TOPIC: Valves

Which one of the following describes the function of a safety valve?

A. Provide overpressure protection to limit the internal pressure in vessels.

B. Control pressure in a system to maintain optimum operational conditions.

C. Sound a warning by lifting at a predetermined value slightly higher than operating pressure.

D. Modulate open as necessary to maintain system pressure and/or temperature within normal limits.

ANSWER: A.

TOPIC: Valves

A vertical safety valve has a compressed spring assembly that is applying 1,200 lbf to the top of the valve disk in opposition to system pressure. System pressure is being exerted on the underside of the valve disk that is 3 inches in diameter.

Which one of the following is the approximate system pressure at which the safety valve will open?

A. 44 psig

B. 64 psig

C. 128 psig

D. 170 psig

ANSWER: D.

TOPIC: Valves

A vertical safety valve with a 3-inch diameter disk has a spring applying 1,000 lbf to the top of the valve disk in opposition to system pressure. Which one of the following is the approximate system pressure at which the safety valve will begin to open?

A. 35 psig

B. 111 psig

C. 141 psig

D. 444 psig

ANSWER: C.

TOPIC: Valves

Refer to the drawing of a typical safety valve (see figure below).

The component indicated by the solid arrow is used when necessary to manually...

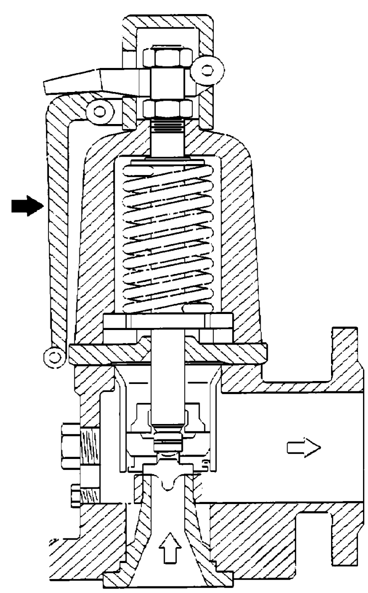
A. ratchet open the safety valve.

B. pop open the safety valve.

C. gag shut the safety valve.

D. determine the position of the safety valve.

ANSWER: B.



SAFETY VALVE

TOPIC: Valves

A vertical safety valve has a compressed spring assembly that is applying 2,500 lbf to the top of the valve disk in opposition to system pressure. System pressure is being exerted on the underside of the valve disk that is 5 inches in diameter.

Which one of the following is the approximate system pressure at which the safety valve will open?

A. 32 psig

B. 127 psig

C. 159 psig

D. 500 psig

ANSWER: B.

TOPIC: Valves

A vertical safety valve with a 2-inch diameter disk has a compressed spring applying 2,400 lbf to the top of the valve disk in opposition to system pressure. Which one of the following is the approximate system pressure at which the safety valve will open?

A. 95 psig

B. 191 psig

C. 382 psig

D. 764 psig

ANSWER: D.

TOPIC: Valves

A completely full water storage tank is being hydrostatically tested to 100 psig using a positive displacement pump (PDP) with a smooth and constant discharge flow rate of 10 gpm. The tank is protected by a safety valve <u>and</u> a relief valve; both valves discharge to the atmosphere. Each valve has an opening setpoint of 105 psig and a maximum rated discharge flow rate of 6 gpm. The PDP is inadvertently left running when tank pressure reaches 100 psig.

With the PDP still running, tank pressure will stabilize __________ 105 psig; and the greater mass flow rate will be coming from the __________ valve.

A. at; safety

B. above; safety

C. at; relief

D. above; relief

ANSWER: B.

TOPIC: Valves

Given the following pressure specifications for a safety relief valve (SRV):

Setpoint pressure (SRV will start to open)	= 1,200 psia
Maximum pressure (SRV will be fully open)	= 1,242 psia
Reseat pressure (SRV will be fully closed)	= 1,152 psia

Which one of the following is the percent accumulation for the SRV?

A. 2.5 percent

B. 3.0 percent

C. 3.5 percent

D. 4.0 percent

ANSWER: C.

TOPIC: Valves

A completely full water storage tank is being hydrostatically tested to 200 psig using a positive displacement pump (PDP) with a smooth and constant discharge flow rate of 8 gpm. The tank is protected by a relief valve <u>and</u> a safety valve; both valves discharge to the atmosphere. Each valve has an opening setpoint of 205 psig and a maximum rated discharge flow rate of 6 gpm. The PDP is inadvertently left running when tank pressure reaches 200 psig.

When conditions stabilize with the PDP still running, the relief valve will be __________ open; and the safety valve will be discharging a flow rate of approximately __________ to the atmosphere.

A. partially; 6 gpm

B. partially; 2 gpm

C. fully; 6 gpm

D. fully; 2 gpm

ANSWER: A.

TOPIC: Valves

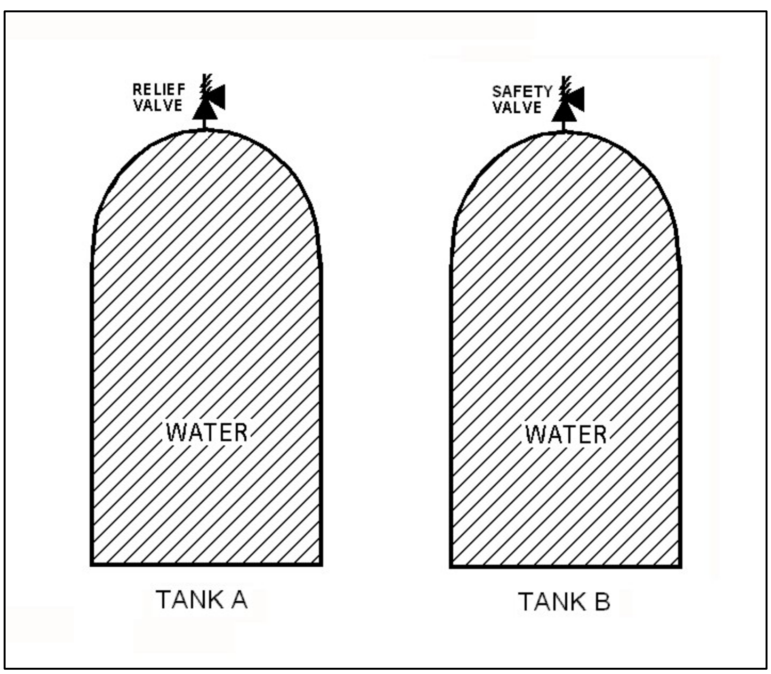
Refer to the drawing of two identical water storage tanks (see figure below). Tank A is protected by a relief valve and Tank B is protected by a safety valve. Each valve has an opening setpoint of 205 psig and a maximum rated discharge flow rate of 8 gpm.

The tanks are being hydrostatically tested to 200 psig. Each tank is being supplied with a smooth and constant flow rate of 2 gpm from separate positive displacement pumps (PDPs). Both PDPs are inadvertently left running when tank pressures reach 200 psig.

With the PDPs running continuously, what will be the resulting status of the relief and safety valves?

	Relief Valve Status	Safety Valve Status
A.	Partially open	Partially open
B.	Partially open	Cycling between fully open and fully closed
C.	Cycling between fully open and fully closed	Partially open
D.	Cycling between fully open and fully closed	Cycling between fully open and fully closed

ANSWER: B.



TOPIC: Valves

A completely full water storage tank is being hydrostatically tested to 200 psig using a positive displacement pump (PDP) with a smooth and constant discharge flow rate of 8 gpm. The tank is protected by a relief valve and a safety valve that both discharge to the atmosphere. The valves have the following characteristics:

- The relief valve opening setpoint is 200 psig with an accumulation of 5 percent.
- The safety valve opening setpoint is 240 psig with a blowdown of 5 percent.
- Both valves have a maximum discharge flow rate of 6 gpm.

The PDP is inadvertently left running when tank pressure reaches 200 psig.

When conditions stabilize with the PDP still running, the relief valve will be __________ open; and the safety valve will be discharging a flow rate of approximately __________ to the atmosphere.

A. partially; 6 gpm

B. partially; 2 gpm

C. fully; 6 gpm

D. fully; 2 gpm

ANSWER: D.

TOPIC: Valves

A completely full water storage tank is being hydrostatically tested to 200 psig using a positive displacement pump (PDP) with a smooth and constant discharge flow rate of 8 gpm. The tank is protected by a relief valve <u>and</u> a safety valve that both discharge to the atmosphere. The valves have the following characteristics:

- The relief valve opening setpoint is 220 psig with an accumulation of 5 percent.
- The safety valve opening setpoint is 260 psig with a blowdown of 5 percent.
- Both valves have a maximum discharge flow rate of 6 gpm.

The PDP is inadvertently left running when tank pressure reaches 200 psig.

After a few minutes with the PDP still running, the relief valve will be discharging a flow rate of approximately __________; and the safety valve will be __________.

A. 2 gpm; partially open

B. 6 gpm; partially open

C. 2 gpm; cycling between fully open and fully closed

D. 6 gpm; cycling between fully open and fully closed

ANSWER: D.

TOPIC: Valves

The primary purpose of a pressure relief valve is to...

A. reduce system energy.

B. reduce system pressure.

C. maintain system integrity.

D. maintain system mass.

ANSWER: C.

TOPIC: Valves

The difference between the setpoint pressure at which a safety valve opens and the pressure at which it closes is called...

A. blowdown.

B. accumulation.

C. setpoint tolerance.

D. setpoint deviation.

ANSWER: A.

TOPIC: Valves

The difference between the setpoint pressure at which a relief valve begins to open and the pressure at which it is fully open is called...

A. setpoint deviation.

B. setpoint tolerance.

C. accumulation.

D. blowdown.

ANSWER: C.

TOPIC: Valves

Which one of the following is a difference between a typical relief valve and a typical safety valve?

A. The actuator closing spring on a relief valve is in a compressed state whereas the actuator closing spring on a safety valve acts in tension.

B. A relief valve gradually opens as pressure increases above the setpoint pressure whereas a safety valve pops open at the setpoint pressure.

C. Relief valves are capable of being gagged whereas safety valves are <u>not</u>.

D. The blowdown of a relief valve is greater than the blowdown of a safety valve.

ANSWER: B.

TOPIC: Valves

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

Both vessels have been pressurized to 50 psig and then isolated. Vessel A is completely filled with water at 150°F. Vessel B is in a saturated condition with one-half steam (100 percent quality) and one-half water (0 percent quality) by volume.

If both relief valves fully open simultaneously, the faster pressure reduction will occur in vessel __________; and if both relief valves close at 40 psig, the greater mass loss will have occurred in vessel __________.

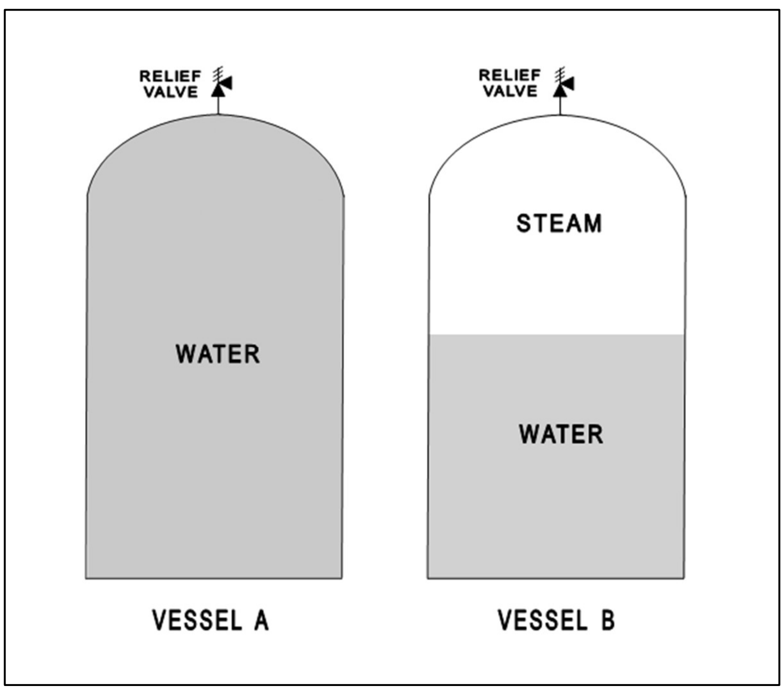
A. A; A

B. A; B

C. B; A

D. B; B

ANSWER: B.



TOPIC: Valves

Water storage tanks A and B are identical except that tank A receives overpressure protection from a relief valve, whereas tank B uses a safety valve. The relief valve and safety valve have the same pressure setpoints and design flow rates.

Water is continuously added to each tank at the same rate (50 percent of the design flow rate of the relief and safety valves). After the tanks are completely full, tank A pressure will __________; and tank B pressure will __________.

A. fluctuate within a few percent of the pressure setpoint; stabilize slightly above the pressure setpoint

B. fluctuate within a few percent of the pressure setpoint; fluctuate within a few percent of the pressure setpoint

C. stabilize slightly above the pressure setpoint; stabilize slightly above the pressure setpoint

D. stabilize slightly above the pressure setpoint; fluctuate within a few percent of the pressure setpoint

ANSWER: D.

TOPIC: Valves

Vessels A and B are identical except that vessel A receives overpressure protection from an installed safety valve. Vessel B has an installed relief valve. The safety and relief valves have the same pressure setpoint and design flow rate.

Water is continuously added to each vessel at the same rate (50 percent of the design flow rate of the safety and relief valves). After vessel pressure reaches the setpoint for each valve, vessel A pressure will __________; and vessel 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

ANSWER: C.

TOPIC: Valves

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

Vessel A is completely filled with subcooled water at 80°F 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_____.

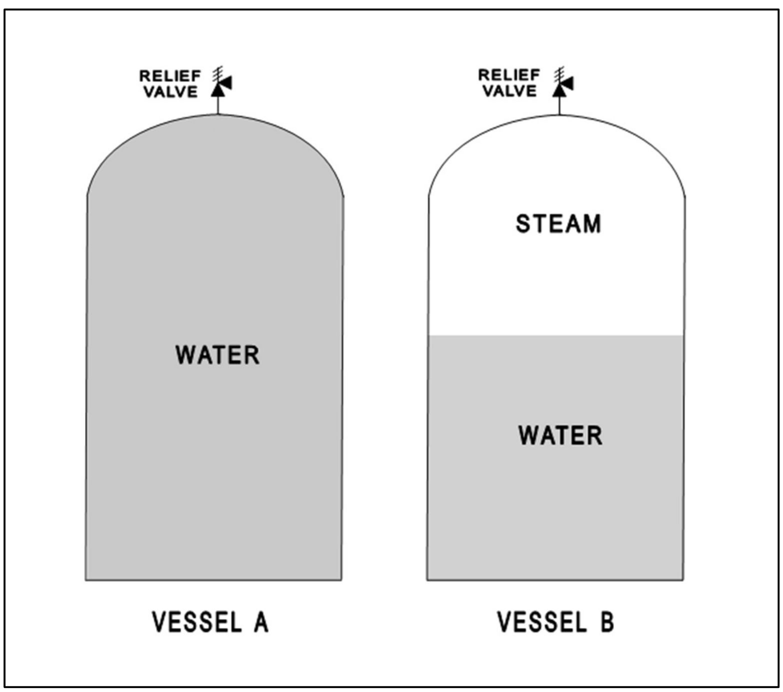
A. A; A

B. A; B

C. B; A

D. B; B

ANSWER: A.



TOPIC: Valves

A completely full water storage tank is being hydrostatically tested to 200 psig using a positive displacement pump (PDP) with a smooth and constant discharge flow rate of 6 gpm. The tank is protected by two relief valves that discharge to the atmosphere. The relief valves have the following characteristics:

- Relief valve A opening setpoint is 200 psig with an accumulation of 1.5 percent.
- Relief valve B opening setpoint is 200 psig with an accumulation of 3.0 percent.
- Each valve has linear flow rate characteristics and a maximum discharge flow rate of 6 gpm.

The PDP is inadvertently left running when tank pressure reaches 200 psig.

With the PDP running continuously, what will be the discharge flow rates of the relief valves when tank pressure stabilizes?

	Relief Valve A	Relief Valve B
A.	1 gpm	5 gpm
B.	2 gpm	4 gpm
C.	3 gpm	3 gpm
D.	4 gpm	2 gpm

ANSWER: D.

TOPIC: Valves

A completely full water tank is being hydrostatically tested to 180 psig using a positive displacement pump (PDP) with a smooth and constant discharge flow rate of 6 gpm. The tank is protected by two relief valves that discharge to the atmosphere. The relief valves have the following characteristics:

- Relief valve A opening setpoint is 180 psig with an accumulation of 5 percent.
- Relief valve B opening setpoint is 200 psig with an accumulation of 5 percent.
- Each relief valve has linear flow rate characteristics and a maximum flow rate of 4 gpm.

The PDP is inadvertently left running when tank pressure reaches 180 psig.

With the PDP still running, at what pressure will the tank stabilize?

A. 190 psig

B. 195 psig

C. 205 psig

D. 210 psig

ANSWER: C.

TOPIC: Valves

A completely full water storage tank is being hydrostatically tested to 200 psig using a positive displacement pump (PDP) with a smooth and constant discharge flow rate of 4 gpm. The tank is protected by a relief valve that discharges to the atmosphere. The relief valve has the following characteristics:

- The opening setpoint is 200 psig with an accumulation of 5 percent.
- The valve has linear flow characteristics and a maximum rated flow rate of 8 gpm.

The PDP is inadvertently left running when tank pressure reaches 200 psig.

With the PDP still running, at what pressure will the tank stabilize?

A. 190 psig

B. 195 psig

C. 205 psig

D. 210 psig

ANSWER: C.

TOPIC: Valves

A completely full water storage tank is being hydrostatically tested to 300 psig using a positive displacement pump (PDP) with a smooth and constant discharge flow rate of 4 gpm. The tank is protected by a relief valve that discharges to the atmosphere. The relief valve has the following characteristics:

- The relief valve opening setpoint is 300 psig with an accumulation of 5 percent.
- The relief valve has linear flow characteristics and a maximum rated flow rate of 6 gpm.

The PDP is inadvertently left running when tank pressure reaches 300 psig.

With the PDP still running, at what pressure will the tank stabilize?

A. 305 psig

B. 310 psig

C. 315 psig

D. 320 psig

ANSWER: B.

TOPIC: Valves

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

A. 55 psig

B. 60 psig

C. 65 psig

D. 80 psig

ANSWER: C.

TOPIC: Valves

A completely full water storage tank is being hydrostatically tested to 200 psig using a positive displacement pump (PDP) with a smooth and constant discharge flow rate of 6 gpm. The tank is protected by two relief valves that discharge to the atmosphere. The relief valves have the following characteristics:

- Relief valve A opening setpoint is 200 psig with an accumulation of 3.0 percent.
- Relief valve B opening setpoint is 200 psig with an accumulation of 1.5 percent.
- Each valve has linear flow rate characteristics and a maximum discharge flow rate of 9 gpm.

The PDP is inadvertently left running when tank pressure reaches 200 psig.

With the PDP running continuously, what will be the discharge flow rates of the relief valves when tank pressure stabilizes?

	Relief Valve A	Relief Valve B
A.	2 gpm	4 gpm
B.	3 gpm	6 gpm
C.	4 gpm	2 gpm
D.	6 gpm	3 gpm

ANSWER: A.

TOPIC: Valves

A cooling water system uses a conventional relief valve (not pilot-operated) with a bench-tested setpoint of 45 psig. The relief valve discharges to a collection tank that is maintained at 5 psi above atmospheric pressure. At what system pressure will the relief valve begin to open?

A. 40 psig

B. 45 psig

C. 50 psig

D. 65 psig

ANSWER: C.

TOPIC: Valves

In a comparison between a globe valve and a gate valve in the same water system application, the gate valve has a __________ pressure drop when fully open and is the __________ choice for throttling.

A. higher; better

B. lower; better

C. higher; poorer

D. lower; poorer

ANSWER: D.

TOPIC: Valves

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

If a cooling water outlet valve is partially closed from the full open position, heat exchanger cooling water pressure upstream of the valve will __________; and the temperature of the lube oil exiting the heat exchanger will __________.

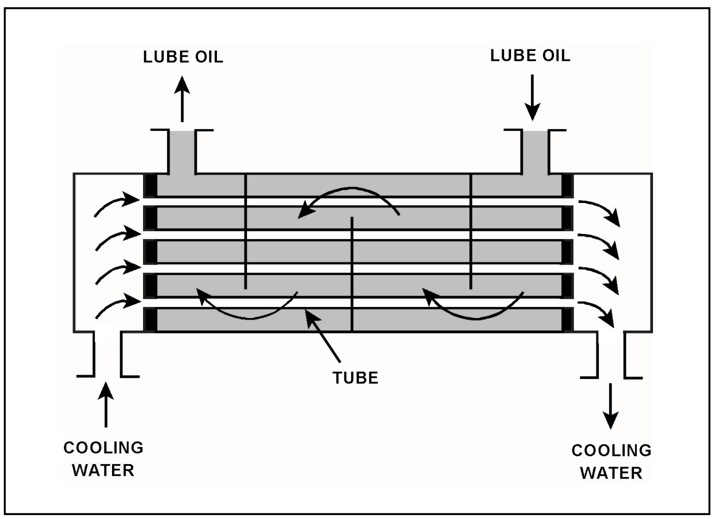
A. increase; decrease

B. increase; increase

C. decrease; decrease

D. decrease; increase

ANSWER: B.



TOPIC: Valves

Consider a 3-inch gate valve and a 3-inch globe valve in separate but identical operating water systems. If both valves are fully open, the gate valve will produce the __________ head loss and the __________ flow rate.

A. smaller; larger

B. larger; smaller

C. smaller; smaller

D. larger; larger

ANSWER: A.

TOPIC: Valves

Which one of the following statements describes the flow rate characteristics of a typical gate valve in an operating water system?

A. The first 25 percent of valve disk travel in the open direction will produce a smaller change in flow rate than the last 25 percent of valve disk travel.

B. The first 25 percent of valve disk travel in the open direction will produce a greater change in flow rate than the last 25 percent of valve disk travel.

C. The first 25 percent of valve disk travel in the open direction will produce approximately the same change in flow rate as the last 25 percent of valve disk travel.

D. A gate valve that has been opened to 25 percent of valve disk travel will result in approximately 25 percent of full flow rate.

ANSWER: B.

TOPIC: Valves

Which one of the following statements describes the flow rate characteristics of a typical globe valve in an operating water system?

A. The first 25 percent of valve disk travel in the open direction will produce a smaller increase in flow rate than the last 25 percent of valve disk travel.

B. The first 25 percent of valve disk travel in the open direction will produce a greater increase in flow rate than the last 25 percent of valve disk travel.

C. The first 25 percent of valve disk travel in the open direction will produce approximately the same increase in flow rate as the last 25 percent of valve disk travel.

D. A globe valve that has been opened to 25 percent of valve disk travel will result in approximately 25 percent of full flow rate.

ANSWER: B.

TOPIC: Valves

A control valve is most likely to experience cavitation when the valve is almost fully __________ because of a relatively __________ pressure drop across the valve seat.

A. open; large

B. open; small

C. closed; large

D. closed; small

ANSWER: C.

TOPIC: Valves

Which one of the following statements describes the throttling characteristics of a typical globe valve?

A. The first third of valve disk travel in the open direction will result in approximately one-third of full flow rate.

B. The first third of valve disk travel in the open direction will produce a smaller increase in flow rate than the last third of valve disk travel.

C. The first third of valve disk travel in the open direction will produce a greater increase in flow rate than the last third of valve disk travel.

D. The first two-thirds of valve disk travel in the open direction will produce approximately the same increase in flow rate as the last third of valve disk travel.

ANSWER: C.

TOPIC: Valves

Refer to the drawing of a cooling water system in which both centrifugal pumps A and B are operating (see figure below).

An operator stops pump B, but the pump B check valve fails to close. In comparison to normal operation with only pump A running, operation with the failed pump B check valve will result in pump A flow rate being __________ than normal; and heat exchanger flow rate being __________ than normal.

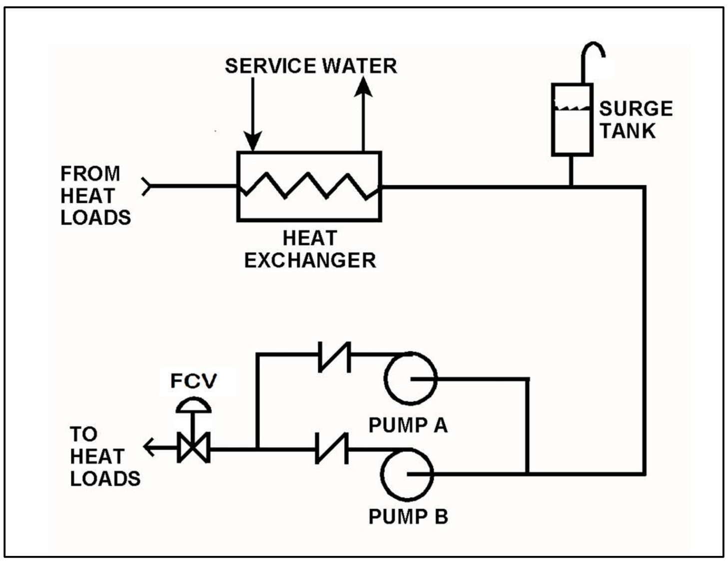
A. higher; higher

B. higher; lower

C. lower; higher

D. lower; lower

ANSWER: B.



TOPIC: Valves

Which one of the following types of similarly sized valves in an operating water system produces the <u>least</u> frictional head loss when fully open?

A. Ball

B. Globe

C. Butterfly

D. Swing check

ANSWER: A.

TOPIC: Valves

Refer to the centrifugal pump operating curve with two system head loss curves (see figure below). The curves apply to a closed cooling water system using one single-speed centrifugal pump discharging through a typical flow control valve.

The system curves are shown for two flow control valve positions--25 percent open and 100 percent open. The pump is currently operating with the flow control valve 25 percent 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...

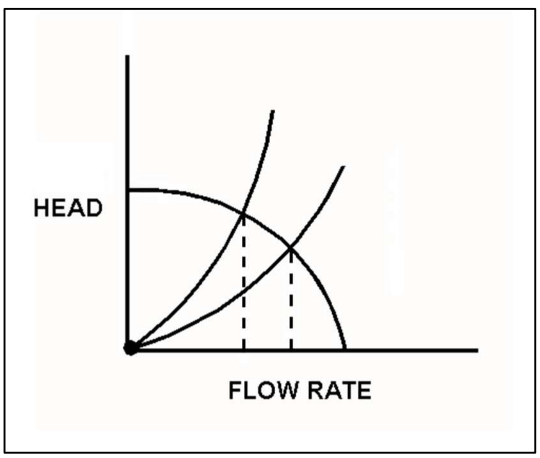
A. 400 gpm.

B. 1,200 gpm.

C. 1,600 gpm.

D. 3,200 gpm.

ANSWER: B.



TOPIC: Valves

Consider a 6-inch globe valve and a 6-inch gate valve in the same water system application. Typically, the valve that requires the most linear disk travel from fully closed to fully open is the ___________ valve; and the valve that produces the smallest pressure drop when fully open is the ___________ valve.

A. gate; gate

B. gate; globe

C. globe; gate

D. globe; globe

ANSWER: A.

TOPIC: Valves

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

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

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

Inlet pressure = 60 psia
Outlet pressure = 55 psia

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

A. 400 gpm

B. 566 gpm

C. 635 gpm

D. Cannot be determined without additional information.

ANSWER: D.

TOPIC: Valves

Subcooled water is flowing through a throttle valve in an open system. The initial steady-state conditions for the throttle valve are as follows:

Inlet pressure = 60 psia
Outlet pressure = 44 psia
Flow rate = 800 gpm

Four hours later, the current steady-state conditions for the throttle valve are as follows:

Inlet pressure = 63 psia
Outlet pressure = 54 psia
Flow rate = 600 gpm

Which one of the following could be responsible for the difference between the initial and current conditions for the throttle valve?

A. The throttle valve was opened more.

B. The throttle valve was closed more.

C. Another valve, located upstream of the throttle valve, was partially closed.

D. Another valve, located downstream of the throttle valve, was partially closed.

ANSWER: D.

TOPIC: Valves

Subcooled water is flowing through a throttled valve in an open system. The initial steady-state conditions for the throttled valve are as follows:

Inlet pressure	= 60 psia
Outlet pressure	= 44 psia
Flow rate	= 800 gpm

After four hours, the current steady-state conditions for the throttled valve are as follows:

Inlet pressure	= 62 psia
Outlet pressure	= 40 psia
Flow rate	= 600 gpm

Which one of the following could be responsible for the difference between the initial and current steady-state conditions for the throttled valve?

A. The throttled valve was opened more.

B. The throttled valve was closed more.

C. Another valve, located upstream of the throttled valve, was partially closed.

D. Another valve, located downstream of the throttled valve, was partially closed.

ANSWER: B.

TOPIC: Valves

Refer to the drawing of an operating cooling water system (see figure below) in which valves A and B are identical. Valve A is one-half open and valve B is fully open. If valve A is opened fully, the differential pressure (D/P) across valve B will…

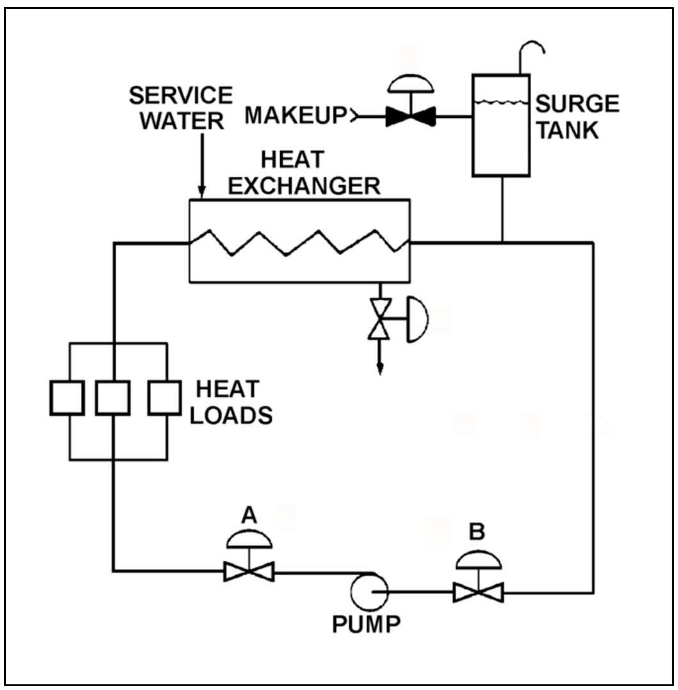
A. increase by the same amount as the absolute change in D/P across valve A.

B. increase by an amount less than the absolute change in D/P across valve A.

C. decrease by the same amount as the absolute change in D/P across valve A.

D. decrease by an amount less than the absolute change in D/P across valve A.

ANSWER: B.



TOPIC: Valves

Consider a 6-inch globe valve and a 6-inch gate valve in the same water system application. The valve that typically requires the <u>least</u> linear travel of the disk from fully closed to fully open is the ___________ valve; and the valve that produces the <u>greatest</u> pressure drop when fully open is the ___________ valve.

A. gate; gate

B. gate; globe

C. globe; gate

D. globe; globe

ANSWER: D.

TOPIC: Valves

Subcooled water is flowing through a throttle valve in an open system. The initial steady-state conditions for the throttle valve are as follows:

Inlet pressure	=	60 psia
Outlet pressure	=	44 psia
Flow rate	=	800 gpm

Four hours later, the current steady-state conditions for the throttle valve are as follows:

Inlet pressure	=	51 psia
Outlet pressure	=	42 psia
Flow rate	=	600 gpm

Which one of the following could be responsible for the difference between the initial and current conditions for the throttle valve?

A. The throttle valve was opened more.

B. The throttle valve was closed more.

C. Another valve, located upstream of the throttle valve, was partially closed.

D. Another valve, located downstream of the throttle valve, was partially closed.

ANSWER: C.

TOPIC: Valves

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

Inlet pressure = 70 psia
Outlet pressure = 60 psia
Flow rate = 600 gpm

The valve was then opened fully, and the following parameters currently exist:

Inlet pressure = 60 psia
Outlet pressure = 55 psia

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

A. 424 gpm

B. 848 gpm

C. 1,200 gpm

D. Cannot be determined without additional information.

ANSWER: D.

TOPIC: Valves

Subcooled water is flowing through a throttle valve in an open system. The initial steady-state conditions for the throttle valve are as follows:

Inlet pressure = 60 psia
Outlet pressure = 44 psia
Flow rate = 800 gpm

After four hours, the current steady-state conditions for the throttle valve are as follows:

Inlet pressure = 58 psia
Outlet pressure = 46 psia
Flow rate = 1,000 gpm

Which one of the following could be responsible for the difference between the initial and current steady-state conditions for the throttle valve?

A. The throttle valve was closed more.

B. The throttle valve was opened more.

C. Another valve, located upstream of the throttle valve, was opened more.

D. Another valve, located downstream of the throttle valve, was opened more.

ANSWER: B.

TOPIC: Valves

Refer to the drawing of an open system with subcooled water flowing through valves A, B, C and D (see figure below). All valves are initially 50 percent open. The inlet pressure to valve A is constant at 60 psia.

The initial steady-state inlet and outlet pressures for valve B are as follows:

Inlet pressure = 50 psia
Outlet pressure = 35 psia

After a single valve operation, the current steady-state inlet and outlet pressures for valve B are as follows:

Inlet pressure = 48 psia
Outlet pressure = 36 psia

Which one of the following valve operations could be responsible for the difference between the initial and current steady-state inlet and outlet pressures for valve B?

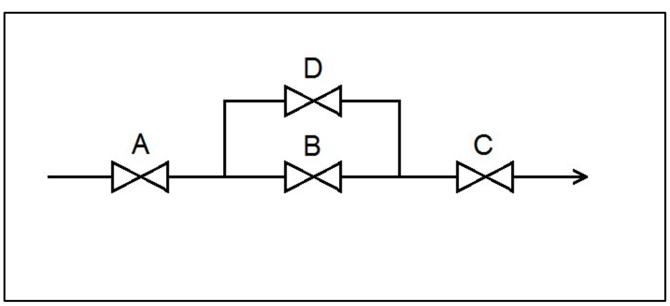
A. Valve A was opened more.

B. Valve B was closed more.

C. Valve C was closed more.

D. Valve D was opened more.

ANSWER: D.



TOPIC: Valves

Refer to the drawing of an operating cooling water system (see figure below) in which valve A is one-half open. Currently, the centrifugal pump is providing a system flow rate of 600 gpm.

If valve A is opened further, until system flow rate is 800 gpm, the differential pressure across valve A will __________; and the differential pressure across the heat exchanger will __________.

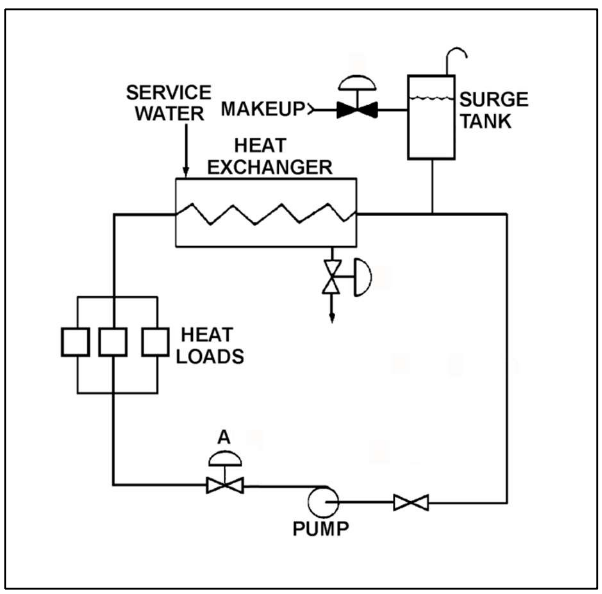
A. decrease; decrease

B. decrease; increase

C. increase; decrease

D. increase; increase

ANSWER: B.



TOPIC: Valves

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

Upon a loss of air pressure, this valve will...

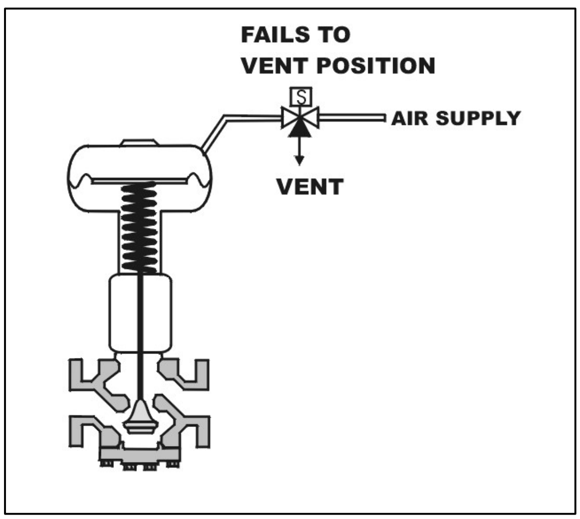
A. go to the fully open position.

B. remain at the current position.

C. go to the fully closed position.

D. go to the midposition.

ANSWER: C.



TOPIC: Valves

Refer to the drawing of a spring-loaded air-operated valve (see figure below) in which the solenoid is shown energized.

Which one of the following will be the final valve position following a loss of electrical power to the solenoid?

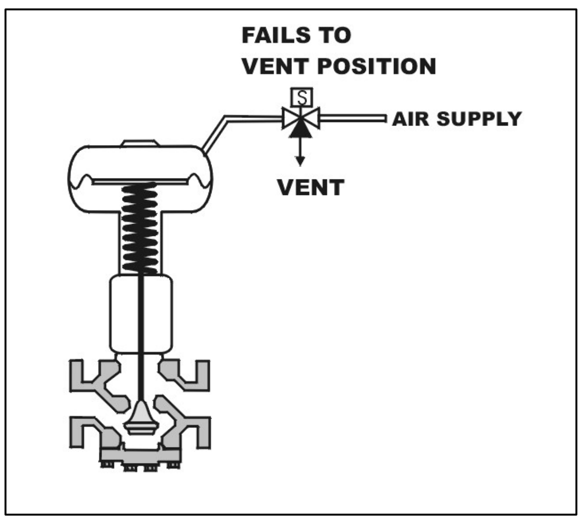
A. Midposition

B. Closed

C. As is

D. Open

ANSWER: B.



TOPIC: Valves

Refer to the drawing of a hydraulically-operated valve that is shown in a throttled position (see figure below).

Select the final position of this valve following a loss of hydraulic system pressure.

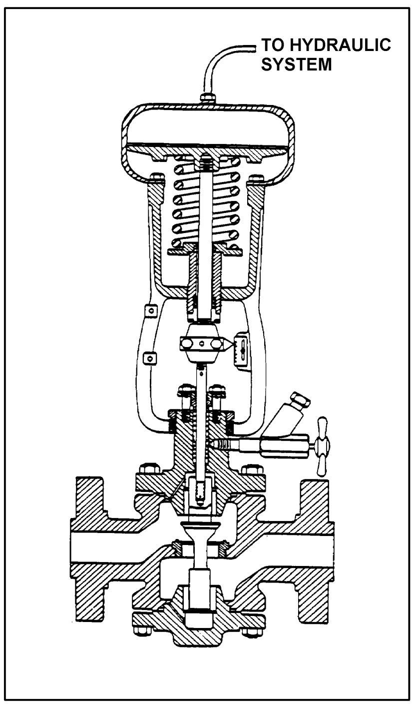
A. Fully open

B. As is

C. Fully closed

D. Midposition

ANSWER: A.



TOPIC: Valves

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

The figure currently depicts normal air supply pressure and an energized solenoid. What will be the valve position following a loss of electrical power to the solenoid?

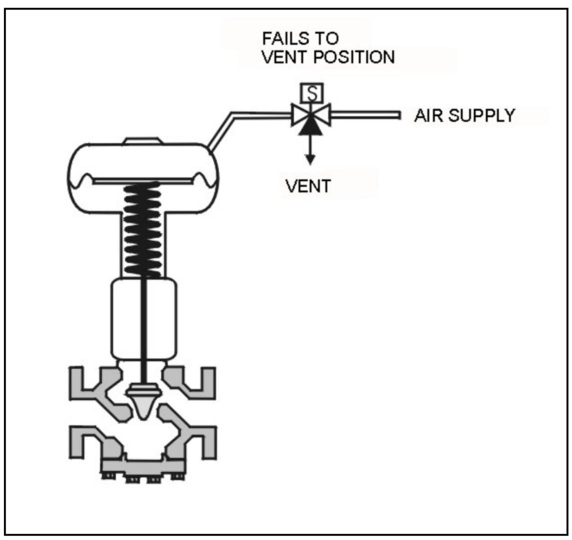
A. As is

B. More open

C. More closed

D. Varies with system flow

ANSWER: B.



TOPIC: Valves

How will a typical motor-operated valve respond to a loss of electrical power to the valve actuator?

A. Open fully

B. Close fully

C. Remain as is

D. Move to 50 percent open

ANSWER: C.

TOPIC: Valves

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?

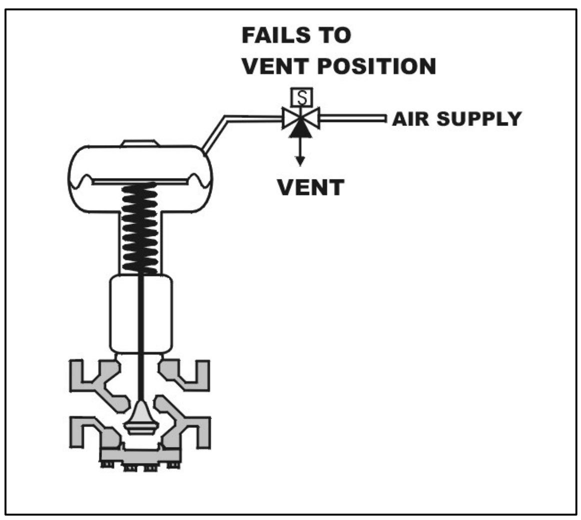
A. Original position

B. More closed

C. More open

D. Varies with system flow

ANSWER: B.



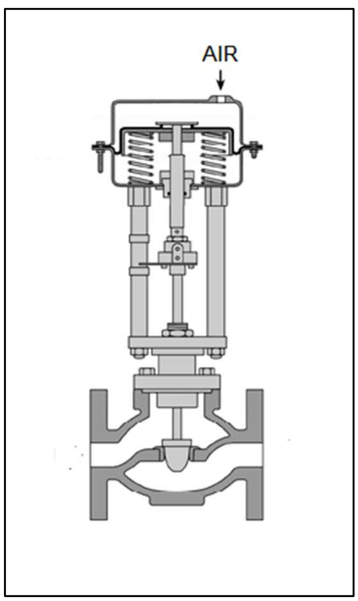
TOPIC: Valves

Refer to the drawing of a pneumatically-operated valve (see figure below). The valve actuator may be shown with or without air pressure applied to it.

Which one of the following describes the type of valve shown, and the fail position on loss of air to the actuator?

	Valve Type	Fail Position
A.	Gate	Open
B.	Gate	Closed
C.	Globe	Open
D.	Globe	Closed

ANSWER: C.



TOPIC: Valves

Refer to the drawing of four air-operated valves (see figure below). **Note:** The valve actuators may be shown with or without air pressure applied.

Given:

- The direction of system flow is from left to right when the valves are open.
- The internal components for each valve are identical except for the orientation of the valve disk and seat.
- The valve actuators exert the same force on the attached valve stem for a given applied air pressure.

If each actuator is vented, which valve disk will remain closed with the most force?

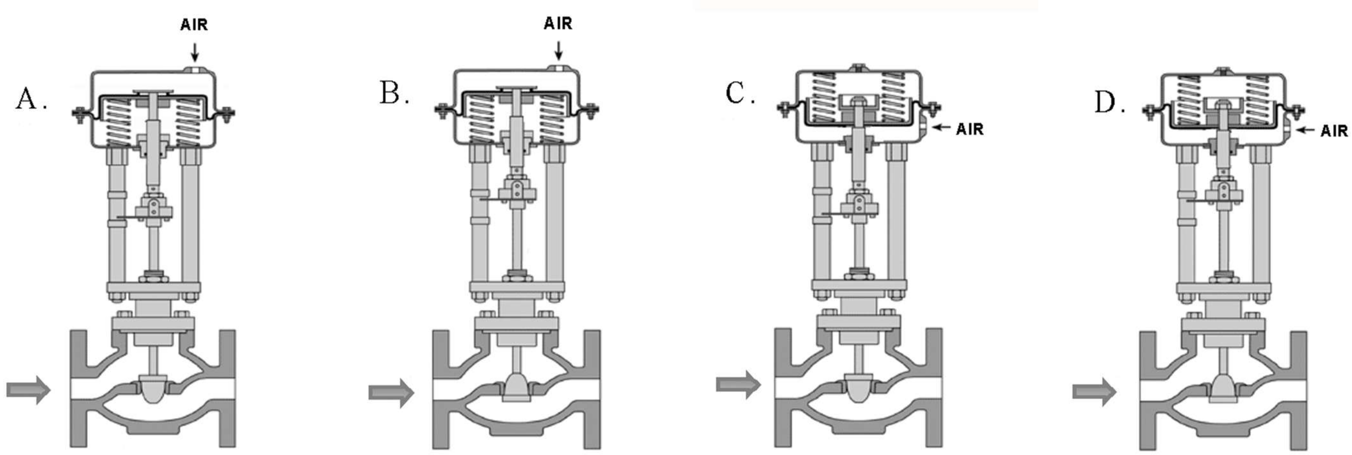
A. A.

B. B.

C. C.

D. D.

ANSWER: C.



TOPIC: Valves

Refer to the drawing of four air-operated valves (see figure below). The valve actuators may be shown with or without air pressure applied.

Which valves are currently shown in their failed (i.e., no air pressure applied to the actuator) positions?

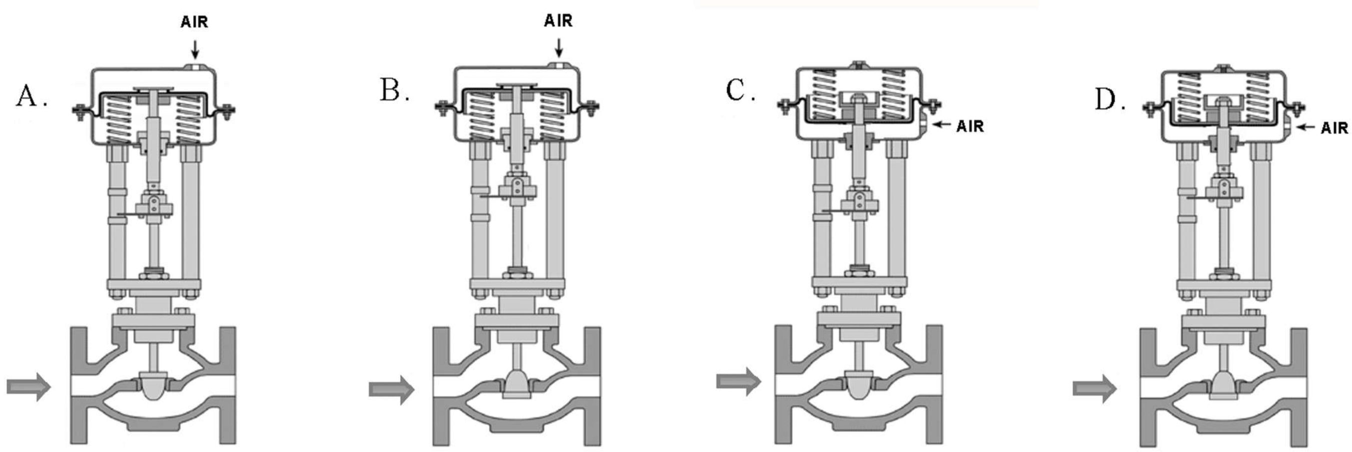
A. A and B

B. B and C

C. C and D

D. D and A

ANSWER: B.



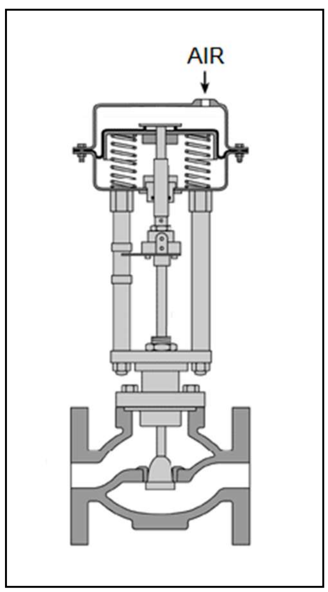
TOPIC: Valves

Refer to the drawing of a pneumatically-operated valve (see figure below). The valve actuator may be shown with or without applied air pressure.

Which one of the following describes the type of valve shown, and the valve's fail position on loss of air to the actuator?

	Valve Type	Fail Position
A.	Ball	Open
B.	Ball	Closed
C.	Globe	Open
D.	Globe	Closed

ANSWER: D.



TOPIC: Valves

An operator attempts to close a fully-open upright manual gate valve to isolate a pump in a cooling water system that has been cooled down for maintenance. However, the operator is unable to rotate the handwheel in the close direction.

Which one of the following could cause this condition?

A. A hydraulic lock has developed under the valve disk.

B. A hydraulic lock has developed in the valve bonnet between the valve disk and the packing gland.

C. The two halves of the valve disk have expanded and are jammed against the valve seats.

D. The valve disk has jammed against its backseat by the difference in the thermal contraction of the stem and the bonnet.

ANSWER: D.

TOPIC: Valves

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

A. The valve may bind during subsequent operation.

B. The valve stem limit switch settings may become inaccurate.

C. The clutch may <u>not</u> reengage the valve motor when required.

D. The stem position may no longer be an accurate indicator of valve position.

ANSWER: A.

TOPIC: Valves

After an adjustment of the packing gland on a valve that had a minor packing leak, an operator attempts to operate the valve, but finds 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.

ANSWER: D.

TOPIC: Valves

An adjustment has just been completed on the packing gland of a motor-operated gate valve to stop a minor stem leak. Which one of the following can occur if the technician overtightened the packing gland?

A. Decreased cooling flow to the valve internals.

B. Separation of the valve disk from the valve stem.

C. Misalignment of the valve position limit switches.

D. Increased stroke time from fully open to fully closed.

ANSWER: D.

TOPIC: Valves

Which one of the following describes the function and use of the backseat on a manual valve?

A. Removes pressure from the packing/stuffing box and is typically used to isolate the stuffing box for valve repacking.

B. Removes pressure from the packing/stuffing box and is typically used when needed to isolate packing leakage.

C. Acts as a backup in case the primary seat leaks and is typically used during system isolation for personnel protection.

D. Acts as a backup in case the primary seat leaks and is typically used when needed to prevent the primary seat from leaking excessively.

ANSWER: B.

TOPIC: Valves

When manually closing a motor-operated valve, why must the operator avoid using excessive valve seating force?

A. The valve may bind and cause the motor to trip on overload during subsequent remote operation.

B. The valve actuator clutch may be damaged and disable subsequent remote operation.

C. The valve stem limit switches may be damaged and cause inaccurate remote valve position indication.

D. The valve actuator position indicator may be damaged and cause inaccurate local valve position indication.

ANSWER: A.

TOPIC: Valves

Refer to the drawing of a water supply pump with two suction sources (see figure below). All motor-operated valves (MOVs) are currently closed.

Which one of the following MOV interlocks will permit the pump to take a suction on either the building sump or the water storage tank, while preventing the two sources from being cross-connected?

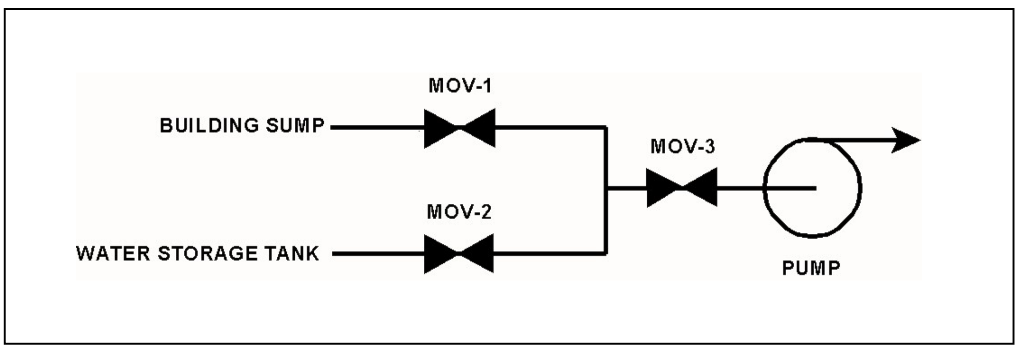
A. Neither MOV-1 nor MOV-2 can be opened unless MOV-3 is fully closed.

B. None of the MOVs can be opened unless at least one MOV remains fully closed.

C. None of the MOVs can be opened unless at least two MOVs remain fully closed.

D. Neither MOV-1 nor MOV-2 can be opened unless the other source MOV is fully closed.

ANSWER: D.



TOPIC: Valves

Refer to the drawing of two valves used in a high temperature water system (see figure below). Both valves are currently closed, as shown in the figure.

The valve that is more likely to become stuck due to mechanical binding as the valve cools down is number _____; and the valve that is more likely to become stuck due to a pressure lock as the valve heats up is number _____.

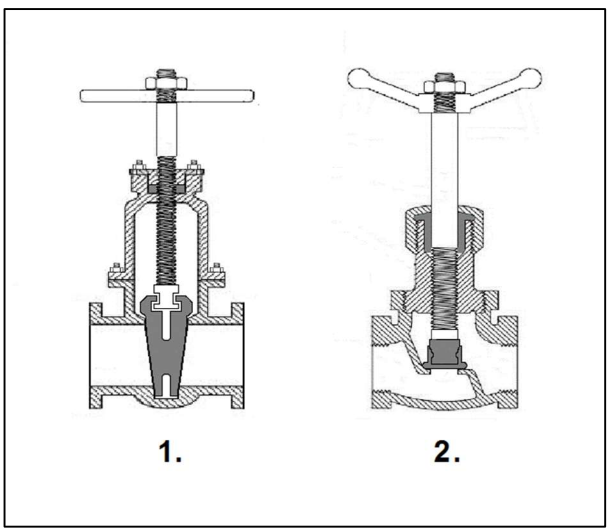
A. 1; 1

B. 1; 2

C. 2; 1

D. 2; 2

ANSWER: A.



TOPIC: Valves

After manually positioning a typical motor-operated valve, the valve actuator motor is <u>reengaged</u> by...

A. taking the manual declutch lever to the disengage position.

B. taking the manual declutch lever to the engage position.

C. racking in the valve actuator motor breaker.

D. energizing the valve actuator motor.

ANSWER: D.

TOPIC: Valves

When the manual declutch lever of a motor-operated valve is moved out of the normal position, it __________ the motor and __________ the handwheel.

A. engages; engages

B. engages; disengages

C. disengages; engages

D. disengages; disengages

ANSWER: C.

TOPIC: Valves

A typical motor-operated valve with a declutch lever is installed in a system. An actuation signal is designed to energize the valve motor and open the valve. The valve is currently open, but being manually/locally closed by a technician as required by a surveillance test procedure. The declutch lever has been operated and released, and the valve is being closed by operation of the valve handwheel.

If an actuation signal is received, how will the valve be affected?

A. The handwheel will disengage and the valve will automatically open.

B. The handwheel will disengage and the valve will remain in the current position.

C. The handwheel will remain engaged and the valve will automatically open.

D. The handwheel will remain engaged and the technician can continue to close the valve.

ANSWER: A.

TOPIC: Valves

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

How will the valve be affected by the actuation signal?

A. The handwheel will disengage and the valve will automatically close.

B. The handwheel will disengage and the valve will remain in the current position.

C. The handwheel will remain engaged and the valve will automatically close.

D. The handwheel will remain engaged and the technician can continue to open the valve.

ANSWER: A.

TOPIC: Valves

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

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

A. The handwheel will turn, but the valve stem will <u>not</u> move.

B. The handwheel will <u>not</u> turn, and the valve stem will <u>not</u> move.

C. The handwheel will turn, and the valve stem will move toward the closed position because the clutch is automatically engaged when the handwheel is turned.

D. The handwheel will turn, and the valve stem will move toward the closed position because the clutch is automatically engaged when the breaker is opened.

ANSWER: A.

TOPIC: Valves

Which one of the following types of similarly sized valves requires the <u>most</u> manual valve stem rotation to move the valve from fully open to fully closed? (Assume that each valve has a non-rising stem.)

A. Ball

B. Gate

C. Plug

D. Butterfly

ANSWER: B.

TOPIC: Valves

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.

ANSWER: B.

TOPIC: Valves

Which one of the following valves is used to control the direction of fluid flow and prevent backflow in a system?

A. Safety valve

B. Relief valve

C. Divert valve

D. Check valve

ANSWER: D.

TOPIC: Valves

Two common types of check valves used in nuclear power plants are...

A. globe and gate.

B. ball and plug.

C. swing and lift.

D. needle and angle.

ANSWER: C.

TOPIC: Valves

A typical check valve is designed to...

A. permit flow in only one direction.

B. prevent system overpressure.

C. isolate system components.

D. perform automatic pump venting.

ANSWER: A.

TOPIC: Valves

Check valves are normally used to prevent...

A. overpressurization of nonoperating system piping and components.

B. backflow through nonoperating components or flowpaths.

C. pump runout by providing a constant backpressure.

D. pump cavitation by keeping nonoperating systems filled.

ANSWER: B.

TOPIC: Valves

Which one of the following is the type of valve used to control the direction of fluid flow through a system and prevent backflow?

A. Butterfly valve

B. Gate valve

C. Globe valve

D. Check valve

ANSWER: D.

TOPIC: Valves

To verify that a manual valve in a pressurized water system is closed, the operator should observe valve position indication and operate the valve handwheel in the...

A. close direction using normal force, and verify there is no substantial handwheel movement.

B. close direction using normal force, then turn the handwheel an additional one-half turn using additional force if necessary.

C. open direction until flow sounds are heard, then close the valve using normal force until the handwheel stops moving.

D. open direction until the valve stem moves, then close the valve using normal force until the handwheel stops moving.

ANSWER: A.

TOPIC: Valves

To verify the position of a fully open manual valve in an operating system, the operator should operate the valve handwheel...

A. in the open direction until the valve is backseated one-half turn.

B. to fully close the valve, then open the valve to the fully open position.

C. in the closed direction, then open the valve to its previously open position.

D. to open the valve until it touches the backseat, then close the valve to the desired position.

ANSWER: C.

TOPIC: Valves

Consider a typical gate valve and a typical globe valve in the same water system application. The globe valve generally has a __________ pressure drop when fully open; and is __________ commonly used for throttling system flow.

A. smaller; less

B. larger; more

C. smaller; more

D. larger; less

ANSWER: B.

TOPIC: Valves

Gate valves should not be used to throttle fluid flow because...

A. the tortuous flow path through a gate valve body makes flow control difficult.

B. gate valves must be fully opened and backseated to prevent stem leakage.

C. the turbulent flow created by a partially opened gate valve will cause erosion damage to the valve seat.

D. the large size of the gate valve disk requires an oversized actuator to accurately position the disk.

ANSWER: C.

TOPIC: Valves

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

Which one of the following describes the type of valve shown?

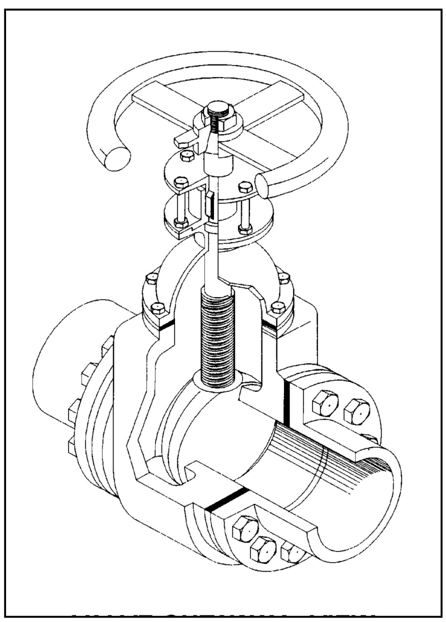
A. Rising-stem globe valve

B. Nonrising-stem globe valve

C. Rising-stem gate valve

D. Nonrising-stem gate valve

ANSWER: D.



TOPIC: Valves

Consider a 3-inch gate valve and a 3-inch globe valve in the same flowing water system application. If both valves are fully open, the globe valve produces the __________ head loss and the __________ flow rate.

A. larger; larger

B. larger; smaller

C. smaller; larger

D. smaller; smaller

ANSWER: B.

TOPIC: Valves

Which one of the following is a generally accepted method for locally verifying that a manual valve is fully closed in a depressurized static piping system?

A. Check a downstream flow gauge to be indicating zero flow.

B. Visually observe the valve rising-stem threading to be fully exposed.

C. Attempt to turn the valve handwheel in the close direction and verify no movement.

D. Compare an upstream and downstream pressure gauge to ensure zero differential pressure.

ANSWER: C.

TOPIC: Valves

In a comparison between a typical gate valve and a typical globe valve in the same water system application with both valves fully open, the gate valve has a __________ pressure drop and is normally used in __________ flow applications.

A. larger; throttling

B. larger; on/off

C. smaller; throttling

D. smaller; on/off

ANSWER: D.

TOPIC: Valves

To verify a manual valve in an operating system is closed, the operator should observe valve position indication and operate the valve handwheel in the...

A. open direction at least one full rotation, then close the valve using normal force.

B. open direction until system flow is observed, then close the valve using normal force.

C. close direction using normal force and verify there is no substantial handwheel movement.

D. close direction using normal force, then operate the valve handwheel an additional one-quarter turn in the close direction.

ANSWER: C.

TOPIC: Valves

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

A. The tortuous flow path through a throttled gate valve body makes flow control difficult.

B. A gate valve will experience stem leakage unless it is fully opened and backseated.

C. The turbulent flow created by a throttled gate valve will cause erosion damage to the valve seat.

D. A fully-open gate valve will produce a greater system head loss than a fully-open globe valve.

ANSWER: C.

TOPIC: Valves

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 close direction during the packing gland adjustment.

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

ANSWER: D.

TOPIC: Valves

Which one of the following is <u>not</u> a generally accepted method for locally verifying that a valve is open?

A. Observe local flow rate instrumentation.

B. Check the local valve position indicator indicates OPEN.

C. Turn the valve operator in the close direction and verify that some movement occurs.

D. Attempt to turn the valve operator in the open direction and verify that no movement occurs.

ANSWER: D.

TOPIC: Valves

Why are gate valves generally <u>not</u> used to throttle water flow?

A. Rapid changes in flow direction inside the valve cause a large unrecoverable system head loss.

B. Gate valves experience stem leakage unless they are fully open or fully closed.

C. The turbulent flow created by a partially opened gate valve causes excessive seat and disk wear.

D. Flow rate through a gate valve is <u>not</u> proportional to the differential pressure across the valve.

ANSWER: C.

TOPIC: Valves

In a comparison between globe valves and gate valves in the same water system application, globe valves...

A. are less effective at throttling flow.

B. are less effective as pressure regulating valves.

C. produce a smaller pressure decrease when fully open.

D. require less force to open against large differential pressures.

ANSWER: D.

TOPIC: Valves

In a comparison between gate valves and globe valves in the same water system application, gate valves...

A. are more effective at throttling flow.

B. are more effective as pressure regulating valves.

C. produce a larger pressure decrease when fully open.

D. require more force to open against large differential pressures.

ANSWER: D.

TOPIC: Valves

In a comparison between butterfly valves and ball valves, __________ valves are generally more leak- tight in high pressure applications; and __________ valves generally exhibit the smaller pressure decrease when fully open.

A. ball; ball

B. ball; butterfly

C. butterfly; ball

D. butterfly; butterfly

ANSWER: A.

TOPIC: Valves

A gate valve is generally a poor choice for throttling fluid flow because...

A. the turbulent flow created by a partially opened gate valve can cause extensive damage to the valve.

B. the tortuous path through a gate valve body can make flow control difficult.

C. excessive stem leakage will result unless the gate valve is fully open or fully closed.

D. the head loss from a throttled gate valve will result in an unacceptable reduction in system flow rate.

ANSWER: A.

TOPIC: Valves

In a comparison between ball valves and butterfly valves in the same water system application, the valve that typically would allow more leakage when fully closed with a high differential pressure is the __________ valve; and the valve that typically would cause the greater pressure loss when fully open is the __________ valve.

A. ball; butterfly

B. ball; ball

C. butterfly; butterfly

D. butterfly; ball

ANSWER: C.

TOPIC: Valves

A typical motor-operated valve has been returned to service following a complete maintenance overhaul of the valve and actuator. The valve was remotely opened and closed to verify operability. The measured valve stroke time in each direction was 15 seconds, which is 25 percent longer than normal.

Which one of the following could have caused the increased stroke time?

A. The valve position limit switches were removed and were <u>not</u> reinstalled.

B. The valve torque limit switches were misadjusted to open at half their normal setpoints.

C. The valve was packed with improved packing material having a lower friction coefficient.

D. The valve stem packing gland was overtightened after the packing material was replaced.

ANSWER: D.

TOPIC: Valves

In a comparison between ball valves and butterfly valves in the same water system application, the valve that would typically be more leak-tight when fully closed with a high differential pressure is the __________ valve; and the valve that typically results in the greater pressure decrease when fully open is the __________ valve.

A. ball; butterfly

B. ball; ball

C. butterfly; butterfly

D. butterfly; ball

ANSWER: A.

TOPIC: Valves

In a comparison between ball valves and butterfly valves in the same cooling water system application, the valve that would typically experience the greater seat leakage when fully closed with a large differential pressure is the __________ valve; and the valve that would typically cause the smaller head loss when fully open is the __________ valve.

A. ball; butterfly

B. ball; ball

C. butterfly; butterfly

D. butterfly; ball

ANSWER: D.

TOPIC: Valves

During a local inspection of a manually-operated 12-inch gate valve, the valve stem is observed to extend outward from the valve handwheel by 1 inch. The entire external valve stem is threaded, except for a 1-inch section that becomes smooth just before the valve stem enters the packing gland.

Which one of the following describes the position of the gate valve?

A. The valve is fully open, or nearly fully open.

B. The valve is fully closed, or nearly fully closed.

C. The valve may be in any position, because it is a rising stem gate valve.

D. The valve may be in any position, because it is a non-rising stem gate valve.

ANSWER: B.

TOPIC: Valves

A typical motor-operated valve has been returned to service following a complete maintenance overhaul of the valve and actuator. When the valve was remotely opened and closed to verify operability, the measured valve stroke time in each direction was 15 seconds, which is shorter than normal for this valve.

Which one of the following could have caused the shorter stroke time?

A. The valve position limit switches were removed and were not reinstalled.

B. The valve torque limit switches were misadjusted to open at twice their normal setpoints.

C. The valve was packed with improved packing material having a lower friction coefficient.

D. The valve stem packing gland was overtightened after the packing material was replaced.

ANSWER: C.

TOPIC: Valves

During a local inspection of a manually operated three-inch gate valve, the valve stem is observed to be flush with the top of the handwheel. Two inches of unthreaded valve stem is visible between the handwheel and the packing gland. The handwheel is mounted to the valve body and valve stem such that the handwheel can be rotated in either direction, but <u>cannot</u> change its axial position.

Which one of the following describes the position of the valve?

A. The valve is fully open or nearly fully open.

B. The valve is fully closed or nearly fully closed.

C. The valve may be in any position because it has a rising stem.

D. The valve may be in any position because it has a non-rising stem.

ANSWER: D.

TOPIC: Sensors and Detectors

For water flowing through a venturi, there is a proportional relationship between flow rate and differential pressure. For steam flowing through a venturi, the relationship must be modified to account for changes in __________ as the steam flows through the venturi.

A. velocity

B. enthalpy

C. internal energy

D. specific volume

ANSWER: D.

TOPIC: Sensors and Detectors

The most probable cause for fluctuating indication from a liquid flow rate differential pressure detector is...

A. gas or steam being trapped in the liquid.

B. unequal temperature gradients in the liquid.

C. vortexing of the liquid passing through the flow device.

D. the valve on the high pressure sensing line being partially closed.

ANSWER: A.

TOPIC: Sensors and Detectors

A properly calibrated differential pressure-type water flow detector is located several feet below a horizontal pipe containing the detector's sensing element. The detector was removed for inspection and then reconnected to the sensing element with its low-pressure sensing line filled with air and its high-pressure sensing line filled with water.

When the water system is operating, indicated flow rate will be...

A. zero.

B. equal to actual flow rate.

C. lower than actual flow rate.

D. higher than actual flow rate.

ANSWER: D.

TOPIC: Sensors and Detectors

How will flow rate indication be affected if the equalizing valve for the associated differential pressure detector is fully opened?

A. Increase temporarily, and then return to the initial value.

B. Decrease temporarily, and then return to the initial value.

C. Increase to the maximum value.

D. Decrease to the minimum value.

ANSWER: D.

TOPIC: Sensors and Detectors

A differential pressure flow detector is connected to a calibrated orifice in a cooling water system. Which one of the following will cause indicated volumetric flow rate to be lower than actual volumetric flow rate?

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.

ANSWER: B.

TOPIC: Sensors and Detectors

Flow rate is being measured using a differential pressure flow detector and a calibrated orifice. If actual flow rate remains constant, which one of the following will cause indicated flow rate to be higher than actual flow rate?

A. The flow detector equalizing valve is inadvertently opened.

B. A leak develops in the high pressure sensing line.

C. Debris becomes lodged in the orifice.

D. The orifice erodes over time.

ANSWER: C.

TOPIC: Sensors and Detectors

Refer to the drawing of a pipe elbow used for flow measurement in a cooling water system (see figure below).

A differential pressure (D/P) flow detector is connected to instrument lines A and B.

If instrument line A develops a leak, indicated flow rate will __________ due to a __________ measured D/P.

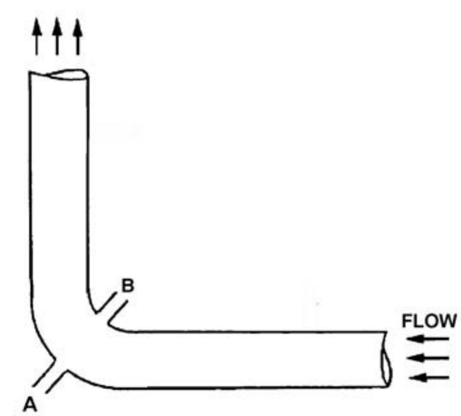
A. increase; larger

B. increase; smaller

C. decrease; larger

D. decrease; smaller

ANSWER: D.



PIPE ELBOW - TOP VIEW

TOPIC: Sensors and Detectors

If the orifice in a differential pressure (D/P) flow sensor erodes such that the orifice opening becomes larger, indicated flow rate will __________ due to a __________ D/P across the orifice. (Assume actual flow rate remains the same.)

A. increase; larger

B. increase; smaller

C. decrease; larger

D. decrease; smaller

ANSWER: D.

TOPIC: Sensors and Detectors

Refer to the drawing of a horizontal pipe elbow (top view) in an operating water system (see figure below).

Three separate differential pressure flow detectors are connected to taps A, B, C, and D as follows:

Detector	Taps
X	A and D
Y	B and D
Z	C and D

Assuming zero head loss in this section of pipe, how will the detectors be affected if tap D ruptures?

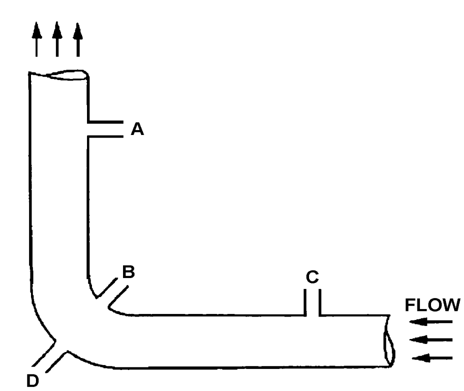
A. All detectors will fail low.

B. All detectors will fail high.

C. Two detectors will fail low and one will fail high.

D. Two detectors will fail high and one will fail low.

ANSWER: A.



PIPE ELBOW - TOP VIEW

TOPIC: Sensors and Detectors

Refer to the drawing of a pipe elbow used for flow measurement in a cooling water system (see figure below).

A differential pressure (D/P) flow detector is connected to instrument lines A and B.

If instrument line B develops a leak, indicated flow rate will __________ due to a __________ measured D/P.

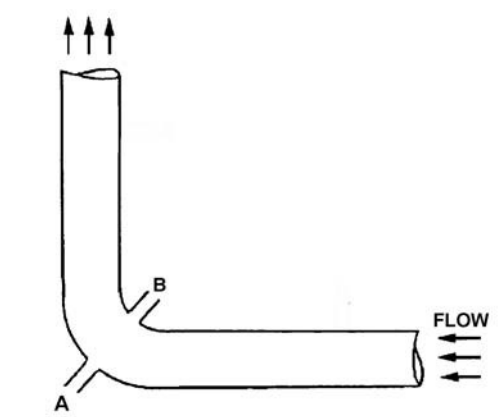
A. increase; larger

B. increase; smaller

C. decrease; larger

D. decrease; smaller

ANSWER: A.



PIPE ELBOW - TOP VIEW

TOPIC: Sensors and Detectors

An orifice is being used in an operating cooling water system to measure flow rate. Which one of the following will cause the differential pressure sensed across the orifice to decrease?

A. System pressure decreases.

B. System flow rate decreases.

C. Debris becomes lodged in the orifice.

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

ANSWER: B.

TOPIC: Sensors and Detectors

Refer to the drawing of a horizontal pipe elbow (top view) in an operating water system (see figure below). Three separate bellows differential pressure flow detectors are connected to taps A, B, C, and D as follows:

Detector	Taps
X	A and D
Y	B and D
Z	C and D

Assume that water is incompressible and there is no head loss in this section of pipe. How will the detectors be affected if system flow rate remains the same while system pressure increases from 1000 psig to 1200 psig?

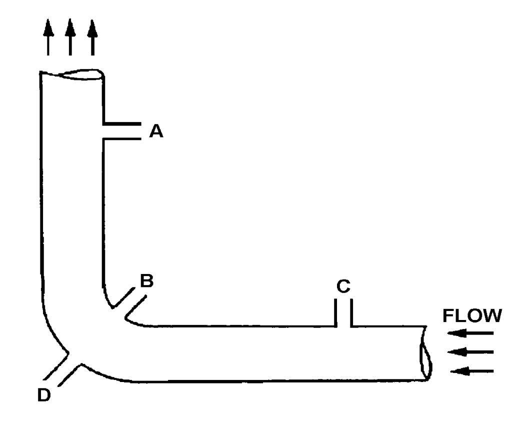
A. All detectors will indicate higher flow.

B. Only two detectors will indicate higher flow.

C. Only one detector will indicate higher flow.

D. Detector indication will not change.

ANSWER: D.



PIPE ELBOW - TOP VIEW

TOPIC: Sensors and Detectors

Refer to the drawing of a pipe elbow (top view) in an operating water system (see figure below).

At which one of the following locations is the highest pressure sensed? (Assume a constant pipe diameter and zero head loss in this section of pipe.)

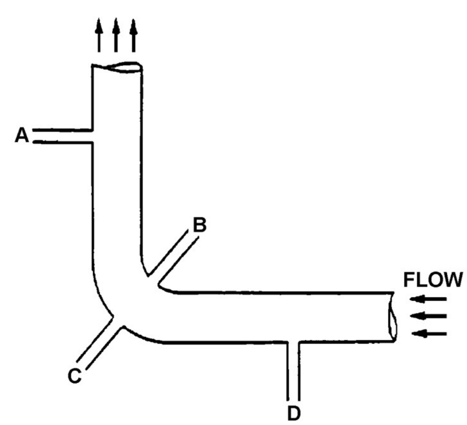
A. Point A

B. Point B

C. Point C

D. Point D

ANSWER: C.



PIPE ELBOW - TOP VIEW

TOPIC: Sensors and Detectors

Refer to the drawing of a horizontal pipe elbow (top view) in an operating water system (see figure below).

Three separate bellows-type differential pressure flow detectors are connected to taps A, B, C, and D as follows:

Detector	Taps
X	A and D
Y	B and D
Z	C and D

Assuming zero head loss in this section of pipe, how will the detectors be affected if tap B experiences a significant leak? (Assume water system pressure does <u>not</u> change.)

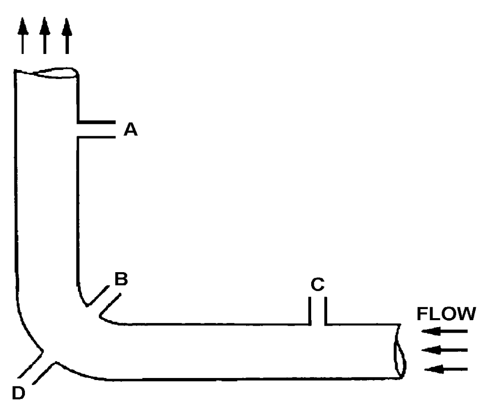
A. All detectors will fail low.

B. All detectors will fail high.

C. Only one detector will fail, and it will fail low.

D. Only one detector will fail, and it will fail high.

ANSWER: D.



PIPE ELBOW - TOP VIEW

TOPIC: Sensors and Detectors

Flow detectors (such as an orifice, flow nozzle, and venturi tube) measure flow rate using the principle that the flow rate of a liquid is...

A. directly proportional to the differential pressure (D/P) squared.

B. inversely proportional to the D/P squared.

C. directly proportional to the square root of the D/P.

D. inversely proportional to the square root of the D/P.

ANSWER: C.

TOPIC: Sensors and Detectors

A cooling water system is operating at steady-state conditions indicating 900 gpm with 60 psid across the flow transmitter venturi. If cooling water flow rate is increased to 1,800 gpm, differential pressure across the flow transmitter venturi will be approximately...

A. 85 psid.

B. 120 psid.

C. 175 psid.

D. 240 psid.

ANSWER: D.

TOPIC: Sensors and Detectors

The flow rate of water passing through a venturi can be determined by measuring the...

A. differential pressure of the water as it passes through the venturi.

B. change in the velocity of the water as it passes through the venturi.

C. linear displacement of a metering plug installed in the throat of the venturi.

D. rotation rate of a paddle wheel-type device installed in the throat of the venturi.

ANSWER: A.

TOPIC: Sensors and Detectors

A cooling water system is operating at a steady-state flow rate of 700 gpm with 60 psid across the flow transmitter venturi. If cooling water flow rate is increased to 1,000 gpm, differential pressure across the flow transmitter venturi will be...

A. 85.7 psid.

B. 122.4 psid.

C. 171.4 psid.

D. 244.8 psid.

ANSWER: B.

TOPIC: Sensors and Detectors

Refer to the drawing of a venturi flow element (see figure below) with direction of water flow indicated by the arrow.

Where should the high pressure tap of a differential pressure flow detector be connected?

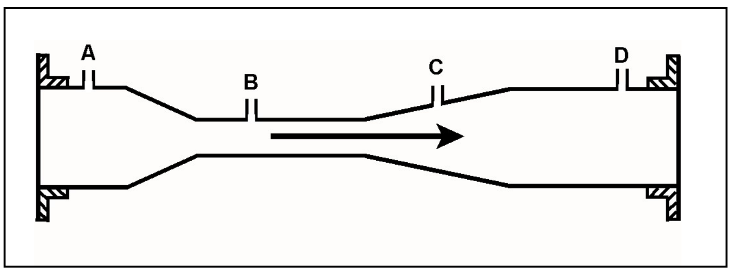
A. Point A

B. Point B

C. Point C

D. Point D

ANSWER: A.



TOPIC: Sensors and Detectors

Which one of the following flow measuring elements produces the largest unrecoverable head loss when used in an operating fluid system?

A. Venturi

B. Flow nozzle

C. Pipe elbow

D. Orifice

ANSWER: D.

TOPIC: Sensors and Detectors

Refer to the drawing of a venturi flow element in an operating cooling water system (see figure below).

At what point does the lowest pressure occur?

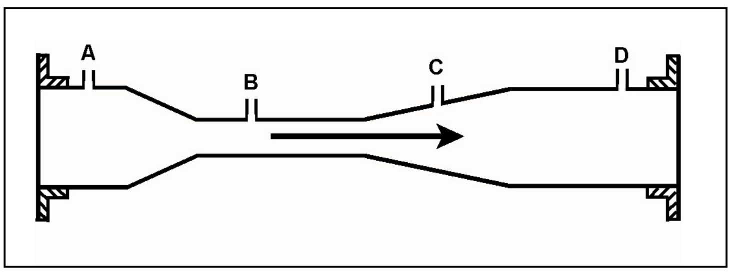
A. Point A

B. Point B

C. Point C

D. Point D

ANSWER: B.



TOPIC: Sensors and Detectors

Refer to the drawing of a venturi flow element in an operating cooling water system (see figure below).

A differential pressure detector measuring flow rate through the venturi will produce the <u>highest</u> flow rate indication if its high-pressure tap is connected at point _____; and its low-pressure tap is connected at point _____.

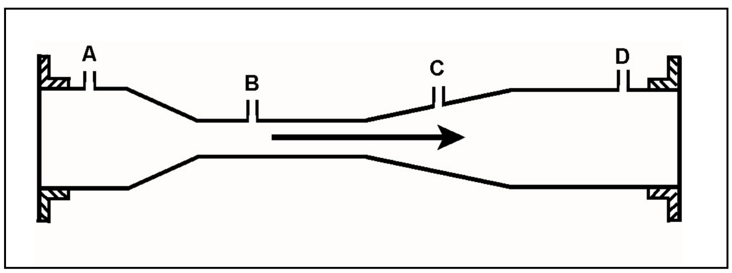
A. A; B

B. A; D

C. B; C

D. B; D

ANSWER: A.



TOPIC: Sensors and Detectors

A cooling water system is operating at a steady-state flow rate of 500 gpm with 60 psid across the associated venturi flow element. If cooling water flow rate increases to 1,000 gpm, the differential pressure sensed by the venturi flow element will be approximately...

A. 85 psid.

B. 120 psid.

C. 240 psid.

D. 480 psid.

ANSWER: C.

TOPIC: Sensors and Detectors

Refer to the drawing of a convergent-divergent venturi (see figure below). Subcooled water is flowing through the venturi, and the pipe diameters at P1 and P2 are equal.

Compared to the conditions at the inlet of the venturi (P1), the pressure at the outlet of the venturi (P2) is __________; and the water velocity at the outlet of the venturi is __________.

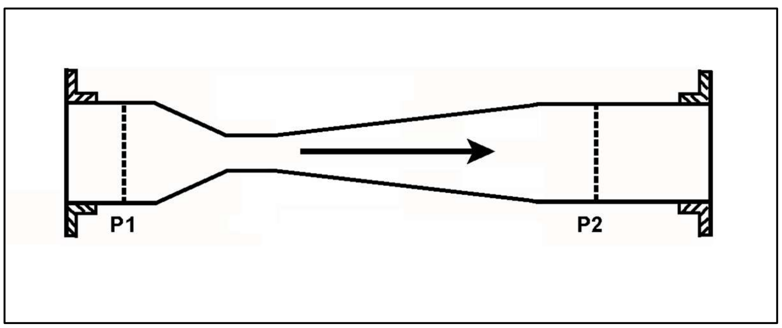
A. the same; the same

B. the same; slightly lower

C. slightly lower; the same

D. slightly lower; slightly lower

ANSWER: C.



TOPIC: Sensors and Detectors

Water is flowing through a venturi flow element. At the throat of the venturi, the __________ water pressure and the __________ water velocity occurs.

A. highest; highest

B. lowest; lowest

C. lowest; highest

D. highest; lowest

ANSWER: C.

TOPIC: Sensors and Detectors

Water is flowing through each of the following devices. Which one of the devices will produce an outlet pressure that is greater than the inlet pressure?

A. Convergent nozzle

B. Divergent nozzle

C. Orifice

D. Flow restrictor

ANSWER: B.

TOPIC: Sensors and Detectors

Refer to the drawing of a pipe elbow (top view) in an operating water system (see figure below).

At which one of the following pairs of connection points will the <u>greatest</u> differential pressure be sensed? (Assume a constant pipe diameter and zero head loss in this section of pipe.)

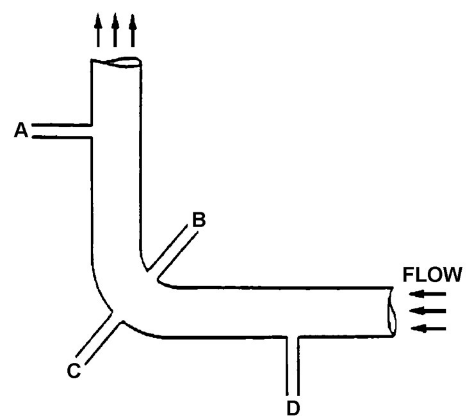
A. Points A and B

B. Points B and C

C. Points C and D

D. Points D and A

ANSWER: B.



PIPE ELBOW - TOP VIEW

TOPIC: Sensors and Detectors

A venturi is being used to measure the flow rate in a cooling water system. As the water flows from the throat to the discharge of the venturi, water pressure will __________; and volumetric flow rate will __________.

A. increase; remain the same

B. increase; increase

C. decrease; remain the same

D. decrease; decrease

ANSWER: A.

TOPIC: Sensors and Detectors

A cooling water system is operating at a steady-state flow rate of 700 gpm with 60 psid across the associated venturi flow element. If cooling water flow rate increases to 900 gpm, the differential pressure sensed by the venturi flow element will be approximately...

A. 68 psid.

B. 77 psid.

C. 99 psid.

D. 127 psid.

ANSWER: C.

TOPIC: Sensors and Detectors

A differential pressure detector is being used with an orifice plate to measure water flow rate through a pipe. When the flow detector was last calibrated, the following parameters were observed:

Upstream Pressure = 125 psig
Downstream Pressure = 116 psig

Actual Flow Rate = 100 gpm
Indicated Flow Rate = 100 gpm

Significant erosion of the orifice has occurred since the calibration such that actual flow rate through the orifice has increased to 120 gpm while the upstream and downstream pressures have changed to 110 psig and 106 psig respectively.

What is the approximate flow rate that is currently indicated?

A. 44 gpm

B. 67 gpm

C. 81 gpm

D. 120 gpm

ANSWER: B.

TOPIC: Sensors and Detectors

A cooling water system is operating at steady-state conditions at 900 gpm with 64 psid across the flow transmitter venturi. Cooling water flow rate changes such that venturi differential pressure decreases to 36 psid.

Which one of the following is the new system flow rate?

A. 506 gpm

B. 576 gpm

C. 675 gpm

D. 745 gpm

ANSWER: C.

TOPIC: Sensors and Detectors

A differential pressure detector is being used with an orifice plate to measure water flow rate through a pipe. When the flow detector was last calibrated, the following parameters were observed:

Upstream Pressure	=	135 psig
Downstream Pressure	=	120 psig
Actual Flow Rate	=	100 gpm
Indicated Flow Rate	=	100 gpm

Significant erosion of the orifice hole has occurred since the last calibration, such that actual flow rate through the orifice has increased to 120 gpm while the upstream and downstream pressures have changed to 124 psig and 109 psig respectively.

What is the currently indicated flow rate?

A. 44 gpm

B. 67 gpm

C. 100 gpm

D. 120 gpm

ANSWER: C.

