

**UNITED STATES NUCLEAR REGULATORY COMMISSION
BOILING WATER REACTOR GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006--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% is required to pass this portion of the NRC operator licensing written examination. All examination papers will be collected 3.0 hours after the examination starts. This examination applies to a typical boiling water reactor (BWR) nuclear power plant.

SECTION	QUESTIONS	% OF TOTAL	SCORE
COMPONENTS	1 - 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 GUIDELINES 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.

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 booklet, then examination aids - steam table booklets, handouts, and scrap paper used during the examination.
12. After turning in your examination materials, leave the examination area, as defined by the proctor. If after leaving you are found in the examination area while the examination is in progress, your examination may be forfeited.

GENERIC FUNDAMENTALS EXAMINATION
EQUATIONS AND CONVERSIONS HANDOUT SHEET

EQUATIONS

$$Q = \rho_p \Delta T$$

$$Q = \rho \Delta h$$

$$Q = UA\Delta T$$

$$Q \% = \rho_{\text{Nat}}^3 \text{ Circ}$$

$$\Delta T \% = \rho_{\text{Nat}}^2 \text{ Circ}$$

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

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

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

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

$$\rho = \frac{\bar{R}}{\tau} \% \frac{\bar{\beta}}{1 \% \lambda_{\text{eff}} \tau}$$

$$\bar{R} = 1 \times 10^{-4} \text{ sec}$$

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

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

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

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

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

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

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

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

$$A = \pi r^2$$

$$F = PA$$

$$\rho = \rho A v$$

$$W_{\text{Pump}} = \rho \Delta P v$$

$$E = IR$$

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

$$\frac{g(z_2 - z_1)}{g_c} + \frac{(v_2^2 - v_1^2)}{2g_c} + v(P_2 - P_1) + (u_2 - u_1) + (q - w) = 0$$

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

CONVERSIONS

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

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

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

$$\text{EC} = (5/9)(\text{EF} - 32)$$

$$\text{EF} = (9/5)(\text{EC}) + 32$$

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

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

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

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

**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

QUESTION: 1

Water storage tanks A and B are identical except that tank A receives overpressure protection from an installed relief valve. Tank B has an installed safety valve. The relief valve and safety valve have the same pressure setpoint and design flow rate.

Water is continuously added to each tank at the same rate (50% of the design flow rate of the relief/safety valve). After tank pressure reaches the setpoint for each valve, tank A pressure will _____ and tank B pressure will _____.

- A. stabilize slightly above the pressure setpoint; stabilize slightly above the pressure setpoint
- B. stabilize slightly above the pressure setpoint; fluctuate within a few percent of the pressure setpoint
- C. fluctuate within a few percent of the pressure setpoint; stabilize slightly above the pressure setpoint
- D. fluctuate within a few percent of the pressure setpoint; fluctuate within a few percent of the pressure setpoint

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JUNE 2006 BWR--FORM A**

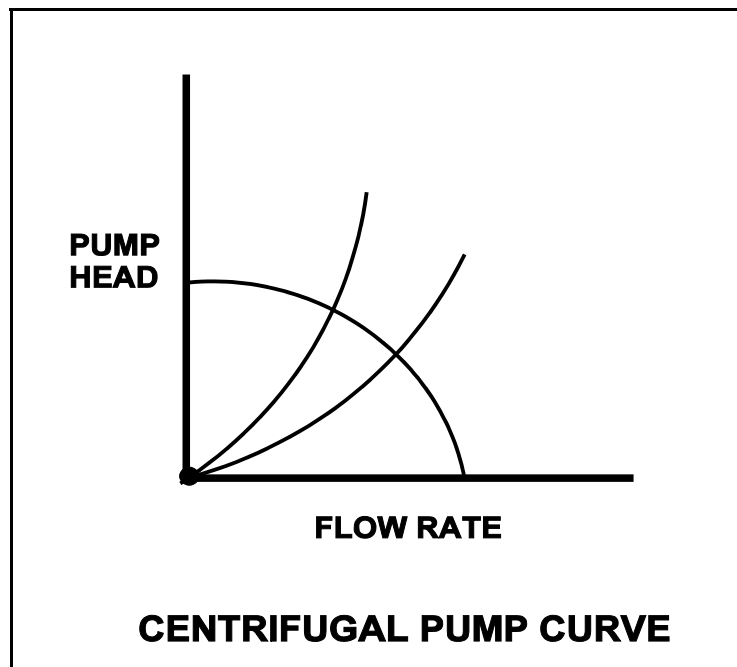
QUESTION: 2

Refer to the centrifugal pump operating curve with two system head loss curves (see figure below). The curves apply to an open cooling water system using one single-speed centrifugal pump discharging through a typical flow control valve. The valve is located on the discharge piping of the pump.

One of the system curves shows system head loss with the flow control valve 25% open. The other system curve shows system head loss with the flow control valve 100% open. The pump is operating and the valve is initially 25% open, resulting in a pump flow rate of 800 gpm.

If the flow control valve is subsequently fully opened, pump flow rate through the valve will be approximately...

- A. 400 gpm.
- B. 1,200 gpm.
- C. 1,600 gpm.
- D. 3,200 gpm.



**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

QUESTION: 3

When manually positioning a motor-operated valve, why must care be taken to avoid using excessive valve seating/backseating force?

