operates at 100 percent power, the main generator produces 1,200 MW at a 0.95 power factor. Plant modifications are planned that will upgrade the feedwater heaters and moisture separator/reheaters without changing the plant's thermal power rating. If the plant modifications improve plant thermal efficiency by 2 percent, what will be the resulting main generator electrical output at 100 percent reactor power with the same power factor?

- A. 1,204 MW
- B. 1,224 MW
- C. 1,244 MW
- D. 1,264 MW

**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 41

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.

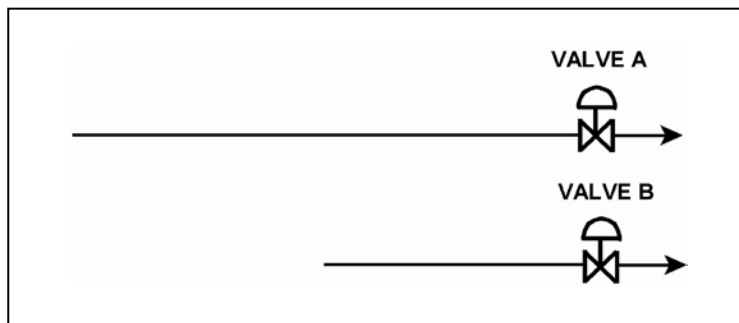
Water is flowing at 10,000 gpm through each pipe when both isolation valves instantly close. Consider two cases:

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
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 42

A nuclear power plant is initially operating at steady-state 80 percent power. If a control system malfunction causes main generator load to rapidly increase to 90 percent, the voids in the two-phase flow in the reactor core will initially _____; which causes indicated reactor vessel water level (measured in the downcomer) to initially _____.

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

QUESTION: 43

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

- A. From the reactor fuel to the core barrel during core uncover.
- B. Through the tube walls in a main condenser during normal operation at 100 percent power.
- C. From the reactor fuel to the steam outlet of the reactor vessel during a station blackout.
- D. From the fuel pellet centerline to the fuel clad during normal operation at 100 percent power.

**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 44

Which one of the following is the approximate quality of a saturated steam-water mixture leaving a fuel bundle at 948 psig and 905 Btu/lbm?

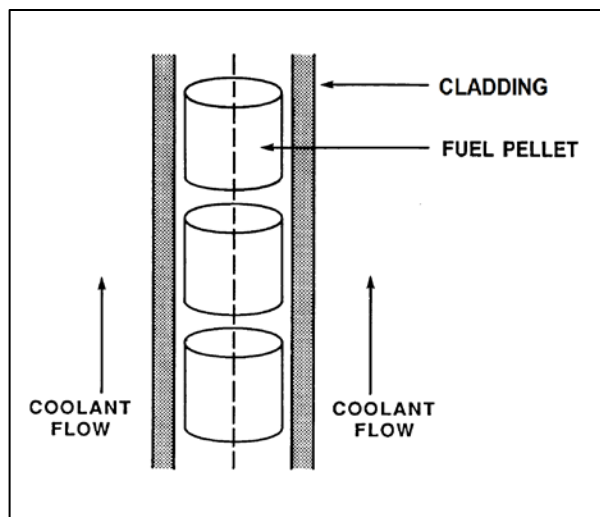
- A. 27 percent
- B. 44 percent
- C. 56 percent
- D. 73 percent

QUESTION: 45

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

With a power plant operating at steady-state 100 percent reactor power at the beginning of a fuel cycle, which one of the following has the greater temperature difference?

- A. Coolant laminar layer
- B. Cladding corrosion film
- C. Zircaloy cladding
- D. Pellet-to-cladding gap



**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 46

After operating at a high power level for several weeks, a reactor was shut down several days ago and cooled down to repair a steam line leak. Shutdown cooling water pumps are currently being used to maintain reactor temperature and pressure. The pumps will be stopped in 30 minutes to test repairs.

What action, if any, should be taken to enhance natural circulation cooling during the test, and why?

- A. No action is necessary; the increase of density in the downcomer and the reduction of density in the core region will easily support natural circulation.
- B. No action is necessary; as the density of the mixture in the core region increases, the liquid in the downcomer will flow into the core.
- C. Raise reactor vessel pressure to allow vessel relief valves to lift to create a heat sink for decay heat while control rod drive flow maintains inventory.
- D. Raise reactor vessel water level above the bottom of the steam separators to provide a liquid flow path from the inside to the outside of the core shroud.

QUESTION: 47

Which one of the following adverse conditions is avoided primarily by maintaining the minimum critical power ratio within specified limits?

- A. Excessive cladding creep
- B. Excessive decay heat in the fuel
- C. Excessive fuel cladding temperatures
- D. Excessive plastic strain on the fuel cladding

**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 48

A reactor was initially operating at steady-state 100 percent power with a top-peaked axial power distribution. Reactor power was reduced and a control rod pattern exchange was completed to establish a bottom-peaked distribution. Reactor power was returned to 100 percent and is currently at steady-state.

Compared to the initial (top-peaked) critical power for a given fuel bundle at steady-state 100 percent power, the current (bottom-peaked) critical power is...

- A. higher, because the highest linear heat generation rate is occurring in the region of the fuel bundle with the highest mass flow rate of coolant.
- B. higher, because the greatest coolant enthalpy rise is occurring in the region of the fuel bundle that contains subcooled or low-quality coolant.
- C. lower, because the highest linear heat generation rate is occurring in the region of the fuel bundle with the highest mass flow rate of coolant.
- D. lower, because the greatest coolant enthalpy rise is occurring in the region of the fuel bundle that contains subcooled or low-quality coolant.

QUESTION: 49

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 the cladding.

**USNRC GENERIC FUNDAMENTALS EXAMINATION
SEPTEMBER 2016 BWR – FORM A**

QUESTION: 50

A reactor is shut down for refueling following 18 months of operation at an average power level of 85 percent. During the shutdown, a reactor vessel metal specimen was removed from the reactor vessel for testing. The testing determined that the nil-ductility transition (NDT) temperature of the specimen decreased from 44°F to 42°F since the previous refueling shutdown.

Which one of the following conclusions is warranted?

- A. The test results are credible and the reactor vessel is more likely to experience brittle fracture now than after the previous refueling shutdown.
- B. The test results are credible and the reactor vessel is less likely to experience brittle fracture now than after the previous refueling shutdown.
- C. The test results are questionable because the specimen NDT temperature would not decrease during the described 18-month period of operation.
- D. The test results are questionable because the specimen NDT temperature would decrease by more than 2°F during the described 18-month period of operation.

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

**SEPTEMBER 2016 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	C	26	40	C
2	16	D	27	41	D
3	17	A	28	42	B
4	18	D	29	43	B
5	19	A	30	44	A
6	20	D	31	45	C
7	21	C	32	46	A
8	22	A	33	47	B
9	23	B	34	48	C
10	24	D	35	49	B
11	25	B	36	50	A
12	26	D	37	1	A
13	27	B	38	2	A
14	28	C	39	3	C
15	29	D	40	4	D
16	30	B	41	5	B
17	31	D	42	6	D
18	32	B	43	7	C
19	33	B	44	8	C
20	34	A	45	9	D
21	35	A	46	10	D
22	36	A	47	11	C
23	37	C	48	12	B
24	38	A	49	13	D
25	39	B	50	14	C