TOPIC: Sensors and Detectors

A cooling water system uses a horizontal venturi with a differential pressure flow detector to provide flow rate indication. Water enters and leaves the venturi at 70°F, 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

ANSWER: A.

TOPIC: Sensors and Detectors

A cooling water system is operating at steady-state conditions. A calibrated system flow meter indicates 600 gpm with 50 psid across the flow element.

If cooling water flow rate increases to 900 gpm, the differential pressure sensed by the flow element will be approximately...

A. 63 psid.

B. 75 psid.

C. 97 psid.

D. 112 psid.

ANSWER: D.

TOPIC: Sensors and Detectors

The following is the current calibration data for an orifice plate that is being used for water flow rate measurement:

Upstream Pressure	= 135 psig
Downstream Pressure	= 120 psig
Flow Rate	= 100 gpm

During a surveillance, the following pressures are observed across the orifice plate:

Upstream Pressure	= 124 psig
Downstream Pressure	= 117 psig

What is the approximate water flow rate through the orifice plate?

A. 47 gpm

B. 57 gpm

C. 68 gpm

D. 78 gpm

ANSWER: C.

TOPIC: Sensors and Detectors

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

The manometer is filled with water and installed across an orifice in a ventilation duct to determine the rate of air flow. The manometer is currently indicating a water level difference of 16 inches at an air flow rate of 300 ft^3/min.

Which one of the following will be the approximate rate of air flow when the manometer indicates a water level difference of 4 inches?

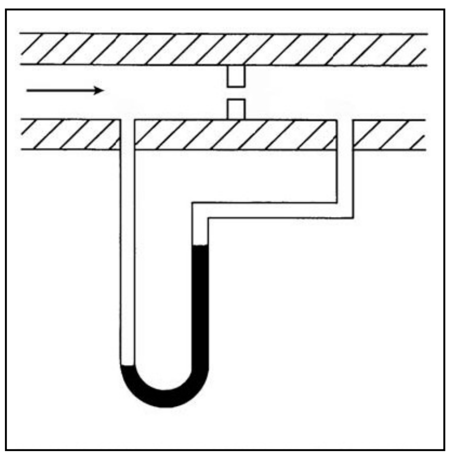
A. 75 ft^3/min.

B. 125 ft^3/min.

C. 150 ft^3/min.

D. 175 ft^3/min.

ANSWER: C.



TOPIC: Sensors and Detectors

A differential pressure detector is being used with an orifice plate to measure water flow rate through a pipe. When the flow instrument was last calibrated, the following parameters were observed:

Upstream Pressure	= 125 psig	Actual Flow Rate	= 100 gpm
Downstream Pressure	= 116 psig	Indicated Flow Rate	= 100 gpm

Since the calibration, debris has collected in the orifice such that the actual flow rate through the orifice has decreased to 80 gpm while the upstream and downstream pressures have changed to 135 psig and 110 psig, respectively.

What is the approximate flow rate that is currently indicated by the flow instrument?

A. 125 gpm

B. 133 gpm

C. 156 gpm

D. 167 gpm

ANSWER: D.

TOPIC: Sensors and Detectors

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

The manometer is filled with water and installed across an orifice in a ventilation duct to determine the rate of air flow. The manometer is currently indicating a water level difference of 8 inches at an air flow rate of 300 cubic feet per minute (ft^3/min).

Which one of the following will be the approximate air flow rate when the manometer indicates a water level difference of 4 inches?

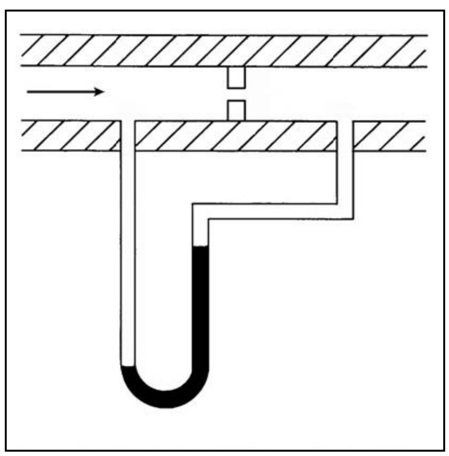
A. 75 ft^3/min

B. 150 ft^3/min

C. 188 ft^3/min

D. 212 ft^3/min

ANSWER: D.



TOPIC: Sensors and Detectors

A cooling water system uses a horizontal venturi with a differential pressure flow detector to provide 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 <u>no</u> 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

ANSWER: C.

TOPIC: Sensors and Detectors

Refer to the drawing of a frictionless venturi flow element (see figure below). Subcooled water is flowing through the venturi with the following initial conditions:

Flow rate = 500 gpm
Tap A pressure = 40 psia
Tap B pressure = 36 psia

Flow rate increases to 1,000 gpm, which results in a tap A pressure of 68 psia. What is the new pressure at tap B?

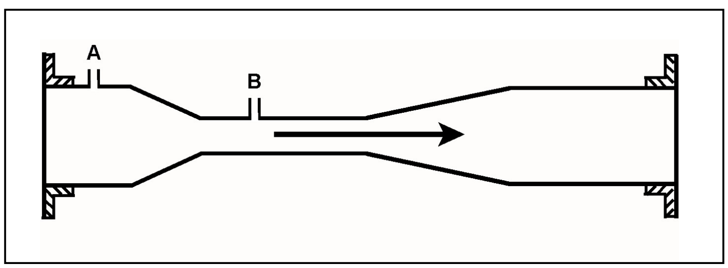
A. 60 psia

B. 52 psia

C. 44 psia

D. 32 psia

ANSWER: B.



TOPIC: Sensors and Detectors

Refer to the drawing of a frictionless venturi flow element (see figure below). Subcooled water is flowing through the venturi with the following initial conditions:

Flow rate = 500 gpm
Tap A pressure = 40 psia
Tap B pressure = 36 psia

When flow rate is increased to 750 gpm, the pressure at tap A increases to 68 psia. What is the new pressure at tap B?

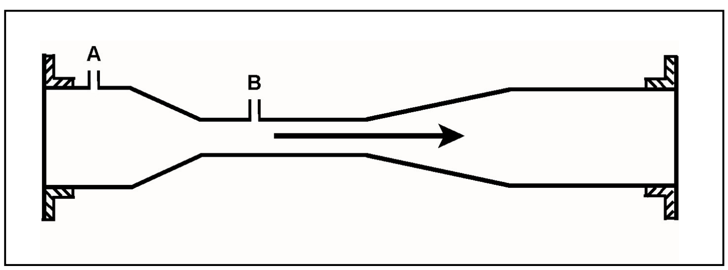
A. 66 psia

B. 62 psia

C. 59 psia

D. 52 psia

ANSWER: C.



TOPIC: Sensors and Detectors

Refer to the drawing of a frictionless venturi flow element (see figure below). Subcooled water is flowing through the venturi with the following initial conditions:

Flow rate = 500 gpm
Tap A pressure = 48 psia
Tap B pressure = 44 psia

When flow rate is increased to 900 gpm, the pressure at tap A increases to 62 psia. What is the new pressure at tap B?

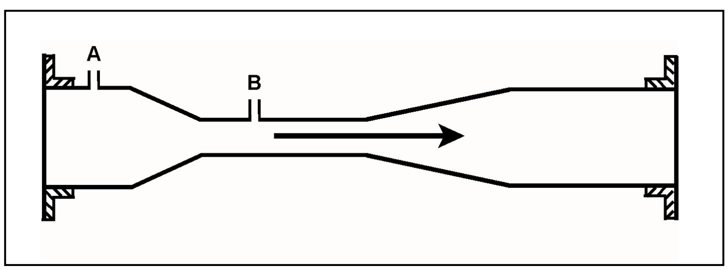
A. 46 psia

B. 49 psia

C. 55 psia

D. 60 psia

ANSWER: B.



TOPIC: Sensors and Detectors

Refer to the drawing of a water storage tank with a differential pressure (D/P) level detector (see figure below).

The associated level instrument was calibrated with the water storage tank at 100°F. If mass in the tank remains constant and the water temperature increases to 120°F, the indicated level will...

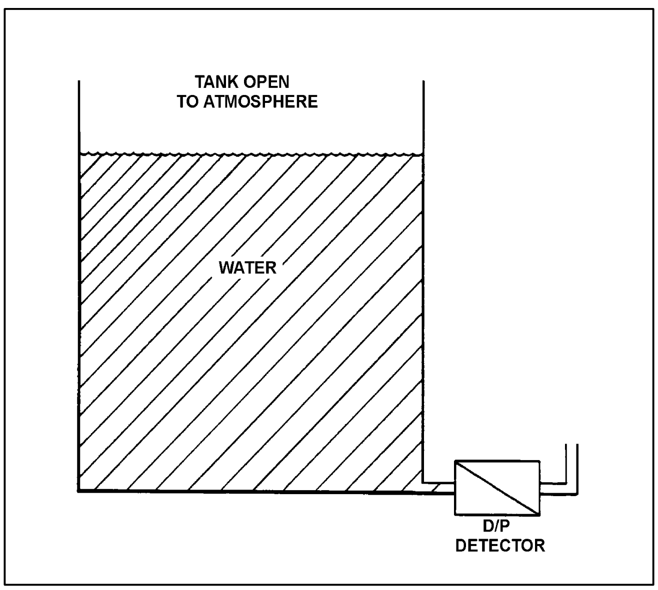
A. remain the same although actual level increases.

B. increase but remain less than actual level.

C. decrease in direct proportion to the temperature rise.

D. increase in direct proportion to the temperature rise.

ANSWER: A.



TOPIC: Sensors and Detectors

Refer to the drawing of a water storage tank with a differential pressure level detector that was recently calibrated at a tank water temperature of 80°F (see figure below).

If the mass of the water in the tank remains the same while the tank water temperature is raised from 80°F to 150°F, the <u>indicated</u> level will...

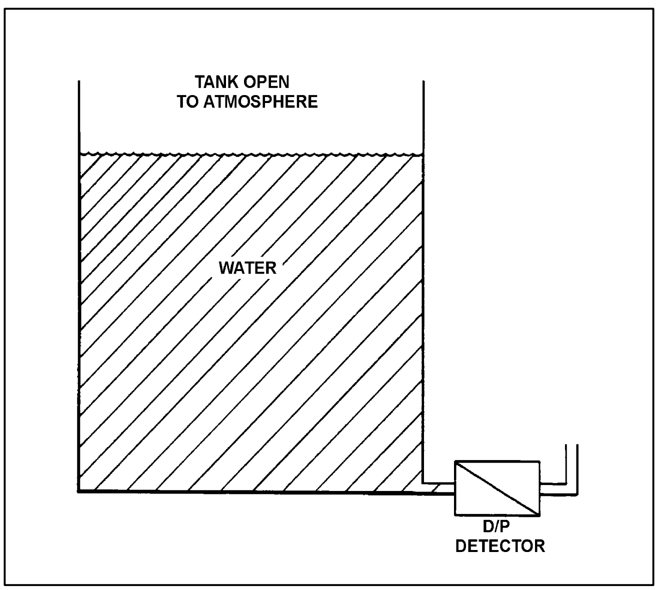
A. remain equal to actual level.

B. increase, due to the expansion of the water.

C. remain the same.

D. decrease, due to the expansion of the water.

ANSWER: C.



TOPIC: Sensors and Detectors

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

Two D/P level indicators are installed on a large water storage tank. Indicator 1 was calibrated at 100°F water temperature and indicator 2 was calibrated at 200°F water temperature.

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

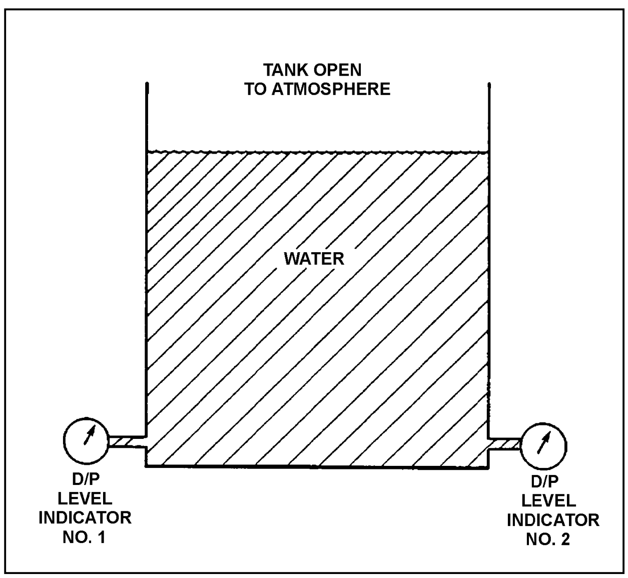
A. Indicator 1 at all water temperatures

B. Indicator 2 at all water temperatures

C. Indicator 1 below 150°F, indicator 2 above 150°F

D. Indicator 2 below 150°F, indicator 1 above 150°F

ANSWER: B.



TOPIC: Sensors and Detectors

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

The level detector is being used in a level control system that was calibrated to maintain tank level at 80 percent when the tank water temperature was 100°F. If tank water temperature gradually increases and stabilizes at 150°F, the level control system will cause actual tank level to...

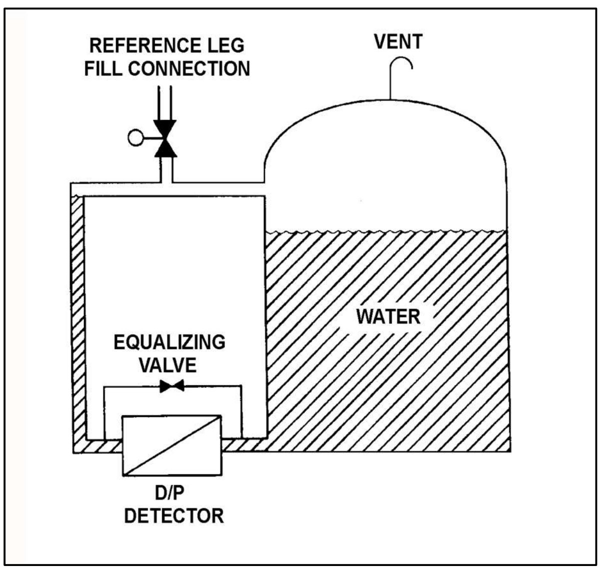
A. remain stable at 80 percent.

B. increase and stabilize above 80 percent.

C. oscillate and then stabilize at 80 percent.

D. decrease and stabilize below 80 percent.

ANSWER: B.



TOPIC: Sensors and Detectors

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

Two D/P level indicators are installed on a large water storage tank. Indicator 1 was calibrated at 100°F water temperature and indicator 2 was calibrated at 200°F water temperature.

Assuming both indicators are on scale, which indicator will indicate the <u>lower</u> level?

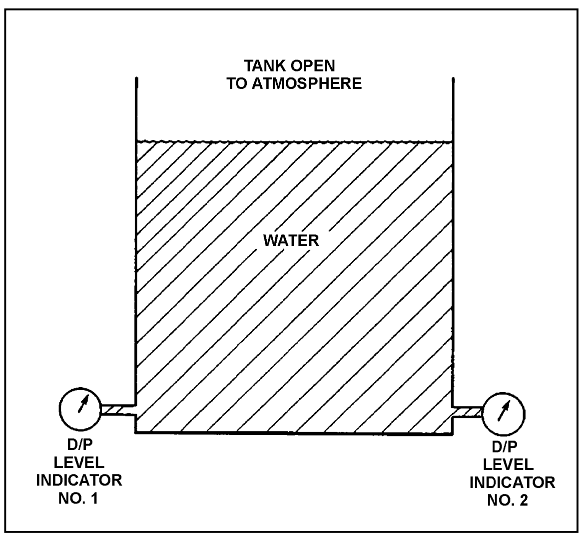
A. Indicator 1 at all water temperatures

B. Indicator 2 at all water temperatures

C. Indicator 1 below 150°F, indicator 2 above 150°F

D. Indicator 2 below 150°F, indicator 1 above 150°F

ANSWER: A.



TOPIC: Sensors and Detectors

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

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

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

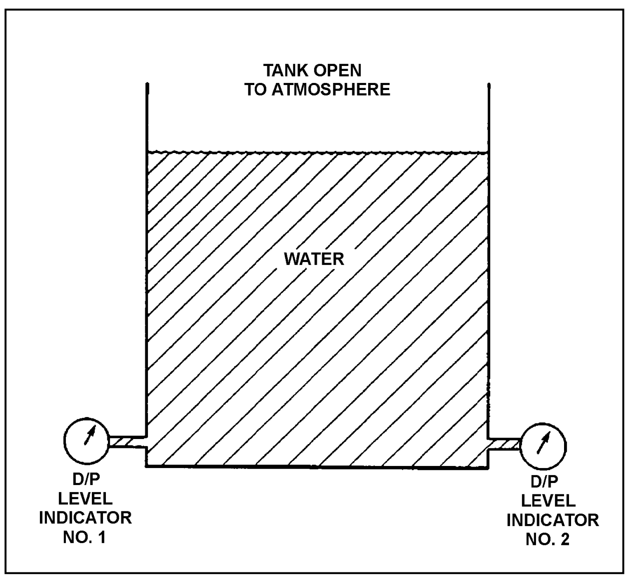
A. Indicator 1 at all water temperatures.

B. Indicator 2 at all water temperatures.

C. Indicator 1 below 150°F, indicator 2 above 150°F.

D. Indicator 2 below 150°F, indicator 1 above 150°F.

ANSWER: B.



TOPIC: Sensors and Detectors

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

Indicator 1 was calibrated at 120°F and indicator 2 was calibrated at 180°F. If tank water temperature is currently 150°F, then indicator...

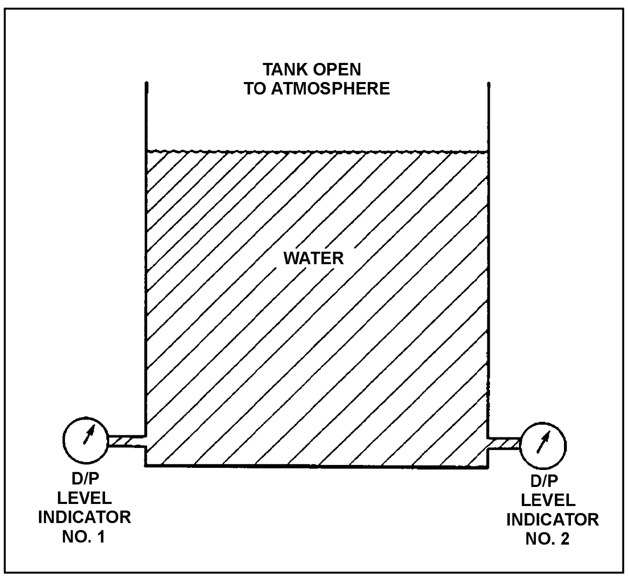
A. 1 will read greater than indicator 2, and greater than actual level.

B. 1 will read greater than indicator 2, and less than actual level.

C. 2 will read greater than indicator 1, and greater than actual level.

D. 2 will read greater than indicator 1, and less than actual level.

ANSWER: C.



TOPIC: Sensors and Detectors

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

Indicator 1 was calibrated at 180°F and indicator 2 was calibrated at 120°F. If tank water temperature is 150°F, then indicator...

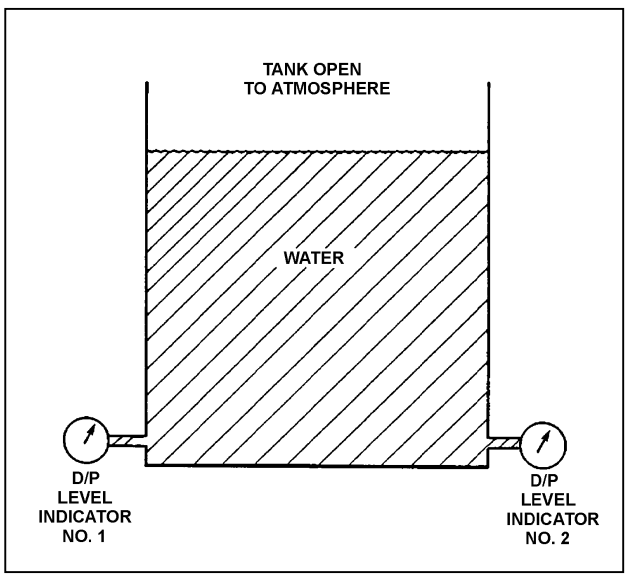
A. 1 will read greater than indicator 2, and greater than actual water level.

B. 1 will read greater than indicator 2, and less than actual water level.

C. 2 will read greater than indicator 1, and greater than actual water level.

D. 2 will read greater than indicator 1, and less than actual water level.

ANSWER: A.



TOPIC: Sensors and Detectors

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

If the differential pressure detector equalizing valve is opened, level indication will:

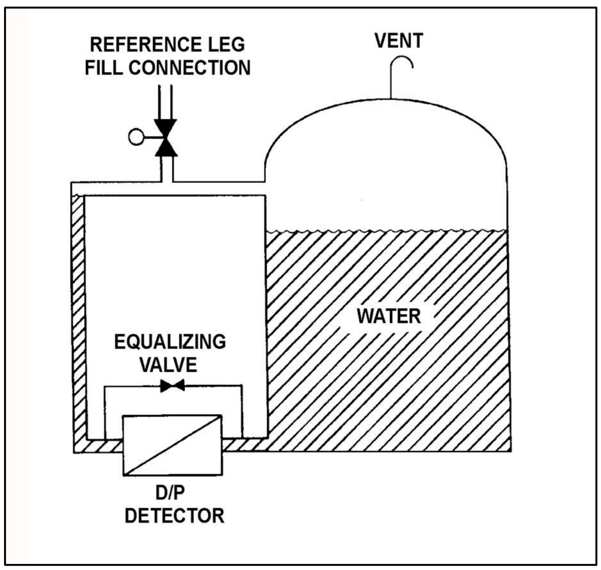
A. decrease and stabilize below actual level.

B. increase and stabilize above actual level.

C. oscillate above and below actual level.

D. remain constant at the current level.

ANSWER: B.



TOPIC: Sensors and Detectors

Refer to the drawing of a water storage tank with a differential pressure (D/P) level detector (see figure below).

The level detector is being used in a level control system that is calibrated to maintain tank level at 75 percent at the current water temperature of 90°F. If water temperature gradually increases and stabilizes at 120°F, the level control system will cause <u>actual</u> tank level to...

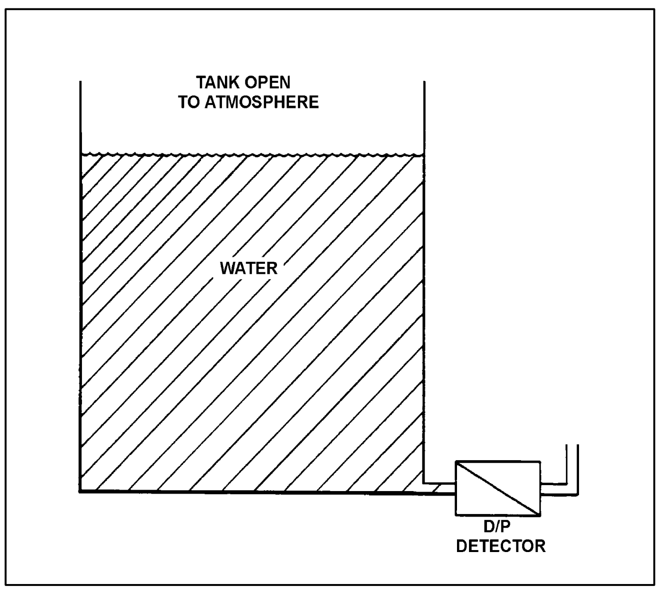
A. remain at 75 percent.

B. increase and stabilize above 75 percent.

C. oscillate around 75 percent.

D. decrease and stabilize below 75 percent.

ANSWER: B.



TOPIC: Sensors and Detectors

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

The D/P sensed by the detector varies in the __________ direction as the temperature of the water in the tank if the __________ of the tank water is constant. (Assume reference leg and tank water temperatures are initially the same.)

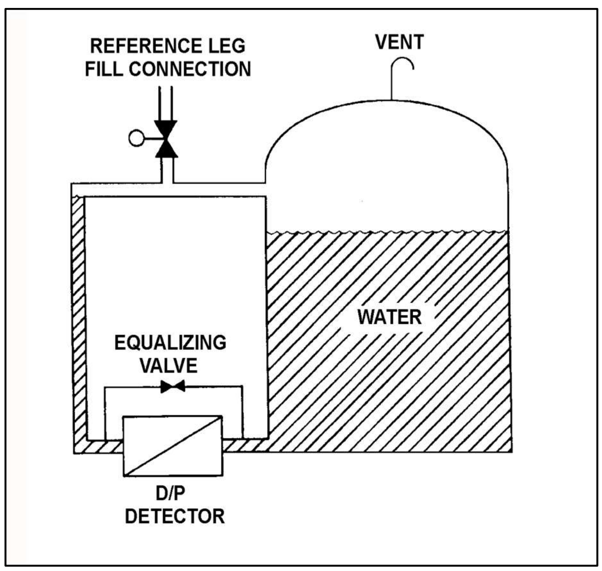
A. same; level

B. inverse; level

C. same; mass

D. inverse; mass

ANSWER: A.



TOPIC: Sensors and Detectors

Refer to the drawing of a water storage tank with a differential pressure (D/P) level detector (see figure below).

The level detector is being used in a level control system that is calibrated to maintain tank level at 75 percent at the current water temperature of 120°F. If water temperature gradually decreases and stabilizes at 90°F, actual tank level will...

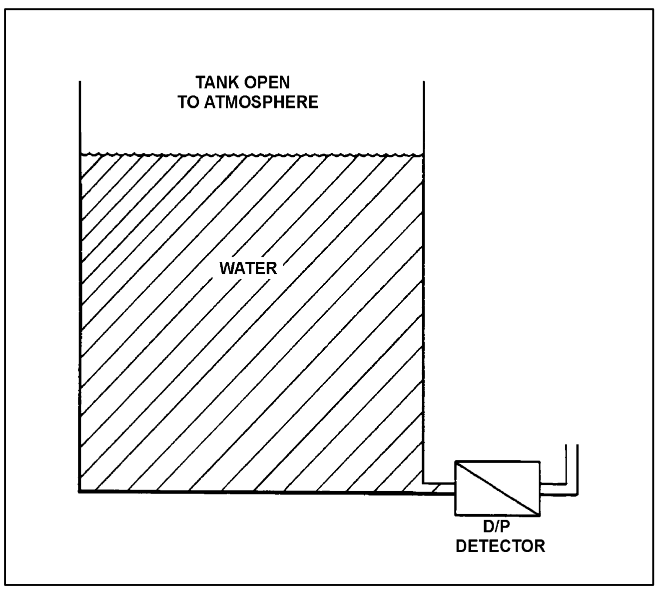
A. remain at 75 percent.

B. increase and stabilize above 75 percent.

C. oscillate around 75 percent.

D. decrease and stabilize below 75 percent.

ANSWER: D.



TOPIC: Sensors and Detectors

A cooling water system is cooling a lube oil heat exchanger. Cooling water system surge tank level is being measured using a differential pressure level detector that has been calibrated at the current water temperature in the tank. A leak in the heat exchanger results in lube oil collecting in the surge tank.

Assuming that the temperature of the contents in the surge tank does <u>not</u> change, indicated tank level will be __________ than actual tank level because lube oil is __________ than water.

A. higher; more dense

B. higher; less dense

C. lower; more dense

D. lower; less dense

ANSWER: D.

TOPIC: Sensors and Detectors

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

Assume the initial temperature of the reference leg and the water in the tank is 100°F, and that reference leg temperature does <u>not</u> change.

If the temperature of the water in the tank increases by 20°F, the D/P sensed by the detector will __________ as long as the water __________ is maintained constant.

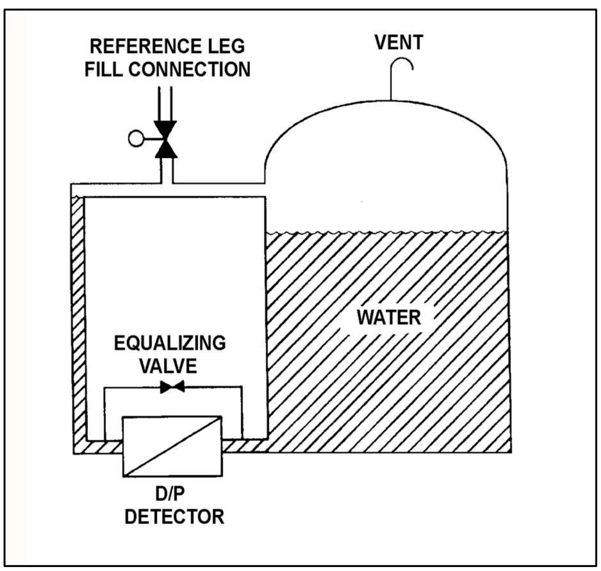
A. increase; level

B. decrease; level

C. increase; mass

D. decrease; mass

ANSWER: A.



TOPIC: Sensors and Detectors

Refer to the drawing of a water storage tank with a differential pressure (D/P) level detection system (see figure below). Assume that the initial temperature of the reference leg and the water in the tank are the same, and that reference leg temperature and level do not change.

The level detector is being used in a level control system (not shown) that is calibrated to maintain tank level at 75 percent at the current tank water temperature (70°F) and pressure (5 psig).

If the tank water temperature remains constant, but the tank pressure is increased by 10 psig, the level control system will cause actual tank level to...

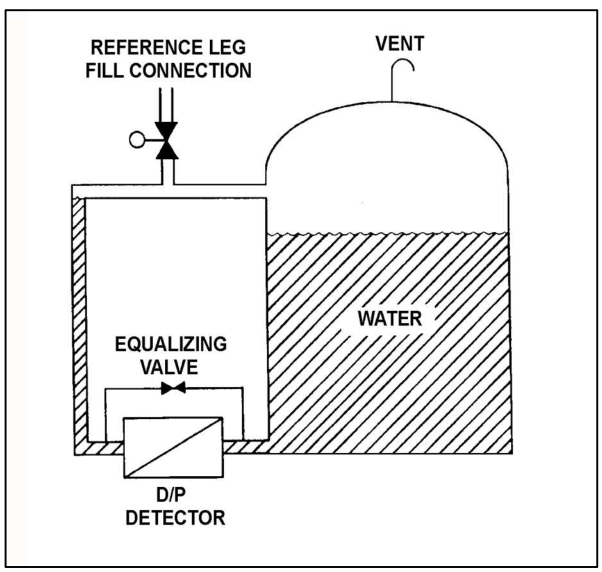
A. remain at 75 percent.

B. increase and stabilize above 75 percent.

C. oscillate around 75 percent.

D. decrease and stabilize below 75 percent.

ANSWER: A.



TOPIC: Sensors and Detectors

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

The D/P level detector was just calibrated and returned to operation with the following conditions:

- The reference leg contains 20 feet of water at 70°F.
- The tank contains 18 feet of water at 70°F.
- Tank level indication is 18 feet.

Assume the actual tank water level and the temperature of the water in the tank and reference leg do <u>not</u> change. Which one of the following will be the new tank level indication if the reference leg water level decreases to 18 feet?

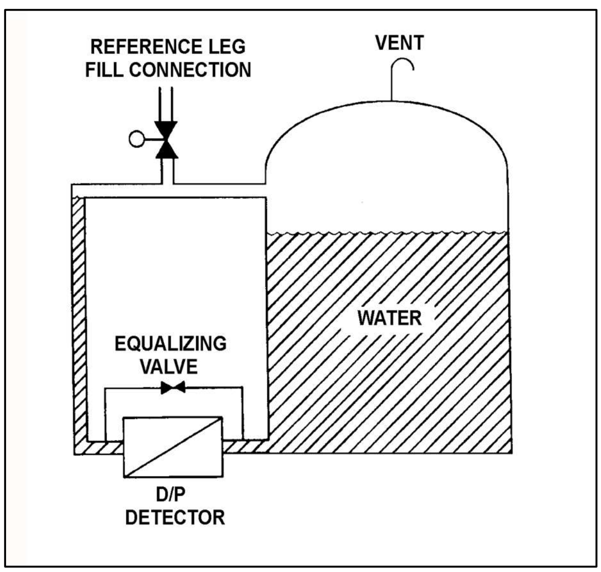
A. 22 feet

B. 20 feet

C. 18 feet

D. 2 feet

ANSWER: B.



TOPIC: Sensors and Detectors

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

The water storage tank is 40 feet tall. The level detection system is calibrated to provide a level indication of 30 feet when the tank and reference leg levels are equal.

If the tank is completely filled with water, the tank level will indicate...

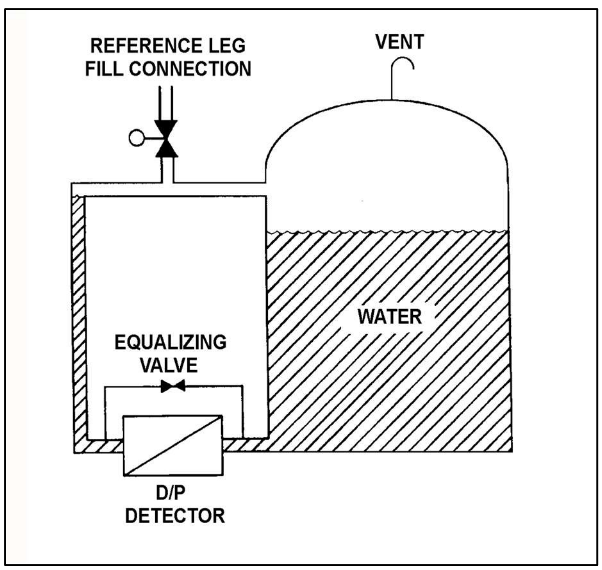
A. less than 30 feet.

B. 30 feet.

C. greater than 30 feet, but less than 40 feet.

D. 40 feet.

ANSWER: B.



TOPIC: Sensors and Detectors

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

Assume that the initial temperature of the reference leg and the water in the tank is 100°F, and that reference leg temperature does <u>not</u> change.

If the temperature of the water in the tank increases by 20°F, the D/P sensed by the detector will __________ if the __________ of the water in the tank is constant.

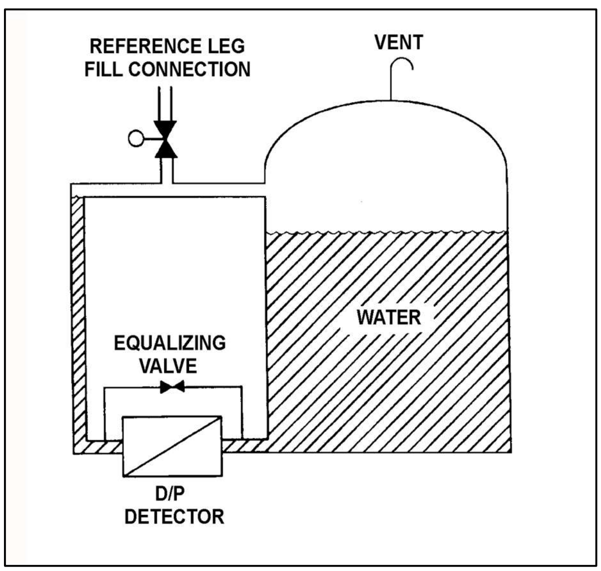
A. decrease; level

B. decrease; mass

C. remain the same; level

D. remain the same; mass

ANSWER: D.



TOPIC: Sensors and Detectors

Refer to the drawing of a vented water storage tank with a differential pressure (D/P) level detection system (see figure below). The water in the tank and reference leg is at the same temperature.

The tank level indicator was just calibrated to indicate 0 percent when the tank is empty and 100 percent when the water level reaches the upper tap. The indicator's display range is 0 percent to 120 percent. The initial water level is as indicated in the figure.

If the tank water level slowly increases and stabilizes just below the top of the tank, the level indication will increase until…

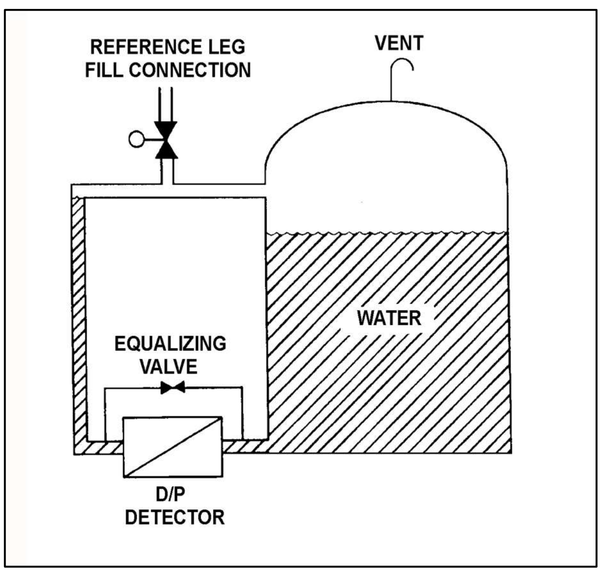
A. the water level stabilizes, at which time the level indication will stabilize at 100 percent.

B. the water level stabilizes, at which time the level indication will stabilize at a value greater than 100 percent.

C. the water level reaches the upper tap, at which time the level indication will remain at 100 percent as the water level continues to increase.

D. the water level reaches the upper tap, at which time the level indication will continue to increase as the water level continues to increase.

ANSWER: C.



TOPIC: Sensors and Detectors

Refer to the drawing of a water storage tank with a differential pressure (D/P) level detection system (see figure below). The level detector has just been calibrated.

How will the indicated level be affected if condensation partially fills the normally-dry reference leg?

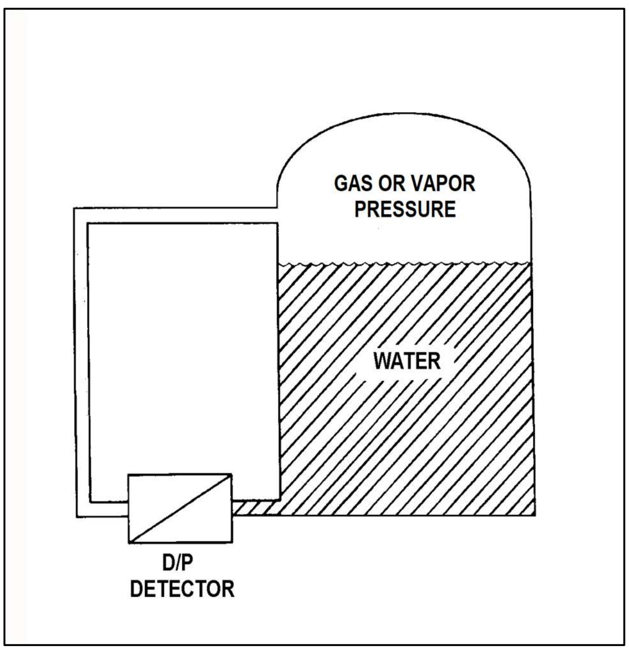
A. Indicated level will <u>not</u> be affected.

B. Indicated level will be lower than actual level.

C. Indicated level will be higher than actual level.

D. Indicated level may be higher or lower than actual level depending on the pressure in the upper volume of the tank.

ANSWER: B.



TOPIC: Sensors and Detectors

Refer to the drawing of a water storage tank with a differential pressure (D/P) level detector (see figure below).

The level instrument has just been calibrated to read actual tank water level. If the reference leg subsequently experiences high ambient temperature, indicated level will...

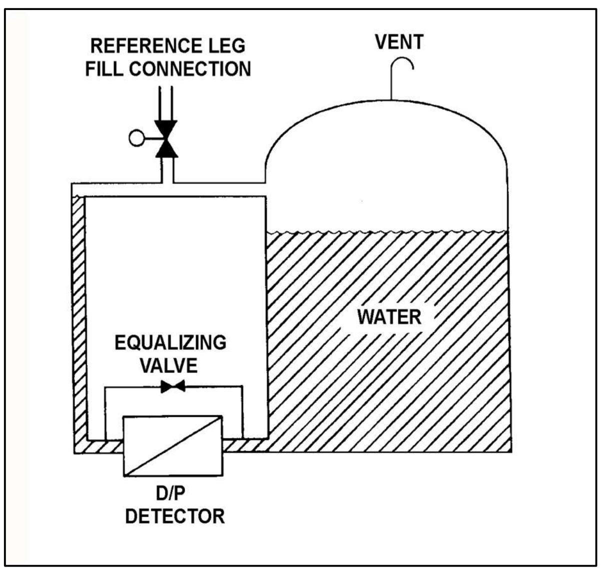
A. equal the actual level.

B. read less than the actual level.

C. read greater than the actual level.

D. drift above and below the actual level.

ANSWER: C.



TOPIC: Sensors and Detectors

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

Indicator 1 was calibrated at 200°F and indicator 2 was calibrated at 100°F. If tank water temperature is 150°F, then...

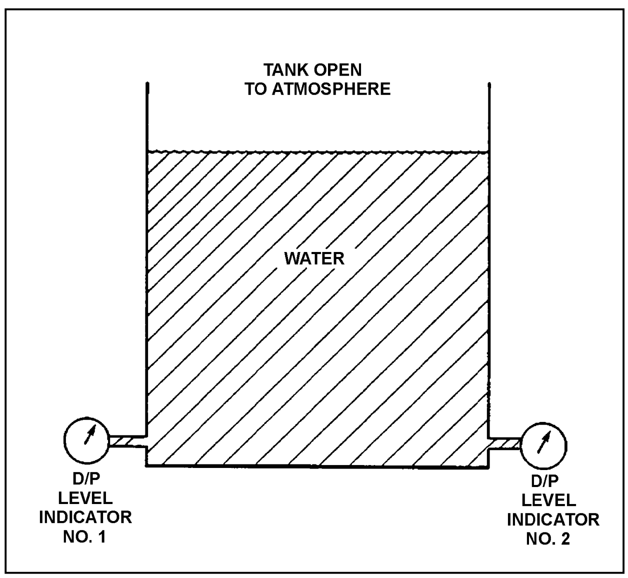
A. indicator 1 will read greater than indicator 2.

B. indicator 2 will read greater than indicator 1.

C. indicators 1 and 2 will read the same.

D. both indicators will be inaccurate, but it is impossible to predict which indicator will read greater.

ANSWER: A.



TOPIC: Sensors and Detectors

Refer to the drawing of two water storage tanks with four differential pressure (D/P) level detectors (see figure below).

The tanks are identical with equal water levels and both are pressurized to 20 psig. All detectors were calibrated at the current water temperature and 70°F external (ambient) temperature.

Which detectors will provide the most accurate level indication following an increase in external (ambient) temperature from 70°F to 100°F? (Assume tank contents temperatures and external pressure do not change.)

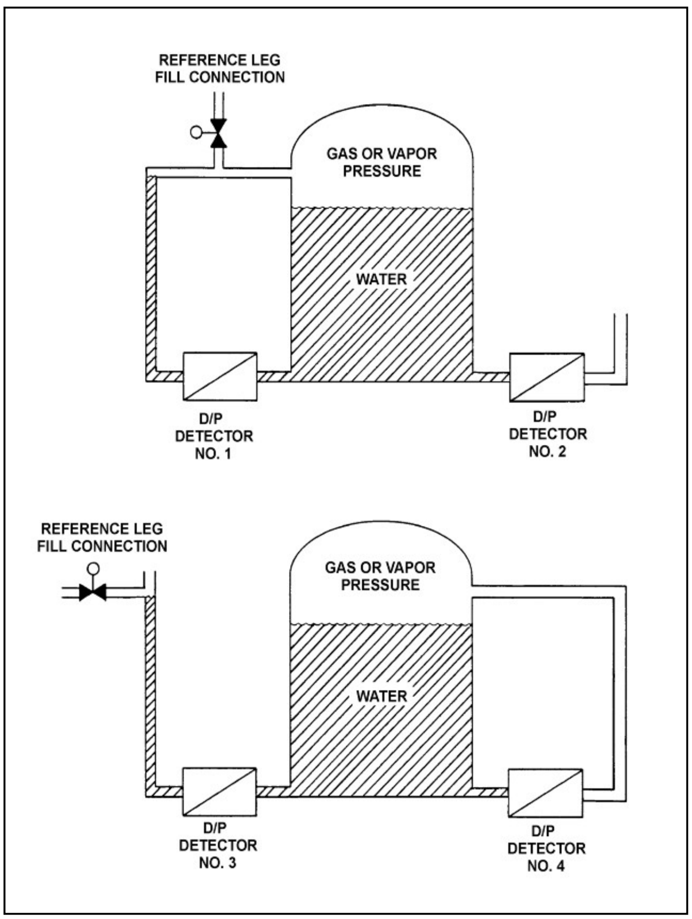
A. 1 and 3

B. 2 and 4

C. 1 and 4

D. 2 and 3

ANSWER: B.



TOPIC: Sensors and Detectors

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

A calibrated D/P level detector is being used to measure level in a vented tank inside the auxiliary building. If building pressure increases with no change in temperature, the associated level indication will...

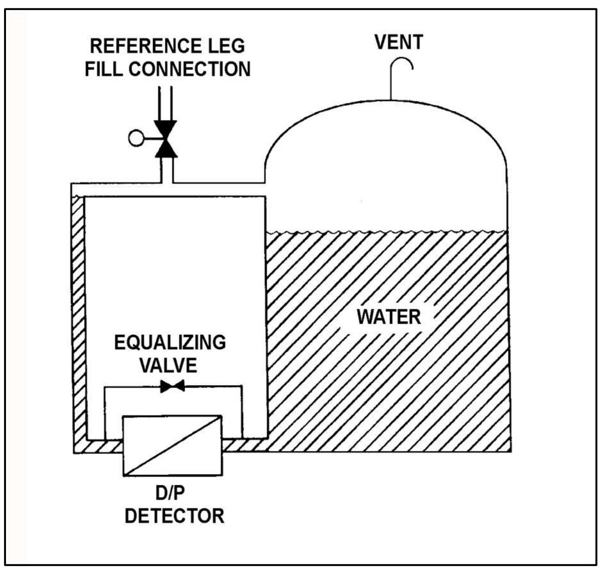
A. decrease, then increase and stabilize at the actual level.

B. decrease and stabilize below the actual level.

C. increase and stabilize above the actual level.

D. remain at the actual level.

ANSWER: D.



TOPIC: Sensors and Detectors

Refer to the drawing of a water storage tank with a differential pressure (D/P) level detector (see figure below).

The associated level instrument was calibrated with the water storage tank at 120°F. If the mass in the tank remains constant and the water temperature decreases to 100°F, the <u>indicated</u> level will...

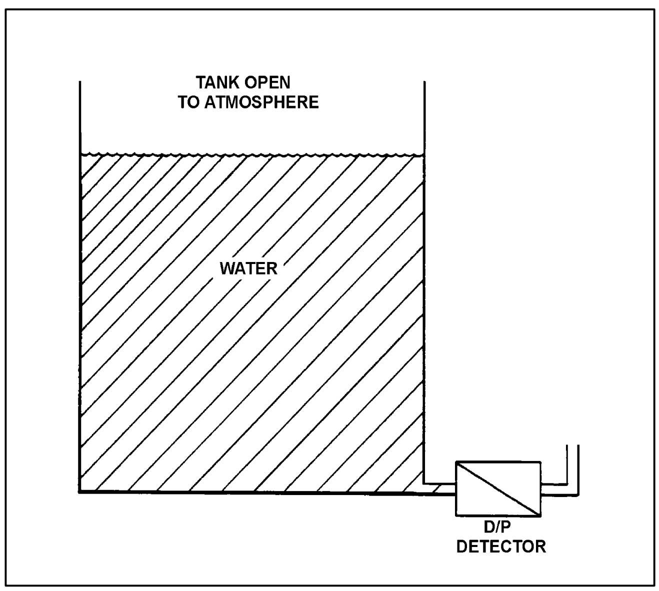
A. remain the same although actual level decreases.

B. remain the same although actual level increases.

C. increase in direct proportion to the temperature decrease.

D. decrease in direct proportion to the temperature decrease.

ANSWER: A.



TOPIC: Sensors and Detectors

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

The level instrument has just been calibrated to indicate actual tank water level. Assume that tank water temperature and level remain constant. If the reference leg temperature increases by 20°F, indicated tank water level will...

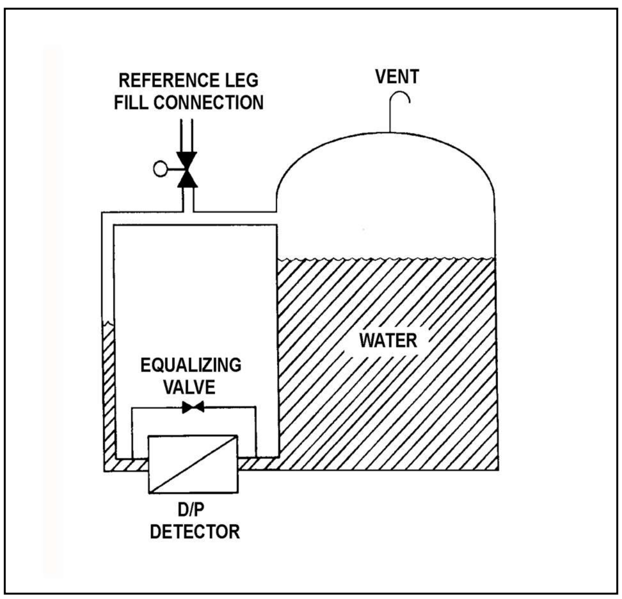
A. be unpredictable.

B. equal the actual level.

C. be less than the actual level.

D. be greater than the actual level.

ANSWER: B.



TOPIC: Sensors and Detectors

The level indication for a wet reference leg differential pressure (D/P) level instrument will fail <u>low</u> as a result of...

A. a break on the reference leg.

B. a rupture of the diaphragm in the D/P cell.

C. the reference leg flashing to steam.

D. a break on the variable leg.

ANSWER: D.

TOPIC: Sensors and Detectors

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

Tank water level indication will be lower than actual level when reference leg temperature is __________ than calibration conditions; or when there is a break in the __________ leg of the D/P detector.

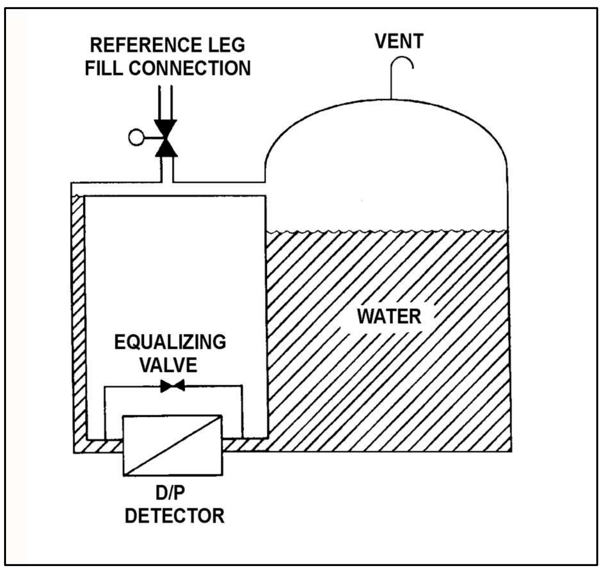
A. less; reference

B. less; variable

C. greater; reference

D. greater; variable

ANSWER: B.



TOPIC: Sensors and Detectors

Semiconductor strain gages are often used in transmitters for...

A. reactor coolant pressure instruments.

B. reactor coolant temperature instruments.

C. control rod position instruments.

D. steam generator level instruments.

ANSWER: A.

TOPIC: Sensors and Detectors

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

A. increase; outer

B. increase; inner

C. decrease; outer

D. decrease; inner

ANSWER: C.

TOPIC: Sensors and Detectors

In a diaphragm type pressure detector, pressure is measured using the __________ of the diaphragm.

A. rotational movement

B. axial deflection

C. change in circumference

D. change in diameter

ANSWER: B.

TOPIC: Sensors and Detectors

A bourdon tube works on the principle that when the pressure inside the tube decreases, the tube tends to: (Assume detected pressure remains above atmospheric pressure.)

A. coil, due to an increased pressure-induced force on the outside of the tube.

B. straighten, due to an increased pressure-induced force on the outside of the tube.

C. coil, due to the spring action of the metal overcoming the pressure-induced force on the inside of the tube.

D. straighten, due to the spring action of the metal overcoming the pressure-induced force on the inside of the tube.

ANSWER: C.

TOPIC: Sensors and Detectors

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 pressure at the inlet to the pump?

A. 31.2 psig

B. 34.6 psig

C. 37.4 psig

D. 39.8 psig

ANSWER: D.

TOPIC: Sensors and Detectors

A cooling water system bourdon tube pressure detector is located inside a sealed building and system pressure currently indicates 50 psig. A building ambient temperature increase of 20°F will cause a __________ change in indicated system pressure; a building pressure increase of 20 psig will cause a __________ change in indicated system pressure.

A. significant; significant

B. negligible; significant

C. significant; negligible

D. negligible; negligible

ANSWER: B.

TOPIC: Sensors and Detectors

A cooling water system pressure detector uses a bourdon tube as the sensing element. Which one of the following explains how the indicated system pressure will be affected if the temperature of the bourdon tube decreases by 30°F? (Assume the cooling water system pressure does not change.)

A. Indicated pressure will decrease because the bourdon tube will become less flexible.

B. Indicated pressure will increase because the bourdon tube will become less flexible.

C. Indicated pressure will decrease because the bourdon tube internal pressure will decrease.

D. Indicated pressure will increase because the bourdon tube internal pressure will decrease.

ANSWER: A.

TOPIC: Sensors and Detectors

A bourdon-tube pressure detector was indicating 50 percent of scale when it was suddenly exposed to a high pressure transient that caused permanent strain to the bourdon tube. The detector remained intact and actual pressure was restored to its original value.

During the pressure transient, the affected pressure indication initially went off scale high. After the original pressure was restored, the indication was...

A. unpredictable.

B. less than 50 percent of scale.

C. 50 percent of scale.

D. greater than 50 percent of scale.

ANSWER: D.

TOPIC: Sensors and Detectors

Refer to the drawing of a bellows-type differential pressure (D/P) detector (see figure below).

The spring in this detector (shown in a compressed state) has weakened from long-term use. If the actual D/P is constant, how will indicated D/P respond as the spring weakens?

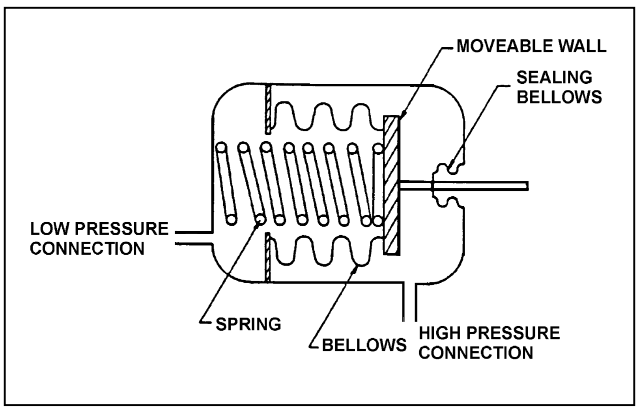
A. Increase, because the spring will expand more

B. Decrease, because the spring will expand more

C. Increase, because the spring will compress more

D. Decrease, because the spring will compress more

ANSWER: C.



TOPIC: Sensors and Detectors

If a bourdon tube pressure detector is over-ranged sufficiently to permanently distort the bourdon tube, subsequent pressure measurement will be inaccurate because the __________ of the detector tube will be inaccurate.

A. distance moved by the tip

B. change in the length

C. expansion of the cross-sectional area

D. change in the volume

ANSWER: A.

TOPIC: Sensors and Detectors

A properly calibrated 0 to 100 psia diaphragm pressure detector is connected to a pressurized system; the low pressure side of the detector is vented to the atmosphere. The detector is currently producing a system pressure indication of 75 psia.

If the detector diaphragm ruptures, indicated pressure will be approximately...

A. 0 psia.

B. 15 psia.

C. 60 psia.

D. 90 psia.

ANSWER: B.

TOPIC: Sensors and Detectors

A resistance temperature detector operates on the principle that the change in the electrical resistance of...

A. two dissimilar metals is directly proportional to the temperature change measured at their junction.

B. two dissimilar metals is inversely proportional to the temperature change measured at their junction.

C. a metal is directly proportional to its change in temperature.

D. a metal is inversely proportional to its change in temperature.

ANSWER: C.

TOPIC: Sensors and Detectors

A resistance temperature detector operates on the principle that the change in the electrical resistance of a metal is __________ proportional to the change in __________.

A. inversely; metal temperature

B. inversely; metal temperature squared

C. directly; metal temperature

D. directly; metal temperature squared

ANSWER: C.

TOPIC: Sensors and Detectors

In a comparison between a thermocouple and a resistance temperature detector, the thermocouple generally...

A. measures temperature less accurately.

B. is less affected by ambient temperature changes.

C. has a lower usable temperature range.

D. responds more slowly to a temperature change.

ANSWER: A.

TOPIC: Sensors and Detectors

If the reference junction temperature of a thermocouple remains constant, the output voltage of the thermocouple is __________ proportional to the __________.

A. directly; measuring junction temperature

B. directly; square root of the measuring junction temperature

C. inversely; measuring junction temperature

D. inversely; square root of the measuring junction temperature

ANSWER: A.

TOPIC: Sensors and Detectors

A thermocouple operates on the principle that a measurable voltage will be produced when two...

A. similar metals form two junctions at the same temperature.

B. similar metals form two junctions at different temperatures.

C. dissimilar metals form two junctions at the same temperature.

D. dissimilar metals form two junctions at different temperatures.

ANSWER: D.

TOPIC: Sensors and Detectors

In contrast to a thermocouple, a resistance temperature detector...

A. is used in high temperature applications.

B. does <u>not</u> require an external power supply for temperature indication.

C. uses a single type of metal or alloy in the sensing element.

D. is commonly placed in direct contact with the monitored substance.

ANSWER: C.

TOPIC: Sensors and Detectors

Refer to the drawing of a simple thermocouple circuit (see figure below).

Circuit temperature indication is initially 350°F. The reference (cold) junction temperature decreases by 10°F, while the measuring junction temperature remains constant. Without temperature compensation for the reference junction, the new temperature indication will be...

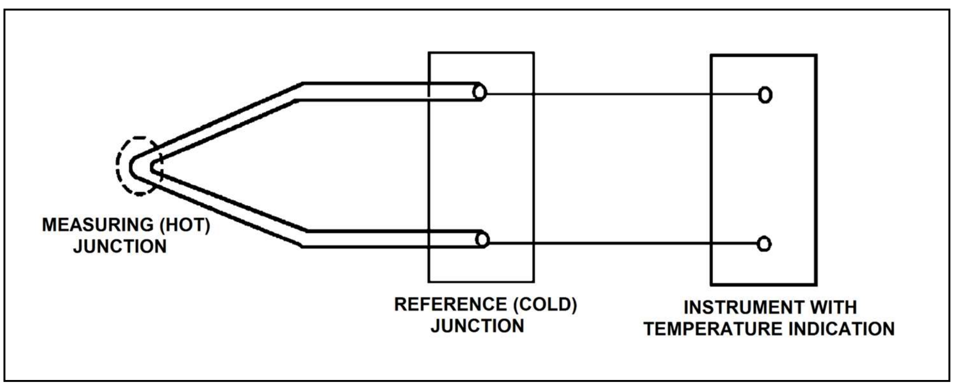
A. 340°F.

B. 350°F.

C. 360°F.

D. 370°F.

ANSWER: C.



TOPIC: Sensors and Detectors

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 temperature changes away from the thermocouple measuring junction do <u>not</u> affect thermocouple temperature indication.

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

D. Ensures that different lengths of thermocouple extension wires do <u>not</u> affect thermocouple temperature indication.

ANSWER: B.

TOPIC: Sensors and Detectors

<u>Unlike</u> a resistance temperature detector, a typical thermocouple...

A. uses a single type of metal in the sensing element

B. requires a temperature-controlled reference junction.

C. can provide temperature input to a valve controller in a cooling water system.

D. requires an external power supply to provide indication of temperature.

ANSWER: B.

TOPIC: Sensors and Detectors

Refer to the drawing of a simple thermocouple circuit (see figure below).

A thermocouple temperature indication is initially 410°F with the reference (cold) junction at 125°F. An ambient temperature decrease lowers the reference junction temperature to 110°F, while the measuring junction temperature remains constant. Without temperature compensation for the reference junction, the new thermocouple temperature indication will be...

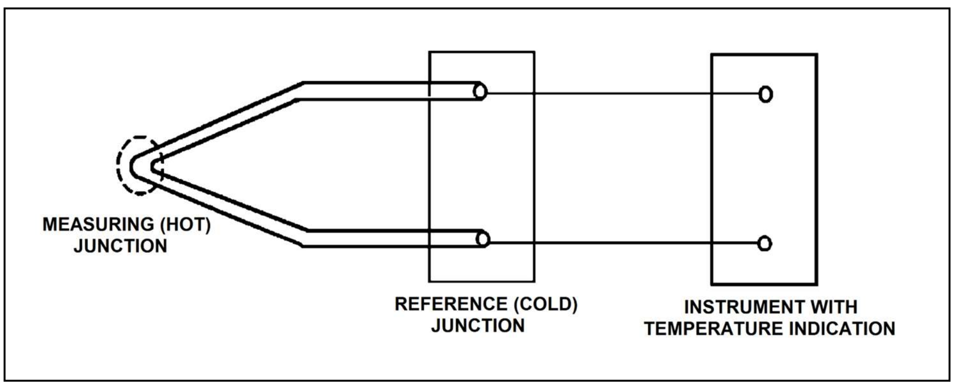
A. 380°F.

B. 395°F.

C. 410°F.

D. 425°F.

ANSWER: D.



TOPIC: Sensors and Detectors

Refer to the drawing of a simple thermocouple circuit (see figure below).

Given that the temperatures at the measuring and reference junctions remain constant, if a ventilation system malfunction causes the temperature of the temperature indication panel to increase by 10°F, indicated temperature will...

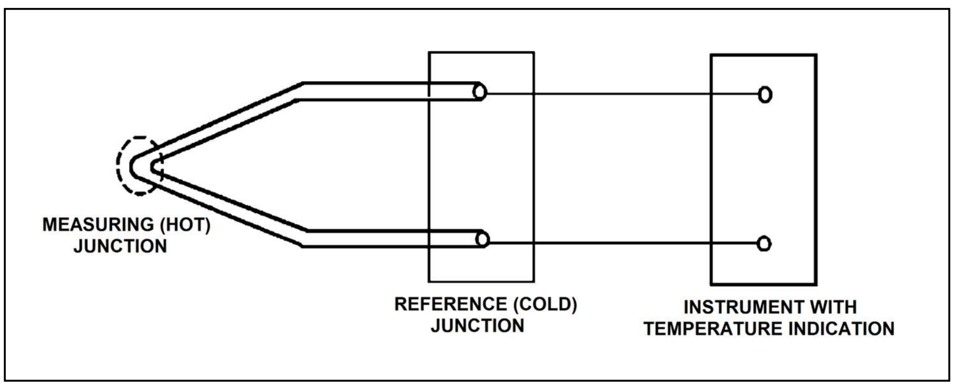
A. not be affected.

B. increase by 10°F.

C. decrease by 10°F.

D. change in an unpredictable manner.

ANSWER: A.



TOPIC: Sensors and Detectors

Refer to the drawing of a simple chromel-alumel thermocouple circuit (see figure below).

What is the effect on the thermocouple reference junctions if the chromel and alumel extension wires from the thermocouple connection head to the reference junction panel are replaced with copper wires?

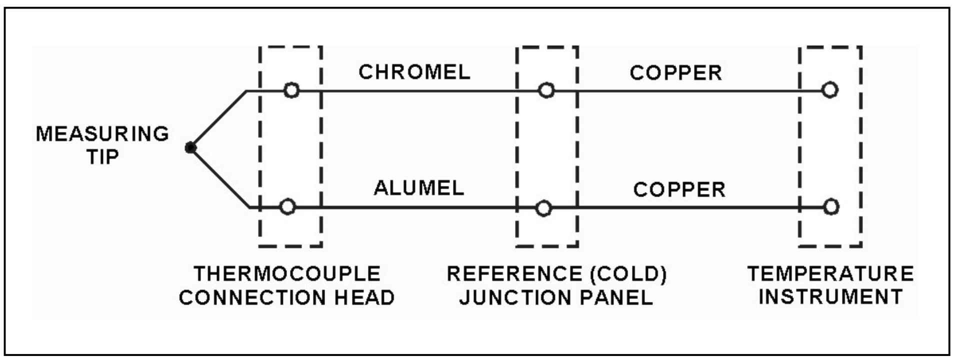
A. There will no longer be any reference junctions.

B. The reference junctions will be located in the temperature instrument.

C. The reference junctions will still be located in the reference junction panel.

D. The reference junctions will be located in the thermocouple connection head.

ANSWER: D.



TOPIC: Sensors and Detectors

Which one of the following is a characteristic of a resistance temperature detector but <u>not</u> a thermocouple?

A. Sensing element is made from a single metal or alloy.

B. Requires a reference junction for accurate temperature measurement.

C. Extension leads made from relatively expensive metals or alloys are required for accurate temperature measurement.

D. Temperature measurement relies on a sensor material property that varies directly with the change in the measured temperature.

ANSWER: A.

TOPIC: Sensors and Detectors

Refer to the drawing of a simple chromel-alumel thermocouple circuit (see figure below).

What is the effect on the thermocouple reference junctions if the copper extension wires from the reference junction panel to the temperature instrument are replaced with alumel (top) and chromel (bottom) extension wires?

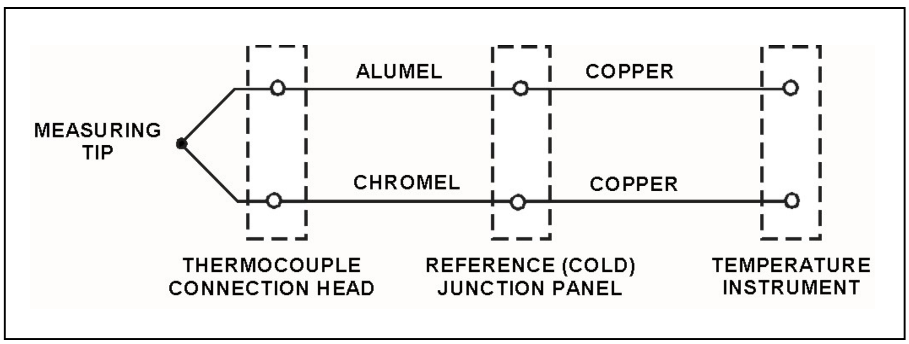
A. The reference junctions will be located in the thermocouple connection head.

B. The reference junctions will still be located in the reference junction panel.

C. The reference junctions will be located in the temperature instrument.

D. There will no longer be any reference junctions.

ANSWER: C.



TOPIC: Sensors and Detectors

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

A. increase; increase

B. increase; decrease

C. decrease; increase

D. decrease; decrease

ANSWER: D.

TOPIC: Sensors and Detectors

Refer to the drawing of a simple thermocouple circuit (see figure below).

The measuring junction temperature is currently 300°F while the reference junction temperature is being held constant at 120°F. The thermocouple circuit is capable of indicating 32°F to 600°F and has just been calibrated at the current conditions.

If the measuring junction temperature decreases and stabilizes at 90°F, what temperature will be indicated?

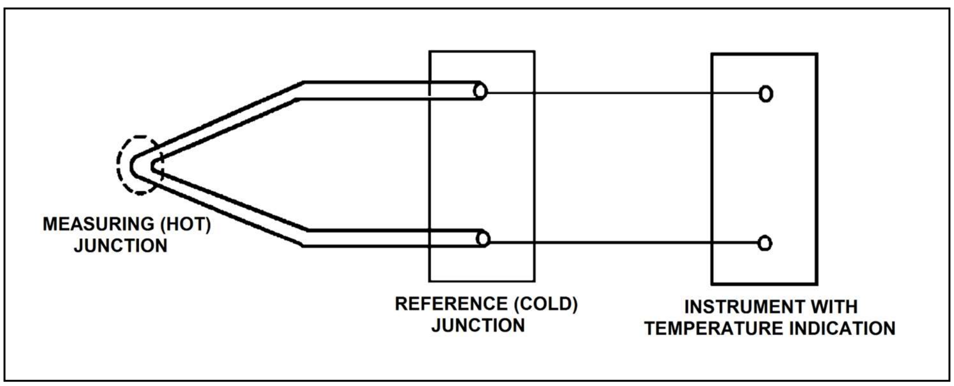
A. 32°F

B. 60°F

C. 90°F

D. 120°F

ANSWER: C.



TOPIC: Sensors and Detectors

For proper operation of a thermocouple circuit, the reference junction temperature…

A. must be less than the measuring junction temperature.

B. must be greater than the measuring junction temperature.

C. may be less than, greater than, or equal to the measuring junction temperature.

D. may be less than or greater than, but not equal to, the measuring junction temperature.

ANSWER: C.

TOPIC: Sensors and Detectors

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

A. increase; increase

B. increase; decrease

C. decrease; increase

D. decrease; decrease

ANSWER: A.

TOPIC: Sensors and Detectors

An open circuit in a thermocouple detector causes the affected temperature indication to fail...

A. high.

B. low.

C. to reference junction temperature.

D. as is.

ANSWER: C.

TOPIC: Sensors and Detectors

If shorting occurs within a resistance temperature detector, the associated indication will fail...

A. low.

B. high.

C. as is.

D. to midscale.

ANSWER: A.

TOPIC: Sensors and Detectors

A resistance temperature detector (RTD) is used in a balanced bridge circuit to indicate temperature. If the RTD develops an open circuit (bridge circuit remains intact), temperature indication will fail...

A. high.

B. low.

C. as is.

D. to midscale.

ANSWER: A.

TOPIC: Sensors and Detectors

Refer to the drawing of a simple thermocouple circuit (see figure below) that is calibrated for a reference junction temperature of 90°F.

Thermocouple temperature indication is currently 150°F. Indicator range is from 0°F to 2000°F.

Which one of the following temperature indications will result if one of the thermocouple extension wires becomes dislodged from its terminal in the reference junction panel?

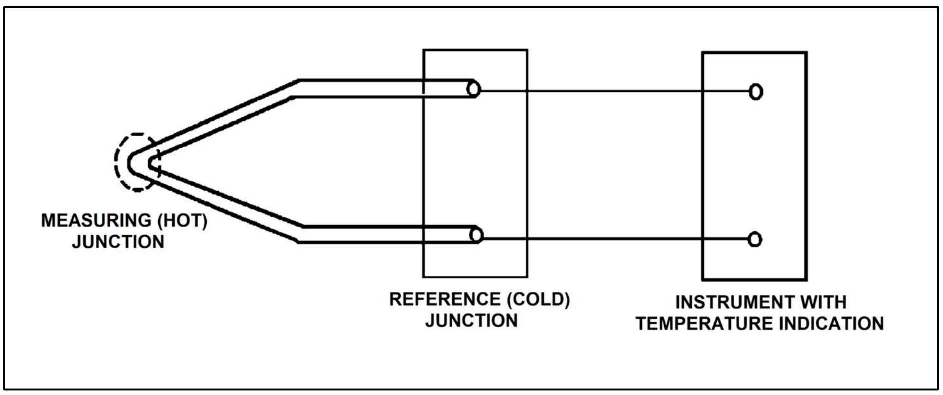
A. 0°F

B. 60°F

C. 90°F

D. 2000°F

ANSWER: C.



TOPIC: Sensors and Detectors

Because of a thermocouple temperature display failure, the millivolt output of a thermocouple circuit is being converted to a temperature value using conversion tables. The tables are based on a thermocouple reference junction temperature of 32°F. The actual reference junction is located in a panel that is maintained at 120°F. Room temperature surrounding the panel is 80°F.

What adjustment must be made to the temperature value taken from the conversion tables to calculate the actual temperature at the measuring tip of the thermocouple?

A. Add 48°F.

B. Subtract 48°F.

C. Add 88°F.

D. Subtract 88°F.

ANSWER: C.

TOPIC: Sensors and Detectors

A resistance temperature detector (RTD) and a thermocouple (TC) are commonly used sensors for temperature measurement. If a temperature display fails, which of the sensors, if any, has a property that can be measured manually and converted to a temperature value with the aid of conversion tables.

A. TC only.

B. RTD only.

C. Both TC and RTD.

D. Neither TC nor RTD.

ANSWER: C.

TOPIC: Sensors and Detectors

Because of a thermocouple temperature display failure, the millivolt output of a thermocouple circuit is being converted to a temperature value using conversion tables. The tables are based on a thermocouple reference junction temperature of 32°F. The actual reference junction is located in a panel that is currently at 80°F.

The temperature value taken from the conversion tables is 120°F.

What adjustment must be made to the temperature value taken from the conversion tables to calculate the actual temperature at the measuring tip of the thermocouple?

A. Add 48°F.

B. Subtract 48°F.

C. Add 88°F.

D. Subtract 88°F.

ANSWER: A.

TOPIC: Sensors and Detectors

Because of a thermocouple temperature display failure, the millivolt output of a thermocouple circuit is being converted to a temperature value using conversion tables. The tables are based on a thermocouple reference junction temperature of 32°F. The actual reference junction is located in a panel that is maintained at 96°F. Room temperature surrounding the panel is 72°F.

What adjustment must be made to the temperature value taken from the conversion tables to calculate the actual temperature at the measuring tip of the thermocouple?

A. Add 64°F.

B. Subtract 64°F.

C. Add 40°F.

D. Subtract 40°F.

ANSWER: A.

TOPIC: Sensors and Detectors

Refer to the drawing of a simple chromel-alumel thermocouple circuit (see figure below).

Given the following:

- The temperature instrument currently indicates 370°F.
- The reference junction temperature is constant at 120°F.
- The temperature instrument is capable of indicating 32°F to 1,000°F and has just been calibrated.

Which one of the following temperature indications will result if the chromel lead becomes disconnected from its terminal in the thermocouple connection head?

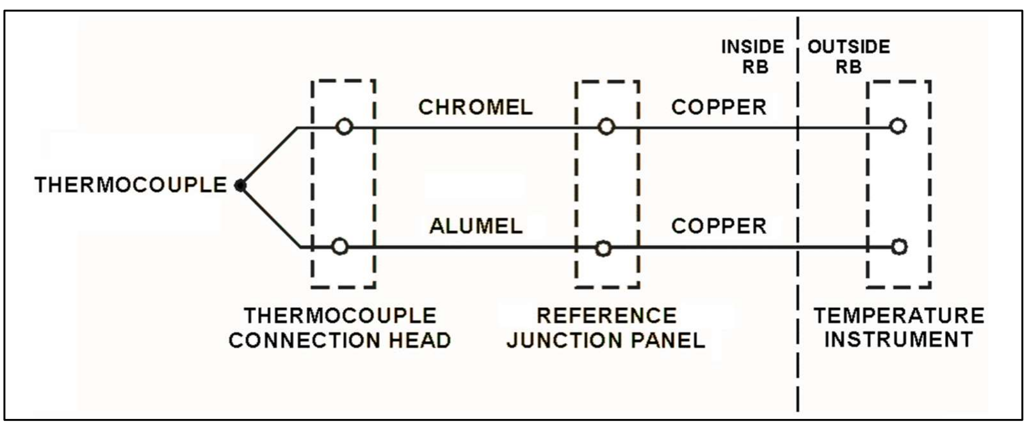
A. 32°F

B. 120°F

C. 250°F

D. 1,000°F

ANSWER: B.



TOPIC: Sensors and Detectors

What type of sensor is most commonly used to provide remote position indication of a valve that is normally either fully open or fully closed?

A. Limit switch

B. Reed switch

C. Servo transmitter

D. Linear variable differential transformer

ANSWER: A.

TOPIC: Sensors and Detectors

Which one of the following devices is commonly used to provide remote indication of valve position on an analog meter in units of "percent of full open"?

A. Limit switch

B. Reed switch

C. Linear variable differential transformer

D. Resistance temperature detector

ANSWER: C.

TOPIC: Sensors and Detectors

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

Coils of wire connected to an AC power supply are being used to monitor the position of a control rod in a reactor. The coils are mounted in a column outside the reactor vessel head such that the steel control rod drive shaft passes upward through the coils as the control rod is withdrawn. Currently, the top of a control rod drive shaft is located between coils A and B as shown. The control rod is to be withdrawn until the top of the control rod drive shaft is located just below coil C.

Compared to the initial coil output currents, after the control rod is withdrawn the output current of coil A will be __________; and the output current of coil B will be __________.

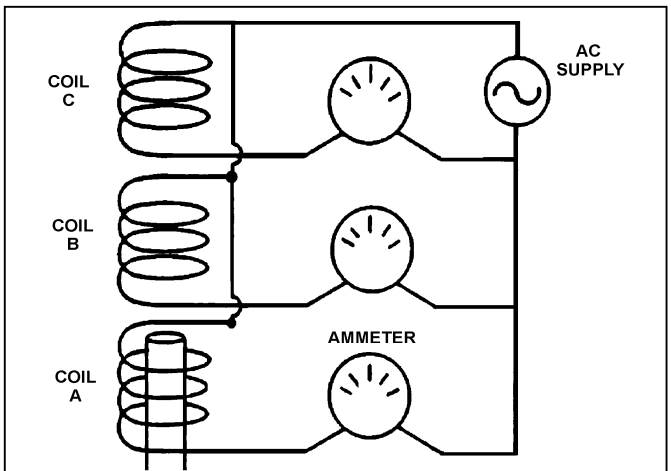
A. higher; higher

B. higher; lower

C. the same; higher

D. the same; lower

ANSWER: D.



CONTROL ROD POSITION DETECTOR

TOPIC: Sensors and Detectors

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 __________.

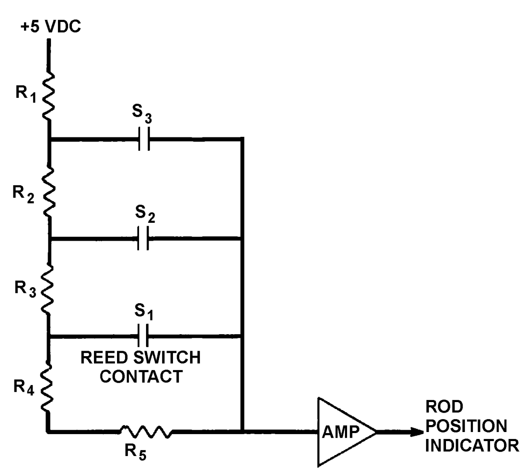
A. lower; higher

B. lower; lower

C. higher; higher

D. higher; lower

ANSWER: A.



CONTROL ROD POSITION DETECTOR

TOPIC: Sensors and Detectors

Reed switches are being used in an electrical measuring circuit to monitor the position of a control rod in a reactor. The reed switches are mounted in a column above the reactor vessel such that the control rod drive shaft passes by the reed switches as the control rod is withdrawn.

Which one of the following describes the action that causes the electrical output of the measuring circuit to change as the control rod is withdrawn?

A. An AC coil on the control rod drive shaft induces a voltage into each reed switch as the drive shaft passes by.

B. A metal tab on the control rod drive shaft mechanically closes each reed switch as the drive shaft passes by.

C. The primary and secondary coils of each reed switch attain maximum magnetic coupling as the drive shaft passes by.

D. A permanent magnet on the control rod drive shaft attracts the movable contact arm of each reed switch as the drive shaft passes by.

ANSWER: D.

TOPIC: Sensors and Detectors

A BF_3 proportional counter is being used to measure neutron level during a reactor startup. Which one of the following describes the method used to ensure that neutron indication is <u>not</u> affected by gamma reactions in the detector?

A. Two counters are used: one sensitive to neutron and gamma and the other sensitive to gamma only. The outputs are electrically opposed to cancel the gamma-induced currents.

B. The BF_3 proportional counter measures neutron flux of such high intensity that the gamma signal is insignificant compared to the neutron signal.

C. In a proportional counter, gamma-induced pulses are of insufficient duration to generate a significant output. Only neutron pulses have sufficient duration to be counted by the detector instrumentation.

D. In a proportional counter, neutron-induced pulses are significantly larger than gamma pulses. The detector instrumentation filters out the smaller gamma pulses.

ANSWER: D.

TOPIC: Sensors and Detectors

Most of the electrons collected in a fission chamber are released as a result of ionizations caused directly by...

A. fission fragments.

B. fission gammas.

C. fission betas.

D. fissionable materials.

ANSWER: A.

TOPIC: Sensors and Detectors

A gas-filled radiation detector operating in the ion chamber region is exposed to a constant gamma radiation field. If the detector's applied voltage is increased, but kept within the ion chamber region, the detector's output will…

A. increase, because the production rate of secondary ions will increase.

B. increase, because the recombination rate of primary ions will decrease.

C. remain the same, because the detector is already producing its maximum output.

D. remain the same, because the detector's operation is unaffected by the change in applied voltage.

ANSWER: D.

TOPIC: Sensors and Detectors

Which one of the following materials is typically installed inside an ion chamber detector that is used for reactor power indication?

A. Polyethylene

B. Boron-10

C. Uranium-238

D. Rhodium-103

ANSWER: B.

TOPIC: Sensors and Detectors

In a gas-filled radiation detector operating in the proportional region, essentially __________ of the ions caused by incident radiation are collected; and the number of ions collected from secondary ionizations is __________ the applied voltage.

A. all; independent of

B. none; related to

C. all; related to

D. none; independent of

ANSWER: C.

TOPIC: Sensors and Detectors

Which one of the following features is typically used to enhance thermal neutron detection in a gas-filled detector?

A. Encapsulate the detector in polyethylene.

B. Encapsulate the detector in boron-10.

C. Line the inside of the detector with polyethylene.

D. Line the inside of the detector with boron-10.

ANSWER: D.

TOPIC: Sensors and Detectors

Which one of the following describes why a BF_3 proportional counter can be used in the source range to measure neutron radiation in a radiation field that also contains gamma radiation?

A. Neutrons directly ionize the BF_3 gas, producing larger pulses than gammas.

B. Neutrons interacting with the BF_3 gas result in the release of alpha particles, which produce larger pulses than gammas.

C. Neutrons are captured by boron-10 and produce additional neutrons that completely ionize the fill gas in the detector.

D. The gamma radiation field is insignificant when compared to the neutron field.

ANSWER: B.

TOPIC: Sensors and Detectors

Which one of the following types of radiation will produce the greatest number of ions while passing through one centimeter of air? (Assume the same initial kinetic energy for each type of radiation.)

A. Alpha

B. Beta

C. Gamma

D. Neutron

ANSWER: A.

TOPIC: Sensors and Detectors

Which one of the following lists the two types of gas-filled radiation detectors whose outputs will be least affected by a small variation (±10 volts) in the voltage applied to the detectors? (Assume the applied voltage remains within normal range.)

A. Limited proportional and Geiger-Mueller

B. Ion chamber and proportional

C. Proportional and limited proportional

D. Geiger-Mueller and ion chamber

ANSWER: D.

TOPIC: Sensors and Detectors

Which one of the following describes a characteristic of a Geiger-Mueller radiation detector?

A. Radiation types can be identified by pulse height and duration.

B. Specific radionuclides can be identified with the use of gamma spectrometry.

C. Small variations in applied voltage will result in large changes in detector output.

D. Any type of radiation that ionizes the detector gas will produce the same magnitude detector output pulse.

ANSWER: D.

TOPIC: Sensors and Detectors

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.

ANSWER: D.

TOPIC: Sensors and Detectors

A gas-filled radiation detector operating in the proportional region is exposed to a constant gamma radiation field. If the detector's applied voltage is increased but maintained within the proportional region, the rate of ion collection will...

A. increase, because more secondary ionizations are occurring in the detector.

B. increase, because fewer primary ions are recombining with electrons prior to reaching the electrodes.

C. stay approximately the same, because the ion chamber is operating at saturated conditions.

D. stay approximately the same, because all of the primary ions were already being collected at the lower voltage.

ANSWER: A.

TOPIC: Sensors and Detectors

What is the function of the positive electrode in an ion chamber?

A. Produce ions when exposed to a radiation field.

B. Release electrons to combine with positive ions.

C. Perform gas quenching to maximize detector sensitivity.

D. Collect the electrons released during gas ionization.

ANSWER: D.

TOPIC: Sensors and Detectors

Just prior to a plant outage, the power range nuclear instruments (using excore detectors) were calibrated at 50 percent reactor power. During the outage, 25 percent of the fuel assemblies were shuffled to reduce the power being produced at the center of the core. No fuel assemblies were replaced.

Immediately after the outage, when the reactor is stabilized at 50 percent, indicated reactor power will be __________ than actual power because neutron leakage from the core has __________.

A. higher; increased

B. higher; decreased

C. lower; increased

D. lower; decreased

ANSWER: A.

TOPIC: Sensors and Detectors

A gas-filled radiation detector operating in the ion chamber is exposed to a constant gamma radiation field. If the applied voltage is increased but maintained within the ion chamber region, the rate of ion collection will...

A. increase, because more secondary ionizations are occurring in the detector.

B. stay approximately the same, because all of the primary ions were already being collected at the lower voltage.

C. increase, because fewer primary ions are recombining in the detector prior to reaching the electrodes.

D. stay approximately the same, because the ion chamber is operating at saturated conditions.

ANSWER: B.

TOPIC: Sensors and Detectors

What is the effect on a gas-filled neutron detector operating in the proportional region if the detector voltage is increased such that the detector operates closer to the high end of the proportional region?

A. Neutron-induced 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-induced pulses, yielding a less accurate neutron count rate.

C. A high rate of incident gamma radiation will result in the combination of multiple small gamma-induced pulses into larger pulses. The larger combined pulses will be counted as neutron-induced 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.

ANSWER: C.

TOPIC: Sensors and Detectors

A gas-filled radiation detector operating in the proportional region is exposed to a constant gamma radiation field. If the applied voltage is decreased but maintained within the proportional region, the rate of ion collection will...

A. stay approximately the same, because all primary ions are collected as long as detector voltage remains in the proportional region.

B. stay approximately the same, because the detector is still operating at saturated conditions.

C. decrease, because a decreased space charge around the positive electrode reduces gas amplification.

D. decrease, because fewer secondary ionizations are occurring in the detector.

ANSWER: D.

TOPIC: Sensors and Detectors

A gas-filled radiation detector operating in the ion chamber region is exposed to a constant gamma radiation field. If the applied voltage is decreased but maintained within the ion chamber region, the rate of ion collection will...

A. stay approximately the same, because all of the primary ions continue to be collected and essentially no secondary ionizations are occurring.

B. stay approximately the same, because detector operation in the ionization chamber region is characterized by complete ionization of the detector gas.

C. decrease, because fewer primary ionizations are occurring in the detector as detector voltage decreases.

D. decrease, because fewer secondary ionizations are occurring in the detector as detector voltage decreases.

ANSWER: A.

TOPIC: Sensors and Detectors

A nuclear power plant startup is in progress immediately following a reactor refueling outage. The external nuclear instrumentation (NI) was calibrated at 50 percent power just prior to the refueling outage and has <u>not</u> been readjusted.

If actual reactor power level is increased to 50 percent and stabilized, NI power level will indicate __________ than actual reactor power level because, when compared to pre-outage 50 percent power level operation, __________.

A. higher; the total core fission rate has increased

B. lower; the total core fission rate has decreased

C. higher; the fission rate in the outer portion of the core has increased

D. lower; the fission rate in the outer portion of the core has decreased

ANSWER: D.

TOPIC: Sensors and Detectors

Which one of the following describes the reason for the high sensitivity of a gas-filled radiation detector operating in the Geiger-Mueller region?