- A. The valve may not operate on demand.
- B. Limit switch settings may change.
- C. The motor may not reengage.
- D. Torque switch settings may change.

QUESTION: 4

A cooling water system uses a horizontal venturi with a differential pressure flow detector to provide cooling water flow rate indication. Water enters and leaves the venturi at 70°F, 100 psig and 24 ft/sec. Water velocity at the throat of the venturi is 50 ft/sec. Assume water is incompressible and the venturi experiences no unrecoverable head loss.

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

- A. 98 psig
- B. 94 psig
- C. 87 psig
- D. 74 psig

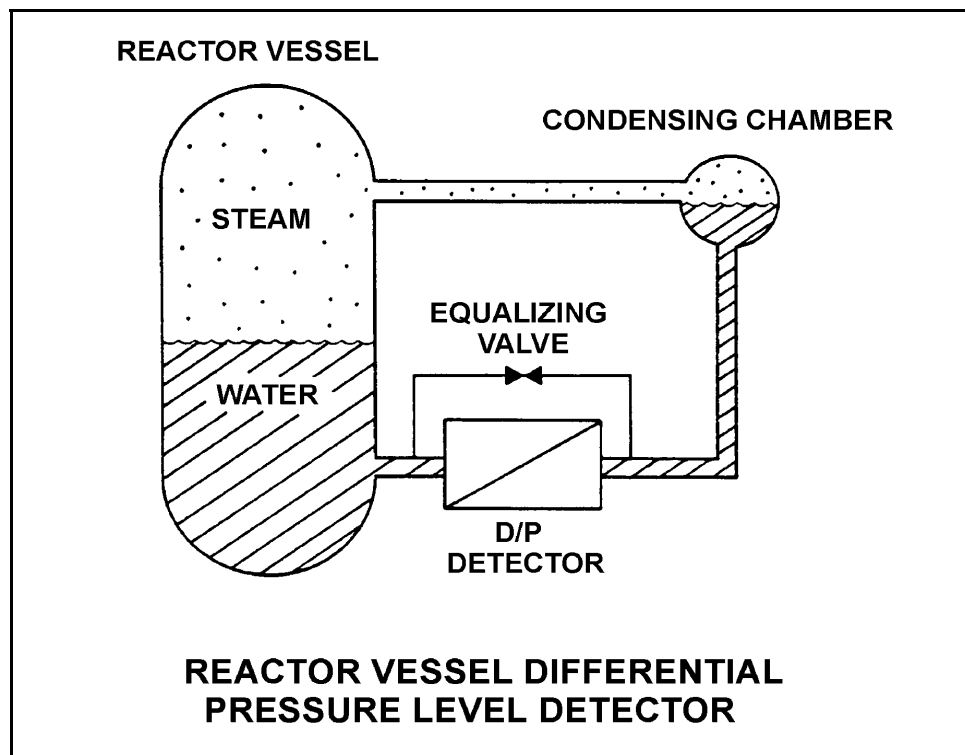
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JUNE 2006 BWR--FORM A**

QUESTION: 5

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

The reactor vessel is supplying steam at normal operating temperature and pressure with accurate level indication. Which one of the following events will result in a vessel level indication that is less than actual level?

- A. Actual RV water level decreases by 6 inches.
- B. The external pressure surrounding the D/P detector decreases by 2 psi.
- C. The temperature surrounding the reference leg increases by 20°F.
- D. RV pressure increases by 50 psi with no change in actual water level.



**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

QUESTION: 6

A centrifugal pump is taking suction from the bottom of a vented cylindrical storage tank that contains 100,000 gallons of water at 60°F. A pressure gauge at the inlet to the pump indicates 40 psig. Over the next several days storage tank temperature increases to 90°F with no change in tank water level and no change in head loss in the pump suction line.

Which one of the following is the current approximate pressure at the inlet to the pump?

- A. 39.8 psig
- B. 37.4 psig
- C. 34.6 psig
- D. 31.2 psig

**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

QUESTION: 7

Select the option that correctly fills in the blanks.

Quench gases are added to gas-filled radiation detectors that operate in the _____ region; the quench gases prevent a single ionization event from causing _____ in the detector gas volume.

- A. ion chamber; multiple discharges
- B. ion chamber; secondary ionizations
- C. Geiger-Mueller; multiple discharges
- D. Geiger-Mueller; secondary ionizations

QUESTION: 8

Which one of the following is used to describe the delay between a process parameter change and the sensing of that change by the process controller?

