UNITED STATES NUCLEAR REGULATORY COMMISSION
BOILING WATER REACTOR GENERIC FUNDAMENTALS EXAMINATION
FEBRUARY 2003--FORM A

Please Print

Name: _____

Facility: _____

Docket No.: _____

Start Time: _____ Stop Time: _____

INSTRUCTIONS TO APPLICANT

Answer all the test items using the answer sheet provided. Each item has equal point value. A score of at least 80% is required to pass this portion of the written licensing examination. All examination papers will be collected 4.0 hours after the examination starts. This examination applies to a typical boiling water reactor (BWR) power plant.

SECTION	QUESTIONS	% OF TOTAL	SCORE
COMPONENTS	1 - 44		
REACTOR THEORY	45 - 72		
THERMODYNAMICS	73 - 100		
TOTALS	100		

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

))))))))))))))))))))))))))))))))))))
Applicant's Signature

RULES AND GUIDELINES FOR THE GENERIC FUNDAMENTALS EXAMINATION

During the administration of this examination the following rules apply:

NOTE: The generic term "control rod" refers to the length of neutron absorber material that can be positioned by the operator to change core reactivity.

1. Print your name in the blank provided on the cover sheet of the examination.

2. Fill in the name of your facility.

3. Fill in your individual docket number.

4. Fill in your start and stop times at the appropriate time.

5. Two aids are provided for your use during the examination:

   (1) An equations and conversions sheet contained within the examination copy, and

   (2) Steam tables provided by your proctor.

6. Place your answers on the answer sheet provided. Credit will only be given for answers properly marked on this sheet. Follow the instructions for filling out the answer sheet.

7. Scrap paper will be provided for calculations.

8. Cheating on the examination will result in the automatic forfeiture of this examination. Cheating could also result in severe penalties.

9. Restroom trips are limited. Only **ONE** examinee may leave the room at a time. In order to avoid the appearance or possibility of cheating, avoid all contact with anyone outside of the examination room.

10. After you have completed the examination, sign the statement on the cover sheet indicating that the work is your own and you have neither given nor received any assistance in completing the examination.

11. Turn in your examination materials, answer sheet on top, followed by the examination booklet, then examination aids - steam table booklets, handouts, and scrap paper used during the examination.

12. After turning in your examination materials, leave the examination area, as defined by the proctor. If after leaving you are found in the examination area while the examination is in progress, your examination may be forfeited.

GENERIC FUNDAMENTALS EXAMINATION
EQUATIONS AND CONVERSIONS HANDOUT SHEET

EQUATIONS

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

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

$Q = UA\Delta T$

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

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

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

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

$SUR = 26.06/\tau$

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

$\rho = \frac{R(}{\tau} + \frac{\bar{\beta}}{1 + \lambda_{eff}\tau}$

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

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

$DRW \propto \varphi^2_{tip}/\varphi^2_{avg}$

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

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

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

$CR_{S/D} = S/(1 - K_{eff})$

$CR_1(1 - K_{eff1}) = CR_2(1 - K_{eff2})$

$1/M = CR_1/CR_X$

$A = \pi r^2$

$F = PA$

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

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

$E = IR$

Eff. = Net Work Out/Energy In

$\upsilon(P_2 - P_1) + \frac{(v_2^2 - v_1^2)}{2g_c} + \frac{g(z_2 - z_1)}{g_c} = 0$

$g_c = 32.2$ lbm-ft/lbf-sec^2

CONVERSIONS

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1 Mw = 3.41×10^6 Btu/hr

1 hp = 2.54×10^3 Btu/hr

1 Btu = 778 ft-lbf

EC = (5/9)(EF - 32)

1 Curie = 3.7×10^{10} dps

1 kg = 2.21 lbm

1 gal_{water} = 8.35 lbm

1 ft^3_{water} = 7.48 gal

$$EF = (9/5)(EC) + 32$$

QUESTION: 1

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

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

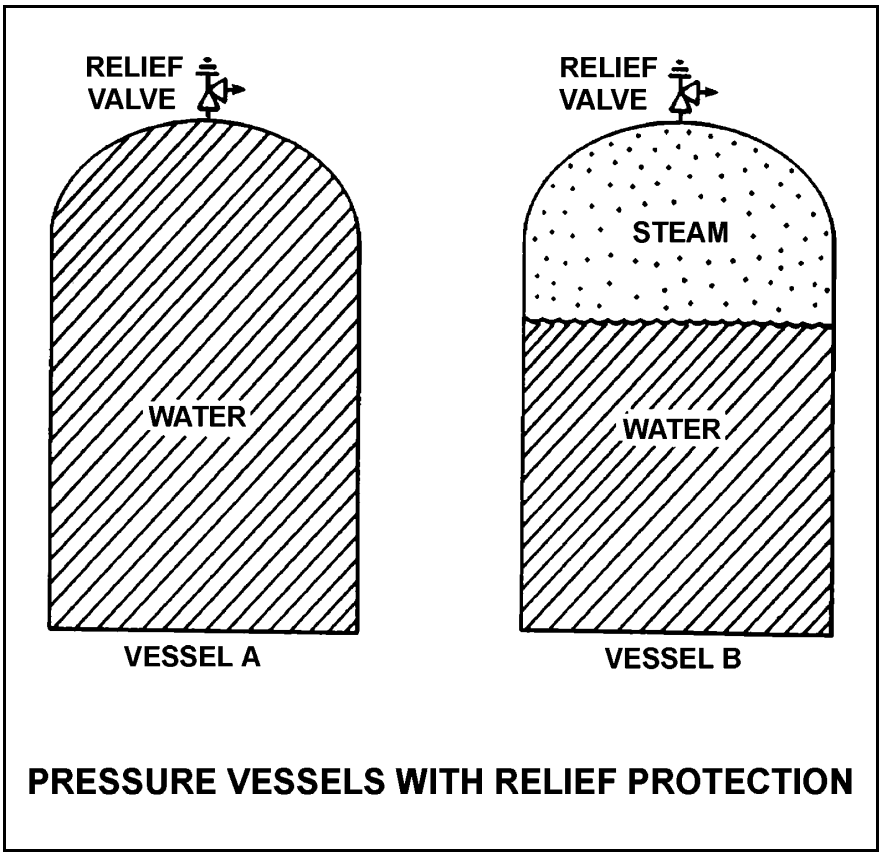
If both relief valves fully open simultaneously, the faster pressure reduction will initially occur in vessel _____ and the faster mass loss will initially occur in vessel _____.

A. A; A

B. A; B

C. B; A

D. B; B



PRESSURE VESSELS WITH RELIEF PROTECTION

QUESTION: 2

Refer to the drawing of a spring-loaded air-operated valve shown in a throttled position (see figure below).

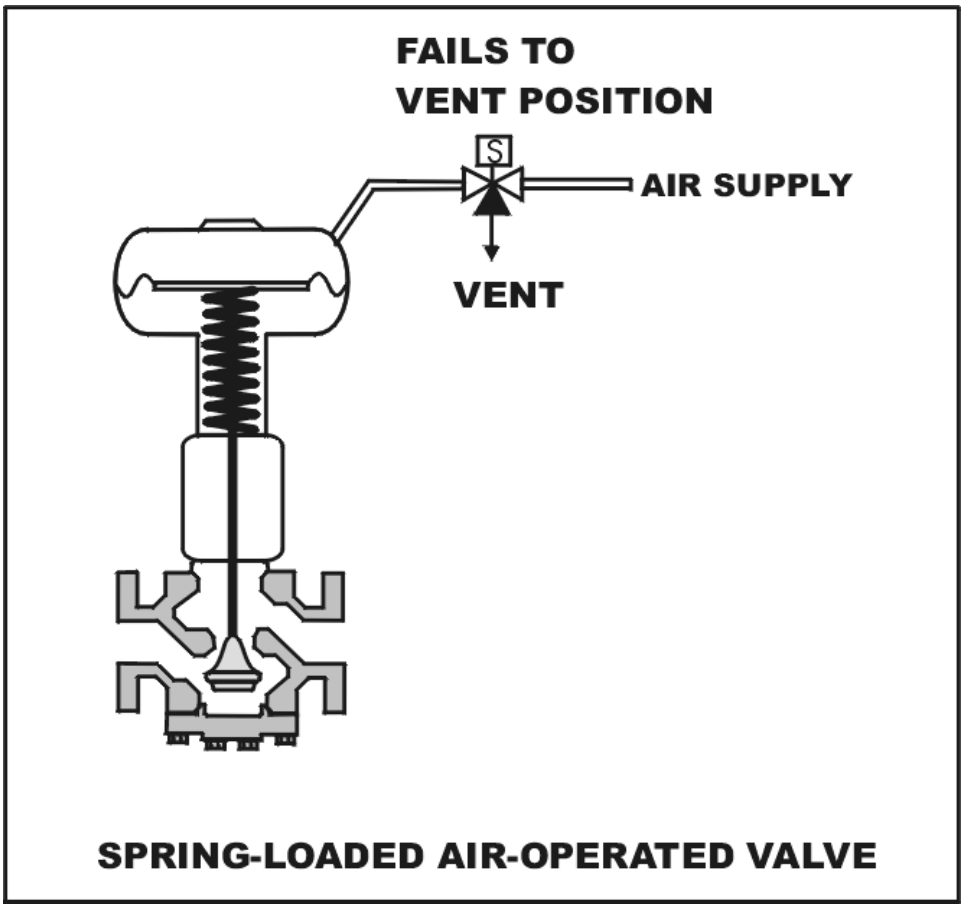
Which one of the following will be the valve position following a reduction in air pressure to the valve actuator caused by a leaking air connection at the valve?