A. Any radiation-induced ionization results in a large detector output pulse.

B. Geiger-Mueller detectors are longer than other types of radiation detectors, resulting in greater detector surface area.

C. The detector output is inversely proportional to the applied voltage within the Geiger-Mueller region.

D. High detector voltage allows differentiation between the various radiation types.

ANSWER: A.

TOPIC: Sensors and Detectors

During a refueling outage, the fuel assemblies were reconfigured to reduce the radial power peak at the center of the core while maintaining the same rated thermal power. Excore power range detectors were calibrated at 50 percent power just prior to the outage.

How will indicated reactor power compare to actual reactor power when the nuclear power plant is stabilized at 50 percent power following the outage?

A. Indicated reactor power will be higher than actual reactor power due to increased core neutron leakage.

B. Indicated reactor power will be higher than actual reactor power due to decreased core neutron leakage.

C. Indicated reactor power will be lower than actual reactor power due to decreased core neutron leakage.

D. Indicated reactor power will be lower than actual reactor power due to increased core neutron leakage.

ANSWER: A.

TOPIC: Sensors and Detectors

Which one of the following statements describes the operation of a gas-filled radiation detector operating in the proportional region?

A. The number of ions collected from both primary and secondary ionizations is independent of the applied voltage.

B. Essentially all of the ions from primary ionizations are collected; the number of ions collected from secondary ionizations is independent of the applied voltage.

C. The number of ions collected from both primary and secondary ionizations varies directly with the applied voltage on a logarithmic scale.

D. Essentially all of the ions from primary ionizations are collected; the number of ions collected from secondary ionizations varies directly with the applied voltage on a logarithmic scale.

ANSWER: D.

TOPIC: Sensors and Detectors

A boron trifluoride (BF_3) detector (proportional counter) is normally used to monitor only source range core neutron level. How will the detector and source range count rate indication be affected if normal detector high voltage is inadvertently applied during reactor operation in the power range?

A. The BF_3 gas will become completely ionized and source range indication will stabilize at a constant low value.

B. The BF_3 gas will become completely ionized and source range indication will stabilize at a constant high value.

C. The detector electrodes will become exposed to an extremely high neutron flux and cause a false high reading on the source range indication.

D. The detector electrodes will become exposed to an extremely high gamma flux and cause a false high reading on the source range indication.

ANSWER: A.

TOPIC: Sensors and Detectors

A beta particle and an alpha particle enter and cause ionization in a gas-filled radiation detector operating in the Geiger-Mueller region. Which one of the following accurately compares the amplitude of the detector pulses caused by each type of radiation?

A. The beta particle pulse will be larger in amplitude.

B. The alpha particle pulse will be larger in amplitude.

C. The pulses will be the same for both types of radiation.

D. Cannot be determined without particle kinetic energy information.

ANSWER: C.

TOPIC: Sensors and Detectors

A nuclear power plant has been shut down for one month. A portable gas-filled radiation detector is needed to monitor shutdown reactor core neutron level from a location outside the reactor vessel. The detector must be able to distinguish between ionizations caused by gamma and neutron radiation.

Which region(s) of the gas-filled detector characteristic curve is/are acceptable for operation of the detector?

A. Geiger-Mueller, Ion Chamber, and Proportional regions are all acceptable.

B. Proportional region is acceptable, and Ion Chamber region also may be usable.

C. Ion Chamber region is acceptable, and Geiger-Mueller region also may be usable.

D. Geiger-Mueller region is acceptable, and Proportional region also may be usable.

ANSWER: B.

TOPIC: Sensors and Detectors

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

ANSWER: C.

TOPIC: Sensors and Detectors

Which one of the following contains the pair of radiation detector types that are the most sensitive to low-energy beta and/or gamma radiation?

A. Geiger-Mueller and scintillation

B. Geiger-Mueller and ion chamber

C. Ion chamber and scintillation

D. Ion chamber and proportional

ANSWER: A.

TOPIC: Sensors and Detectors

A beta particle and an alpha particle with equal kinetic energies cause ionization in a gas-filled radiation detector. The detector is operating in the ion chamber region of the gas ionization curve. Which one of the following describes the amplitudes of the detector pulses caused by each type of radiation?

A. The beta particle pulse will be larger in amplitude.

B. The alpha particle pulse will be larger in amplitude.

C. The amplitudes of both pulses will be approximately equal for all detector voltages in the ion chamber region.

D. The amplitudes of both pulses will be approximately equal for all detector voltages in the ion chamber region, as well as all detector voltages outside the ion chamber region.

ANSWER: B.

TOPIC: Sensors and Detectors

Which one of the following types of radiation detectors is generally not used for measuring a high-intensity beta and gamma radiation field because of a relatively long detector recovery time, or dead time, following each ionization event?

A. Geiger-Mueller

B. Ion chamber

C. Proportional

D. Scintillation

ANSWER: A.

TOPIC: Sensors and Detectors

A proportional detector with pulse height discrimination circuitry is being used in a constant field of neutron and gamma radiation to provide source range neutron count rate indication. Assume that the pulse height discrimination setpoint does not change.

If the detector voltage is increased but maintained within the proportional region, count rate indication will increase because...

A. a single neutron- or gamma-induced ionizing event will result in multiple pulses inside the detector.

B. the ratio of the number of neutron-induced pulses to gamma-induced pulses inside the detector will increase.

C. the positive space charge effect will increase and promote the collection of both gamma- and neutron-induced pulses.

D. all detector pulses will increase in amplitude and previously uncounted gamma pulses will be added to the total count rate.

ANSWER: D.

TOPIC: Sensors and Detectors

Which one of the following types of radiation detectors uses a gas volume for radiation detection and will typically produce the weakest output signal if all of the detectors are placed in the same gamma radiation field?

A. Geiger-Mueller

B. Ion chamber

C. Proportional counter

D. Scintillation

ANSWER: B.

TOPIC: Sensors and Detectors

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

A. Geiger-Mueller

B. Ion chamber

C. Proportional counter

D. Scintillation

ANSWER: A.

TOPIC: Sensors and Detectors

A fission chamber neutron detector is located in a constant neutron radiation field and is initially operating in the proportional region. If the voltage applied to the detector is changed such that the detector operates in the ion chamber region, the rate of neutron interactions in the detector will __________; and the amplitude of each neutron-induced detector pulse will __________.

A. increase; increase

B. decrease; decrease

C. remain the same; increase

D. remain the same; decrease

ANSWER: D.

TOPIC: Sensors and Detectors

Which one of the following describes the positive space charge effect associated with a gas-filled radiation detector?

A. Multiple detector pulses result from a single ionization event because positive ions form a cloud around the negative electrode, which increases the electric field strength, thereby initiating secondary ionizations.

B. Multiple detector pulses result from a single ionization event because positive ions form a cloud around the positive electrode, which increases the electric field strength, thereby initiating secondary ionizations.

C. The pulse amplitude resulting from an ionization event is reduced because positive ions form a cloud around the negative electrode, which reduces the electric field strength, thereby limiting secondary ionizations.

D. The pulse amplitude resulting from an ionization event is reduced because positive ions form a cloud around the positive electrode, which reduces the electric field strength, thereby limiting secondary ionizations.

ANSWER: D.

TOPIC: Sensors and Detectors

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

A. Geiger-Mueller only.

B. Geiger-Mueller and Ionization Chamber.

C. Proportional only.

D. Proportional and Ionization Chamber.

ANSWER: A.

TOPIC: Sensors and Detectors

Which one of the following personal radiation monitoring devices can be charged with DC voltage to “zero” the device prior to use?

A. Film badge

B. Alarming dosimeter

C. Thermoluminescent dosimeter

D. Self-reading pocket dosimeter

ANSWER: D.

TOPIC: Sensors and Detectors

A Geiger-Mueller detector with a pancake probe (often called a frisker) is being used to monitor personnel leaving a radiologically controlled area. The probe is equipped with a mica window.

Two individuals have radioactive skin contamination—one individual with only alpha emitters, and the other with only beta emitters. Both types of radiation are being emitted at the same rate. The same percentage of each type of radiation enters the probe's detection chamber and causes ionization.

Which one of the following describes the detector's count rate response to the alpha and beta radiation?

A. The count rate will be higher for the alpha radiation.

B. The count rate will be higher for the beta radiation.

C. The count rate will be the same for both types of radiation.

D. Cannot be determined without knowing the energy levels of the radiation.

ANSWER: C.

TOPIC: Sensors and Detectors

Just prior to a plant outage, the power range nuclear instruments (using excore detectors) were calibrated at 50 percent reactor power. During the outage, 40 fuel assemblies from the center of the core were exchanged with 40 higher enriched fuel assemblies from the outer portions of the core. No other fuel assemblies were affected.

Immediately after the outage, when the reactor is stabilized at 50 percent power, indicated reactor power will be __________ than actual reactor power because neutron leakage from the core has __________.

A. lower; decreased

B. lower; increased

C. higher; decreased

D. higher; increased

ANSWER: A.

TOPIC: Sensors and Detectors

A proportional detector with pulse height discrimination circuitry is being used in a constant field of neutron and gamma radiation to provide source range neutron count rate indication. Assume the pulse height discrimination threshold does not change.

If the detector voltage is decreased significantly, but maintained within the proportional region, the detector count rate indication will __________; and the detector will become __________ susceptible to the positive space charge effect.

A. decrease; less

B. decrease; more

C. remain the same; less

D. remain the same: more

ANSWER: A.

TOPIC: Sensors and Detectors

A gas-filled radiation detector that operates in the Geiger-Mueller region of the gas ionization curve is being used in a constant radiation field. If the detector's operating voltage is increased by 50 volts while remaining in the Geiger-Mueller region, the detector's count rate indication will __________; and the ability of the detector to detect gamma radiation will __________.

A. increase; improve

B. increase; remain the same

C. remain the same; improve

D. remain the same; remain the same

ANSWER: D.

TOPIC: Sensors and Detectors

A proportional detector with pulse height discrimination circuitry is being used in a constant field of neutron and gamma radiation to provide source range neutron count rate indication. Assume the pulse height discrimination value does <u>not</u> change.

If the detector voltage is increased significantly, but maintained within the proportional region, the detector count rate indication will __________; and the detector will become __________ susceptible to the positive space charge effect.

A. increase; less

B. increase; more

C. remain the same; less

D. remain the same: more

ANSWER: B.

TOPIC: Sensors and Detectors

A fission chamber detector is initially operating in the proportional region to measure neutron flux in the source range. If the voltage applied to the detector is changed so that the detector now operates in the ion chamber region, the detector will produce __________ pulses; and will experience a __________ positive space charge effect.

A. larger; larger

B. larger; smaller

C. smaller; larger

D. smaller; smaller

ANSWER: D.

TOPIC: Sensors and Detectors

A gas-filled radiation detector is operating in the proportional region with a count rate indication of 1.0×10^5 cpm in a constant radiation field. The detector does <u>not</u> have pulse height discrimination circuitry.

If the detector's operating voltage is increased by 20 percent while remaining in the proportional region, the total number of ions resulting from a single ionization within the detector will __________; and the detector count rate indication will __________.

A. increase; increase

B. increase; remain the same

C. remain the same; increase

D. remain the same; remain the same

ANSWER: B.

TOPIC: Sensors and Detectors

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

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

A. ion; gas

B. ion; electrodes

C. electron; gas

D. electron; electrodes

ANSWER: C.

TOPIC: Sensors and Detectors

A typical gamma ray (1 to 2 MeV) normally produces a free electron in a gas-filled radiation detector by…

A. transferring energy to a nucleus, which recoils and leaves behind a free electron.

B. transferring energy to a bound electron, which recoils and becomes a free electron.

C. entering the electrostatic field of a nucleus, where it transforms into a proton and a free electron.

D. entering the electrostatic field of a bound electron, where it transforms into a positron and a free electron.

ANSWER: B.

TOPIC: Sensors and Detectors

A typical alpha particle produces free electrons in a gas-filled radiation detector <u>primarily</u> by…

A. colliding with gas nuclei.

B. colliding with bound electrons.

C. electrostatic attraction of gas nuclei.

D. electrostatic attraction of bound electrons.

ANSWER: D.

TOPIC: Sensors and Detectors

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

A. The output of an SRPD is a dose rate in mR/hr.

B. SRPDs are primarily sensitive to beta radiation.

C. SRPD readings must be considered inaccurate when they are dropped.

D. SRPDs hold their charge indefinitely when removed from a radiation field.

ANSWER: C.

TOPIC: Sensors and Detectors

Which one of the following types of radiation is the major contributor to the dose indication on a self-reading pocket dosimeter (SRPD)?

A. Alpha

B. Beta

C. Gamma

D. Neutron

ANSWER: C.

TOPIC: Sensors and Detectors

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

A. Provides dose rate indication in mR/hr.

B. More sensitive to gamma radiation than beta radiation.

C. Contains crystals that luminesce when exposed to ionizing radiation.

D. Can be stored as an accurate record of lifetime radiation exposure.

ANSWER: B.

TOPIC: Sensors and Detectors

A nuclear plant worker normally wears a thermoluminescent dosimeter (TLD) or similar device for measuring radiation exposure. When a self-reading pocket dosimeter (SRPD) is also required, where will the SRPD be worn and why?

A. Below the waist near the TLD to measure radiation from the same source(s).

B. Below the waist away from the TLD to measure radiation from different sources.

C. Above the waist near the TLD to measure radiation from the same source(s).

D. Above the waist away from the TLD to measure radiation from different sources.

ANSWER: C.

TOPIC: Sensors and Detectors

A Geiger-Mueller detector with a pancake probe (often called a frisker) is being used to monitor workers leaving a radiologically controlled area for contamination. The probe is equipped with a mica window. The background detector count rate is 20 cpm.

As one worker's shoe is scanned, the count rate increases to 200 cpm. When a sheet of paper is placed between the probe and the shoe, the count rate decreases to 60 cpm. Which one of the following is indicated by the decrease in the count rate?

A. The contamination contains beta particles.

B. The contamination contains alpha particles.

C. The contamination does <u>not</u> contain beta particles.

D. The contamination does <u>not</u> contain alpha particles.

ANSWER: B.

TOPIC: Sensors and Detectors

A Geiger Mueller detector with a pancake probe (sometimes called a frisker) is being used to monitor for skin contamination. During frisking, the probe is more likely to detect contamination if the probe is held __________ than one-half inch from the skin; and is moved __________ than two inches per second.

A. farther; faster

B. farther; slower

C. closer; faster

D. closer; slower

ANSWER: D.

TOPIC: Sensors and Detectors

A nuclear plant worker normally wears a thermoluminescent dosimeter (TLD) or similar device for measuring whole body radiation exposure. When a self-reading pocket dosimeter (SRPD) is also required for whole body monitoring, where will the SRPD be worn and why?

A. Near the TLD to add exposure to the TLD measurement.

B. Near the TLD to measure radiation affecting the same part of the body.

C. Away from the TLD to add exposure to the TLD measurement.

D. Away from the TLD to measure radiation affecting a different part of the body.

ANSWER: B.

TOPIC: Sensors and Detectors

A Geiger-Mueller detector with a pancake probe is being used to monitor workers leaving a radiologically controlled area for contamination. The probe is sensitive to alpha, beta, and gamma radiation. The background count rate is 20 cpm. As one worker's shoe is scanned the count rate increases to 1,000 cpm.

Given the following separate actions:

- When a sheet of paper is placed between the probe and the shoe, the count rate decreases to 600 cpm.
- When a sheet of aluminum foil is placed between the probe and the shoe, the count rate decreases to 600 cpm.

Which one of the following lists the type(s) of radiation being emitted by the contamination?

A. Beta only

B. Alpha only

C. Beta and gamma

D. Alpha and gamma

ANSWER: D.

TOPIC: Sensors and Detectors

A Geiger-Mueller detector with a pancake probe is being used to monitor workers leaving a radiologically controlled area for contamination. The probe is sensitive to alpha, beta, and gamma radiation. The background count rate is 20 cpm. As one worker's shoe is scanned, the count rate increases to 1,000 cpm.

Given the following separate actions:

- When a sheet of paper is placed between the probe and the shoe, the count rate decreases to 400 cpm.
- When a sheet of aluminum foil is placed between the probe and the shoe, the count rate decreases to 20 cpm.

The results of the above actions indicate that the radiation from the shoe contamination consists of…

A. beta only.

B. alpha and beta only.

C. beta and gamma only.

D. alpha, beta, and gamma.

ANSWER: B.

TOPIC: Sensors and Detectors

Which one of the following describes the ion collection that occurs in a proportional counter, such as a BF_3 detector?

A. A fraction of the ions created by primary ionizations are collected. No secondary ionizations take place.

B. Virtually all of the ions created by primary ionizations are collected. No secondary ionizations take place.

C. Virtually all of the ions created by primary ionizations along with a fraction of the ions created by secondary ionizations are collected.

D. Virtually all of the ions created by primary and secondary ionizations are collected.

ANSWER: D.

TOPIC: Sensors and Detectors

A fission chamber neutron monitoring instrument is operating in the proportional region. If a complete loss of fission chamber gas pressure occurs, the instrument indication will fail...

A. upscale.

B. downscale.

C. as is.

D. to midscale.

ANSWER: B.

TOPIC: Sensors and Detectors

During reactor power operation, a reactor coolant sample is taken and analyzed. Which one of the following lists three radionuclides that are all indicative of a fuel cladding failure if detected in elevated concentrations in the reactor coolant sample?

A. Lithium-6, cobalt-60, and argon-41

B. Iodine-131, cesium-138, and strontium-89

C. Nitrogen-16, xenon-135, and manganese-56

D. Hydrogen-2, hydrogen-3, and oxygen-18

ANSWER: B.

TOPIC: Sensors and Detectors

During power operation, a reactor coolant sample is taken and analyzed. Which one of the following lists three nuclides that are all indicative of a possible fuel cladding failure if found to be at elevated concentrations in the reactor coolant sample?

A. Oxygen-18, iron-59, and zirconium-95

B. Cobalt-60, iodine-131, and xenon-135

C. Krypton-85, strontium-90, and cesium-136

D. Hydrogen-2, hydrogen-3, and nitrogen-16

ANSWER: C.

TOPIC: Controllers and Positioners

The difference between the setpoint in an automatic controller and the steady-state value of the controlled parameter is called...

A. offset.

B. gain.

C. deadband.

D. feedback.

ANSWER: A.

TOPIC: Controllers and Positioners

The range of values around the setpoint of a measured variable where <u>no</u> <u>action</u> occurs in an automatic flow controller is called...

A. deviation.

B. error.

C. deadband.

D. bias.

ANSWER: C.

TOPIC: Controllers and Positioners

An automatic flow controller is being used to position a valve in a cooling water system. The controller develops a flow error signal and then increases the magnitude of the signal to drive the valve operator.

The factor by which the magnitude of the flow error signal is increased is referred to as...

A. bias.

B. gain.

C. feedback.

D. offset.

ANSWER: B.

TOPIC: Controllers and Positioners

A typical flow controller uses a/an __________ method of control.

A. open-loop

B. on-off

C. closed-loop

D. external regulating

ANSWER: C.

TOPIC: Controllers and Positioners

Which one of the following terms 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

ANSWER: C.

TOPIC: Controllers and Positioners

An automatic flow controller is being used to position a valve in a cooling water system. A signal that is proportional to valve position is received by the controller. This signal is referred to as...

A. gain.

B. bias.

C. feedback.

D. error.

ANSWER: C.

TOPIC: Controllers and Positioners

A flow controller has proportional, integral, and derivative control features. Which one of the following lists the effect on the control features when the controller is switched from the automatic mode to the manual mode?

A. Only the derivative feature will be lost.

B. Only the integral and derivative features will be lost.

C. All proportional, integral, and derivative features will be lost.

D. All control features will continue to influence the controller output.

ANSWER: C.

TOPIC: Controllers and Positioners

Consider a direct-acting proportional flow controller that is maintaining flow rate at a value that is offset from the controller setpoint. If the controllers gain is increased, the controller's offset will __________; and the controller's proportional band will __________.

A. decrease; decrease

B. decrease; increase

C. increase; decrease

D. increase; increase

ANSWER: A.

TOPIC: Controllers and Positioners

An emergency diesel generator (DG) is operating as the only power source connected to an emergency bus. The governor of the DG is <u>directly</u> sensing DG __________ and will <u>directly</u> adjust DG __________ flow to maintain a relatively constant DG frequency.

A. speed; air

B. speed; fuel

C. load; air

D. load; fuel

ANSWER: B.

TOPIC: Controllers and Positioners

If the turbine shaft speed signal received by a typical turbine governor control system fails low during turbine startup, the turbine governor will cause turbine speed to...

A. decrease to a minimum speed setpoint.

B. decrease until the mismatch with demanded turbine speed is nulled.

C. increase until the mismatch with demanded turbine speed is nulled.

D. increase until an upper limit is reached or the turbine trips on overspeed.

ANSWER: D.

TOPIC: Controllers and Positioners

A diesel generator (DG) is the only power source connected to an emergency bus. In this alignment, the governor of the DG directly senses DG __________ and adjusts DG fuel flow to maintain a relatively constant DG __________.

A. voltage; voltage

B. voltage; frequency

C. speed; voltage

D. speed; frequency

ANSWER: D.

TOPIC: Controllers and Positioners

If the turbine shaft speed signal received by a typical turbine governor control system fails high during turbine startup, the turbine governor will cause turbine speed to...

A. increase until an upper limit is reached or the turbine trips on overspeed.

B. increase until the mismatch with the turbine speed demand signal is nulled.

C. decrease until a lower limit is reached or turbine steam flow is isolated.

D. decrease until the mismatch with the turbine speed demand signal is nulled.

ANSWER: C.

TOPIC: Controllers and Positioners

Refer to the drawing of a water storage tank and level control system (see figure below) that have just been returned to service following replacement of the drain valve actuator. Unfortunately, the original direct-acting actuator was mistakenly replaced with a reverse-acting actuator.

Given:

- The drain valve will now fail open if operating air pressure is lost.
- The level control system uses a direct-acting proportional-integral level controller with a setpoint of 15 feet.
- The level controller receives input from a direct-acting level sensor.
- The level controller is currently in manual control, with an operator maintaining the tank water level at 14 feet.
- Tank inlet and outlet flow rates are currently equal with the drain valve 50 percent open.

If the level controller is shifted to automatic control, the tank water level will…

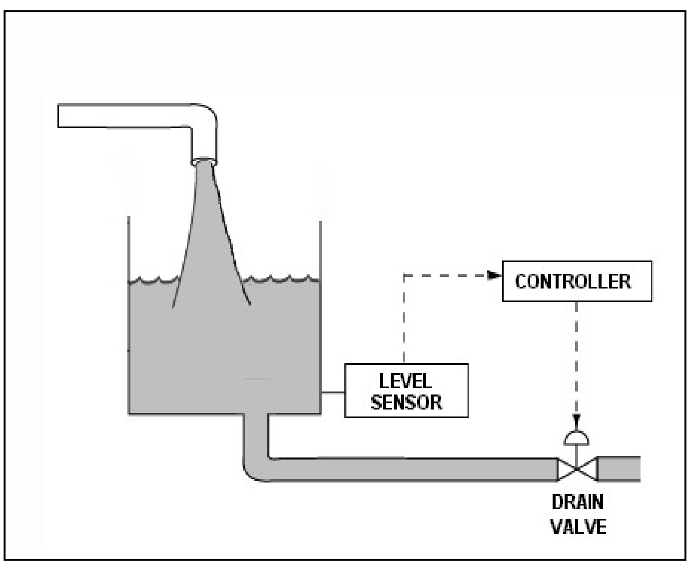
A. increase and stabilize at 15 feet.

B. increase and stabilize slightly higher than 15 feet.

C. decrease until the tank nearly empties.

D. increase until the tank overflows.

ANSWER: C.



TOPIC: Controllers and Positioners

Refer to the drawing of a 30-foot water storage tank and its level control system (see figure below).

The level control system has just been returned to service following replacement of the drain valve actuator. Unfortunately, the original direct-acting actuator was mistakenly replaced with a reverse-acting actuator.

Given:

- The drain valve will now fail open if air pressure is lost to its actuator.
- The level control system uses a direct-acting level sensor and a direct-acting proportional-integral level controller with a setpoint of 15 feet.
- The tank water level is stable at 16 feet with the drain valve 50 percent open.
- The level controller is in Manual control.

If the level controller is shifted to Automatic control, the tank water level will…

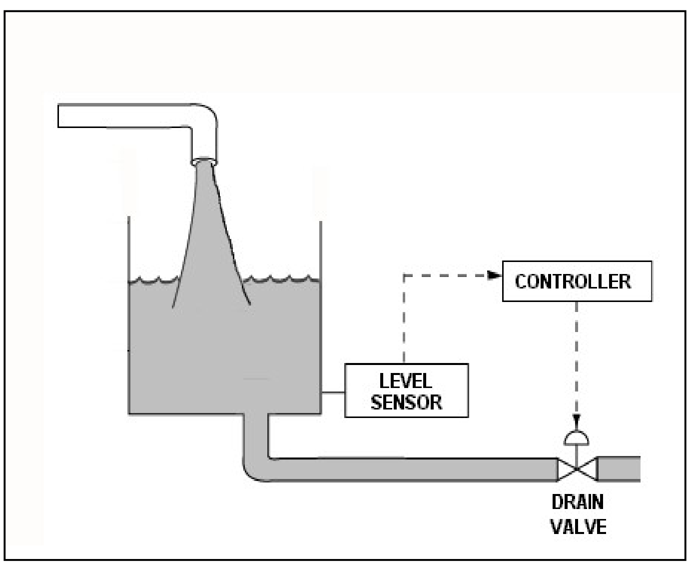
A. increase until the tank overflows.

B. decrease until the tank almost completely empties.

C. initially increase, and then decrease and stabilize at 15 feet.

D. initially decrease, and then increase and stabilize at 15 feet.

ANSWER: A.



TOPIC: Controllers and Positioners

Refer to the drawing of a water storage tank with an automatic level control system (see figure below). The makeup valve will fail closed if its actuator loses air pressure.

Given the following possible combinations of characteristics for the level sensor and controller:

	Level Sensor	Controller
1.	Direct-Acting	Direct-Acting
2.	Direct-Acting	Reverse-Acting
3.	Reverse-Acting	Direct-Acting
4.	Reverse-Acting	Reverse-Acting

Which of the above combinations will work effectively with the makeup valve in the level control system to maintain the desired tank water level?

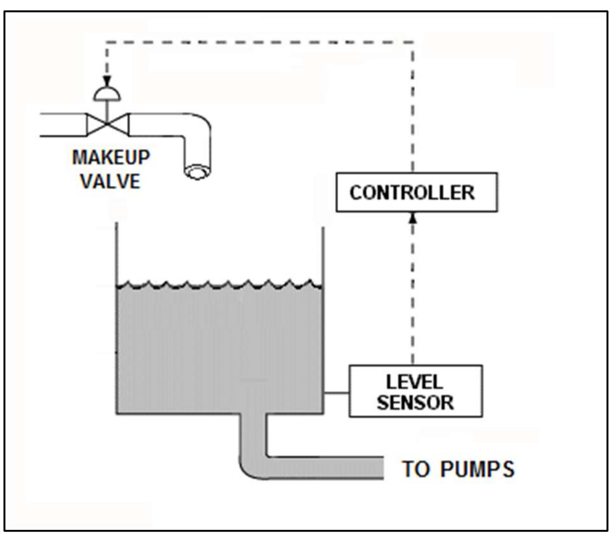
A. 1 only

B. 1 and 4

C. 2 only

D. 2 and 3

ANSWER: D.



TOPIC: Controllers and Positioners

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

If the temperature transmitter fails high (high temperature output signal), the temperature controller will position the temperature control valve more __________, causing the actual heat exchanger lube oil outlet temperature to __________.

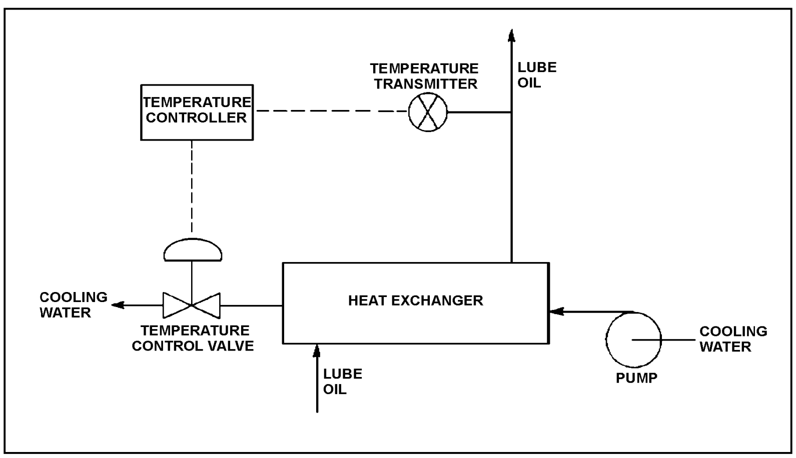
A. open; decrease

B. open; increase

C. closed; decrease

D. closed; increase

ANSWER: A.



TOPIC: Controllers and Positioners

If a typical flow controller is in manual control, the output of the flow controller is determined by the...

A. operator.

B. system feedback.

C. plant computer.

D. flow error signal.

ANSWER: A.

TOPIC: Controllers and Positioners

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

If the temperature transmitter fails <u>low</u> (low temperature output signal), the temperature controller will position the temperature control valve in the __________ direction, which causes the actual heat exchanger lube oil outlet temperature to __________.

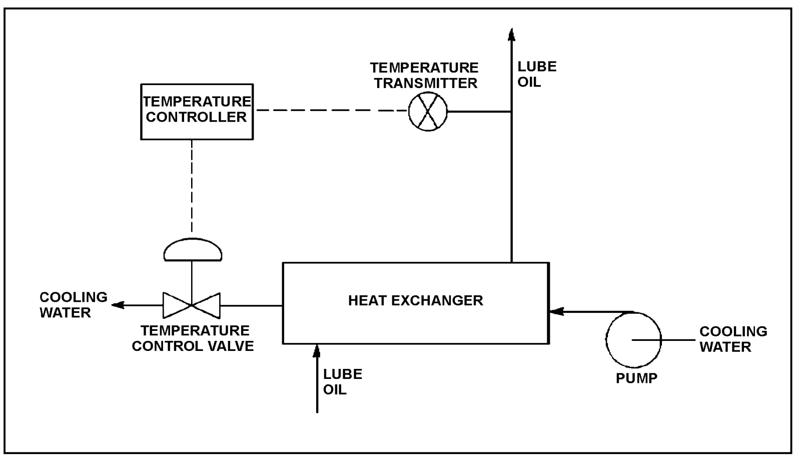
A. close; increase

B. close; decrease

C. open; increase

D. open; decrease

ANSWER: A.



TOPIC: Controllers and Positioners

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

Which one of the following describes the type of control used in the lube oil temperature control system?

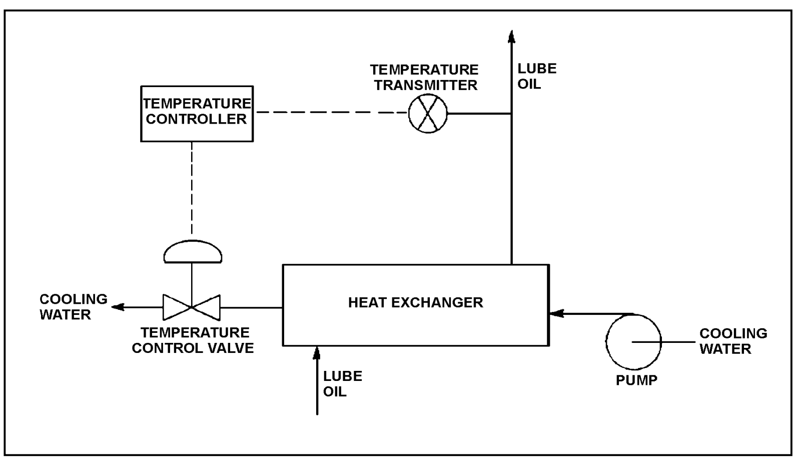
A. Open loop, because lube oil temperature feedback is being provided to the controller from the lube oil temperature transmitter.

B. Open loop, because lube oil temperature is being controlled by positioning a flow control valve in a separate system.

C. Closed loop, because lube oil temperature feedback is being provided to the controller from the lube oil temperature transmitter.

D. Closed loop, because lube oil temperature is being controlled by positioning a flow control valve in a separate system.

ANSWER: C.



TOPIC: Controllers and Positioners

Refer to the drawing of a lube oil temperature control system (see figure below). The temperature control valve is currently 50 percent open.

If the cooling water inlet temperature decreases, the temperature controller will position the temperature control valve more __________, causing cooling water differential temperature through the heat exchanger to __________.

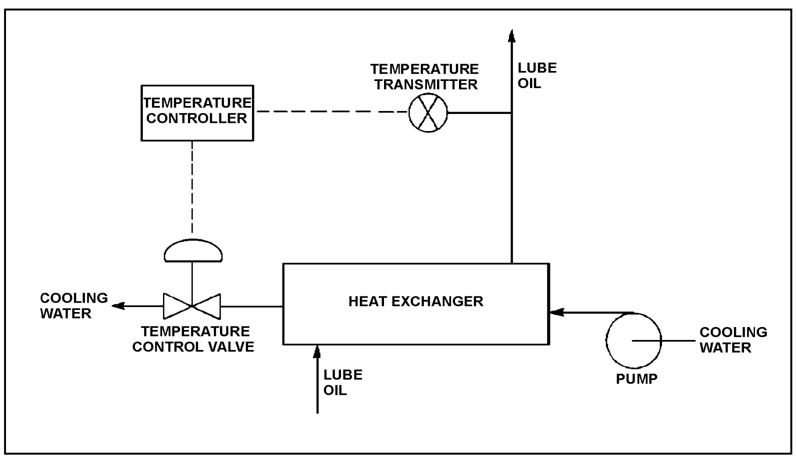
A. closed; increase

B. closed; decrease

C. open; increase

D. open; decrease

ANSWER: A.



TOPIC: Controllers and Positioners

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

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

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

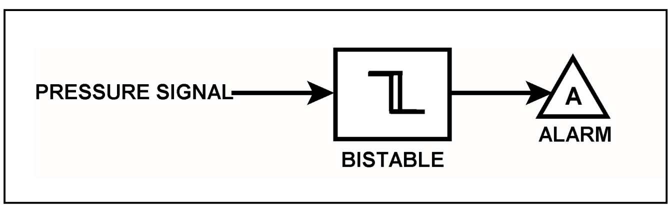
A. The alarm is currently actuated and will turn off at 95 psig.

B. The alarm will actuate at 100 psig and will <u>not</u> 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.

ANSWER: C.



TOPIC: Controllers and Positioners

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

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

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

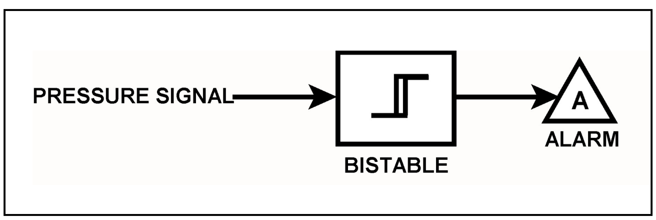
A. The alarm is currently actuated and will turn off at 95 psig.

B. The alarm will actuate at 100 psig and will <u>not</u> 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.

ANSWER: B.



TOPIC: Controllers and Positioners

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

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

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

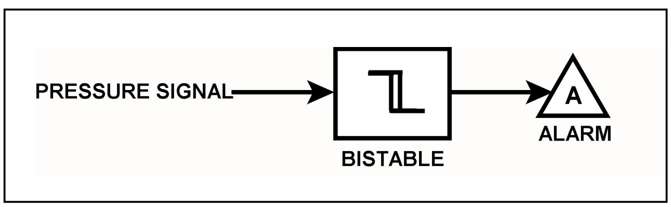
A. The alarm will actuate at 100 psig and will <u>not</u> turn off.

B. The alarm will actuate at 100 psig and will turn off at 95 psig.

C. The alarm is currently actuated and will <u>not</u> turn off.

D. The alarm is currently actuated and will turn off at 95 psig.

ANSWER: A.



TOPIC: Controllers and Positioners

Refer to the drawing of four bistable symbols (see figure below).

A temperature controller uses a bistable that turns on to actuate a warning light when the controlled temperature reaches a low setpoint. The warning light extinguishes immediately after the temperature increases above the low setpoint.

Which one of the following bistable symbols indicates the characteristics of the bistable?

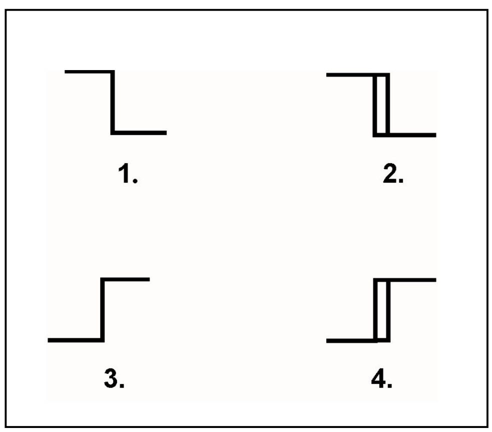
A. 1.

B. 2.

C. 3.

D. 4.

ANSWER: A.



TOPIC: Controllers and Positioners

Refer to the drawing of four bistable symbols (see figure below).

A temperature controller uses a bistable that turns on to actuate a warning light when the controlled temperature reaches a high setpoint. The bistable turns off to extinguish the warning light when the temperature decreases to 5°F below the high setpoint.

Which one of the following bistable symbols indicates the characteristics of the bistable?

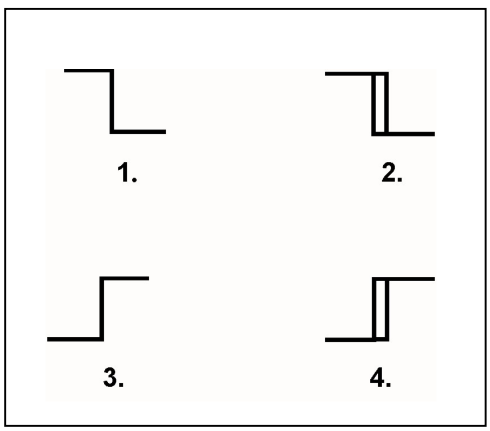
A. 1.

B. 2.

C. 3.

D. 4.

ANSWER: D.



TOPIC: Controllers and Positioners

Refer to the drawing of a temperature 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 temperature of 130°F. The bistable has a 5°F deadband, or neutral zone.

If the current temperature is 150°F, which one of the following describes the alarm circuit response as temperature slowly decreases to 110°F?

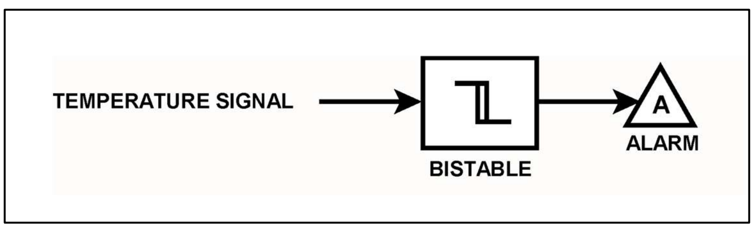
A. The alarm is currently actuated and will <u>not</u> turn off.

B. The alarm will actuate at 130°F and will <u>not</u> turn off.

C. The alarm is currently actuated and will turn off at 125°F.

D. The alarm will actuate at 130°F and will turn off at 125°F.

ANSWER: B.



TOPIC: Controllers and Positioners

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

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

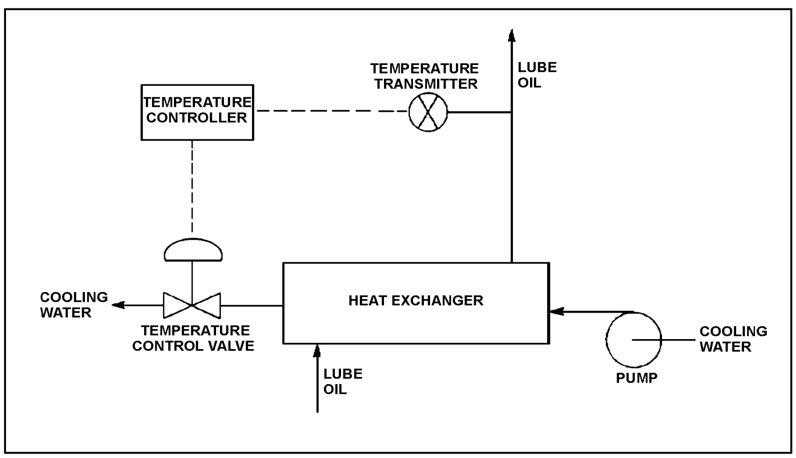
A. Half the temperature deviation from setpoint will produce a given controller output.

B. Twice the temperature deviation from setpoint will produce a given controller output.

C. The temperature control valve will move half as far for a given change in controller output.

D. The temperature control valve will move twice as far for a given change in controller output.

ANSWER: A.



TOPIC: Controllers and Positioners

A direct-acting proportional controller is being used with a direct-acting transmitter to control the temperature of lube oil exiting a heat exchanger. The controller's proportional band is 70°F to 120°F.

Which one of the following will be the controller's output percentage when the measured lube oil temperature is 83°F?

A. 13 percent

B. 26 percent

C. 37 percent

D. 74 percent

ANSWER: B.

SOLUTION:

TOPIC: Controllers and Positioners

A reverse-acting proportional controller is being used with a direct-acting transmitter to control the temperature of lube oil exiting a heat exchanger. The controller's proportional band is 70°F to 120°F.

Which one of the following will be the controller's output percentage when the measured lube oil temperature is 83°F?

A. 13 percent

B. 26 percent

C. 74 percent

D. 87 percent

ANSWER: C.

TOPIC: Controllers and Positioners

The temperature of the water in a storage tank is monitored by a bistable alarm circuit. If water temperature decreases to 50°F, a bistable turns on to actuate an alarm indicator. As soon as the water temperature exceeds 50°F, the bistable turns off to clear the alarm.

Which one of the following bistable symbols indicates the characteristics of the bistable used in the alarm circuit?

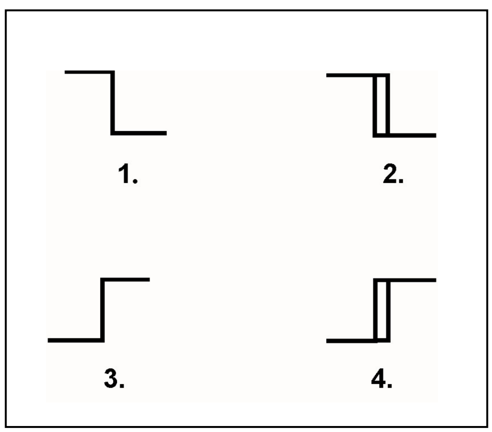
A. 1.

B. 2.

C. 3.

D. 4.

ANSWER: A.



TOPIC: Controllers and Positioners

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

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

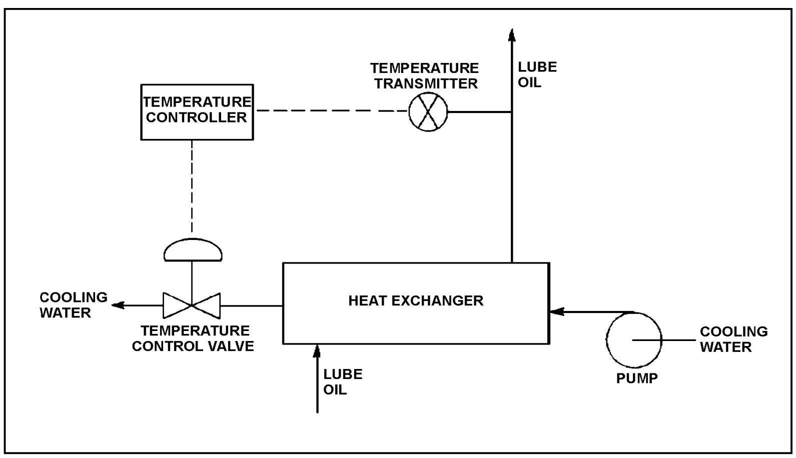
A. Increases the range of lube oil temperatures that produces a proportional controller response.

B. Increases the change in valve position resulting from a given change in lube oil temperature.

C. Increases the difference between the controller setpoint and the lube oil temperature at steady-state conditions.

D. Increases the lube oil temperature deviation from setpoint required to produce a given controller output.

ANSWER: B.



TOPIC: Controllers and Positioners

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

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

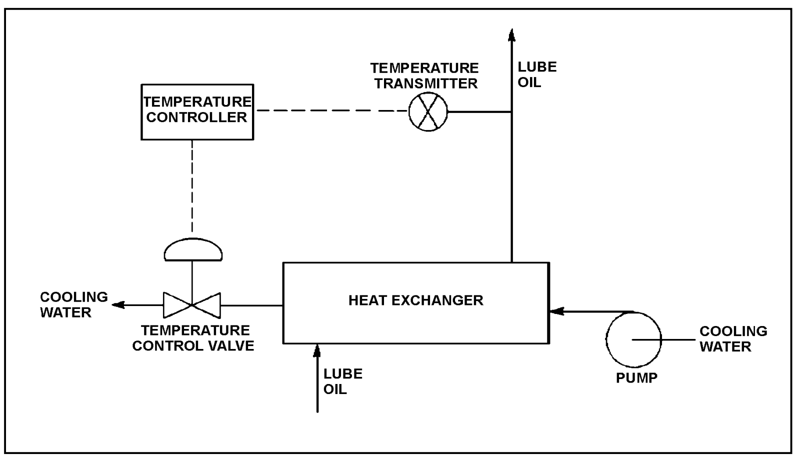
A. Half the change in measured temperature will produce the same change in controller input.

B. Twice the change in measured temperature will produce the same change in controller input.

C. The temperature control valve will move half as far for the same change in controller input.

D. The temperature control valve will move twice as far for the same change in controller input.

ANSWER: D.



TOPIC: Controllers and Positioners

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

The temperature controller is a direct-acting proportional-integral controller with a gain of 1.0. A step increase in lube oil temperature results in an initial controller demand for the temperature control valve (TCV) to open an additional 10 percent. After the lube oil temperature stabilizes, the final TCV position is 60 percent open.

If the controller's gain was 2.0 rather than 1.0, the initial controller demand for the above temperature transient would be for the TCV to open an additional __________ percent; and the final TCV position would be __________ percent open.

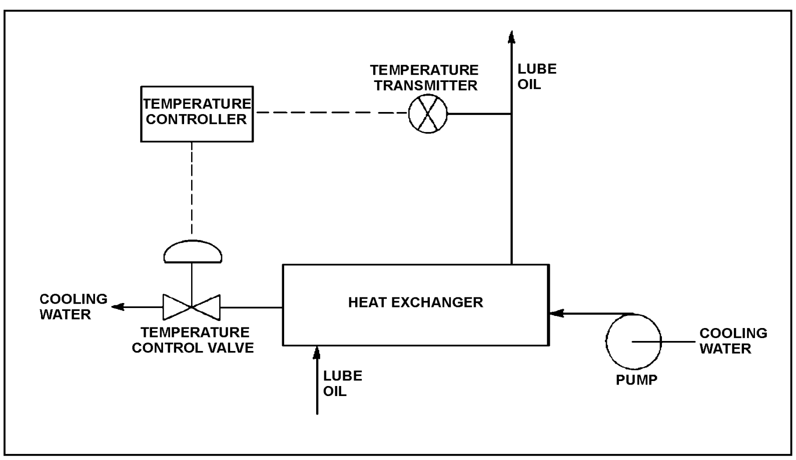
A. 5; 60

B. 5; less than 60

C. 20; 60

D. 20; more than 60

ANSWER: C.



TOPIC: Controllers and Positioners

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

The temperature controller is a direct-acting proportional-integral controller with a gain of 1.0. All system temperatures are initially stable.

An increase in lube oil temperature causes the controller to open the temperature control valve (TCV) farther. What would be the effect on the TCV response if the controller gain was 2.0 rather than 1.0?

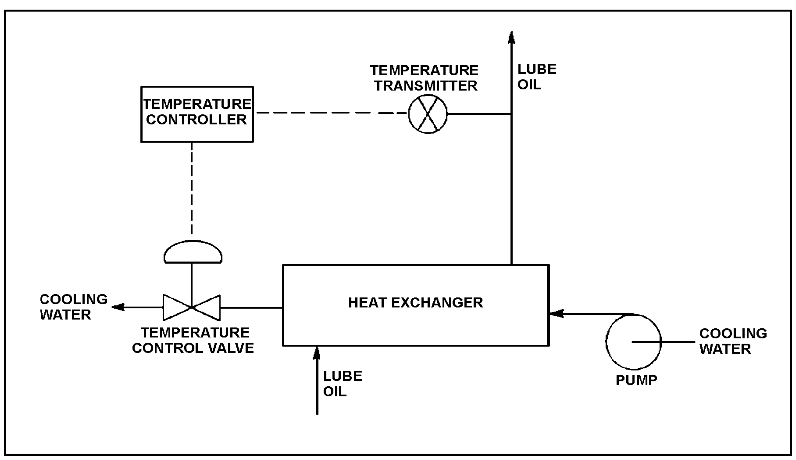
A. The final TCV position would be half as far from its initial position.

B. The final TCV position would be twice as far from its initial position.

C. The final TCV position would be the same, but the TCV initially would travel a greater distance in response to the lube oil temperature change.

D. The final TCV position would be the same, but the TCV initially would travel a shorter distance in response to the lube oil temperature change.

ANSWER: C.



TOPIC: Controllers and Positioners

Refer to the drawing of four bistable symbols (see figure below).

A temperature controller uses a bistable that turns on to actuate a warning light when the controlled temperature reaches a low setpoint. The bistable turns off to extinguish the warning light when the temperature increases to 5°F above the low setpoint.

Which one of the following bistable symbols indicates the characteristics of the bistable?

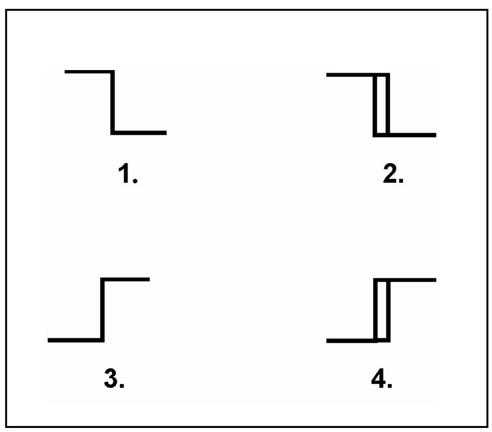
A. 1.

B. 2.

C. 3.

D. 4.

ANSWER: B.



TOPIC: Controllers and Positioners

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

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

A. 12 percent

B. 24 percent

C. 38 percent

D. 76 percent

ANSWER: B.

TOPIC: Controllers and Positioners

Refer to the drawing of a temperature 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 temperature of 130°F. The bistable has a 5°F deadband, or neutral zone.

If the current temperature is 150°F, which one of the following describes the alarm circuit response as temperature slowly decreases to 110°F?

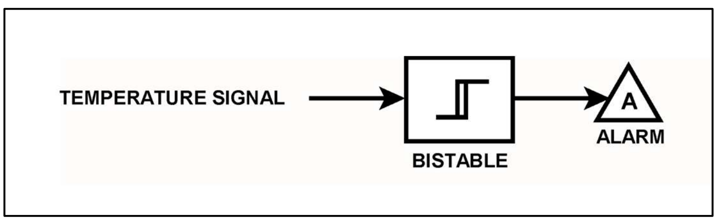
A. The alarm is currently actuated and will not turn off.

B. The alarm will actuate at 130°F and will not turn off.

C. The alarm is currently actuated and will turn off at 125°F.

D. The alarm will actuate at 130°F and will turn off at 125°F.

ANSWER: C.



TOPIC: Controllers and Positioners

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

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

If system pressure increases to 105 psig, and subsequently decreases to __________; the status of the alarm will be __________.

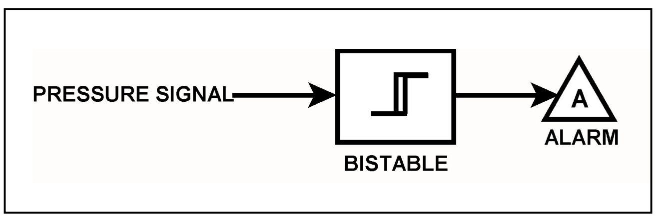
A. 100 psig; off

B. 98 psig; off

C. 94 psig; on

D. 92 psig; off

ANSWER: D.



TOPIC: Controllers and Positioners

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

The bistable will turn on at a system pressure of 100 psig. The bistable has a 5 psig deadband, or neutral zone.

If system pressure is currently 98 psig, which one of the following describes the status of the alarm?

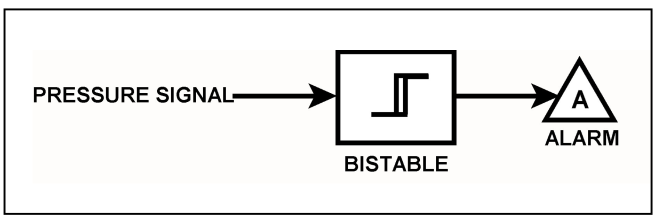
A. The alarm is <u>not</u> actuated.

B. The alarm is actuated and will turn off at 95 psig.

C. The alarm is actuated and will turn off at 105 psig.

D. Additional information is needed to determine the status of the alarm.

ANSWER: D.



TOPIC: Controllers and Positioners

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

The temperature control system uses a direct-acting controller and transmitter. The temperature of the lube oil leaving the heat exchanger is currently stable at 93°F.

To be compatible with the controller, the temperature control valve must fail __________ on a loss of control air pressure; and for the temperature control system to return the lube oil heat exchanger outlet temperature to 93°F after a large change in lube oil heat loads, the controller must have a/an __________ characteristic.

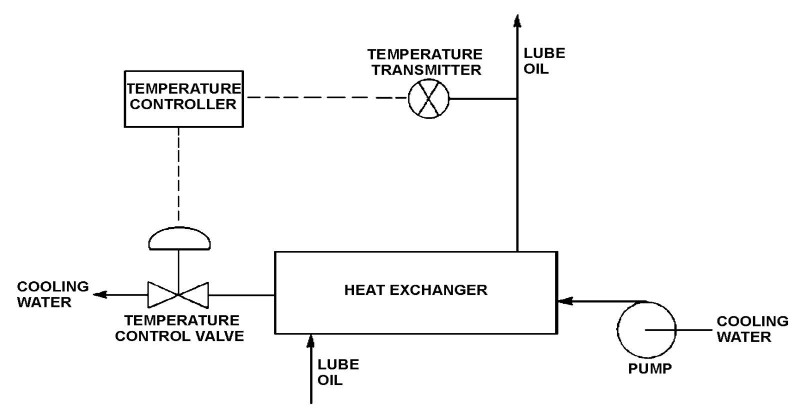
A. closed; integral

B. closed; derivative

C. open; integral

D. open; derivative

ANSWER: A.



LUBE OIL TEMPERATURE CONTROL SYSTEM

TOPIC: Controllers and Positioners

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

The temperature controller is a direct-acting proportional-only controller with a gain of 2.0. All system temperatures are initially stable with the temperature control valve (TCV) 40 percent open.

A sudden increase in the lube oil heat load causes the controller to open the TCV farther. Eventually, all system temperatures stabilize with the final TCV position at 50 percent open.

If the controller's gain was 1.5 rather than 2.0 when the increase in lube oil heat load occurred, the final TCV position would be __________; and the TCV would require __________ time to reach its final position.

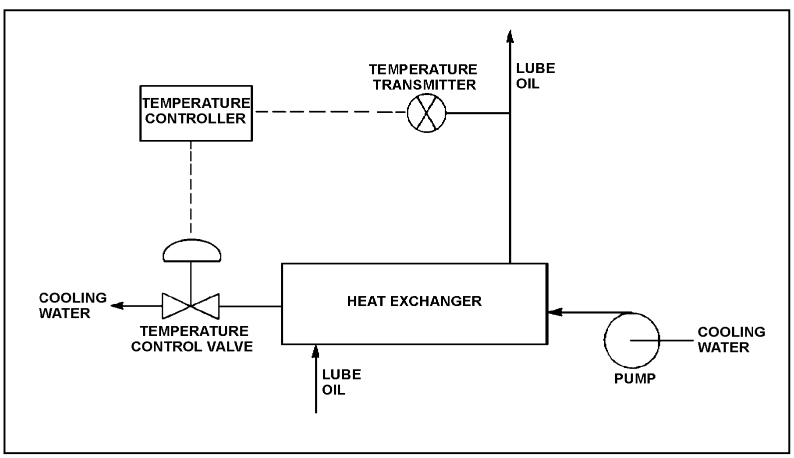
A. the same; less

B. the same; more

C. less than 50 percent open; less

D. more than 50 percent open; more

ANSWER: B.



TOPIC: Controllers and Positioners

Refer to the drawing of a lube oil temperature control system (see figure below). The temperature control system uses a direct-acting transmitter and a direct-acting proportional controller with a 20°F proportional band.

Given:

- The lube oil temperature controller setpoint is 90☜F.
- The heat exchanger lube oil outlet temperature is stable at 93☜F.
- The temperature control valve is 60 percent open.

If the controller's proportional band is changed to 30°F, the heat exchanger lube oil outlet temperature will stabilize __________ than 93°F; and the controller output needed to position the temperature control valve to 60 percent open will be __________.

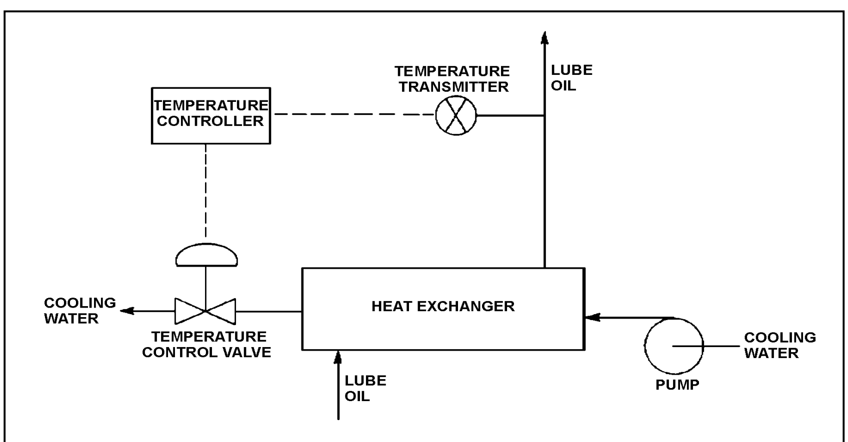
A. lower; the same

B. lower; greater

C. higher; the same

D. higher; greater

ANSWER: C.



LUBE OIL TEMPERATURE CONTROL SYSTEM

TOPIC: Controllers and Positioners

An air-operated valve requires 3,600 pounds-force from its diaphragm actuator for proper valve operation. The diameter of the diaphragm is 12 inches.

Which one of the following is the minimum actuator air pressure needed for proper valve operation?

A. 32 psig

B. 47 psig

C. 81 psig

D. 96 psig

ANSWER: A.

TOPIC: Controllers and Positioners

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

The temperature control system uses a reverse-acting proportional controller and a direct-acting transmitter. The controller's proportional band is 80°F to 130°F.

Which one of the following will be the controller's output percentage when the measured lube oil temperature is 98°F?

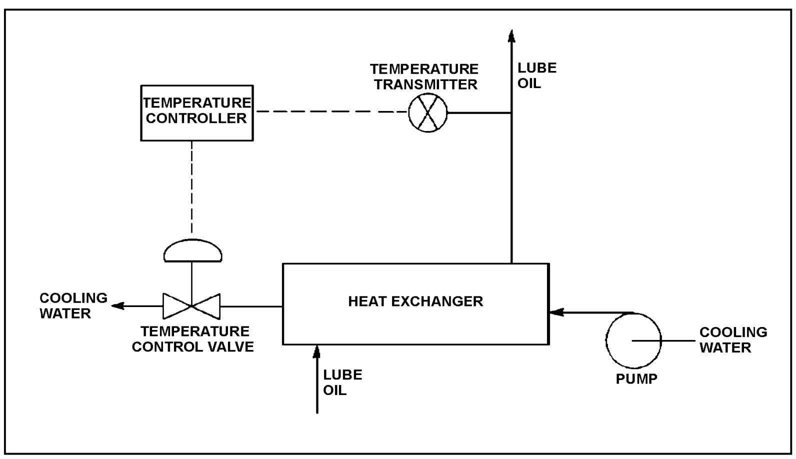
A. 18 percent

B. 32 percent

C. 36 percent

D. 64 percent

ANSWER: D.



TOPIC: Controllers and Positioners

The output pressure of a pneumatic controller is typically insufficient to drive a valve actuator accurately. To overcome this problem, a pneumatic control system will <u>normally</u> employ a...

A. valve actuating lead/lag unit.

B. pressure regulator.

C. valve positioner.

D. pressure modulator.

ANSWER: C.

TOPIC: Controllers and Positioners

Which one of the following describes a characteristic of pneumatic valve positioners?

A. They provide auto and manual demand signals to valve controllers and valve actuators.

B. They supply air pressure to valve actuators in response to a control signal to regulate valve position.

C. They can either receive or supply air to/from valve controllers, depending on the direction of valve travel.

D. They act independently of the valve controller, in order to prevent pressure transients on the valve actuator diaphragm.

ANSWER: B.

TOPIC: Controllers and Positioners

An air-operated isolation valve requires 4,800 pounds-force from its diaphragm actuator and 4 inches of stem travel for proper operation. The valve positioner can supply up to 80 psig of air pressure to the actuator.

What is the minimum surface area of the actuator diaphragm required for proper valve operation?

A. 15 square inches

B. 60 square inches

C. 120 square inches

D. 240 square inches

ANSWER: B.

TOPIC: Controllers and Positioners

What is the purpose of a valve positioner in a typical pneumatic valve control system?

A. Convert the valve controller pneumatic output signal into a mechanical force to position the valve.

B. Convert the valve controller pneumatic output signal into an electrical output to position the valve.

C. Compare the valve controller pneumatic output signal to the valve position, and adjust the valve actuator air supply pressure to position the valve.

D. Compare the valve controller pneumatic output signal to the setpoint error, and adjust the valve actuator air supply pressure to position the valve.

ANSWER: C.

TOPIC: Controllers and Positioners

An air-operated isolation valve requires 3,200 pounds-force from its diaphragm actuator and 4 inches of stem travel for proper operation. The area of the actuator diaphragm is 80 square inches.

What is the approximate air pressure required for proper valve operation?

A. 10 psig

B. 25 psig

C. 40 psig

D. 55 psig

ANSWER: C.

TOPIC: Controllers and Positioners

An air-operated isolation valve requires 3,600 pounds-force from its diaphragm actuator and 4 inches of stem travel for proper operation. The valve positioner can supply up to 120 psig of air pressure to the actuator.

What is the minimum surface area of the actuator diaphragm required for proper valve operation?

A. 30 square inches

B. 60 square inches

C. 90 square inches

D. 120 square inches

ANSWER: A.

TOPIC: Controllers and Positioners

An air-operated isolation valve requires 2,400 pounds-force applied to the top of the actuator diaphragm to open. The actuator diaphragm has a surface area of 60 square inches and the valve stem travels 2 inches from fully open to fully closed.

If control air pressure to the valve actuator begins to increase from 0 psig, which one of the following is the approximate air pressure required to open the valve?

A. 10 psig

B. 20 psig

C. 30 psig

D. 40 psig

ANSWER: D.

TOPIC: Controllers and Positioners

An air-operated isolation valve requires 3,200 pounds-force from its diaphragm actuator and 4 inches of stem travel for proper operation. The area of the actuator diaphragm is 160 square inches.

What is the approximate air pressure required for proper valve operation?

A. 20 psig

B. 40 psig

C. 60 psig

D. 80 psig

ANSWER: A.

TOPIC: Controllers and Positioners

An air-operated isolation valve requires 2,800 pounds-force (lbf) from its diaphragm actuator and 4 inches of stem travel for proper operation. The valve positioner can supply up to 117 psig of air pressure to the actuator.

What is the minimum surface area of the actuator diaphragm required for proper valve operation?

A. 24 square inches

B. 48 square inches

C. 94 square inches

D. 138 square inches

ANSWER: A.

TOPIC: Controllers and Positioners

Which one of the following describes the operation of a typical pneumatic valve positioner?

A. Compares the valve controller demand signal with actual valve position and sends an error signal to the valve controller for adjustment of the demand signal.

B. Compares the valve controller automatic and manual setpoints and sends an error signal to the valve controller to ensure the manual demand signal is tracking the automatic demand signal.

C. Receives a valve position error signal from the valve controller and positions the valve as necessary to null the valve position error signal.

D. Receives a demand signal from the valve controller and supplies the appropriate air pressure to the valve actuator to move the valve to the demanded position.

ANSWER: D.

TOPIC: Controllers and Positioners

An air-operated isolation valve requires 3,600 pounds-force applied to the top of the actuator diaphragm to open. The actuator diaphragm has a diameter of 9 inches and the valve stem travels 3 inches from fully open to fully closed.

If control air pressure to the valve actuator begins to increase from 0 psig, which one of the following is the approximate air pressure at which the valve will begin to open?

A. 14 psig

B. 57 psig

C. 81 psig

D. 127 psig

ANSWER: B.

TOPIC: Controllers and Positioners

An air-operated isolation valve requires 2,400 pounds-force applied to the top of the actuator diaphragm to open. The actuator diaphragm has a diameter of 12 inches.

If control air pressure to the valve actuator begins to increase from 0 psig, which one of the following is the approximate air pressure at which the valve will begin to open?

A. 21 psig

B. 34 psig

C. 43 psig

D. 64 psig

ANSWER: A.

TOPIC: Controllers and Positioners

Which one of the following describes a characteristic of pneumatic valve positioners?

A. They can provide automatic and manual demand signals to pneumatic controllers and valve actuators.

B. They can increase or decrease air pressure to valve actuators to obtain the proper valve response.

C. They can either supply or receive air to/from pneumatic controllers, depending on the direction of valve travel.

D. They can increase air pressure to valve actuators above existing main air header pressure.

ANSWER: B.

TOPIC: Controllers and Positioners

An air-operated isolation valve requires 3,600 pounds-force applied to the top of the actuator diaphragm to open. The actuator diaphragm has a diameter of 8 inches.

If control air pressure to the valve actuator begins to increase from 0 psig, which one of the following is the approximate air pressure at which the valve will begin to open?

A. 32 psig

B. 45 psig

C. 56 psig

D. 72 psig

ANSWER: D.

TOPIC: Controllers and Positioners

An air-operated isolation valve requires 2,400 pounds-force applied to the top of the actuator diaphragm to open against spring pressure. The actuator diaphragm has a diameter of 12 inches.

If control air pressure to the valve actuator begins to decrease from 100 psig, which one of the following is the approximate air pressure at which the valve will begin to close?

A. 5 psig

B. 17 psig

C. 21 psig

D. 66 psig

ANSWER: C.

TOPIC: Controllers and Positioners

Refer to the drawing of a flyball-weight mechanical speed governor (see figure below).

In the figure below, the purpose of the spring on the flyball mechanism is to __________ centrifugal force by driving the flyballs __________.

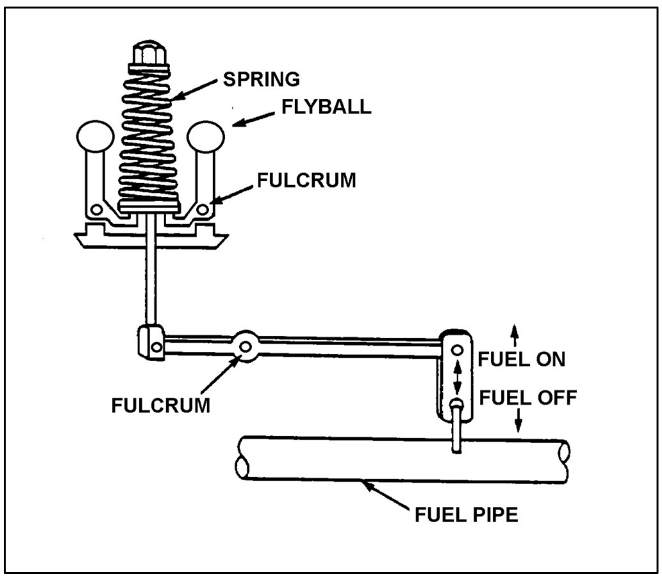
A. counteract; outward

B. aid; inward

C. counteract; inward

D. aid; outward

ANSWER: C.



TOPIC: Controllers and Positioners

A diesel generator is supplying an isolated electrical bus with the governor operating in the isochronous mode. If a large electrical load is started on the bus, generator frequency will...

A. initially decrease, then increase and stabilize below the initial value.

B. initially decrease, then increase and stabilize at the initial value.

C. initially decrease, then increase and stabilize above the initial value.

D. remain constant during and after the load start.

ANSWER: B.

TOPIC: Controllers and Positioners

A diesel generator is supplying an isolated electrical bus with the governor operating in the isochronous mode. If a large electrical bus load trips, generator frequency will...

A. initially increase, then decrease and stabilize below the initial value.

B. initially increase, then decrease and stabilize at the initial value.

C. initially increase, then decrease and stabilize above the initial value.

D. remain constant during and after the load trip.

ANSWER: B.

TOPIC: Controllers and Positioners

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

A. increase, and then decrease and stabilize below the initial value.

B. increase, and then decrease and stabilize above the initial value.

C. decrease, and then increase and stabilize below the initial value.

D. decrease, and then increase and stabilize above the initial value.

ANSWER: B.

TOPIC: Controllers and Positioners

Which one of the following refers to the transfer of controller modes from Automatic to Manual or Manual to Automatic without causing a system perturbation?

A. A direct transfer

B. A deadband transfer

C. A bumpless transfer

D. An analog-to-digital transfer

ANSWER: C.

TOPIC: Controllers and Positioners

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 is direct-acting.

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

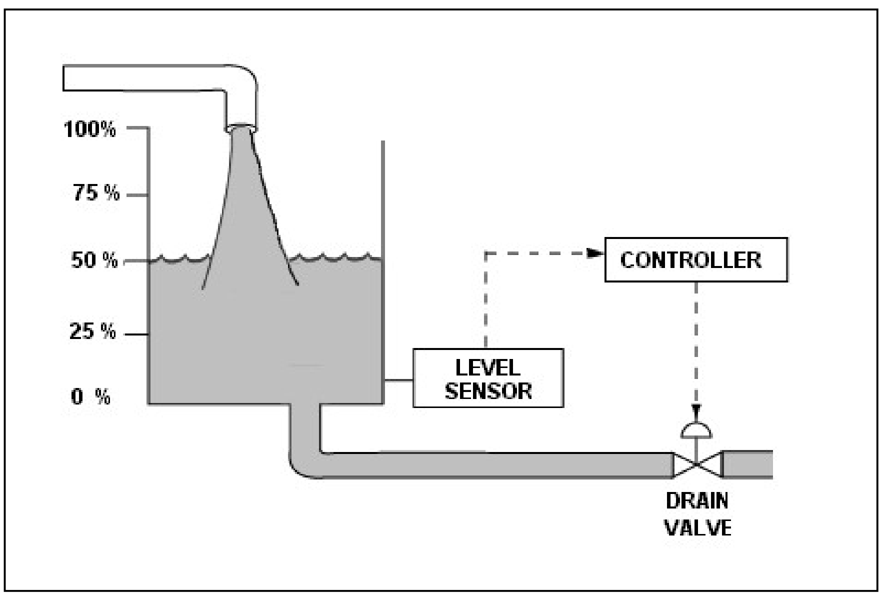
A. direct-acting; open

B. direct-acting; closed

C. reverse-acting; open

D. reverse-acting; closed

ANSWER: D.



TOPIC: Controllers and Positioners

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 is direct-acting.

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

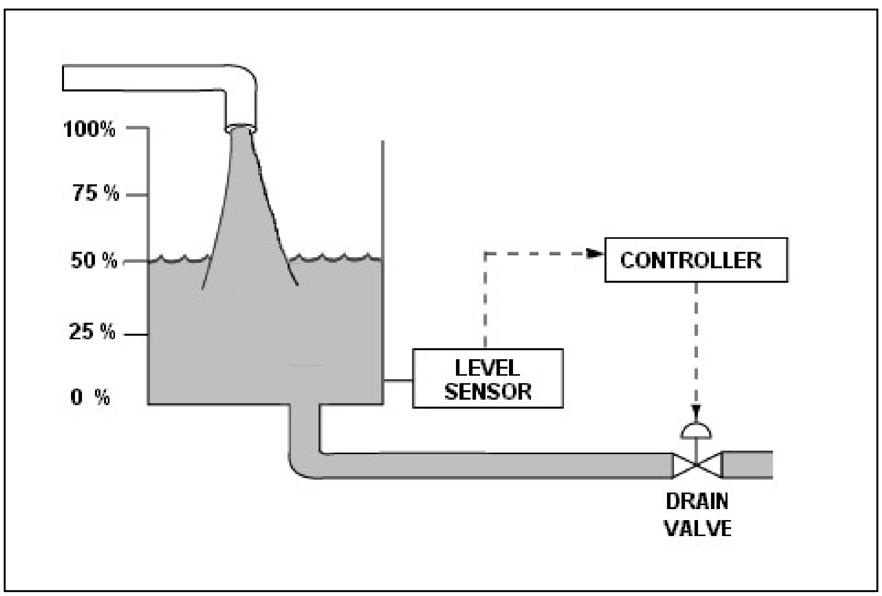
A. direct-acting; open

B. direct-acting; closed

C. reverse-acting; open

D. reverse-acting; closed

ANSWER: B.



TOPIC: Controllers and Positioners

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

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

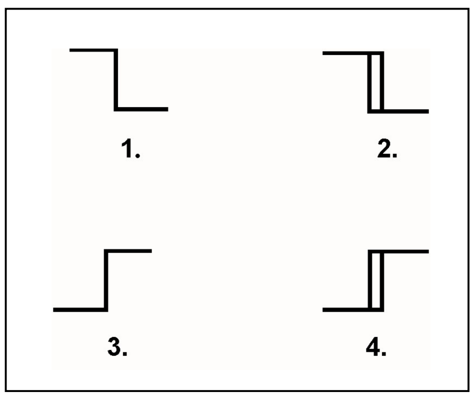
A. 1.

B. 2.

C. 3.

D. 4.

ANSWER: D.



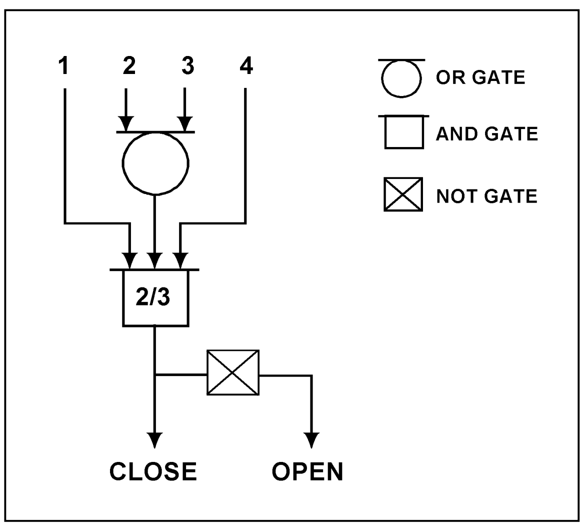
TOPIC: Controllers and Positioners

Refer to the valve controller logic diagram (see figure below).

Which one of the following combinations of inputs will result in the valve receiving an OPEN signal?

	INPUTS			
	1.	2.	3.	4.
A.	On	Off	Off	On
B.	Off	On	On	Off
C.	On	Off	On	Off
D.	Off	On	Off	On

ANSWER: B.



TOPIC: Controllers and Positioners

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

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

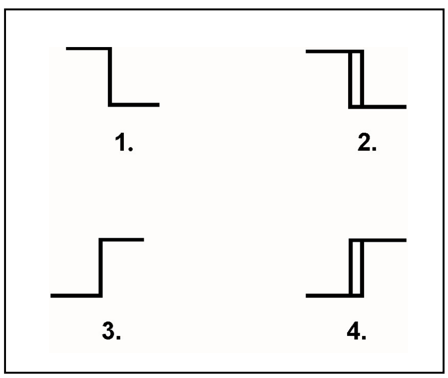
A. 1.

B. 2.

C. 3.

D. 4.

ANSWER: B.



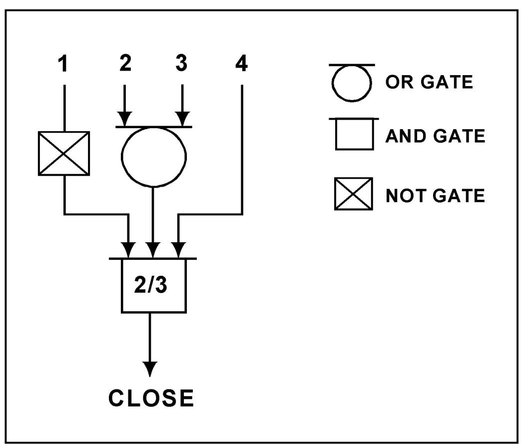
TOPIC: Controllers and Positioners

Refer to the valve controller logic diagram (see figure below).

Which one of the following combinations of inputs will result in the valve receiving a CLOSE signal?

	INPUTS			
	1.	2.	3.	4.
A.	On	On	Off	Off
B.	Off	Off	On	Off
C.	On	Off	Off	On
D.	On	On	On	Off

ANSWER: B.



TOPIC: Controllers and Positioners

A direct-acting proportional-integral controller receives input from a direct-acting transmitter. Which one of the following describes the response of the controller, operating in automatic mode, to an increase in the controlled parameter above the controller setpoint?

A. The controller will develop an output signal that continues to increase until the controlled parameter equals the controller setpoint, at which time the output signal stops increasing.

B. The controller will develop an output signal that will remain directly proportional to the difference between the controlled parameter and the controller setpoint.

C. The controller will develop an output signal that continues to increase until the controlled parameter equals the controller setpoint, at which time the output signal becomes zero.

D. The controller will develop an output signal that will remain directly proportional to the rate of change of the controlled parameter.

ANSWER: A.

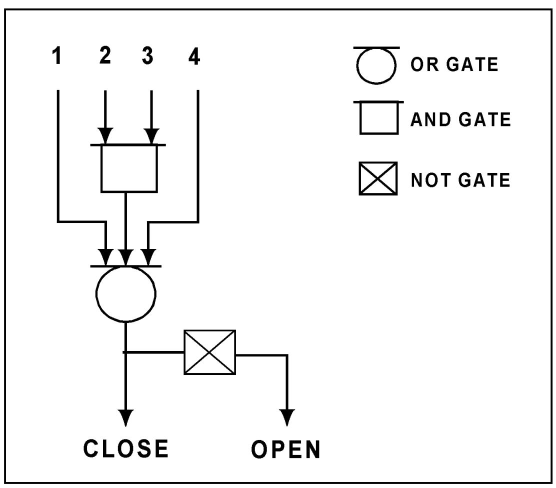
TOPIC: Controllers and Positioners

Refer to the valve controller logic diagram (see figure below).

Which one of the following combinations of inputs will result in the valve receiving an OPEN signal?

	INPUTS			
	1.	2.	3.	4.
A.	On	Off	On	On
B.	Off	On	Off	Off
C.	On	Off	Off	On
D.	Off	On	On	Off

ANSWER: B.



TOPIC: Controllers and Positioners

Consider a direct-acting proportional flow controller that is maintaining flow rate at a value that is offset from the controller's setpoint. If the controller's gain is decreased, the controller's offset will __________; and the controller's proportional band will __________.

A. decrease; decrease

B. decrease; increase

C. increase; decrease

D. increase; increase

ANSWER: D.

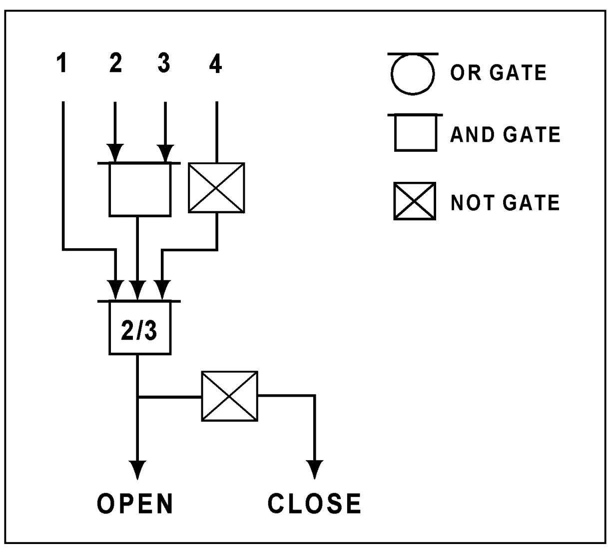
TOPIC: Controllers and Positioners

Refer to the logic diagram for a valve controller (see figure below).

Which one of the following combinations of inputs will result in the valve receiving a CLOSE signal?

	INPUTS			
	1	2	3	4
A.	On	On	On	On
B.	Off	On	On	On
C.	On	Off	Off	Off
D.	Off	On	On	Off

ANSWER: B.



TOPIC: Controllers and Positioners

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

A direct-acting proportional temperature controller is being used to control the heat exchanger lube oil outlet temperature. When the lube oil outlet temperature matches the controller setpoint of 90°F, the controller output signal is 50 percent.

Current lube oil outlet temperature is stable at 100°F with the controller output signal at 70 percent.

What is the temperature proportional band for this controller?

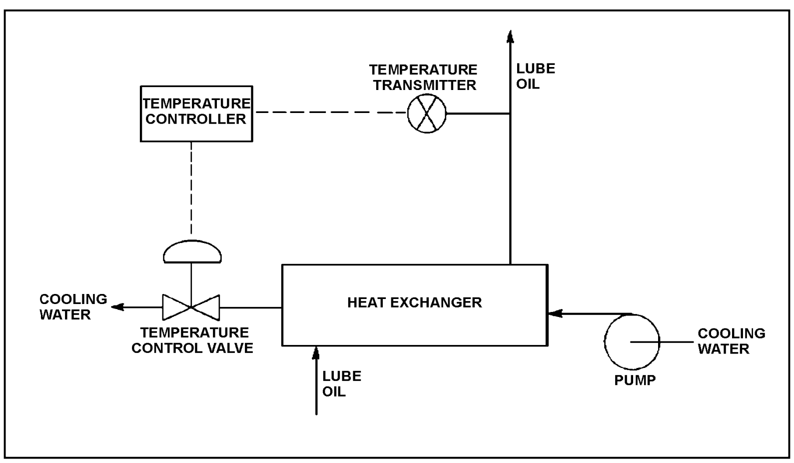
A. 90°F to 140°F

B. 90°F to 115°F

C. 65°F to 140°F

D. 65°F to 115°F

ANSWER: D.



TOPIC: Controllers and Positioners

The level in a fluid collection tank is being controlled by an automatic level controller using proportional-only control. Initially the tank level is stable, but then the flow into the tank increases and stabilizes at a higher flow rate.

As tank level increases, the controller positions a drain valve more open than necessary to stabilize the level. As tank level decreases, the controller positions the drain valve more closed than necessary to stabilize the level. This cycle is repeated continuously, never reaching a stable tank level or drain valve position.

The excessive valve positioning described above could be caused by the controller's gain being too __________; or by the controller's proportional band being too __________.

A. low; wide

B. low; narrow

C. high; wide

D. high; narrow

ANSWER: D.

TOPIC: Controllers and Positioners

A proportional controller is being used to control the water level in a tank. When the tank water level matches the controller setpoint of 50 percent, the controller output signal is 50 percent.

Tank water level begins to rise and the controller stabilizes the water level at 60 percent, at which time the controller output signal is 90 percent.

What is the <u>offset</u> for this controller at the 60 percent tank water level?

A. 10 percent

B. 30 percent

C. 40 percent

D. 67 percent

ANSWER: A.

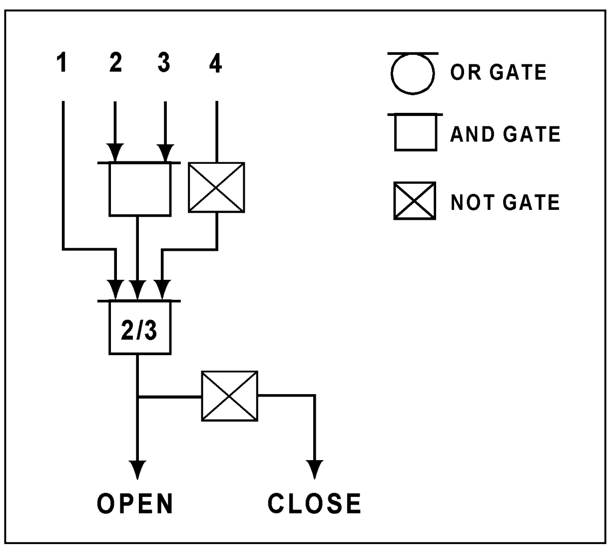
TOPIC: Controllers and Positioners

Refer to the logic diagram for a valve controller (see figure below).

Which one of the following combinations of inputs will result in the valve receiving an OPEN signal?

	INPUTS			
	1	2	3	4
A.	Off	On	Off	Off
B.	Off	On	On	Off
C.	On	Off	Off	On
D.	On	Off	On	On

ANSWER: B.



TOPIC: Controllers and Positioners

The water level in a tank is being controlled by an automatic level controller using proportional-only control as shown in the figure below. Initially the tank level is stable at 50 percent, but then the flow into the tank increases and stabilizes at a higher flow rate.

As tank level increases, the controller positions the drain valve more open than necessary to stabilize the level. As tank level decreases, the controller positions the drain valve more closed than necessary to stabilize the level. This cycle is repeated continuously, never reaching a stable tank level or drain valve position.

The excessive valve cycling described above can be reduced if the controller's gain is ____________ or if the controller's proportional band is ____________.

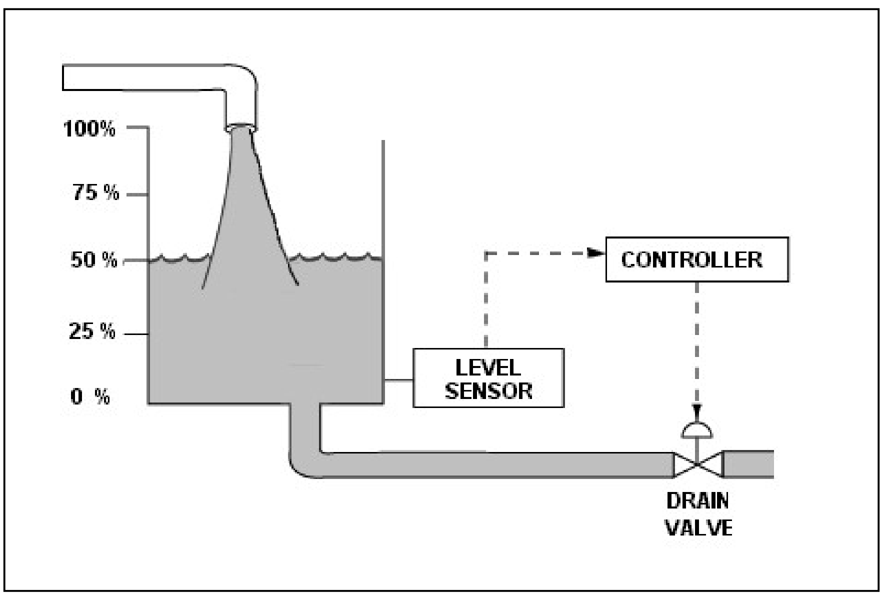
A. increased; widened

B. increased; narrowed

C. decreased; widened

D. decreased; narrowed

ANSWER: C.