- A. Offset
- B. Gain
- C. Dead time
- D. Time constant

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JUNE 2006 BWR--FORM A**

QUESTION: 9

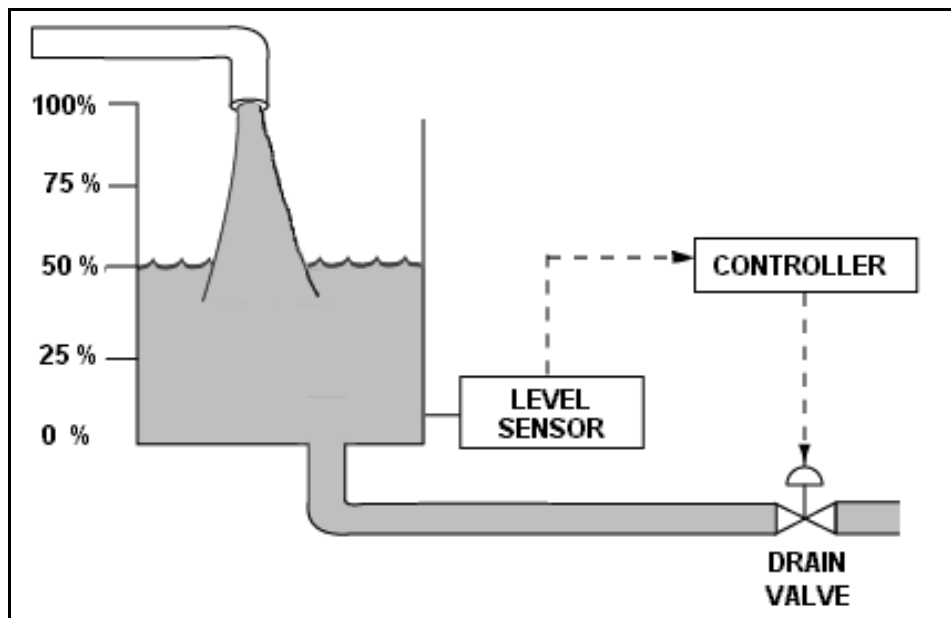
Refer to the drawing of a water storage tank with an automatic level control system (see figure below).

Given:

- The drain valve fails closed on loss of controller output signal.
- The level sensor output signal changes directly with tank water level.

For proper automatic control of tank water level, the controller must be _____; and the control loop must be _____.

- A. direct-acting; open
- B. direct-acting; closed
- C. reverse-acting; open
- D. reverse-acting; closed



**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

QUESTION: 10

By starting a centrifugal pump with the discharge valve throttled versus fully open, the possibility of pump runout is _____; and the possibility of pump cavitation is _____.

- A. decreased; decreased
- B. decreased; increased
- C. increased; decreased
- D. increased; increased

QUESTION: 11

A centrifugal cooling water pump is driven by an ac induction motor. The pump can supply cooling water to several heat loads, all of which are in parallel alignment. The following pump conditions initially exist:

Pump motor current: 100 amps
Pump flow rate: 400 gpm
Pump suction temperature: 70°F

Four hours later, the motor is drawing 95 amps. Which one of the following could be responsible for the observed decrease in motor amps?

- A. The temperature of the cooling water being pumped decreased to 60°F with no change in pump flow rate.
- B. The temperature of the cooling water being pumped increased to 80°F with no change in pump flow rate.
- C. Cooling water flow was established to an additional heat load with no change in the temperature of the cooling water being pumped.
- D. Cooling water flow was isolated from an out-of-service heat load with no change in the temperature of the cooling water being pumped.

**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

QUESTION: 12

A centrifugal firewater pump is operating to pressurize a fire main. The pump takes suction on a water reservoir. The reservoir water level and the pump are both at sea level.

Given:

- The pump has a design shutoff head of 100 feet.
- The required net positive suction head (NPSH) for the pump is 15 feet.
- The reservoir water temperature is 60°F.
- A fire hose connected to the fire main is being used to suppress an elevated fire.

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

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

QUESTION: 13

Which one of the following will occur as a direct result of operating a positive displacement pump with insufficient net positive suction head?

- A. Increased slip
- B. Decreased pump speed
- C. Increased flow rate
- D. Vapor binding

**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

QUESTION: 14

Which one of the following will result from prolonged operation of an ac motor with excessively high stator temperatures?

- A. Decreased electrical current demand due to reduced counter electromotive force
- B. Increased electrical current demand due to reduced counter electromotive force
- C. Decreased electrical resistance to ground due to breakdown of winding insulation
- D. Increased electrical resistance to ground due to breakdown of winding insulation

QUESTION: 15

A main generator is operating and connected to an infinite power grid with the following initial generator parameters:

Terminal Voltage:	22 KV
Frequency:	60 Hertz
Load--Real:	575 MW
Load--Reactive:	100 MVAR (in)
Power Factor:	0.985

Which one of the following contains a combination of manual adjustments to the main generator voltage regulator and speed control setpoints such that each adjustment will result in a decrease in main generator amps? (Assume that generator power factor remains less than 1.0.)

- | | <u>VOLTAGE
SETPOINT</u> | <u>SPEED
SETPOINT</u> |
|----|-----------------------------|---------------------------|
| A. | Increase | Increase |
| B. | Increase | Decrease |
| C. | Decrease | Increase |
| D. | Decrease | Decrease |

**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

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.