A. Original position

B. More closed

C. More open

D. Varies with system flow



QUESTION: 3

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

A. The disk separated from the valve stem as a result of overtightening the packing gland.

B. The operator placed the valve in the wrong position for adjusting the packing gland.

C. The valve was overtorqued in the closed direction during the packing gland adjustment.

D. The maintenance technician overtightened the packing gland, causing the stem to bind.

QUESTION: 4

A stop check valve is a type of check valve that:

A. cannot be shut remotely.

B. can be used to prevent flow in both directions.

C. contains both a gate valve disk and a check valve disk.

D. can be opened manually to allow flow in both directions.

QUESTION: 5

In a comparison of a typical gate valve with a typical globe valve in the same application, the globe valve has a _____ pressure drop with both valves fully open, and is the better choice for _____ flow in high-pressure fluid systems.

A. lower; isolating

B. lower; throttling

C. higher; isolating

D. higher; throttling

QUESTION: 6

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

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

A. 109 psig

B. 98 psig

C. 86 psig

D. 71 psig

QUESTION: 7

Which one of the following will cause indicated volumetric flow rate to be lower than actual volumetric flow rate using a differential pressure flow detector and a calibrated orifice?

A. System pressure decreases.

B. The orifice erodes over time.

C. Debris becomes lodged in the orifice.

D. A leak develops in the low pressure sensing line.

QUESTION: 8

A steam flow measuring instrument uses density compensation and square root extraction to convert the differential pressure across the flow element to flow rate in lbm/hr.

The purpose of density compensation in this flow measuring instrument is to convert _____ to _____.

A. volumetric flow rate; mass flow rate

B. volumetric flow rate; differential pressure

C. differential pressure; mass flow rate

D. differential pressure; volumetric flow rate

QUESTION: 9

Refer to the drawing of a reactor vessel level detection system (see figure below). The differential pressure (D/P) detector was calibrated while the plant was at normal operating conditions.

With the plant initially at normal operating conditions, a reactor vessel head leak has occurred. The reactor pressure has decreased by 300 psia, and ambient air temperature surrounding the reference leg has increased by 80EF, where these parameters have stabilized.

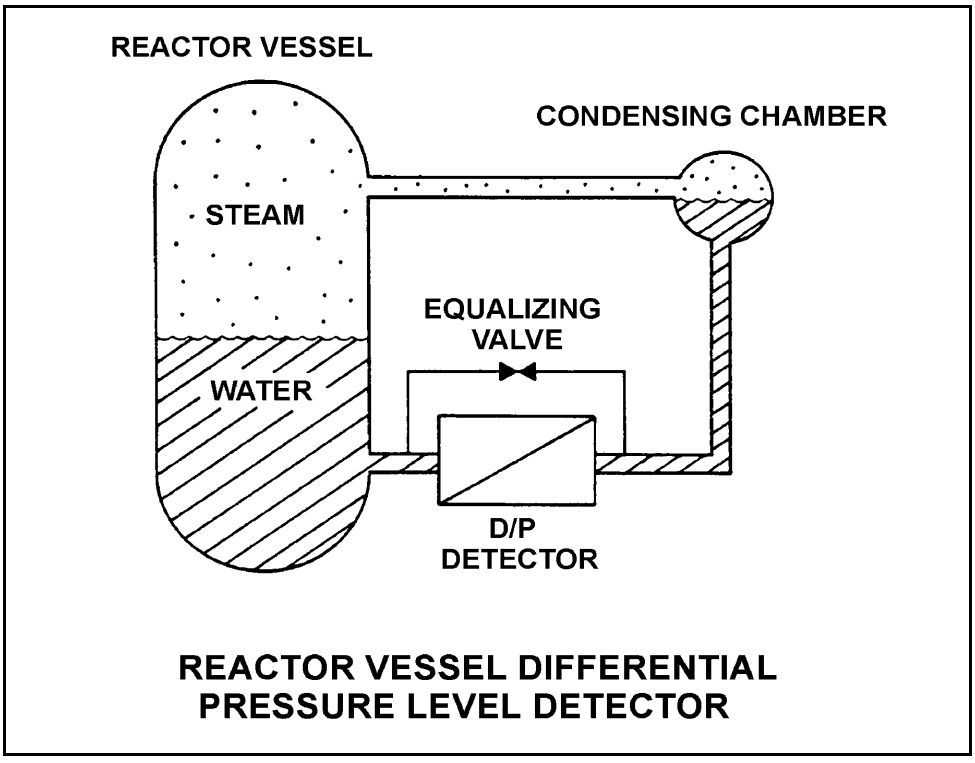
If the actual reactor vessel level is 6 feet above the fuel, the reduced reactor vessel pressure will tend to make the indicated reactor vessel level read _____ than actual; the increased reference leg temperature will tend to make the indicated reactor vessel level read _____ than actual.

A. lower; higher

B. lower; lower

C. higher; higher

D. higher; lower



REACTOR VESSEL DIFFERENTIAL PRESSURE LEVEL DETECTOR

QUESTION: 10

If the pressure sensed by a bourdon tube increases, the curvature of the detector will _____ because of the greatest force being applied to the _____ curve of the detector.

A. increase; inner

B. decrease; inner

C. increase; outer

D. decrease; outer

QUESTION: 11

What is the purpose of the reference junction panel that is provided with many thermocouple circuits?

A. Ensures that thermocouple output is amplified sufficiently for use by temperature indication devices.

B. Ensures that only temperature changes at the thermocouple measuring junction affect thermocouple temperature indication.

C. Ensures that electrical noise in the thermocouple extension wires does not affect thermocouple temperature indication.

D. Ensures that different lengths of thermocouple extension wires do not affect thermocouple temperature indication.

QUESTION: 12

Refer to the simplified drawing of a control rod position detector circuit (see figure below).

A magnet on the control rod extension (or drive) shaft sequentially closes individual reed switches mounted vertically adjacent to the control rod drive housing. A constant +5 dc volts is supplied to the input of the resistor network at resistor R_1.

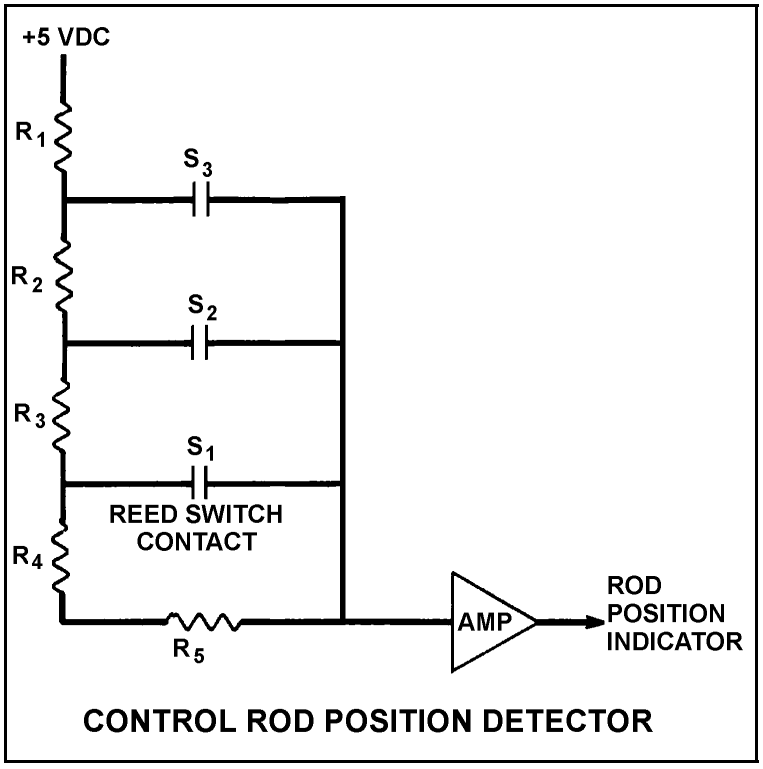
A control rod is initially fully inserted such that all reed switch contacts are open; then the rod is withdrawn until reed switch contact S_1 is closed. Compared to the initial circuit currents, the current through resistor R_5 after the rod withdrawal will be _____, and the output current of the resistor network to the amplifier will be _____.

A. lower, higher

B. lower, lower

C. higher, higher

D. higher, lower



QUESTION: 13

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

A. Neutron pulses will become so large that gamma pulse discrimination is no longer needed, yielding a more accurate neutron count rate.

B. The positive space charge effect will increase and prevent collection of both gamma and neutron pulses, yielding a less accurate neutron count rate.

C. A high rate of incident gamma radiation will result in multiple small gamma pulses that combine to look like larger pulses. The larger combined pulses will be counted as neutron pulses, yielding a less accurate neutron count rate.

D. Detection of any single ionizing event will result in ionizing nearly the entire detector gas volume. The resulting large pulses will prevent the detector from differentiating between radiation types, yielding a less accurate neutron count rate.

QUESTION: 14

A Geiger-Mueller radiation detector is located in a radiation field consisting of beta, gamma, and fast neutron radiation. Assuming each type of radiation enters the detector gas chamber and ionizes the detector gas, which one of the following describes the resulting detector pulse sizes?