TOPIC: Controllers and Positioners

A proportional controller is being used to control the water level in a tank. When the tank water level matches the controller setpoint of 20 feet, the controller output is 50 percent.

Tank water level is currently stable at 25 feet with the controller output at 75 percent.

What is the tank water level proportional band for this controller?

A. 10 to 30 feet

B. 10 to 40 feet

C. 20 to 30 feet

D. 20 to 40 feet

ANSWER: A.

TOPIC: Controllers and Positioners

A proportional controller is being used to control the water level in a tank. Initially, the controller input and output signals are both stable at 50 percent of their full range. If the controller input signal increases to 60 percent, the controller output signal will increase to 90 percent.

What is the gain for this controller?

A. 0.25

B. 0.5

C. 2.0

D. 4.0

ANSWER: D.

TOPIC: Controllers and Positioners

Which one of the following is a characteristic that applies to a proportional-only controller, but not to a proportional-integral controller?

A. Gain

B. Offset

C. Rate component

D. Bistable component

ANSWER: B.

TOPIC: Controllers and Positioners

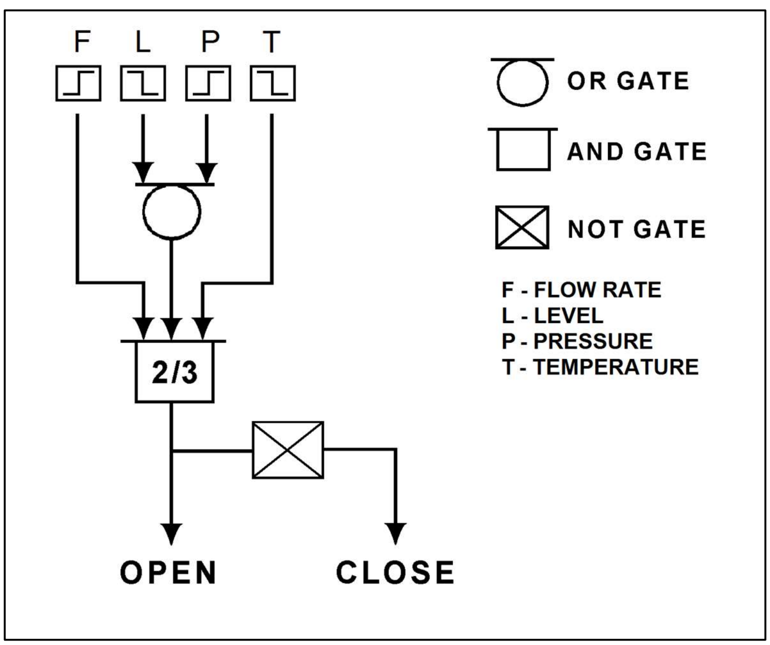
Refer to the logic diagram for a valve controller (see figure below).

Which one of the following combinations of flow rate (F), level (L), pressure (P), and temperature (T) inputs will result in the valve receiving a CLOSE signal? (The options below indicate whether the parameters are higher or lower than the associated bistable setpoints.)

INPUTS

	F	L	P	T
A.	Higher	Higher	Lower	Higher
B.	Lower	Lower	Higher	Lower
C.	Higher	Lower	Lower	Higher
D.	Lower	Higher	Higher	Lower

ANSWER: A.



TOPIC: Controllers and Positioners

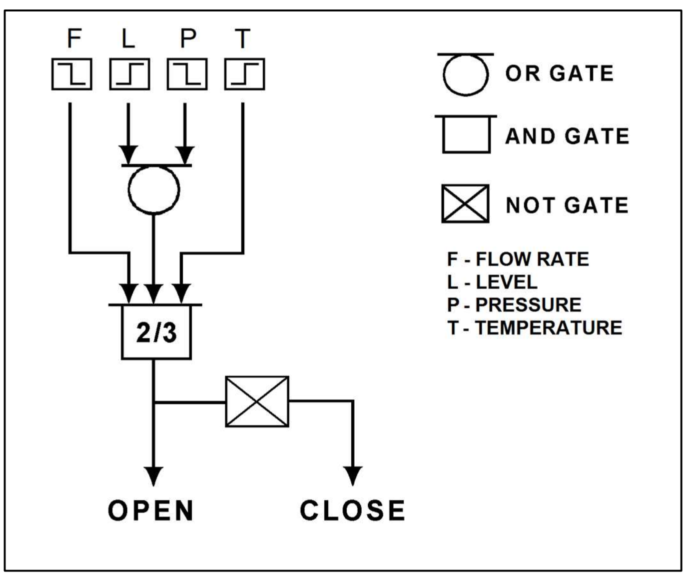
Refer to the logic diagram for a valve controller (see figure below).

Which one of the following combinations of flow rate (F), level (L), pressure (P), and temperature (T) input conditions will result in the valve receiving a CLOSE signal? (The options below indicate whether the input values are higher or lower than the associated bistable setpoints.)

INPUT CONDITIONS

	F	L	P	T
A.	Higher	Higher	Lower	Higher
B.	Lower	Lower	Higher	Lower
C.	Higher	Lower	Lower	Higher
D.	Lower	Higher	Higher	Lower

ANSWER: B.



TOPIC: Controllers and Positioners

Refer to the drawing of a water storage tank with an automatic level control system (see figure below). The level control system uses a reverse-acting level sensor and a direct-acting controller. The flow rate of water entering the tank is constant, and within the capacity of the drain valve.

For the level control system to maintain a stable water level in the tank at a value up to 10 percent above or below the controller's setpoint, the controller must have a __________ characteristic; and the drain valve must fail __________ on a loss of air pressure to its actuator.

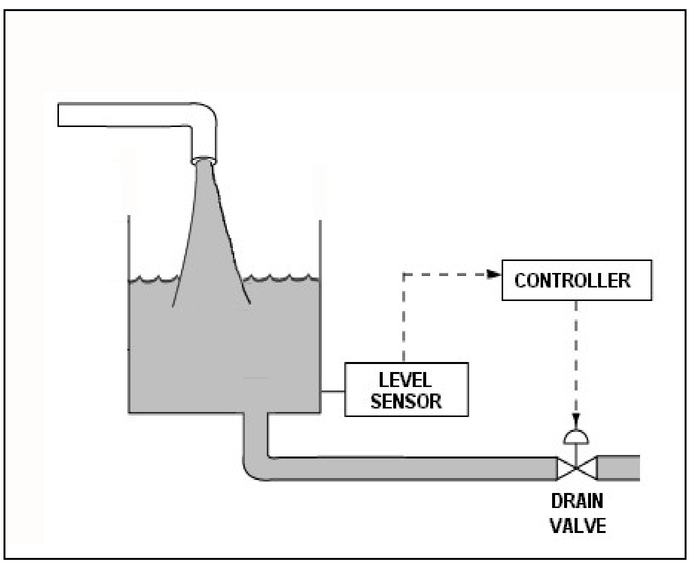
A. proportional-only; closed

B. proportional-only; open

C proportional-integral; closed

D. proportional-integral; open

ANSWER: B.



TOPIC: Controllers and Positioners

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

The level control system has the following characteristics:

- The level sensor is direct-acting.
- The controller is reverse-acting.
- The controller uses proportional control.
- The controller's setpoint is 12 feet.
- The controller's proportional band is 6 feet to 18 feet.
- The drain valve will fail open if the actuator loses air pressure.

When the tank water level is 15 feet, the controller's output will be _____ percent; and the drain valve will be _____ percent open.

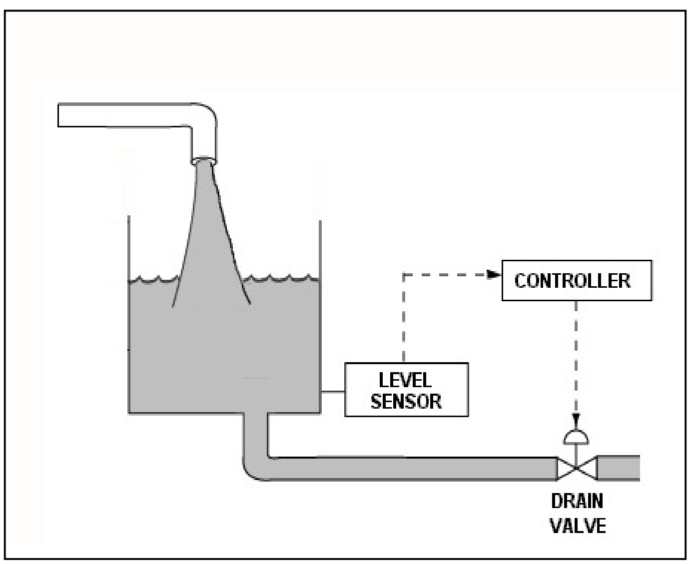
A. 25; 25

B. 25; 75

C. 75; 25

D. 75; 75

ANSWER: B.



TOPIC: Controllers and Positioners

The water level in a tank is being controlled by an automatic level controller and is initially at the controller setpoint. A drain valve is then opened, causing tank level to decrease. The decreasing level causes the controller to begin to open a makeup water supply valve. After a few minutes, a new steady-state tank level below the original level is established, with the supply rate equal to the drain rate.

The controller in this system uses __________ control.

A. proportional, integral, and derivative

B. proportional and integral only

C. proportional only

D. bistable

ANSWER: C.

TOPIC: Controllers and Positioners

A proportional-derivative controller senses an increase in the controlled parameter above the controller setpoint. The derivative function causes the controller output signal to...

A. increase until the controlled parameter equals the controller setpoint, at which time the output signal becomes constant.

B. remain directly proportional to the difference between the controlled parameter and the controller setpoint.

C. increase until the controlled parameter equals the controller setpoint, at which time the output signal becomes zero.

D. change at a rate that is directly proportional to the rate of change of the controlled parameter.

ANSWER: D.

TOPIC: Controllers and Positioners

In a proportional controller, the term "offset" refers to the difference between the...

A. control point and setpoint.

B. control point and proportional band.

C. deadband and setpoint.

D. deadband and proportional band.

ANSWER: A.

TOPIC: Controllers and Positioners

The level in a tank is controlled by an automatic control system. Level is initially at its setpoint. A drain valve is then opened, causing tank level to begin to decrease. The decreasing level causes the controller to begin to open a makeup supply valve. After a few minutes, with the drain valve still open, level is again constant at the setpoint.

The controller in this system uses primarily __________ control.

A. integral

B. on-off

C. derivative

D. proportional

ANSWER: A.

TOPIC: Controllers and Positioners

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

The controller in this system uses primarily __________ control.

A. bistable

B. proportional

C. integral

D. derivative

ANSWER: A.

TOPIC: Controllers and Positioners

Which one of the following controller types is designed to control the measured parameter at the controller setpoint?

A. Integral

B. Proportional

C. On-Off

D. Derivative

ANSWER: A.

TOPIC: Controllers and Positioners

The level in a drain collection tank is being controlled by an automatic level controller and is initially stable at the controller setpoint. Flow rate into the tank increases, causing tank level to increase. The increasing level causes the controller to throttle open a tank drain valve. After a few minutes, a new stable tank level above the original level is established, with the drain flow rate equal to the supply flow rate.

The controller in this system uses __________ control.

A. on-off

B. proportional

C. proportional plus integral

D. proportional plus integral plus derivative

ANSWER: B.

TOPIC: Controllers and Positioners

The level in a drain collection tank is being controlled by an automatic level controller and level is initially at the controller setpoint. Flow rate into the tank causes tank level to increase. The increasing level causes the controller to fully open a tank drain valve. When level decreases below the setpoint, the controller closes the drain valve. Tank level continues to be controlled in this manner within a narrow band above and below the setpoint.

The controller in this system uses __________ control.

A. on-off

B. proportional

C. proportional plus integral

D. proportional plus integral plus derivative

ANSWER: A.

TOPIC: Controllers and Positioners

The temperature of the water in a small outside storage tank is controlled by a set of heaters submerged in the tank. The heaters will energize at a water temperature of 40°F and deenergize at 48°F. When energized, the heaters produce a constant thermal output.

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

A. Bistable

B. Proportional

C. Proportional plus integral

D. Proportional plus derivative

ANSWER: A.

TOPIC: Controllers and Positioners

The level in a water collection tank is being controlled by an automatic level controller that positions a tank drain valve. Tank level is initially stable at the controller setpoint. Then, flow rate into the tank increases, slowly at first, and then faster until a stable flow rate is attained.

When tank level increases, the controller begins to open the tank drain valve farther. The level controller output signal increases both as the tank level increases and as the rate of the tank level change quickens. After a few minutes, a new stable tank level above the original level is established, with the drain flow rate equal to the supply flow rate.

The controller in this system uses __________ control.

A. proportional only

B. proportional plus integral

C. proportional plus derivative

D. proportional plus integral plus derivative

ANSWER: C.

TOPIC: Controllers and Positioners

The level in a drain collection tank is being controlled by an automatic level controller, and is initially stable at the controller setpoint. Flow rate into the tank increases, slowly at first, and then faster until a stable higher flow rate is attained.

As tank level begins to increase, the level controller slowly opens a tank drain valve. The level controller output signal increases both as the tank level increases and as the rate of tank level change quickens. After a few minutes, tank level returns to, and remains at, the original level with the drain flow rate equal to the supply flow rate.

The controller in this system uses __________ control.

A. proportional only

B. proportional plus derivative only

C. proportional plus integral only

D. proportional plus integral plus derivative

ANSWER: D.

TOPIC: Controllers and Positioners

Refer to the drawing of a water storage tank with a level control system (see figure below). The tank water level is being automatically controlled at 50 percent by a proportional-integral (PI) controller that positions the drain valve. Tank water level is currently stable with 500 gpm entering the tank and the drain valve is 50 percent open.

Tank inlet flow rate suddenly increases to 700 gpm and remains constant. When tank water level stabilizes, level will be __________; and the drain valve position will be __________.

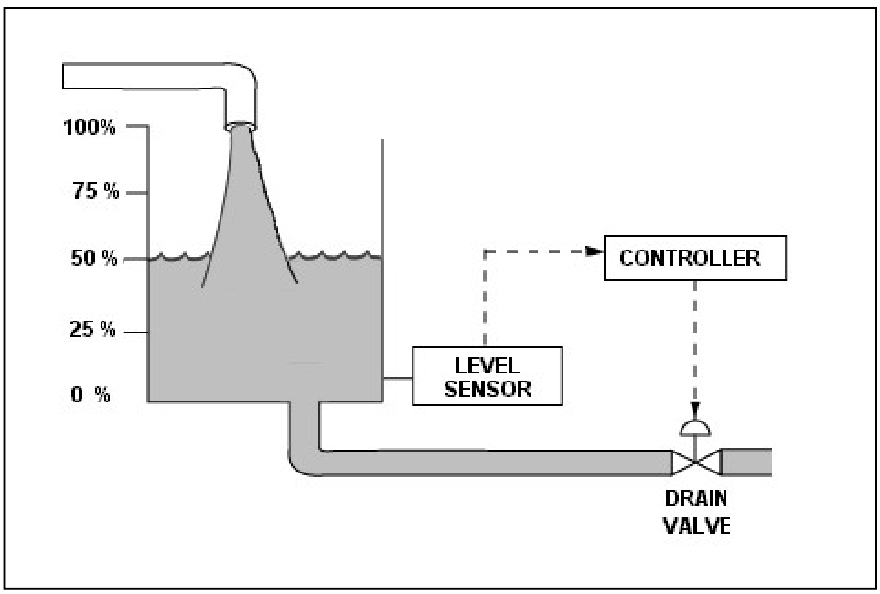
A. higher than 50 percent; more open

B. higher than 50 percent; the same

C. 50 percent; more open

D. 50 percent; the same

ANSWER: C.



TOPIC: Controllers and Positioners

Refer to the drawing of a water storage tank with a level control system (see figure below). The tank water level is being automatically controlled at 50 percent by a proportional-integral (PI) controller that positions the drain valve. Tank water level is currently stable with 500 gpm entering the tank and the drain valve is 50 percent open.

The tank suddenly develops a constant 200 gpm leak, while the input flow rate remains constant at 500 gpm. When tank water level stabilizes, level will be __________; and the drain valve position will be __________.

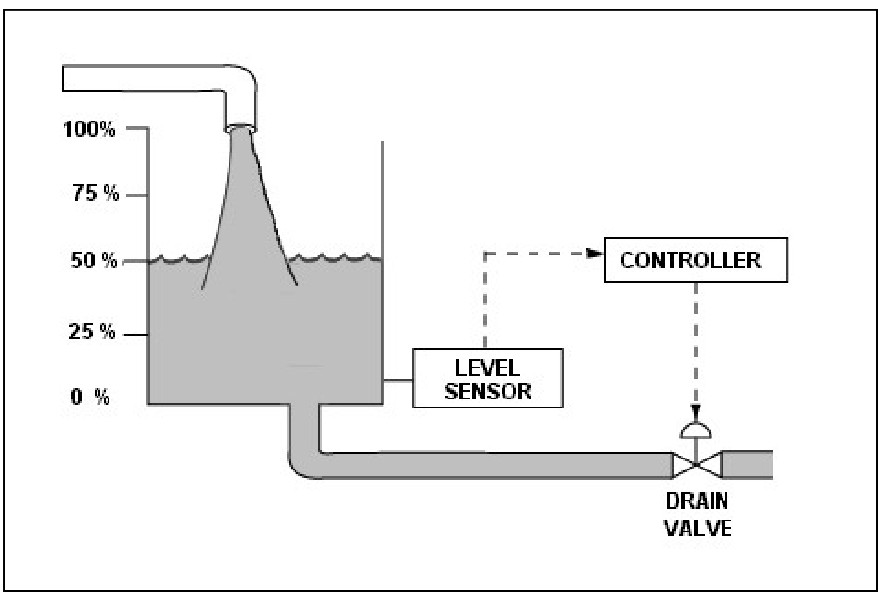
A. 50 percent; more open

B. 50 percent; more closed

C. lower than 50 percent; more open

D. lower than 50 percent; more closed

ANSWER: B.



TOPIC: Controllers and Positioners

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

The tank water level is being automatically controlled by a proportional-only controller with a setpoint of 50 percent. Tank water level is currently stable at 50 percent with 500 gpm entering the tank and the drain valve is 50 percent open.

The tank suddenly develops a 200 gpm leak, while the input flow rate remains constant at 500 gpm. After the tank water level stabilizes, level will be __________; and the drain valve position will be __________.

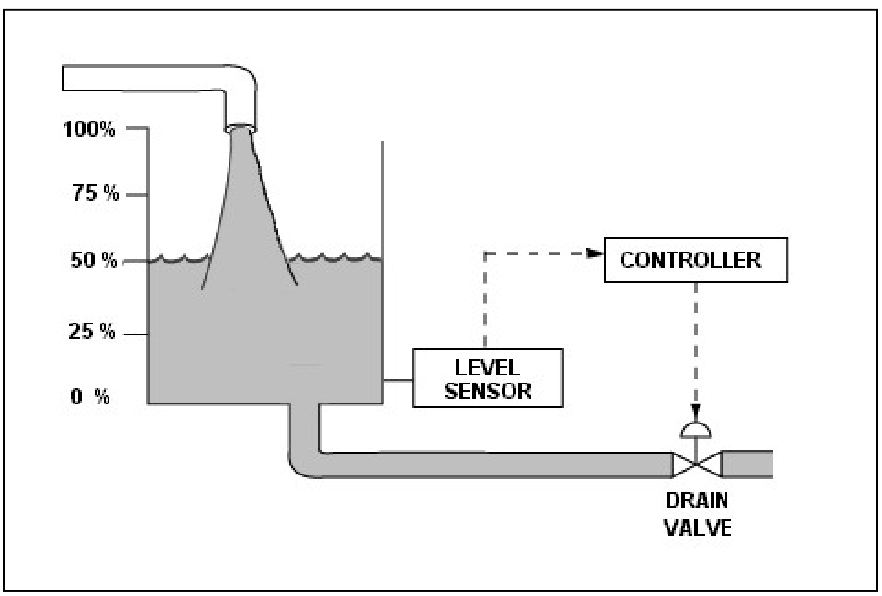
A. 50 percent; more than 50 percent open

B. 50 percent; less than 50 percent open

C. below 50 percent; more than 50 percent open

D. below 50 percent; less than 50 percent open

ANSWER: D.



TOPIC: Controllers and Positioners

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

The tank water level is being automatically controlled by a proportional-only controller with a level setpoint of 50 percent. Tank water level is currently stable at 50 percent with 500 gpm entering the tank and the drain valve 50 percent open.

If the tank input flow rate suddenly increases to 700 gpm, then after the tank water level stabilizes, the water level will be __________ 50 percent; and the drain valve position will be __________ open.

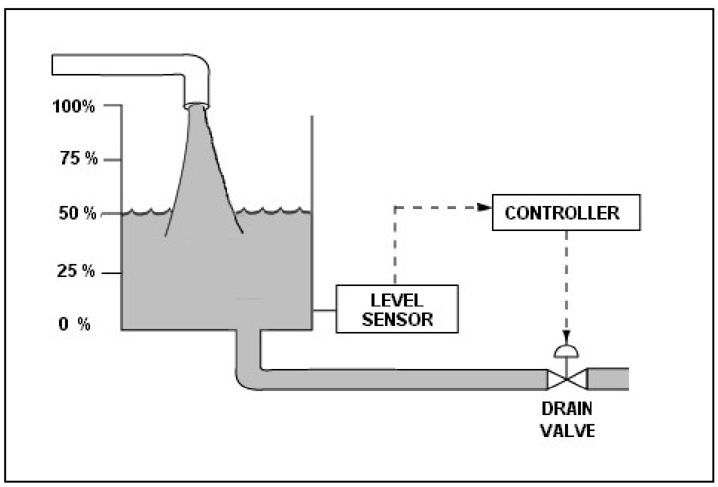
A. equal to; more than 50 percent

B. equal to; 50 percent

C. greater than; more than 50 percent

D. greater than; 50 percent

ANSWER: C.



TOPIC: Controllers and Positioners

A system pressure controller has the following features:

- The controller output signal is 50 percent when the differential pressure (ΔP) between the pressure setpoint and the actual system pressure is zero.
- The controller output signal increases linearly with the ΔP.
- The controller output signal is not affected by the rate of change of the ΔP.
- The controller output signal is not affected by the length of time the ΔP exists.

Which one of the following lists the type(s) of control used by the controller described above?

A. Bistable only

B. Proportional only

C. Proportional plus integral

D. Proportional plus derivative

ANSWER: B.

TOPIC: Controllers and Positioners

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

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

A. Proportional only

B. Proportional plus integral

C. Proportional plus derivative

D. Proportional plus integral plus derivative

ANSWER: C.

TOPIC: Controllers and Positioners

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

The flow control valve is positioned by a level controller that can maintain a stable tank water level anywhere between 10 percent above and 10 percent below the controller setpoint. The level controller receives input from a direct-acting level detector.

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

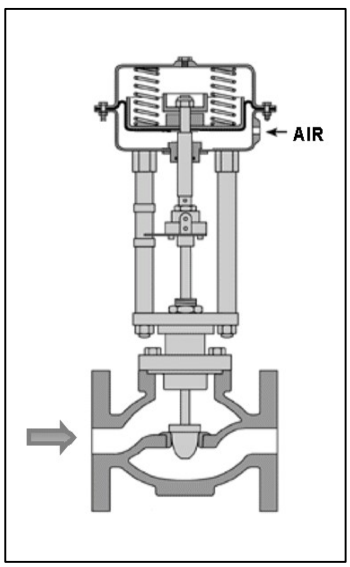
A. Direct-acting with proportional only control.

B. Direct-acting with proportional-integral control.

C. Reverse-acting with proportional only control.

D. Reverse-acting with proportional-integral control.

ANSWER: C.



TOPIC: Controllers and Positioners

An outside water storage tank is equipped with submerged heaters. The heaters energize at minimum power when water temperature decreases to 48°F. If water temperature continues to decrease, heater power will increase directly with the temperature deviation from 48°F, regardless of cooldown rate, until maximum power is reached at 40°F. Different cooldown rates have the same effect on heater operation. On cold days, the tank water temperature is usually maintained at about 44°F with the heaters energized at half power.

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

A. Proportional only

B. Proportional plus integral only

C. Proportional plus derivative only

D. Proportional plus integral plus derivative

ANSWER: A.

TOPIC: Controllers and Positioners

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

The flow control valve is positioned by a level controller that can maintain a stable tank water level anywhere between 10 percent above and 10 percent below the controller setpoint. The level controller receives input from a direct-acting level detector.

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

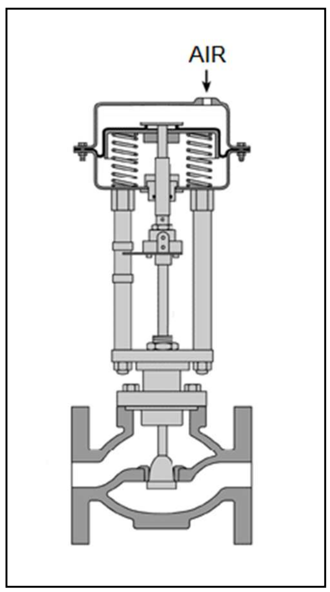
A. Direct-acting with proportional only control.

B. Direct-acting with proportional plus integral control.

C. Reverse-acting with proportional only control.

D. Reverse-acting with proportional plus integral control.

ANSWER: A.



TOPIC: Controllers and Positioners

Refer to the drawing of a flow control valve (see figure below) located in the makeup water supply line to a water storage tank.

The flow control valve is positioned by a tank level controller that can maintain a stable water level anywhere between 10 percent above and 10 percent below the controller setpoint. The tank level controller receives input from a direct-acting tank level detector.

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

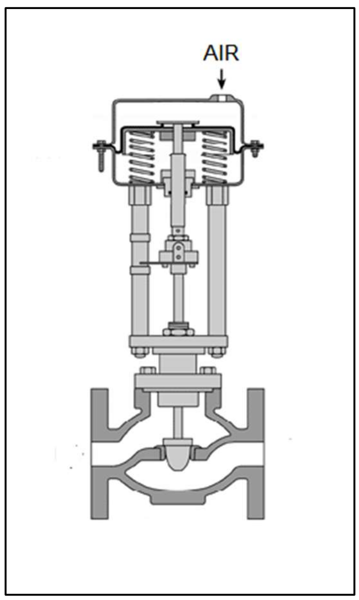
A. Direct-acting with proportional only control.

B. Direct-acting with proportional-integral control.

C. Reverse-acting with proportional only control.

D. Reverse-acting with proportional-integral control.

ANSWER: A.



TOPIC: Controllers and Positioners

A reverse-acting proportional controller will be used to maintain level in a water storage tank by positioning an air-operated makeup water flow control valve. The level controller receives input from a direct-acting level detector.

Which pair of flow control valves shown below will be compatible with the level controller in the above application?

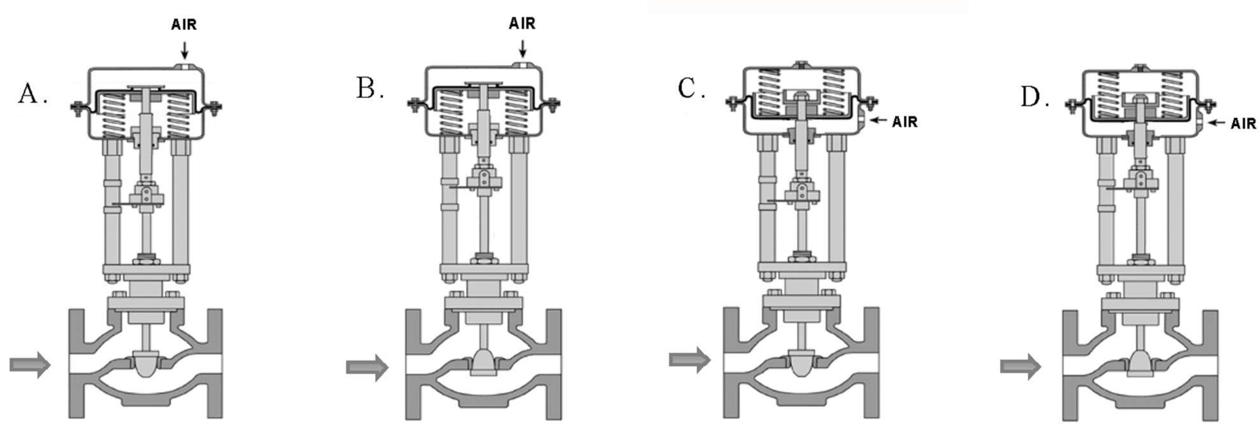
A. A and B

B. B and C

C. C and D

D. D and A

ANSWER: B.



TOPIC: Controllers and Positioners

Given:

- A direct-acting proportional pneumatic controller will be used to maintain level in a condensate collection tank by positioning an air-operated flow control valve in the tank's drain line.
- The controller's input will vary directly with tank condensate level.

Which pair of flow control valves shown below will be compatible with the controller in the above application?

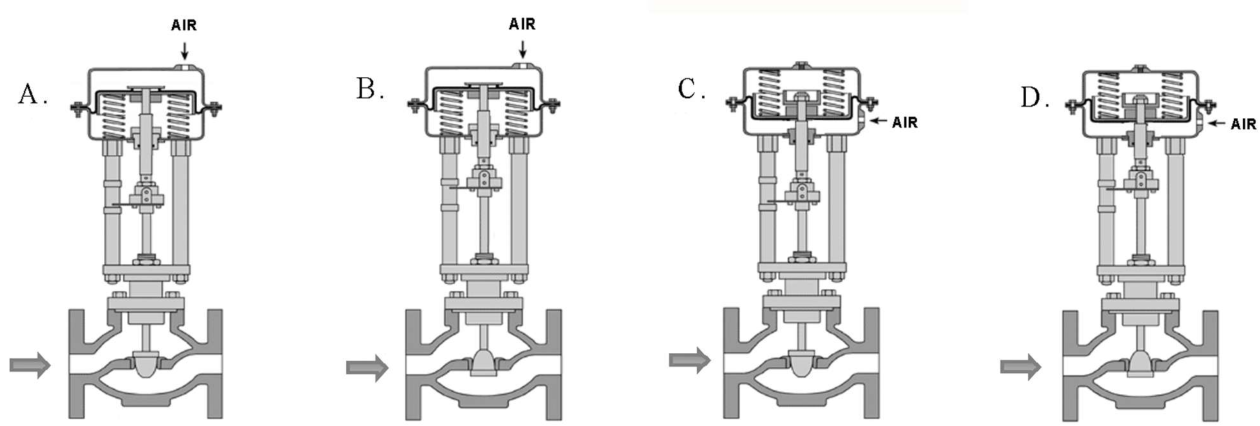
A. A and B

B. B and C

C. C and D

D. D and A

ANSWER: B.



TOPIC: Controllers and Positioners

Given:

- A direct-acting proportional pneumatic controller will be used to maintain level in a water storage tank by positioning an air-operated flow control valve in the tank's makeup water supply line.
- The controller's input will vary directly with tank level.

Which pair of flow control valves shown below will be compatible with the controller in the above application?

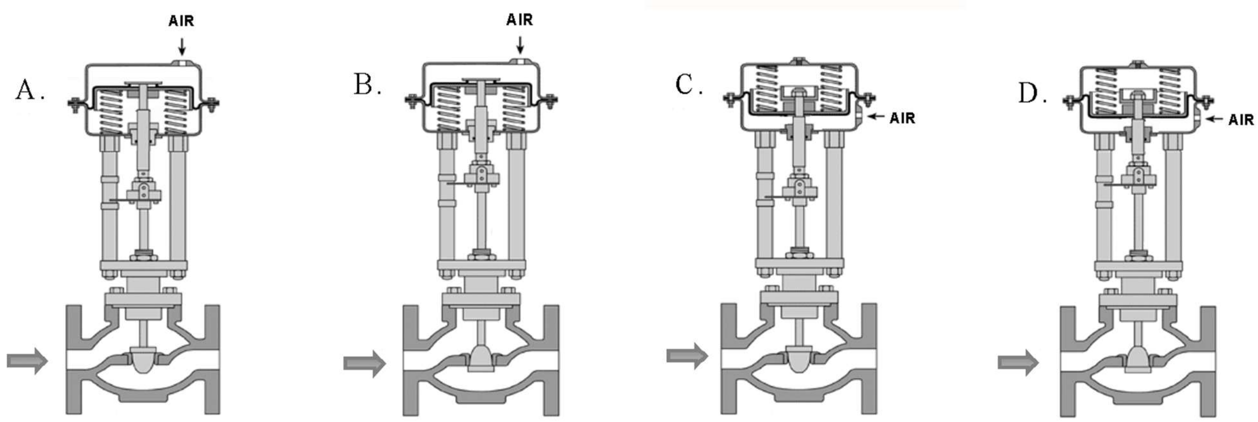
A. A and B

B. B and C

C. C and D

D. D and A

ANSWER: D.



TOPIC: Controllers and Positioners

Given:

- A reverse-acting proportional pneumatic controller will be used to maintain level in a water storage tank by positioning an air-operated flow control valve in the tank's drain line.
- The controller's input will vary directly with tank level.

Which pair of flow control valves shown below will be compatible with the controller in the above application?

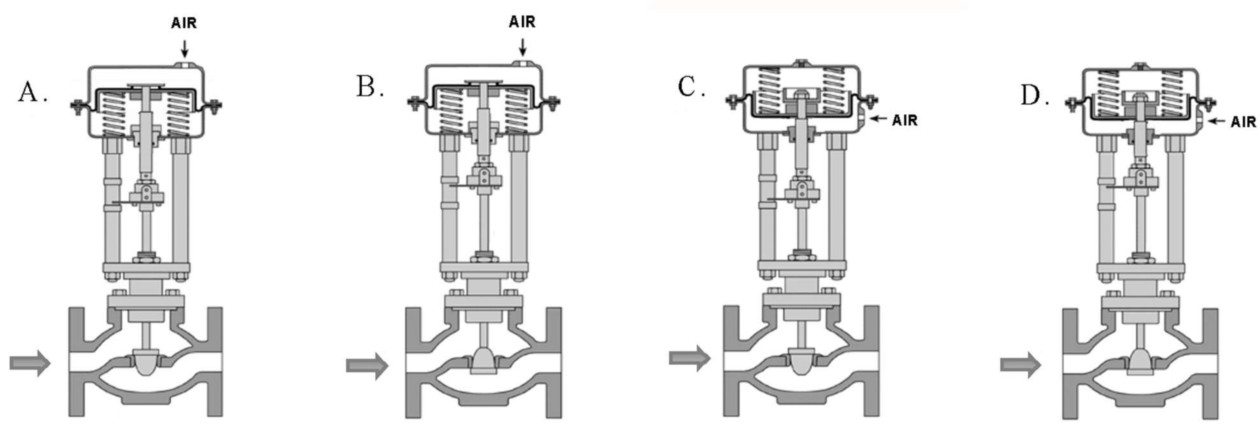
A. A and B

B. B and C

C. C and D

D. D and A

ANSWER: D.



TOPIC: Controllers and Positioners

What precaution must be observed before transferring a valve controller from the automatic mode to the manual mode of control?

A. Ensure that a substantial steady-state deviation is established between the automatic and manual valve controller outputs.

B. Ensure that the automatic and manual valve controller outputs are matched.

C. Ensure that the automatic valve controller output is increasing before transferring to the manual mode of control.

D. Ensure that the automatic valve controller output is decreasing before transferring to the manual mode of control.

ANSWER: B.

TOPIC: Controllers and Positioners

Prior to shifting a valve controller from automatic to manual control, why should the automatic and manual controller output signals be matched?

A. To ensure the valve will operate in manual control upon demand.

B. To ensure valve position indication is accurate in manual control.

C. To move the valve to the new position prior to the transfer.

D. To prevent a sudden valve repositioning during the transfer.

ANSWER: D.

TOPIC: Pumps

Which one of the following contains indications of cavitation in an operating centrifugal pump?

A. Low flow rate with low discharge pressure.

B. Low flow rate with high discharge pressure.

C. High motor amps with low discharge pressure.

D. High motor amps with high discharge pressure.

ANSWER: A.

TOPIC: Pumps

After a motor-driven centrifugal pump is started, the following indications are observed:

Oscillating flow rate.
Oscillating discharge pressure.
Oscillating motor amps.

These indications are symptoms that the pump is experiencing...

A. excessive thrust.

B. cavitation.

C. runout.

D. wear ring failure.

ANSWER: B.

TOPIC: Pumps

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

A. Increase pump inlet temperature.

B. Decrease pump speed.

C. Increase pump suction pressure.

D. Decrease pump recirculation flow rate.

ANSWER: A.

TOPIC: Pumps

Pump cavitation occurs when vapor bubbles are formed at the eye of a pump impeller...

A. when the localized flow velocity exceeds sonic velocity for the existing fluid temperature.

B. when the localized pressure exceeds the vapor pressure for the existing fluid temperature.

C. and enter a high pressure region of the pump where they collapse, causing damaging pressure pulsations.

D. and are discharged from the pump where they collapse in downstream piping, causing damaging pressure pulsations.

ANSWER: C.

TOPIC: Pumps

Which one of the following contains symptoms associated with cavitation in an operating centrifugal pump?

A. Decreased motor current and pump speed.

B. Decreased pump and motor temperature.

C. Steadily increasing discharge pressure.

D. Increased noise and vibration.

ANSWER: D.

TOPIC: Pumps

Which one of the following will promptly result in cavitation of a centrifugal pump that is initially operating at 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.

ANSWER: C.

TOPIC: Pumps

Which one of the following describes pump cavitation?

A. Vapor bubbles are formed when the enthalpy difference between pump discharge and pump suction exceeds the latent heat of vaporization.

B. Vapor bubbles are formed in the eye of the pump impeller and collapse as they enter higher pressure regions of the pump.

C. Vapor bubbles are produced when the localized pressure exceeds the vapor pressure at the existing temperature.

D. Vapor bubbles are discharged from the pump where they collapse on downstream piping and cause localized water hammers.

ANSWER: B.

TOPIC: Pumps

Which one of the following is an indication of pump cavitation?

A. Pump motor amps are pegged high.

B. Pump discharge pressure indicates zero.

C. Pump motor amps are fluctuating.

D. Pump discharge pressure indicates shutoff head.

ANSWER: C.

TOPIC: Pumps

If a centrifugal pump is started with the discharge valve fully open versus throttled, the possibility of pump runout will __________; and the possibility of pump cavitation will __________.

A. increase; decrease

B. increase; increase

C. decrease; decrease

D. decrease; increase

ANSWER: B.

TOPIC: Pumps

If a centrifugal pump is started with the discharge valve throttled versus fully open, the possibility of pump runout will __________; and the possibility of pump cavitation will __________.

A. increase; decrease

B. increase; increase

C. decrease; decrease

D. decrease; increase

ANSWER: C.

TOPIC: Pumps

The presence of air in a pump casing may result in __________ when the pump is started.

A. vortexing

B. pump runout

C. pump overspeed

D. gas binding

ANSWER: D.

TOPIC: Pumps

Which one of the following contains three indications of a vapor-bound motor-operated centrifugal pump that is operating in a cooling water system?

A. Fluctuating pump discharge pressure, reduced system flow rate, and increased pump motor current.

B. Reduced system flow rate, increased pump motor current, and increased pump noise level.

C. Increased pump motor current, increased pump noise level, and fluctuating pump discharge pressure.

D. Increased pump noise level, fluctuating pump discharge pressure, and reduced system flow rate.

ANSWER: D.

TOPIC: Pumps

Which one of the following is an effective method for ensuring that a centrifugal pump remains primed and does not become gas bound during pump operation and after pump shutdown?

A. Install the pump below the level of the suction supply.

B. Install a check valve in the discharge piping of the pump.

C. Install an orifice plate in the discharge piping of the pump.

D. Install a pump recirculation line from the pump discharge piping to the pump suction piping.

ANSWER: A.

TOPIC: Pumps

Operating a motor-driven centrifugal pump for an extended period of time under no flow conditions will cause...

A. pump failure from overspeed.

B. pump failure from overheating.

C. motor failure from overspeed.

D. motor failure from overheating.

ANSWER: B.

TOPIC: Pumps

When a centrifugal pump is operating at shutoff head, it is pumping at __________ capacity and __________ discharge head.

A. maximum; maximum

B. maximum; minimum

C. minimum; maximum

D. minimum; minimum

ANSWER: C.

TOPIC: Pumps

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

Which point represents pump operation at shutoff head?

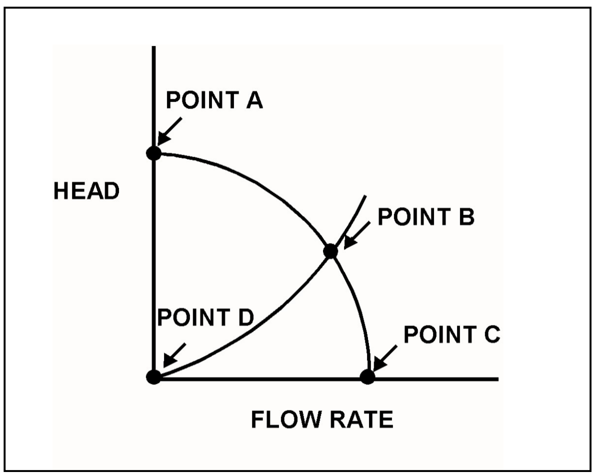
A. Point A

B. Point B

C. Point C

D. Point D

ANSWER: A.



TOPIC: Pumps

Operating a centrifugal pump at shutoff head without recirculation flow can quickly result in...

A. discharge piping overpressure.

B. suction piping overpressure.

C. excessive pump leakoff.

D. pump overheating.

ANSWER: D.

TOPIC: Pumps

A motor-driven centrifugal pump with <u>no</u> recirculation flow path must be stopped when discharge pressure reaches the pump shutoff head to prevent...

A. overheating of the pump.

B. overheating of the motor.

C. bursting of the pump casing.

D. water hammer in downstream lines.

ANSWER: A.

TOPIC: Pumps

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

The flowpath through valve A is designed to...

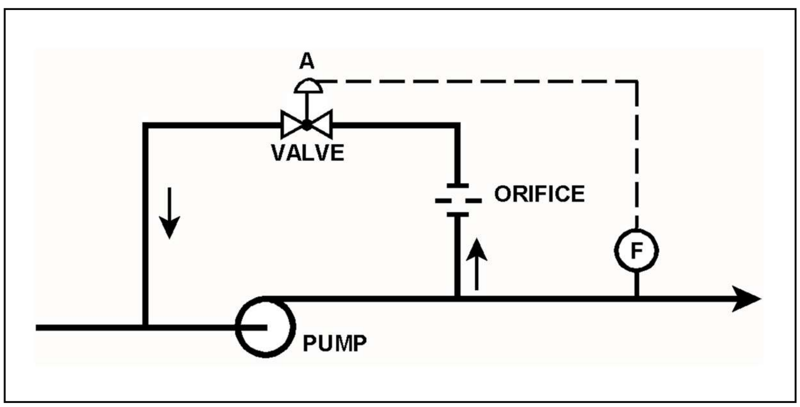
A. prevent pump runout by creating a recirculation flowpath.

B. provide a small flow rate through the pump during shutoff head conditions.

C. direct a small amount of water to the pump suction to raise available net positive suction head.

D. prevent the discharge piping from exceeding design pressure during no-flow conditions.

ANSWER: B.



TOPIC: Pumps

Which one of the following is at a relatively high value when a centrifugal pump is operating at shutoff head?

A. Pump motor current

B. Pump volumetric flow rate

C. Available net positive suction head

D. Required net positive suction head

ANSWER: C.

TOPIC: Pumps

Which one of the following describes radial-flow centrifugal pump operating parameters at shutoff head?

A. High discharge pressure, low flow, low power demand

B. High discharge pressure, high flow, low power demand

C. Low discharge pressure, low flow, high power demand

D. Low discharge pressure, high flow, high power demand

ANSWER: A.

TOPIC: Pumps

Which one of the following conditions applies to a centrifugal pump running at shutoff head?

A. The volumetric flow rate for the pump has been maximized.

B. Cavitation will occur immediately upon reaching shutoff head.

C. Available net positive suction head is at a maximum value for the existing fluid conditions.

D. Pump differential pressure is at a minimum value.

ANSWER: C.

TOPIC: Pumps

Which one of the following will result from operating an AC motor-driven radial-flow centrifugal pump in a water system for an extended period with the discharge valve shut and no recirculation flow?

A. No motor damage, but the pump will overheat and may be damaged.

B. No motor damage, but the pump will overspeed and may be damaged.

C. No pump damage, but the motor will overspeed and may be damaged.

D. No pump damage, but the motor will overheat and may be damaged.

ANSWER: A.

TOPIC: Pumps

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

Which one of the following describes the effect on the pump if a complete flow blockage occurs in the discharge line just downstream of the flow transmitter?

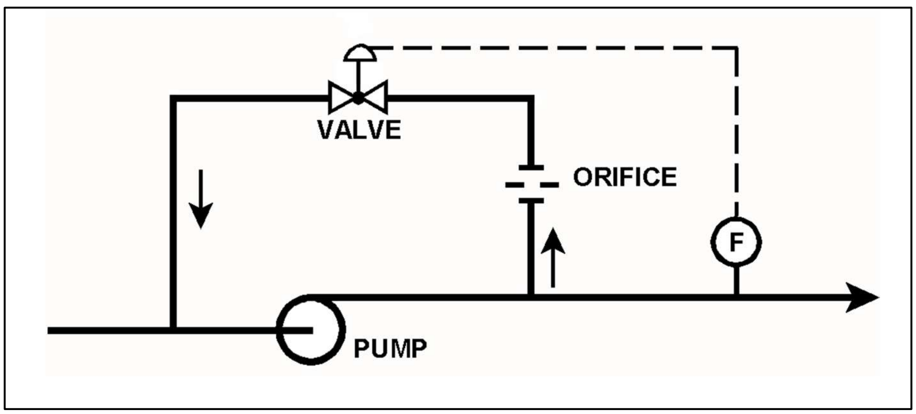
A. The pump will overheat after a relatively short period of time, due to a loss of both main flow and recirculation flow.

B. The pump will overheat after a relatively long period of time, due to a loss of main flow only.

C. The pump will overheat after a relatively long period of time, due to a loss of recirculation flow only.

D. The pump will be able to operate under these conditions indefinitely, due to sustained main flow.

ANSWER: B.



TOPIC: Pumps

A variable-speed centrifugal fire water pump is taking a suction on an open storage tank and discharging through a 4-inch diameter fire hose and through a nozzle located 50 feet above the pump.

Which one of the following will cause the pump to operate at shutoff head?

A. The fire hose is replaced with a 6-inch diameter fire hose.

B. The fire hose is replaced with a 2-inch diameter fire hose.

C. Pump speed is increased until steam formation at the eye of the pump prevents pump flow.

D. Pump speed is decreased until pump discharge pressure is insufficient to cause flow.

ANSWER: D.

TOPIC: Pumps

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

Valve A will open when pump...

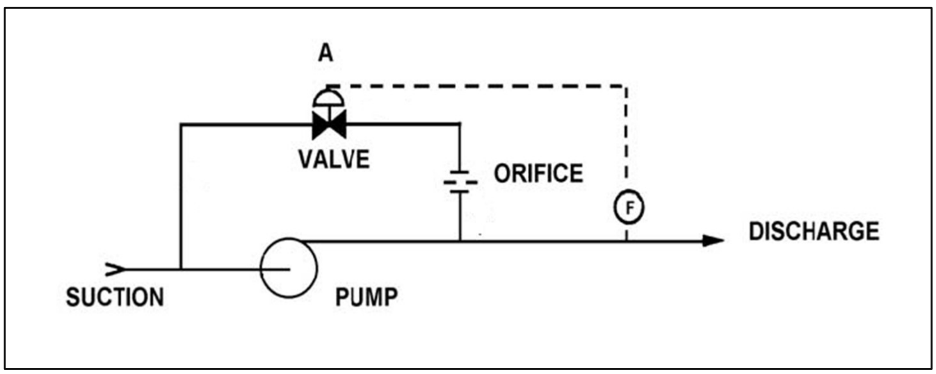
A. discharge pressure increases above a setpoint.

B. discharge pressure decreases below a setpoint.

C. flow rate increases above a setpoint.

D. flow rate decreases below a setpoint.

ANSWER: D.



TOPIC: Pumps

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

A. The fire hose nozzle is raised to an elevation that prevents any flow.

B. Suction temperature is increased to the point that gas binding occurs.

C. Pump speed is adjusted to the value at which cavitation occurs.

D. Suction pressure is adjusted until available net positive suction head is reduced to zero feet.

ANSWER: A.

TOPIC: Pumps

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

A. A firefighter inadvertently severs the fire hose.

B. The fire hose becomes completely crimped in a fire door.

C. Fire water storage tank level drops below the pump suction tap.

D. A firefighter adjusts the fire hose nozzle spray pattern from DELUGE to FOG.

ANSWER: B.

TOPIC: Pumps

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

A. A firefighter inadvertently severs the fire hose.

B. The fire hose becomes partially crimped in a fire door.

C. Fire water storage tank level drops below the pump suction tap.

D. A firefighter adjusts the fire hose nozzle spray pattern from DELUGE to OFF.

ANSWER: D.

TOPIC: Pumps

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

Valve A will close when pump...

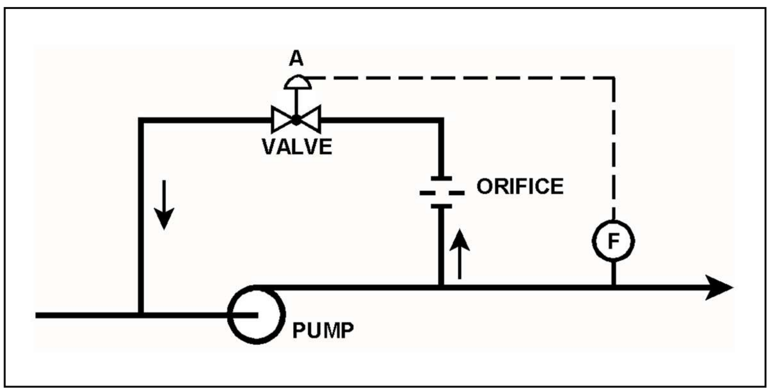
A. discharge pressure increases above a setpoint.

B. discharge pressure decreases below a setpoint.

C. flow rate increases above a setpoint.

D. flow rate decreases below a setpoint.

ANSWER: C.



TOPIC: Pumps

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

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

Pump discharge pressure = 30 psig
Pump suction pressure = 10 psig

With the discharge valve still closed, if the pump speed is doubled, which one of the following will be the new pump discharge pressure?

A. 80 psig

B. 90 psig

C. 120 psig

D. 130 psig

ANSWER: B.

TOPIC: Pumps

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

After the pump is started, the pump suction and discharge pressures stabilize as follows:

Pump suction pressure	= 5 psig
Pump discharge pressure	= 35 psig

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

A. 65 psig

B. 120 psig

C. 125 psig

D. 140 psig

ANSWER: C.

TOPIC: Pumps

The available net positive suction head for a pump may be expressed as...

A. discharge pressure minus saturation pressure of the fluid being pumped.

B. discharge pressure minus suction pressure.

C. suction pressure minus saturation pressure of the fluid being pumped.

D. suction pressure plus discharge pressure.

ANSWER: C.

TOPIC: Pumps

Which one of the following operations in a closed system will cause a decrease in available net positive suction head for a centrifugal pump?

A. Decreasing the inlet fluid temperature.

B. Increasing the pump discharge pressure.

C. Throttling open the pump suction valve.

D. Throttling open the pump discharge valve.

ANSWER: D.

TOPIC: Pumps

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

The available net positive suction head for the centrifugal pump will be increased by...

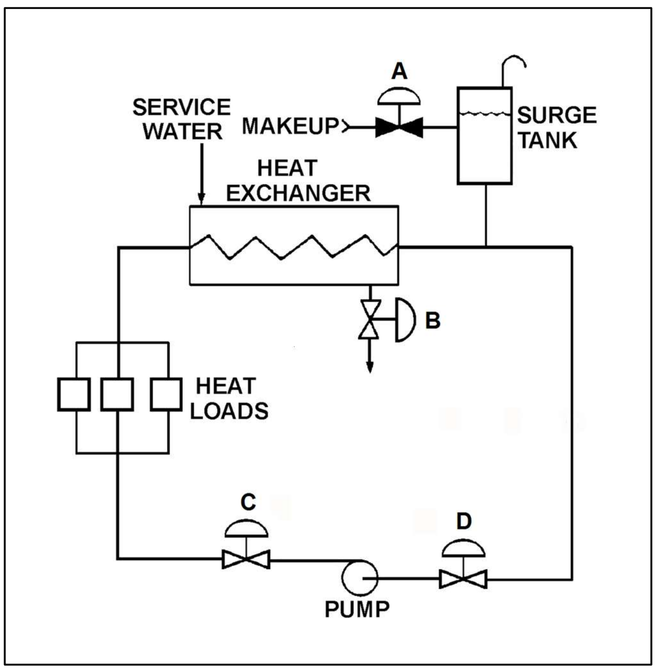
A. opening surge tank makeup valve A to raise tank level.

B. throttling heat exchanger service water valve B more closed.

C. throttling pump discharge valve C more open.

D. throttling pump suction valve D more closed.

ANSWER: A.



TOPIC: Pumps

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

The available net positive suction head for the centrifugal pump will be decreased by...

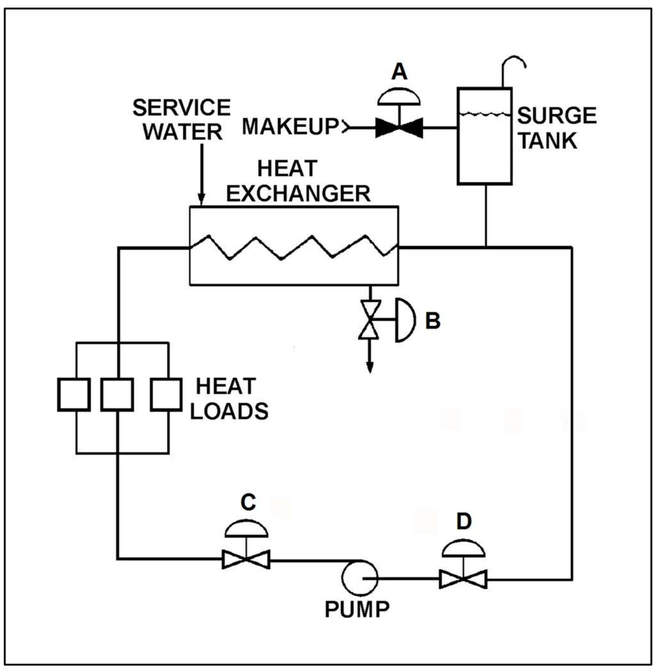
A. opening surge tank makeup valve A to raise tank level.

B. throttling heat exchanger service water valve B more open.

C. throttling pump discharge valve C more open.

D. reducing the heat load on the cooling water system.

ANSWER: C.



TOPIC: Pumps

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

Which one of the following will increase available net positive suction head for the centrifugal pump?

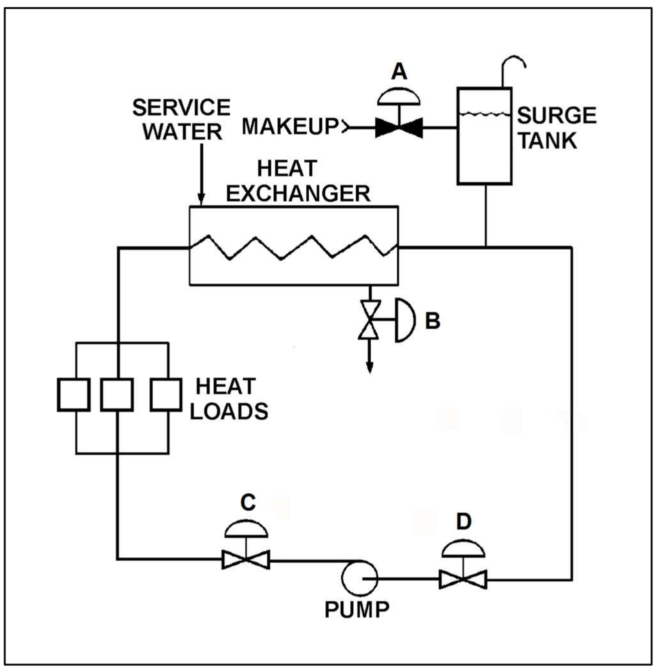
A. Draining the surge tank to decrease level by 10 percent.

B. Positioning heat exchanger service water valve B more closed.

C. Positioning pump discharge valve C more closed.

D. Positioning pump suction valve D more closed.

ANSWER: C.



TOPIC: Pumps

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

The available net positive suction head for the centrifugal pump will be decreased by...

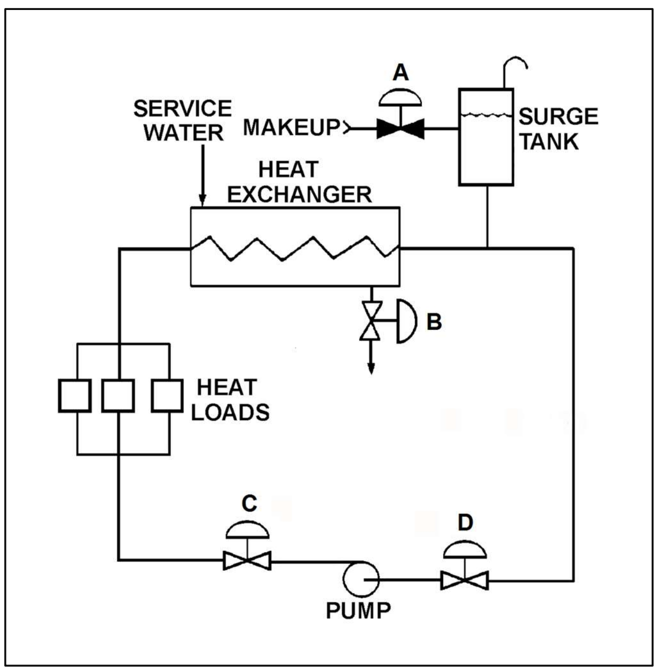
A. increasing surge tank level by 5 percent.

B. throttling heat exchanger service water valve B more open.

C. throttling pump discharge valve C more closed.

D. increasing the heat loads on the cooling water system.

ANSWER: D.



TOPIC: Pumps

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

Which one of the following will decrease available net positive suction head for the centrifugal pump?

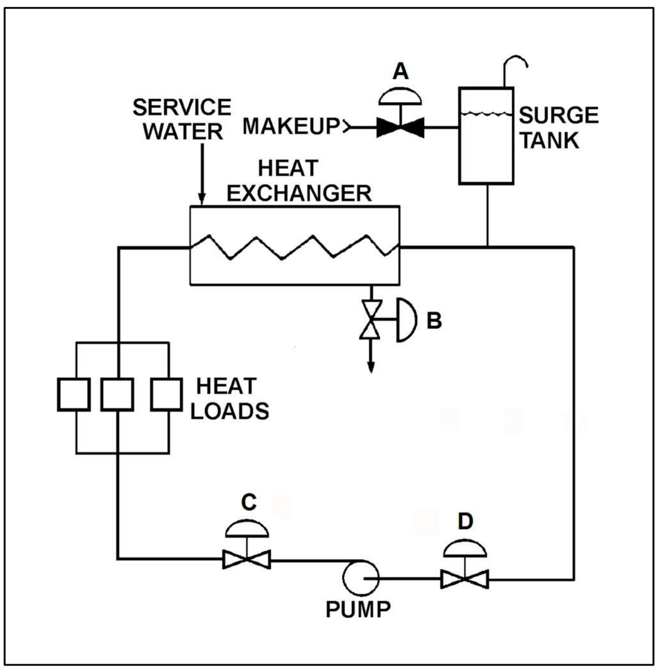
A. Adding water to the surge tank to raise level by 10 percent.

B. Positioning heat exchanger service water valve B more open.

C. Positioning pump discharge valve C more open.

D. Reducing heat loads on the cooling water system by 10 percent.

ANSWER: C.



TOPIC: Pumps

A cooling water pump is operating with pump suction parameters as follows:

Suction Temperature = 124°F
Suction Pressure = 11.7 psia

What is the approximate available net positive suction head (NPSH) for the pump? (Neglect the contribution of the suction fluid velocity to NPSH.)

A. 23 feet

B. 27 feet

C. 31 feet

D. 35 feet

ANSWER: A.

TOPIC: Pumps

A centrifugal pump is operating at maximum design flow rate, taking suction on a vented water storage tank and discharging through two parallel valves. Valve A is fully open and valve B is half open.

Which one of the following will occur if valve B is fully closed?

A. The pump will operate at shutoff head.

B. The pump will operate at runout conditions.

C. The pump available net positive suction head will increase.

D. The pump required net positive suction head will increase.

ANSWER: C.

TOPIC: Pumps

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

Which one of the following will increase the available net positive suction head for the centrifugal pump?

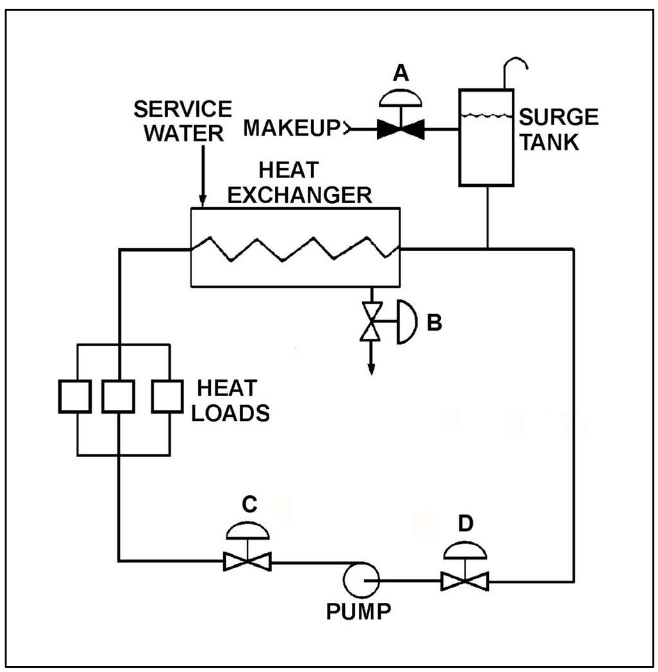
A. Draining the surge tank to decrease level by 10 percent.

B. Positioning the service water valve B more closed.

C. Positioning the pump discharge valve C more open.

D. Reducing the heat loads on the cooling water system.

ANSWER: D.



TOPIC: Pumps

A centrifugal pump is needed to take suction on a water storage tank and deliver high pressure water to a water spray system. To minimize axial thrust on the pump shaft, the pump should have __________ stage(s); and to maximize the available NPSH at the impeller inlet, the pump should have a __________ suction impeller.

A. a single; single

B. a single; double

C. multiple opposed; single

D. multiple opposed; double

ANSWER: D.

TOPIC: Pumps

A centrifugal pump is taking suction on an open storage tank that has been filled to a level of 40 feet with 10,000 gallons of 60°F water. The pump is located at the base of the tank, takes a suction from the bottom of the tank, and discharges to a lake.

Given:

- The pump is currently operating at its design flow rate of 200 gpm and a total developed head of 150 feet.
- The pump requires 4 feet of net positive suction head.

How will the centrifugal pump flow rate be affected as the water storage tank level decreases?

A. Flow rate will remain constant until the pump begins to cavitate at a tank level of about 4 feet.

B. Flow rate will remain constant until the pump becomes air bound when the tank empties.

C. Flow rate will gradually decrease until the pump begins to cavitate at a tank level of about 4 feet.

D. Flow rate will gradually decrease until the pump becomes air bound when the tank empties.

ANSWER: D.

TOPIC: Pumps

Refer to the drawing below of a centrifugal pump taking suction from the bottom of an open storage tank containing water at 66°F. Pump and water level elevations are indicated in the figure. Assume standard atmospheric pressure.

Assuming that pump suction head loss is negligible, what is the approximate value of net positive suction head available to the pump?

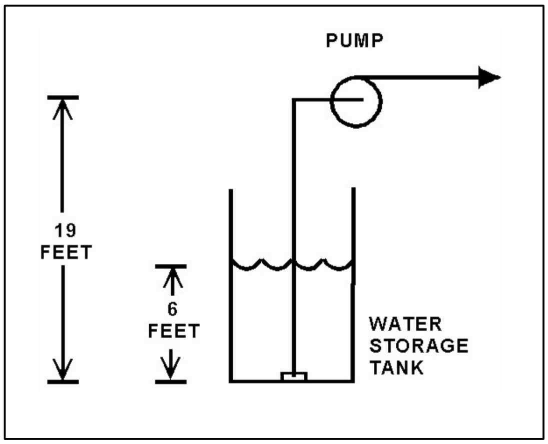
A. 6 feet

B. 13 feet

C. 20 feet

D. 25 feet

ANSWER: C.



TOPIC: Pumps

Refer to the drawing of an elevated centrifugal pump taking suction from the bottom of an open storage tank containing water at 66°F (see figure below). Assume standard atmospheric pressure.

The pump requires 4.0 feet of net positive suction head (NPSH). Assume that pump suction head loss is negligible.

If tank water level is allowed to decrease continuously, at what approximate water level will the pump begin to cavitate?

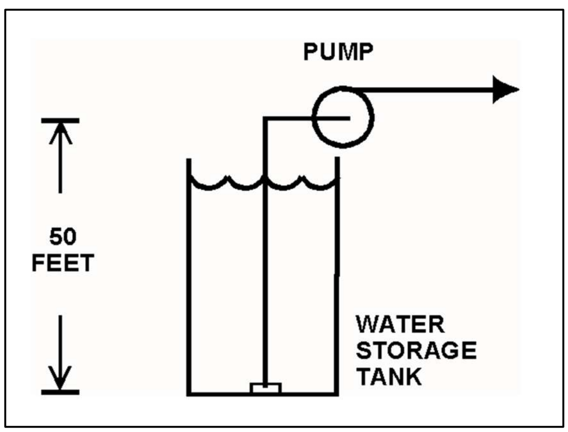
A. 34 feet

B. 29 feet

C. 21 feet

D. 16 feet

ANSWER: C.



TOPIC: Pumps

Refer to the drawing of a centrifugal pump taking suction from the bottom of an open storage tank containing water at 66°F (see figure below). Pump and water level elevations are indicated in the figure. Assume standard atmospheric pressure.

Assuming that pump suction head loss is negligible, what is the approximate value of net positive suction head available to the pump?

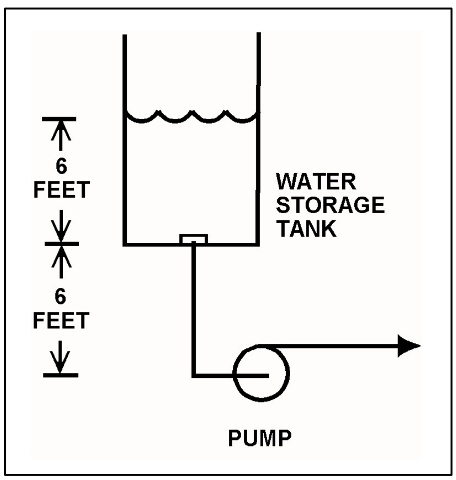
A. 6 feet

B. 12 feet

C. 39 feet

D. 45 feet

ANSWER: D.



TOPIC: Pumps

Refer to the drawing of a centrifugal pump taking suction from the bottom of an open water storage tank (see figure below).

Given:

- The tank contains 60°F water.
- The eye of the pump impeller is located 50 feet above the bottom of the tank.
- The pump requires a minimum net positive suction head of 4 feet.

Which one of the following describes the effect on pump operation if tank water level is allowed to continuously decrease?

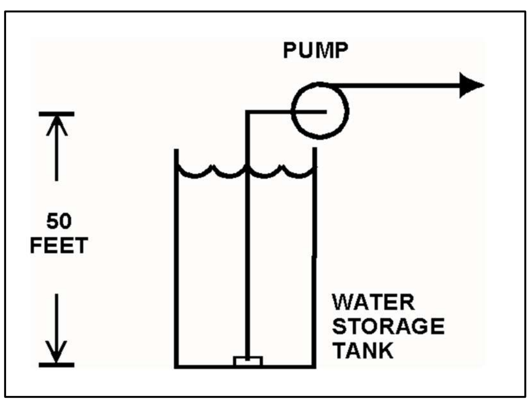
A. The pump will operate normally until tank water level decreases below approximately 20 feet, at which time the pump will cavitate.

B. The pump will operate normally until tank water level decreases below approximately 16 feet, at which time the pump will cavitate.

C. The pump will operate normally until the pump suction becomes uncovered, at which time the pump will cavitate.

D. The pump will operate normally until the pump suction becomes uncovered, at which time the pump will become air bound.

ANSWER: A.



TOPIC: Pumps

A centrifugal pump is taking suction on a water storage tank and delivering the makeup water to a cooling water system. The pump will have the lowest net positive suction head requirement if the pump is operated at a relatively __________ speed with a __________ discharge flow control valve.

A. high; fully open

B. high; throttled

C. low; fully open

D. low; throttled

ANSWER: D.

TOPIC: Pumps

Refer to the drawing below of a centrifugal pump taking suction from the bottom of an open storage tank containing water at 75°F. Pump and water level elevations are indicated in the figure. Assume standard atmospheric pressure.

Assuming that pump suction head loss is negligible, what is the approximate value of net positive suction head available to the pump?

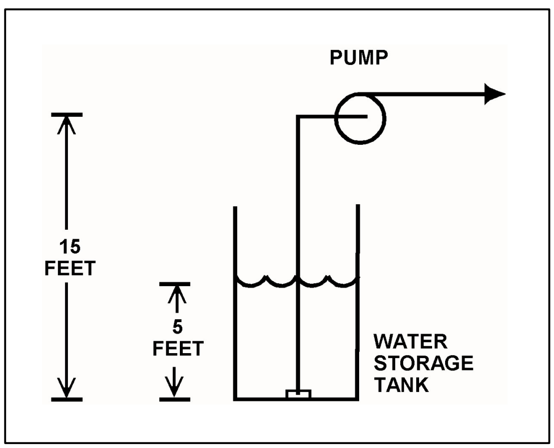
A. 5 feet

B. 10 feet

C. 17 feet

D. 23 feet

ANSWER: D.



TOPIC: Pumps

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

A. high; fully open

B. high; throttled

C. low; fully open

D. low; throttled

ANSWER: A.

TOPIC: Pumps

An operating centrifugal pump has a net positive suction head (NPSH) requirement of 150 feet. Water at 300°F is entering the pump. Which one of the following is the lowest listed pump inlet pressure that will provide adequate NPSH for the pump?

A. 60 psia

B. 83 psia

C. 108 psia

D. 127 psia

ANSWER: D.

TOPIC: Pumps

The current conditions for a centrifugal water pump are as follows:

Pump suction pressure = 140 psia
Pump suction temperature = 300°F

The pump requires a net positive suction head (NPSH) of 150 feet for pumping water at 300°F. Which one of the following is the lowest listed pump suction pressure that will provide the required NPSH for the current pump suction temperature?

A. 132 psia

B. 128 psia

C. 73 psia

D. 67 psia

ANSWER: B.

TOPIC: Pumps

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

Given:

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

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

A. The pump is currently cavitating; pump flow rate will decrease continuously as tank level decreases.

B. The pump is currently cavitating; pump flow rate will remain about the same until the tank empties.

C. The pump is currently <u>not</u> cavitating; pump flow rate will gradually decrease with tank level and then rapidly decrease when cavitation begins at a lower tank level.

D. The pump is currently <u>not</u> cavitating; pump flow rate will gradually decrease with tank level and then rapidly decrease as the pump becomes air bound when the tank empties.

ANSWER: D.

TOPIC: Pumps

Refer to the drawing of a centrifugal pump taking suction from a reservoir.

The pump is located on shore, with the eye of the pump 4 feet higher than the reservoir water level. The pump's suction line extends 4 feet below the surface of the reservoir. Which one of the following modifications would increase the pump's available net positive suction head? (Assume the reservoir is at a uniform temperature and ignore any changes in suction line head loss due to friction.)

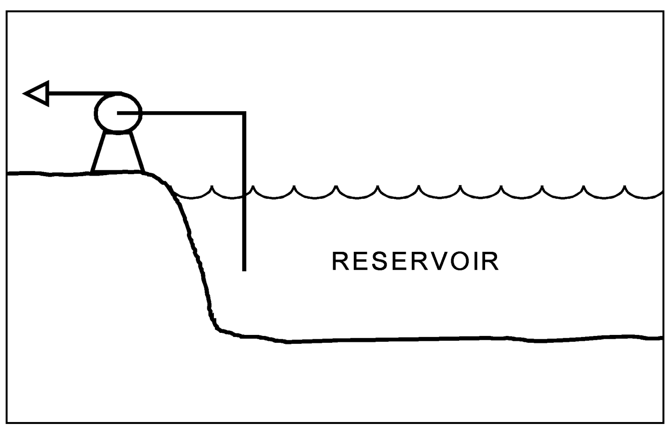
A. Raise the pump and suction line by 2 feet.

B. Lower the pump and suction line by 2 feet.

C. Lengthen the suction line to take a suction from 2 feet deeper.

D. Shorten the suction line to take a suction from 2 feet shallower.

ANSWER: B.



TOPIC: Pumps

Refer to the drawing of a centrifugal pump taking suction from a reservoir (see figure below).

The pump is located on shore, with the eye of the pump 4 feet higher than the reservoir water level. The pump's suction line extends 4 feet below the surface of the reservoir. Which one of the following modifications would decrease the pump's available net positive suction head? (Assume the reservoir is at a uniform temperature and ignore any changes in suction line head loss due to friction.)

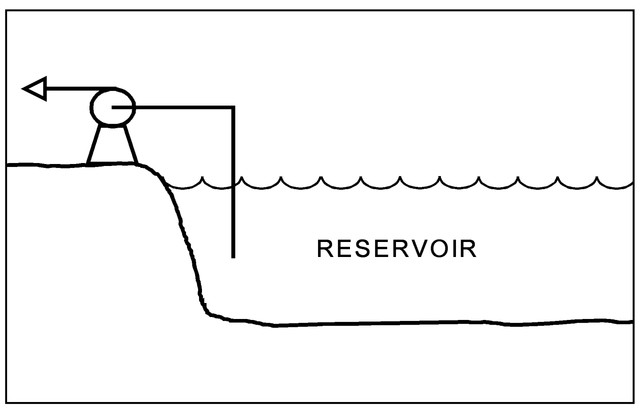
A. Raise the pump and suction line by 2 feet.

B. Lower the pump and suction line by 2 feet.

C. Lengthen the suction line to take a suction from 2 feet deeper.

D. Shorten the suction line to take a suction from 2 feet shallower.

ANSWER: A.



TOPIC: Pumps

Refer to the drawing of a centrifugal pump with a water storage tank for its suction source. The storage tank is open to the atmosphere and contains 20 feet of water at 60°F. The pump is currently stopped.

If the temperature of the water in the storage tank and pump suction piping increases to 80°F, with the accompanying water expansion, the suction head for the pump will __________; and the available net positive suction head for the pump will __________.

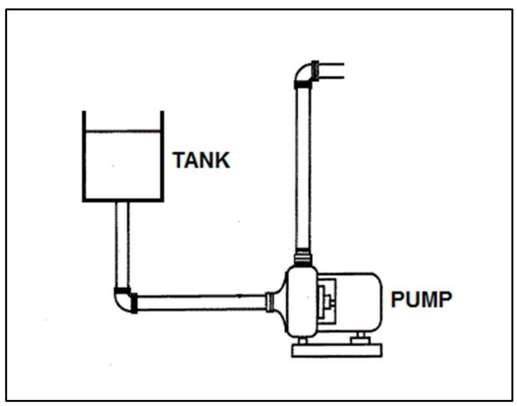
A. increase; increase

B. increase; decrease

C. remain the same; increase

D. remain the same; decrease

ANSWER: B.



TOPIC: Pumps

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

Given:

- The storage tank is filled to a level of 26 feet with 60°F water.
- The pump requires 45 feet of net positive suction head.
- The pump is currently operating at 50 gpm.

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

A. The pump is currently cavitating; pump flow rate will decrease continuously as tank level decreases.

B. The pump is currently cavitating; pump flow rate will remain about the same until the tank empties.

C. The pump is currently <u>not</u> cavitating; pump flow rate will gradually decrease with tank level, and then rapidly decrease when the tank empties.

D. The pump is currently <u>not</u> cavitating; pump flow rate will gradually decrease with tank level, and then rapidly decrease when cavitation begins before the tank empties.

ANSWER: D.

TOPIC: Pumps

A centrifugal pump is operating normally in a closed cooling water system. If system pressure is increased by 10 psi, the available net positive suction head (NPSH) for the pump will __________; and the pump mass flow rate will __________. (Assume the water density does not change and the minimum required NPSH for the pump is maintained.)

A. increase; increase

B. increase; remain the same

C. decrease; decrease

D. decrease; remain the same

ANSWER: B.

TOPIC: Pumps

Refer to the drawing of a centrifugal pump with a water storage tank for its suction source. The storage tank is open to the atmosphere and contains 20 feet of water at 90°F. The pump is currently stopped.

If the temperature of the water in the storage tank and pump suction piping decreases to 70°F, with the accompanying water contraction, the suction head for the pump will __________; and the available net positive suction head for the pump will __________.

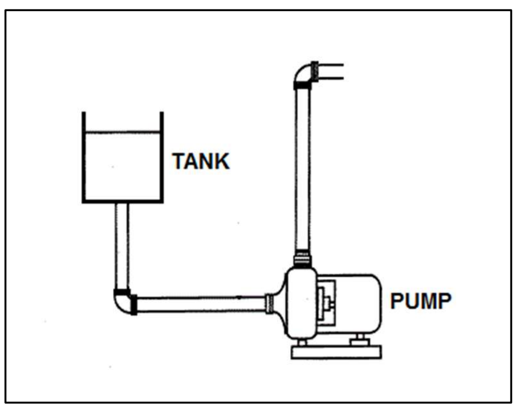
A. decrease; increase

B. decrease; remain the same

C. remain the same; increase

D. remain the same; remain the same

ANSWER: A.



TOPIC: Pumps

Shutting the discharge valve on an operating motor-driven radial-flow centrifugal pump in a water system will cause the motor amps to __________ and the pump discharge pressure to __________.

A. decrease, increase

B. decrease, decrease

C. increase, increase

D. increase, decrease

ANSWER: A.

TOPIC: Pumps

When starting an AC motor-driven centrifugal pump, the response of motor current will be...

A. low starting amps, increasing to a higher equilibrium value of running amps.

B. low starting amps, remaining at a low equilibrium value of running amps.

C. high starting amps, decreasing to a lower equilibrium value of running amps.

D. high starting amps, remaining at a high equilibrium value of running amps.

ANSWER: C.

TOPIC: Pumps

A constant-speed radial-flow centrifugal pump motor draws the least current when the pump is...

A. at runout conditions.

B. at operating conditions.

C. accelerating to normal speed during start.

D. at shutoff head.

ANSWER: D.

TOPIC: Pumps

A centrifugal pump was initially circulating water at 100°F in a cooling water system. Over several hours, the water temperature increased to 150°F. Assuming system flow rate (gpm) was constant, pump motor amps __________ during the heatup because __________.

A. decreased; the water density decreased

B. decreased; the water volume increased

C. increased; the water density decreased

D. increased; the water volume increased

ANSWER: A.

TOPIC: Pumps

An AC motor-driven centrifugal pump was initially circulating water at 200°F in a cooling water system. Over several hours, the circulating water temperature decreased to 120°F while system flow rate (gpm) remained constant.

During the system cooldown, pump motor current __________ because __________

A. decreased; the water density increased

B. increased; the water density increased

C. decreased; the pump motor efficiency decreased

D. increased; the pump motor efficiency decreased

ANSWER: B.

TOPIC: Pumps

A centrifugal pump is operating in a closed system with all valves fully open. If the pump discharge valve is throttled 75 percent closed, pump motor current will...

A. increase and stabilize at a higher value.

B. decrease and stabilize at a lower value.

C. increase briefly, then return to the original value.

D. decrease briefly, then return to the original value.

ANSWER: B.

TOPIC: Pumps

Which one of the following operating conditions for a motor-driven radial-flow centrifugal pump will result in the most current being drawn by the pump motor?

A. Pump discharge head is at shutoff head.

B. The pump is operating at minimum flow.

C. Pump discharge head is at design head.

D. The pump is operating at runout.

ANSWER: D.

TOPIC: Pumps

Initially, an AC motor-driven centrifugal pump was operating in a cooling water system with cooling water temperature at 150°F. Over several hours, the cooling water temperature decreased and is currently 100°F. Assuming pump flow rate (gpm) remained constant, the pump motor is drawing __________ current because __________ is greater.

A. more; cooling water density

B. more; motor efficiency

C. less; cooling water density

D. less; motor efficiency

ANSWER: A.

TOPIC: Pumps

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

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

ANSWER: C.

TOPIC: Pumps

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

Initially, centrifugal pump A is circulating water at 100°F. If the temperature of the cooling water entering pump A increases to 200°F, the pump's motor current will... (Assume the pump's volumetric flow rate is constant.)

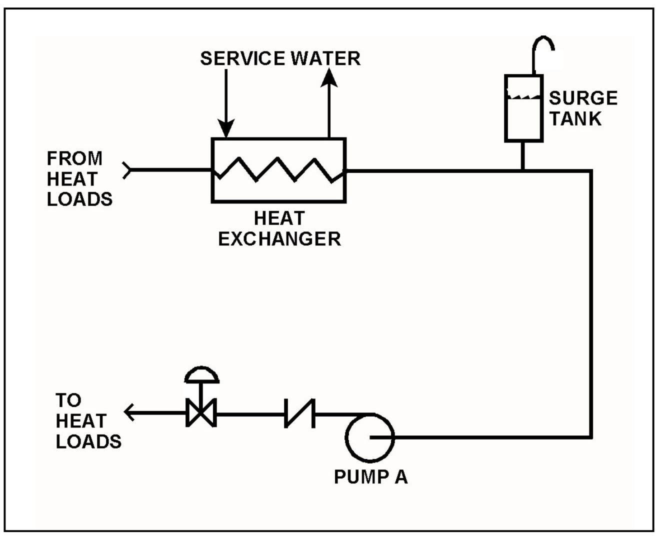
A. increase, because the speed of the pump shaft will increase.

B. decrease, because the speed of the pump shaft will decrease.

C. increase, because the density of the cooling water will increase.

D. decrease, because the density of the cooling water will decrease.

ANSWER: D.



TOPIC: Pumps

A constant-speed radial-flow centrifugal pump motor draws the <u>least</u> current when the pump is...

A. at maximum rated flow conditions.

B. operating on recirculation flow only.

C. accelerating to normal speed during start.

D. at shutoff head with no recirculation flow.

ANSWER: D.

TOPIC: Pumps

A typical radial-flow centrifugal pump is operating at rated conditions in an open system with all valves fully open. If the pump discharge valve is throttled to 50 percent closed, pump discharge pressure will __________; and pump motor current will __________.

A. decrease; decrease

B. decrease; increase

C. increase; increase

D. increase; decrease

ANSWER: D.

TOPIC: Pumps

A centrifugal pump in a cooling water system is operating with a motor current of 200 amps. After several hours, the system water density has increased by 3 percent, while the pump head and volumetric flow rate have remained the same.

Which one of the following is the new pump motor current?

A. 203 amps

B. 206 amps

C. 218 amps

D. 236 amps

ANSWER: B.

TOPIC: Pumps

A constant-speed centrifugal pump motor draws the most current when the pump is...

A. at maximum rated flow conditions.

B. operating at runout flow.

C. accelerating to normal speed during start.

D. at shutoff head with no recirculation flow.

ANSWER: C.

TOPIC: Pumps

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.

ANSWER: B.

TOPIC: Pumps

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

A. Decreases due to decreased pump work.

B. Decreases due to decreased counter electromotive force.

C. Increases due to increased pump work.

D. Increases due to decreased counter electromotive force.

ANSWER: A.

TOPIC: Pumps

A centrifugal pump is circulating water at 180°F with a pump motor current of 200 amps. After several hours, system temperature has changed such that the water density has increased by 6 percent.

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

A. 203 amps

B. 206 amps

C. 212 amps

D. 224 amps

ANSWER: C.

TOPIC: Pumps

An AC motor-driven centrifugal water pump was just started. During the start, motor current remained peaked for 2 seconds, and then decreased and stabilized at about one-fifth the standard running current. Normally, the starting current peak lasts about 4 seconds.

Which one of the following could have caused the abnormal start indications above?

A. The pump shaft was initially seized and the motor breaker opened.

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

C. The pump was initially air bound, and then primed itself after 2 seconds of operation.

D. The coupling between the motor and pump shafts was left disconnected after maintenance.

ANSWER: D.

TOPIC: Pumps

A radial-flow 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 <u>no</u> change in pump flow rate.

B. The temperature of the cooling water being pumped increased to 80°F with <u>no</u> change in pump flow rate.

C. Cooling water flow was established to an additional heat load with <u>no</u> change in the temperature of the cooling water being pumped.

D. Cooling water flow was isolated from an out-of-service heat load with <u>no</u> change in the temperature of the cooling water being pumped.

ANSWER: D.

TOPIC: Pumps

A radial-flow 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. Initially, the following pump conditions exist:

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

Four hours later, the pump motor is drawing 105 amps. Which one of the following could be responsible for the observed increase in motor current?

A. The temperature of the cooling water being pumped decreased to 60°F with <u>no</u> change in pump volumetric flow rate.

B. The temperature of the cooling water being pumped increased to 80°F with <u>no</u> change in pump volumetric flow rate.

C. Cooling water flow was established to an additional heat load with <u>no</u> change in the temperature of the cooling water being pumped.

D. Cooling water flow was isolated from an out-of-service heat load with <u>no</u> change in the temperature of the cooling water being pumped.

ANSWER: C.

TOPIC: Pumps

A motor-driven centrifugal pump exhibited indications of pump failure while being started. Which one of the following pairs of observations indicate that the pump failure is a sheared impeller shaft?

A. Excessive duration of high starting current and motor breaker trips.

B. Excessive duration of high starting current and <u>no</u> change in system flow rate.

C. Lower than normal running current and motor breaker trips.

D. Lower than normal running current and <u>no</u> change in system flow rate.

ANSWER: D.

TOPIC: Pumps

Some large centrifugal pumps are started with their discharge valves closed to prevent...

A. cavitation in the pump.

B. lifting the discharge relief valve.

C. loss of recirculation (miniflow).

D. excessive current in the pump motor.

ANSWER: D.

TOPIC: Pumps

Some large centrifugal pumps are interlocked so that the pump will not start unless its discharge valve is at least 90 percent closed. This interlock is provided to minimize...

A. pump discharge pressure.

B. heating of the pumped fluid.

C. the potential for cavitation at the pump suction.

D. the duration of the pump motor starting current.

ANSWER: D.

TOPIC: Pumps

Which one of the following contains two reasons for starting a typical radial-flow centrifugal pump with the discharge piping full of water and the discharge valve closed?