**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

QUESTION: 17

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

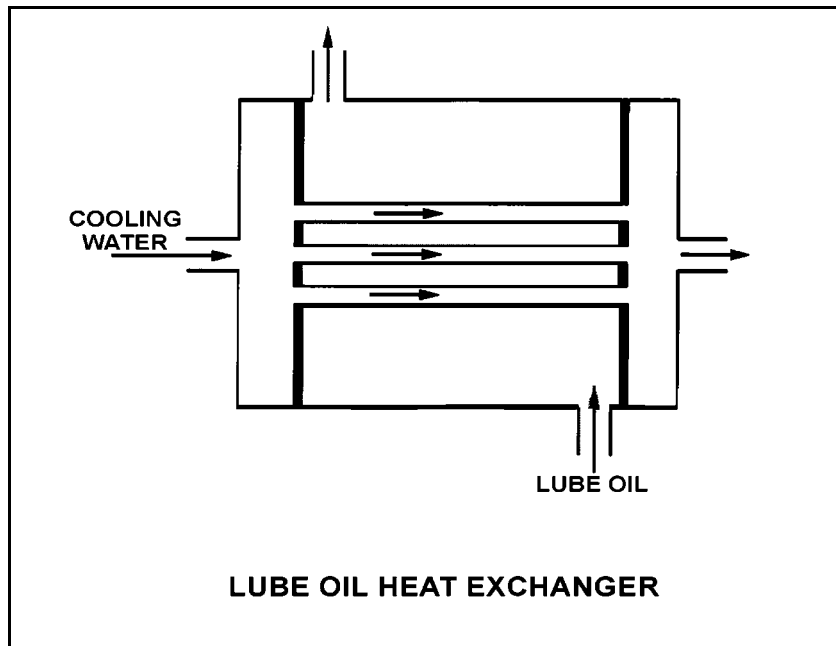
Given the following initial parameters:

Cooling water inlet temperature (T_{cw-in}) = 75EF
Cooling water outlet temperature (T_{cw-out}) = 95EF
Oil inlet temperature (T_{oil-in}) = 150EF
Oil outlet temperature ($T_{oil-out}$) = 110EF

Air leakage into the heat exchanger causes some of the heat exchanger tubes to become uncovered. As a result, T_{cw-out} decreases to 89EF. Assume the inlet temperatures, mass flow rates, and specific heats of both fluids remain the same.

Which one of the following will be the new approximate temperature of the oil exiting the heat exchanger ($T_{oil-out}$)?

- A. 116EF
- B. 122EF
- C. 130EF
- D. 138EF



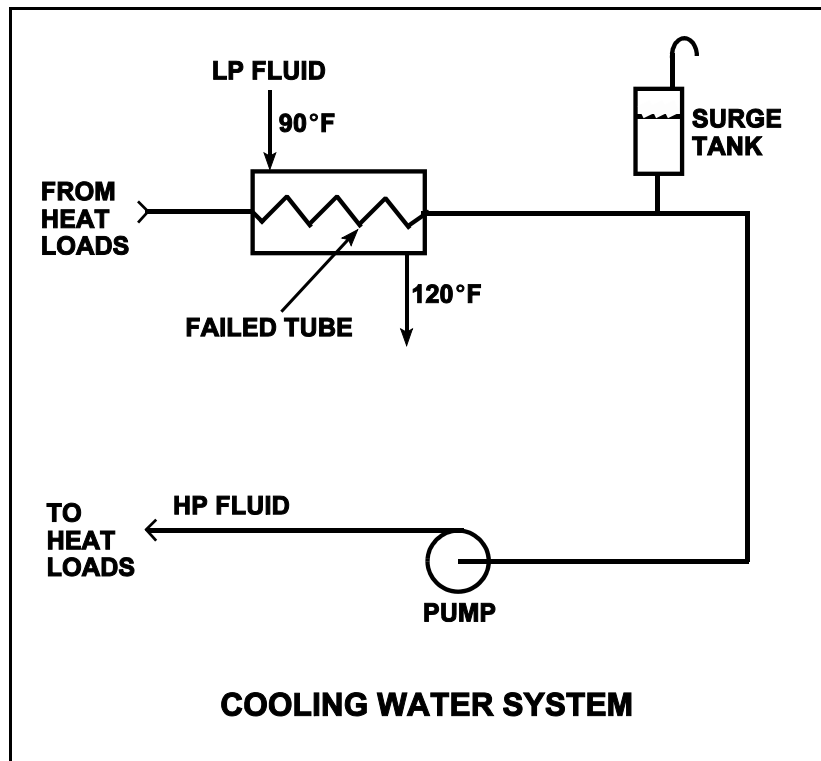
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JUNE 2006 BWR--FORM A**

QUESTION: 18

Refer to the drawing of an operating cooling water system (see figure below) that is transferring heat between a low pressure (LP) and high pressure (HP) water system.

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

- A. Level in the surge tank will increase.
- B. HP fluid pump flow rate will decrease.
- C. HP fluid heat exchanger differential temperature will increase.
- D. LP fluid heat exchanger outlet temperature will increase.



**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

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.

QUESTION: 20

A condensate demineralizer differential pressure (D/P) gauge indicates 6.0 psid at 50% flow rate. Which one of the following combinations of condensate flow and demineralizer D/P observed later at various power levels indicates an increase in the accumulation of insoluble corrosion products in the demineralizer?

	CONDENSATE <u>FLOW</u>	DEMINERALIZER <u>D/P (PSID)</u>
A.	100%	23.5
B.	75%	16.5
C.	60%	8.5
D.	25%	1.5

**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

QUESTION: 21

Prior to connecting a main generator to a power grid, generator voltage should be _____ grid voltage and generator frequency should be _____ grid frequency.