A. Beta radiation will produce a larger pulse size than either gamma or fast neutron radiation.

B. Gamma radiation will produce a larger pulse size than either beta or fast neutron radiation.

C. Fast neutron radiation will produce a larger pulse size than either beta or gamma radiation.

D. Beta, gamma, and fast neutron radiation will produce pulse sizes that are equal in magnitude.

QUESTION: 15

The level in a tank is controlled by an automatic level controller. Level is initially at 50% when the tank develops a leak. When level decreases to 45% the level controller opens a makeup supply valve. After a few minutes level is 55% and the makeup valve closes. With the leak still in progress, level continuously oscillates between 45% and 55% as the makeup valve opens and closes.

The controller in this system uses primarily _____ control.

A. integral

B. proportional

C. bistable

D. derivative

QUESTION: 16

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

Given:

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

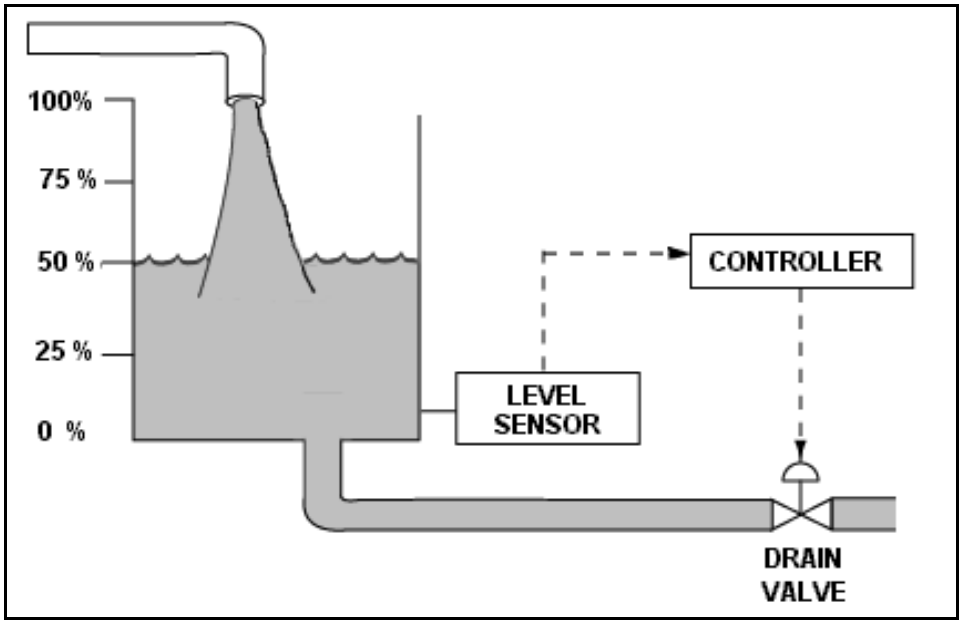
For proper automatic control of tank water level, the controller must be _____; and the control loop must be _____.

A. direct-acting; open

B. direct-acting; closed

C. reverse-acting; open

D. reverse-acting; closed



QUESTION: 17

Refer to the drawing of a pressure bistable in an 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 dead band, or neutral zone.

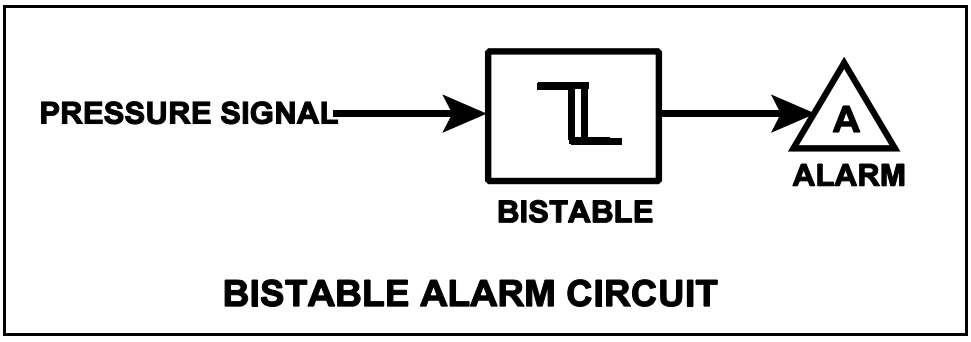
If current system pressure is 90 psig, which one of the following describes the alarm response as system pressure is slowly increased to 110 psig?

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.



QUESTION: 18

Which one of the following will result in immediate cavitation of a centrifugal pump that is initially operating at normal rated flow?

A. Recirculation flow path is aligned.

B. Recirculation flow path is isolated.

C. Pump suction valve is fully closed.

D. Pump discharge valve is fully closed.

QUESTION: 19

Refer to the drawing of a pump with a recirculation line (see figure below).

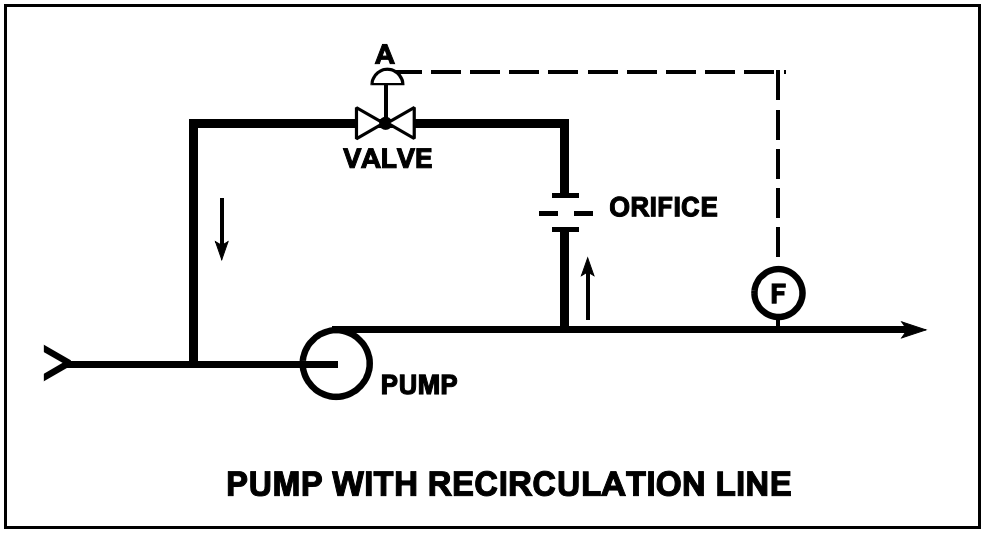
Valve "A" will close when pump:

A. discharge pressure increases above a setpoint.

B. discharge pressure decreases below a setpoint.

C. flow rate increases above a setpoint.

D. flow rate decreases below a setpoint.



PUMP WITH RECIRCULATION LINE

QUESTION: 20

A variable-speed centrifugal pump is operating at rated speed in an open system. If the pump speed is decreased by 50%, available net positive suction head (NPSH) will _____ and required NPSH will _____.

A. increase; decrease

B. increase; remain the same

C. decrease; decrease

D. decrease; remain the same

QUESTION: 21

An ac induction motor-driven centrifugal pump is circulating water at 180EF with a motor current of 100 amps. After several hours, system temperature has changed such that the water density has increased by 4%.

Assuming pump head and volumetric flow rate do not change, which one of the following is the new pump motor current?

A. 84 amps

B. 96 amps

C. 104 amps

D. 116 amps

QUESTION: 22

An ac motor-driven centrifugal pump was just started. During the start, motor current remained peaked for 6 seconds before decreasing to standard running current. Normally, the starting current peak lasts about 4 seconds.

Which one of the following could have caused the extended starting current peak?

A. The pump shaft was seized and did not turn.

B. The pump was initially rotating slowly in the reverse direction.

C. The pump discharge check valve was stuck closed and did not open.

D. The pump was initially air bound, and then primed itself after 6 seconds of operation.

QUESTION: 23

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

Given:

- The pump has a shutoff head of 100 feet.
- The required net positive suction head (NPSH) for the pump is 15 feet.
- The reservoir water temperature is 60EF.
- 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 <u>unable</u> 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: 24

A positive displacement pump is operating at a constant speed in an open system with its suction and discharge valves fully open. Which one of the following will increase if the pump discharge valve is throttled to 50% closed?

A. Proximity to cavitation

B. Required net positive suction head

C. Pump flow rate

D. Pump slip

QUESTION: 25

Which one of the following describes the proper location for a relief valve that will be used to prevent exceeding the design pressure of a positive displacement pump and associated piping?

A. On the pump suction piping upstream of the suction isolation valve

B. On the pump suction piping downstream of the suction isolation valve

C. On the pump discharge piping upstream of the discharge isolation valve

D. On the pump discharge piping downstream of the discharge isolation valve

QUESTION: 26

A cooling water system is being returned to service following maintenance on the two identical centrifugal cooling water pumps. The two pumps take suction from a common suction header and discharge to a common discharge header. Each pump is driven by a three phase ac induction motor.

Cooling water pump A was started five minutes ago to initiate flow in the cooling water system. Cooling water pump B is about to be started in parallel alignment with pump A.

When pump B is started, which one of the following would cause the ammeter for pump B to remain off-scale high for several seconds longer than usual before returning to normal running current indication?