A. Prevent pump runout and prevent motor overspeed.

B. Prevent pump runout and ensure lubrication of pump seals.

C. Prevent water hammer and ensure adequate pump recirculation flow.

D. Prevent water hammer and prevent excessive duration of starting current.

ANSWER: D.

TOPIC: Pumps

Refer to the drawing of a cooling water system and the associated pump/system operating curves (see figure below) in which pumps A and B are identical single-speed centrifugal pumps and only pump A is operating.

If pump B is started, system flow rate will be __________ and common pump discharge pressure will be __________.

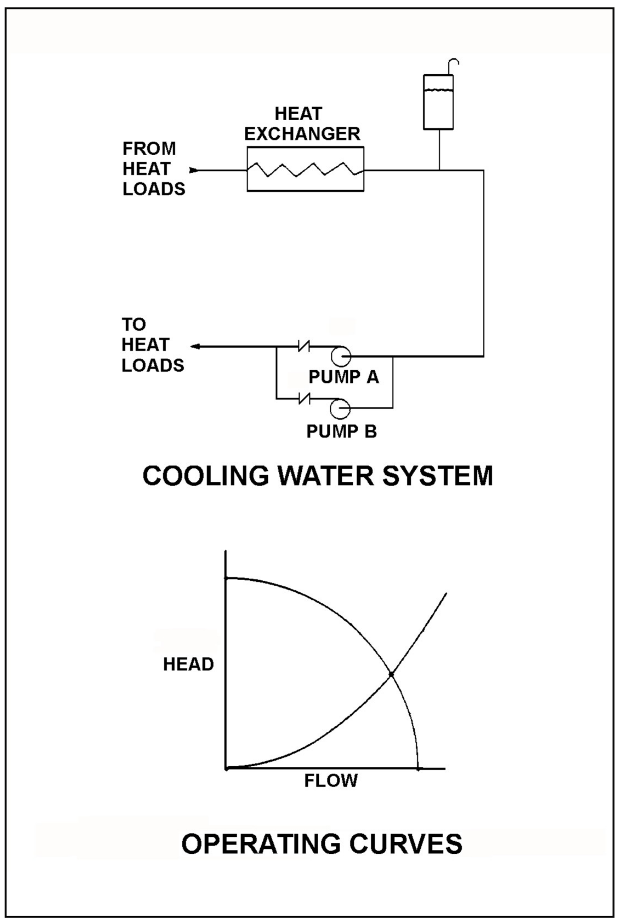
A. the same; higher

B. higher; the same

C. the same; the same

D. higher; higher

ANSWER: D.



TOPIC: Pumps

Refer to the drawing of a cooling water system and the associated pump/system operating curves (see figure below).

Pumps A and B are identical single-speed centrifugal pumps, and only pump A is operating. If pump B is started, after the system stabilizes system flow rate will be...

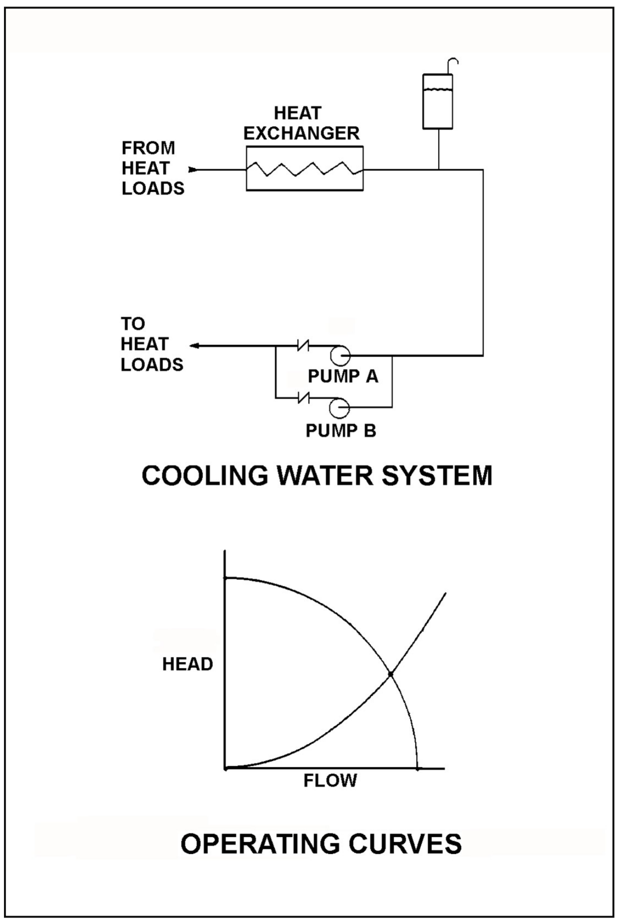
A. twice the original flow.

B. the same as the original flow.

C. less than twice the original flow.

D. more than twice the original flow.

ANSWER: C.



TOPIC: Pumps

A centrifugal pump is operating in parallel with a positive displacement pump in an open water system. Each pump has the same maximum design pressure.

If pump discharge pressure increases to the maximum design pressure of each pump, the centrifugal pump will be operating near __________ flow rate and the positive displacement pump will be operating near __________ flow rate.

A. minimum; minimum

B. minimum; maximum rated

C. maximum rated; minimum

D. maximum rated; maximum rated

ANSWER: B.

TOPIC: Pumps

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

Pumps A and B are identical single-speed centrifugal pumps and both pumps are initially operating when pump B trips. After the system stabilizes, system flow rate will be...

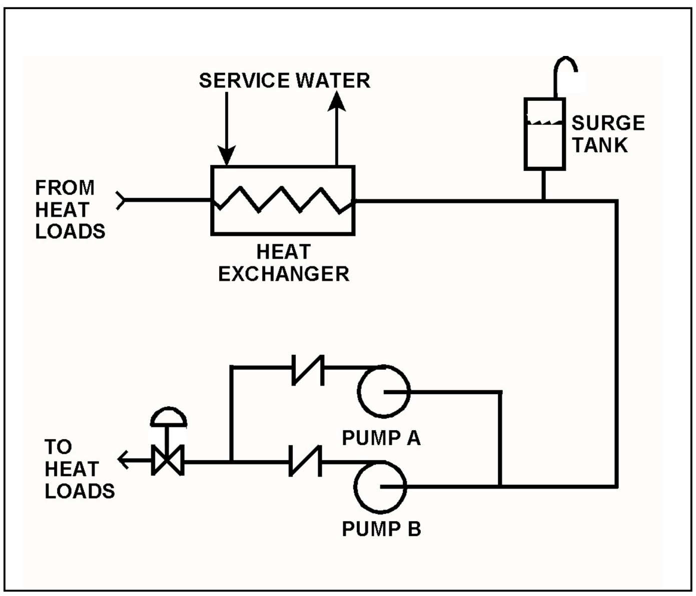
A. more than one-half the original flow.

B. one-half the original flow.

C. less than one-half the original flow.

D. the same; only the pump head will change.

ANSWER: A.



TOPIC: Pumps

Which one of the following is an indication of pump runout?

A. Low pump flow rate

B. High pump vibration

C. Low pump motor current

D. High pump discharge pressure

ANSWER: B.

TOPIC: Pumps

Which one of the following is an indication of pump runout?

A. High discharge pressure

B. Low pump motor current

C. High pump flow rate

D. Pump flow reversal

ANSWER: C.

TOPIC: Pumps

Which one of the following describes typical radial-flow centrifugal pump runout conditions?

A. High discharge pressure, low flow, high power demand

B. High discharge pressure, high flow, low power demand

C. Low discharge pressure, low flow, low power demand

D. Low discharge pressure, high flow, high power demand

ANSWER: D.

TOPIC: Pumps

A centrifugal pump is operating at its maximum design flow rate, delivering water through two parallel valves. Valve A is half open, and valve B is one quarter open.

Which one of the following will occur if both valves are fully opened?

A. The pump will operate at shutoff head.

B. The pump available net positive suction head will increase.

C. The pump required net positive suction head will decrease.

D. The pump will operate at runout conditions.

ANSWER: D.

TOPIC: Pumps

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

Which point represents pump operation at runout conditions?

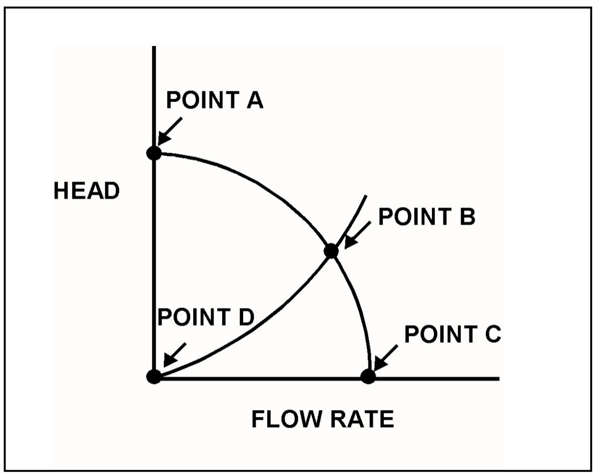
A. Point A

B. Point B

C. Point C

D. Point D

ANSWER: C.



TOPIC: Pumps

Refer to the drawing of a cooling water system in which only centrifugal pump A is operating and the common pump discharge valve is currently 90 percent open (see figure below).

An abnormal total heat load on the cooling water system is causing pump A to approach operation at runout conditions. Which one of the following will cause pump A to operate further away from runout conditions? (Assume that satisfactory available net positive suction head is maintained at all times.)

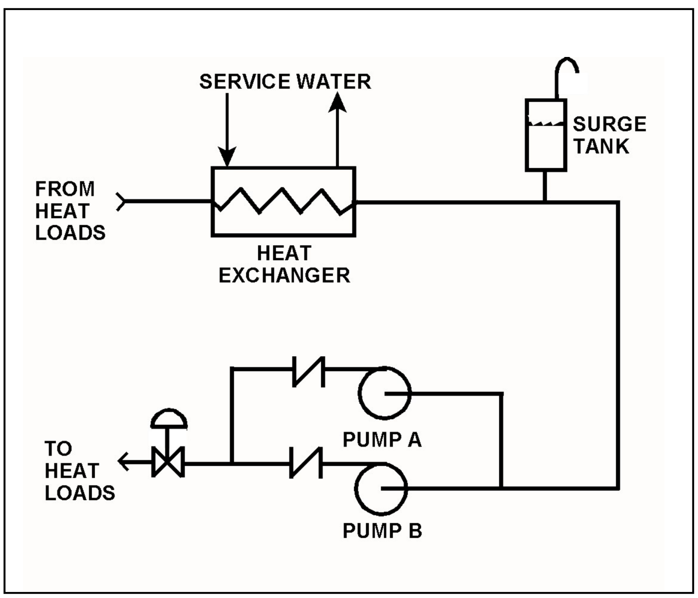
A. Starting pump B.

B. Raising the water level in the surge tank by 2 feet.

C. Decreasing heat exchanger service water flow rate by 10 percent.

D. Positioning the common pump discharge valve to 100 percent open.

ANSWER: A.



TOPIC: Pumps

A flow-limiting venturi in the discharge piping of a centrifugal pump decreases the potential for the pump to experience...

A. runout.

B. reverse flow.

C. shutoff head.

D. water hammer.

ANSWER: A.

TOPIC: Pumps

Refer to the drawing of a radial-flow centrifugal pump with a recirculation line in an open system (see figure below). The recirculation line throttle valve is currently 50 percent open. The pump is currently operating very close to runout.

To move pump operation farther away from runout, without reducing the pump's available net positive suction head, an orifice can be installed at point _____; or the pump's recirculation line throttle valve can be positioned more __________.

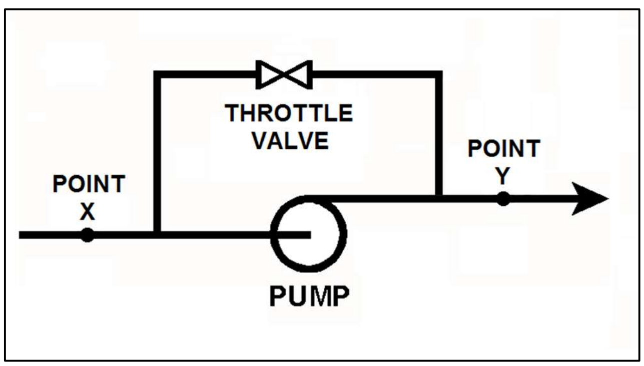
A. X; open

B. X; closed

C. Y; open

D. Y; closed

ANSWER: D.



TOPIC: Pumps

Refer to the drawing of a lube oil temperature control system and the associated pump/system operating curves (see figure below).

The pump is initially operating at point B. If the temperature control valve modulates further open, operating point B will be located on curve __________ closer to point __________.

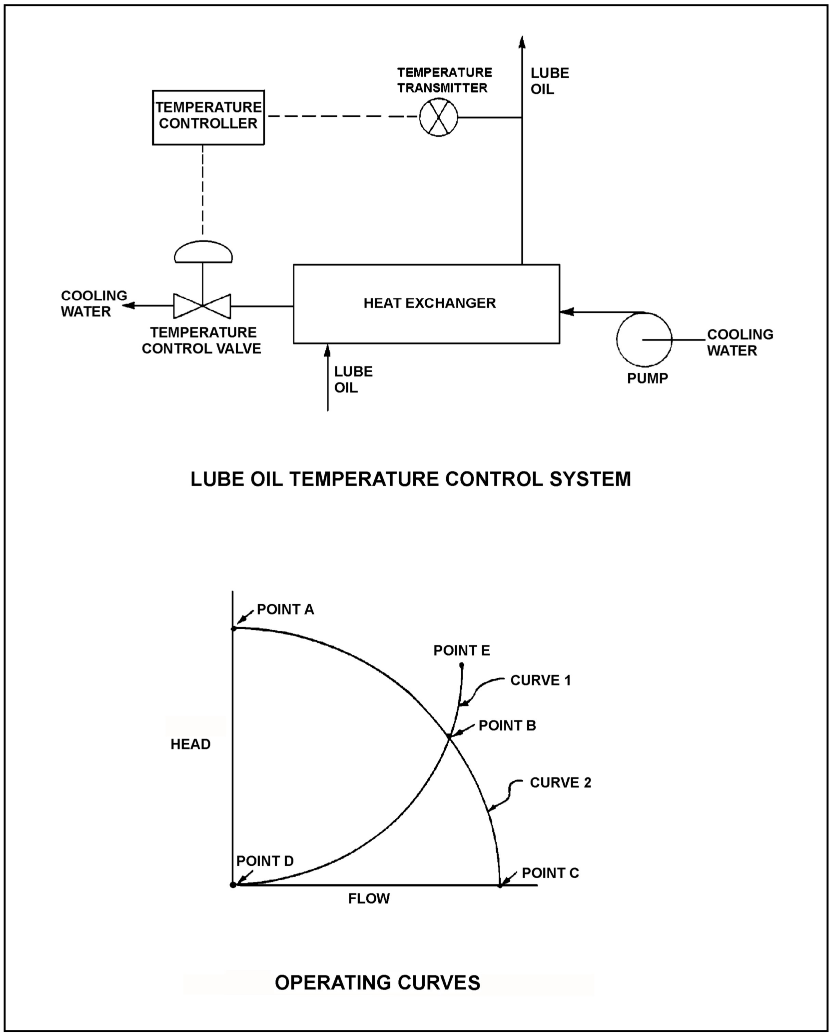
A. 1; D

B. 2; A

C. 1; E

D. 2; C

ANSWER: D.



TOPIC: Pumps

Refer to the drawing of a lube oil temperature control system and the associated pump/system operating curves (see figure below).

The pump is operating at point B on the operating curve. If the temperature control valve modulates further closed, operating point B will be located on curve __________ closer to point __________.

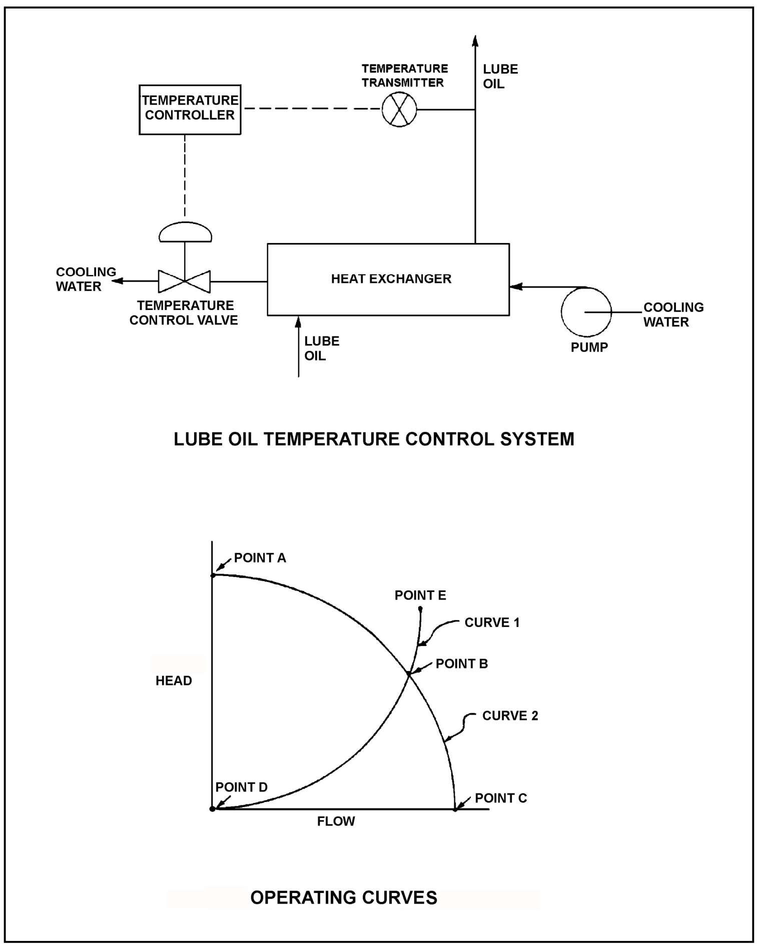
A. 1; D

B. 2; A

C. 1; E

D. 2; C

ANSWER: B.



TOPIC: Pumps

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

Initially, a centrifugal pump is operating with a partially open discharge valve in a closed system. The discharge valve is then opened fully.

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

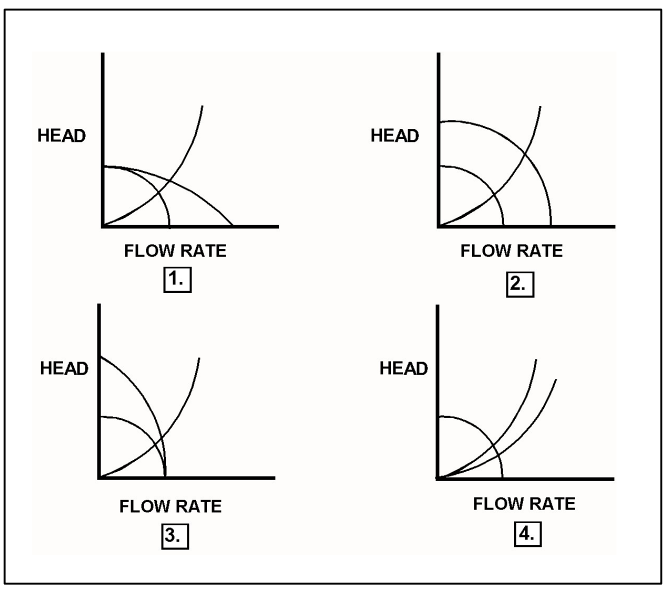
A. 1.

B. 2.

C. 3.

D. 4.

ANSWER: D.



TOPIC: Pumps

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

Two identical constant-speed centrifugal pumps are operating in series in an open system when one pump trips.

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

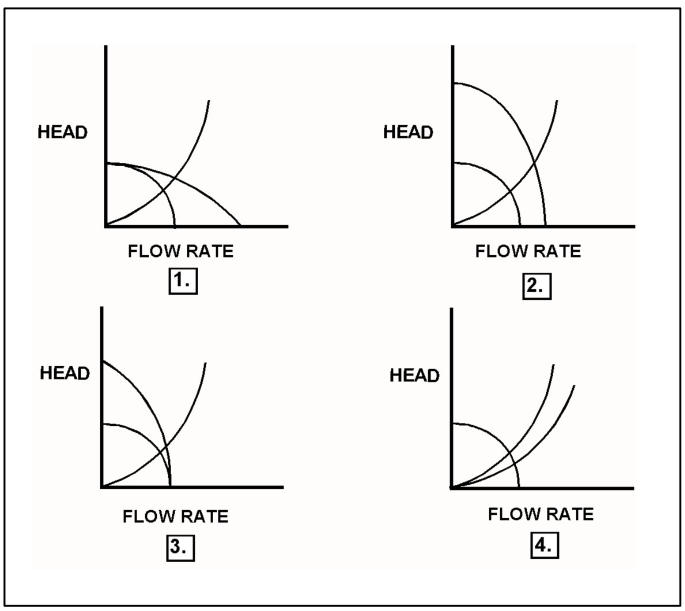
A. 1.

B. 2.

C. 3.

D. 4.

ANSWER: C.



TOPIC: Pumps

Refer to the drawing of four sets of centrifugal pump and system operating curves (see figure below). Each set of curves shows the steady-state "before and after" conditions for a change in pump and/or system operating conditions.

Initially, one centrifugal pump was operating in a cooling water system. Then, a second identical centrifugal pump was started in series with the first.

Which set of operating curves shown below depicts the steady-state "before and after" conditions described above?

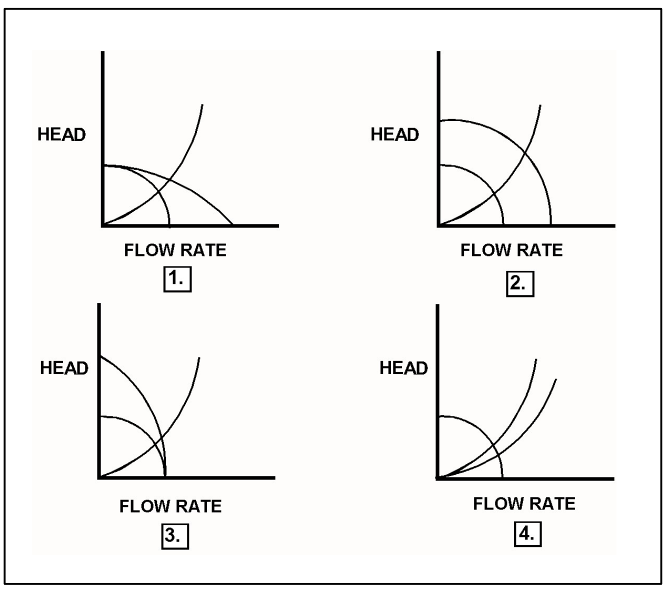
A. 1.

B. 2.

C. 3.

D. 4.

ANSWER: C.



TOPIC: Pumps

Initially, two identical centrifugal pumps were operating in parallel in a closed system when one pump tripped.

Which set of operating curves shown below depicts the steady-state "before and after" conditions described above?

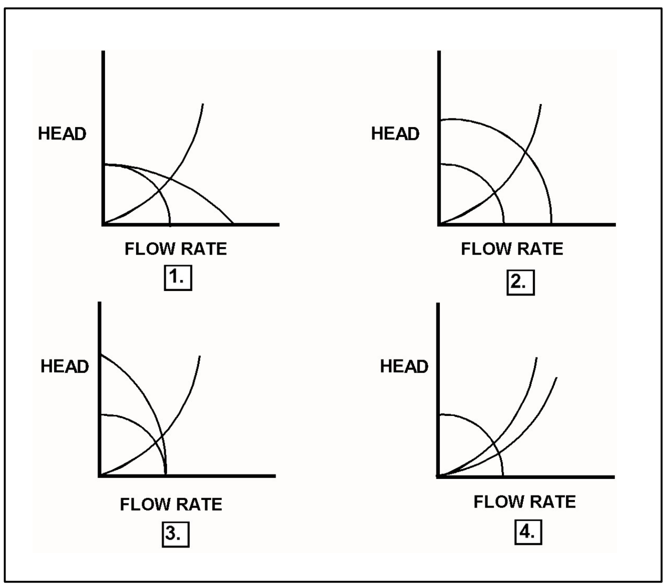
A. 1.

B. 2.

C. 3.

D. 4.

ANSWER: A.



TOPIC: Pumps

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

Initially, a constant-speed centrifugal pump was operating in an closed system. Another identical centrifugal pump was then started in parallel with the first.

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

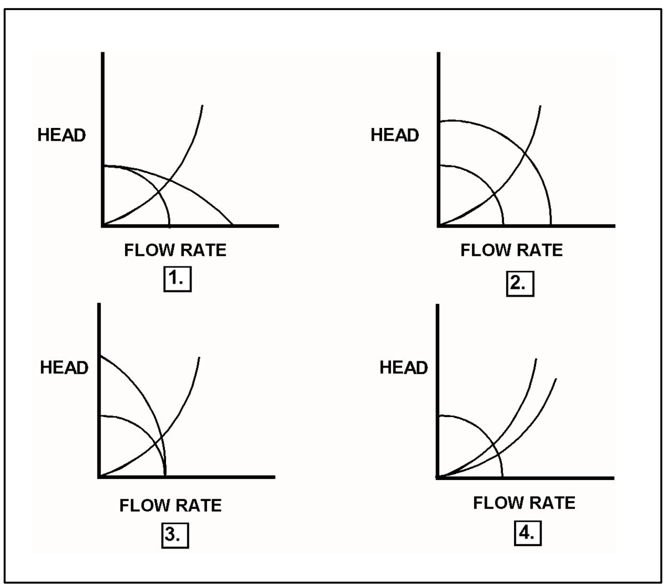
A. 1.

B. 2.

C. 3.

D. 4.

ANSWER: A.



TOPIC: Pumps

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

Initially, a centrifugal pump is operating in a closed water system and discharging through a single heat exchanger. A second heat exchanger is then placed in service in parallel with the first.

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

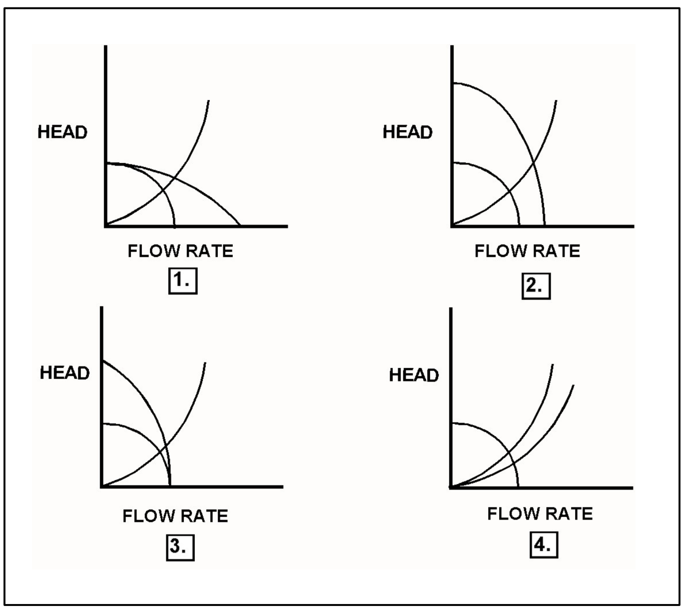
A. 1.

B. 2.

C. 3.

D. 4.

ANSWER: D.



TOPIC: Pumps

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

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

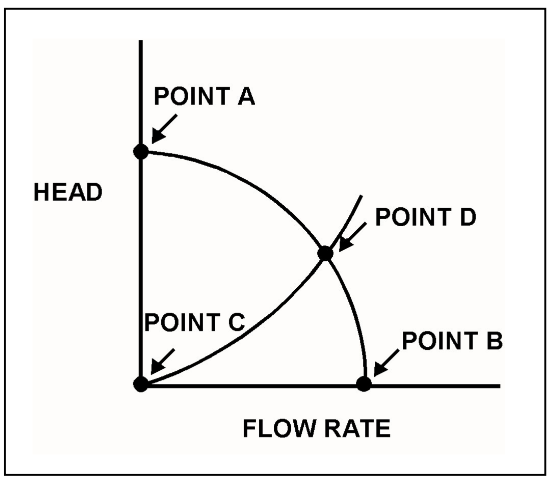
A. The frictional and throttling losses in the piping system as the system flow rate increases.

B. The frictional losses between the pump impeller and its casing as the differential pressure (D/P) across the pump increases.

C. The pump flow losses, due to the decrease in available net positive suction head as the system flow rate increases.

D. The pump flow losses, due to back leakage through the clearances between the pump impeller and casing as the D/P across the pump increases.

ANSWER: A.



TOPIC: Pumps

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

A centrifugal pump is initially operating at point B. If the pump speed is reduced by one-half, the new operating point will be located on curve _____ closer to point _____.

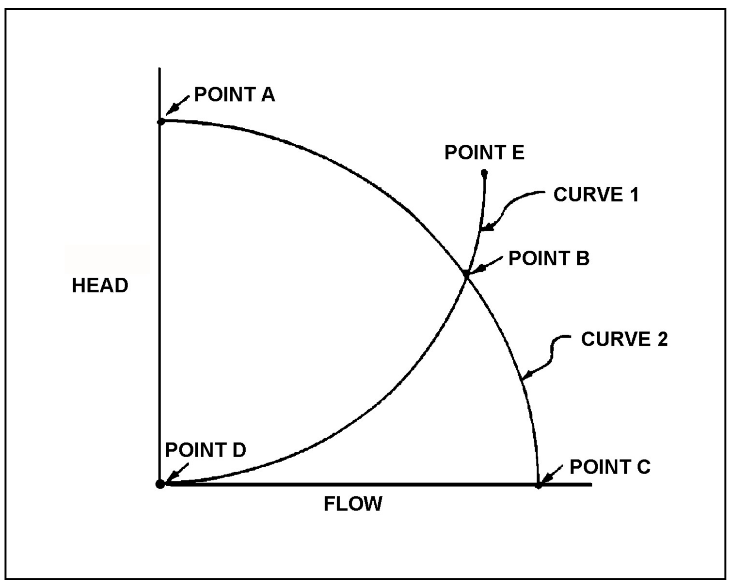
A. 1; D

B. 2; A

C. 1; E

D. 2; C

ANSWER: A.



TOPIC: Pumps

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

Initially, the pump is operating with the temperature control valve one-half open. If the temperature control valve is positioned more closed, the system head loss will __________; and the pump head will __________.

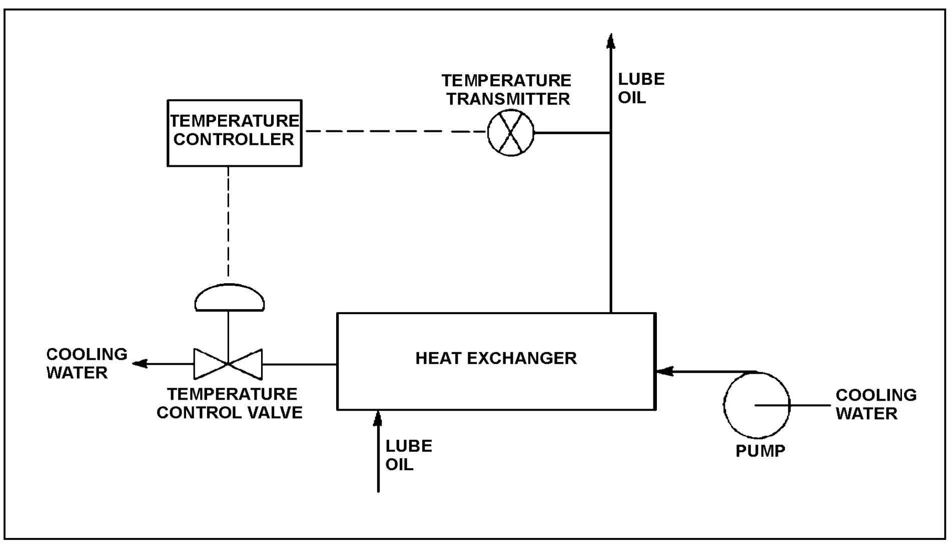
A. increase, decrease

B. increase, increase

C. decrease, decrease

D. decrease, increase

ANSWER: B.



TOPIC: Pumps

Refer to the drawing of a lube oil temperature control system and the associated pump/system operating curves (see figure below).

If the pump is initially operating at point B, how will the operating point change if the temperature controller setpoint is decreased by 10°F?

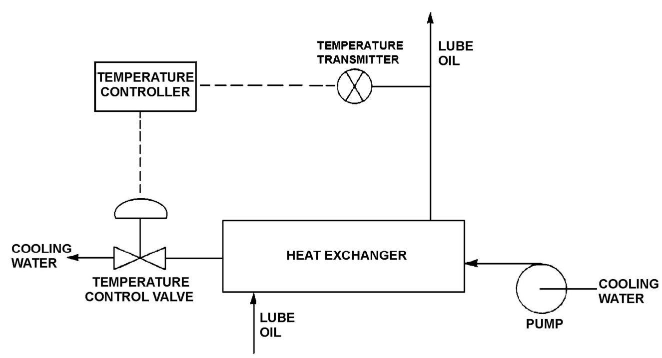
A. Operating point B will be located on curve 1 closer to point E.

B. Operating point B will be located on curve 1 closer to point D.

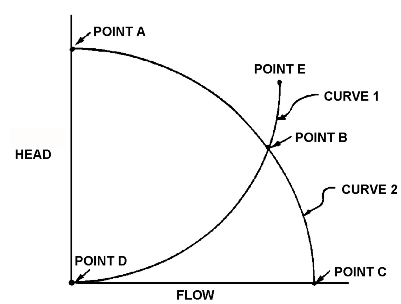
C. Operating point B will be located on curve 2 closer to point A.

D. Operating point B will be located on curve 2 closer to point C.

ANSWER: D.



LUBE OIL TEMPERATURE CONTROL SYSTEM



OPERATING CURVES

TOPIC: Pumps

Refer to the drawing showing two operating points for the same centrifugal pump (see figure below).

Operating point A was generated from pump performance data taken six months ago. Current pump performance data was used to generate operating point B. Which one of the following would cause the observed difference between operating points A and B?

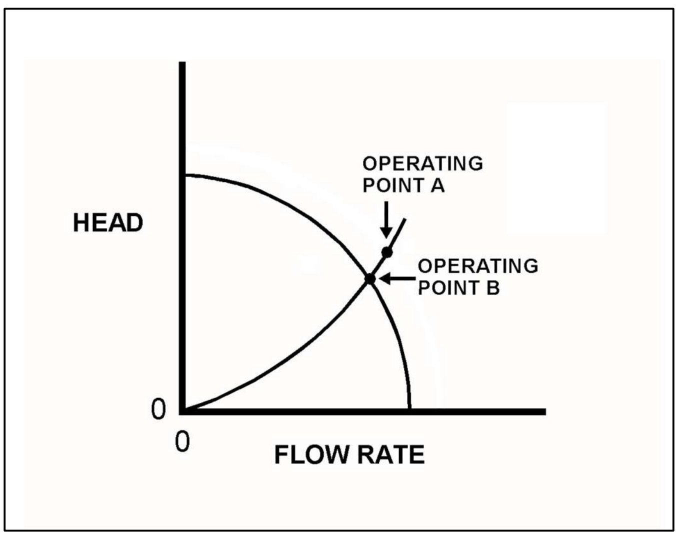
A. The pump discharge valve was more open when data was collected for operating point A.

B. The pump discharge valve was more closed when data was collected for operating point A.

C. The pump internal components have worn since data was collected for operating point A.

D. The system piping head loss has increased since data was collected for operating point A.

ANSWER: C.



TOPIC: Pumps

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

Initially, a two-speed centrifugal pump is operating at low speed in a cooling water system and discharging through a heat exchanger. The pump is then switched to high speed.

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

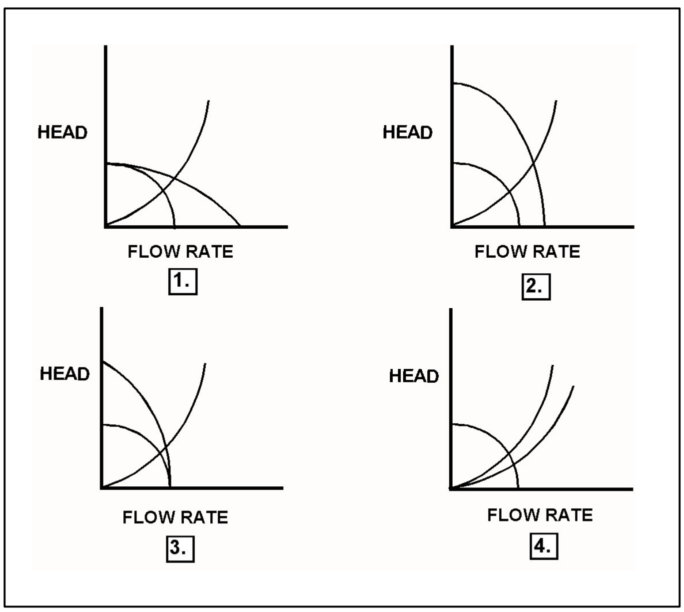
A. 1.

B. 2.

C. 3.

D. 4.

ANSWER: B.



TOPIC: Pumps

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

Initially, a two-speed centrifugal pump is operating at high speed in a cooling water system and discharging through a heat exchanger. The pump is then switched to low speed.

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

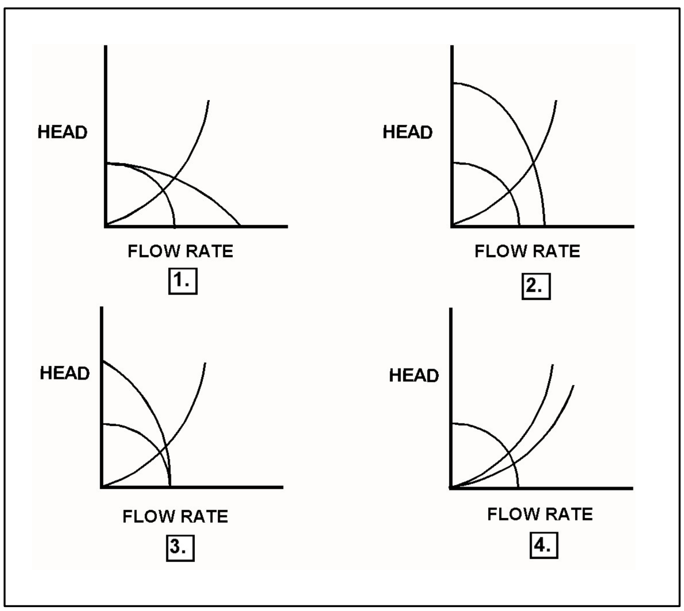
A. 1.

B. 2.

C. 3.

D. 4.

ANSWER: B.



TOPIC: Pumps

Refer to the drawing of a cooling water system and the associated pump/system operating curves (see figure below). Pumps A and B are identical single-speed centrifugal pumps and initially only pump A is operating.

Pump B is then started. After the system stabilizes, system flow rate will be...

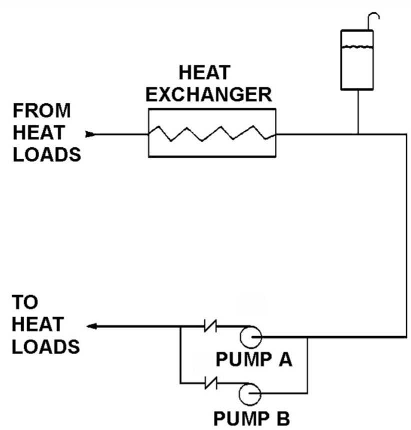
A. the same as the initial flow rate.

B. less than twice the initial flow rate.

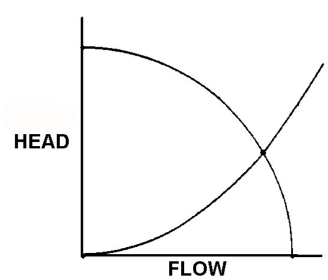
C. twice the initial flow rate.

D. more than twice the initial flow rate.

ANSWER: B.



COOLING WATER SYSTEM



OPERATING CURVES

TOPIC: Pumps

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

Which one of the following changes to the cooling water system will result in a higher cooling water pump flow rate and a reduced pump discharge head?

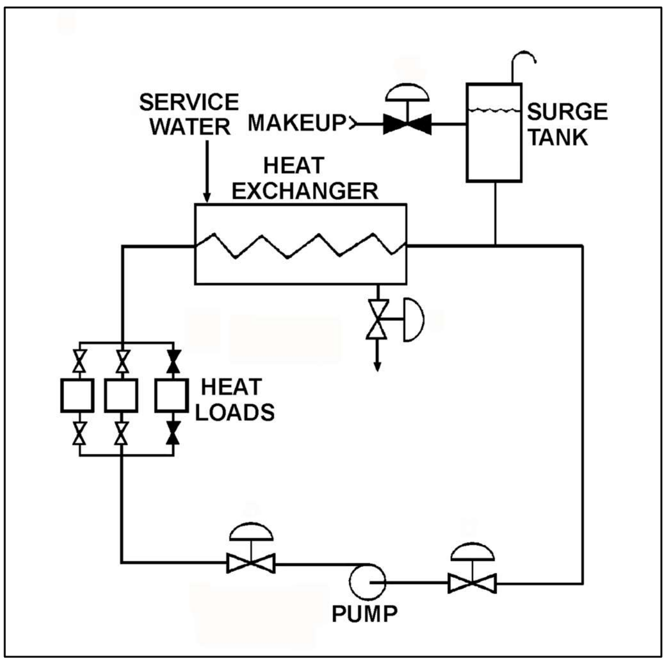
A. Increase pump speed by 20 percent.

B. Decrease pump speed by 20 percent.

C. Isolate one of the two in-service heat loads.

D. Place the third system heat load in service.

ANSWER: D.



TOPIC: Pumps

A centrifugal pump is located adjacent to the bottom of an open water storage tank. The pump is taking suction from a river and discharging to the bottom of the tank. Initially the tank was empty and the pump was operating at point B on the drawing below.

When tank water level reaches 30 feet, the new pump operating point will be located on curve __________ closer to point __________. (Assume that no other changes occur in the system.)

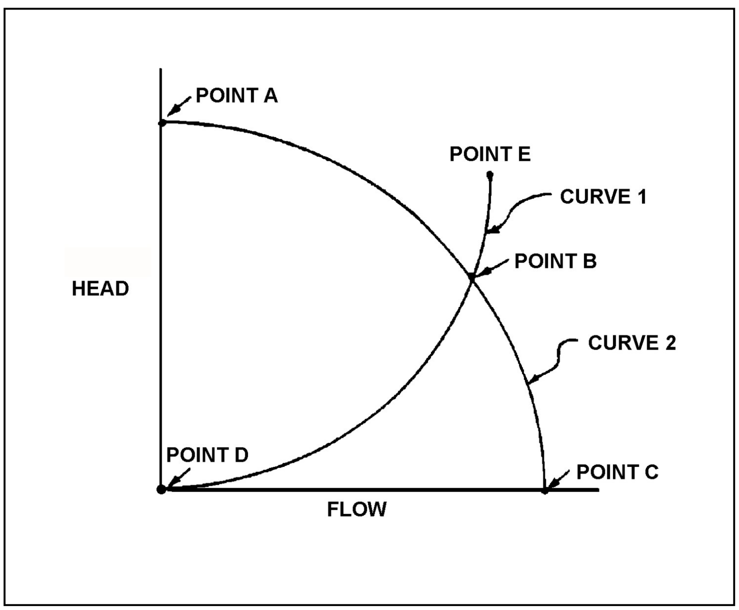
A. 1; D

B. 2; A

C. 1; E

D. 2; C

ANSWER: B.



TOPIC: Pumps

A centrifugal pump is used to provide makeup water to a storage tank that is 30 feet high. The pump is located at the base of the tank. The pump can be aligned to fill the tank via a top connection or a bottom connection using piping of equal lengths and diameters. The tank is currently half full.

With the pump in operation, the pump will have the highest discharge pressure if the pump is aligned to fill the tank via the ________ connection; and the tank will become full in the least amount of time if the pump is aligned to fill the tank via the ________ connection.

A. top; top

B. top; bottom

C. bottom; top

D. bottom; bottom

ANSWER: B.

TOPIC: Pumps

Refer to the drawing of operating curves for a centrifugal pump in a closed water system (see figure below).

Which one of the following describes the value of head where the two curves cross?

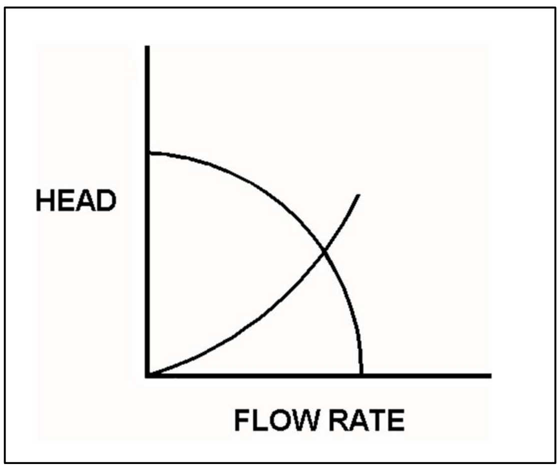
A. The maximum amount of head that the pump can provide.

B. The amount of pump head that is required to avoid cavitation.

C. The amount of pump head that is converted to kinetic energy in the pump.

D. The amount of pump head that is converted to heat and other losses as the water circulates through the system.

ANSWER: D.



TOPIC: Pumps

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

Which one of the following changes to the cooling water system will result in a lower cooling water pump flow rate <u>and</u> a higher pump discharge head?

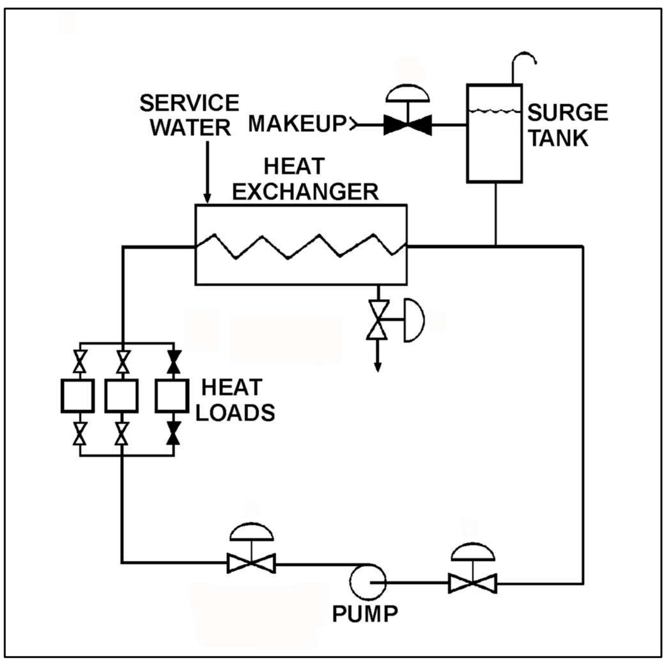
A. Decrease pump speed by 20 percent.

B. Increase pump speed by 20 percent.

C. Isolate one of the two in-service heat loads.

D. Place the third system heat load in service.

ANSWER: C.



TOPIC: Pumps

A centrifugal pump is used to provide makeup water to a vented storage tank that is 30 feet high. The pump is located at the base of the tank. The pump can be aligned to fill the tank via a top connection or a bottom connection using piping of equal lengths and diameters.

With the tank half full, the operating pump will have the lowest discharge pressure if the pump is aligned to fill the tank via the ________ connection; and the tank will require the longest amount of time to become completely full if the pump is aligned to fill the tank via the ________ connection.

A. top; top

B. top; bottom

C. bottom; top

D. bottom; bottom

ANSWER: C.

TOPIC: Pumps

Refer to the pump and system curves (see figure below) for a centrifugal pump operating in a cooling water system.

Operating point A existed when data was taken six months ago. Operating point B is the current operating point. Which one of the following could be responsible for the difference between the operating points?

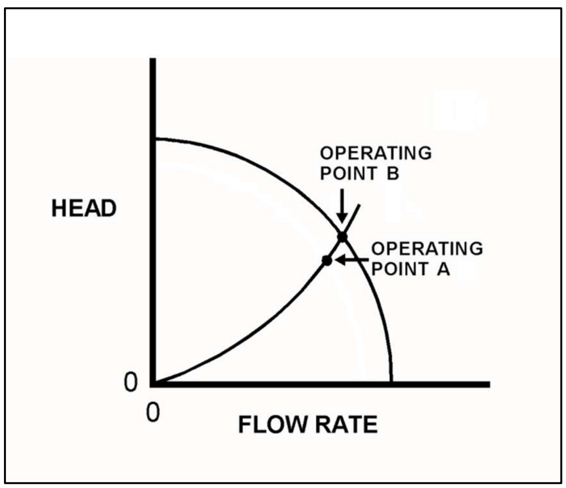
A. The pump discharge valve was more open when the data was collected for operating point A.

B. The pump discharge valve was more closed when the data was collected for operating point A.

C. The pump was rotating faster when the data was collected for operating point A.

D. The pump was rotating slower when the data was collected for operating point A.

ANSWER: D.



TOPIC: Pumps

A motor-driven radial-flow centrifugal pump is used to provide makeup water to a vented storage tank that is 30 feet high. The pump is located at the base of the tank. The pump can be aligned to fill the tank via a top connection or a bottom connection using piping of equal lengths and diameters. The tank is currently empty.

With tank filling underway, the pump motor will have the lowest power demand if the pump is using the __________ connection; and the tank will require the least amount of time to become completely full if the pump is using the __________ connection.

A. top; top

B. top; bottom

C. bottom; top

D. bottom; bottom

ANSWER: B.

TOPIC: Pumps

Refer to the drawing showing two different operating points for the same centrifugal pump operating in the same cooling water system (see figure below).

Operating point A was generated from pump data collected two days ago. Operating point B was generated from pump data collected today. Which one of the following would cause the observed difference between operating points A and B?

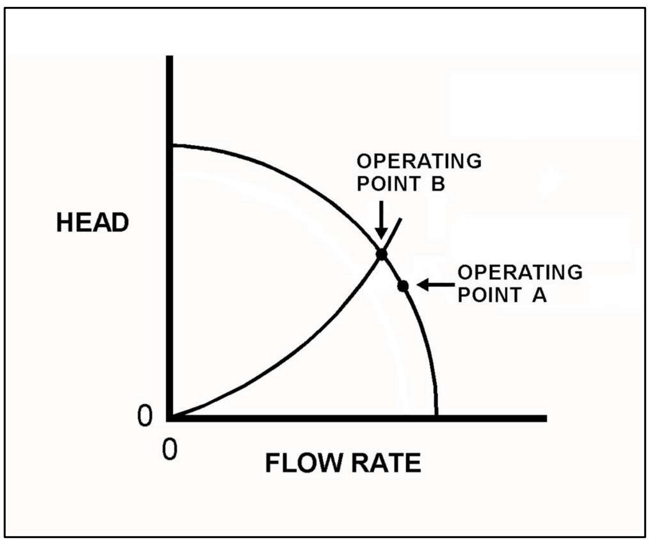
A. The pump was rotating faster when data was collected for operating point B.

B. The pump was rotating slower when data was collected for operating point B.

C. The pump discharge valve was more open when data was collected for operating point B.

D. The pump discharge valve was more closed when data was collected for operating point B.

ANSWER: D.



TOPIC: Pumps

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

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

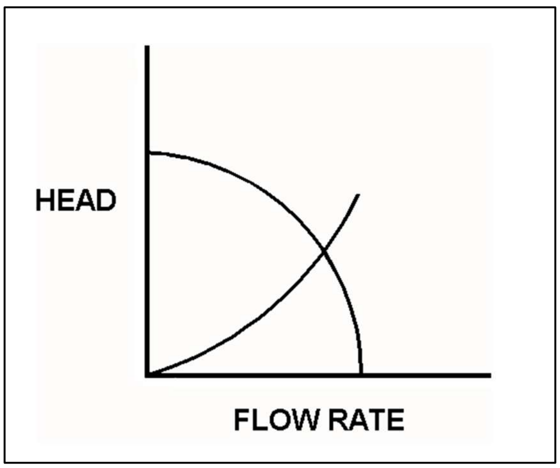
A. higher; lower

B. higher; higher

C. lower; lower

D. lower; higher

ANSWER: D.



TOPIC: Pumps

Refer to the drawing showing two operating points for the same centrifugal pump operating in a cooling water system (see figure below).

The pump's operating point can be shifted from point A to point B by…

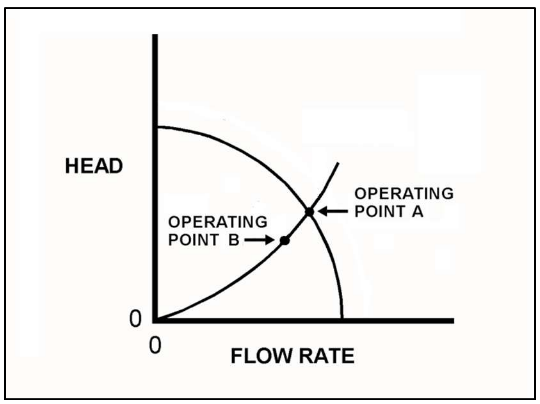
A. increasing the speed of the pump.

B. decreasing the speed of the pump.

C. closing the pump discharge valve more.

D. opening the pump discharge valve more.

ANSWER: B.



TOPIC: Pumps

A motor-driven centrifugal pump is operating in an open system with its discharge valve throttled to 50 percent open. If the discharge valve is fully opened, the pump's available net positive suction head (NPSH) will __________; and the pump's required NPSH will __________.

A. remain the same; increase

B. remain the same; remain the same

C. decrease; increase

D. decrease; remain the same

ANSWER: C.

TOPIC: Pumps

Increasing the flow rate from a centrifugal pump by throttling open the discharge valve will cause pump head to...

A. increase and stabilize at a higher value.

B. decrease and stabilize at a lower value.

C. remain constant because pump head is a design parameter.

D. increase, then decrease following the pump's efficiency curve.

ANSWER: B.

TOPIC: Pumps

A centrifugal pump is operating normally in an open system. If the pump recirculation valve is opened farther, pump discharge pressure will __________; and pump flow rate will __________.

A. increase; decrease

B. decrease; increase

C. increase; increase

D. decrease; decrease

ANSWER: B.

TOPIC: Pumps

A centrifugal pump is operating normally in an open system with all valves fully open. If the pump discharge valve is throttled to 50 percent, pump suction pressure will __________; and pump discharge pressure will __________.

A. increase; decrease

B. decrease; increase

C. increase; increase

D. decrease; decrease

ANSWER: C.

TOPIC: Pumps

A variable-speed centrifugal pump is operating at rated speed in an open system. If the pump speed is decreased by 50 percent, 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

ANSWER: A.

TOPIC: Pumps

A motor-driven centrifugal pump is operating in an open system with its discharge valve throttled to 50 percent. How will the pump be affected if the discharge valve is fully opened?

A. Total developed head decreases, and motor current decreases.

B. Total developed head increases, and available net positive suction head decreases.

C. The potential for pump cavitation decreases, and pump differential pressure decreases.

D. Available net positive suction head decreases, and pump differential pressure decreases.

ANSWER: D.

TOPIC: Pumps

A variable speed motor-driven centrifugal pump is operating at 50 percent speed in an open system. If the pump speed is increased to 100 percent, available net positive suction head (NPSH) will __________; and required NPSH will __________.

A. increase; remain the same

B. increase; increase

C. decrease; remain the same

D. decrease; increase

ANSWER: D.

TOPIC: Pumps

Which one of the following describes a reason for designing centrifugal pumps with suction nozzles that are larger than their discharge nozzles?

A. Increases total pump head by increasing the velocity head at the suction of the pump.

B. Increases the differential pressure across the pump by decreasing pump head loss.

C. Increases pump available net positive suction head by decreasing head loss at the pump suction.

D. Increases pump capacity by decreasing turbulence at the suction of the pump.

ANSWER: C.

TOPIC: Pumps

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 eye of the pump impeller 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 fire hose spray nozzle elevations (referenced to sea level) will the pump 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

ANSWER: B.

TOPIC: Pumps

A centrifugal firewater pump is operating to pressurize a fire main. The pump takes suction from a water reservoir. A fire hose connected to the fire main is being used to suppress an elevated fire.

Given:

- The eye of the pump impeller is located 5 feet above the reservoir water level.
- The pump has a design shutoff head of 120 feet.
- The required net positive suction head (NPSH) for the pump is 15 feet.
- The reservoir water temperature is 60°F.

At which one of the following elevations above the eye of the pump impeller will the fire hose spray nozzle first be unable to provide flow? (Disregard all sources of head loss.)

A. 111 feet

B. 116 feet

C. 121 feet

D. 126 feet

ANSWER: B.

TOPIC: Pumps

A centrifugal firewater pump is operating to pressurize a fire main. The pump takes suction from a vented water storage tank. A fire hose connected to the fire main is being used to suppress an elevated fire.

Given:

- The eye of the pump impeller is located 30 feet below the tank water level.
- The pump has a design shutoff head of 120 feet.
- The required net positive suction head (NPSH) for the pump is 15 feet.
- The tank water temperature is 60°F.

At which one of the following elevations above the eye of the pump impeller will the fire hose spray nozzle first be <u>unable</u> to provide flow? (Disregard all sources of head loss.)

A. 106 feet

B. 121 feet

C. 136 feet

D. 151 feet

ANSWER: D.

TOPIC: Pumps

A centrifugal cooling water pump is operating in an open system with its discharge valve fully open. If the discharge valve is repositioned to 50 percent open, the pump's available net positive suction head (NPSH) will __________; and the pump's required NPSH will __________.

A. remain the same; decrease

B. remain the same; remain the same

C. increase; decrease

D. increase; remain the same

ANSWER: C.

TOPIC: Pumps

A centrifugal firewater pump is operating to pressurize a fire main. The pump takes suction from a water reservoir. A fire hose connected to the fire main is being used to suppress an elevated fire.

Given:

- The eye of the pump impeller is located 15 feet below the reservoir water level.
- The pump has a design shutoff head of 120 feet.
- The required net positive suction head (NPSH) for the pump is 15 feet.
- The reservoir water temperature is 60°F.

At which one of the following elevations above the reservoir water level will the fire hose spray nozzle first be <u>unable</u> to provide flow? (Disregard all sources of head loss.)

A. 91 feet

B. 106 feet

C. 121 feet

D. 136 feet

ANSWER: C.

TOPIC: Pumps

A motor-driven centrifugal pump is operating in a closed-loop cooling water system and is unable to achieve its rated volumetric flow rate due to cavitation. Which one of the following will enable the pump to achieve a higher volumetric flow rate before cavitation occurs?

A. Operate the system at a higher pressure.

B. Operate the system at a higher temperature.

C. Remove the existing pump motor and install a motor with a higher horsepower rating.

D. Remove the existing pump and install a same-capacity pump with a higher minimum required net positive suction head rating.

ANSWER: A.

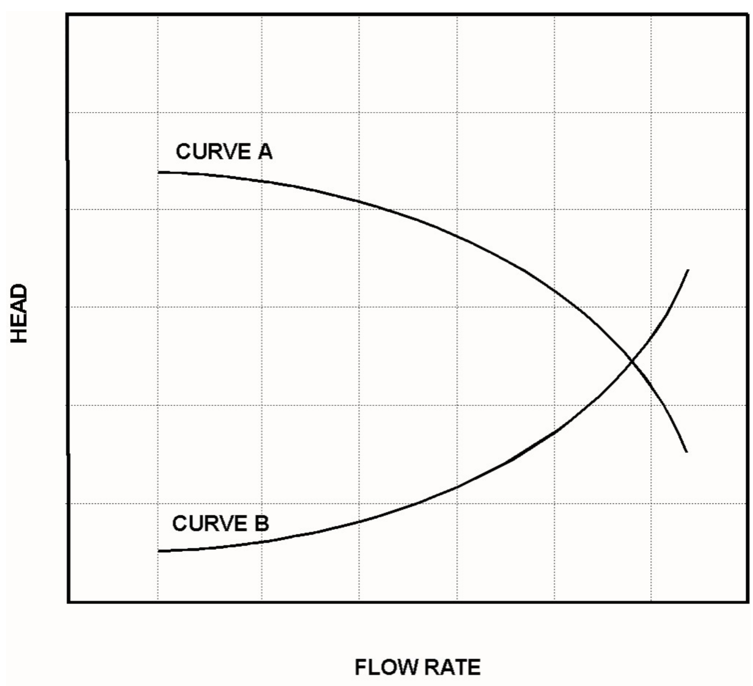
TOPIC: Pumps

Refer to the graph that represents the head-capacity characteristics for a single-speed centrifugal cooling water pump (see figure below).

Which one of the following lists a pair of parameters that could be represented by curves A and B? (Note: NPSH is net positive suction head.)

	Curve A	Curve B
A.	Pump Head	Available NPSH
B.	Available NPSH	Required NPSH
C.	Required NPSH	System Head Loss
D.	System Head Loss	Pump Head

ANSWER: B.



TOPIC: Pumps

Centrifugal pumps A and B are identical except that pump A uses a single-suction impeller while pump B uses a double-suction impeller. If both pumps are pumping water at the same inlet temperature, inlet pressure, and flow rate, single-suction pump A typically will have the __________ impeller axial thrust and the __________ required net positive suction head.

A. greater; greater

B. greater; smaller

C. smaller; greater

D. smaller; smaller

ANSWER: A.

TOPIC: Pumps

A motor-driven centrifugal pump is operating normally in a closed cooling water system. When the pump discharge flow control valve is opened further, the pump is unable to provide the desired volumetric flow rate due to cavitation. Which one of the following will enable a higher pump volumetric flow rate before cavitation occurs?

A. Remove the existing motor and install a motor with a lower horsepower rating.

B. Remove the existing motor and install a motor with a higher horsepower rating.

C. Remove the existing pump and install a same-capacity pump with a lower minimum net positive suction head requirement.

D. Remove the existing pump and install a same-capacity pump with a higher minimum net positive suction head requirement.

ANSWER: C.

TOPIC: Pumps

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

The pump is unable to achieve its rated volumetric flow rate due to cavitation. Which one of the following will enable the pump to achieve a higher volumetric flow rate before cavitation occurs?

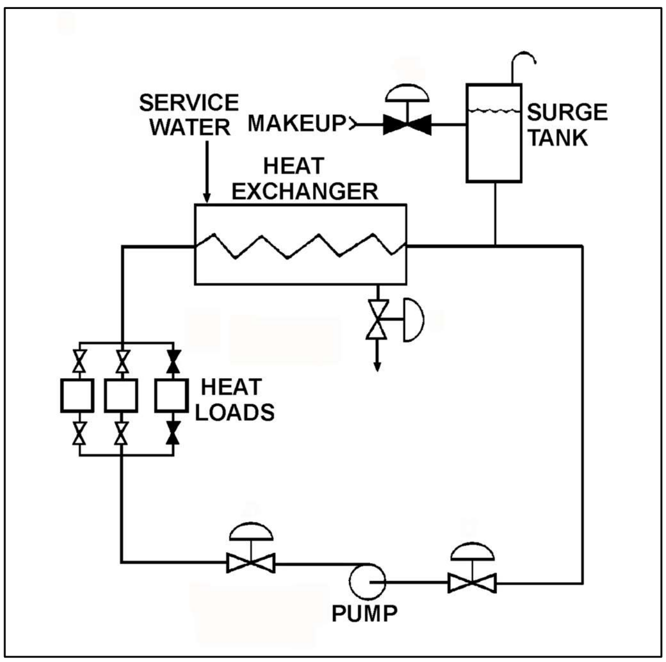
A. Decrease the service water flow rate.

B. Operate the system at a lower pressure.

C. Move the surge tank connection closer to the suction of the pump.

D. Remove the existing pump motor and install a motor with a higher horsepower rating.

ANSWER: C.



TOPIC: Pumps

Refer to the drawing of an operating cooling water system (see figure below). The pump discharge valve is partially throttled to produce the following initial pump operating parameters:

Pump discharge pressure	=	45 psig
Pump suction pressure	=	15 psig
Pump flow rate	=	120 gpm

After a few hours of operation, the current pump operating parameters are as follows:

Pump discharge pressure	=	48 psig
Pump suction pressure	=	18 psig
Pump flow rate:	=	120 gpm

Which one of the following could be responsible for the change in pump operating parameters?

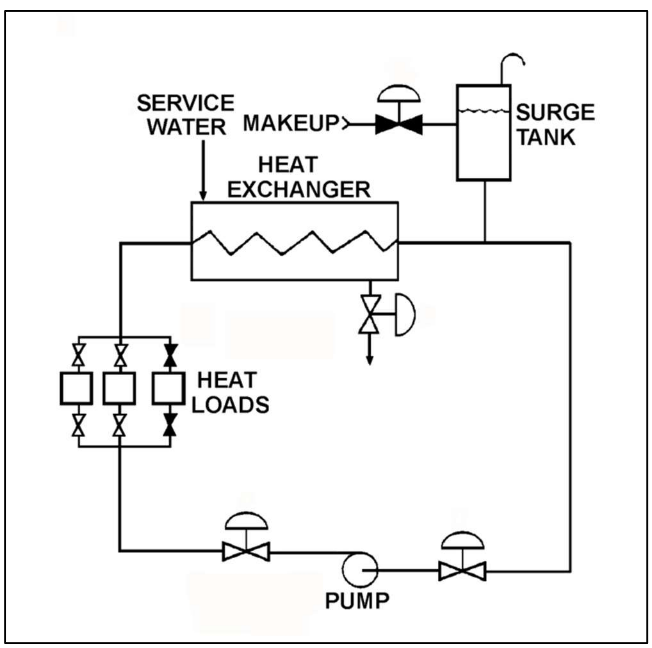
A. The pump speed increased with no other changes to the system.

B. The surge tank level increased with no other changes to the system.

C. The pump discharge valve was closed further while pump speed increased.

D. The pump discharge valve was closed further while surge tank level increased.

ANSWER: B.



TOPIC: Pumps

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

The pump is unable to achieve its rated volumetric flow rate due to cavitation. Which one of the following will enable the pump to achieve a higher volumetric flow rate before cavitation occurs?

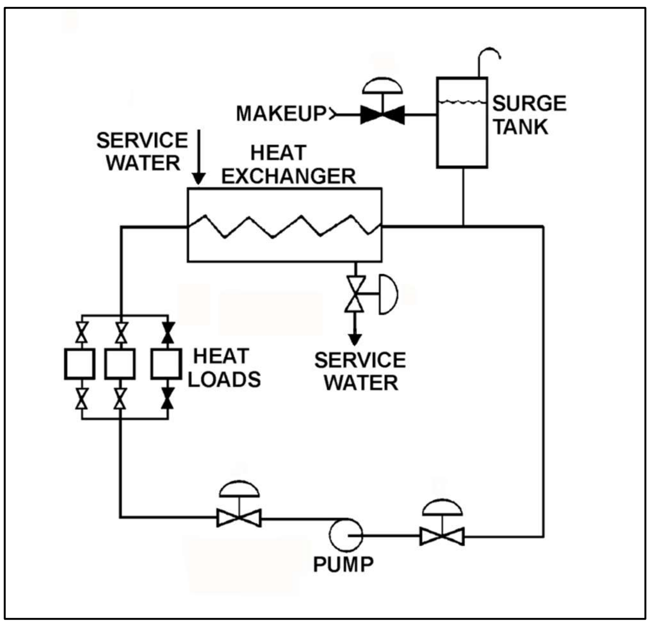
A. Decrease the surge tank water level.

B. Increase the service water flow rate to the heat exchanger.

C. Move the surge tank connection closer to the discharge of the pump.

D. Remove the existing pump motor and install a motor with a higher horsepower rating.

ANSWER: B.



TOPIC: Pumps

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

How will the centrifugal pump flow rate be affected if the surge tank level decreases from 8 feet to 4 feet? (Assume the pump maintains adequate net positive suction head.)

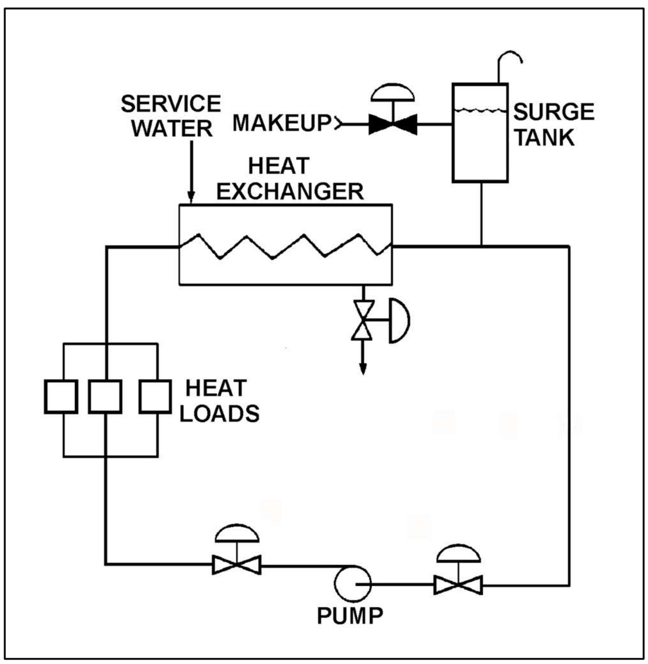
A. Pump flow rate will increase.

B. Pump flow rate will decrease.

C. Pump flow rate will remain the same.

D. Pump flow rate will oscillate.

ANSWER: C.



TOPIC: Pumps

Consider the required net positive suction head ($NPSH_R$) and the available net positive suction head ($NPSH_A$) for a typical centrifugal pump operating normally in a closed cooling water system. If the pump flow rate increases, __________ will be affected; and if the pump inlet pressure increases, __________ will be affected.

A. only $NPSH_A$; only $NPSH_A$

B. only $NPSH_A$; both $NPSH_R$ and $NPSH_A$

C. both $NPSH_R$ and $NPSH_A$; only $NPSH_A$

D. both $NPSH_R$ and $NPSH_A$; both $NPSH_R$ and $NPSH_A$

ANSWER: C.

TOPIC: Pumps

How are the required net positive suction head ($NPSH_R$) and available net positive suction head ($NPSH_A$) for an in-service centrifugal water pump determined?

A. Both $NPSH_R$ and $NPSH_A$ are calculated using water parameter values at the pump inlet.

B. Both $NPSH_R$ and $NPSH_A$ are determined from pump curves provided by the pump manufacturer.

C. $NPSH_R$ is calculated using water parameter values at the pump inlet, while $NPSH_A$ is determined from pump curves provided by the pump manufacturer.

D. $NPSH_A$ is calculated using water parameter values at the pump inlet, while $NPSH_R$ is determined from pump curves provided by the pump manufacturer.

ANSWER: D.

TOPIC: Pumps

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

If the surge tank water level increases from 8 feet to 9 feet, the pump mass flow rate will…

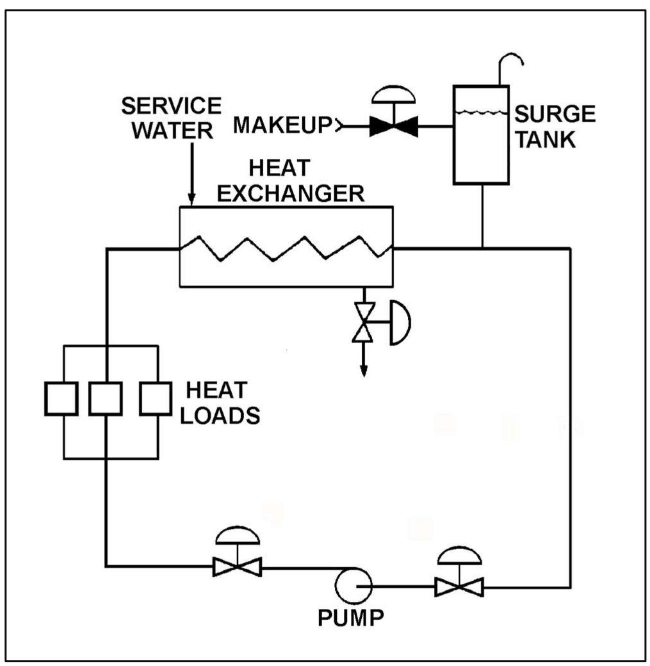
A. increase, because the pump suction head will increase while the pump discharge head decreases.

B. increase, because the pump suction head will increase while the pump discharge head remains the same.

C. remain the same, because the pump suction and discharge heads will increase by the same amount.

D. remain the same, because the pump suction and discharge heads will be unaffected by the change in surge tank water level.

ANSWER: C.



TOPIC: Pumps

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

A. Fully open, to reduce motor starting power requirements.

B. Throttled, to reduce motor starting power requirements.

C. Fully open, to ensure adequate pump net positive suction head.

D. Throttled, to ensure adequate pump net positive suction head.

ANSWER: B.

TOPIC: Pumps

A typical single-stage radial-flow centrifugal pump is being returned to service following maintenance on its three-phase AC induction motor. Which one of the following will occur when the pump is started if two of the three motor power leads were inadvertently swapped during restoration?

A. The motor breaker will trip on instantaneous overcurrent.

B. The motor will <u>not</u> turn and will emit a humming sound.

C. The pump will rotate in the reverse direction with reduced or no flow rate.

D. The pump will rotate in the normal direction with reduced flow rate.

ANSWER: C.

TOPIC: Pumps

If the speed of a positive displacement pump is increased, the available net positive suction head will __________; and the pump will operate __________ cavitation.

A increase; closer to

B. decrease; further from

C. increase; further from

D. decrease; closer to

ANSWER: D.

TOPIC: Pumps

An increase in positive displacement pump speed will cause the available net positive suction head for the pump to...

A. decrease, due to the increase in fluid flow rate.

B. decrease, due to the increase in fluid discharge pressure.

C. increase, due to the increase in fluid discharge pressure.

D. increase, due to the increase in fluid flow rate.

ANSWER: A.

TOPIC: Pumps

The minimum required net positive suction head for a typical positive displacement pump will increase the most if the pump...

A. speed increases from 1,200 rpm to 1,600 rpm.

B. discharge pressure decreases from 100 psig to 50 psig.

C. suction temperature increases from 75°F to 85°F.

D. discharge valve is positioned from 90 percent open to fully open.

ANSWER: A.

TOPIC: Pumps

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.

ANSWER: C.

TOPIC: Pumps

A positive displacement pump (PDP) is operating in an open system. PDP parameters are as follows:

PDP speed	=	1,000 rpm
PDP discharge pressure	=	2,000 psig
PDP suction pressure	=	50 psig
PDP flow rate	=	150 gpm

Which one of the following changes will cause PDP flow rate to exceed 200 gpm?

A. A second identical discharge path is opened.

B. PDP speed is increased to 1,500 rpm.

C. PDP suction pressure is increased to 120 psig.

D. Downstream system pressure is decreased to 1,000 psig.

ANSWER: B.

TOPIC: Pumps

If the fully open discharge valve of a reciprocating positive displacement pump is closed approximately 10 percent, pump flow rate will __________; and pump head will __________. (Assume "ideal" pump response.)

A. decrease; increase

B. remain constant; increase

C. decrease; remain constant

D. remain constant; remain constant

ANSWER: B.

TOPIC: Pumps

A variable-speed positive displacement pump is operating at 100 rpm with a flow rate of 60 gpm in an open system. To decrease pump flow rate to 30 gpm, pump speed must be decreased to approximately...

A. 25 rpm.

B. 35 rpm.

C. 50 rpm.

D. 71 rpm.

ANSWER: C.

TOPIC: Pumps

Which one of the following conditions will result in the greatest increase in volumetric flow rate through a positive displacement pump?

A. Doubling the pump speed.

B. Doubling the pump net positive suction head.

C. Reducing the downstream system pressure by one-half.

D. Positioning the discharge valve from half open to fully open.

ANSWER: A.

TOPIC: Pumps

Which one of the following describes single-speed pump operating characteristics?

A. Centrifugal pumps deliver a variety of flow rates at a constant head.

B. Centrifugal pumps deliver a constant head over a variety of flow rates.

C. Positive displacement pumps deliver a variety of flow rates at a constant head.

D. Positive displacement pumps deliver a constant flow rate over a variety of heads.

ANSWER: D.

TOPIC: Pumps

A positive displacement pump (PDP) is operating in an open water system. PDP parameters are as follows:

PDP speed	=	480 rpm
PDP discharge pressure	=	1,000 psig
PDP suction pressure	=	10 psig
PDP flow rate	=	60 gpm

Which one of the following changes will cause PDP flow rate to exceed 100 gpm?

A. A second identical discharge path is opened.

B. PDP speed is increased to 900 rpm.

C. PDP suction pressure is increased to 40 psig.

D. Downstream system pressure is decreased to 500 psig.

ANSWER: B.

TOPIC: Pumps

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

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

A. increase; decrease

B. remain constant; decrease

C. increase; remain constant

D. remain constant; remain constant

ANSWER: B.

TOPIC: Pumps

A variable-speed positive displacement pump is operating at 100 rpm with a flow rate of 60 gpm in an open system. To decrease pump flow rate to 25 gpm, pump speed must be decreased to approximately...

A. 17 rpm.

B. 33 rpm.

C. 42 rpm.

D. 62 rpm.

ANSWER: C.

TOPIC: Pumps

Which one of the following will result in the greatest increase in volumetric flow rate to a system that is currently receiving flow from a positive displacement pump operating at 400 rpm with a discharge pressure of 100 psig?

A. Increase pump speed to 700 rpm.

B. Reduce system pressure to decrease pump discharge pressure to 40 psig.

C. Start a second identical positive displacement pump in series with the first.

D. Start a second identical positive displacement pump in parallel with the first.

ANSWER: D.

TOPIC: Pumps

A section of pipe is being hydrostatically tested to 1,400 psig using a positive displacement pump. The operating characteristics of the positive displacement pump are shown in the drawing below.

Which one of the following could cause the difference between the expected and the actual pump performance?

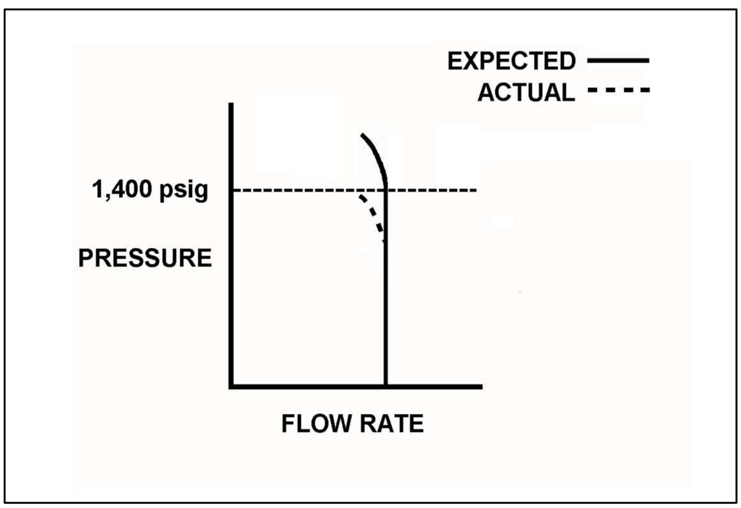
A. Pump internal leakage is greater than expected.

B. Pipe section boundary valve leakage is greater than expected.

C. A relief valve on the pump discharge piping opened prior to its setpoint of 1,400 psig.

D. The available NPSH is smaller than expected, but remains above the required NPSH.

ANSWER: A.



TOPIC: Pumps

Which one of the following conditions will result in the greatest increase in volumetric flow rate from a positive displacement pump operating at 300 rpm and a discharge pressure of 100 psig?

A. Increasing pump speed to 700 rpm.

B. Decreasing pump discharge pressure to 30 psig.

C. Starting a second identical positive displacement pump in series with the first.

D. Starting a second identical positive displacement pump in parallel with the first.

ANSWER: A.

TOPIC: Pumps

An ideal (no slip) reciprocating positive displacement pump is operating in an open system to provide makeup water to a coolant system that is being maintained at 800 psig. The pump discharge valve is fully open.

If the pump discharge valve is subsequently throttled to 80 percent open, the pump flow rate will __________; and the pump head will __________.

A. decrease; increase

B. decrease; remain constant

C. remain constant; increase

D. remain constant; remain constant

ANSWER: C.

TOPIC: Pumps

A pump is needed to supply fuel oil from a day tank to a diesel engine fuel injection system. The pump must maintain a nearly constant flow rate with a minimum of discharge pressure fluctuations as system pressure varies between 200 psig and 1,900 psig.

Which one of the following types of pumps would be most suitable for this application?

A. Axial-flow centrifugal

B. Radial-flow centrifugal

C. Rotary positive displacement

D. Reciprocating positive displacement

ANSWER: C.

TOPIC: Pumps

An ideal positive displacement pump is pumping to a system operating at 100 psig. Assume pump speed is constant, zero pump slip, and pump backpressure remains within normal pump operating limits.

If system pressure increases to 200 psig, the pump head will __________; and pump flow rate will __________.

A. increase; remain the same

B. increase; decrease

C. remain the same; remain the same

D. remain the same; decrease

ANSWER: A.

TOPIC: Pumps

Use the following drawing of system and pump operating curves for a positive displacement pump with discharge relief valve protection to answer the following question.

A positive displacement pump is initially supplying water at 40 gpm with a pump discharge pressure of 400 psia. If pump speed is increased until pump flow rate is 80 gpm, what is the new pump discharge pressure?

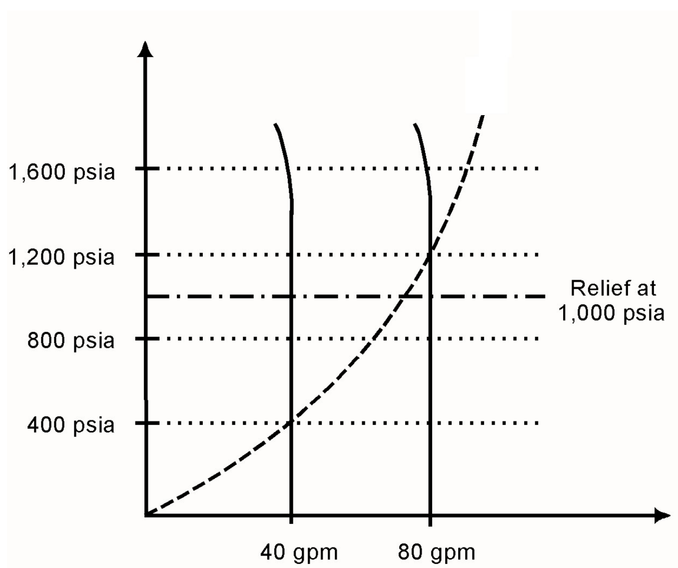
A. 800 psia

B. 1,000 psia

C. 1,200 psia

D. 1,600 psia

ANSWER: B.



TOPIC: Pumps

Use the following drawing of system and pump operating curves for an operating positive displacement pump with relief valve protection to answer the following question.

A positive displacement pump is initially supplying water at 40 gpm with a pump discharge pressure of 200 psia. If pump speed is increased until pump flow rate is 80 gpm, what is the new pump discharge pressure?

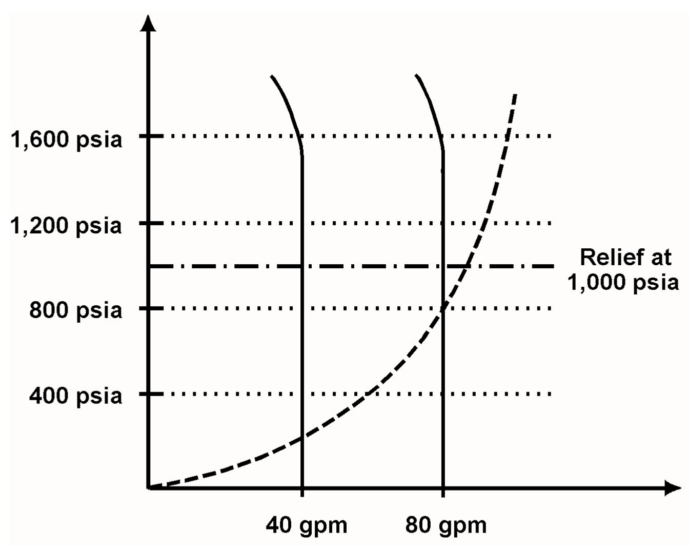
A. 400 psia

B. 800 psia

C. 1,000 psia

D. 1,600 psia

ANSWER: B.



TOPIC: Pumps

Refer to the drawing of operating curves for a positive displacement water pump in a closed system (see figure below).

Which one of the following describes the value of the head where the two curves cross?

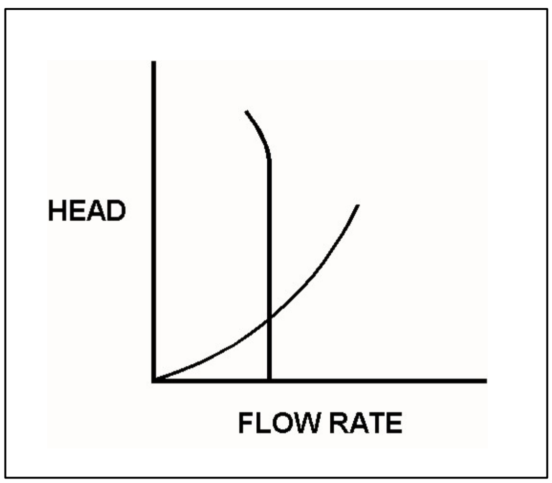
A. The maximum amount of head that the pump can provide.

B. The amount of pump head that is required to avoid cavitation.

C. The amount of pump head that is converted to kinetic energy in the pump.

D. The amount of pump head that is converted to heat as the water circulates through the system.

ANSWER: D.



TOPIC: Pumps

Refer to the drawing of operating curves for a positive displacement pump in a closed water system (see figure below).

Which one of the following describes the value of the pump head where the two curves cross?

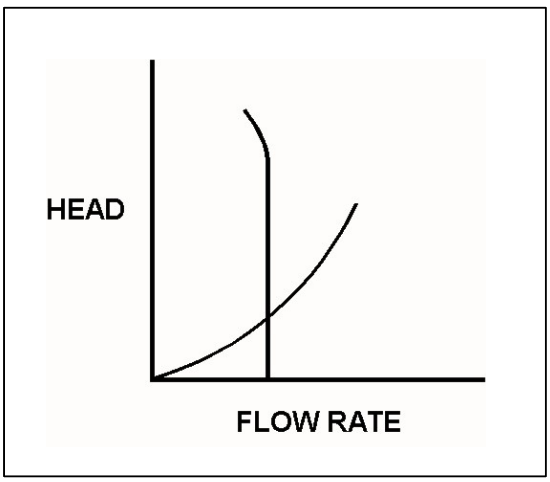
A. The amount of pump head produced at zero flow rate.

B. The amount of pump head required to avoid cavitation.

C. The amount of pump head needed to maintain the system flow rate.

D. The amount of pump head converted to kinetic energy in the pump.

ANSWER: C.



TOPIC: Pumps

When starting a positive displacement pump, why must the pump discharge valve be fully open?

A. Prevents pump cavitation.

B. Reduces motor starting current.

C. Minimizes the potential for water hammer.

D. Ensures integrity of the pump and system piping.

ANSWER: D.