- A. equal to; slightly higher than
- B. higher than; slightly higher than
- C. equal to; equal to
- D. higher than; equal to

**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

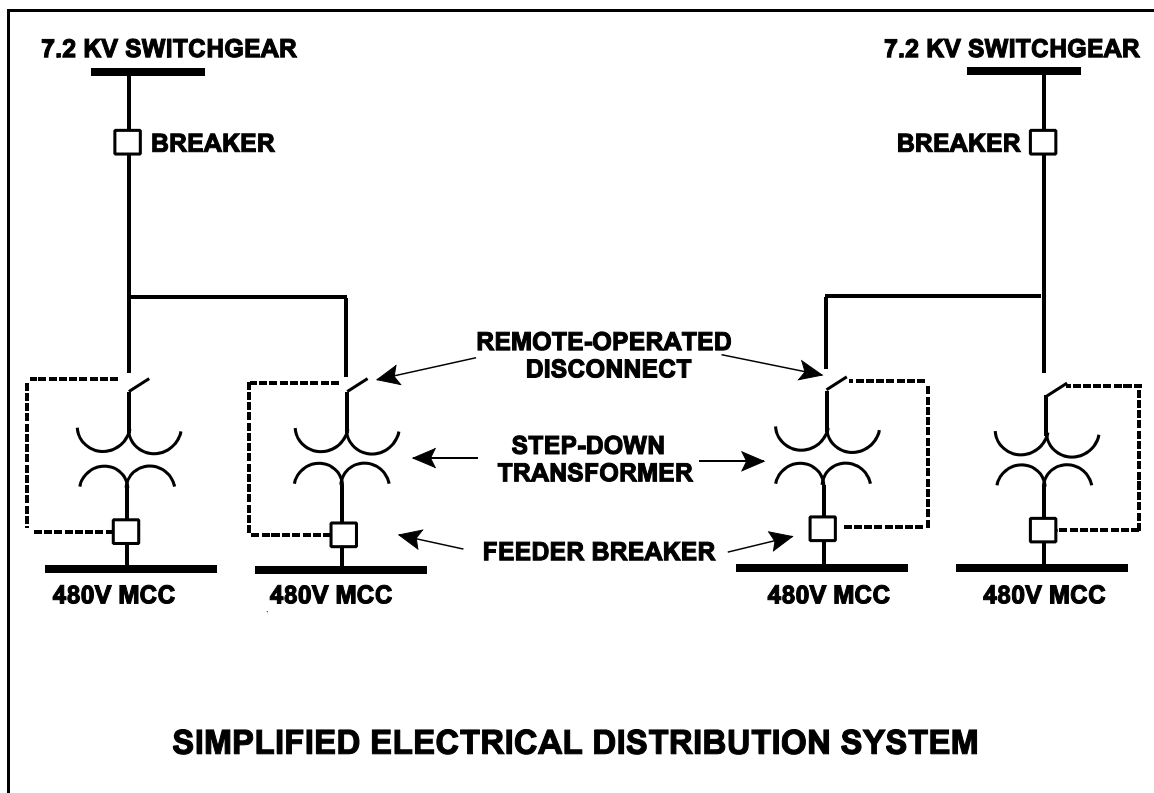
QUESTION: 22

Refer to the simplified drawing of an electrical distribution system (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
JUNE 2006 BWR--FORM A**

QUESTION: 23

A thermal neutron exists at an energy _____ the epithermal range and its cross section for absorption in U-235 _____ as the neutron energy decreases.

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

QUESTION: 24

The fractional change in neutron population from one generation to the next is called...

- A. beta.
- B. lambda.
- C. reactivity.
- D. K-effective.

**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

QUESTION: 25

Reactor power is increased at a constant rate from 50 kW to 370 kW in 2 minutes. What is the approximate doubling time?

- A. 42 seconds
- B. 60 seconds
- C. 86 seconds
- D. 120 seconds

QUESTION: 26

Select the option below that completes the following statement.

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

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

**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

QUESTION: 27

Which one of the following describes why most reactor power is produced in the lower half of a core (versus the upper half) that has been operating at 100% power for several weeks at the beginning of a fuel cycle?

- A. Xenon concentration is higher in the upper half of the core.
- B. The moderator-to-fuel ratio is higher in the upper half of the core.
- C. The void coefficient is adding more negative reactivity in the upper half of the core.
- D. Control rods are adding more negative reactivity in the upper half of the core.

QUESTION: 28

A nuclear reactor is operating steady state at the point of adding heat (POAH) during a reactor startup near the beginning of a fuel cycle. Reactor pressure is stable at 600 psig and main steam isolation valves are closed (no steam flow from reactor).

If a control rod is manually inserted for 5 seconds, and the reactor does not scram, when conditions stabilize reactor power will be _____; and reactor vessel pressure will be _____.

- A. at the POAH; 600 psig
- B. at the POAH; less than 600 psig
- C. less than the POAH; 600 psig
- D. less than the POAH; less than 600 psig

**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

QUESTION: 29

Which one of the following parameters typically has the greatest influence on the shape of a differential rod worth curve?

- A. Core xenon distribution
- B. Burnable poison distribution
- C. Core radial neutron flux distribution
- D. Core axial neutron flux distribution

QUESTION: 30

A fission product poison can be differentiated from all other fission products in that a fission product poison will...