A. The pump packing was removed and not reinstalled.

B. The pump was initially rotating in the reverse direction.

C. Two phases of the motor windings were electrically switched.

D. The coupling between the motor and the pump was removed and not reinstalled.

QUESTION: 27

The number of starts for an electric motor in a given period of time should be limited because overheating of the _____ can occur due to the _____ counter electromotive force produced at low rotor speeds.

A. windings; high

B. windings; low

C. commutator and/or slip rings; high

D. commutator and/or slip rings; low

QUESTION: 28

A 120 VDC battery is rated at 800 amp-hours for a continuous 50 kW load. Approximately how long will the fully charged battery be able to supply a continuous 50 kW load before the battery rating is exceeded?

A. 115 minutes

B. 90 minutes

C. 75 minutes

D. 60 minutes

QUESTION: 29

A main turbine-generator is operating in parallel with an infinite power grid. If the turbine control valves (or throttle valves) slowly fail open, the generator will experience high current primarily due to: (Assume no generator protective actuations occur.)

A. excessive generator MWe.

B. excessive generator KVAR (VARs out).

C. excessive generator KVAR (VARs in).

D. generator reverse power.

QUESTION: 30

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

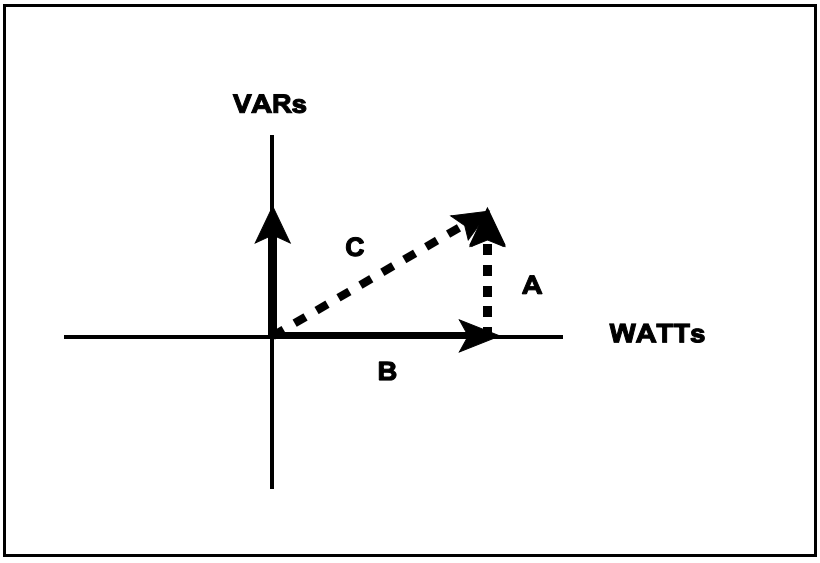
Which one of the following represents the power factor for this system?

A. A divided by B

B. A divided by C

C. B divided by A

D. B divided by C



QUESTION: 31

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

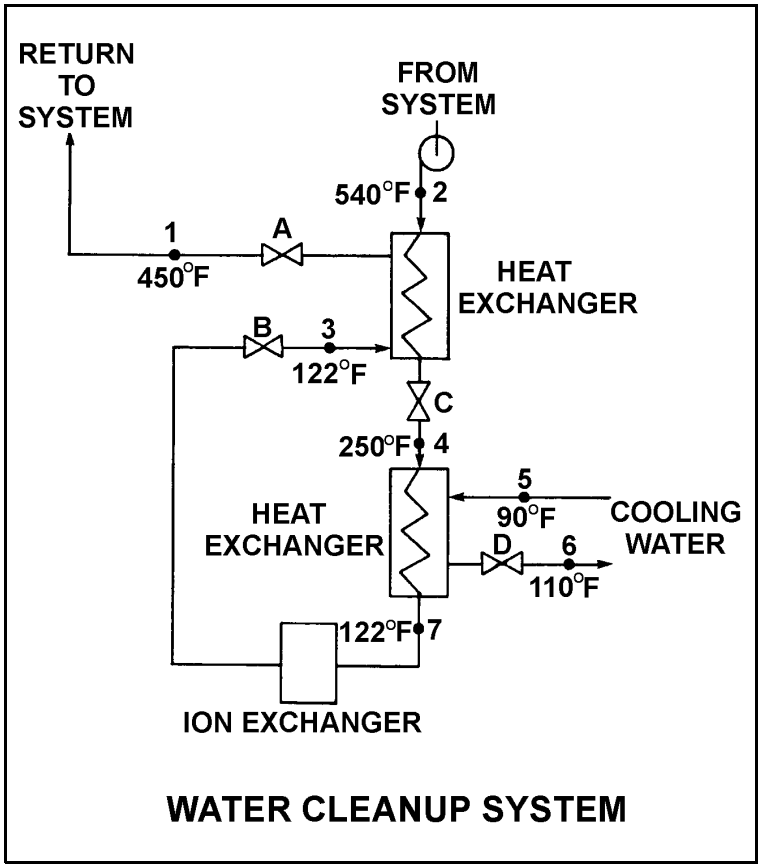
If cooling water flow rate is 1.0 x 10^6 lbm/hr, what is the approximate water flow rate in the cleanup system?

A. 1.6 x 10^5 lbm/hr

B. 3.2 x 10^5 lbm/hr

C. 1.6 x 10^6 lbm/hr

D. 3.2 x 10^6 lbm/hr



QUESTION: 32

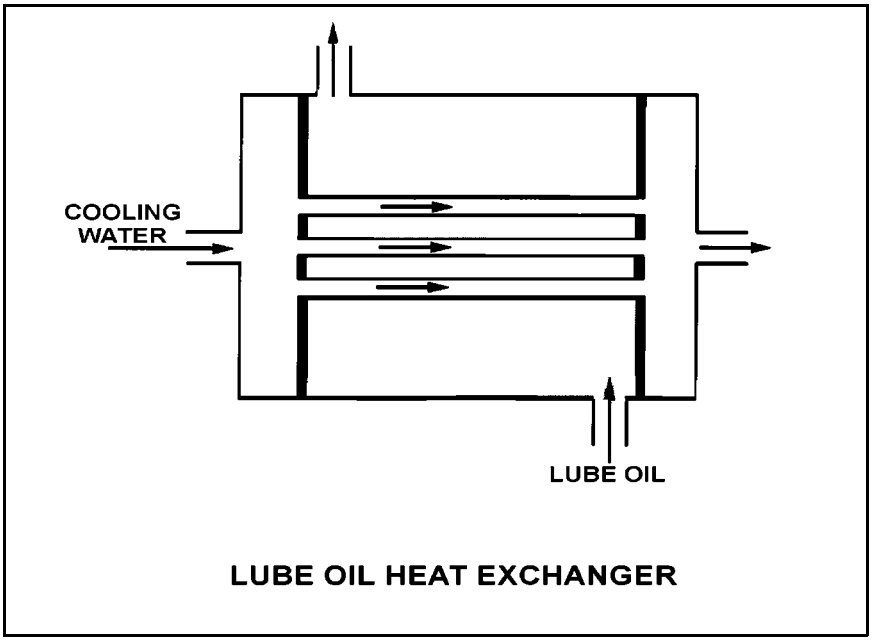
Refer to the drawing of a lube oil heat exchanger (see figure below).

The lube oil heat exchanger is in service with the following inlet temperatures:

Lube oil inlet temperature: 130EF
Cooling water inlet temperature: 70EF

Assuming the cooling water flow rate exceeds the lube oil flow rate, which one of the following pairs of heat exchanger outlet temperatures is possible? (Assume both fluids have the same specific heat.)

	Lube Oil Outlet Temp	Cooling Water Outlet Temp
A.	100EF	90EF
B.	100EF	100EF
C.	110EF	90EF
D.	110EF	100EF



LUBE OIL HEAT EXCHANGER

QUESTION: 33

A reactor is shut down with a reactor coolant temperature of 400EF and all control rods fully inserted. What is the major adverse consequence resulting from rapidly reducing the reactor coolant temperature to 250EF?

A. Excessive stress in the ceramic fuel pellets of the reactor core

B. Excessive stress on the reactor vessel wall

C. Uncontrolled reactor criticality

D. Loss of core inlet subcooling

QUESTION: 34

A pressure gauge on a condenser reads 27 inches of mercury (Hg) vacuum. What is the absolute pressure corresponding to this vacuum? (Assume an atmospheric pressure of 15 psia.)

A. 1.0 psia

B. 1.5 psia

C. 13.5 psia

D. 14.0 psia

QUESTION: 35

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

$T_{oil\ in}$ = 174EF
$T_{oil\ out}$ = 114EF
$T_{water\ in}$ = 85EF
$T_{water\ out}$ = 115EF

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

$T_{oil\ in}$ = 179EF
$T_{oil\ out}$ = 119EF
$T_{water\ in}$ = 85EF
$T_{water\ out}$ = 115EF

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.

QUESTION: 36

A nuclear plant is operating normally at 50% power. Which one of the following will result from a cooling water tube rupture in the main condenser?