TOPIC: Pumps

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

A. Protect the pump and suction piping from overpressure if the discharge valve is open during system startup.

B. Protect the pump and suction piping from overpressure if the suction valve is closed during pump operation.

C. Protect the pump and discharge piping from overpressure if the discharge valve is closed during pump operation.

D. Protect the pump and discharge piping from overpressure due to thermal expansion of pump contents when the pump is stopped with its suction valve closed.

ANSWER: C.

TOPIC: Pumps

A positive displacement pump should be started with its suction valve __________ and its discharge valve __________.

A. throttled; throttled

B. throttled; fully open

C. fully open; throttled

D. fully open; fully open

ANSWER: D.

TOPIC: Pumps

A positive displacement pump should be started with its suction valve __________ and its discharge valve __________.

A. closed; closed

B. closed; open

C. open; closed

D. open; open

ANSWER: D.

TOPIC: Motors and Generators

A motor-driven cooling water pump is operating normally. How will pump motor current respond if the pump experiences a locked rotor?

A. Decreases immediately to zero due to breaker trip.

B. Decreases immediately to no-load motor amps.

C. Increases immediately to many times running current, then decreases to no-load motor amps.

D. Increases immediately to many times running current, then decreases to zero upon breaker trip.

ANSWER: D.

TOPIC: Motors and Generators

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

A. Decreases due to decreased pump flow rate.

B. Decreases due to increased counter electromotive force.

C. Increases due to decreased pump flow rate.

D. Increases due to decreased counter electromotive force.

ANSWER: D.

TOPIC: Motors and Generators

A motor-driven centrifugal pump exhibits indications of pump failure while being started in an idle cooling water system. Assuming the pump motor breaker does <u>not</u> trip, which one of the following pairs of indications would be observed if the failure is a locked pump shaft?

A. Lower than normal running current with zero system flow rate.

B. Lower than normal running current with a fraction of normal system flow rate.

C. Excessive duration of peak starting current with zero system flow rate.

D. Excessive duration of peak starting current with a fraction of normal system flow rate.

ANSWER: C.

TOPIC: Motors and Generators

When an AC motor-driven centrifugal pump was started, the motor ammeter reading immediately increased to, and stabilized at, many times the normal operating value. Which one of the following describes a possible cause for the ammeter response?

A. The pump was started with a fully closed discharge valve.

B. The pump was started with a fully open discharge valve.

C. The pump shaft seized upon start and did not rotate.

D. The pump shaft separated from the motor shaft upon start.

ANSWER: C.

TOPIC: Motors and Generators

If the generator bearings on a motor-generator set begin to overheat from excessive friction, which one of the following will occur?

A. Generator current will begin to increase.

B. Generator windings will begin to heat up.

C. Motor current will begin to decrease.

D. Motor windings will begin to heat up.

ANSWER: D.

TOPIC: Motors and Generators

A thermal overload device for a large motor protects the motor from...

A. sustained overcurrent by opening the motor breaker or motor line contacts.

B. sustained overcurrent by opening contacts in the motor windings.

C. instantaneous overcurrent by opening the motor breaker or motor line contacts.

D. instantaneous overcurrent by opening contacts in the motor windings.

ANSWER: A.

TOPIC: Motors and Generators

Which one of the following will provide the initial motor protection against electrical damage caused by gradual bearing failure?

A. Thermal overload device

B. Overcurrent trip relay

C. Underfrequency relay

D. Undervoltage device

ANSWER: A.

TOPIC: Motors and Generators

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

A. Decreased electrical current demand due to reduced counter electromotive force.

B. Increased electrical current demand due to reduced counter electromotive force.

C. Decreased electrical resistance to ground due to breakdown of winding insulation.

D. Increased electrical resistance to ground due to breakdown of winding insulation.

ANSWER: C.

TOPIC: Motors and Generators

Continuous operation of a motor at rated load with a loss of required cooling to the motor windings will eventually result in...

A. cavitation of the pumped fluid.

B. failure of the motor overcurrent protection devices.

C. breakdown of the motor insulation and electrical grounds.

D. phase current imbalance in the motor and overspeed trip actuation.

ANSWER: C.

TOPIC: Motors and Generators

Thermal overload devices will provide the first electrical protection for a pump motor in the event of...

A. a locked rotor upon starting.

B. an electrical short circuit.

C. gradual motor bearing damage.

D. a sheared shaft during operation.

ANSWER: C.

TOPIC: Motors and Generators

Which one of the following trip signals will trip the breaker for an operating motor that experiences a seized rotor?

A. Undervoltage

B. Underfrequency

C. Time-delayed overcurrent

D. Instantaneous overcurrent

ANSWER: C.

TOPIC: Motors and Generators

A large AC motor has a maximum ambient temperature rating of 40°C. Which one of the following will occur if the motor is continuously operated at rated load with an ambient temperature of 50°C?

A. Accelerated embrittlement of the motor windings, leading to an open circuit within the motor windings.

B. Accelerated embrittlement of the motor windings, leading to a short circuit within the motor windings.

C. Accelerated breakdown of the motor winding insulation, leading to an open circuit within the motor windings.

D. Accelerated breakdown of the motor winding insulation, leading to a short circuit within the motor windings.

ANSWER: D.

TOPIC: Motors and Generators

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

100 MW
0 MVAR
2,900 amps
20 KV

If main generator field current is reduced slightly, amps will __________; and MW will __________.

A. increase; decrease

B. decrease; decrease

C. increase; remain the same

D. decrease; remain the same

ANSWER: C.

TOPIC: Motors and Generators

Excessive current will be drawn by an AC induction motor that is operating...

A. completely unloaded.

B. at full load.

C. with open-circuited stator windings.

D. with short-circuited stator windings.

ANSWER: D.

TOPIC: Motors and Generators

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

500 MW
300 MVAR (out)
2,800 amps

If main generator field current is reduced slightly, amps will __________; and MW will __________.

A. increase; decrease

B. increase; remain the same

C. decrease; decrease

D. decrease; remain the same

ANSWER: D.

TOPIC: Motors and Generators

A main generator is connected to an infinite power grid. If the voltage supplied to the generator field is slowly and continuously decreased, the generator will experience high current due to... (Assume no generator protective actuations occur.)

A. excessive generator MW.

B. excessive generator MVAR out.

C. excessive generator MVAR in.

D. generator reverse power.

ANSWER: C.

TOPIC: Motors and Generators

An AC generator is supplying an isolated electrical system with a power factor of 1.0. If generator voltage is held constant while real load (KW) increases, the current supplied by the generator will increase in direct proportion to the __________ of the change in real load. (Assume the generator power factor remains constant at 1.0.)

A. cube

B. square

C. amount

D. square root

ANSWER: C.

TOPIC: Motors and Generators

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

600 MW
100 MVAR (in)
13,800 amps
25 KV

If main generator excitation current is increased slightly, amps will initially __________; and MW will initially __________.

A. decrease; increase

B. increase; increase

C. decrease; remain the same

D. increase; remain the same

ANSWER: C.

TOPIC: Motors and Generators

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

600 MW
100 MVAR (in)
13,800 amps
25 KV

If main generator excitation current is decreased slightly, amps will __________; and MVAR will __________.

A. decrease; increase

B. increase; increase

C. decrease; decrease

D. increase; decrease

ANSWER: B.

TOPIC: Motors and Generators

A main generator is connected to an infinite power grid. Which one of the following conditions will exist if the generator is operating underexcited?

A. Negative MVAR (VARs in) with a leading power factor

B. Positive MVAR (VARs out) with a leading power factor

C. Positive MVAR (VARs out) with a lagging power factor

D. Negative MVAR (VARs in) with a lagging power factor

ANSWER: A.

TOPIC: Motors and Generators

A diesel generator (DG) is supplying both KW and KVAR to an electrical bus that is connected to an infinite power grid. Assuming DG and bus voltage do not change, if the DG voltage regulator setpoint is increased slightly, DG KW will __________; and DG amps will __________.

A. remain the same; increase

B. remain the same; remain the same

C. increase; increase

D. increase; remain the same

ANSWER: A.

TOPIC: Motors and Generators

A diesel generator (DG) is supplying an electrical bus that is connected to an infinite power grid. Assuming DG terminal voltage and bus frequency do not change, if the DG governor setpoint is increased from 60.0 Hz to 60.1 Hz, DG KVAR load will __________; and DG amps will __________.

A. increase; increase

B. increase; remain the same

C. remain the same; increase

D. remain the same; remain the same

ANSWER: C.

TOPIC: Motors and Generators

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

600 MW
100 MVAR (out)
13,800 amps
25 KV

If main generator field current is decreased, amps will initially __________; and MVAR will initially __________.

A. decrease; increase

B. increase; increase

C. decrease; decrease

D. increase; decrease

ANSWER: C.

TOPIC: Motors and Generators

A diesel generator (DG) is supplying both KW and KVAR to an electrical bus that is connected to an infinite power grid. Assuming bus voltage does <u>not</u> change, if the DG voltage regulator setpoint is decreased slightly, DG KW will __________; and DG amps will __________.

A. remain the same; decrease

B. remain the same; remain the same

C. decrease; decrease

D. decrease; remain the same

ANSWER: A.

TOPIC: Motors and Generators

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

100 MW
0 MVAR
2,900 amps
20 KV

If main generator excitation is increased, amps will __________; and MW will __________.

A. remain the same; increase

B. remain the same; remain the same

C. increase; increase

D. increase; remain the same

ANSWER: D.

TOPIC: Motors and Generators

A main generator is supplying power to an infinite power grid. If the generator field current is slowly and continuously increased, the generator will experience high current due to: (Assume no generator protective actuations occur.)

A. generator reverse power.

B. excessive generator MW.

C. excessive generator MVAR in.

D. excessive generator MVAR out.

ANSWER: D

TOPIC: Motors and Generators

Two identical 1,000 MW generators are operating in parallel supplying the same isolated electrical bus. The generator output breakers provide identical protection for the generators. Generator A and B output indications are as follows:

Generator A	Generator B
22 KV	22 KV
60.2 Hertz	60.2 Hertz
800 MW	800 MW
50 MVAR (out)	25 MVAR (in)

A malfunction causes the voltage regulator for generator B to slowly and continuously increase the terminal voltage for generator B. If no operator action is taken, generator B output current will...

A. increase continuously until the output breaker for generator A trips on overcurrent.

B. increase continuously until the output breaker for generator B trips on overcurrent.

C. initially decrease, and then increase until the output breaker for generator A trips on overcurrent.

D. initially decrease, and then increase until the output breaker for generator B trips on overcurrent.

ANSWER: D.

TOPIC: Motors and Generators

Refer to the partial drawing of two identical radial-flow centrifugal pumps in a cooling water system (see figure below). Each pump is driven by an identical three-phase AC induction motor.

The cooling water system is being returned to service following maintenance on the pumps. Pump A was started five minutes ago to initiate flow in the cooling water system. Pump B is about to be started.

When pump B is started, which one of the following would cause the motor ammeter for pump B to remain off-scale high for a longer time than usual before stabilizing at a lower running current?

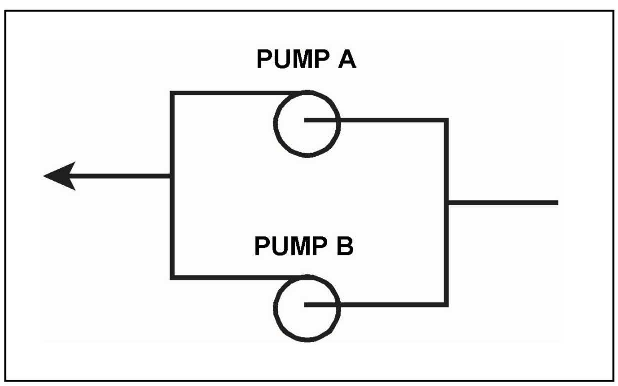
A. Pump B was initially rotating in the reverse direction.

B. The motor coupling for pump B was removed and not reinstalled.

C. The packing material for pump B was removed and not reinstalled.

D. Two phases of the motor windings for pump B were electrically switched.

ANSWER: A.



TOPIC: Motors and Generators

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 <u>no</u> generator protective actuations occur.)

A. excessive generator MW.

B. excessive generator VARs out.

C. excessive generator VARs in.

D. generator reverse power.

ANSWER: A.

TOPIC: Motors and Generators

A main generator is operating and connected to an infinite power grid. Elevated main generator winding temperature requires a reduction in reactive load from 200 MVAR (out) to 150 MVAR (out). To accomplish the reactive load reduction, the operator must __________ the generator field current; when generator reactive load equals 150 MVAR (out) the generator power factor will be __________ than the initial power factor.

A. increase; larger

B. increase; smaller

C. decrease; larger

D. decrease; smaller

ANSWER: C.

TOPIC: Motors and Generators

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

22 KV
60 Hertz
575 MW
100 MVAR (in)

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 initially result in an increase in main generator amps?

	Voltage Setpoint	Speed Setpoint
A.	Increase	Increase
B.	Increase	Decrease
C.	Decrease	Increase
D.	Decrease	Decrease

ANSWER: C.

TOPIC: Motors and Generators

A nuclear power plant startup is in progress. The main generator has just been connected to the power grid with the following generator indications:

20 KV
288 amps
10 MW
0 MVAR

The operator suspects the main generator is operating under reverse power conditions and attempts to increase generator load (MW) normally. If the main generator is operating under reverse power conditions when the operator attempts to increase generator load, generator MW will initially __________; and generator amps will initially __________.

A. decrease; decrease

B. decrease; increase

C. increase; decrease

D. increase; increase

ANSWER: A.

TOPIC: Motors and Generators

A main generator is connected to an infinite power grid with the following generator output parameters:

22 KV
60 Hertz
575 MW
100 MVAR (in)

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 initially result in a decrease in main generator amps?

	Voltage Setpoint	Speed Setpoint
A.	Increase	Increase
B.	Increase	Decrease
C.	Decrease	Increase
D.	Decrease	Decrease

ANSWER: B.

TOPIC: Motors and Generators

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

22 KV
60 Hertz
600 MW
100 MVAR (out)

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 initially result in an increase in main generator amps?

	Voltage Setpoint	Speed Setpoint
A.	Increase	Increase
B.	Increase	Decrease
C.	Decrease	Increase
D.	Decrease	Decrease

ANSWER: A.

TOPIC: Motors and Generators

A main generator is connected to an infinite power grid. Which one of the following pairs of main generator output parameters places the generator in the closest proximity to slipping a pole?

A. 800 MW; 200 MVAR (in)

B. 800 MW; 600 MVAR (in)

C. 400 MW; 200 MVAR (out)

D. 400 MW; 600 MVAR (out)

ANSWER: B.

TOPIC: Motors and Generators

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

22 KV
60 Hertz
600 MW
100 MVAR (out)

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 initially result in a decrease in main generator amps?

	Voltage Setpoint	Speed Setpoint
A.	Increase	Increase
B.	Increase	Decrease
C.	Decrease	Increase
D.	Decrease	Decrease

ANSWER: D.

TOPIC: Motors and Generators

During a surveillance test, a 4,000 KW diesel generator (DG) and a 1,000 MW main generator (MG) at a nuclear power plant are connected to the same power grid.

The following stable generator output conditions exist:

Diesel Generator	Main Generator
700 KW	800 MW
200 KVAR (out)	100 MVAR (out)

A malfunction then occurs, causing the voltage regulator for the MG to slowly and continuously increase the MG field current. If no operator action is taken, the DG output current will __________ until a breaker trip separates the generators.

A. remain about the same

B. increase continuously

C. initially increase, and then decrease

D. initially decrease, and then increase

ANSWER: D.

TOPIC: Motors and Generators

A main generator is connected to an infinite power grid with the following generator output parameters:

22 KV
60 Hertz
575 MW
100 MVAR (in)

Which one of the following contains a combination of minor adjustments to the main generator voltage regulator and speed control setpoints such that each adjustment will cause the main generator to operate at a power factor closer to 1.0? (Assume the generator power factor remains less than 1.0.)

	Voltage Setpoint	Speed Setpoint
A.	Increase	Increase
B.	Increase	Decrease
C.	Decrease	Increase
D.	Decrease	Decrease

ANSWER: A.

TOPIC: Motors and Generators

A main turbine-generator is connected to an infinite power grid with the following generator output parameters:

25 KV
20,000 amps
830 MW
248 MVAR (out)

Which one of the following will significantly increase main generator output amperage without a significant change in main generator MW output? (Assume the generator power factor remains less than 1.0.)

A. Increasing the main turbine speed control setpoint.

B. Increasing the main generator voltage regulator setpoint.

C. A 10 percent decrease in power grid electrical loads.

D. A 10 percent increase in power grid electrical loads.

ANSWER: B

TOPIC: Motors and Generators

A main generator is connected to an infinite power grid with the following generator output parameters:

22 KV
60 Hertz
575 MW
100 MVAR (out)

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 main generator operation at a power factor closer to 1.0? (Assume the generator power factor remains less than 1.0.)

	Voltage Setpoint	Speed Setpoint
A.	Increase	Increase
B.	Increase	Decrease
C.	Decrease	Increase
D.	Decrease	Decrease

ANSWER: C.

TOPIC: Motors and Generators

During a surveillance test, a 4,000 KW diesel generator (DG) and a 1,000 MW main generator (MG) at a nuclear power plant are connected to a power grid.

The following stable generator output conditions initially exist:

Diesel Generator	Main Generator
700 KW	800 MW
200 KVAR (out)	100 MVAR (out)

A malfunction then occurs, causing the voltage regulator for the MG to slowly and continuously decrease the MG field current. If no operator action is taken, the DG output current will __________ until a breaker trip separates the generators.

A. increase continuously

B. decrease continuously

C. initially increase, and then decrease

D. initially decrease, and then increase

ANSWER: A.

TOPIC: Motors and Generators

A main generator is connected to an infinite power grid with the following generator output parameters:

100 MW
0 MVAR
2,625 amps
22 KV

If the main generator field current is decreased, main generator amps will initially __________; and MW will initially __________.

A. decrease; decrease

B. increase; decrease

C. decrease; remain the same

D. increase; remain the same

ANSWER: D.

TOPIC: Motors and Generators

A 4,000 KW diesel generator (DG) is supplying 2,000 KW to a 4.16 KV emergency bus. The DG governor is in the isochronous mode (no speed droop). The emergency bus is about to be synchronized with, and then connected to, an infinite offsite power grid by closing the emergency bus normal power feeder breaker.

The following stable emergency bus and normal power conditions currently exist:

Emergency Bus (from DG)	Normal Power (from Offsite)
4.16 KV	4.16 KV
60.0 Hz	60.1 Hz

When the emergency bus normal power feeder breaker is closed, the DG will… (Assume no additional operator action.)

A. transfer KW load to the offsite power grid but remain partially loaded.

B. transfer KW load to the offsite power grid until the DG is completely unloaded.

C. acquire KW load from the offsite power grid but remain within its KW load rating.

D. acquire KW load from the offsite power grid and ultimately exceed its KW load rating.

ANSWER: B.

TOPIC: Motors and Generators

A radial-flow centrifugal cooling water pump is being powered by a 480 VAC <u>induction</u> motor. If the motor input voltage slowly decreases from 480 VAC to 450 VAC, the pump flow rate will __________; and the motor current will __________. (Assume the motor does <u>not</u> stall.)

A. decrease; increase

B. decrease; decrease

C. remain the same; increase

D. remain the same; decrease

ANSWER: A.

TOPIC: Motors and Generators

A main generator is connected to an infinite power grid with the following generator output parameters:

22 KV
60 Hertz
575 MW
100 MVAR (out)

Which one of the following contains a combination of minor adjustments to the main generator voltage regulator and speed control setpoints such that each adjustment will cause the main generator to operate at a power factor farther from 1.0? (Assume the generator power factor remains less than 1.0.)

	Voltage Setpoint	Speed Setpoint
A.	Increase	Increase
B.	Increase	Decrease
C.	Decrease	Increase
D.	Decrease	Decrease

ANSWER: B.

TOPIC: Motors and Generators

A main generator is connected to an infinite power grid with the following generator output parameters:

22 KV
60 Hertz
975 MW
200 MVAR (out)

Main generator stator winding temperature is abnormally high. Which one of the following contains a combination of manual adjustments to the main generator speed control and voltage regulator setpoints such that each adjustment will reduce the main generator stator winding temperature? (Assume power factor remains less than 1.0.)

	Speed Setpoint	Voltage Setpoint
A.	Increase	Increase
B.	Increase	Decrease
C.	Decrease	Increase
D.	Decrease	Decrease

ANSWER: D.

TOPIC: Motors and Generators

A 4,000 KW rated diesel generator (DG) is supplying 2,000 KW to a 4.16 KV emergency bus. The DG governor is in the isochronous mode (<u>no</u> speed droop). The emergency bus is about to be synchronized with, and then connected to, an infinite offsite power grid by closing the emergency bus normal power feeder breaker.

The following stable emergency bus and normal power conditions currently exist:

Emergency Bus <u>(from DG)</u>	Normal Power <u>(from Offsite)</u>
4.16 KV	4.16 KV
60.1 Hz	59.9 Hz

When the emergency bus normal power feeder breaker is closed, the DG will… (Assume <u>no</u> additional operator action is taken.)

A. transfer KW load to the offsite power grid, but remain partially loaded.

B. transfer KW load to the offsite power grid until the DG is completely unloaded.

C. acquire KW load from the offsite power grid, but remain within its KW load rating.

D. acquire KW load from the offsite power grid and ultimately exceed its KW load rating.

ANSWER: D.

TOPIC: Motors and Generators

A fault on the offsite AC electrical distribution system caused a sustained 30 percent voltage reduction on <u>all</u> phases of the <u>onsite</u> three-phase AC electrical distribution system. As a result, several operating three-phase AC induction motors in the plant experienced automatic breaker trips.

Which one of the following could be responsible for the automatic breaker trips?

A. Excessive motor current leading to breaker trips from thermal overload.

B. Excessive motor current leading to breaker trips from instantaneous overcurrent.

C. Insufficient breaker control power leading to breaker trips from trip mechanism malfunctions.

D. Insufficient breaker control power leading to breaker trips from closing mechanism malfunctions.

ANSWER: A.

TOPIC: Motors and Generators

A shutdown nuclear power plant is operating normally when an electrical fault causes a sustained 20 percent voltage reduction on <u>all</u> phases of the onsite three-phase AC electrical distribution system. Assume that all previously-operating three-phase AC induction motors continue operating, and the mechanical load on each motor remains the same.

As a result of the voltage reduction, the operating three-phase AC induction motors will draw __________ current; and will experience __________ stator temperatures.

A. more; higher

B. more; lower

C. less; higher

D. less; lower

ANSWER: A.

TOPIC: Motors and Generators

Refer to the partial drawing of two identical radial-flow centrifugal pumps in a cooling water system (see figure below). Each pump is driven by an identical three-phase AC induction motor.

The cooling water system is being returned to service following maintenance on the pumps. Pump A was started 5 minutes ago to initiate flow in the cooling water system.

When pump B is started, which one of the following will cause the ammeter for pump B to stabilize at a higher-than-normal value for the pump configuration?

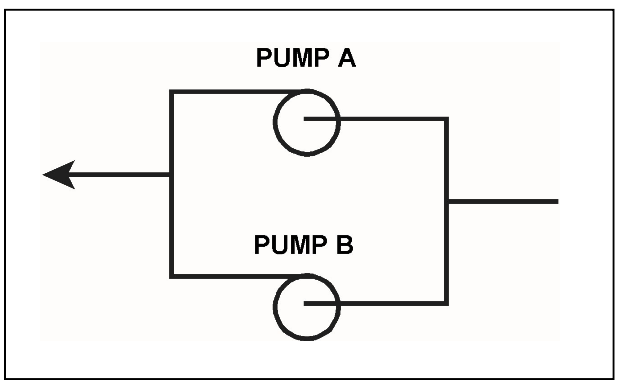
A. Pump B was initially rotating in the reverse direction.

B. There is an obstruction in the discharge piping from pump B.

C. The packing gland for pump B was overtightened since the pump last operated.

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

ANSWER: C.



TOPIC: Motors and Generators

If the speed of a centrifugal pump is increased to double pump flow rate, pump motor current will...

A. remain constant.

B. increase two-fold (double).

C. increase four-fold.

D. increase eight-fold.

ANSWER: D.

TOPIC: Motors and Generators

A motor-driven centrifugal pump is operating with the following parameters:

Pump speed = 1,800 rpm
Pump head = 100 psid
Motor current = 10 amps

What will be the approximate value of pump head if pump speed is increased such that the motor draws 640 amps?

A. 400 psid

B. 800 psid

C. 1,200 psid

D. 1,600 psid

ANSWER: D.

TOPIC: Motors and Generators

A motor-driven centrifugal pump is operating with a flow rate of 3,000 gpm and a current requirement of 200 amps. If the pump speed is reduced such that the flow rate is 2,000 gpm, what is the final current requirement at the new lower speed? (Assume a constant motor voltage.)

A. 59 amps

B. 89 amps

C. 133 amps

D. 150 amps

ANSWER: A.

TOPIC: Motors and Generators

A motor-driven centrifugal pump is operating with the following parameters:

Speed	=	1,800 rpm
Motor current	=	40 amps
Pump head	=	20 psi
Pump flow rate	=	400 gpm

What will be the approximate values of pump head and motor current if pump speed is increased to 2,000 rpm?

A. 22 psi, 44 amps

B. 25 psi, 49 amps

C. 22 psi, 49 amps

D. 25 psi, 55 amps

ANSWER: D.

TOPIC: Motors and Generators

A motor-driven centrifugal pump is operating at 600 rpm with the following parameters:

Motor current	= 10 amps
Pump head	= 50 psi
Pump flow rate	= 200 gpm

What will be the approximate value of pump head if the flow is increased such that the motor draws 640 amps?

A. 400 psi

B. 600 psi

C. 800 psi

D. 1,200 psi

ANSWER: C.

TOPIC: Motors and Generators

A motor-driven centrifugal pump is operating with a throttled discharge valve in an open system. If the pump discharge valve is fully opened to increase system flow rate, which one of the following will increase?

A. Pump discharge pressure

B. Available net positive suction head

C. Motor amps

D. Pump speed

ANSWER: C.

TOPIC: Motors and Generators

A centrifugal pump is operating with the following parameters:

Speed	= 3,600 rpm
Motor current	= 100 amps
Pump head	= 50 psi
Pump flow rate	= 400 gpm

What will be the approximate values of pump head and motor current if pump speed is decreased to 2,000 rpm?

A. 8.6 psi, 30.1 amps

B. 8.6 psi, 17.1 amps

C. 15.4 psi, 30.1 amps

D. 15.4 psi, 17.1 amps

ANSWER: D.

TOPIC: Motors and Generators

A two-speed centrifugal pump is driven by an AC motor with the following initial conditions:

Pump speed	=	400 rpm
Motor current	=	40 amps
Pump head	=	60 psid

What will be the approximate value of pump head if pump speed is increased to 1,600 rpm?

A. 240 psid

B. 480 psid

C. 960 psid

D 3,840 psid

ANSWER: C.

TOPIC: Motors and Generators

A motor-driven centrifugal pump is operating with the following parameters:

Speed	=	1,200 rpm
Motor current	=	40 amps
Pump head	=	20 psid
Pump flow rate	=	400 gpm

What will be the approximate values of pump head and motor current if pump speed is increased to 1,600 rpm?

A. 25 psid, 55 amps

B. 25 psid, 95 amps

C. 36 psid, 55 amps

D. 36 psid, 95 amps

ANSWER: D.

TOPIC: Motors and Generators

A motor-driven centrifugal pump is operating with the following parameters:

Speed	= 1,200 rpm
Motor current	= 40 amps
Pump head	= 20 psi
Pump flow rate	= 400 gpm

What will be the approximate values of pump head and motor current if pump speed is increased to 1,800 rpm?

A. 36 psi, 95 amps

B. 36 psi, 135 amps

C. 45 psi, 95 amps

D. 45 psi, 135 amps

ANSWER: D.

TOPIC: Motors and Generators

A motor-driven centrifugal pump is operating with the following parameters:

Speed	= 1,800 rpm
Motor current	= 40 amps
Pump head	= 20 psid
Pump flow rate	= 400 gpm

What will be the approximate values of pump head and motor current if pump speed is decreased to 1,200 rpm?

A. 13 psid, 18 amps

B. 13 psid, 12 amps

C. 9 psid, 18 amps

D. 9 psid, 12 amps

ANSWER: D.

TOPIC: Motors and Generators

A motor-driven centrifugal pump is operating with a flow rate of 3,000 gpm and a motor current of 150 amps. If the pump speed is reduced such that the flow rate is 2,000 gpm, what is the final motor current at the new lower speed?

A. 44 amps

B. 59 amps

C. 67 amps

D. 100 amps

ANSWER: A.

TOPIC: Motors and Generators

A motor-driven centrifugal pump is operating at 600 rpm with the following parameters:

Motor current	=	100 amps
Pump head	=	50 psid
Pump flow rate	=	880 gpm

What will be the approximate value of pump head if pump speed is increased to 1,200 rpm?

A. 71 psid

B. 100 psid

C. 141 psid

D. 200 psid

ANSWER: D.

TOPIC: Motors and Generators

A multi-speed centrifugal pump is operating at 3,600 rpm with a flow rate of 3,000 gpm. Which one of the following approximates the new flow rate if the speed is decreased to 3,000 rpm?

A. 1,000 gpm

B. 1,500 gpm

C. 2,000 gpm

D. 2,500 gpm

ANSWER: D.

TOPIC: Motors and Generators

A multi-speed centrifugal pump is operating with a flow rate of 1,800 gpm at a speed of 3,600 rpm.

Which one of the following approximates the new flow rate if the pump speed is decreased to 2,400 rpm?

A. 900 gpm

B. 1,050 gpm

C. 1,200 gpm

D. 1,350 gpm

ANSWER: C.

TOPIC: Motors and Generators

A multi-speed motor-driven centrifugal pump is operating with the following parameters:

Motor current	=	27 amps
Pump head	=	50 psid
Pump flow rate	=	880 gpm

Which one of the following will be the approximate new value of pump head if pump speed is increased such that the motor draws 64 amps?

A. 89 psid

B. 119 psid

C. 211 psid

D. 281 psid

ANSWER: A.

TOPIC: Motors and Generators

Which one of the following describes the relationship between the current drawn by an AC induction motor and the amount of heat generated in the motor windings?

A. Heat generation is directly proportional to the current.

B. Heat generation is proportional to the cube of the current.

C. Heat generation is proportional to the square of the current.

D. Heat generation is proportional to the square root of the current.

ANSWER: C.

TOPIC: Motors and Generators

A motor-driven centrifugal pump is operating at 600 rpm with the following parameters:

Motor current	=	100 amps
Pump head	=	50 psid
Pump flow rate	=	880 gpm

What will be the approximate value of pump head if pump speed is increased such that the motor draws 640 amps?

A. 93 psid

B. 126 psid

C. 173 psid

D. 320 psid

ANSWER: C.

TOPIC: Motors and Generators

A rotary positive displacement pump (PDP) is being used to supply water to a piping system. The PDP is driven by an AC induction motor. The initial parameters are:

System pressure	=	500 psig
PDP flow rate	=	50 gpm
PDP motor current	=	40 amps

After several hours, the PDP motor speed is increased such that the new PDP flow rate is 100 gpm. If system pressure does <u>not</u> change, what is the approximate value of the PDP motor current at the 100 gpm flow rate?

A. 80 amps

B. 160 amps

C. 320 amps

D. 640 amps

ANSWER: A.

TOPIC: Motors and Generators

Refer to the pump performance curves for a centrifugal cooling water pump (see figure below). The pump is being driven by a single-speed AC induction motor. Pump flow rate is being controlled by a throttled discharge flow control valve.

The following initial pump conditions exist:

Pump motor current = 50 amps
Pump flow rate = 400 gpm

What will be the approximate value of pump motor current if the flow control valve is repositioned such that pump flow rate is 800 gpm?

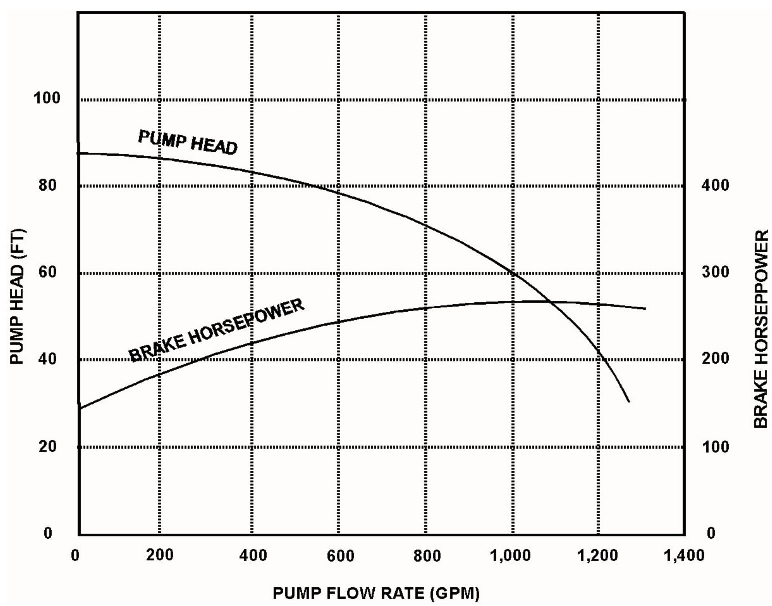
A. Less than 100 amps

B. 200 amps

C. 400 amps

D. More than 500 amps

ANSWER: A.



TOPIC: Motors and Generators

Consider two identical single-speed AC induction motors, one of which is connected to a radial-flow centrifugal pump and the other to a reciprocating-type positive displacement pump (PDP). Both pumps are taking suction at the same elevation from a vented water storage tank.

Each pump has a maximum design backpressure of 800 psig, and each is operating with the following initial conditions:

Flow rate	=	200 gpm
Backpressure	=	400 psig
Motor current	=	100 amps

If the backpressure for each pump increases to 600 psig, the centrifugal pump will have a __________ flow rate than the PDP; and the centrifugal pump will have a __________ motor current than the PDP.

A. lower; higher

B. lower; lower

C. higher; higher

D. higher; lower

ANSWER: B.

TOPIC: Motors and Generators

Refer to the pump performance curves for a centrifugal cooling water pump (see figure below). The pump is being driven by a single-speed AC induction motor. Pump flow rate is being controlled by a throttled discharge flow control valve.

The following initial pump conditions exist:

Motor current = 100 amps
Pump flow rate = 800 gpm

What will be the approximate value of pump motor current if the flow control valve is repositioned such that pump flow rate decreases to 400 gpm?

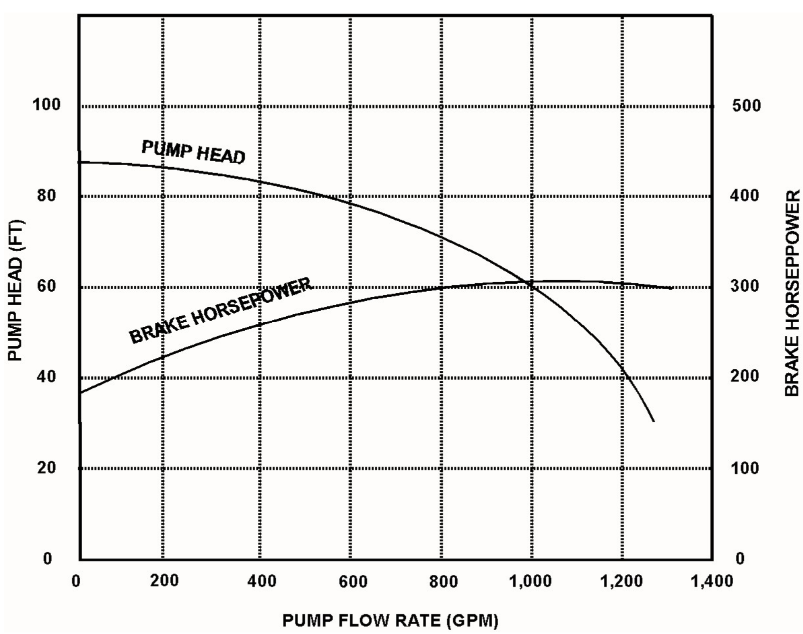
A. Less than 15 amps

B. 25 amps

C. 50 amps

D. Greater than 75 amps

ANSWER: D.



TOPIC: Motors and Generators

An AC induction motor is connected to a radial-flow centrifugal pump in a cooling water system. When the pump is started, the time period required to reach a stable running current will be shorter if the pump discharge valve is fully __________; and the stable running current will be lower if the pump discharge valve is fully __________.

A. open; open

B. open; closed

C. closed; open

D. closed; closed

ANSWER: D.

TOPIC: Motors and Generators

A centrifugal pump is driven by a single-speed AC induction motor. Pump flow rate is controlled by a throttled discharge flow control valve.

The following initial pump conditions exist:

Pump motor current	=	50 amps
Pump flow rate	=	400 gpm

What will the resulting pump motor current be if the flow control valve is repositioned such that pump flow rate increases to 800 gpm?

A. 100 amps

B. 200 amps

C. 400 amps

D. Cannot be determined without additional information.

ANSWER: D.

TOPIC: Motors and Generators

An axial flow ventilation fan is being driven by an AC motor. The fan is operating at its maximum rated flow rate. How will the fan motor current initially change if the flow rate through the fan is decreased by partially closing a discharge damper?

A. The motor current will increase in accordance with the centrifugal pump laws.

B. The motor current will increase, but not in accordance with the centrifugal pump laws.

C. The motor current will decrease in accordance with the centrifugal pump laws.

D. The motor current will decrease, but not in accordance with the centrifugal pump laws.

ANSWER: B

TOPIC: Motors and Generators

Consider two identical single-speed AC induction motors, one of which is connected to a radial-flow centrifugal pump and the other to a rotary-type positive displacement pump (PDP). Both pumps are taking suction from the bottom of a vented water storage tank.

Each pump is operating with the following initial conditions:

Flow rate	=	200 gpm
Backpressure	=	600 psig
Motor current	=	100 amps

If the backpressure for each pump decreases to 400 psig, the centrifugal pump will have a __________ flow rate than the PDP; and the centrifugal pump will have a __________ motor current than the PDP.

A. lower; lower

B. lower; higher

C. higher; lower

D. higher; higher

ANSWER: D.

TOPIC: Motors and Generators

Refer to the pump performance curves for a centrifugal cooling water pump (see figure below). The pump is being driven by a single-speed AC induction motor. Pump flow rate is being controlled by a throttled discharge flow control valve.

The following initial pump conditions exist:

Motor current = 10 amps
Pump flow rate = 200 gpm

What will be the approximate value of pump motor current if the flow control valve is repositioned such that pump flow rate increases to 800 gpm?

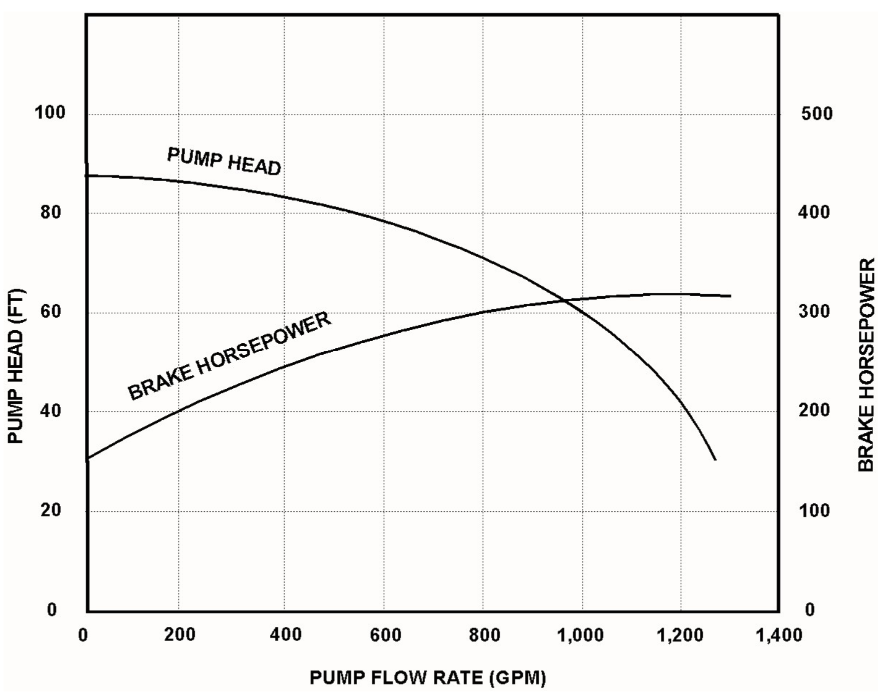
A. 15 amps

B. 40 amps

C. 160 amps

D. Greater than 200 amps

ANSWER: A.



TOPIC: Motors and Generators

A motor-driven radial-flow centrifugal pump is operating to provide makeup water from a constant head source to a vented storage tank that is 30 feet tall. The pump is located at the base of the tank and discharges directly into the bottom of the tank. As the tank water level increases from 20 to 25 feet, the pump discharge pressure will __________; and the pump motor current will __________.

A. decrease; decrease

B. decrease; increase

C. increase; decrease

D. increase; increase

ANSWER: C.

TOPIC: Motors and Generators

An air-cooled AC induction motor is initially operating at steady-state conditions, producing a work output of 50 hp. A reduction in cooling air flow rate to the motor causes the average stator winding temperature to increase by 20ºF. To maintain a 50 hp work output at the higher stator winding temperature, the voltage applied to the motor must be __________ because the stator winding resistance has __________.

A. increased; increased

B. increased; decreased

C. decreased; increased

D. decreased; decreased

ANSWER: A.

TOPIC: Motors and Generators

The rate of heat production in the stator windings of an AC induction motor is __________ proportional to the __________ of the stator current.

A. directly, square

B. directly; amount

C. inversely; square

D. inversely; amount

ANSWER: A.

TOPIC: Motors and Generators

An <u>axial</u> flow ventilation fan is being driven by an AC motor. The fan is operating at 90 percent of rated flow rate with its discharge damper partially closed. How will the fan motor current change if its discharge damper is fully opened?

A. The motor current will increase in accordance with the centrifugal pump laws.

B. The motor current will increase, but not in accordance with the centrifugal pump laws.

C. The motor current will decrease in accordance with the centrifugal pump laws.

D. The motor current will decrease, but not in accordance with the centrifugal pump laws.

ANSWER: D.

TOPIC: Motors and Generators

Initially, an AC induction motor is operating with the following steady-state conditions:

Motor current	= 25 amps
Average stator winding temperature	= 140°F
Ambient temperature	= 90°F

Assume the stator winding electrical resistance, motor heat transfer properties, and ambient temperature do not change. If a change in motor load causes the motor current to increase to 50 amps, which one of the following will be the new steady-state average stator winding temperature?

A. 190°F

B. 200°F

C. 280°F

D. 290°F

ANSWER: D.

TOPIC: Motors and Generators

Refer to the partial drawing of two identical centrifugal pumps in a cooling water system (see figure below). Each pump is driven by an identical three-phase AC induction motor.

The cooling water system is being returned to service following maintenance on the pumps. Pump A was started five minutes ago to initiate flow in the cooling water system. Pump B is about to be started.

When pump B is started, which one of the following will cause pump B to experience high starting current for a shorter time than usual before stabilizing at a lower running current?

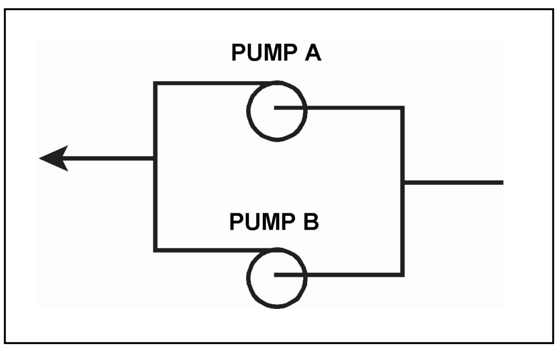
A. Pump B is initially rotating in the reverse direction.

B. The motor coupling for pump B was removed and not reinstalled.

C. The packing gland for pump B was tightened since the pump last operated.

D. The voltage applied to the motor for pump B is 20 percent lower than normal.

ANSWER: B.



TOPIC: Motors and Generators

Refer to the partial drawing of two identical single-speed radial-flow centrifugal pumps in a cooling water system (see figure below). Pumps 1 and 2 are driven by identical three-phase AC induction motors. Initially, pump 1 is operating normally and pump 2 is stopped.

Then pump 2 is started, but its discharge check valve remains partially closed. When conditions stabilize, pump _____ will have the smaller motor current; and pump _____ will have the greater discharge head.

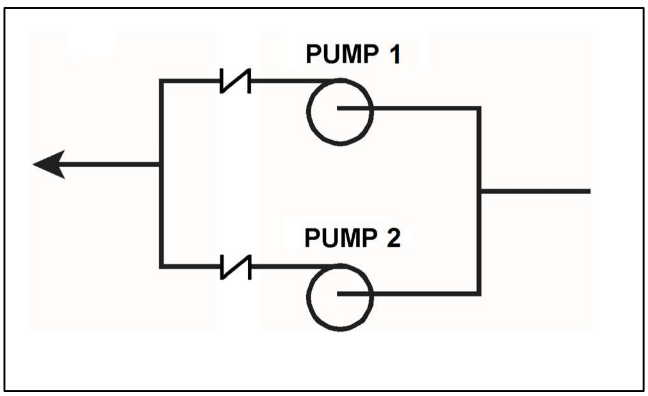
A. 1; 1

B. 1; 2

C. 2; 1

D. 2; 2

ANSWER: D.



TOPIC: Motors and Generators

The starting current for a typical AC induction motor is usually much higher than the full-load running current because...

A. starting torque is lower than full-load running torque.

B. starting torque is higher than full-load running torque.

C. rotor speed during start is too low to generate significant counter electromotive force in the stator.

D. rotor current during start is too low to generate significant counter electromotive force in the stator.

ANSWER: C.

TOPIC: Motors and Generators

The average starting current for a typical AC induction motor is approximately...

A. ten to fifteen times its normal running current.

B. five to seven times its normal running current.

C. two to three times its normal running current.

D. the same as its normal running current.

ANSWER: B.

TOPIC: Motors and Generators

Which one of the following describes the motor current indications that would be observed during the start of a large AC motor connected to a load?

A. Amps slowly increase to the normal operating value over a period of five time constants.

B. Amps immediately increase to the normal operating value and stabilize.

C. Amps immediately increase to many times the normal operating value and then decrease to the normal operating value.

D. Amps immediately increase to the full-scale value and then decrease rapidly to zero due to overload protection.

ANSWER: C.

TOPIC: Motors and Generators

If the discharge valve of a large motor-driven centrifugal pump is kept closed during a normal pump start, the current indication for the AC induction motor will rise to...

A. approximately the full-load current value, and then decrease to the no-load current value.

B. approximately the full-load current value, and then stabilize at the full-load current value.

C. several times the full-load current value, and then decrease to the no-load current value.

D. several times the full-load current value, and then decrease to the full-load value.

ANSWER: C.

TOPIC: Motors and Generators

Which one of the following is a characteristic of a typical AC induction motor that causes starting current to be greater than running current?

A. The rotor magnetic field induces an opposing voltage in the stator that is proportional to rotor speed.

B. After the motor starts, resistors are added to the electrical circuit to limit the running current.

C. A large amount of starting current is required to initially establish a rotating magnetic field.

D. The rotor does not develop maximum induced current flow until it has achieved synchronous speed.

ANSWER: A.

TOPIC: Motors and Generators

The starting current in an AC motor is significantly higher than the full-load running current because...

A. little counter electromotive force is induced in the rotor windings during motor start.

B. motor torque production is highest during motor start.

C. little counter electromotive force is induced in the stator windings during motor start.

D. work performed by the motor is highest during motor start.

ANSWER: C.

TOPIC: Motors and Generators

Starting current in an AC induction motor is typically __________ times the full-load running current.

A. 1/4 to 1/2

B. 2 to 3

C. 5 to 7

D. 10 to 12

ANSWER: C.

TOPIC: Motors and Generators

Which one of the following describes the motor current during the start of a typical motor-driven radial-flow centrifugal pump with a closed discharge valve?

A. Current immediately increases to the full-load value and then gradually decreases to the no-load value.

B. Current immediately increases to the full-load value and then stabilizes at the full-load value.

C. Current immediately increases to many times the full-load value and then rapidly decreases to the no-load value after several seconds and then stabilizes.

D. Current immediately increases to many times the full-load value and then rapidly decreases to the full-load value after several seconds and then stabilizes.

ANSWER: C.

TOPIC: Motors and Generators

Which one of the following describes the motor current indications that would be observed during the start of a large motor-driven radial-flow centrifugal pump with a closed discharge valve?

A. Current immediately increases to the full-load value and then gradually decreases to the no-load value over several minutes.

B. Current immediately increases to the no-load value and then stabilizes.

C. Current immediately increases to many times the no-load value and then rapidly decreases to the no-load value after several seconds.

D. Current immediately increases to many times the no-load value and then gradually decreases to the no-load value after several minutes.

ANSWER: C.

TOPIC: Motors and Generators

Two identical AC induction motors are connected to identical radial-flow centrifugal pumps being used to provide cooling water flow in separate systems in a nuclear power plant. Each motor is rated at 1,000 hp. The discharge valve for pump A is fully open and the discharge valve for pump B is fully shut. Each pump is currently off.

If the pumps are started under these conditions, the longer time period required to stabilize motor current will be experienced by the motor for pump _____; and the higher stable motor current will be experienced by the motor for pump _____.

A. A; A

B. A; B

C. B; A

D. B; B

ANSWER: A.

TOPIC: Motors and Generators

Which one of the following describes when the highest stator current will be experienced by an AC induction motor?

A. During motor operation at full load.

B. During motor operation at zero load.

C. Immediately after energizing the motor.

D. Immediately after deenergizing the motor.

ANSWER: C.

TOPIC: Motors and Generators

Two identical AC induction motors are connected to identical radial-flow centrifugal pumps in identical but separate cooling water systems. Each motor is rated at 200 hp. The discharge valve for pump A is fully shut and the discharge valve for pump B is fully open. Each pump is currently off.

If the pumps are started under these conditions, the longer time period required to stabilize motor current will be experienced by the motor for pump _____; and the higher stable motor current will be experienced by the motor for pump _____.

A. A; A

B. A; B

C. B; A

D. B; B

ANSWER: D.

TOPIC: Motors and Generators

Two identical AC induction motors are connected to identical radial-flow centrifugal pumps in identical but separate cooling water systems. Each motor is rated at 200 hp. The discharge valve for pump A is fully shut and the discharge valve for pump B is fully open. Each pump is currently off.

If the pumps are started under these conditions, the shorter time period required to reach a stable running current will be experienced by the motor for pump _____; and the higher stable running current will be experienced by the motor for pump _____.

A. A; A

B. A; B

C. B; A

D. B; B

ANSWER: B.

TOPIC: Motors and Generators

To minimize the duration of high starting current, an AC induction motor should be started __________ to __________ the stator counter electromotive force.

A. unloaded; quickly establish

B. unloaded; delay

C. partially loaded; quickly establish

D. partially loaded; delay

ANSWER: A.

TOPIC: Motors and Generators

Two identical AC induction motors are connected to identical radial-flow centrifugal pumps in identical but separate cooling water systems. Each motor is rated at 200 hp. The discharge valve for pump A is fully open and the discharge valve for pump B is fully closed. Each pump is currently off.

If the pumps are started under these conditions, the shorter time period required to reach a stable running current will be experienced by the motor for pump _____; and the higher stable running current will be experienced by the motor for pump _____.

A. A; A

B. A; B

C. B; A

D. B; B

ANSWER: C.

TOPIC: Motors and Generators

What is the primary reason for limiting the number of starts for an electric motor in a given period of time?

A. Prevent overheating of the windings due to high starting currents.

B. Prevent overheating of the windings due to shorting within the stator.

C. Prevent rotor damage due to excessive cyclic stresses on the shaft.

D. Prevent rotor damage due to excessive axial displacement of the shaft.

ANSWER: A.

TOPIC: Motors and Generators

The frequency of starts for large AC motors should be limited to prevent excessive...

A. heat buildup within the motor.

B. wear of pump thrust bearings.

C. torsional stresses on the motor shaft.

D. arcing and degradation of motor breaker contacts.

ANSWER: A.

TOPIC: Motors and Generators

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; low

B. windings; high

C. commutator and/or slip rings; low

D. commutator and/or slip rings; high

ANSWER: A.

TOPIC: Motors and Generators

The frequency of start/stop cycles for an electrical motor is limited to prevent...

A. overheating the motor windings.

B. overheating the motor supply bus.

C. excessive shaft torsional stresses.

D. excessive cycling of the motor breaker.

ANSWER: A.

TOPIC: Motors and Generators

Frequent starts of large motors will result in overheating of the motor windings due to high current flow caused by...

A. low electrical resistance of the motor windings.

B. an electrical short circuit between the rotor and stator.

C. high counter electromotive force at low rotor speeds.

D. windage losses between the rotor and stator.

ANSWER: A.

TOPIC: Motors and Generators

Which one of the following is the primary reason for limiting the number of motor starts in a given time period?

A. Minimizes pitting of contacts in the motor breaker.

B. Prevents excessive torsional stresses on the motor shaft.

C. Prevents overheating of the motor windings.

D. Minimizes axial stresses on the motor bearings.

ANSWER: C.

TOPIC: Motors and Generators

A large centrifugal pump is driven by a 200 horsepower AC induction motor. The motor breaker control circuit contains the following protection devices: instantaneous overcurrent relay, motor thermal overload relay, control power fuses, and an anti-pumping device.

The pump had been manually started and stopped several times during a 5 minute period when the motor breaker tripped. Which one of the following is the most likely cause of the breaker trip?

A. Motor thermal overload.

B. Instantaneous overcurrent.

C. Blown control power fuse.

D. Anti-pumping device actuation.

ANSWER: A.

TOPIC: Heat Exchangers

The rate of heat transfer between two liquids in a heat exchanger will increase if the… (Assume single-phase conditions and a constant specific heat for both liquids.)

A. inlet temperature of the hotter liquid decreases by 20°F.

B. inlet temperature of the colder liquid increases by 20°F.

C. flow rates of both liquids decrease by 10 percent.

D. flow rates of both liquids increase by 10 percent.

ANSWER: D.

TOPIC: Heat Exchangers

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

Given the following information:

$c_{p\text{-oil}}$ = 1.1 Btu/lbm-°F
$c_{p\text{-water}}$ = 1.0 Btu/lbm-°F
$T_{oil\ in}$ = 174°F
$T_{oil\text{-}out}$ = 114°F
$T_{water\text{-}in}$ = 85°F
$T_{water\text{-}out}$ = 115°F
$\dot{m}_{oil}$ = 4.0×10^4 lbm/hr
$\dot{m}_{water}$ = ?

What is the approximate mass flow rate of the cooling water?

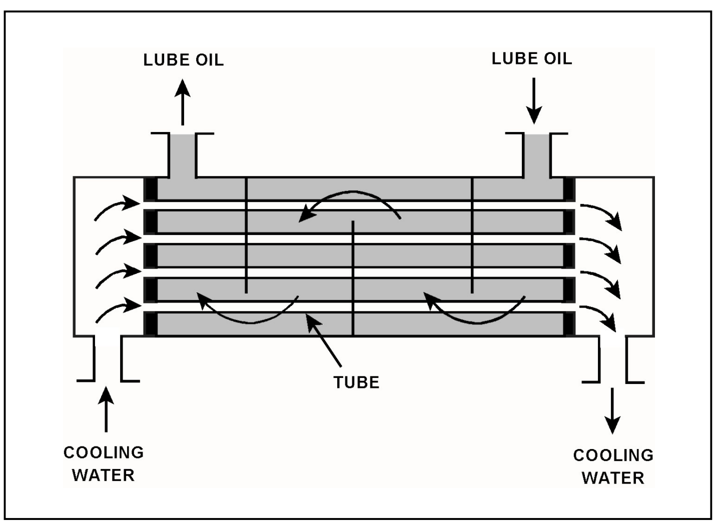
A. 8.8×10^4 lbm/hr

B. 7.3×10^4 lbm/hr

C. 2.2×10^4 lbm/hr

D. 1.8×10^4 lbm/hr

ANSWER: A.



TOPIC: Heat Exchangers

The rate of heat transfer between two liquids in a single-phase heat exchanger will decrease if the... (Assume constant specific heat capacities.)

A. inlet temperatures of both liquids decrease by 20°F.

B. inlet temperatures of both liquids increase by 20°F.

C. flow rate of the colder liquid decreases by 10 percent.

D. flow rate of the hotter liquid increases by 10 percent.

ANSWER: C.

TOPIC: Heat Exchangers

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

Given the following information:

$\dot{m}_{oil}$ = 2.0×10^4 lbm/hr
$\dot{m}_{water}$ = 3.0×10^4 lbm/hr
$c_{p\text{-}oil}$ = 1.1 Btu/lbm-°F
$c_{p\text{-}water}$ = 1.0 Btu/lbm-°F
$T_{cw\text{-}in}$ = 92°F
$T_{cw\text{-}out}$ = 125°F
$T_{oil\text{-}in}$ = 180°F
$T_{oil\text{-}out}$ = ?

Which one of the following is the approximate temperature of the lube oil exiting the heat exchanger ($T_{oil\text{-}out}$)?

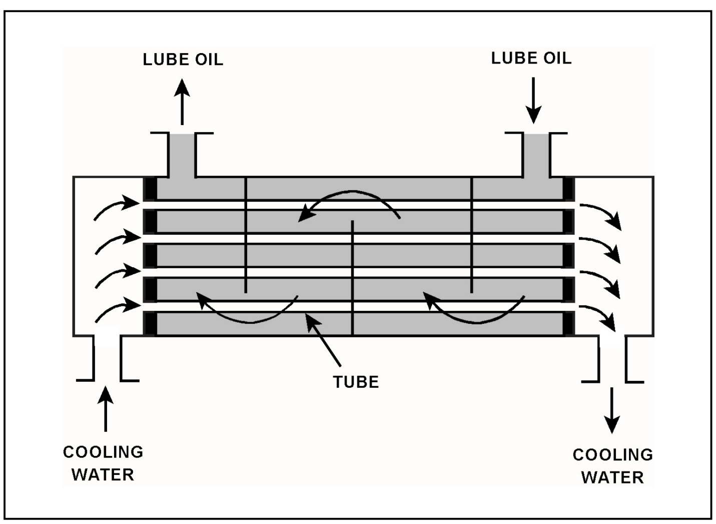
A. 126°F

B. 135°F

C. 147°F

D. 150°F

ANSWER: B.



TOPIC: Heat Exchangers

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

A. The inlet temperatures of both liquids decrease by 20°F.

B. The inlet temperatures of both liquids increase by 20°F.

C. The inlet temperature of the hotter liquid increases by 20°F.

D. The inlet temperature of the colder liquid increases by 20°F.

ANSWER: D.

TOPIC: Heat Exchangers

Refer to the drawing of an operating heat exchanger (see figure below). Assume the overall heat exchanger heat transfer coefficient does <u>not</u> change.

The rate of heat transfer between the two liquids will <u>increase</u> if the…

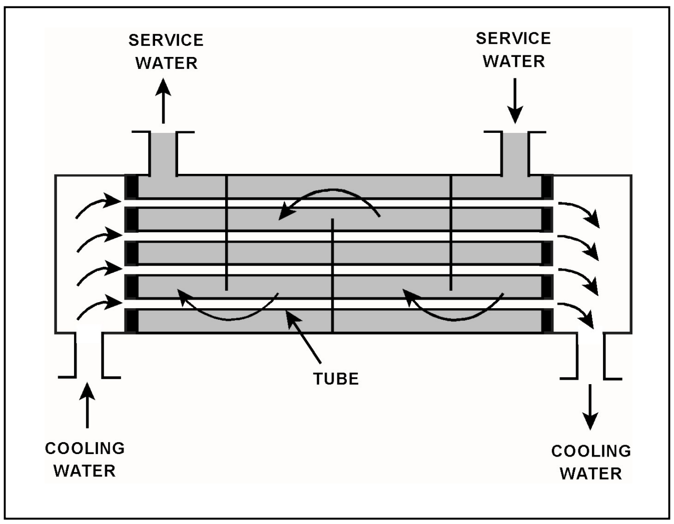
A. inlet temperatures of both liquids increase by 20°F.

B. inlet temperatures of both liquids decrease by 20°F.

C. mass flow rate of the hotter liquid increases by 10 percent.

D. mass flow rate of the colder liquid decreases by 10 percent.

ANSWER: C.



TOPIC: Heat Exchangers

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

Given the following information:

$\dot{m}_{oil}$ = 1.5×10^4 lbm/hr
$\dot{m}_{water}$ = 2.5×10^4 lbm/hr
$c_{p\text{-}oil}$ = 1.1 Btu/lbm-°F
$c_{p\text{-}water}$ = 1.0 Btu/lbm-°F
$T_{cw\text{-}in}$ = 92°F
$T_{cw\text{-}out}$ = 125°F
$T_{oil\text{-}in}$ = 160°F
$T_{oil\text{-}out}$ = ?

Which one of the following is the approximate temperature of the lube oil exiting the heat exchanger ($T_{oil\text{-}out}$)?

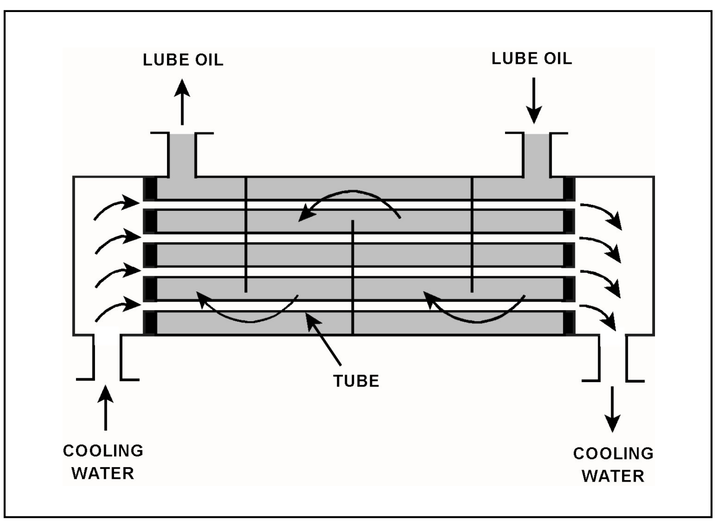
A. 110°F

B. 127°F

C. 135°F

D. 147°F

ANSWER: A.



TOPIC: Heat Exchangers

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

Given the following information:

$c_{p\text{-oil}}$ = 1.1 Btu/lbm-°F
$c_{p\text{-water}}$ = 1.0 Btu/lbm-°F
$\dot{m}_{oil}$ = 1.2×10^4 lbm/hr
$\dot{m}_{water}$ = 1.61×10^4 lbm/hr
$T_{oil\ in}$ = 170°F
$T_{oil\ out}$ = 120°F
$T_{water\ out}$ = 110°F
$T_{water\ in}$ = ?

Which one of the following is the approximate cooling water inlet temperature ($T_{water\ in}$) for the heat exchanger?

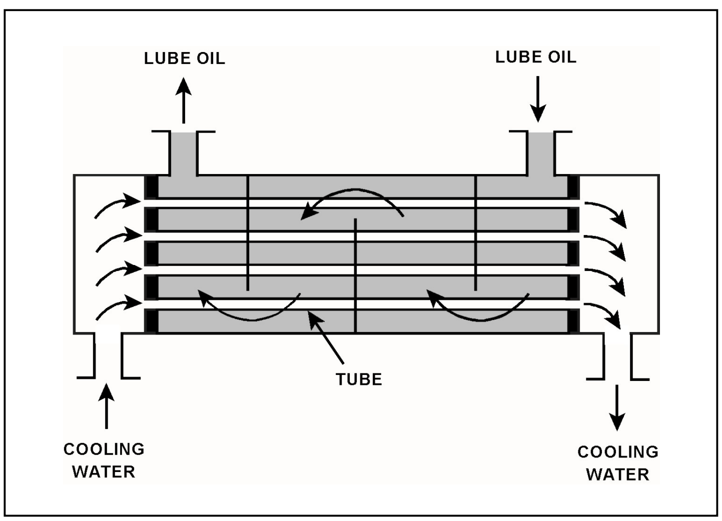
A. 65°F

B. 69°F

C. 73°F

D. 77°F

ANSWER: B.



TOPIC: Heat Exchangers

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

Given the following information:

$\dot{m}_{oil}$ = 1.8×10^4 lbm/hr
$\dot{m}_{water}$ = 3.3×10^4 lbm/hr
$c_{p\text{-}oil}$ = 1.1 Btu/lbm-°F
$c_{p\text{-}water}$ = 1.0 Btu/lbm-°F
$T_{cw\text{-}in}$ = 90°F
$T_{cw\text{-}out}$ = 120°F
$T_{oil\text{-}in}$ = 190°F
$T_{oil\text{-}out}$ = ?

What is the approximate temperature of the lube oil exiting the heat exchanger ($T_{oil\text{-}out}$)?

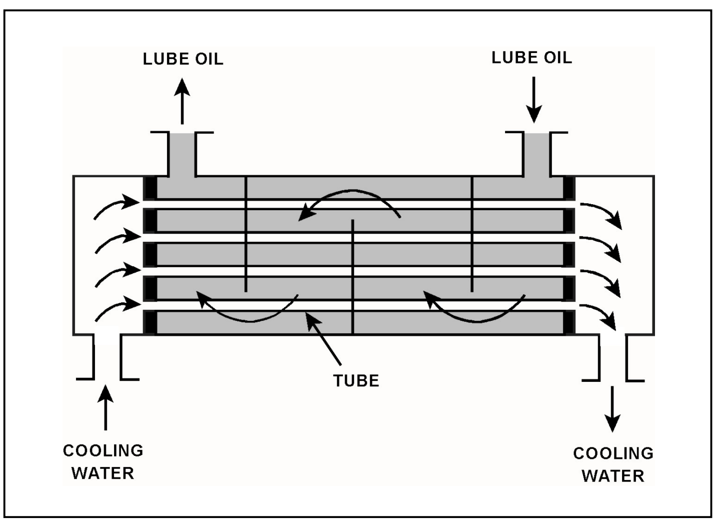
A. 110°F

B. 120°F

C. 130°F

D. 140°F

ANSWER: D.



TOPIC: Heat Exchangers

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

Given the following information:

$\dot{m}_{oil}$ = 1.5×10^4 lbm/hr
$\dot{m}_{water}$ = 2.5×10^4 lbm/hr
$c_{p\text{-}oil}$ = 1.1 Btu/lbm-°F
$c_{p\text{-}water}$ = 1.0 Btu/lbm-°F
$T_{oil\text{-}in}$ = 160°F
$T_{oil\text{-}out}$ = 110°F
$T_{cw\text{-}in}$ = 92°F
$T_{cw\text{-}out}$ = ?

Which one of the following is the approximate temperature of the cooling water exiting the heat exchanger ($T_{cw\text{-}out}$)?

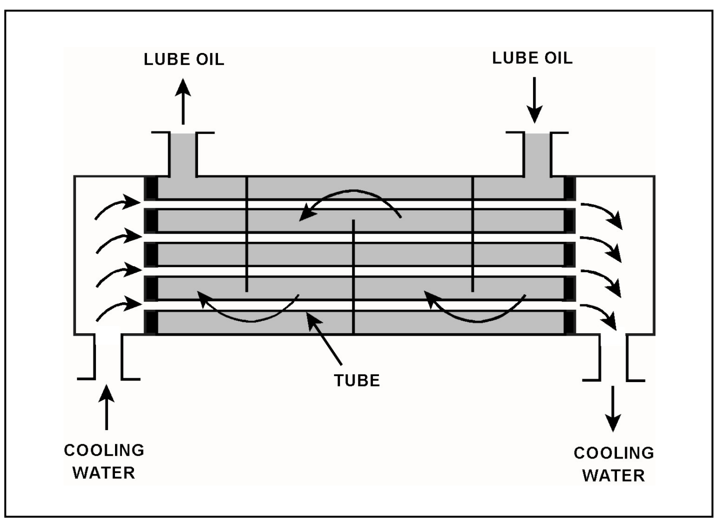
A. 110°F

B. 115°F

C. 120°F

D. 125°F

ANSWER: D.



TOPIC: Heat Exchangers

The rate of heat transfer between two liquids in a heat exchanger will decrease if the: (Assume single-phase conditions and a constant specific heat for both liquids.)

A. inlet temperature of the hotter liquid increases by 20°F.

B. inlet temperature of the colder liquid decreases by 20°F.

C. flow rates of both liquids decrease by 10 percent.

D. flow rates of both liquids increase by 10 percent.

ANSWER: C.

TOPIC: Heat Exchangers

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

Given the following heat exchanger parameters:

- Lube oil flow rate is 200 lbm/min.
- Lube oil enters the heat exchanger at 140°F.
- Lube oil leaves the heat exchanger at 100°F.
- Specific heat of the lube oil is 0.8 Btu/lbm-°F.
- Cooling water flow rate is 400 lbm/min.
- Cooling water enters the lube oil heat exchanger at 60°F.
- Specific heat of the cooling water is 1.0 Btu/lbm-°F.

What is the approximate temperature of the cooling water leaving the lube oil heat exchanger?

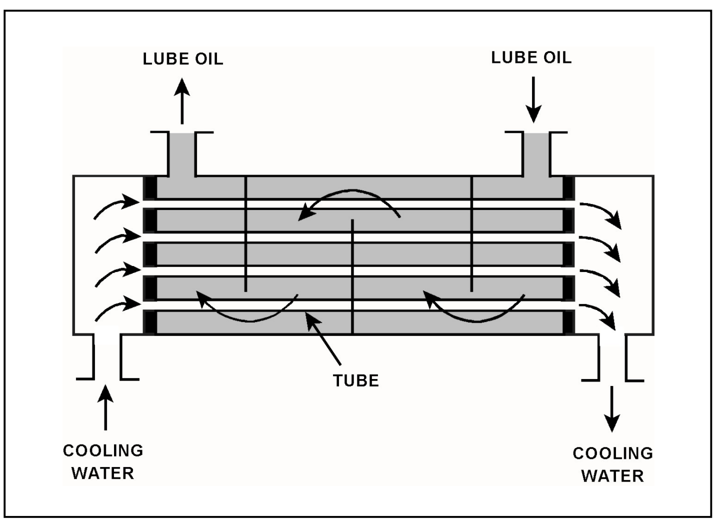
A. 76°F

B. 85°F

C. 92°F

D. 124°F

ANSWER: A.



TOPIC: Heat Exchangers

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

Given the following information:

$\dot{Q}_{oil}$ = 1.0×10^7 Btu/hr
$T_{oil\ in}$ = 170°F
$T_{oil\ out}$ = 134°F
$T_{water\ in}$ = 85°F
$T_{water\ out}$ = 112°F
$c_{p\text{-}oil}$ = 1.1 Btu/lbm-°F
$c_{p\text{-}water}$ = 1.0 Btu/lbm-°F
$\dot{m}_{water}$ = ?

Which one of the following is the approximate mass flow rate of the cooling water?

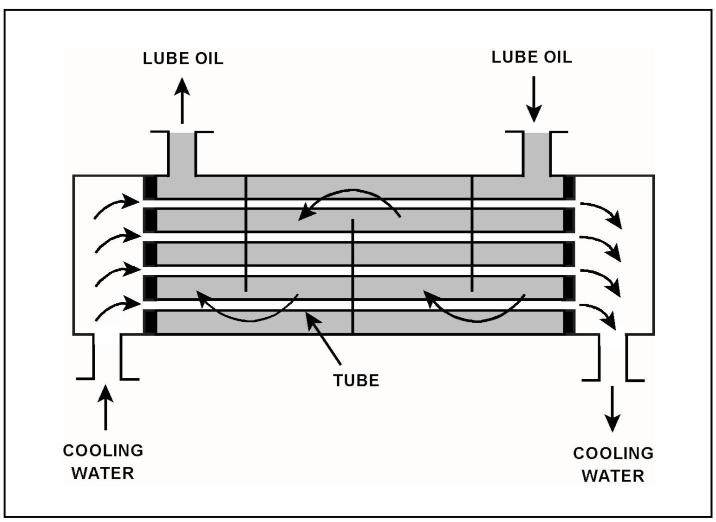
A. 4.5×10^5 lbm/hr

B. 3.7×10^5 lbm/hr

C. 2.5×10^5 lbm/hr

D. 1.2×10^5 lbm/hr

ANSWER: B.



TOPIC: Heat Exchangers

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

Given the following information:

$\dot{m}_{oil}$ = 1.8×10^4 lbm/hr
$\dot{m}_{water}$ = 3.3×10^4 lbm/hr
$c_{p\text{-}oil}$ = 1.1 Btu/lbm-°F
$c_{p\text{-}water}$ = 1.0 Btu/lbm-°F
$T_{cw\text{-}in}$ = 90°F
$T_{cw\text{-}out}$ = 120°F
$T_{oil\text{-}in}$ = 170°F
$T_{oil\text{-}out}$ = ?

What is the approximate temperature of the lube oil exiting the heat exchanger ($T_{oil\text{-}out}$)?

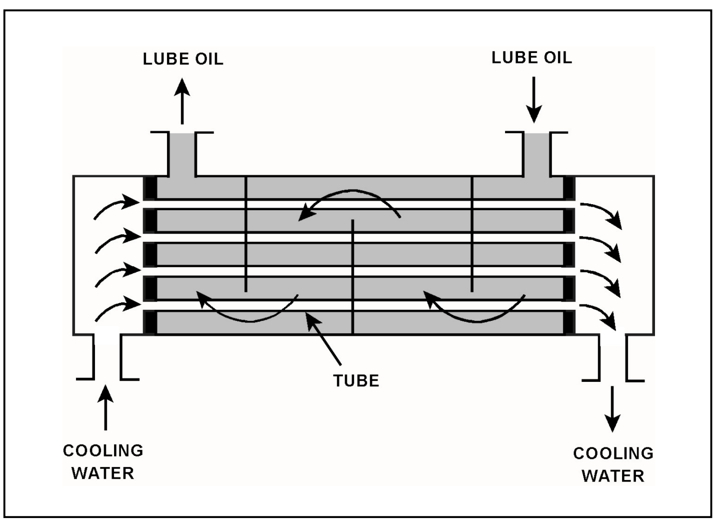
A. 110°F

B. 120°F

C. 130°F

D. 140°F

ANSWER: B.



TOPIC: Heat Exchangers

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

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

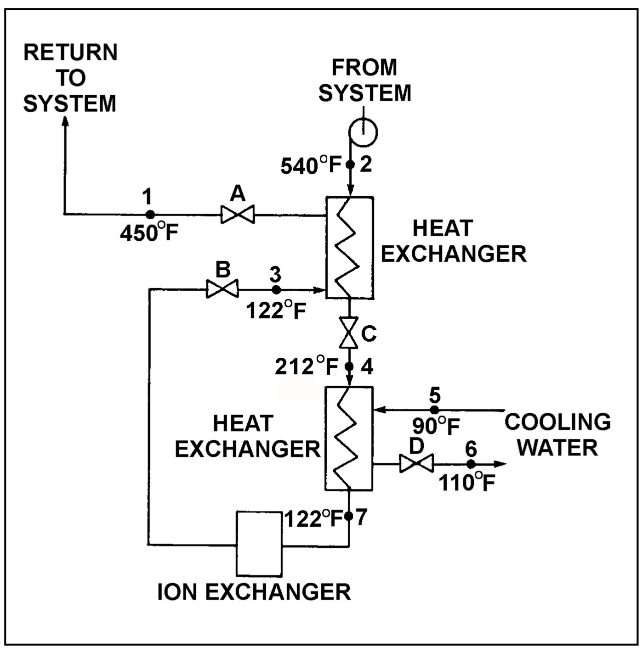
A. 2.2×10^5 lbm/hr

B. 3.2×10^5 lbm/hr

C. 2.2×10^6 lbm/hr

D. 3.2×10^6 lbm/hr

ANSWER: A.



TOPIC: Heat Exchangers

A main turbine-generator was operating at 80 percent load with the following <u>initial</u> steady-state lube oil and cooling water temperatures for the main turbine lube oil heat exchanger:

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

Six months later, the following <u>current</u> steady-state heat exchanger temperatures are observed:

$T_{oil\ in}$ = 177°F
$T_{oil\ out}$ = 111°F
$T_{water\ in}$ = 85°F
$T_{water\ out}$ = 115°F

Assume the lube oil system is a closed system. Also, assume the following did <u>not</u> change:

- Cooling water mass flow rate
- Cooling water and lube oil specific heats
- Heat exchanger heat transfer coefficient

Which one of the following could be responsible for the differences between the initial and current steady-state heat exchanger temperatures?

A. The current main turbine-generator load is lower than the initial load.

B. The current main turbine-generator load is higher than the initial load.

C. The current main turbine lube oil mass flow rate is less than the initial flow rate.

D. The current main turbine lube oil mass flow rate is greater than the initial flow rate.

ANSWER: C.

TOPIC: Heat Exchangers

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

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

Six months later, the current steady-state heat exchanger temperatures are:

$T_{oil\ in}$ = 174°F
$T_{oil\ out}$ = 120°F
$T_{water\ in}$ = 85°F
$T_{water\ out}$ = 120°F

Assume that the lube oil mass flow rate does not change, and that the specific heat values for the cooling water and lube oil do not change. Also assume that the main turbine lube oil system is a closed system.

The differences between the initial and current steady-state heat exchanger temperatures could be caused by the current main turbine-generator load being __________ with the current heat exchanger cooling water mass flow rate being __________.

A. higher; lower

B. higher; higher

C. lower; lower

D. lower; higher

ANSWER: C.

TOPIC: Heat Exchangers

Refer to the drawing of an operating parallel-flow lube oil heat exchanger (see figure below). Assume that lube oil (LO) inlet temperature is greater than cooling water (CW) inlet temperature.

Unlike a counter-flow heat exchanger, in a parallel-flow heat exchanger the __________ temperature can never be greater than the __________ temperature.

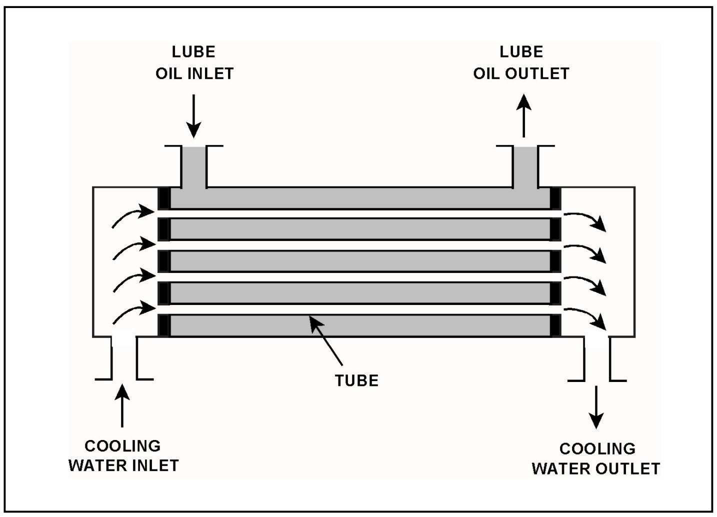
A. LO outlet; CW inlet

B. LO outlet; CW outlet

C. CW outlet; LO inlet

D. CW outlet; LO outlet

ANSWER: D.



TOPIC: Heat Exchangers

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

Assume there is no heat loss from the process water cleanup system to the surroundings and the process water flow rate does <u>not</u> change. If valve D closes fully, what will be the final steady-state temperature of the process water flowing through the filter?

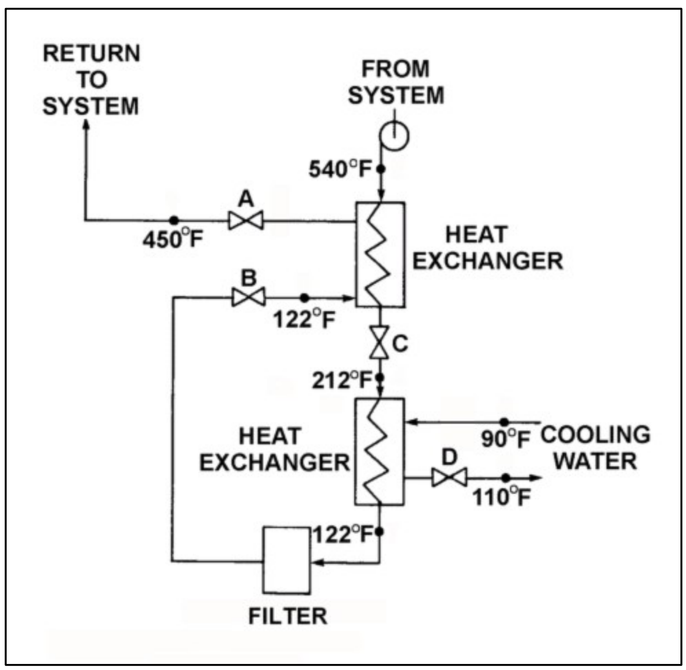
A. 212°F

B. 302°F

C. 450°F

D. 540°F

ANSWER: D.



TOPIC: Heat Exchangers

A counter-flow heat exchanger is being used to cool the lube oil for a main turbine and generator.

The main turbine and generator was initially operating at 100 percent load with the following stable heat exchanger conditions:

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

Main turbine and generator load was reduced, and the heat exchanger cooling water mass flow rate was decreased to one-half of its initial value, resulting in the following stable current conditions:

$T_{oil\ in}$ = 178°F
$T_{oil\ out}$ = 138°F
$T_{water\ in}$ = 85°F
$T_{water\ out}$ = ?

Assume that the lube oil mass flow rate and the specific heats of both fluids did not change.

Which one of the following is the current cooling water outlet temperature?

A. 115°F

B. 125°F

C. 135°F

D. 145°F

ANSWER: B.

TOPIC: Heat Exchangers

Given the following parameter values for a feedwater heater:

Feedwater inlet temperature	=	320°F
Feedwater inlet pressure	=	1,000 psia
Feedwater mass flow rate	=	1.0×10^6 lbm/hr
Extraction steam pressure	=	500 psia

Assume that the extraction steam enters the heater as a dry saturated vapor and leaves the heater as a saturated liquid at 500 psia.

Which one of the following is the approximate mass flow rate of extraction steam required to increase feedwater temperature to 380°F?

A. 5.2×10^4 lbm/hr

B. 7.9×10^4 lbm/hr

C. 8.4×10^4 lbm/hr

D. 8.9×10^4 lbm/hr

ANSWER: C.

TOPIC: Heat Exchangers

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

<u>Unlike</u> a counter-flow heat exchanger, in the parallel-flow heat exchanger the __________ temperature will <u>always</u> be greater than the __________ temperature.

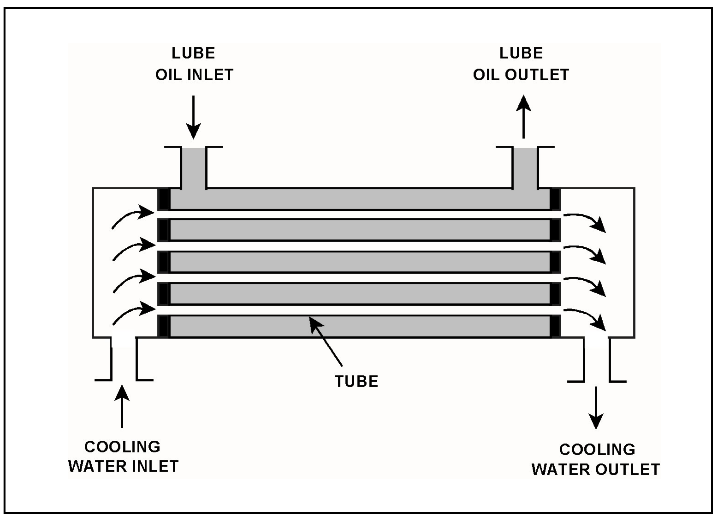
A. CW outlet; LO inlet

B. CW outlet; LO outlet

C. LO outlet; CW inlet

D. LO outlet; CW outlet

ANSWER: D.



TOPIC: Heat Exchangers

Given the following parameters for an operating lube oil heat exchanger:

Lube oil inlet temperature	= 150°F
Lube oil outlet temperature	= 105°F
Cooling water inlet temperature	= 60°F
Cooling water outlet temperature	= 110°F

Considering only counter-flow and parallel-flow heat exchanger designs, the lube oil heat exchanger described above must be…

A. counter-flow, because the lube oil outlet temperature is less than the cooling water outlet temperature.

B. counter-flow, because the change in lube oil temperature is less than the change in cooling water temperature.

C. parallel-flow, because the lube oil outlet temperature is less than the cooling water outlet temperature.

D. parallel-flow, because the change in lube oil temperature is less than the change in cooling water temperature.

ANSWER: A.

TOPIC: Heat Exchangers

The manufacturers of shell and U-tube heat exchangers recommend a <u>maximum</u> tube fluid velocity to limit the __________ of the tubes; and a <u>minimum</u> tube fluid velocity to limit the __________ of the tubes.

A. erosion; fouling

B. erosion; thermal contraction

C. thermal expansion; fouling

D. thermal expansion; thermal contraction

ANSWER: A.

TOPIC: Heat Exchangers

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

Given:

- The cooling water inlet temperature is constant.
- The lube oil inlet temperature is constant.
- The lube oil mass flow rate is constant.

If the cooling water mass flow rate increases, the lube oil outlet temperature will __________; and the cooling water outlet temperature will __________.

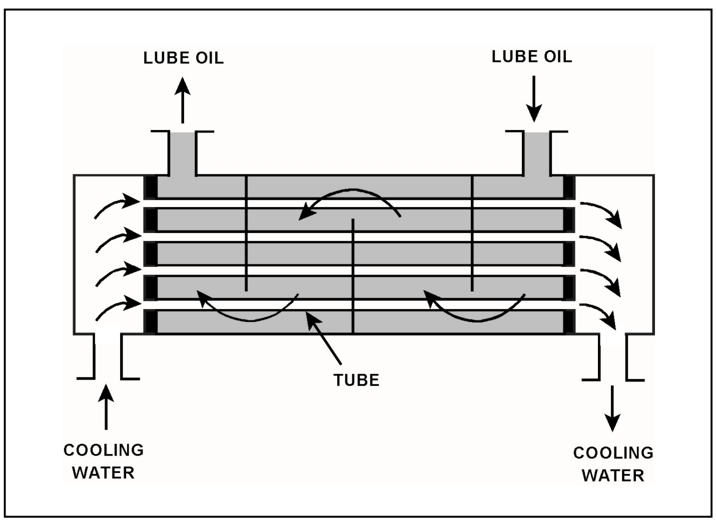
A. increase; increase

B. increase; decrease

C. decrease; increase

D. decrease; decrease

ANSWER: D.



TOPIC: Heat Exchangers

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

A. The mass flow rate of the hotter liquid decreases by 10 percent.

B. The mass flow rate of the colder liquid decreases by 10 percent.

C. The inlet temperature of the hotter liquid increases by 20°F.

D. The inlet temperature of the colder liquid increases by 20°F.

ANSWER: C.

TOPIC: Heat Exchangers

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

The rate of heat transfer between the lube oil and cooling water will increase if the cooling water inlet temperature __________; <u>or</u> if the cooling water mass flow rate __________.