- A. be produced in direct proportion to the fission rate in the core.
- B. remain radioactive for thousands of years after the final reactor criticality.
- C. depress the power production in some core locations and cause peaking in others.
- D. migrate out of the fuel pellets and into the reactor coolant via pinhole defects in the clad.

**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

QUESTION: 31

A nuclear power plant is being returned to operation following a refueling outage. Fuel preconditioning requires reactor power to be increased from 10% to full power gradually over a one week period.

During this slow power increase, most of the positive reactivity added by the operator is required to overcome the negative reactivity from...

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

QUESTION: 32

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

Which one of the following contributes to the need for a much higher 100% 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
JUNE 2006 BWR--FORM A**

QUESTION: 33

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 $\beta = 0.006$.)

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

QUESTION: 34

A nuclear reactor is stable at the point of adding heat (POAH) with the reactor coolant at 160°F during the reactor heat-up and pressurization phase of a reactor startup. Control rods are withdrawn a few notches to raise reactor power and establish a heat-up rate. Assume no core voiding occurs.

If no further control rod withdrawal occurs, reactor power will initially increase, and then...

- A. remain stable until voiding begins to occur.
- B. continue to increase until the control rods are reinserted.
- C. decrease and stabilize at a subcritical power level.
- D. decrease and stabilize at the POAH.

**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

QUESTION: 35

A nuclear power plant is operating at 60% of rated power in the middle of a fuel cycle when a turbine control system malfunction closes the turbine steam inlet valves an additional 5 percent. Which one of the following describes the initial reactor power change and the cause for the power change?

- A. Decrease, because the rate of neutron absorption in the moderator initially increases.
- B. Decrease, because the rate of neutron absorption at U-238 resonance energies initially increases.
- C. Increase, because the rate of neutron absorption in the moderator initially decreases.
- D. Increase, because the rate of neutron absorption at U-238 resonance energies initially decreases.

QUESTION: 36

A nuclear power plant has been operating for one hour at 50% of rated power following six months of operation at steady-state 100% power. Which one of the following is the percentage of rated thermal power currently being generated by decay heat?

- A. 1% to 2%
- B. 3% to 5%
- C. 6% to 8%
- D. 9% to 11%

**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

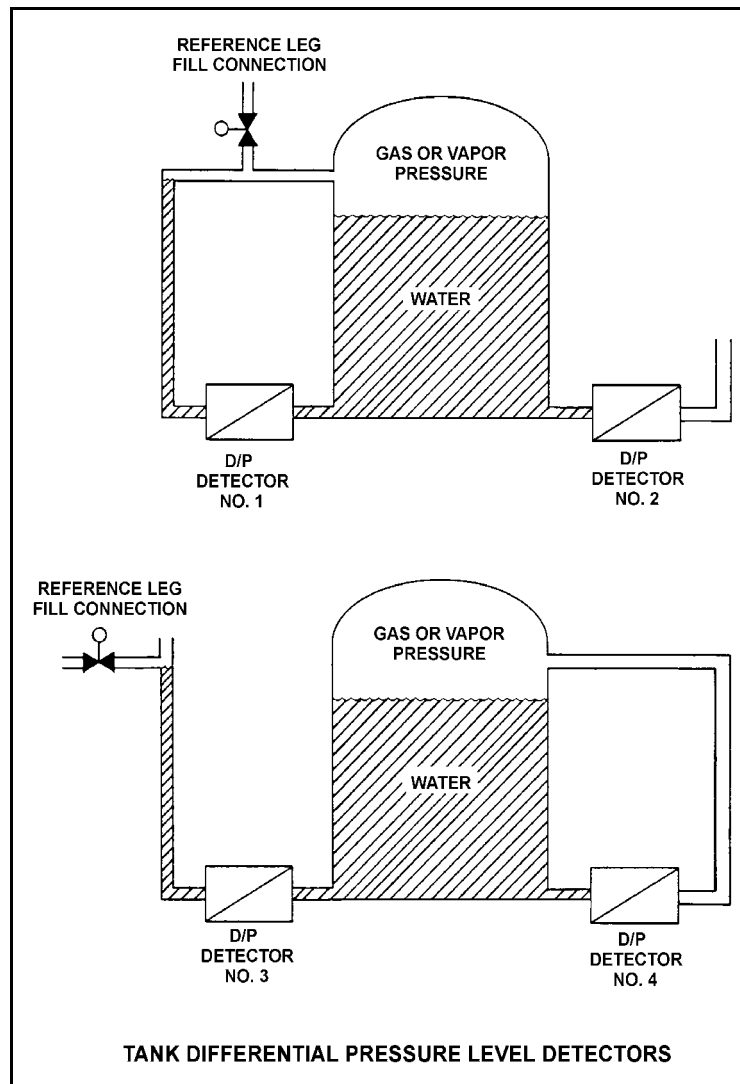
QUESTION: 37

Refer to the drawing of four identical tank differential pressure (D/P) level detectors with different piping configurations (see figure below).

The tanks are identical and are presently at 2 psig overpressure, the same constant water level, and a temperature of 60°F. They are surrounded by atmospheric pressure. All level detectors have been calibrated and are producing the same level indication. A leak in the top of each tank causes a complete loss of overpressure in both tanks.