A. Increased condenser vacuum

B. Increased conductivity of the condensate

C. Decreased condensate pump net positive suction head

D. Decreased condensate pump flow rate

QUESTION: 37

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 µmho/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 µmho/cm

B. 2.0 µmho/cm

C. 5.0 µmho/cm

D. 10.0 µmho/cm

QUESTION: 38

When a mixed-bed demineralizer resin is exhausted, the resin should be replaced or regenerated because:

A. ions previously removed by the resin will be released into solution.

B. the resin will fracture and possibly escape through the retention screens.

C. particles previously filtered out of solution will be released.

D. the resin will physically bond together, thereby causing a flow blockage.

QUESTION: 39

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

A. conductivity at the demineralizer outlet.

B. decontamination factor of the demineralizer.

C. differential pressure across the demineralizer.

D. pH at the demineralizer outlet.

QUESTION: 40

Refer to the drawing of a valve control circuit (see figure below).

Pushbutton PB2 was depressed to open the valve, and the current contact/pushbutton status is as shown with the following exceptions:

LS1 is closed.
LS3 is closed.
#1 contact is closed.
#2 contact is closed.

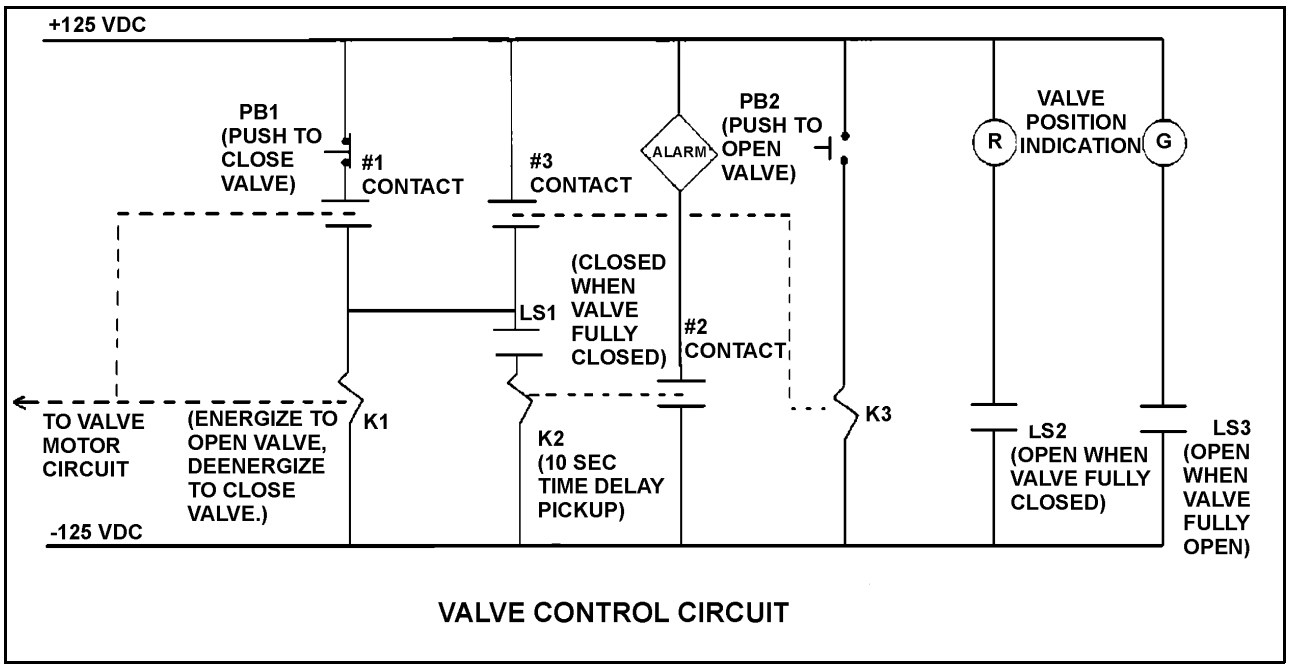
Which one of the following describes the condition of the valve and its control circuit?

A. The valve is closed and the valve motor circuit has just been energized to open the valve.

B. The valve is closed and an open demand signal has existed for at least 10 seconds.

C. The valve is partially open and the valve motor circuit is deenergized as PB2 was prematurely released.

D. The valve is partially open and an open demand signal has existed for at least 10 seconds.



VALVE CONTROL CIRCUIT

QUESTION: 41

Refer to the drawing of a motor controller circuit for a three-phase ac motor (see figure below).

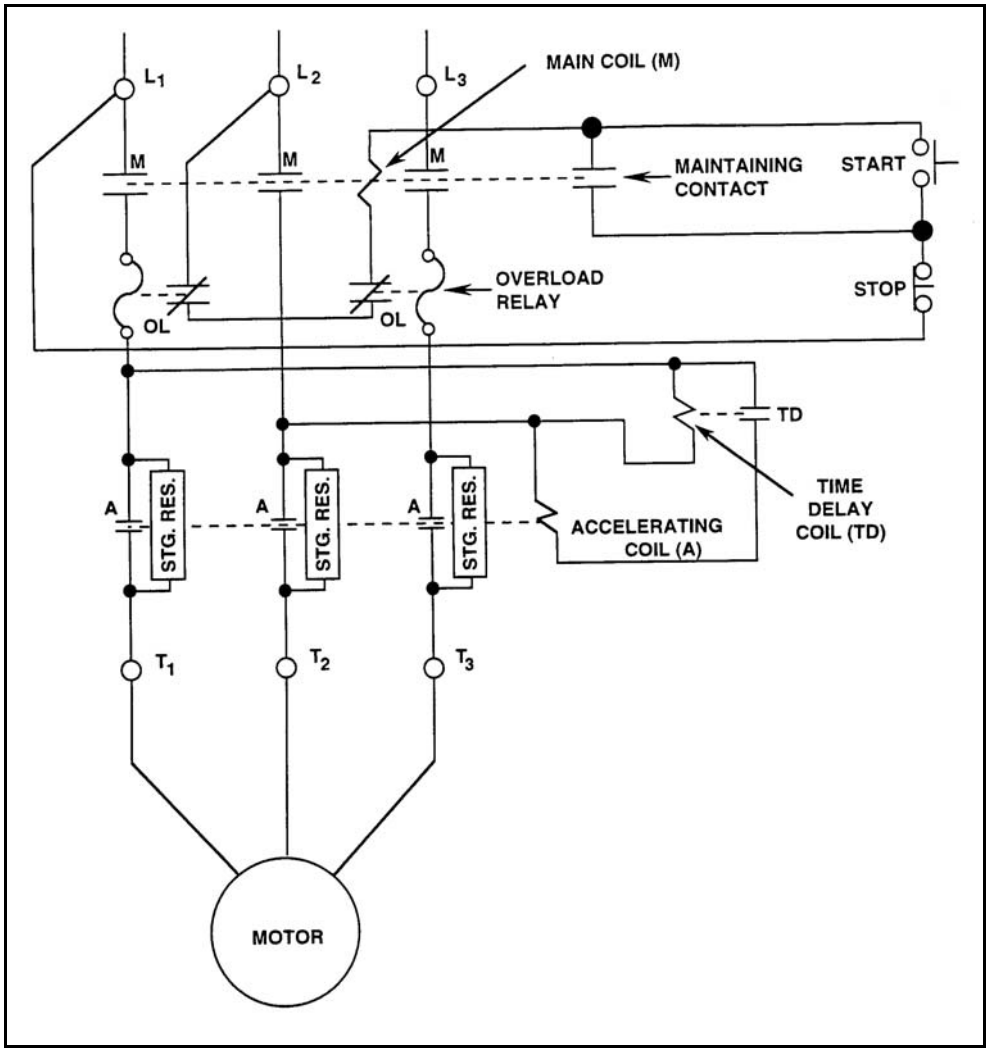
The motor receives overload protection from _____ overload (OL) relays, and _____ OL relay(s) must actuate to deenergize the motor.

A. two; one

B. two; two

C. three; one

D. three; two



QUESTION: 42

Which one of the following is an unsafe practice if performed by an electrician working on or near energized electrical equipment?

A. Having a person stand by to deenergize the equipment in the event of an emergency.

B. Standing on insulating rubber material to increase the electrical resistance of the body to ground.

C. Using two hands for balance and to prevent dropping tools onto energized equipment.

D. Covering exposed energized circuits with insulating material to prevent inadvertent contact.

QUESTION: 43

A main generator is being paralleled to the power grid. Generator voltage has been properly adjusted and the synchroscope is rotating slowly in the clockwise direction.

The generator breaker must be closed as the synchroscope pointer reaches the 12 o'clock position to prevent:

A. motoring of the generator due to unequal frequencies.

B. excessive arcing within the generator output breaker due to out-of-phase voltages.

C. excessive MWe load transfer to the generator due to unequal frequencies.

D. excessive MWe load transfer to the generator due to out-of-phase voltages.

QUESTION: 44

What is an advantage of using high voltage electrical disconnects instead of breakers to isolate main power transformers?

A. Disconnects can be operated either locally or remotely.

B. Disconnects provide direct visual indication that the circuit is broken.

C. Disconnects are cheaper and provide the same automatic protection as a breaker.

D. Disconnects are capable of interrupting a higher current flow with less heating than a breaker.

QUESTION: 45

Which one of the following types of neutrons in a reactor is more likely to cause fission of a U-238 nucleus in the reactor fuel? (Assume that each type of neutron remains in the reactor core until it interacts with a U-238 nucleus.)

A. Thermal neutron

B. Prompt neutron at birth

C. Delayed neutron at birth

D. Neutron at a U-238 resonance energy

QUESTION: 46

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: 47

Which one of the following combinations of core conditions at 30% power indicates the largest amount of excess reactivity exists in the core?