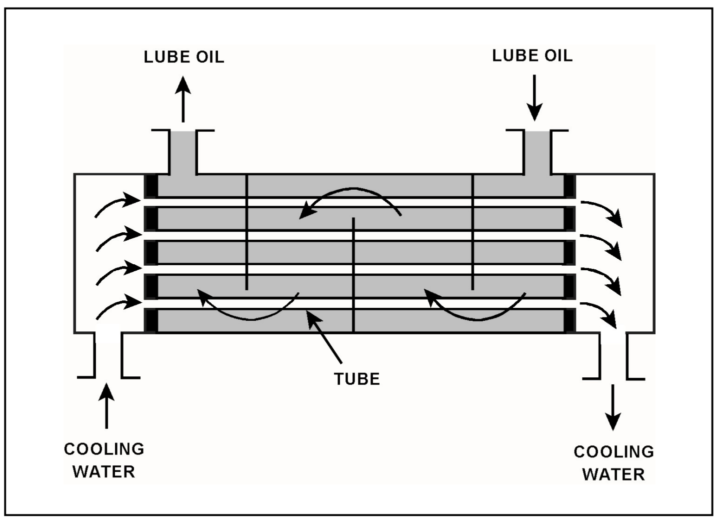
A. decreases; decreases

B. decreases; increases

C. increases; decreases

D. increases; increases

ANSWER: B.



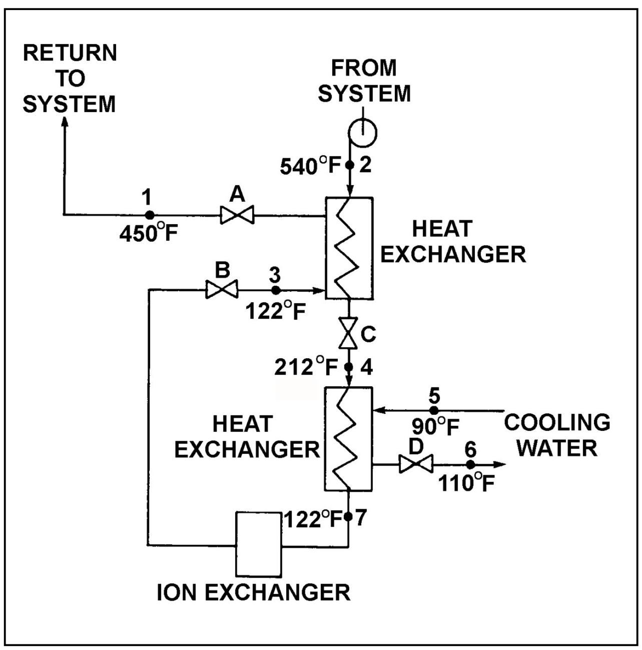
TOPIC: Heat Exchangers

Refer to the drawing of an operating water cleanup system (see figure below) in which valves A, B, C, and D are fully open. Currently, the centrifugal pump is providing a cleanup water flow rate of 120 gpm.

If valve C is throttled to 50 percent, how will the temperatures at points 3 and 6 be affected?

	Point 3	Point 6
A.	Decrease	Decrease
B.	Decrease	Increase
C.	Increase	Decrease
D.	Increase	Increase

ANSWER: A.



TOPIC: Heat Exchangers

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

All valves are identical and are initially 50 percent open. To <u>lower</u> the temperature at point 7, the operator can adjust valve __________ in the <u>open</u> direction.

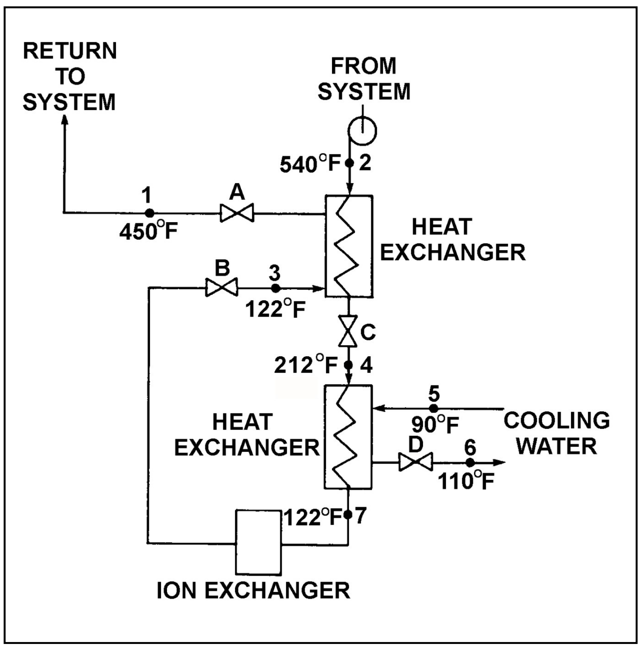
A. A

B. B

C. C

D. D

ANSWER: D.



TOPIC: Heat Exchangers

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

Increasing the oil flow rate through the heat exchanger will cause the oil outlet temperature to __________ and the cooling water outlet temperature to __________.

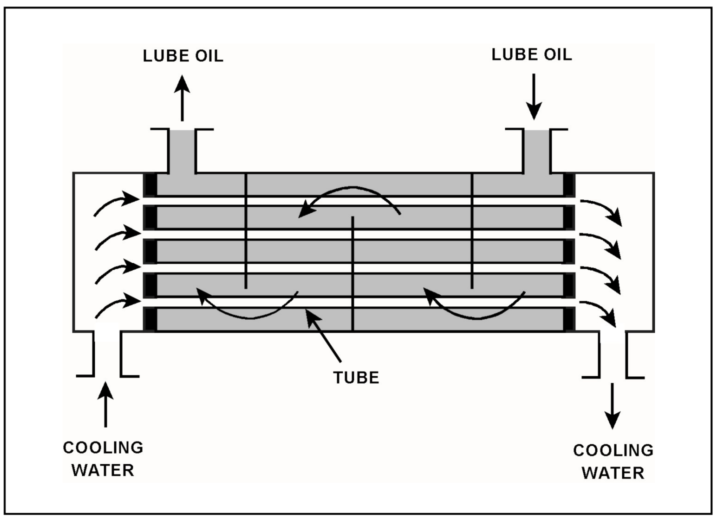
A. increase; increase

B. increase; decrease

C. decrease; increase

D. decrease; decrease

ANSWER: A.



TOPIC: Heat Exchangers

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

Assume that the inlet lube oil and inlet cooling water temperatures are constant and cooling water flow rate remains the same. Decreasing the oil flow rate through the heat exchanger will cause the lube oil outlet temperature to __________ and the cooling water outlet temperature to __________.

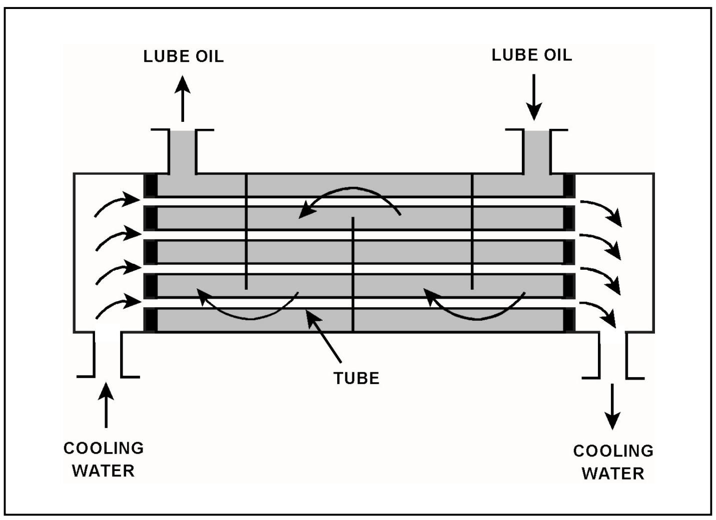
A. increase, increase

B. increase, decrease

C. decrease, increase

D. decrease, decrease

ANSWER: D.



TOPIC: Heat Exchangers

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

Valves A, B, and C are fully open. Valve D is 80 percent open. If valve D is throttled to 50 percent, the temperature at point...

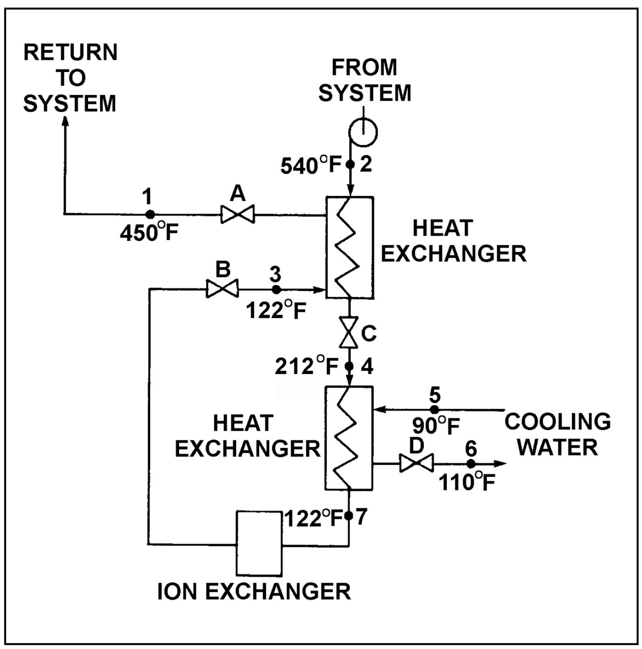
A. 3 will decrease.

B. 4 will increase.

C. 5 will increase.

D. 6 will decrease.

ANSWER: B.



TOPIC: Heat Exchangers

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

Valves A, B, and C are fully open. Valve D is 20 percent open. If valve D is opened to 100 percent, the temperature at point...

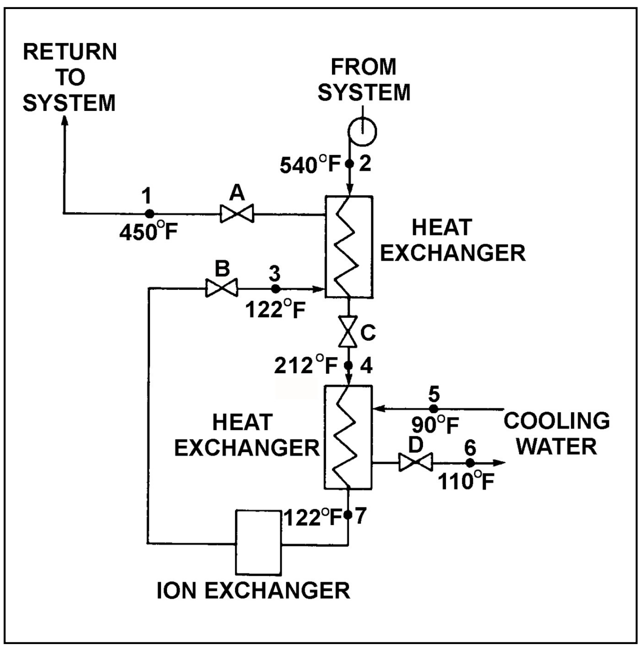
A. 3 will increase.

B. 4 will decrease.

C. 5 will decrease.

D. 7 will increase.

ANSWER: B.



TOPIC: Heat Exchangers

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

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

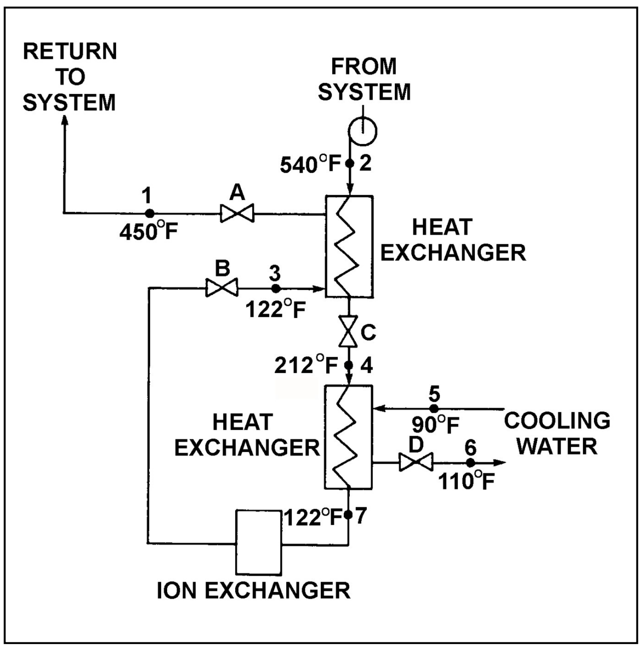
A. A; open

B. B; close

C. C; open

D. D; close

ANSWER: B.



TOPIC: Heat Exchangers

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

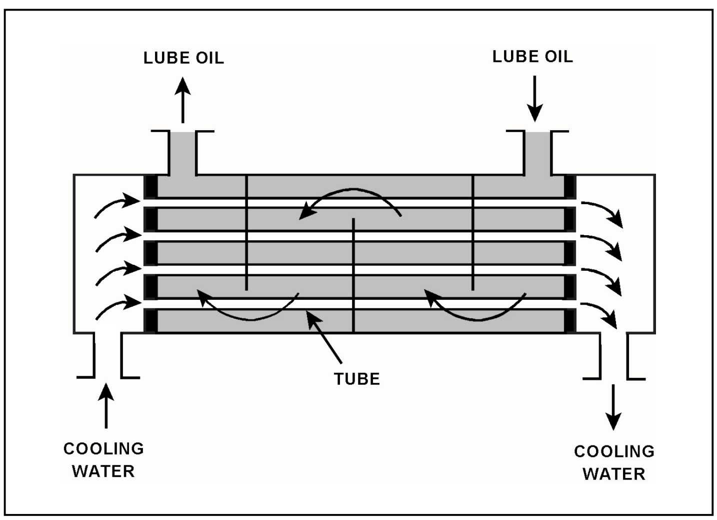
The lube oil heat exchanger is in service with the following inlet temperatures:

Lube oil inlet temperature = 120°F
Cooling water inlet temperature = 60°F

Assuming that cooling water flow rate is greater than 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.	100°F	100°F
B.	90°F	90°F
C.	80°F	80°F
D.	80°F	100°F

ANSWER: C.



TOPIC: Heat Exchangers

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

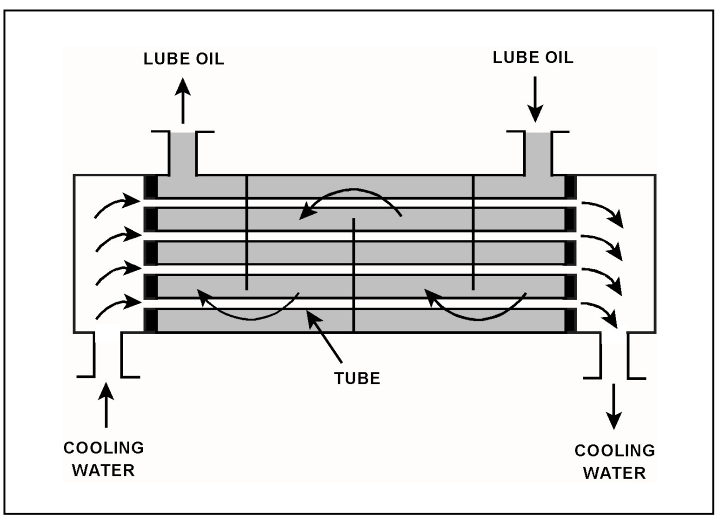
The lube oil heat exchanger is in service with the following inlet temperatures:

Lube oil inlet temperature	= 130°F
Cooling water inlet temperature	= 70°F

Assuming that cooling water flow rate is greater than 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.	90°F	100°F
B.	90°F	110°F
C.	100°F	100°F
D.	100°F	110°F

ANSWER: A.



TOPIC: Heat Exchangers

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

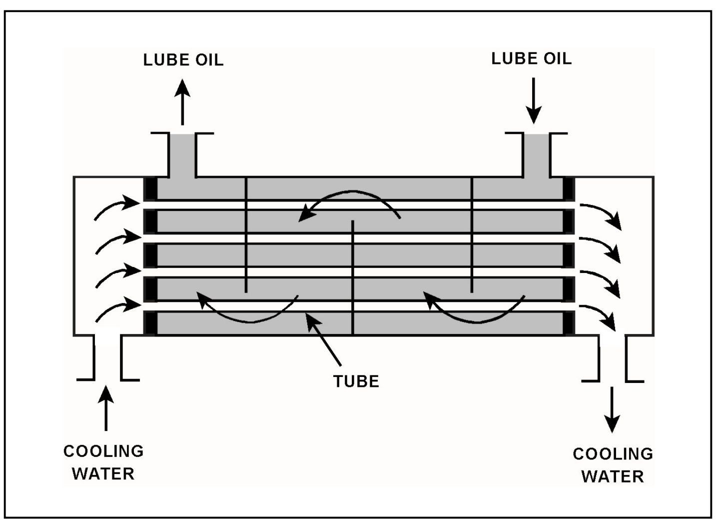
The lube oil heat exchanger is in service with the following inlet temperatures:

Lube oil inlet temperature = 110°F
Cooling water inlet temperature = 75°F

Assuming that cooling water flow rate is greater than 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.	100°F	100°F
B.	100°F	90°F
C.	90°F	100°F
D.	90°F	90°F

ANSWER: D.



TOPIC: Heat Exchangers

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

All valves are identical and are initially 50 percent open. To <u>raise</u> the temperature at point 4, the operator can adjust valve __________ in the __________ direction.

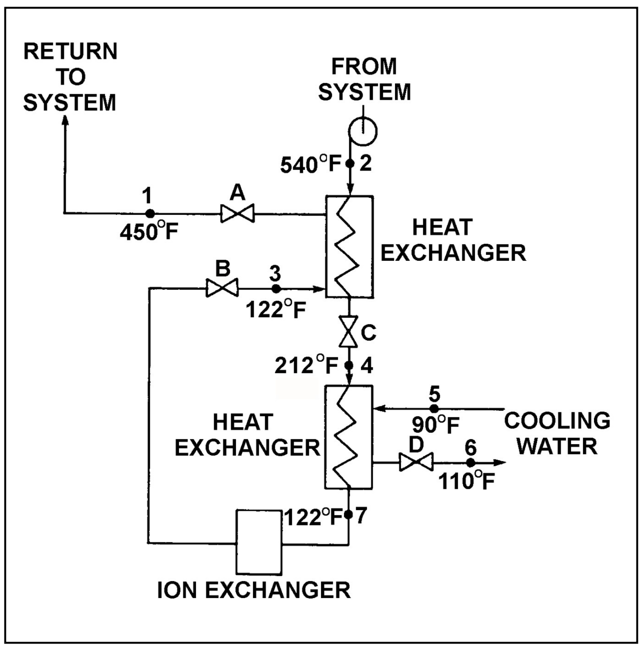
A. A; shut

B. B; shut

C. C; open

D. D; open

ANSWER: C.



TOPIC: Heat Exchangers

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

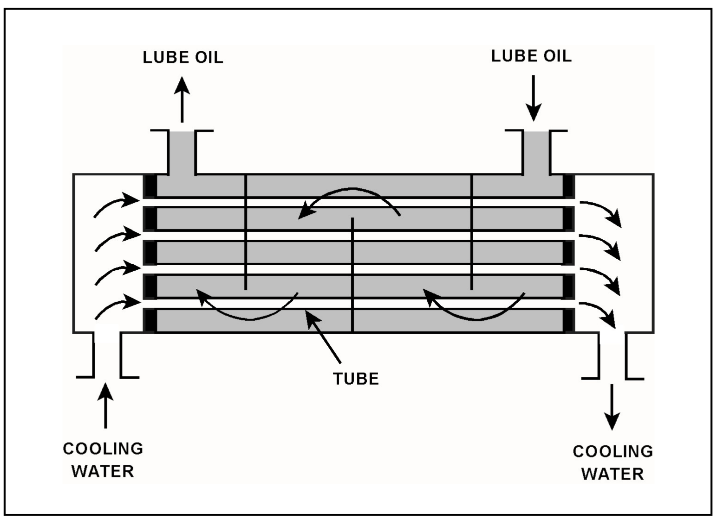
The lube oil heat exchanger is in service with the following inlet temperatures:

Lube oil inlet temperature = 130°F
Cooling water inlet temperature = 70°F

Assuming that cooling water flow rate is greater than lube oil flow rate, which one of the following pairs of heat exchanger outlet temperatures is not possible? (Assume both fluids have the same specific heat.)

	Lube Oil Outlet Temp	Cooling Water Outlet Temp
A.	90°F	86°F
B.	100°F	85°F
C.	110°F	84°F
D.	120°F	83°F

ANSWER: D.



TOPIC: Heat Exchangers

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

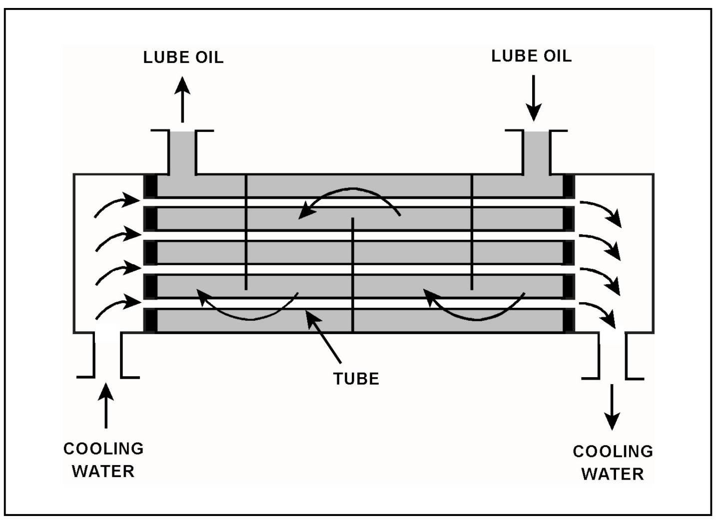
The lube oil heat exchanger is in service with the following inlet temperatures:

Lube oil inlet temperature	= 130°F
Cooling water inlet temperature	= 70°F

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.	100°F	90°F
B.	100°F	100°F
C.	110°F	90°F
D.	110°F	100°F

ANSWER: A.



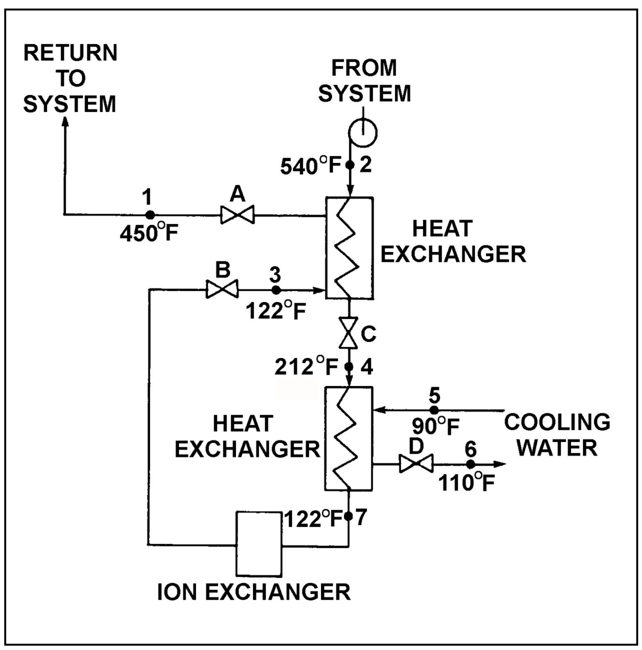
TOPIC: Heat Exchangers

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

Valves A, B, and D are fully open and valve C is 50 percent open. If valve C is opened to 100 percent, how will the temperatures at points 3 and 6 be affected?

	Point 3	Point 6
A.	Decrease	Decrease
B.	Decrease	Increase
C.	Increase	Decrease
D.	Increase	Increase

ANSWER: D.



TOPIC: Heat Exchangers

Refer to the drawing of an operating water cleanup system (see figure below). All valves are identical and are initially 50 percent open.

To raise the temperature at point 7, the operator can adjust valve _____ in the close direction.

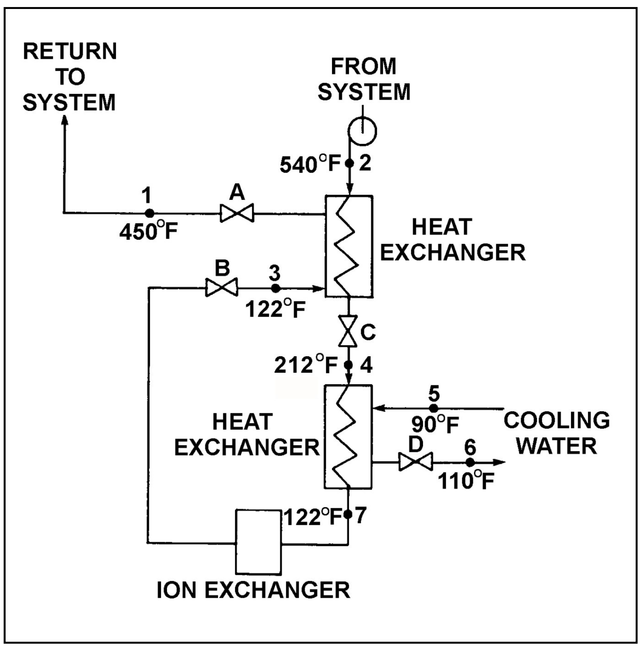
A. A

B. B

C. C

D. D

ANSWER: D.



TOPIC: Heat Exchangers

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

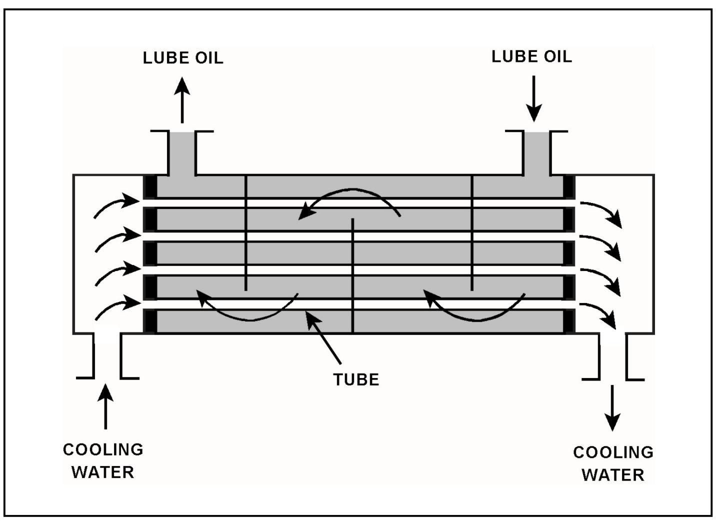
The lube oil heat exchanger is in service with the following inlet temperatures:

Lube oil inlet temperature = 130°F
Cooling water inlet temperature = 70°F

Assume that cooling water mass flow rate is less than lube oil mass flow rate, and that both fluids have the same specific heat. Which one of the following pairs of heat exchanger outlet temperatures is not possible?

Lube Oil Outlet Temp	Cooling Water Outlet Temp
A. 100°F	105°F
B. 105°F	105°F
C. 110°F	90°F
D. 115°F	90°F

ANSWER: C.



TOPIC: Heat Exchangers

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

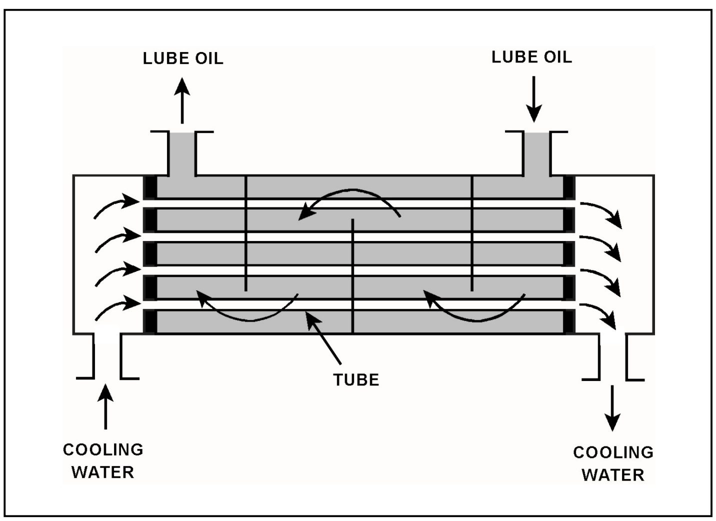
The lube oil heat exchanger is in service with the following inlet temperatures:

Lube oil inlet temperature = 120°F
Cooling water inlet temperature = 60°F

Assuming that cooling water flow rate is greater than 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.	90°F	100°F
B.	90°F	85°F
C.	95°F	100°F
D.	95°F	85°F

ANSWER: B.



TOPIC: Heat Exchangers

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

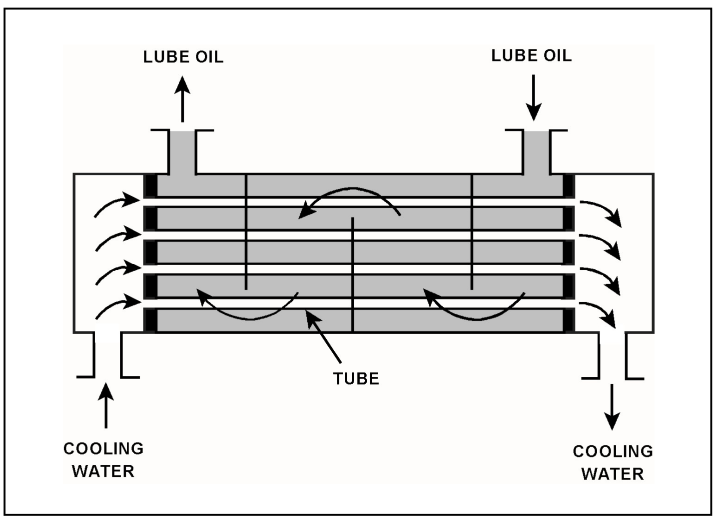
The lube oil heat exchanger is in service with the following inlet temperatures:

Lube oil inlet temperature	= 130°F
Cooling water inlet temperature	= 70°F

Given that cooling water mass flow rate is greater than lube oil mass flow rate, which one of the following pairs of heat exchanger outlet temperatures is <u>not</u> possible? (Assume both fluids have the same specific heat.)

	Lube Oil Outlet Temp	Cooling Water Outlet Temp
A.	90°F	105°F
B.	90°F	100°F
C.	110°F	95°F
D.	110°F	85°F

ANSWER: C.



TOPIC: Heat Exchangers

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

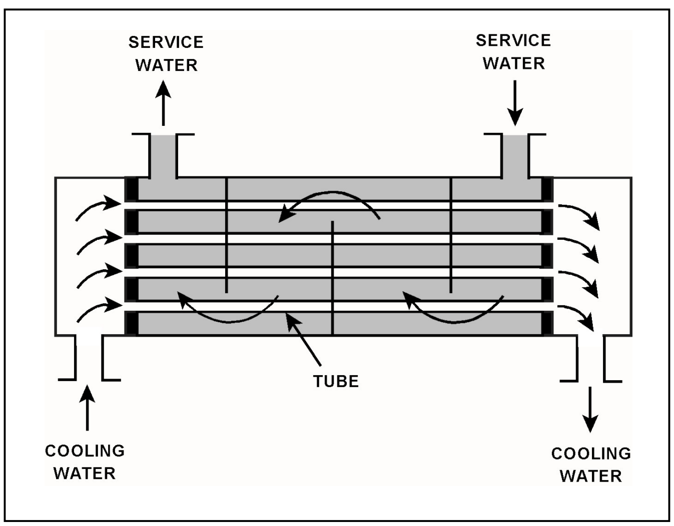
The heat exchanger is in service with the following inlet temperatures:

Service water inlet temperature = 130°F
Cooling water inlet temperature = 70°F

Assume that both fluids have the same specific heat, and that service water mass flow rate is greater than cooling water mass flow rate. Which one of the following pairs of heat exchanger outlet temperatures is possible?

	Service Water Outlet Temp.	Cooling Water Outlet Temp.
A.	120°F	82°F
B.	110°F	90°F
C.	100°F	98°F
D.	90°F	106°F

ANSWER: A.



TOPIC: Heat Exchangers

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

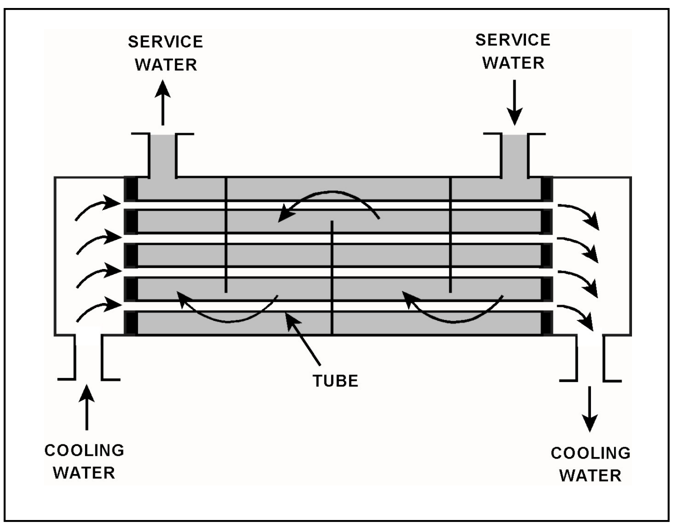
The heat exchanger is in service with the following inlet temperatures:

Cooling water inlet temperature = 70°F
Service water inlet temperature = 130°F

Assume that both fluids have the same specific heat, and that cooling water mass flow rate is greater than service water mass flow rate. Which one of the following pairs of heat exchanger outlet temperatures is <u>not</u> possible?

	Cooling Water Outlet Temp.	Service Water Outlet Temp.
A.	78°F	120°F
B.	90°F	110°F
C.	98°F	100°F
D.	100°F	90°F

ANSWER: B.



TOPIC: Heat Exchangers

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

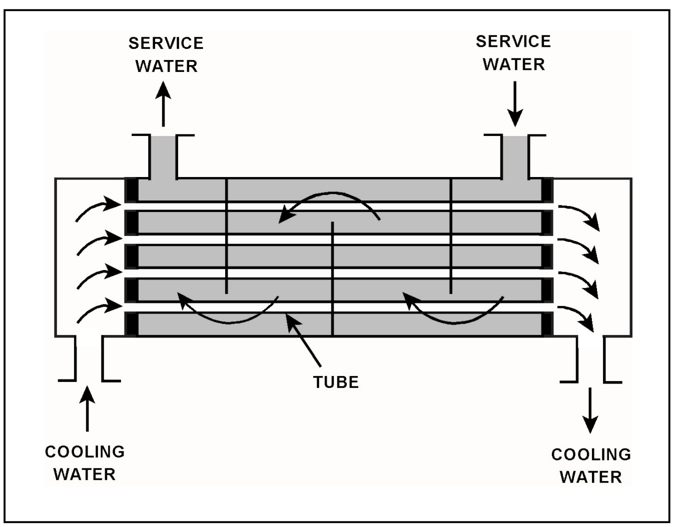
The heat exchanger is in service with the following inlet temperatures:

Service water inlet temperature = 130°F
Cooling water inlet temperature = 70°F

Assume that both fluids have the same specific heat, and that cooling water mass flow rate is greater than service water mass flow rate. Which one of the following pairs of heat exchanger outlet temperatures is possible?

	Service Water Outlet Temp.	Cooling Water Outlet Temp.
A.	120°F	90°F
B.	110°F	95°F
C.	100°F	100°F
D.	90°F	105°F

ANSWER: D.



TOPIC: Heat Exchangers

Severe stress in a mechanical component, induced by a sudden, unequally distributed temperature reduction is a description of...

A. fracture stress.

B. brittle fracture.

C. thermal shock.

D. pressurized thermal shock.

ANSWER: C.

TOPIC: Heat Exchangers

The <u>major</u> thermodynamic concern resulting from <u>rapidly</u> cooling a reactor vessel is...

A. thermal shock.

B. stress corrosion.

C. loss of shutdown margin.

D. loss of subcooling margin.

ANSWER: A.

TOPIC: Heat Exchangers

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

If scaling occurs inside the cooling water tubes, cooling water outlet temperature will __________; and lube oil outlet temperature will __________. (Assume the lube oil and cooling water flow rates do <u>not</u> change.)

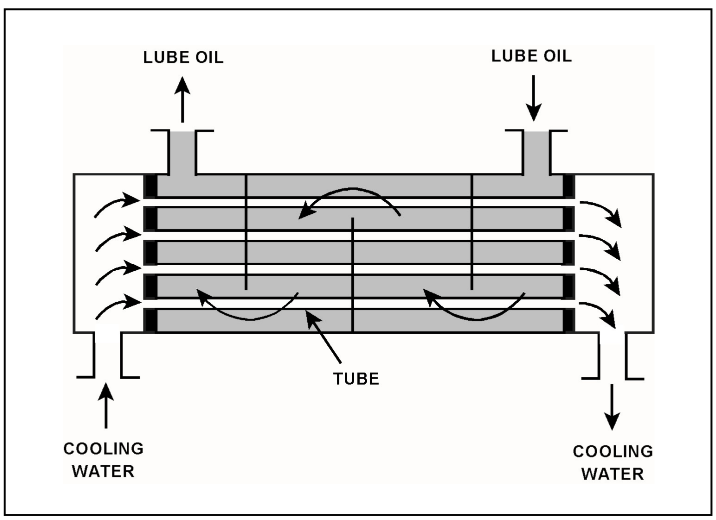
A. decrease; decrease

B. decrease; increase

C. increase; decrease

D. increase; increase

ANSWER: B.



TOPIC: Heat Exchangers

Which one of the following will occur to reduce the heat transfer rate in a parallel-flow heat exchanger as scaling increases on the exterior surface of the tubes?

A. Flow rate through the tubes will decrease.

B. Surface area of the tubes will decrease.

C. Thermal conductivity of the tubes will decrease.

D. Delta-T across the tubes will decrease.

ANSWER: C.

TOPIC: Heat Exchangers

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

If mineral deposits accumulate on the outside of the cooling water tubes, the cooling water outlet temperature will __________; and the lube oil outlet temperature will __________. (Assume the lube oil and cooling water inlet temperatures and mass flow rates do <u>not</u> change.)

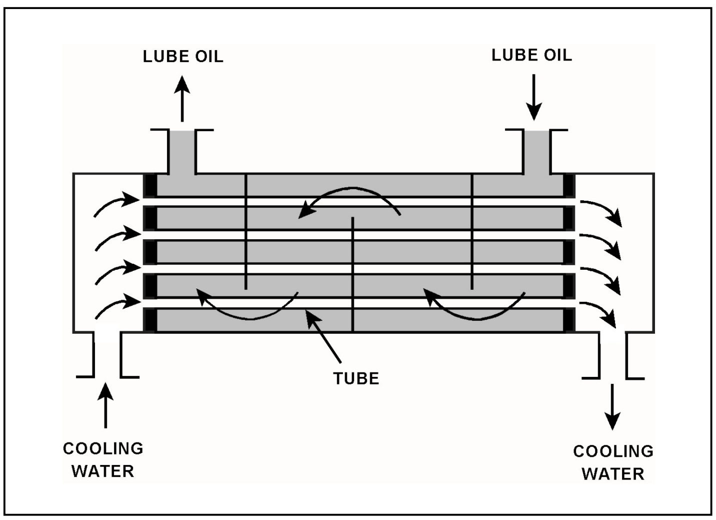
A. decrease; increase

B. decrease; decrease

C. increase; increase

D. increase; decrease

ANSWER: A.



TOPIC: Heat Exchangers

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

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

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

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

Assume the final cooling water and lube oil flow rates are the same as the initial flow rates, and 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.

ANSWER: A.

TOPIC: Heat Exchangers

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

If mineral deposits accumulate on the inside of the cooling water tubes, cooling water outlet temperature will __________; and lube oil outlet temperature will __________. (Assume the lube oil and cooling water inlet temperatures and flow rates do <u>not</u> change.)

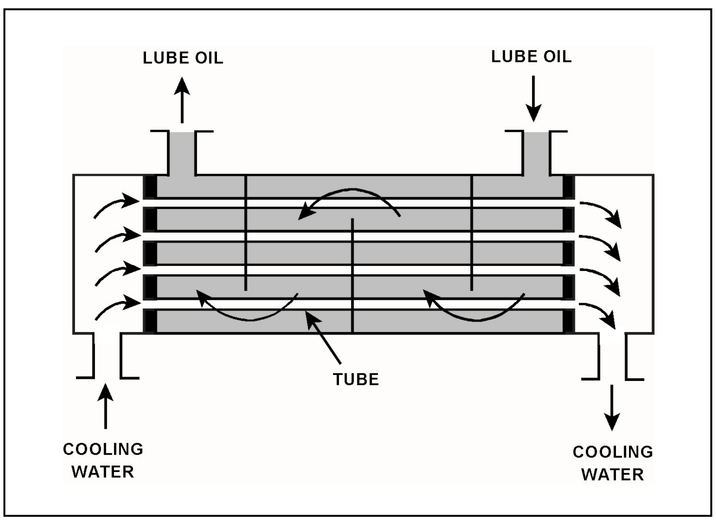
A. increase; decrease

B. increase; increase

C. decrease; decrease

D. decrease; increase

ANSWER: D.



TOPIC: Heat Exchangers

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

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

The following parameters are currently stable at their initial values:

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

Compared to their initial values, the current cooling water outlet temperature is __________; and the current cooling water mass flow rate is __________.

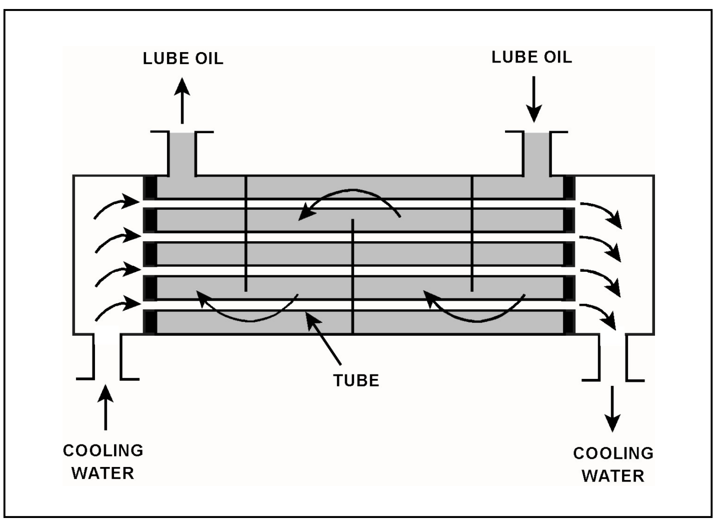
A. lower; greater

B. lower; smaller

C. higher; greater

D. higher; smaller

ANSWER: A.



TOPIC: Heat Exchangers

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

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

The following parameters are currently stable at their initial values:

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

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

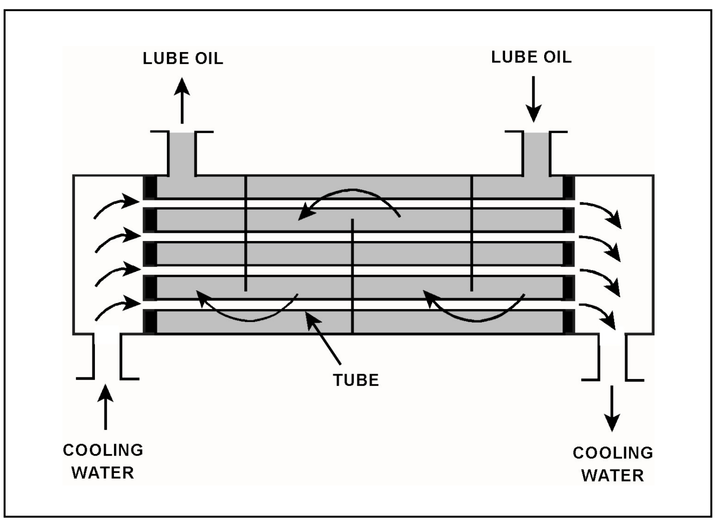
A. lower; lower

B. lower; higher

C. higher; lower

D. higher; higher

ANSWER: D.



TOPIC: Heat Exchangers

Chemically treated water is flowing through the tubes of a heat exchanger being cooled by fresh water. The shell side pressure is less than tube side pressure. What will occur as a result of a tube failure?

A. Shell side pressure will increase and the chemically treated water system will be diluted.

B. Shell side pressure will decrease and the chemically treated water inventory will be depleted.

C. Shell side pressure will increase and the chemically treated water inventory will be depleted.

D. Shell side pressure will decrease and the chemically treated water system will be diluted.

ANSWER: C.

TOPIC: Heat Exchangers

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

Which one of the following effects will occur because of the failed tube in the heat exchanger?

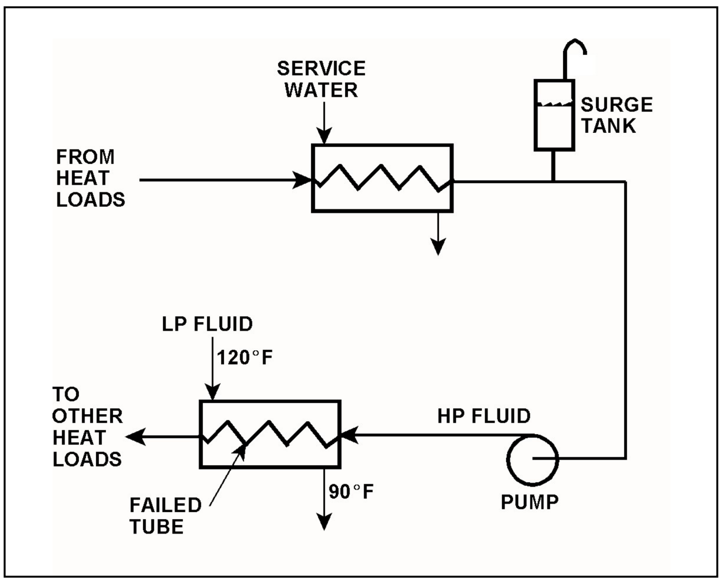
A. Level in the surge tank will increase.

B. Flow in the low pressure (LP) system will reverse.

C. Pressure in the low pressure (LP) system will decrease.

D. Low pressure (LP) fluid heat exchanger outlet temperature will decrease.

ANSWER: D.



TOPIC: Heat Exchangers

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

Which one of the following will occur as a result of the indicated tube failure in the heat exchanger? (HP = high pressure; LP = low pressure)

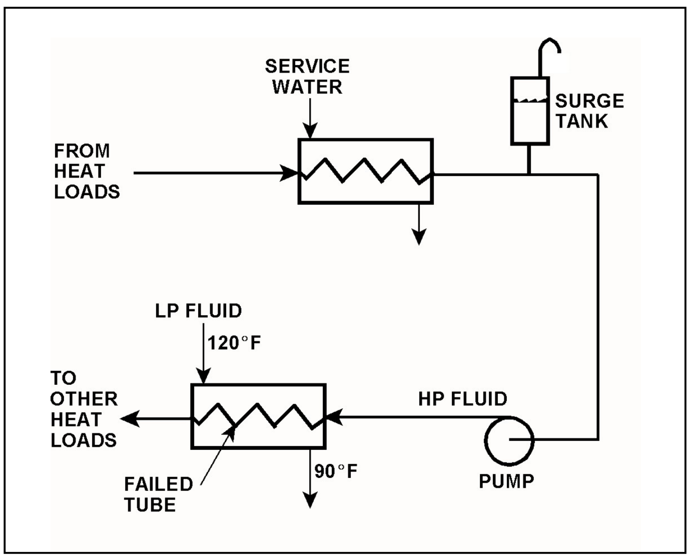
A. HP fluid inventory will increase.

B. Level in the surge tank will decrease.

C. Pressure in the LP system will decrease.

D. Temperature in the LP system will increase.

ANSWER: B.



TOPIC: Heat Exchangers

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

The heat exchanger was operating with the following initial parameters:

Cooling water inlet temperature ($T_{cw\text{-}in}$)	=	71°F
Cooling water outlet temperature ($T_{cw\text{-}out}$)	=	91°F
Oil inlet temperature ($T_{oil\text{-}in}$)	=	175°F
Oil outlet temperature ($T_{oil\text{-}out}$)	=	125°F

The heat exchanger was vented, resulting in the following current parameters:

Cooling water inlet temperature ($T_{cw\text{-}in}$)	=	71°F
Cooling water outlet temperature ($T_{cw\text{-}out}$)	=	95°F
Oil inlet temperature ($T_{oil\text{-}in}$)	=	175°F
Oil outlet temperature ($T_{oil\text{-}out}$)	=	?

Assume that the mass flow rates and specific heats of both fluids were unchanged.

Which one of the following is the <u>current</u> lube oil outlet temperature ($T_{oil\text{-}out}$)?

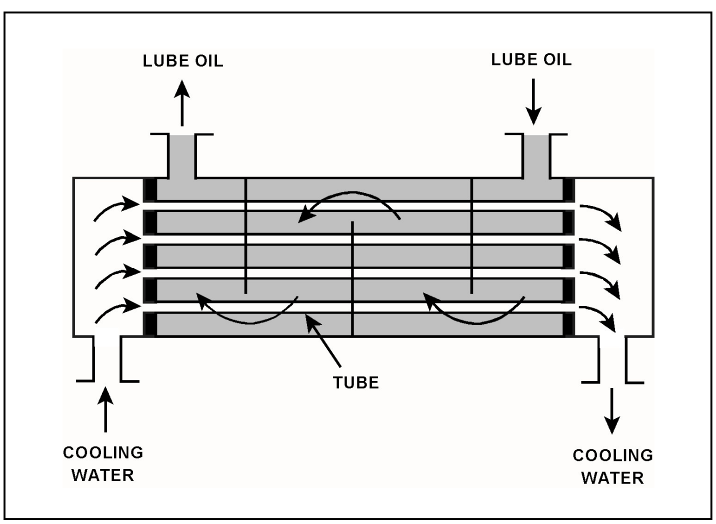
A. 115°F

B. 120°F

C. 130°F

D. 135°F

ANSWER: A.



TOPIC: Demins and Ion Exchange

A demineralizer is being used in a water purification system. How will the accumulation of suspended solids in the demineralizer affect the performance of the demineralizer?

A. The rate of resin depletion will increase.

B. The flow rate of water through the demineralizer will increase.

C. The differential pressure across the demineralizer will decrease.

D. The rate of unwanted ion removal from the system will decrease.

ANSWER: D.

TOPIC: Demins and Ion Exchange

A sudden increase in the conductivity of water at the outlet of a demineralizer may result from...

A. increased demineralizer flow rate.

B. reduced demineralizer inlet temperature.

C. increased demineralizer effluent pressure.

D. reduced demineralizer inlet conductivity.

ANSWER: A.

TOPIC: Demins and Ion Exchange

Which one of the following conditions can lead to channeling in an operating demineralizer?

A. Suspended solids forming a mat on the surface layer of the resin bed.

B. A sudden 10°F decrease in the temperature of the influent to the demineralizer.

C. Exhaustion of the resin bed due to high conductivity of the demineralizer influent.

D. Operation of the demineralizer with influent flow rate at 10 percent below design flow rate.

ANSWER: A.

TOPIC: Demins and Ion Exchange

High differential pressure in a demineralizer could be caused by all of the following <u>except</u>...

A. crud buildup.

B. high flow rate.

C. resin exhaustion.

D. resin overheating.

ANSWER: C.

TOPIC: Demins and Ion Exchange

Which one of the following is an indication of resin exhaustion in a demineralizer?

A. An increase in suspended solids in the effluent.

B. A decrease in the flow rate through the demineralizer.

C. An increase in the conductivity of the effluent.

D. An increase in the differential pressure across the demineralizer.

ANSWER: C.

TOPIC: Demins and Ion Exchange

The decontamination factor for ionic impurities 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.

ANSWER: C.

TOPIC: Demins and Ion Exchange

The ion exchange efficiency of a condensate demineralizer is determined by performing a calculation using the...

A. demineralizer inlet and outlet pH.

B. demineralizer inlet and outlet conductivity.

C. change in pH at the outlet of the demineralizer over a period of time.

D. change in conductivity at the outlet of the demineralizer over a period of time.

ANSWER: B.

TOPIC: Demins and Ion Exchange

Which one of the following is an indication that a demineralizer resin has become exhausted?

A. Decreased demineralizer process water flow rate.

B. Decreased demineralizer influent conductivity.

C. Decreased demineralizer differential pressure.

D. Decreased demineralizer decontamination factor.

ANSWER: D.

TOPIC: Demins and Ion Exchange

The ion exchange efficiency of a condensate demineralizer can be calculated using the values for demineralizer inlet and outlet...

A. conductivity.

B. pH.

C. N-16 radioactivity.

D. pressure.

ANSWER: A.

TOPIC: Demins and Ion Exchange

To determine the decontamination factor for ionic impurities of a demineralizer, the two parameters that must be monitored are inlet and outlet...

A. pH.

B. conductivity.

C. suspended solids.

D. pressure.

ANSWER: B.

TOPIC: Demins and Ion Exchange

What percentage of impurities is being removed from the water passing through an ion exchanger if the ion exchanger has a decontamination factor of 25?

A. 99 percent

B. 96 percent

C. 88 percent

D. 75 percent

ANSWER: B.

TOPIC: Demins and Ion Exchange

What percentage of ionic impurities is being removed from the water passing through an ion exchanger if the ion exchanger has a decontamination factor of 50?

A. 98 percent

B. 96 percent

C. 75 percent

D. 50 percent

ANSWER: A.

TOPIC: Demins and Ion Exchange

The decontamination factor of a condensate demineralizer has just been determined to be 50, 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. 0.4 µmho/cm

B. 1.0 µmho/cm

C. 4.0 µmho/cm

D. 10.0 µmho/cm

ANSWER: A.

TOPIC: Demins and Ion Exchange

The decontamination 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 <u>into</u> this demineralizer, which one of the following is the conductivity of the condensate at the <u>outlet</u> of the demineralizer?

A. 0.5 µmho/cm

B. 2.0 µmho/cm

C. 5.0 µmho/cm

D. 10.0 µmho/cm

ANSWER: B.

TOPIC: Demins and Ion Exchange

The decontamination factor of a demineralizer has just been determined to be 5.0, based on conductivity measurements.

If fluid having a conductivity of 20 μmho/cm is flowing <u>into</u> this demineralizer, which one of the following is the conductivity of the fluid at the <u>outlet</u> of the demineralizer?

A. 0.4 μmho/cm

B. 4.0 μmho/cm

C. 10.0 μmho/cm

D. 100.0 μmho/cm

ANSWER: B.

TOPIC: Demins and Ion Exchange

What percentage of ionic impurities is being removed from the water passing through an ion exchanger if the ion exchanger has a decontamination factor of 1.0?

A. 100 percent

B. 99 percent

C. 1 percent

D. 0 percent

ANSWER: D.

TOPIC: Demins and Ion Exchange

Two indications of channeling through an operating demineralizer are a __________-than-normal demineralizer differential pressure and a __________-than-normal decontamination factor for ionic impurities.

A. higher; lower

B. higher; higher

C. lower; lower

D. lower; higher

ANSWER: C.

TOPIC: Demins and Ion Exchange

Mixed-bed demineralizer 1A was removed from service after it became saturated with sodium (Na^+) ions while processing condensate with 10 times the normal sodium concentration. Alternate mixed-bed demineralizer 1B has restored the condensate sodium concentration to normal. Demineralizer 1A has <u>not</u> been processed in any way since being removed from service.

If demineralizer 1A is returned to service to replace demineralizer 1B, the downstream condensate system sodium concentration will...

A. remain the same, because demineralizer 1A can <u>no</u> longer remove <u>any</u> anions from the condensate.

B. remain the same, because demineralizer 1A can <u>no</u> longer remove <u>any</u> cations from the condensate.

C. increase, <u>only</u> due to the water volume contained in demineralizer 1A mixing with the condensate influent.

D. increase, due to <u>both</u> the water volume contained in demineralizer 1A mixing with the condensate influent <u>and</u> the release of sodium ions from the resin.

ANSWER: D.

TOPIC: Demins and Ion Exchange

If water containing negatively charged ionic impurities passes through a mixed-bed ion exchanger, the negatively charged ionic impurities will be removed by the __________ exchange resin, with the corresponding release of __________ ions into the water.

A. anion; negative

B. anion; positive

C. cation; negative

D. cation; positive

ANSWER: A.

TOPIC: Demins and Ion Exchange

How does demineralizer differential pressure indicate the condition of a demineralizer resin bed?

A. Low differential pressure indicates flow blockage in the demineralizer.

B. Low differential pressure indicates that the demineralizer resin bed is exhausted.

C. High differential pressure indicates flow blockage in the demineralizer.

D. High differential pressure indicates that the demineralizer resin bed is exhausted.

ANSWER: C.

TOPIC: Demins and Ion Exchange

A lower-than-expected differential pressure across a mixed-bed demineralizer is an indication of...

A. depletion of the resin.

B. channeling through the resin bed.

C. improper resin regeneration.

D. a decrease in inlet conductivity.

ANSWER: B.

TOPIC: Demins and Ion Exchange

As the operating time of a demineralizer resin bed increases, the differential pressure across the bed...

A. increases due to depletion of the resin ion exchange sites.

B. increases due to trapping of suspended solids.

C. decreases due to gradual resin breakdown.

D. decreases due to erosion of the resin ion exchange sites.

ANSWER: B.

TOPIC: Demins and Ion Exchange

Which one of the following will cause a large pressure drop across a demineralizer that is in operation?

A. Channeling of flow through the demineralizer.

B. Decrease in flow rate through the demineralizer.

C. Accumulation of suspended solids filtered by the resin beads.

D. Improper demineralizer venting after resin fill.

ANSWER: C.

TOPIC: Demins and Ion Exchange

An indication that a demineralizer resin bed is clogged is a...

A. large pressure drop across the bed.

B. high flow rate through the bed.

C. temperature rise in the effluent.

D. large conductivity increase across the bed.

ANSWER: A.

TOPIC: Demins and Ion Exchange

A higher-than-expected differential pressure across an operating demineralizer can be caused by...

A. exhaustion of the cation exchange resin.

B. channeling through the resin bed.

C. insufficient resin backwash.

D. decreased demineralizer inlet conductivity.

ANSWER: C.

TOPIC: Demins and Ion Exchange

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

	Fluid Flow Rate	Demineralizer D/P (psid)
A.	100%	23.5
B.	75%	16.5
C.	60%	8.5
D.	25%	1.5

ANSWER: B.

TOPIC: Demins and Ion Exchange

A fresh demineralizer that continuously processes water with a high concentration of suspended solids will <u>first</u> 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.

ANSWER: C.

TOPIC: Demins and Ion Exchange

A fluid demineralizer differential pressure (D/P) gauge indicates 4.0 psid at 50% flow rate. Which one of the following combinations of flow and demineralizer D/P observed at various power levels over the next few days indicates an increase in the accumulation of insoluble corrosion products in the demineralizer?

	Fluid Flow Rate	Demineralizer D/P (psid)
A.	25%	0.9
B.	60%	6.3
C.	75%	8.7
D.	100%	15.6

ANSWER: B.

TOPIC: Demins and Ion Exchange

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

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

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

ANSWER: C.

TOPIC: Demins and Ion Exchange

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

A. The resin has developed low resistance flow paths, which can decrease the decontamination factor for the demineralizer.

B. The resin has developed low resistance flow paths, which can increase the decontamination factor for the demineralizer.

C. The resin has become compacted, which can reduce the flow rate through the demineralizer and decrease the decontamination factor for the demineralizer.

D. The resin has become compacted, which can reduce the flow rate through the demineralizer and increase the decontamination factor for the demineralizer.

ANSWER: A.

TOPIC: Demins and Ion Exchange

Which one of the following, if processed through a demineralizer, will rapidly reduce the effectiveness of the demineralizer?

A. Oily water

B. Condensate

C. Makeup water

D. Radioactive water

ANSWER: A.

TOPIC: Demins and Ion Exchange

What is the reason for bypassing a demineralizer due to high temperature?

A. Resins expand and restrict flow through the demineralizer.

B. Resins decompose and restrict flow through the demineralizer.

C. Resins decompose and create preferential flowpaths through the demineralizer.

D. Resins decompose and release resin particles into the flow.

ANSWER: D.

TOPIC: Demins and Ion Exchange

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 particles may escape through the retention screens.

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

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

ANSWER: A.

TOPIC: Demins and Ion Exchange

A demineralizer that has been exposed to excessively __________ should be bypassed because the resin beads may release previously removed ions.

A. high flow rate

B. low flow rate

C. high temperature

D. low temperature

ANSWER: C.

TOPIC: Demins and Ion Exchange

A result of proper demineralizer operation on water with ionic impurities is that the exiting water will <u>always</u> have a...

A. higher pH.

B. lower pH.

C. higher conductivity.

D. lower conductivity.

ANSWER: D.

TOPIC: Demins and Ion Exchange

Demineralizer 1A was removed from service after it became saturated with chloride ions while processing fluid with 10 times the normal chloride concentration. Replacement demineralizer 1B has restored the chloride concentration to normal. Demineralizer 1A has not been processed in any way since being removed from service.

If demineralizer 1A is returned to service to replace demineralizer 1B, the downstream fluid system chloride concentration will...

A. remain the same, because demineralizer 1A resin has already been conditioned by previous operation.

B. remain the same, because demineralizer 1A resin can no longer remove chloride ions from the fluid.

C. increase, only due to the volume of water contained in demineralizer 1A mixing with the incoming fluid.

D. increase, due to both the volume of water contained in demineralizer 1A mixing with the incoming fluid and the release of chloride ions from the resin.

ANSWER: D.

TOPIC: Demins and Ion Exchange

A demineralizer should be removed from service if the demineralizer differential pressure is __________ than the established limit, or if the demineralizer decontamination factor is __________ than the established limit.

A. less; less

B. less; greater

C. greater; less

D. greater; greater

ANSWER: C.

TOPIC: Bkrs, Rlys, and Disconnects

To completely deenergize an electrical component and its associated control and indication circuits, the component breaker should be...

A. open with the control switch in Pull-To-Lock.

B. open with the control switch tagged in the open position.

C. racked out and tagged in the racked-out position.

D. racked out with control power fuses removed.

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

Which one of the following describes the normal operation of a local breaker overcurrent trip flag indicator?

A. Actuates when no lockout is present; satisfies an electrical interlock to remotely close a breaker.

B. Actuates when a breaker overcurrent trip has occurred; can be manually reset when the overcurrent condition clears.

C. Actuates when a breaker has failed to trip on an overcurrent condition; can be manually reset when the overcurrent condition clears.

D. Actuates to cause a breaker trip when the overcurrent trip setpoint is reached; can be remotely reset when the overcurrent condition clears.

ANSWER: B.

TOPIC: Bkrs, Rlys, and Disconnects

Which one of the following describes the local overcurrent trip flag indicators for a breaker?

A. They actuate prior to breaker tripping to warn of imminent protective action.

B. They indicate breaker overcurrent trip actuation during and after breaker trip actuation.

C. When actuated, they indicate that the associated breaker has failed to trip open.

D. When actuated, they indicate that the breaker overcurrent trip relay has been reset.

ANSWER: B.

TOPIC: Bkrs, Rlys, and Disconnects

Loss of breaker control power will cause...

A. breaker line voltage to indicate zero regardless of actual breaker position.

B. the remote breaker position to indicate open regardless of actual breaker position.

C. inability to operate the breaker locally and remotely.

D. failure of the closing spring to charge following local closing of the breaker.

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

Which one of the following will result from a loss of control power to a motor supply breaker?

A. The motor ammeter indication will be zero regardless of actual breaker position.

B. The breaker position will remotely indicate closed regardless of actual position.

C. The breaker will <u>trip</u> open due to the actuation of its protective trip device.

D. The charging motor will <u>not</u> recharge the closing spring after the breaker closes.

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

Which one of the following will cause a loss of ability to remotely open a breaker and a loss of remote breaker position indication?

A. Failure of the breaker control switch.

B. Racking the breaker to the TEST position.

C. Mechanical binding of the breaker tripping bar.

D. Loss of control power for the breaker.

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

Which one of the following will cause a loss of indication from the remote breaker position indicating lights associated with a typical 480 VAC load supply breaker?

A. Locally opening the breaker.

B. Loss of breaker line voltage.

C. Removing the breaker control power fuses.

D. Burnout of the local breaker position indicating lights.

ANSWER: C.

TOPIC: Bkrs, Rlys, and Disconnects

How is typical breaker operation affected when the associated breaker control power transfer switch is placed in the LOCAL position?

A. Control power will be available to provide protective trips, and the breaker can be electrically operated only from the control room.

B. Control power will be removed from both the open and close circuits, and the breaker can be electrically operated only from the control room.

C. Control power will be available to provide protective trips, and the breaker can be electrically operated only from the breaker cabinet.

D. Control power will be removed from both the open and close circuits, and the breaker can be electrically operated only from the breaker cabinet.

ANSWER: C.

TOPIC: Bkrs, Rlys, and Disconnects

A typical 120 VAC manual circuit breaker tripped due to overload. To close this circuit breaker, the handle must be moved from the...

A. OFF position directly to the ON position; trip latch reset is not required.

B. midposition directly to the ON position; trip latch reset is not required.

C. OFF position to the midposition to reset the trip latch, and then to the ON position.

D. midposition to the OFF position to reset the trip latch, and then to the ON position.

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

Two identical 1,000 MW generators are operating in parallel, supplying the same isolated electrical bus. The generator output breakers provide identical protection for the generators. Generator A and B output indications are as follows:

Generator A	Generator B
22.5 KV	22.5 KV
60.2 Hertz	60.2 Hertz
750 MW	750 MW
25 MVAR (out)	50 MVAR (out)

A malfunction causes the voltage regulator setpoint for generator B to slowly and continuously increase. If no operator action is taken, which one of the following describes the electrical current indications for generator A?

A. Current will decrease continuously until the output breaker for generator A trips on reverse power.

B. Current will decrease continuously until the output breaker for generator B trips on reverse power.

C. Current will initially decrease, and then increase until the output breaker for generator A trips on overcurrent.

D. Current will initially decrease, and then increase until the output breaker for generator B trips on overcurrent.

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

Two identical 1,000 MW generators are operating in parallel, supplying all the loads on an isolated electrical bus. The generator output breakers provide identical protection for the generators. Generator A and B output indications are as follows:

Generator A	Generator B
28 KV	28 KV
60 Hertz	60 Hertz
150 MW	100 MW
25 MVAR (out)	50 MVAR (out)

A malfunction causes the voltage regulator setpoint for generator B to slowly and continuously decrease. If no operator action is taken, the electrical current indication for generator B will...

A. initially decrease, and then increase until the output breaker for generator A trips on overcurrent.

B. initially decrease, and then increase until the output breaker for generator B trips on overcurrent.

C. decrease continuously until the output breaker for generator A trips on overcurrent.

D. decrease continuously until the output breaker for generator B trips on reverse power.

ANSWER: A.

TOPIC: Bkrs, Rlys, and Disconnects

Two identical 1,000 MW generators are operating in parallel supplying the same isolated electrical bus. The generator output breakers also provide identical protection for the generators. Generator A and B output indications are as follows:

Generator A	Generator B
22 KV	22 KV
60.2 Hertz	60.2 Hertz
200 MW	200 MW
25 MVAR (out)	50 MVAR (out)

A malfunction causes the voltage regulator setpoint for generator A to slowly and continuously increase. If no operator action is taken, generator B output current will...

A. initially decrease, and then increase until the output breaker for generator A trips on overcurrent.

B. initially decrease, and then increase until the output breaker for generator B trips on overcurrent.

C. increase continuously until the output breaker for generator A trips on overcurrent.

D. increase continuously until the output breaker for generator B trips on overcurrent.

ANSWER: A.

TOPIC: Bkrs, Rlys, and Disconnects

Two identical 1,000 MW electrical generators are operating in parallel supplying the same isolated electrical bus. The generator output breakers provide identical protection for the generators. Generator A and B output indications are as follows:

Generator A	Generator B
22 KV	22 KV
60.2 Hertz	60.2 Hertz
200 MW	200 MW
25 MVAR (out)	50 MVAR (out)

A malfunction causes the voltage regulator setpoint for generator A to slowly and continuously decrease. If no operator action is taken, generator B output current will increase until...

A. the output breaker for generator A trips on overcurrent.

B. the output breaker for generator B trips on overcurrent.

C. the output breaker for generator A trips on reverse power.

D. the output breaker for generator B trips on reverse power.

ANSWER: B.

TOPIC: Bkrs, Rlys, and Disconnects

Two identical 1,000 MW generators are operating in parallel supplying the same isolated electrical bus. The generator output breakers provide identical protection for the generators. Generator A and B output indications are as follows:

Generator A	Generator B
22 KV	22 KV
60.2 Hertz	60.2 Hertz
200 MW	200 MW
25 MVAR (out)	50 MVAR (out)

A malfunction causes the voltage regulator setpoint for generator B to slowly and continuously increase. If no operator action is taken, generator A output current will...

A. increase continuously until the output breaker for generator A trips on overcurrent.

B. decrease continuously until the output breaker for generator B trips on overcurrent.

C. initially decrease, and then increase until the output breaker for generator A trips on overcurrent.

D. initially decrease, and then increase until the output breaker for generator B trips on overcurrent.

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

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

What is the purpose of depressing the S1 pushbutton?

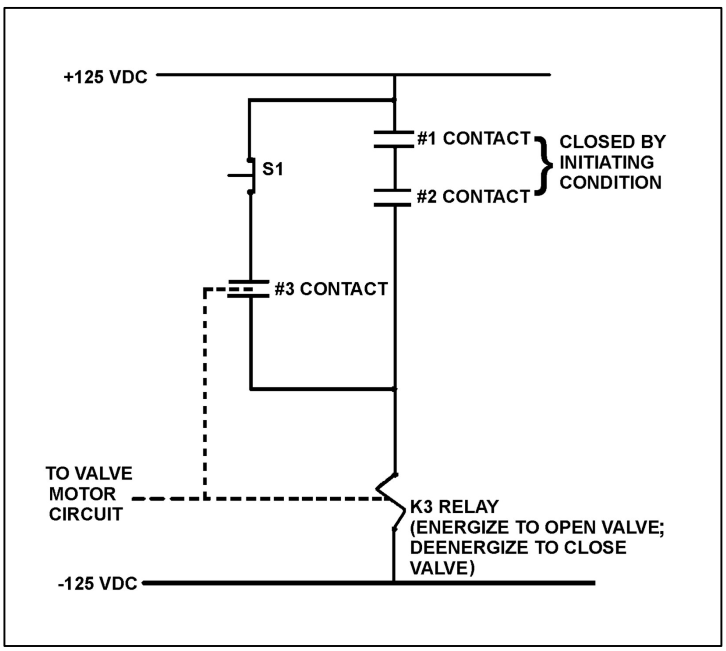
A. To deenergize the K3 relay after the initiating condition has cleared.

B. To prevent energizing the K3 relay when the initiating condition occurs.

C. To manually energize the K3 relay in the absence of the initiating condition.

D. To maintain the K3 relay energized after the initiating condition has cleared.

ANSWER: A.



TOPIC: Bkrs, Rlys, and Disconnects

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

One purpose of the K3 relay is to...

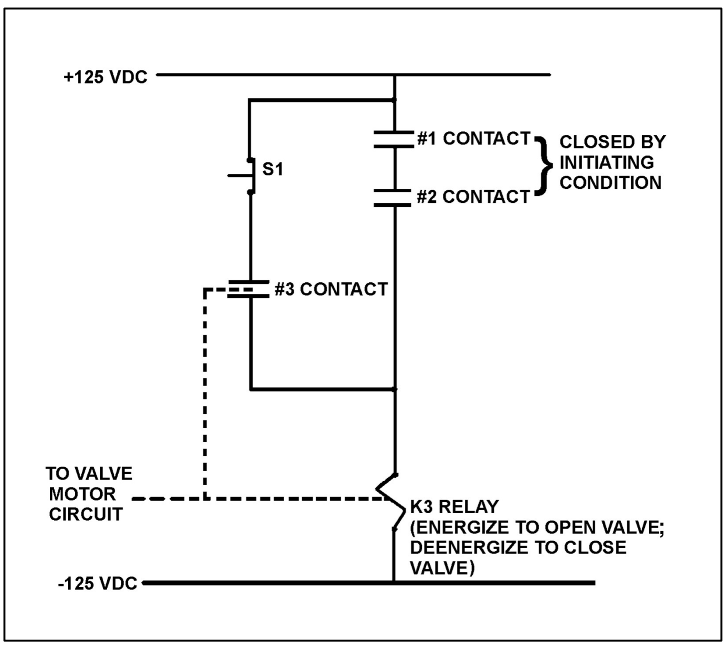
A. hold the valve open after one or both initiating conditions have cleared, even if the reset pushbutton (S1) is depressed.

B. hold the valve open even if one or both initiating conditions have cleared.

C. close the valve as soon as either initiating condition has cleared.

D. close the valve as soon as both initiating conditions have cleared.

ANSWER: B.



TOPIC: Bkrs, Rlys, and Disconnects

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

The valve is currently open with the contact configuration as shown. If the S1 pushbutton is depressed, the valve will __________; and when the S1 pushbutton is subsequently released, the valve will __________.

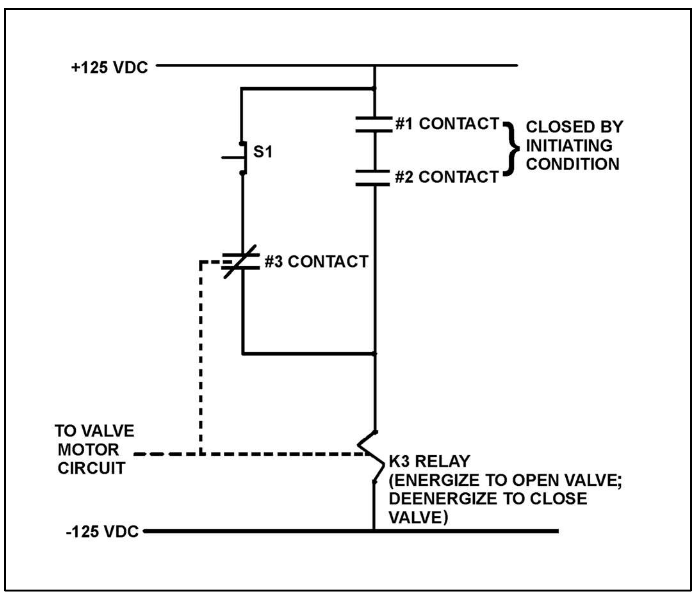
A. remain open; remain open

B. close; remain closed

C. remain open; close

D. close; open

ANSWER: B.



TOPIC: Bkrs, Rlys, and Disconnects

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

Which one of the following describes the function of the #3 contact?

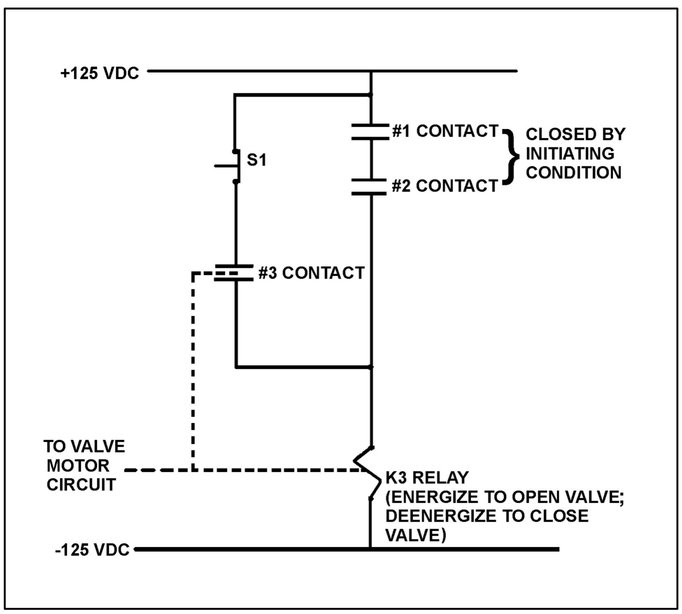
A. To keep the K3 relay energized after the initiating condition clears.

B. To provide a method for manually energizing the K3 relay.

C. To increase circuit reliability because any one of the three contacts can energize the K3 relay.

D. To ensure the K3 relay can always be deenergized even with the initiating condition present.

ANSWER: A.



TOPIC: Bkrs, Rlys, and Disconnects

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

The initiating condition occurs and closes the #1 and #2 contacts to energize the K3 relay and open the valve. Which one of the following will close the valve?

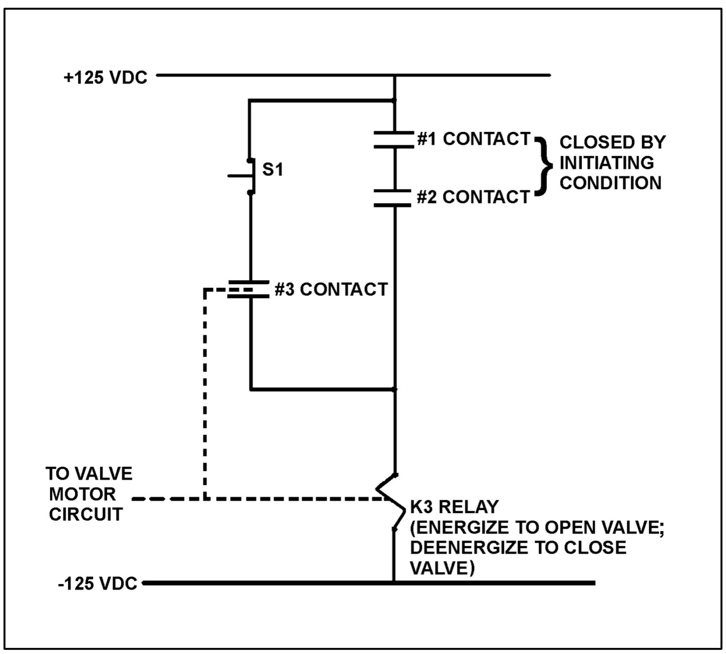
A. Loss of 125 VDC.

B. Both #1 and #2 contacts open.

C. Either #1 or #2 contact opens.

D. Depressing the S1 pushbutton with the initiating condition present.

ANSWER: A.



TOPIC: Bkrs, Rlys, and Disconnects

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

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

If the valve is currently closed, when will the alarm actuate?

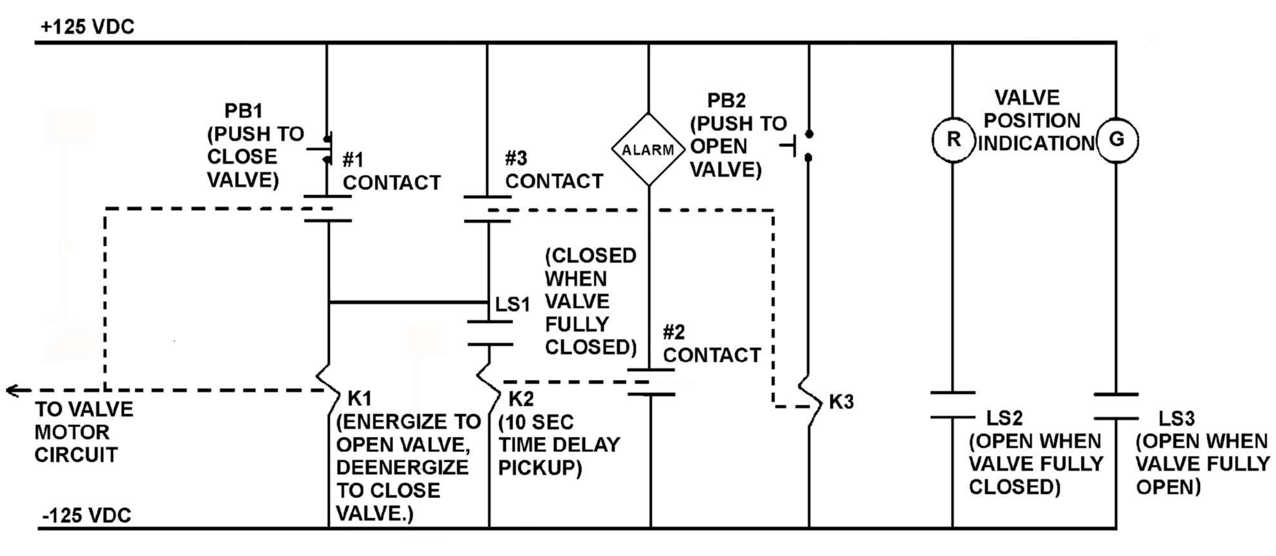
A. As soon as PB2 is pushed.

B. Ten seconds after PB2 is pushed if the valve is still closed.

C. Immediately upon pushing PB2 and for the next 10 seconds if the valve remains closed.

D. Ten seconds after PB2 is pushed if the valve is still stroking open.

ANSWER: B.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

Refer to the drawing of a valve motor control circuit for a valve that is currently fully closed (see figure below).

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

Which one of the following describes when the motor-operated valve will begin to stroke open?

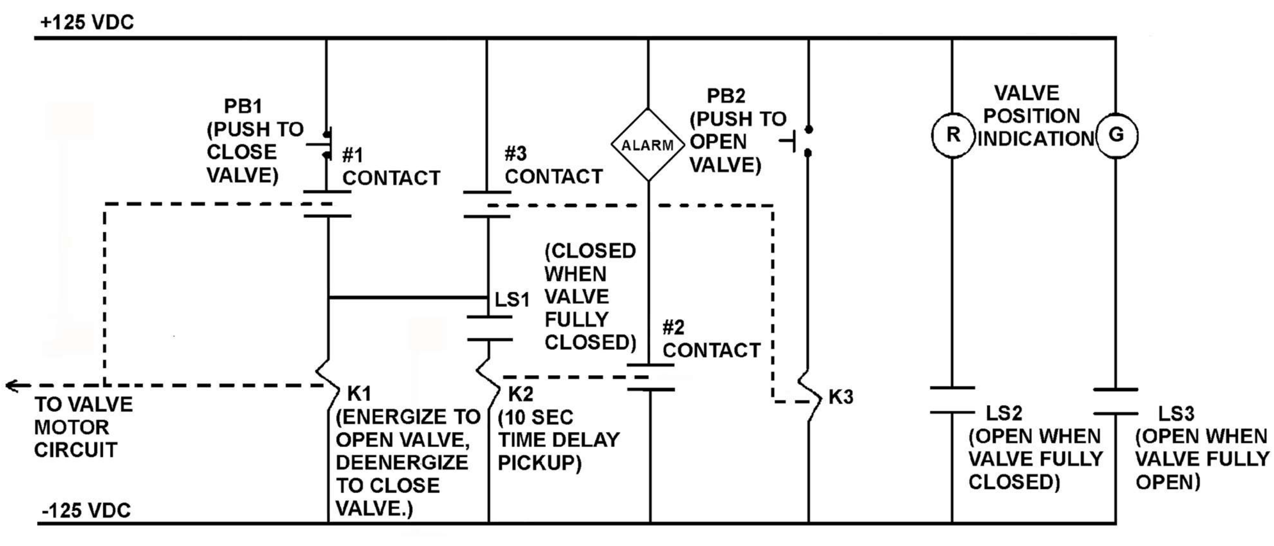
A. At the same time the alarm actuates.

B. 10 seconds after PB2 is depressed.

C. Immediately after PB2 is depressed.

D. Immediately after PB1 is depressed if contact #1 is closed.

ANSWER: C.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

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

Pushbutton PB2 was depressed to open the valve, and the current contact and 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?

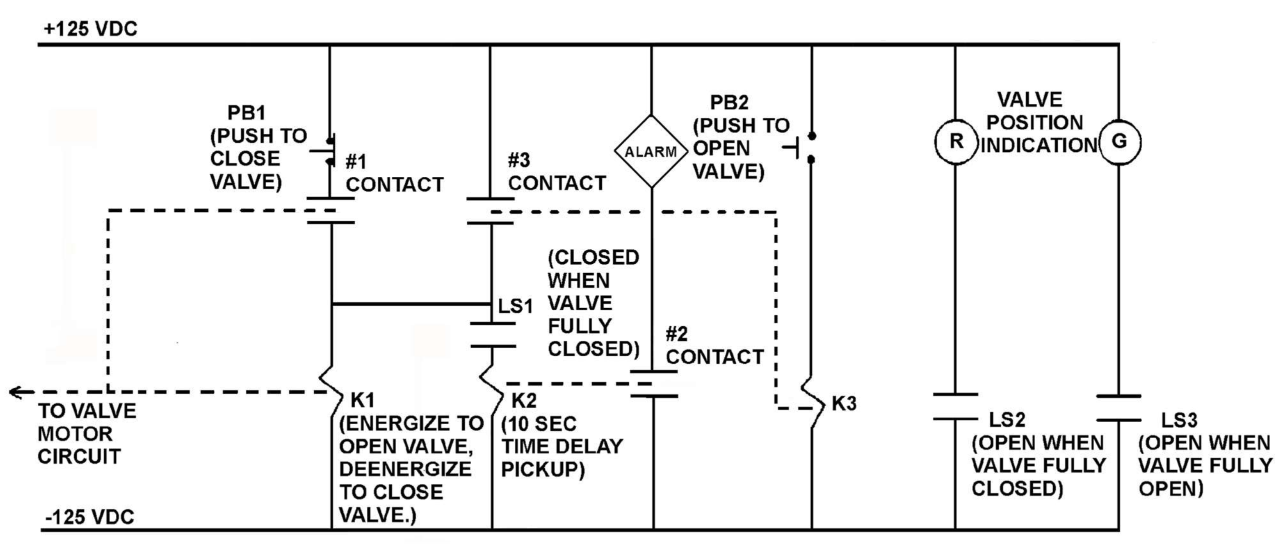
A. The valve is closed and the valve motor circuit has just been energized to open the valve.

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 because PB2 was prematurely released.

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

ANSWER: B.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

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

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

Which one of the following describes the purpose of the alarm?

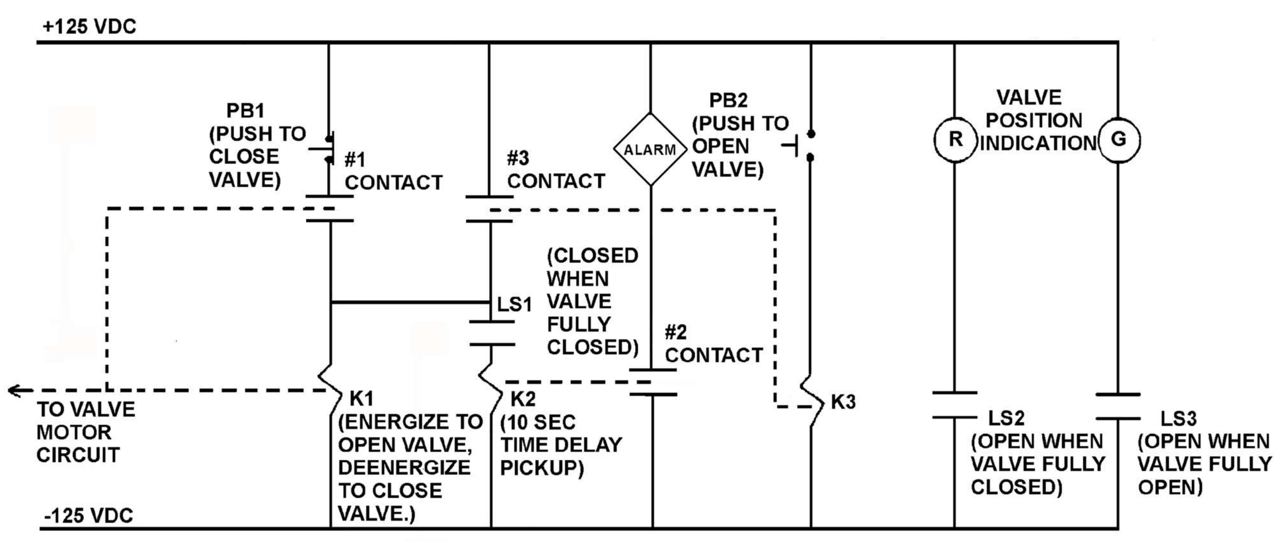
A. Alert the operator when the valve motor circuit has been energized for 10 seconds after pushbutton PB2 is depressed.