Which level detector(s) will produce the highest level indication?

- A. No. 1 only
- B. No. 2 only
- C. No. 1 and 4
- D. No. 2 and 3



**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

QUESTION: 38

An open vessel contains one pound-mass of water at 204EF and standard atmospheric pressure. If 16.0 Btu of heat is added to the water, the water temperature will rise by about _____; and approximately _____ of the water mass will become vapor.

- A. 8EF; 1 percent
- B. 8EF; 10 percent
- C. 16EF; 1 percent
- D. 16EF; 10 percent

QUESTION: 39

A nuclear power plant is operating at 100% power when the only in-service steam jet air ejector is inadvertently isolated from the main condenser. The operator verifies circulating water system parameters have not changed. If no operator action is taken over the next 60 minutes, condenser vacuum will...

- A. slowly increase (lower absolute pressure).
- B. slowly decrease and stabilize at a slightly lower vacuum (higher absolute pressure).
- C. slowly and continuously decrease (higher absolute pressure) towards atmospheric pressure.
- D. remain essentially the same (constant absolute pressure).

**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

QUESTION: 40

If the moisture content of the steam supplied to a main turbine increases, (assume no change in steam pressure, condenser pressure, or control valve position) turbine work will...

- A. decrease, because the enthalpy of the steam being supplied to the turbine has decreased.
- B. decrease, because moist steam results in more windage losses in the turbine.
- C. increase, because the enthalpy of the steam being supplied to the turbine has increased.
- D. increase, because moist steam results in less windage losses in the turbine.

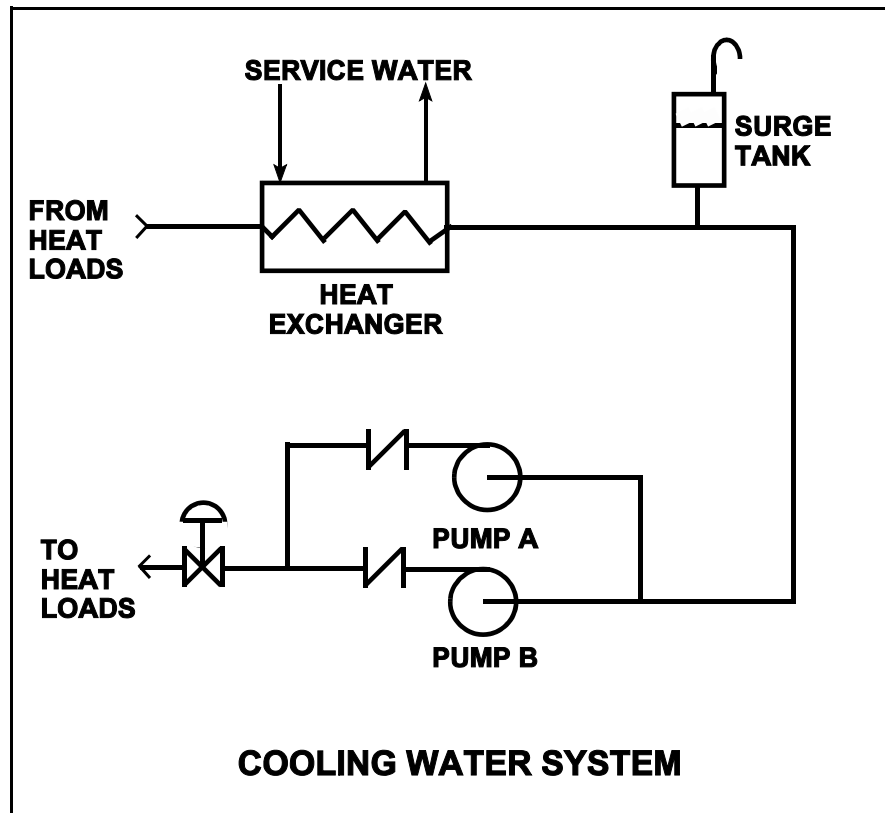
**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

QUESTION: 41

Refer to the drawing of a cooling water system in which only pump A is operating and the pump discharge valve is currently 50% open (see figure below).

If pump A is cavitating, which one of the following will reduce or eliminate cavitation in pump A?

- A. Starting pump B
- B. Positioning the discharge valve to 75% open
- C. Raising the water level in the surge tank by 2 feet
- D. Decreasing heat exchanger service water flow rate by 10%



**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

QUESTION: 42

A nuclear power plant is operating at full power when a 200 gpm reactor coolant leak occurs, which results in a reactor scram and initiation of emergency coolant injection. Reactor vessel pressure stabilizes at 900 psia and all injection pumps are operating with all pump miniflow paths isolated. The shutoff heads for the pumps are as follows:

High pressure coolant injection (HPCI) pumps: 800 psia
Low pressure coolant injection (LPCI) pumps: 200 psia

Which pumps are currently threatened for operability and why?

- A. Only the LPCI pumps due to pump overheating
- B. All LPCI and HPCI pumps due to pump overheating
- C. Only the HPCI pumps due to motor overheating
- D. All LPCI and HPCI pumps due to motor overheating

QUESTION: 43

Which one of the following is the order of core heat transfer mechanisms, from the least desirable to the most desirable?