	CONTROL ROD POSITION	REACTOR RECIR-CULATION FLOW
A.	25% rod density	25%
B.	50% rod density	50%
C.	25% rod density	50%
D.	50% rod density	25%

QUESTION: 48

A reactor is initially operating at steady-state 60% power near the end of core life when a fully withdrawn control rod suddenly inserts completely into the core. No operator action is taken and the plant control systems stabilize the reactor at a power level in the power range.

Compared to the initial shutdown margin (SDM), the new steady-state SDM is _____; compared to the initial 60% power core K_{eff}, the new steady-state core K_{eff} is _____.

A. the same; smaller

B. the same; the same

C. less negative; smaller

D. less negative; the same

QUESTION: 49

If reactor power changes from 10^{-5}% to 10^{-6}% in 5 minutes, the average reactor period is:

A. negative 80 seconds.

B. positive 80 seconds.

C. negative 130 seconds.

D. positive 130 seconds.

QUESTION: 50

Two reactors are identical in every way except that reactor A is at the beginning of core life and reactor B is near the end of core life. Both reactors are operating at 100% power when a reactor scram occurs at the same time on each reactor. The reactor systems for each reactor respond identically to the scram and no operator action is taken.

Ten minutes after the scram, the higher shutdown fission rate will exist in reactor _____ because it has a _____ delayed neutron fraction.

A. A; larger

B. B; larger

C. A; smaller

D. B; smaller

QUESTION: 51

Refer to the unlabeled reactor response curve shown below for a reactor that was initially subcritical in the source range. A small amount of positive reactivity was added at time = 0 sec.

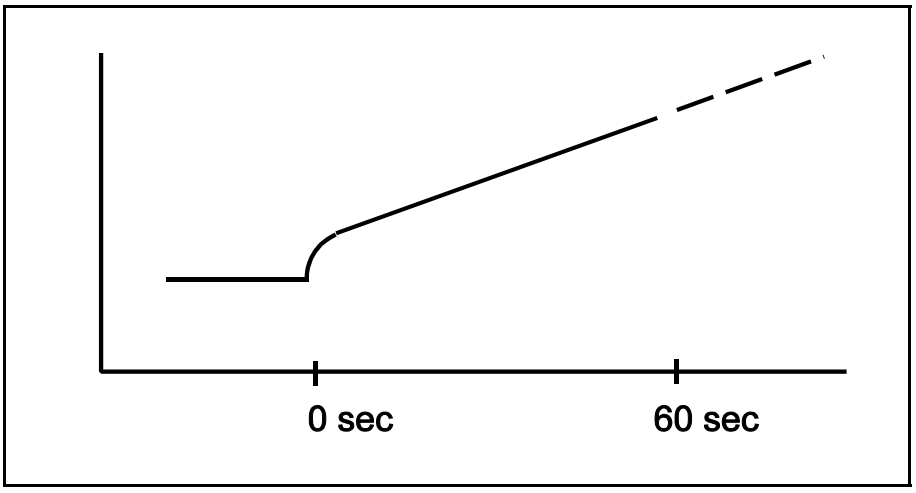
The response curve shows _____ versus time for a reactor that is currently (at time = 60 sec) _____.

A. reactor period; exactly critical

B. reactor period; supercritical

C. reactor fission rate; exactly critical

D. reactor fission rate; supercritical



QUESTION: 52

Which one of the following describes the overall core reactivity effect of a moderator temperature increase in an undermoderated reactor core?

A. Negative reactivity will be added because more neutrons will be absorbed by U-238 at resonance energies while slowing down.

B. Negative reactivity will be added because more neutrons will be captured by the moderator while slowing down.

C. Positive reactivity will be added because fewer neutrons will be absorbed by U-238 at resonance energies while slowing down.

D. Positive reactivity will be added because fewer neutrons will be captured by the moderator while slowing down.

QUESTION: 53

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

A. Becomes more negative due to a greater fractional loss of moderator for a 1% void increase at higher void fractions

B. Becomes more negative due to the reduction in the fast fission contribution to the neutron population

C. Becomes less negative due to a greater fraction of neutrons lost to leakage from the core

D. Becomes less negative due to the increased absorption of neutrons by U-238

QUESTION: 54

The reverse power effect (or reverse reactivity effect) occasionally observed when a shallow control rod is withdrawn one or two notches is due to a relatively:

A. small local power decrease due to increased local Doppler effects.

B. small local power decrease due to the shadowing effect of nearby control rods.

C. large local power increase being offset by a void-related power decrease.

D. large local power increase being offset by a moderator temperature-related power decrease.

QUESTION: 55

As a control rod is withdrawn from notch position 00 to notch position 48, the absolute value of integral rod worth will:

A. decrease, then increase.

B. increase, then decrease.

C. decrease continuously.

D. increase continuously.

QUESTION: 56

If the void fraction surrounding centrally located fuel bundles decreases, the worth of the associated control rod(s) will:

A. increase, because the average neutron energy in the area of the affected control rod(s) increases.

B. increase, because less neutrons are resonantly absorbed in the fuel while they are being thermalized, resulting in more thermal neutrons available to be absorbed by the affected control rod(s).

C. decrease, because the diffusion length of the thermal neutrons decreases, resulting in fewer thermal neutrons reaching the affected control rod(s).

D. decrease, because neutrons will experience a shorter slowing down length, resulting in a larger fraction of thermal neutrons being absorbed by the fuel and less thermal neutrons available to be absorbed by the affected control rod(s).

QUESTION: 57

A control rod located at notch position _____ in the core would be considered a _____ control rod.

A. 36; deep

B. 36; intermediate

C. 12; intermediate

D. 12; deep

QUESTION: 58

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.

QUESTION: 59

The major contributor to the production of Xe-135 in a reactor that has been operating at full power for 2 weeks is:

A. the radioactive decay of iodine.

B. the radioactive decay of promethium.

C. direct production from fission of U-235.

D. direct production from fission of U-238.

QUESTION: 60

A nuclear plant has been operating at 100% power for several months. Which one of the following describes the relative contributions of beta decay and neutron capture to Xe-135 removal from the reactor core?

A. Beta decay and neutron capture contribute equally

B. Primary - beta decay; secondary - neutron capture

C. Primary - neutron capture; secondary - beta decay

D. Not enough information given to make a comparison

QUESTION: 61

Reactors A and B are operating at steady-state 100% power with equilibrium core Xe-135. The reactors are identical except that reactor A is operating near the end of core life and reactor B is operating near the beginning of core life.

Which reactor is experiencing the most negative reactivity from equilibrium core Xe-135?

A. Reactor A due to a greater concentration of equilibrium core Xe-135

B. Reactor A due to lower competition from the fuel for thermal neutrons

C. Reactor B due to a greater thermal neutron flux in the core

D. Reactor B due to a smaller accumulation of stable fission product poisons

QUESTION: 62

Following a seven day shutdown, a reactor startup is performed and a plant is taken to 100% power over a 16-hour period. After reaching 100% power, what type of reactivity will the operator need to add to compensate for core xenon-135 changes over the next 24 hours?

A. Negative only

B. Negative, then positive

C. Positive only

D. Positive, then negative

QUESTION: 63

A reactor is initially operating at 100% power with equilibrium core xenon-135. Power is decreased to 75% over a 1-hour period and stabilized. No subsequent operator actions are taken.

Considering only the reactivity effects of core xenon-135 changes, which one of the following describes reactor power 10 hours after the power change?

A. Greater than 75% and decreasing slowly

B. Greater than 75% and increasing slowly

C. Less than 75% and decreasing slowly

D. Less than 75% and increasing slowly

QUESTION: 64

Burnable poisons are loaded into the core to:

A. reduce the rod shadowing effect between shallow rods early in core life.

B. provide for flux shaping in areas of deep rods during high power operation.

C. increase the excess reactivity that can be loaded into the core during refueling.

D. ensure the moderator coefficient of reactivity remains negative throughout core life.

QUESTION: 65

Refer to the drawing of a 1/M plot with curves A and B (see figure below). Assume that each axis has linear units.

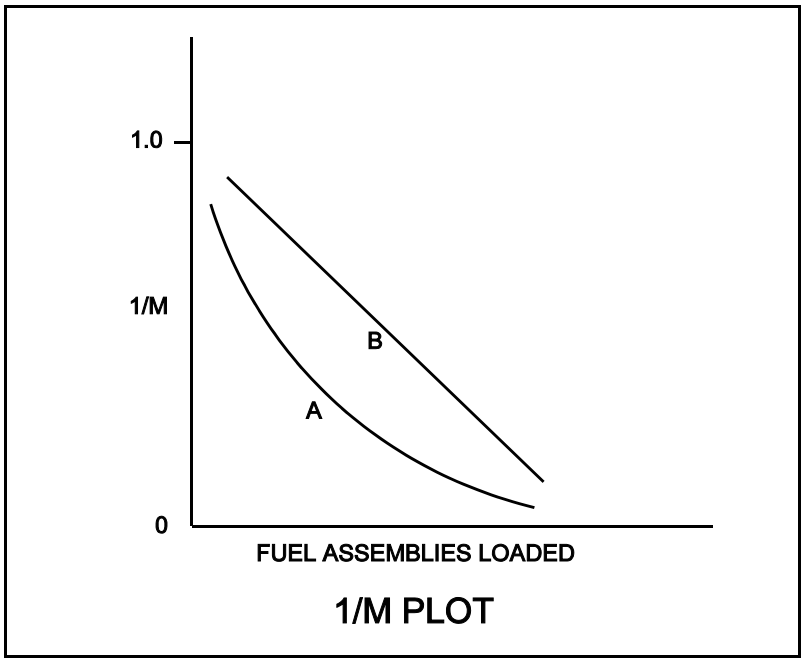
Curve A would result if each fuel assembly loaded during the early stages of the refueling caused a relatively _____ fractional change in source range count rate compared to the later stages of the refueling; curve B would result if each fuel assembly contained equal _____.