- A. Film boiling, single-phase convection, nucleate boiling
- B. Film boiling, nucleate boiling, single-phase convection
- C. Single-phase convection, nucleate boiling, film boiling
- D. Single-phase convection, film boiling, nucleate boiling

**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

QUESTION: 44

Core inlet subcooling is defined as the difference between the temperature of the fluid _____ and the saturation temperature of the fluid in the core inlet plenum.

- A. in the core inlet plenum
- B. at the feedwater pump discharge
- C. in the downcomer area
- D. in the lower fuel channel area

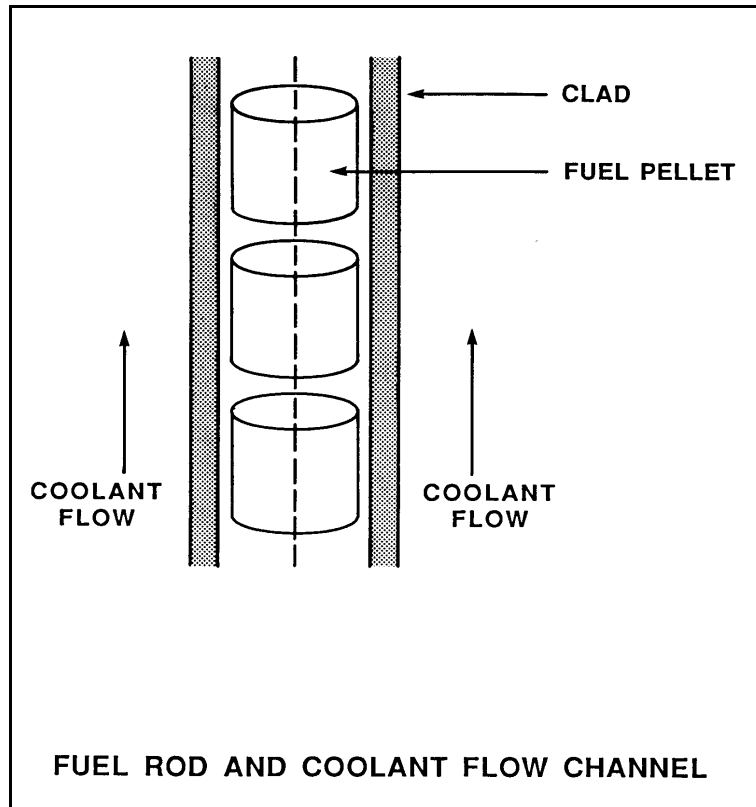
**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

QUESTION: 45

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

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

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



**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

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.

QUESTION: 47

Given the following initial core parameters for a segment of a fuel rod:

$$\begin{aligned} \text{Power density} &= 2 \text{ kW/ft} \\ T_{\text{coolant}} &= 540^{\circ}\text{F} \\ T_{\text{fuel centerline}} &= 1,200^{\circ}\text{F} \end{aligned}$$

Reactor power is increased such that the following core parameters now exist for the fuel rod segment:

$$\begin{aligned} \text{Power density} &= 3 \text{ kW/ft} \\ T_{\text{coolant}} &= 540^{\circ}\text{F} \\ T_{\text{fuel centerline}} &= ? \end{aligned}$$

Assuming void fraction surrounding the fuel rod segment does not change, what will be the new stable $T_{\text{fuel centerline}}$?

- A. 1,380^oF
- B. 1,530^oF
- C. 1,670^oF
- D. 1,820^oF

**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

QUESTION: 48

A nuclear power plant is operating at 90% power near the end of a fuel cycle when reactor recirculation flow rate suddenly decreases by 10%. 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

QUESTION: 49

The presence of embrittling isotopes is one of the initiating factors of pellet-clad interaction. Which one of the following describes the primary source of the embrittling isotopes?

- A. Created during fission of the reactor fuel
- B. Introduced during the fuel manufacturing process
- C. Migrate from reactor coolant through cladding
- D. Produced as corrosion products inside fuel rod

**USNRC GENERIC FUNDAMENTALS EXAMINATION
JUNE 2006 BWR--FORM A**

QUESTION: 50

A nuclear reactor is shut down for refueling following 18 months of operation at an average power level of 85%. During the shutdown, a reactor vessel metal specimen was removed from the reactor vessel for testing. The tests determined that the nil-ductility transition (NDT) temperature of the specimen has increased from 42EF to 72EF 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 increase during the described 18-month period of operation.
- D. The test results are questionable because the specimen NDT temperature would increase by less than indicated during the described 18-month period of operation.

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

**JUNE 2006 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	B	26	40	B
2	16	B	27	41	C
3	17	A	28	42	B
4	18	C	29	43	D
5	19	D	30	44	C
6	20	A	31	45	B
7	21	C	32	46	B
8	22	C	33	47	C
9	23	B	34	48	D
10	24	A	35	49	D
11	25	D	36	50	B
12	26	B	37	1	C
13	27	D	38	2	A
14	28	C	39	3	C
15	29	B	40	4	A
16	30	A	41	5	C
17	31	B	42	6	B
18	32	D	43	7	A
19	33	C	44	8	A
20	34	B	45	9	A
21	35	A/B	46	10	D
22	36	A	47	11	B
23	37	D	48	12	D
24	38	C	49	13	A
25	39	A	50	14	D