A. small; fuel enrichment

B. small; reactivity

C. large; fuel enrichment

D. large; reactivity



QUESTION: 66

With $K_{eff} = 0.985$, how much reactivity must be added to make a reactor critical?

A. 1.48% ΔK/K

B. 1.50% ΔK/K

C. 1.52% ΔK/K

D. 1.54% ΔK/K

QUESTION: 67

A reactor is critical at 10^{-6}% power. Control rods are withdrawn for 2 seconds and then stopped, resulting in a stable reactor period of positive 100 seconds.

If control rods had been inserted (instead of withdrawn) for 2 seconds with the reactor initially critical at 10^{-6}% power, the stable reactor period would have been: (Assume equal absolute values of reactivity are added in both cases.)

A. longer than negative 100 seconds, because, compared to power increases, reactor power decreases are more limited by delayed neutrons.

B. shorter than negative 100 seconds, because, compared to power increases, reactor power decreases are less limited by delayed neutrons.

C. longer than negative 100 seconds, because, compared to power increases, reactor power decreases result in larger delayed neutron fractions.

D. shorter than negative 100 seconds, because, compared to power increases, reactor power decreases result in smaller delayed neutron fractions.

QUESTION: 68

A reactor is slightly supercritical during a reactor startup. A short control rod withdrawal is performed to establish the desired reactor period. Assume that the reactor remains slightly supercritical after the control rod withdrawal, and that reactor power remains well below the point of adding heat.

Immediately after the control rod withdrawal is stopped, the reactor period will initially lengthen and then...

A. stabilize at a positive value.

B. turn and slowly shorten.

C. stabilize at infinity.

D. continue to slowly lengthen.

QUESTION: 69

A reactor is stable at the point of adding heat (POAH) with the reactor coolant at 160EF 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:

A. remain stable until voiding begins to occur.

B. increase until the control rods are reinserted.

C. decrease and stabilize at a subcritical power level.

D. decrease and stabilize at the POAH.

QUESTION: 70

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

A. Fuel temperature change

B. Moderator temperature change

C. Fission product poison change

D. Core void fraction change

QUESTION: 71

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

What is the effect on core flow rate?

A. Core flow rate will decrease due to an increase in core voiding.

B. Core flow rate will increase due to the decrease in recirculation ratio.

C. Core flow rate will increase due to the decrease in two-phase flow resistance.

D. Core flow rate will decrease due to an increase in two-phase flow resistance.

QUESTION: 72

A reactor is initially operating at 100% power when a control rod fully inserts into the core. Assuming no operator action, reactor power will initially decrease and then:

A. return to the original power level with the void boundary lower in the core.

B. stabilize at a lower power level with the void boundary lower in the core.

C. return to the original power level with the void boundary higher in the core.

D. stabilize at a lower power level with the void boundary higher in the core.

QUESTION: 73

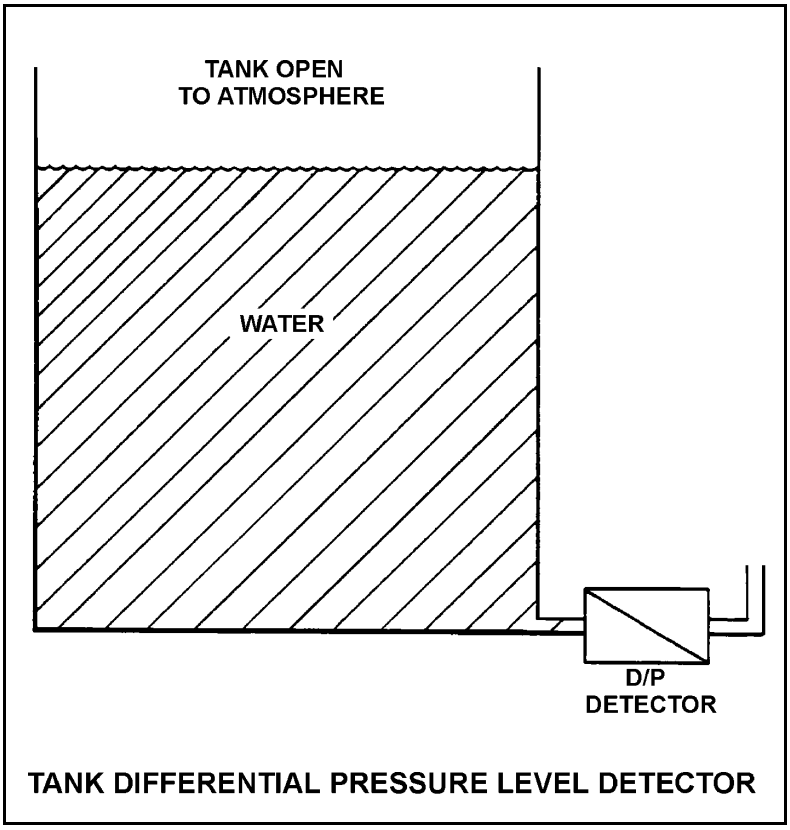
Refer to the drawing of a tank with a differential pressure (D/P) level detector (see figure below). If the tank contains 30 feet of water at 60EF, what is the approximate D/P sensed by the detector?

A. 2 psid

B. 13 psid

C. 20 psid

D. 28 psid



TANK DIFFERENTIAL PRESSURE LEVEL DETECTOR

QUESTION: 74

An open container holds one pound-mass of liquid water at saturated conditions and atmospheric pressure. The addition of 4 Btus will:

A. result in 4EF of superheat.

B. vaporize a portion of the water.

C. increase the density of the water.

D. raise the temperature of the water by 4EF.

QUESTION: 75

A nuclear plant is shutdown and steam is escaping to atmosphere through a leak in a main steam line. If main steam line pressure is 300 psia, what is the approximate temperature of the steam as it reaches atmospheric pressure? (Assume the steam in the main steam line has a quality of 100%.)

A. 212°F

B. 268°F

C. 322°F

D. 358°F

QUESTION: 76

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

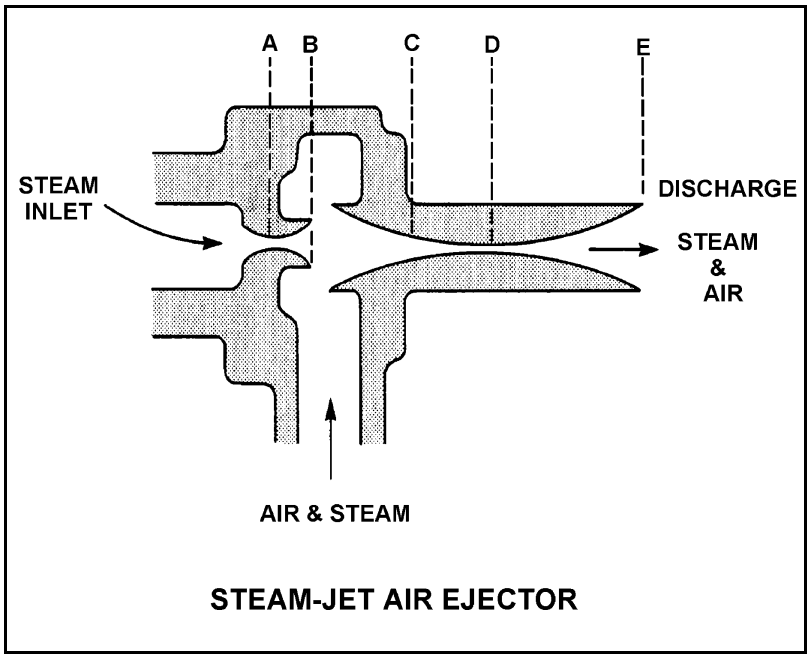
Steam flowing from D to E undergoes a pressure _____ and a velocity _____.

A. decrease; decrease

B. decrease; increase

C. increase; increase

D. increase; decrease



QUESTION: 77

Which one of the following is a primary function performed by a main condenser?

A. Deaerate turbine exhaust condensate

B. Remove ions from main condensate

C. Filter out impurities from main condensate

D. Provide net positive suction head for feed water pumps

QUESTION: 78

A nuclear plant is operating at steady-state 85% power when the extraction steam to a high-pressure feedwater heater is isolated. Which one of the following describes the initial effect on main turbine-generator output (MWe)? (Assume no operator action and no reactor protection actuation.)

A. MWe increases because plant efficiency increases.

B. MWe decreases because plant efficiency decreases.

C. MWe increases because the total steam flow rate through the turbine increases.

D. MWe decreases because the total steam flow rate through the turbine decreases.

QUESTION: 79

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

A. cavitation.

B. water hammer.

C. thermal shock.

D. positive reactivity addition.

QUESTION: 80

Which one of the following describes pump head?

A. The energy added by a pump to increase fluid pressure or velocity

B. The energy added by a pump in excess of shutoff head

C. The fluid energy required to ensure a pump does not cavitate

D. The fluid energy contained at the inlet of a pump

QUESTION: 81

Two identical single-speed centrifugal pumps (CPs) and two identical single-speed positive displacement pumps (PDPs) are able to take suction on a vented water storage tank and provide makeup water flow to a cooling water system. The pumps are capable of being cross-connected to provide multiple configurations. In single pump alignment, each pump will supply 100 gpm at a system pressure of 1,200 psig.

Given the following information:

Centrifugal Pumps

Shutoff head:	1,500 psig
Maximum design pressure:	2,000 psig
Flow rate with no backpressure:	180 gpm

Positive Displacement Pumps

Maximum design pressure:	2,000 psig

Which one of the following makeup water pump configurations will supply the highest initial flow rate to a cooling water system that is drained and depressurized?

A. Two CPs in series

B. Two CPs in parallel

C. Two PDPs in parallel

D. One PDP and one CP in series (CP supplying PDP)

QUESTION: 82

Which one of the following describes a heat transfer flow path in which conduction is the most significant heat transfer mechanism?

A. From the reactor fuel to the core barrel during core uncovery

B. From the main turbine exhaust steam to the atmosphere via main condenser cooling water and a cooling tower during normal operation

C. From the reactor fuel to the steam outlet of the reactor vessel during a station blackout

D. From a fuel pellet to the fuel clad via the fuel rod fill gas during normal operation

QUESTION: 83

Given the following data for a typical steam condenser, select the condenser heat load in megawatts thermal (MWt).

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

A. 587 MWt

B. 629 MWt

C. 671 MWt

D. 733 MWt

QUESTION: 84

Which one of the following pairs of fluids undergoing heat transfer in typical cross-flow design heat exchangers will yield the greatest heat exchanger overall heat transfer coefficient? (Assume comparable heat exchanger sizes and fluid flow rates.)

A. Oil to water in a lube oil cooler

B. Steam to water in a feedwater heater

C. Water to air in a ventilation heating unit

D. Water to water in a cooling water heat exchanger

QUESTION: 85

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

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

A. At a scratch on the surface of a fuel rod near the top of a fuel assembly

B. At a scratch on the surface of a fuel rod near the bottom of a fuel assembly

C. In the bulk fluid of a coolant channel near the top of a fuel assembly

D. In the bulk fluid of a coolant channel near the bottom of a fuel assembly

QUESTION: 86

If ΔT is the temperature difference between the fuel rod clad and the coolant, which one of the following describes the heat transfer from a fuel rod at the departure from nucleate boiling?

A. Steam bubbles begin to form on the fuel rod clad, causing a rapid decrease in the heat flux from the fuel rod for a given ΔT.

B. Steam bubbles completely blanket the fuel rod clad, causing a rapid increase in the heat flux from the fuel rod for a given ΔT.

C. Steam bubbles begin to blanket the fuel rod clad, causing a rapid increase in the ΔT for a given heat flux.

D. Steam bubbles completely blanket the fuel rod clad, causing a rapid decrease in the ΔT for a given heat flux.

QUESTION: 87

Refer to the drawing of a core recirculation jet pump (see figure below).

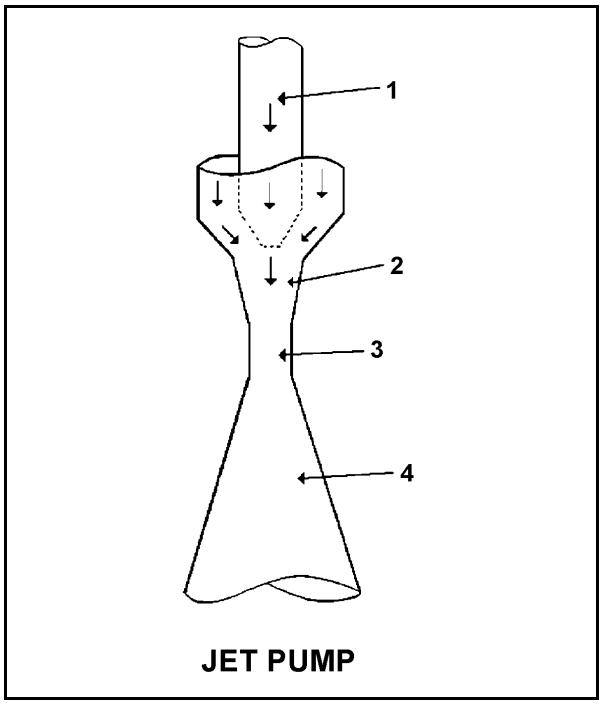
The lowest pressure will exist at point _____, and the highest velocity will occur at point _____.

A. 3; 3

B. 3; 4

C. 4; 3

D. 4; 4



QUESTION: 88

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

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

A. lower; lower

B. lower; higher

C. higher; lower

D. higher; higher

QUESTION: 89

Core orificing is used in the reactor core because the orifices:

A. counteract the buoyant force of the bubbles accelerating flow in the high-powered bundles.

B. improve the distribution of core flow to offset the effect of increasing quality on bundle flow.

C. increase core ΔP so that minor crud buildup on fuel bundles will not adversely affect flow.

D. decrease flow during periods of natural circulation to increase the void coefficient.

QUESTION; 90

Reactor coolant flow that bypasses the core is necessary to:

A. provide a source of water to the incore thermocouples to ensure they measure a representative coolant temperature.

B. act as a neutron reflector to minimize fast neutron leakage.

C. ensure that recirculation pump flow rate is adequate to prevent pump overheating.

D. provide cooling to prevent excessive boiling in the bypass region.

QUESTION: 91

After operating at high power for several weeks, the reactor was shut down yesterday and cooled down for steam line leak repairs. Shutdown cooling water pumps are being used to maintain reactor temperature and pressure. The pumps will be stopped in 30 minutes to commence a 4-hour test.

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

A. No action necessary; the increase of density in the downcomer and the reduction of density in the core region will easily support circulation.

B. No action necessary; the density of the mixture in the core region increases, thereby allowing liquid in the downcomer to enter the core.

C. Raise vessel pressure to allow vessel relief valves to lift and create a heat sink for decay heat while control rod drive flow maintains inventory.

D. Raise 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: 92

A reactor is operating at 40% of rated thermal power with power distribution peaked both radially and axially in the center of the core. Reactor power is then increased to 70% over the next two hours using only reactor recirculation flow rate adjustments for reactivity control.

Neglecting any effect from reactor poisons, when power is stabilized at 70%, the location of the maximum core radial peaking factor will _____ of the core and the location of the maximum core axial peaking factor will _____ of the core.

A. move away from the center; move toward the bottom

B. move away from the center; move toward the top

C. remain near the center; move toward the bottom

D. remain near the center; move toward the top

QUESTION: 93

The fraction of the limiting power density (FLPD) is equal to:

Where: LHGR = Linear heat generation rate
TPF = Total peaking factor

A. $\frac{\text{LHGR (actual)}}{\text{LHGR (limit)}}$

B. $\frac{\text{LHGR (limit)}}{\text{LHGR (actual)}}$

C. $\frac{\text{LHGR (limit) x TPF}}{\text{LHGR (actual)}}$

D. $\frac{\text{LHGR (actual)}}{\text{LHGR (limit) x TPF}}$

QUESTION: 94

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

A. Excessive plastic strain on cladding

B. Excessive cladding creep

C. Excessive decay heat in the fuel

D. Excessive cladding temperatures

QUESTION: 95

A plant is operating at 90% power at the end of core life 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: 96

A step increase in reactor power results in a fuel cladding surface temperature increase from 560EF to 590EF. The fuel thermal time constant is 6 seconds.

Which one of the following is the approximate fuel cladding surface temperature 6 seconds after the power change?

A. 579EF

B. 575EF

C. 570EF

D. 567EF

QUESTION: 97

Select the purpose of the gap between the fuel pellet and the clad.

A. Prevent contact between the fuel pellets and the clad

B. Increase heat transfer from the fuel pellet to the clad

C. Accommodate differential expansion between the fuel pellets and the clad

D. Reduce diffusion of fission product gases through the clad and into the reactor coolant system

QUESTION: 98

Gross fuel cladding failure during a design basis loss of coolant accident is prevented by adhering to the...

A. linear heat generation rate limit.

B. maximum average planar linear heat generation rate limit.

C. minimum critical power ratio limit.

D. preconditioning interim operating management recommendations.

QUESTION: 99

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

A. A high reactor gamma flux rather than a high neutron flux

B. A high reactor vessel material strength rather than a high material ductility

C. A high reactor coolant oxygen content rather than a low oxygen content

D. A rapid 100EF reactor cooldown at a high temperature rather than a low temperature

QUESTION: 100

A reactor is shutdown with the shutdown cooling system maintaining reactor coolant temperature at 240EF immediately following an uncontrolled cooldown from 500EF. If reactor coolant temperature is held constant at 240EF, which one of the following describes the change in tensile stress on the inner wall of the reactor vessel (RV) over the next few hours?

A. Decreases, because the temperature gradient across the RV wall will decrease.

B. Increases, because the temperature gradient across the RV wall will decrease.

C. Decreases, because the inner RV wall temperature will approach the nil-ductility transition temperature.

D. Increases, because the inner RV wall temperature will approach the nil-ductility transition temperature.

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

FEBRUARY 2003 NRC GENERIC FUNDAMENTALS EXAMINATION
BOILING WATER REACTOR - ANSWER KEY

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