B. Alert the operator when the valve has not moved off its closed seat within 10 seconds of depressing pushbutton PB2.

C. Alert the operator that the valve is opening by sounding the alarm for 10 seconds after PB2 is depressed.

D. Alert the operator if the valve has not reached full open within 10 seconds of depressing pushbutton PB2.

ANSWER: B.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

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

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

The valve is half open and moving to the open position. Which one of the following describes the current condition of the valve position indicating lights?

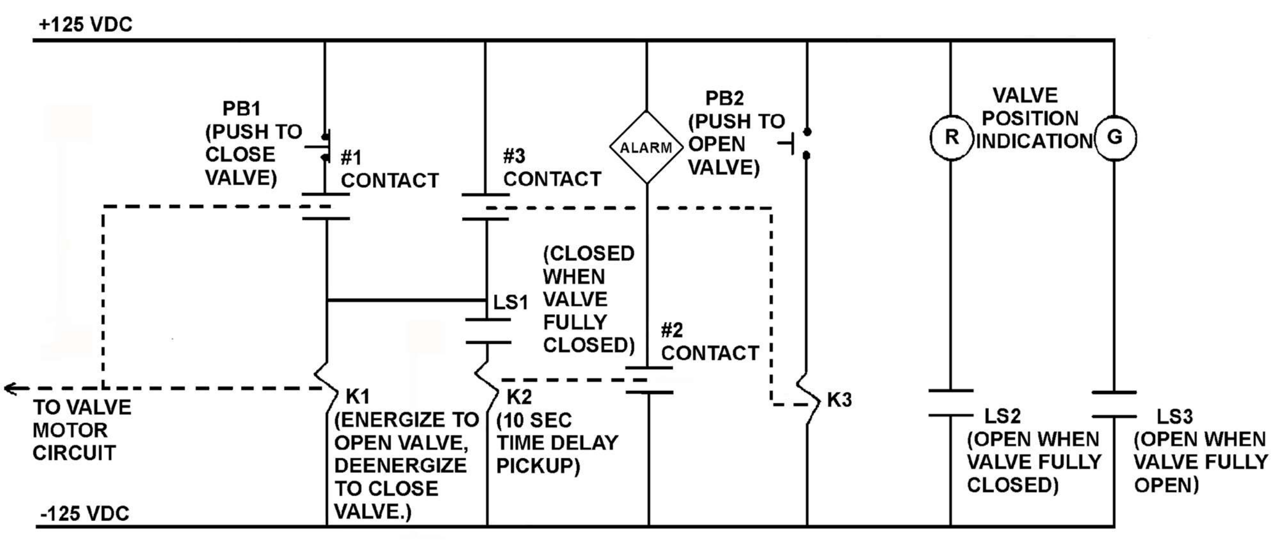
A. Red light on, green light on

B. Red light on, green light off

C. Red light off, green light on

D. Red light off, green light off

ANSWER: A.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

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

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

Pushbutton PB2 has been momentarily depressed and then released, and the valve is currently at mid-stroke and moving to the open position. Under these conditions, which one of the following describes the position of contacts #1, #2, and #3?

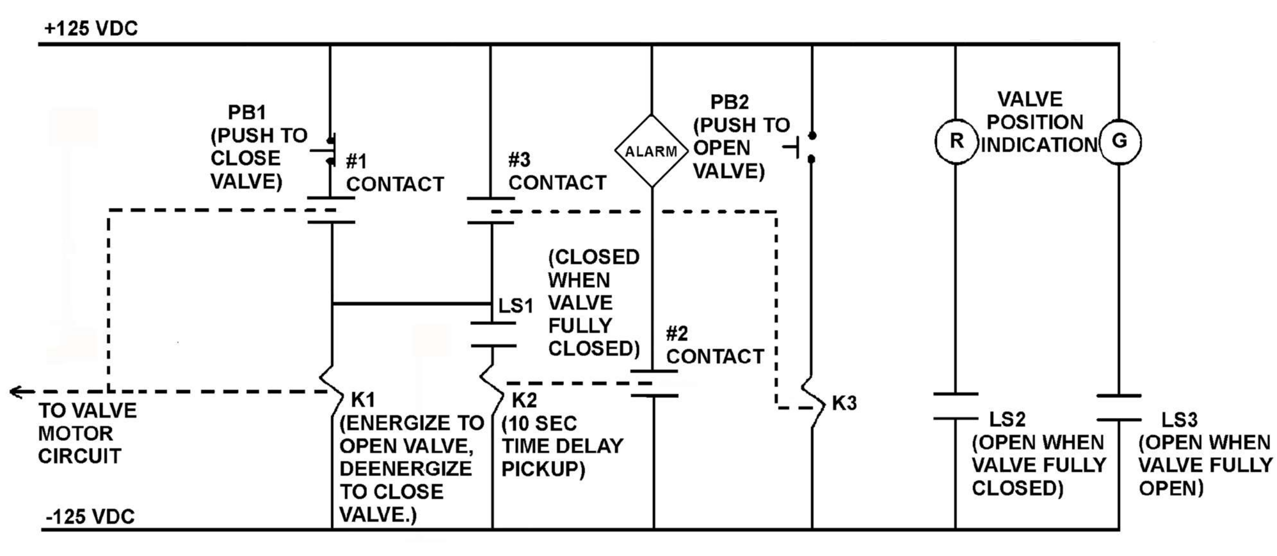
A. #1 closed; #2 open; #3 open

B. #1 open; #2 closed; #3 closed

C. #1 open; #2 closed; #3 open

D. #1 closed; #2 open; #3 closed

ANSWER: A.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

Refer to the drawing of a valve motor control circuit (see figure below) for a valve that is currently fully open and has a 10-second stroke time.

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

Which one of the following describes the valve response if the control switch is taken to the CLOSE position for two seconds and then released?

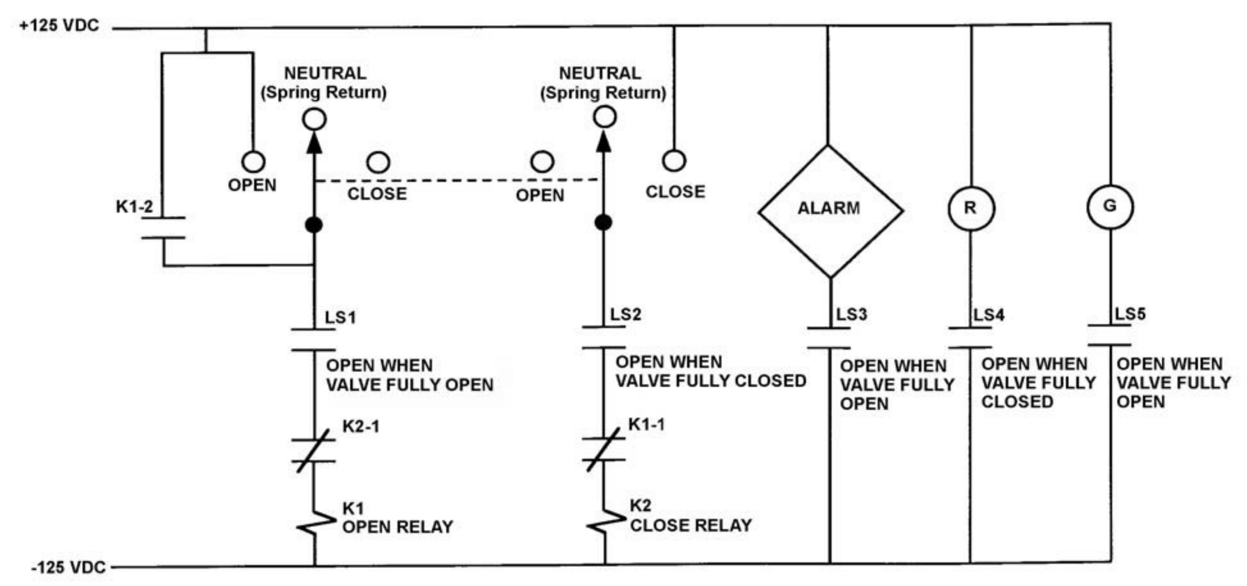
A. The valve will <u>not</u> move.

B. The valve will close fully.

C. The valve will begin to close and then stop moving.

D. The valve will begin to close and then open fully.

ANSWER: C.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

Refer to the drawing of a valve motor control circuit (see figure below) for a valve that is currently fully closed and has a 10-second stroke time.

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

Which one of the following describes the valve response if the control switch is taken to the OPEN position for two seconds and then released?

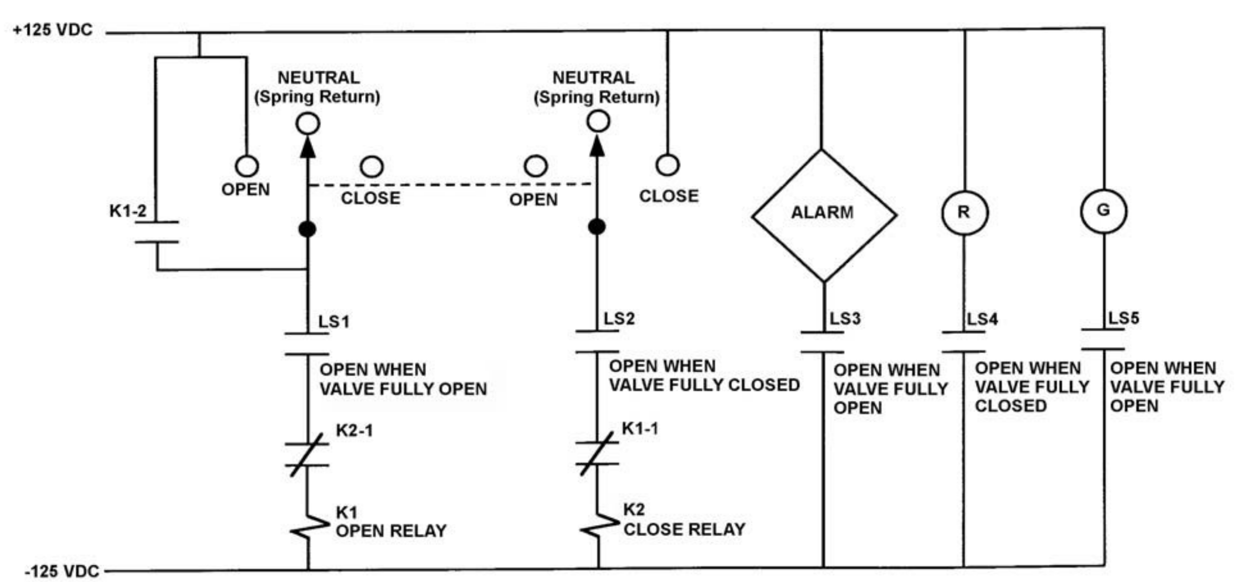
A. The valve will <u>not</u> move.

B. The valve will open fully.

C. The valve will begin to open and then stop moving.

D. The valve will begin to open and then close fully.

ANSWER: B.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

Refer to the drawing of a valve motor control circuit (see figure below) for a valve that is currently fully open and has a 10-second stroke time. Limit switch LS2 has failed open.

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

Which one of the following describes the valve response if the control switch is taken to the CLOSE position for 2 seconds and then released?

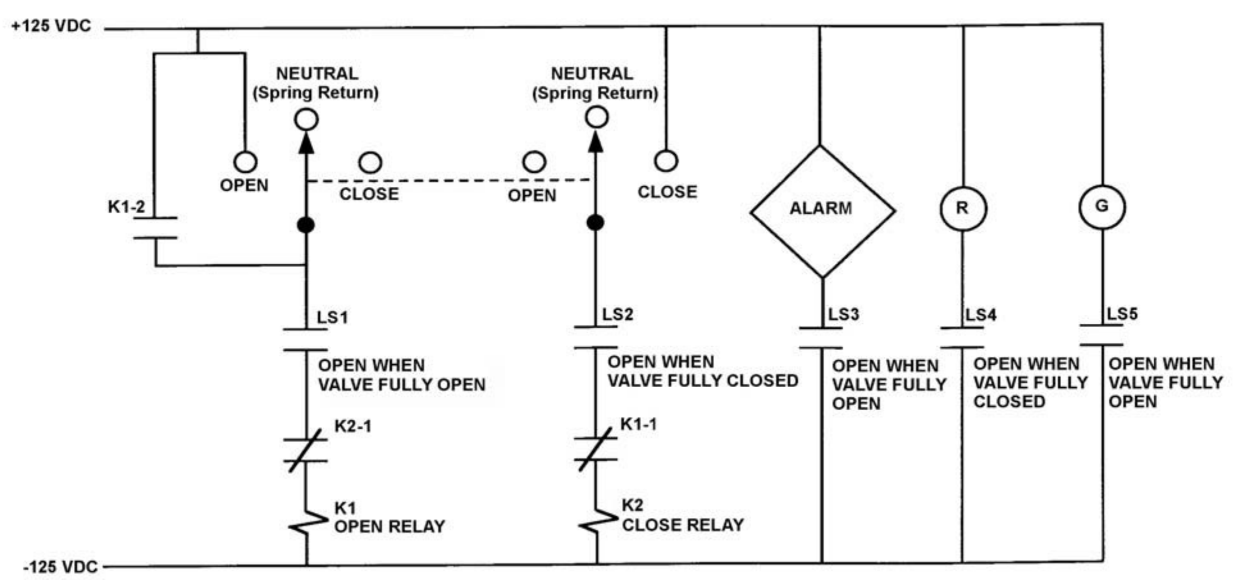
A. The valve will <u>not</u> move.

B. The valve will close fully.

C. The valve will begin to close and then stop moving.

D. The valve will begin to close and then open fully.

ANSWER: A.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

Refer to the drawing of a valve motor control circuit (see figure below) for a valve that is currently fully closed and has a 10-second stroke time.

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

The operator takes the control switch to OPEN momentarily and the valve begins to open. Five seconds later, the operator takes the switch to CLOSE momentarily and then releases the switch. Which one of the following describes the valve response after the switch is released?

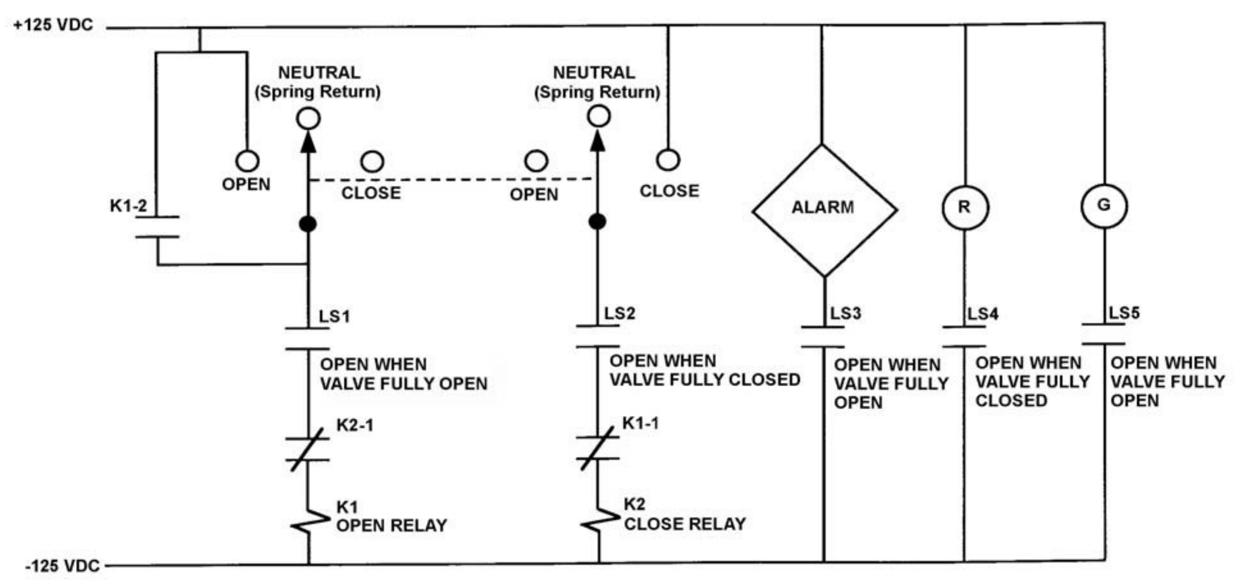
A. The valve will stop opening and remain partially open.

B. The valve will stop opening and then go fully closed.

C. The valve will open fully and remain fully open.

D. The valve will open fully and then go fully closed.

ANSWER: C.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

Refer to the drawing of a valve motor control circuit (see figure below) for a valve that is currently fully closed and has a 10-second stroke time.

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

An operator takes the control switch to OPEN momentarily and the valve begins to open. Five seconds later, the operator places and holds the switch in the CLOSE position. Which one of the following describes the valve response with the switch held in the CLOSE position?

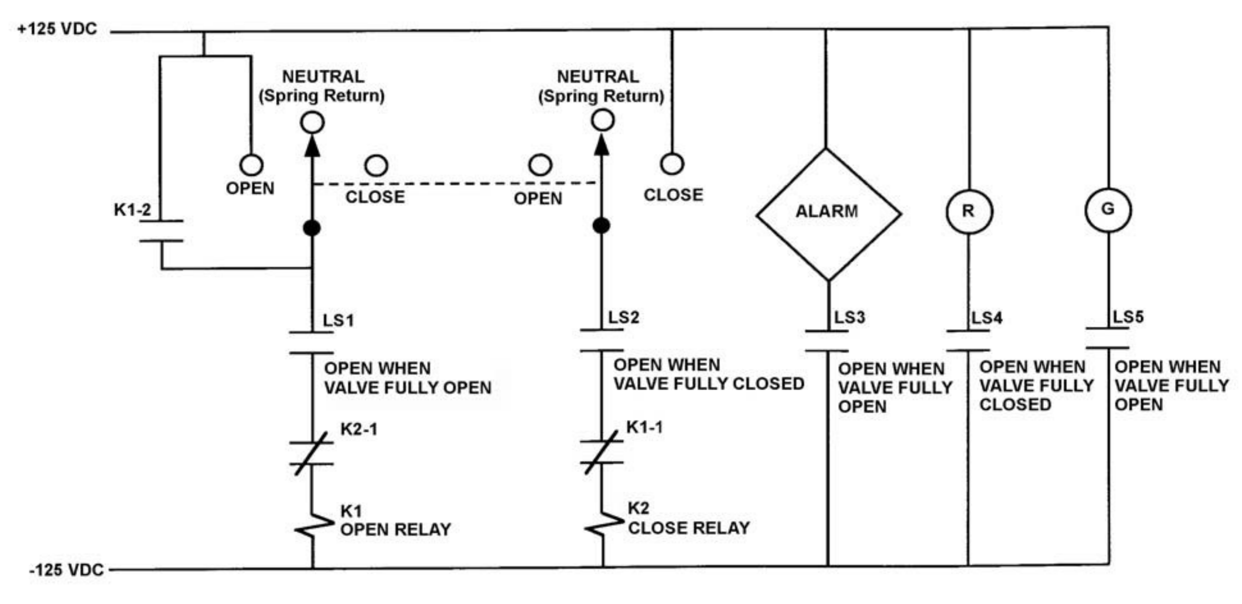
A. The valve will stop opening and remain partially open.

B. The valve will stop opening and then go fully closed.

C. The valve will open fully and remain fully open.

D. The valve will open fully and then go fully closed.

ANSWER: D.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

Refer to the drawing of a valve motor control circuit (see figure below) for a valve that is currently fully closed and has a 10-second stroke time.

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

An operator takes the control switch to OPEN. Two seconds later, after verifying the valve is opening, the operator releases the control switch. Which one of the following describes the valve motor control circuit alarm response after the switch is released?

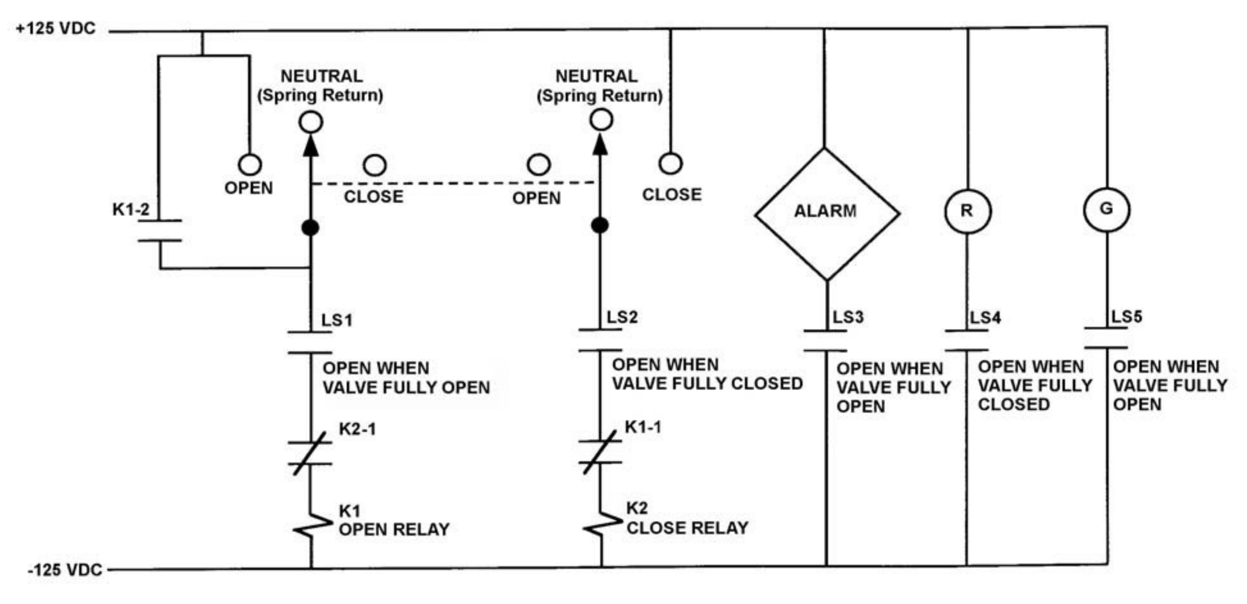
A. The alarm will continue to actuate for approximately 8 seconds.

B. The alarm will continue to actuate until additional operator action is taken.

C. The alarm will actuate after approximately 8 seconds.

D. The alarm will <u>not</u> actuate until additional operator action is taken.

ANSWER: A.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

Refer to the drawing of a motor and its control circuit (see figure below).

Note: Relay contacts are shown open/closed according to the standard convention for control circuit drawings.

What is the purpose of the Time Delay Coil (TD) in the motor controller circuit?

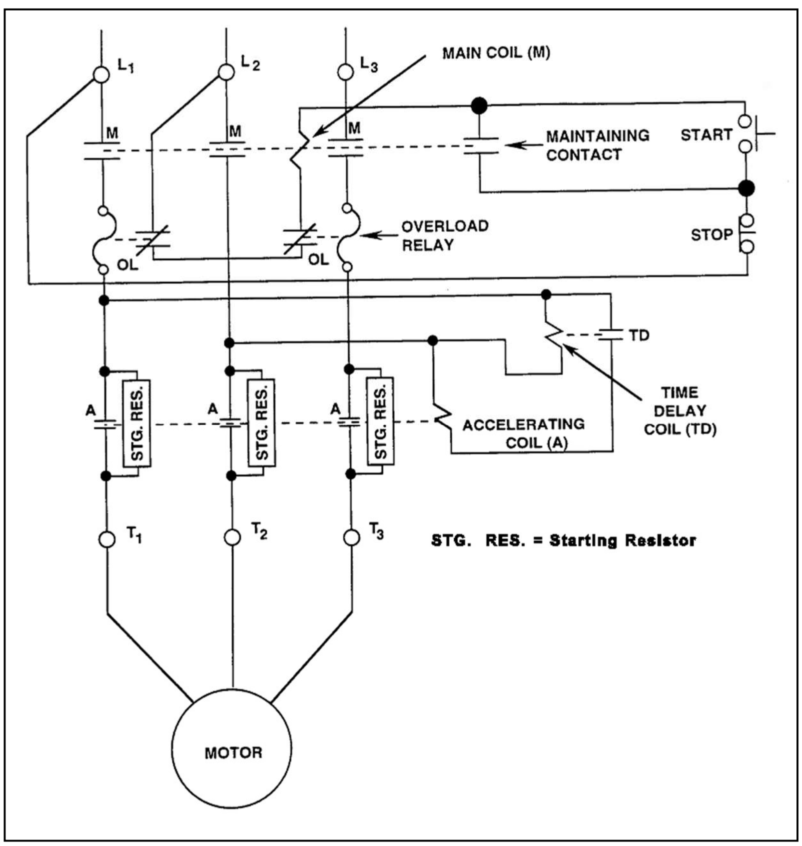
A. Ensures the motor cannot be started until the overload relays are reset.

B. Ensures the motor cannot be started until the accelerating coil is energized.

C. Allows the motor to come up to speed before bypassing the starting resistors.

D. Allows the motor to come up to speed before placing the starting resistors in the circuit.

ANSWER: C.



TOPIC: Bkrs, Rlys, and Disconnects

Refer to the drawing of a motor and its control circuit (see figure below).

Note: Relay contacts are shown open/closed according to the standard convention for control circuit drawings.

The motor receives overload protection from __________ overload relays; and __________ overload relay(s) must actuate to deenergize the motor.

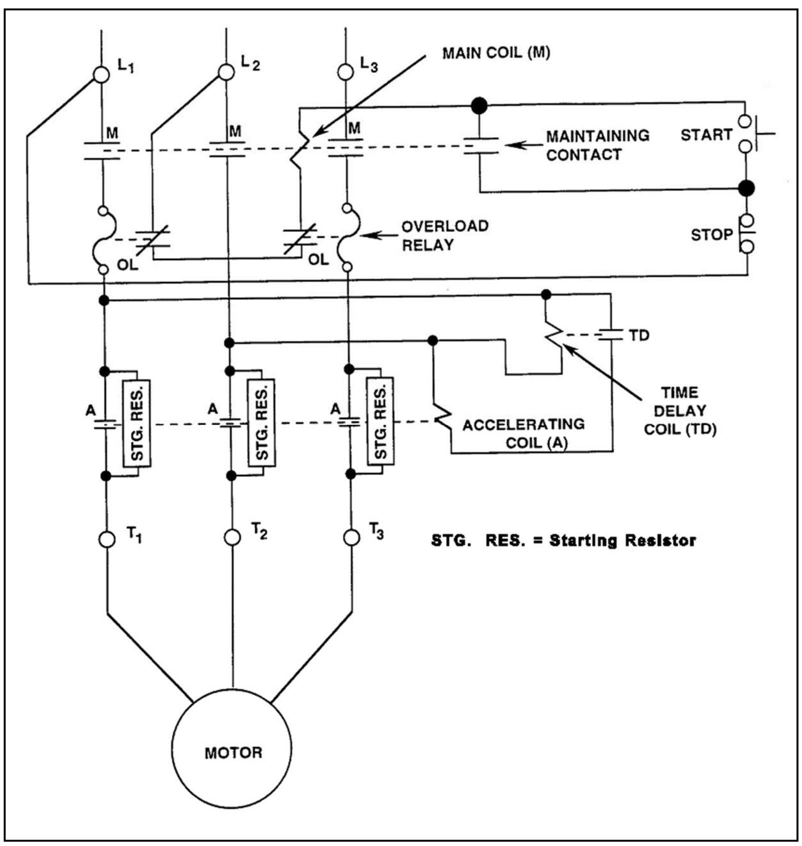
A. two; one

B. two; two

C. three; one

D. three; two

ANSWER: A.



TOPIC: Bkrs, Rlys, and Disconnects

Refer to the drawing of a valve motor control circuit (see figure below) for a valve that is currently fully closed and has a 10-second stroke time.

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

The operator takes the control switch to OPEN for 5 seconds and then releases the switch. After one minute, the operator takes the control switch to CLOSE for 5 seconds and then releases the switch. Which one of the following describes the valve position immediately after the control switch is released the second time?

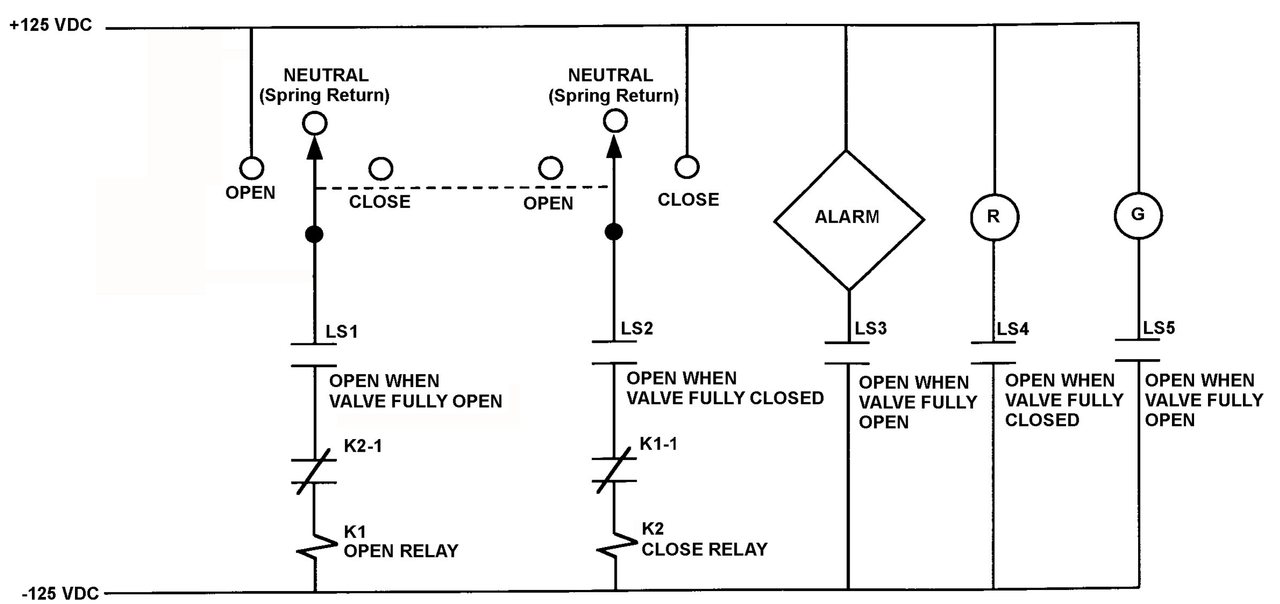
A. Approximately fully open.

B. Approximately fully closed.

C. Approximately 50 percent open.

D. Cannot be determined without additional information.

ANSWER: B.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

Refer to the drawing of a motor and its control circuit (see figure below).

Note: Relay contacts are shown open/closed according to the standard convention for control circuit drawings.

How are the starting resistors employed before and after the motor is energized?

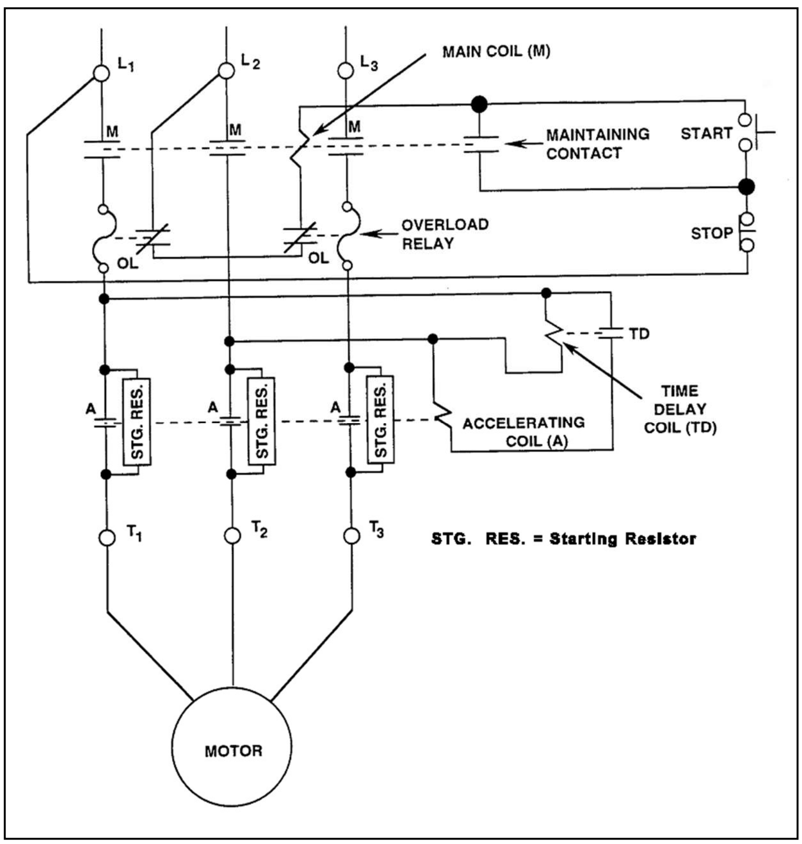
A. Inserted before the motor is energized; simultaneously bypassed after the motor gains speed.

B. Inserted before the motor is energized; sequentially bypassed as the motor gains speed.

C. Bypassed before the motor is energized; simultaneously inserted after the motor gains speed.

D. Bypassed before the motor is energized; sequentially inserted as the motor gains speed.

ANSWER: A.



TOPIC: Bkrs, Rlys, and Disconnects

Refer to the drawing of a motor and its control circuit (see figure below).

Note: Relay contacts are shown open/closed according to the standard convention for control circuit drawings.

The motor has been operating for several hours when it is decided to stop the motor. What is the status of the starting resistors before and after the motor STOP pushbutton is depressed?

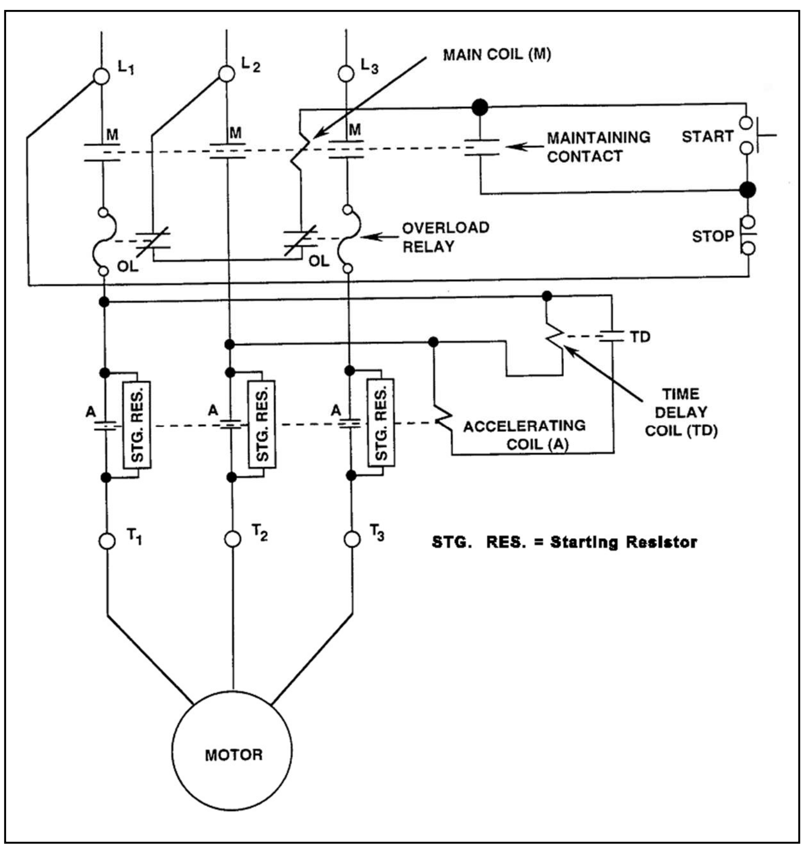
A. Initially inserted in the motor circuit; bypassed immediately after the STOP pushbutton is depressed.

B. Initially inserted in the motor circuit; bypassed following a preset time delay after the STOP pushbutton is depressed.

C. Initially bypassed; bypass is removed immediately after the STOP pushbutton is depressed.

D. Initially bypassed; bypass is removed following a preset time delay after the STOP pushbutton is depressed.

ANSWER: C.



TOPIC: Bkrs, Rlys, and Disconnects

Refer to the drawing of a valve motor control circuit (see figure below) for a valve that is currently fully closed and has a 10-second stroke time.

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

Which one of the following describes the valve response if the control switch is taken to the OPEN position for two seconds and then released?

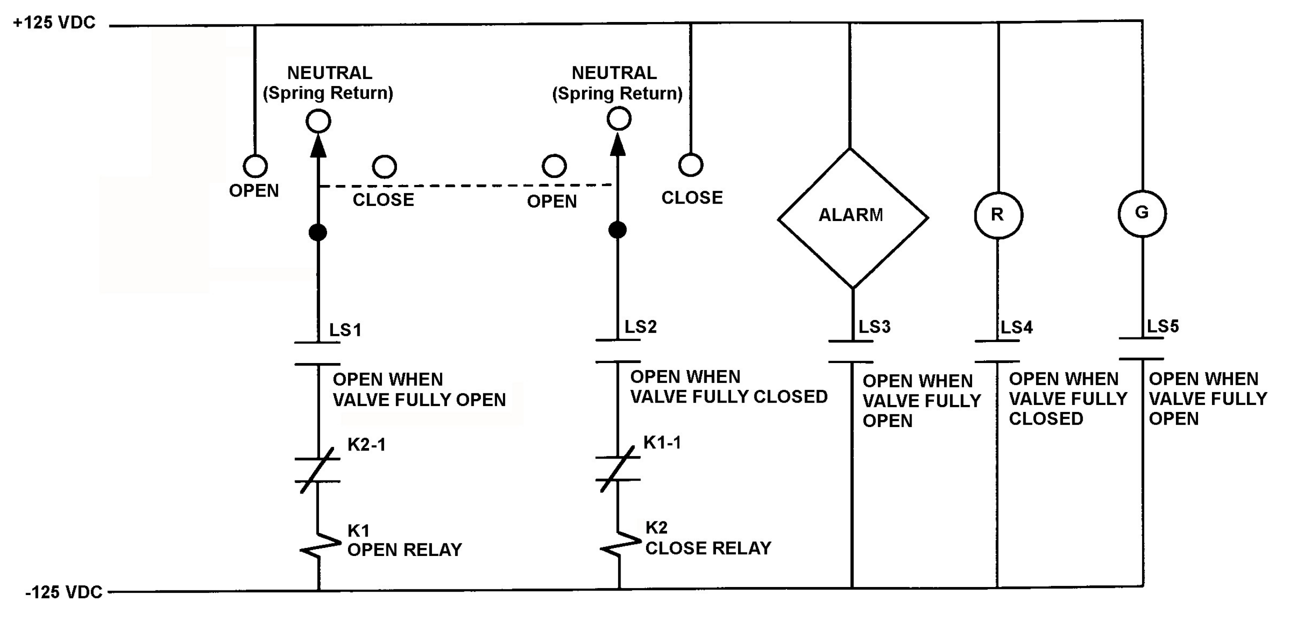
A. The valve will <u>not</u> move.

B. The valve will open fully.

C. The valve will begin to open and then stop moving.

D. The valve will begin to open and then close fully.

ANSWER: C.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

Refer to the drawing of a motor and its control circuit (see figure below).

Note: Relay contacts are shown open/closed according to the standard convention for control circuit drawings.

The motor has been idle for several days when it is decided to start the motor. What is the status of the starting resistors before and after the motor START pushbutton is depressed?

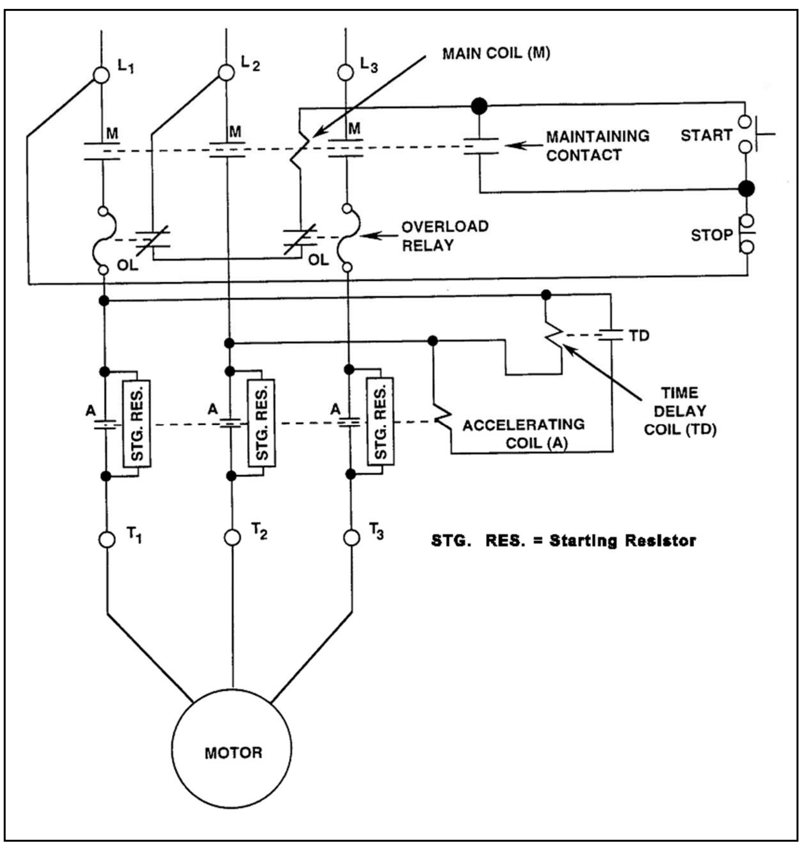
A. Initially bypassed; bypass is removed immediately after the START pushbutton is depressed.

B. Initially bypassed; bypass is removed following a preset time delay after the START pushbutton is depressed.

C. Initially inserted in the motor circuit; bypassed immediately after the START pushbutton is depressed.

D. Initially inserted in the motor circuit; bypassed following a preset time delay after the START pushbutton is depressed.

ANSWER: D.



TOPIC: Bkrs, Rlys, and Disconnects

Refer to the drawing of a valve motor control circuit (see figure below) for a valve that is currently fully open and has a 10-second stroke time.

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

The operator takes the control switch to CLOSE. Two seconds later, after verifying the valve is closing, the operator releases the control switch. Which one of the following describes the valve motor control circuit alarm response after the switch is released?

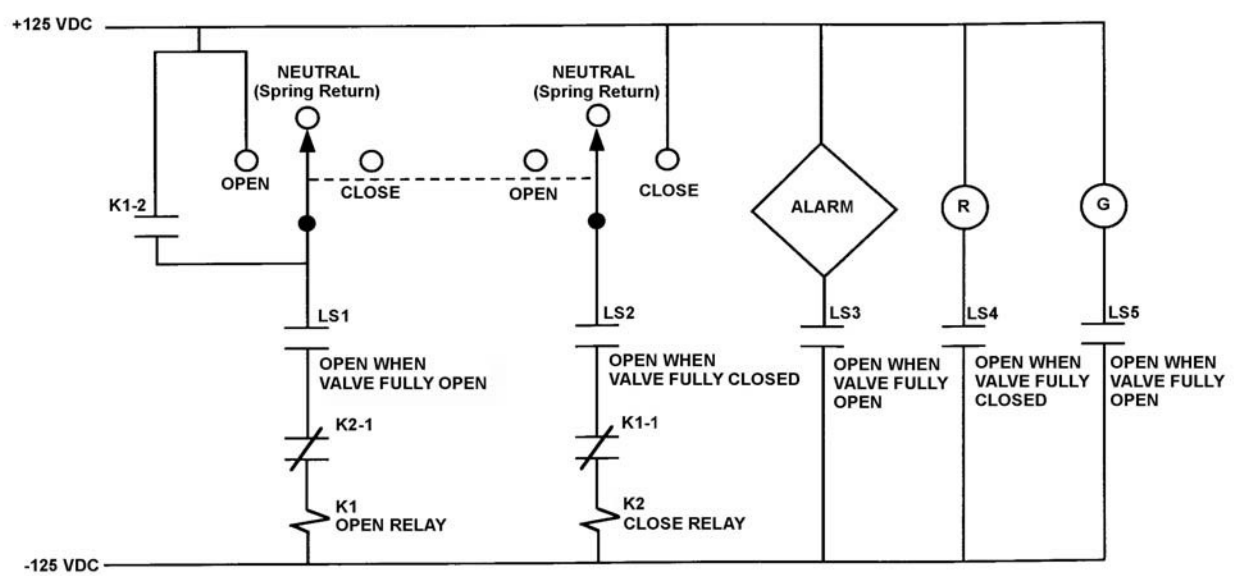
A. The alarm will continue to actuate for approximately 8 seconds.

B. The alarm will continue to actuate until additional operator action is taken.

C. The alarm will actuate after approximately 8 seconds.

D. The alarm will <u>not</u> actuate until additional operator action is taken.

ANSWER: B.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

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

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

Which one of the following will actuate the alarm?

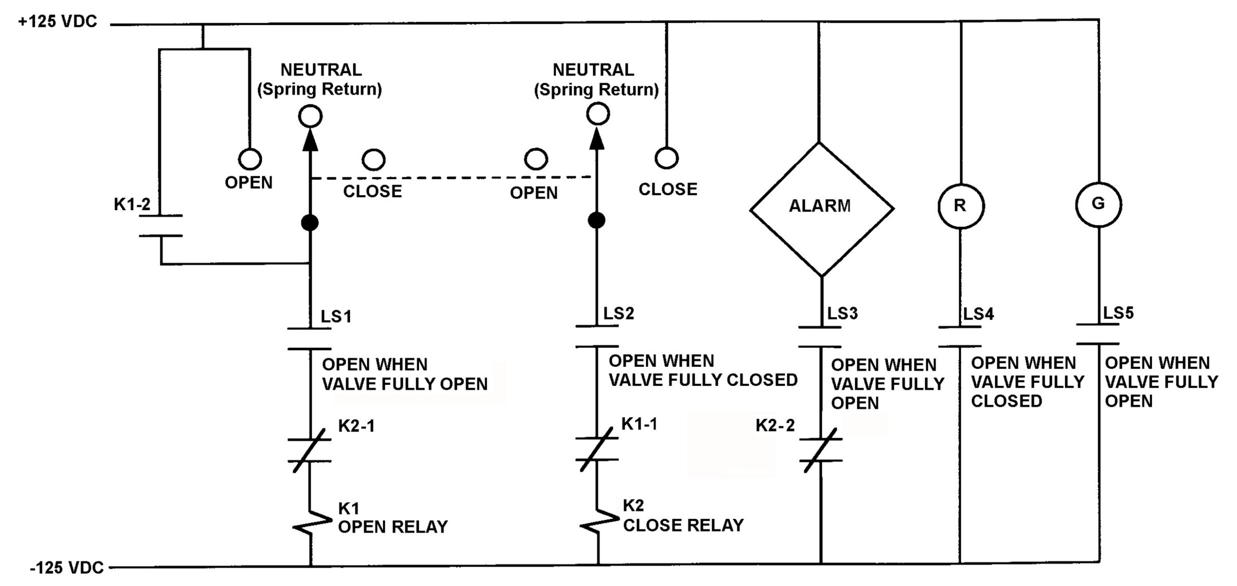
A. With the valve partially closed, the control switch is taken to the CLOSE position.

B. With the valve partially closed, the control switch is taken to the OPEN position.

C. With the valve fully open, the control switch is taken to the CLOSE position.

D. With the valve fully open, the control switch is taken to the OPEN position.

ANSWER: B.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

Refer to the drawing of a valve motor control circuit (see figure below) for a valve that is currently fully open and has a 10-second stroke time.

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

The operator takes the control switch to CLOSE momentarily and the valve begins to close. Five seconds later, the operator takes the switch to OPEN momentarily and then releases the switch. Which one of the following describes the valve response after the switch is released?

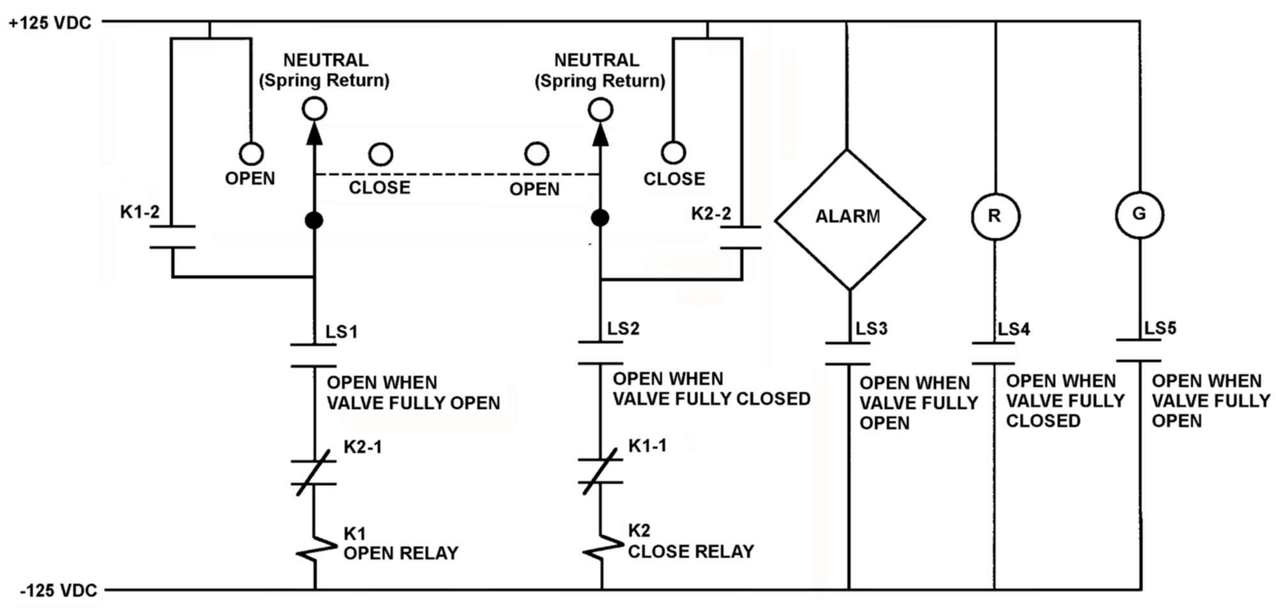
A. The valve will stop closing and remain partially open.

B. The valve will stop closing and then go fully open.

C. The valve will close fully and remain fully closed.

D. The valve will close fully and then go fully open.

ANSWER: C.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

Refer to the drawing of a valve motor control circuit (see figure below) for a valve that is currently fully closed and has a 10-second stroke time.

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

An operator takes the control switch to OPEN momentarily and the valve begins to open. Five seconds later, the operator takes the control switch to CLOSE momentarily and releases the switch. Which one of the following describes the valve response when the control switch is taken to CLOSE momentarily and released?

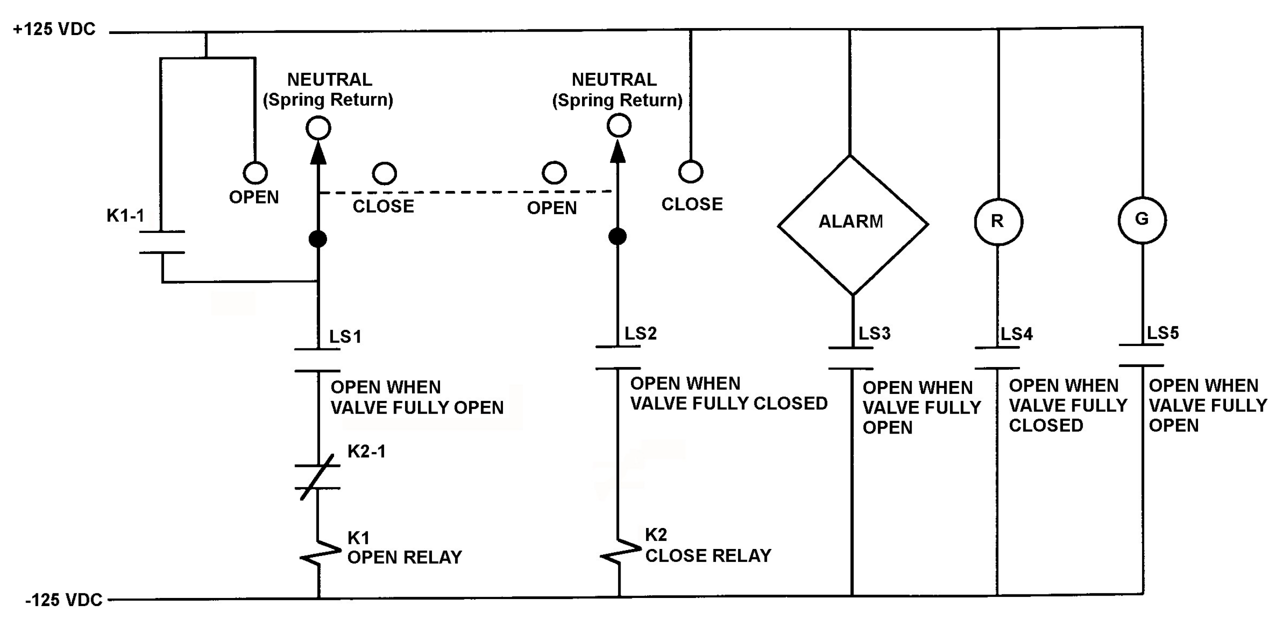
A. The valve will stop opening and remain partially open.

B. The valve will stop opening and then go fully closed.

C. The valve will open fully and remain fully open.

D. The valve will open fully and then go fully closed.

ANSWER: A.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

Refer to the drawing of a valve motor control circuit (see figure below) for a valve that is currently fully closed and has a 10-second stroke time.

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

The operator takes the control switch to OPEN momentarily and the valve begins to open. Five seconds later, the operator takes the switch to CLOSE momentarily and then releases the switch. Which one of the following describes the valve response after the switch is released?

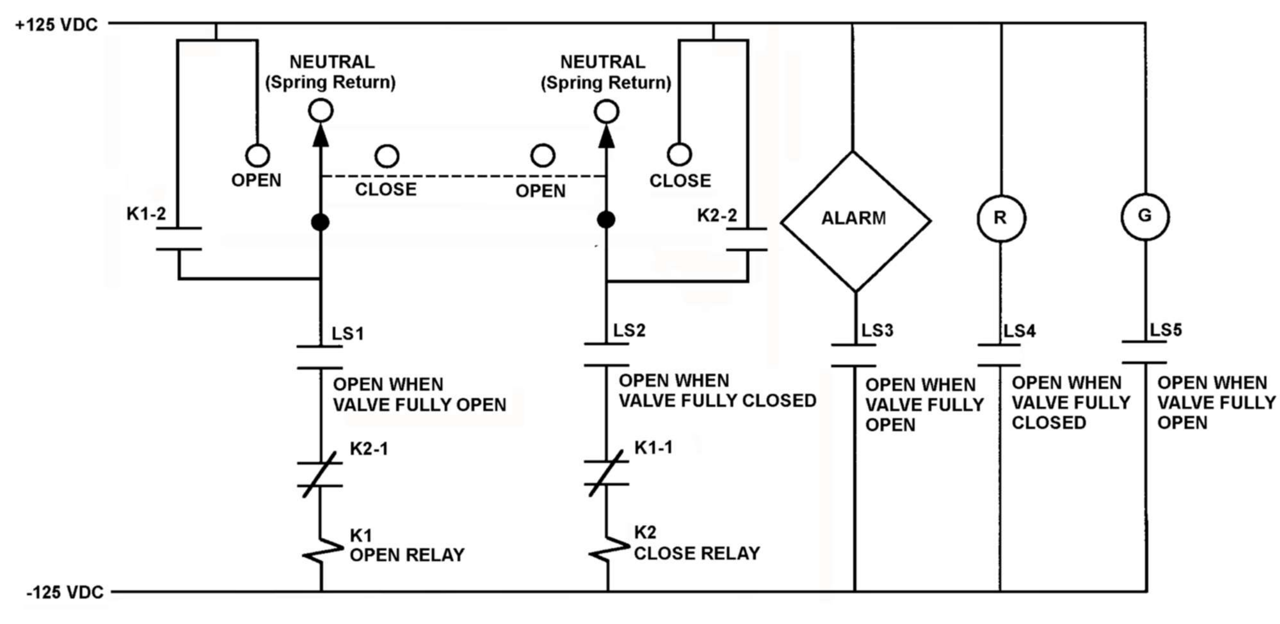
A. The valve will stop opening and remain partially open.

B. The valve will stop opening and then go fully closed.

C. The valve will open fully and remain fully open.

D. The valve will open fully and then go fully closed.

ANSWER: C.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects
KNOWLEDGE: K1.06 [2.3/2.6]

Refer to the drawing of a valve motor control circuit (see figure below) for a valve that is currently fully open and has a 10-second stroke time.

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

The operator takes the control switch to CLOSE. Two seconds later, after verifying the valve is closing, the operator releases the control switch. Which one of the following describes the valve motor control circuit alarm response after the switch is released?

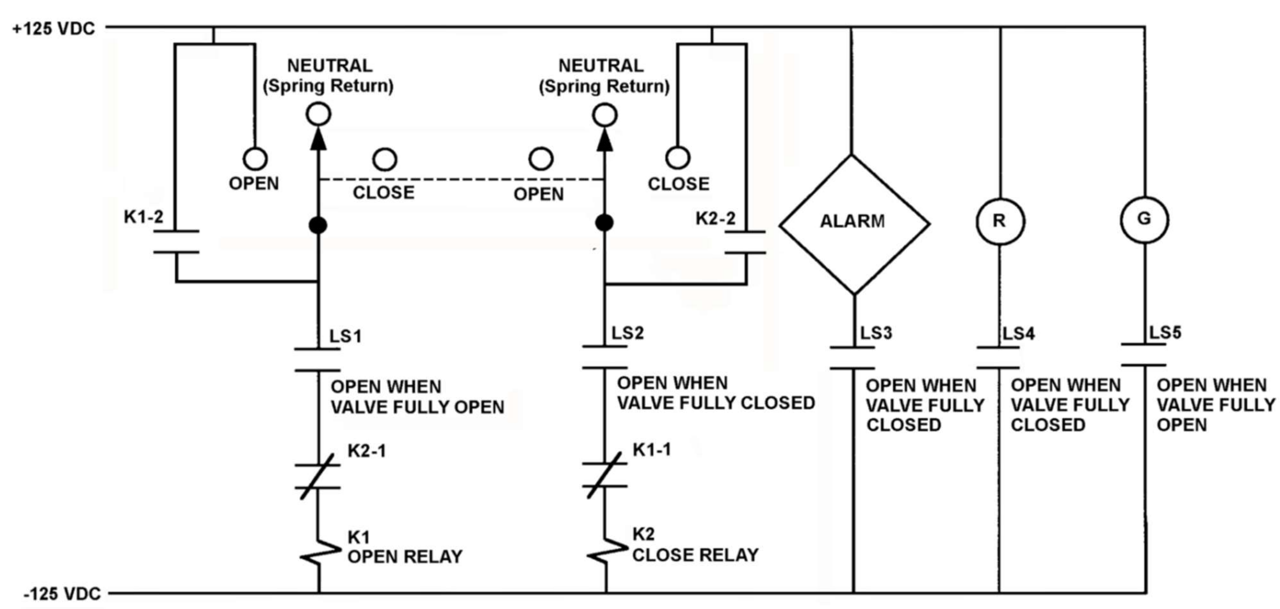
A. The alarm will continue to actuate for approximately 8 seconds.

B. The alarm will continue to actuate until additional operator action is taken.

C. The alarm will actuate after approximately 8 seconds.

D. The alarm will <u>not</u> actuate until additional operator action is taken.

ANSWER: A.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

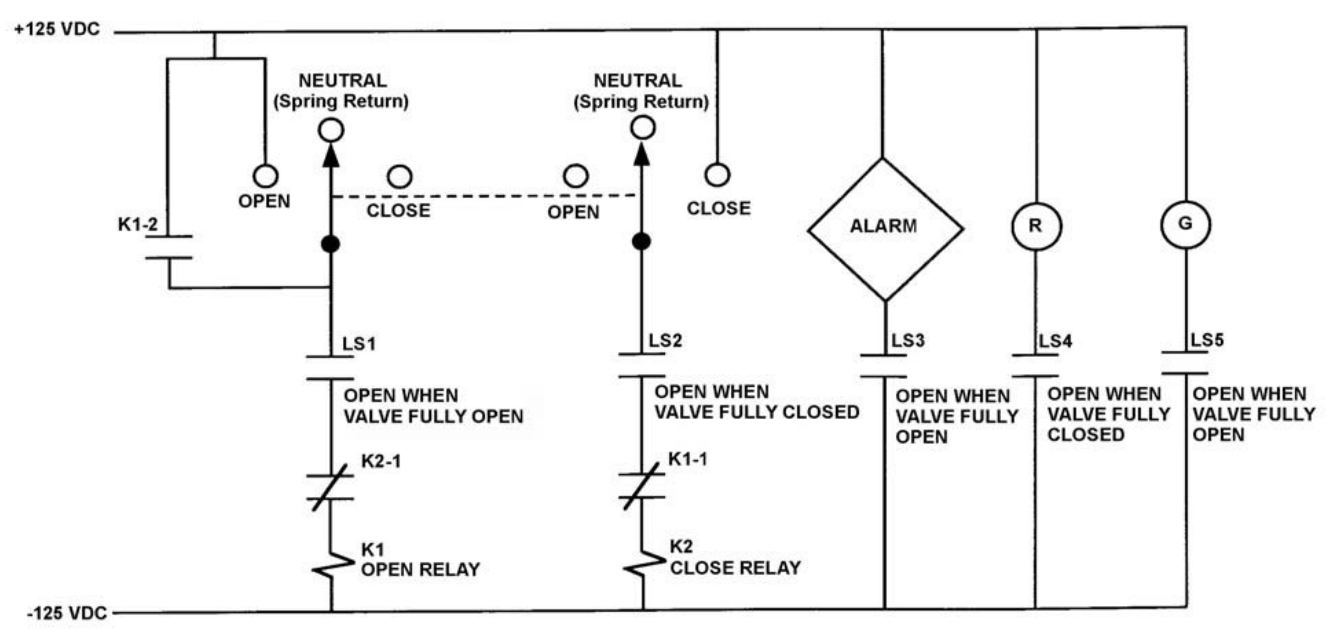
Refer to the drawing of a valve motor control circuit (see figure below) for a valve that is currently fully open and has a 16-second stroke time.

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

An operator takes the control switch to CLOSE. Two seconds later, after verifying the valve is closing, the operator releases the control switch. When the valve stops moving, what will be the status of the alarm and the red (R) and green (G) indicating lights?

	Alarm	Red Ind. Light	Green Ind. Light
A.	On	On	On
B.	On	Off	On
C.	Off	On	Off
D.	Off	Off	Off

ANSWER: A.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

Refer to the drawing of a valve motor control circuit (see figure below) for a valve that is currently fully open and has a 10-second stroke time.

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

The operator takes the control switch to CLOSE. Two seconds later, after verifying the valve is closing, the operator releases the control switch. Which one of the following describes the valve motor control circuit alarm response after the switch is released?

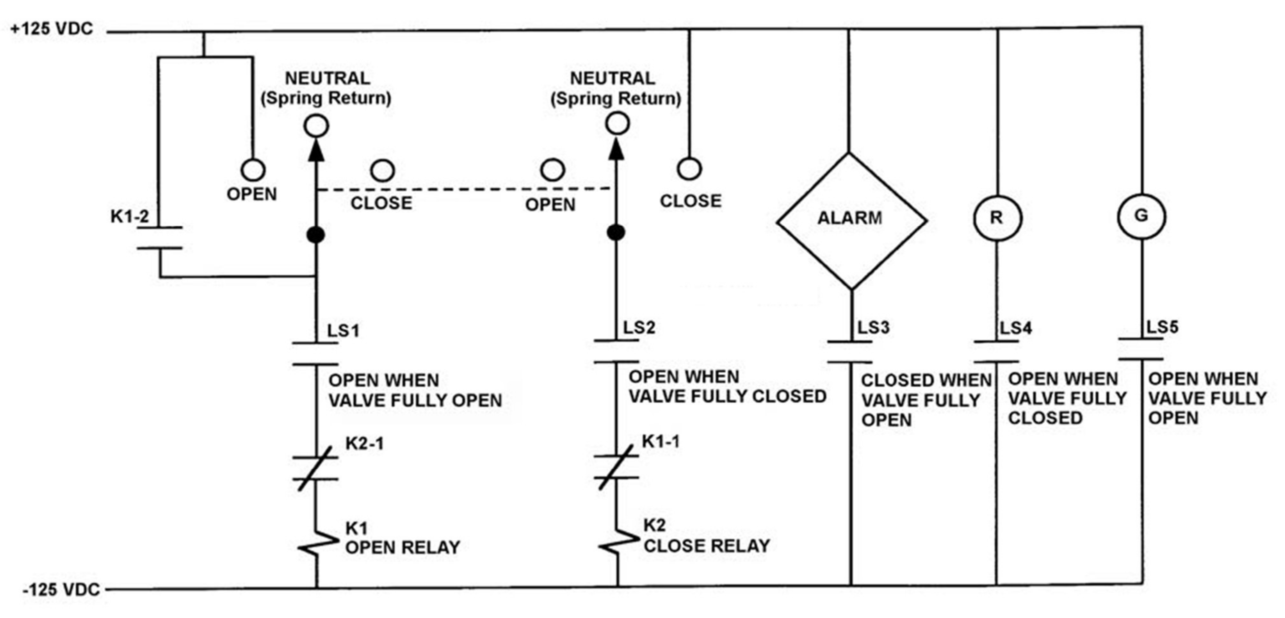
A. The alarm will actuate after approximately 8 seconds.

B. The alarm will <u>not</u> actuate until additional operator action is taken.

C. The alarm will continue to actuate for approximately 8 seconds.

D. The alarm will continue to actuate until additional operator action is taken.

ANSWER: B.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

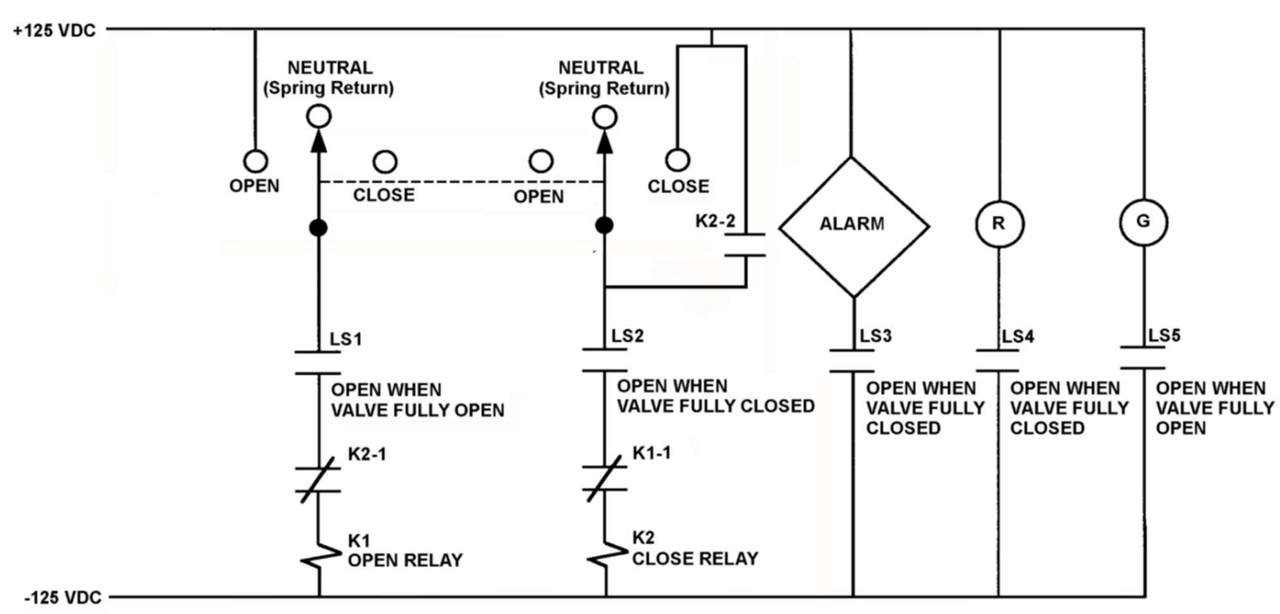
Refer to the drawing of a valve motor control circuit (see figure below) for a valve that is currently fully open and has a 16-second stroke time.

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

An operator takes the control switch to CLOSE. Two seconds later, after verifying the valve is closing, the operator releases the control switch. When the valve stops moving, what will be the status of the alarm and the red (R) and green (G) indicating lights?

	Alarm	Red Ind. Light	Green Ind. Light
A.	On	On	On
B.	On	Off	Off
C.	Off	On	Off
D.	Off	Off	On

ANSWER: D.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

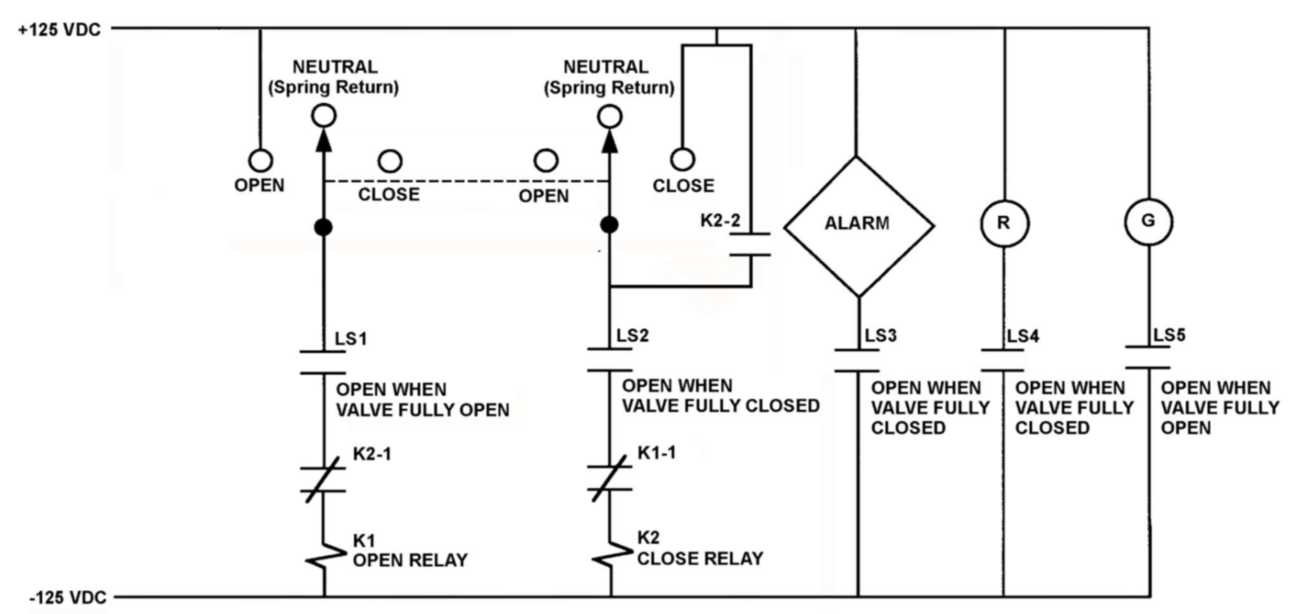
Refer to the drawing of a valve motor control circuit (see figure below) for a valve that is currently fully open and has an 8-second stroke time.

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings. All contacts are functional, <u>except for contact K2-2 which has failed open.</u>

An operator takes the control switch to CLOSE. Four seconds later, the operator releases the control switch. When the valve stops moving, what will be the status of the alarm and the red (R) and green (G) indicating lights?

	Alarm	Red Ind. Light	Green Ind. Light
A.	On	On	On
B.	On	Off	Off
C.	Off	On	Off
D.	Off	Off	On

ANSWER: A.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

Refer to the drawing of a valve motor control circuit (see figure below) for a valve that is currently fully closed and has a 10-second stroke time.

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

The operator takes the control switch to OPEN. Two seconds later, after verifying the valve is opening, the operator releases the control switch. Which one of the following describes the alarm response after the control switch is released?

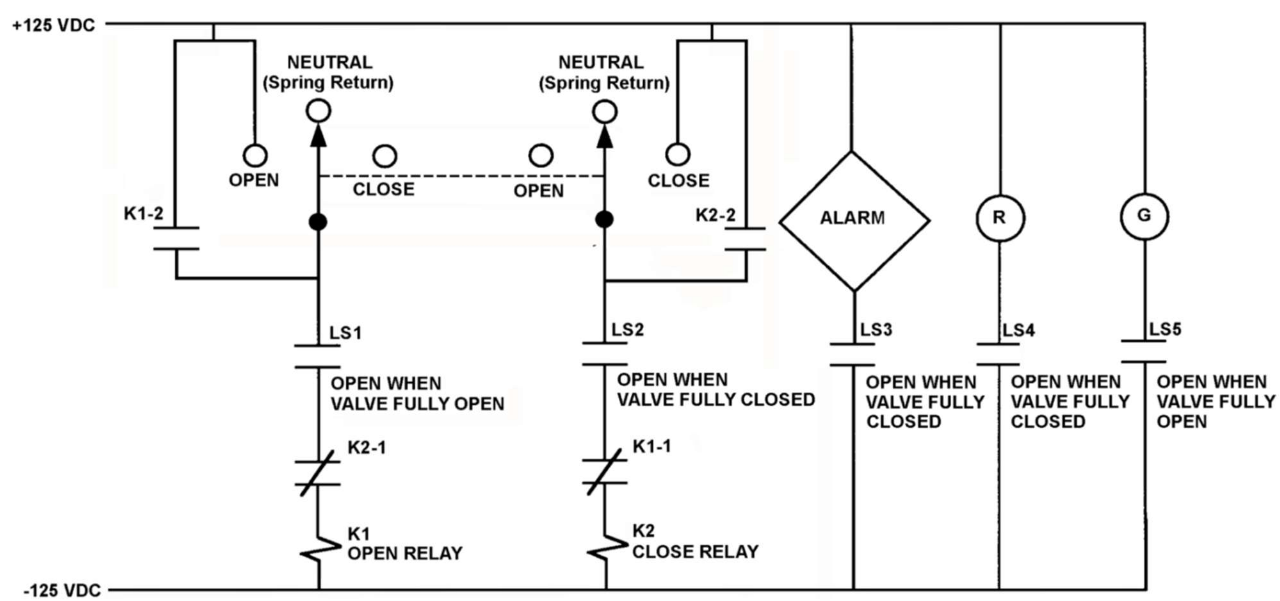
A. The alarm will activate after approximately 8 seconds.

B. The alarm will <u>not</u> activate until additional operator action is taken.

C. The alarm will remain activated for approximately 8 seconds, and then deactivate.

D. The alarm will remain activated until additional operator action is taken.

ANSWER: D.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

Refer to the drawing of a valve motor control circuit (see figure below) for a valve that is currently fully closed and has a 10-second stroke time.

Note: Limit switch (LS) contacts are shown open regardless of valve position, but relay contacts are shown open/closed according to the standard convention for control circuit drawings.

The operator takes the control switch to OPEN. Two seconds later, after verifying the valve is opening, the operator releases the control switch. Which one of the following describes the valve motor control circuit alarm response after the switch is released?

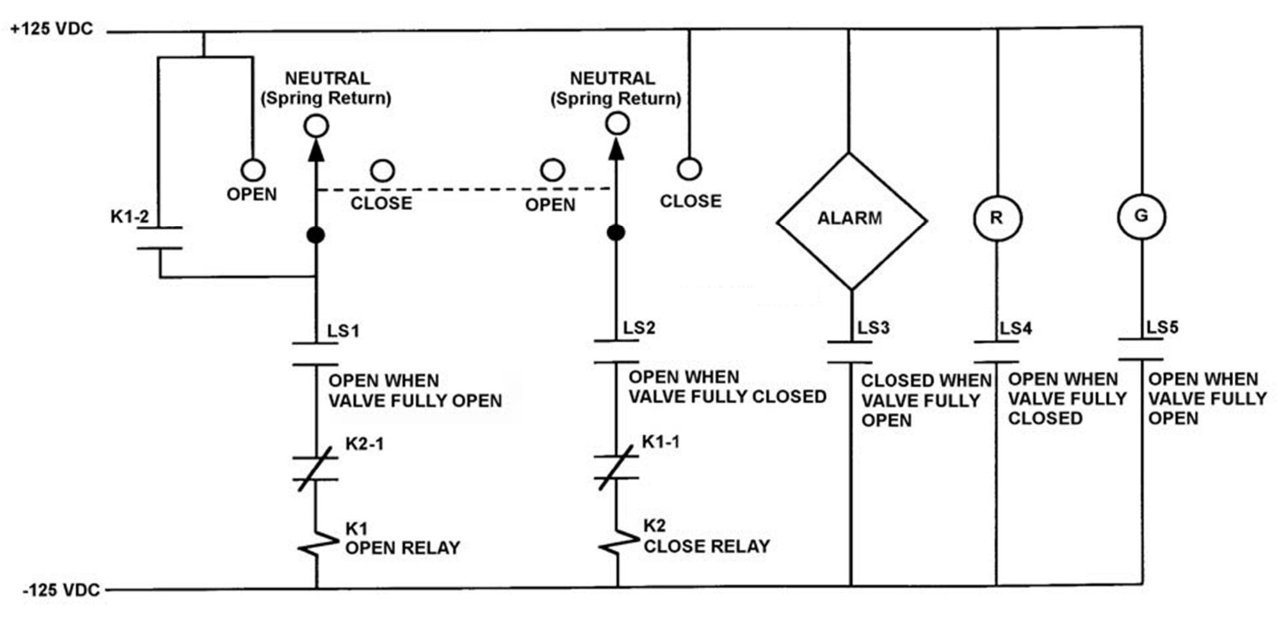
A. The alarm will actuate after approximately 8 seconds.

B. The alarm will not actuate until additional operator action is taken.

C. The alarm will continue to actuate for approximately 8 seconds.

D. The alarm will continue to actuate until additional operator action is taken.

ANSWER: A.



VALVE MOTOR CONTROL CIRCUIT

TOPIC: Bkrs, Rlys, and Disconnects

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

The valve is currently closed with the contact configuration as shown. If the S1 pushbutton is depressed, the valve will __________; and when the S1 pushbutton is subsequently released, the valve will __________.

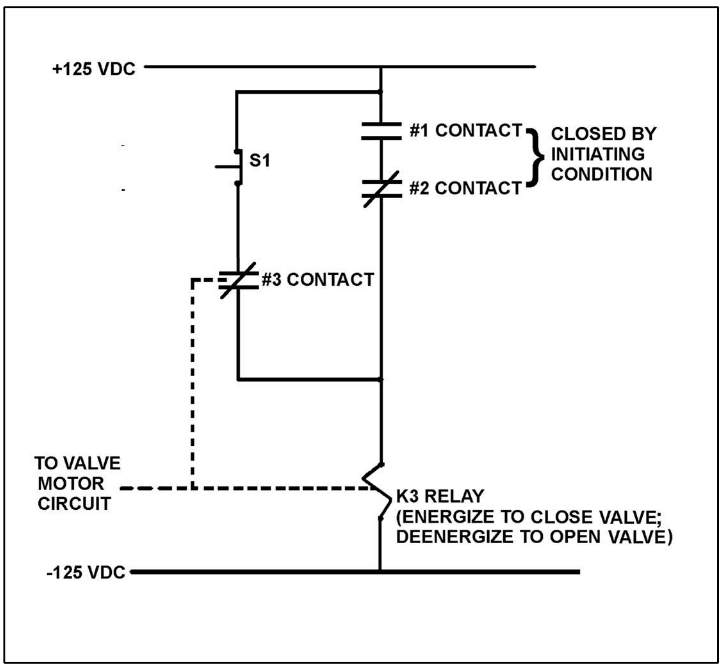
A. open; close

B. open; remain open

C. remain closed; open

D. remain closed; remain closed

ANSWER: B.



TOPIC: Bkrs, Rlys, and Disconnects

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

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

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

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

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

ANSWER: A.

TOPIC: Bkrs, Rlys, and Disconnects

A 480 VAC motor is supplied power via an electrical disconnect in series with a breaker. Which one of the following describes the proper operations to isolate power to the motor?

A. Open the disconnect first, then the breaker.

B. Open the breaker first, then the disconnect.

C. Open the device that is closest to the motor first.

D. Open the device that is closest to the power source first.

ANSWER: B.

TOPIC: Bkrs, Rlys, and Disconnects

Which one of the following is an <u>unsafe</u> practice if performed while working on or near energized electrical equipment?

A. Use insulated tools to prevent inadvertent contact with adjacent equipment.

B. Cover exposed energized circuits with insulating material to prevent inadvertent contact.

C. Attach a metal strap from your body to a nearby neutral ground to ensure that you are grounded.

D. Have a person standing by with the ability to remove you from the equipment in the event of an emergency.

ANSWER: C.

TOPIC: Bkrs, Rlys, and Disconnects

The primary reason for isolating emergency electrical loads from their power supply bus prior to energizing the bus via the emergency diesel generator is to prevent an...

A. overcurrent condition on the generator.

B. overcurrent condition on the loads.

C. underfrequency condition on the generator.

D. underfrequency condition on the loads.

ANSWER: A.

TOPIC: Bkrs, Rlys, and Disconnects

A main generator is being connected to an infinite power grid that is operating at 60 Hz. Generator output voltage is equal to the grid voltage but generator frequency is at 57 Hz.

Which one of the following generator conditions is most likely to occur if the generator output breaker is closed with voltages in phase (synchronized), but with the existing frequency difference? (Assume <u>no</u> generator breaker protective trip occurs.)

A. Reverse power

B. Underfrequency

C. Undervoltage

D. Overspeed

ANSWER: A.

TOPIC: Bkrs, Rlys, and Disconnects

Closing the output breaker of a three-phase generator onto a deenergized bus can...

A. produce an overvoltage condition on the bus.

B. produce an overcurrent condition on the generator if the bus was not first unloaded.

C. result in a reverse power trip of the generator circuit breaker if generator frequency is low.

D. result in large reactive currents in the generator.

ANSWER: B.

TOPIC: Bkrs, Rlys, and Disconnects

A main generator is being paralleled to an infinite power grid. Closing the output breaker of the generator with the frequency of the generator 0.1 Hz higher than grid frequency will result in the generator...

A. behaving as a real load to the grid.

B. behaving as a reactive load to the grid.

C. supplying a portion of the grid reactive load.

D. supplying a portion of the grid real load.

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

Which one of the following generator conditions is most likely to result in equipment damage from high current flow?

A. Tripping the output breaker under full-load conditions.

B. Tripping the generator prime mover under full-load conditions.

C. Closing the output breaker onto a bus that has a short-circuit fault.

D. Closing the output breaker onto a bus that has an open-circuit fault.

ANSWER: C.

TOPIC: Bkrs, Rlys, and Disconnects

A main generator is about to be connected to an infinite power grid. Closing the generator output breaker with the generator voltage slightly lower than grid voltage and with generator frequency slightly higher than grid frequency will initially result in: (Assume no generator breaker protective trip occurs.)

A. the generator supplying reactive power to the grid.

B. the generator attaining a leading power factor.

C. the generator acting as a real load to the grid.

D. motoring of the generator.

ANSWER: B.

TOPIC: Bkrs, Rlys, and Disconnects

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 just as the synchroscope pointer reaches the 12 o'clock position to prevent...

A. motoring of the generator, due to unequal frequencies.

B. excessive MW load transfer to the generator, due to unequal frequencies.

C. excessive MW load transfer to the generator, due to out-of-phase voltages.

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

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

During paralleling operations of the main generator to an infinite power grid, closing the generator output breaker with the frequency of the generator at 61 hertz and the grid frequency at 60 hertz will...

A. cause the generator to immediately increase load.

B. trip open the generator breaker on reverse power.

C. cause the generator voltage to increase.

D. cause the generator current to decrease.

ANSWER: A.

TOPIC: Bkrs, Rlys, and Disconnects

Which one of the following evolutions will draw the <u>highest</u> current from the main generator during operation of the output breaker?

A. Opening the output breaker under full-load conditions.

B. Opening the output breaker under no-load conditions.

C. Closing the output breaker with voltages out of phase.

D. Closing the output breaker with voltages in phase.

ANSWER: C.

TOPIC: Bkrs, Rlys, and Disconnects

Under which one of the following pre-existing conditions will closing a breaker between two electrical generators cause a sudden large and possibly damaging mechanical torque to be exerted on both of the generators?

A. One generator is supplying a 3 percent higher voltage than the other.

B. One generator is supplying a 3 percent higher frequency than the other.

C. The voltage of one generator is out of phase with the other by 30 degrees.

D. The capacity of one generator is twice that of the other generator.

ANSWER: C.

TOPIC: Bkrs, Rlys, and Disconnects

A main generator is about to be connected to an infinite power grid with the following conditions:

Generator frequency	=	59.5 Hz
Grid frequency:	=	59.8 Hz
Generator voltage:	=	115.1 KV
Grid voltage:	=	114.8 KV

When the generator output breaker is closed, the generator will...

A. acquire real load and reactive load.

B. acquire real load but become a reactive load to the grid.

C. become a real load to the grid but acquire reactive load.

D. become a real load and a reactive load to the grid.

ANSWER: C.

TOPIC: Bkrs, Rlys, and Disconnects

A main generator is about to be connected to an infinite power grid. Closing the generator output breaker with generator and grid voltages matched, but with generator frequency lower than grid frequency will initially result in the generator...

A. picking up a portion of the grid real load.

B. picking up a portion of the grid reactive load.

C. experiencing reverse power conditions.

D. experiencing overspeed conditions.

ANSWER: C.

TOPIC: Bkrs, Rlys, and Disconnects

A main generator is about to be connected to an infinite power grid. Closing the generator output breaker with the __________ of the generator higher than that of the grid will initially result in generator real load __________.

A. frequency; decreasing

B. frequency; increasing

C. voltage; decreasing

D. voltage; increasing

ANSWER: B.

TOPIC: Bkrs, Rlys, and Disconnects

A main generator is about to be connected to an infinite power grid. Closing the generator output breaker with generator and grid voltages matched, but with generator frequency 0.1 Hz higher than grid frequency will initially result in the generator...

A. picking up a portion of the grid real load.

B. picking up a portion of the grid reactive load.

C. experiencing reverse power conditions.

D. experiencing overspeed conditions.

ANSWER: A.

TOPIC: Bkrs, Rlys, and Disconnects

A main generator is about to be connected to an infinite power grid with the following conditions:

Generator frequency	= 59.8 Hz
Grid frequency	= 59.5 Hz
Generator voltage	= 114.8 KV
Grid voltage	= 115.1 KV

When the generator output breaker is closed, the generator will initially...

A. acquire real load and reactive load.

B. acquire real load, but become a reactive load to the grid.

C. become a real load to the grid, but acquire reactive load.

D. become a real load and a reactive load to the grid.

ANSWER: B.

TOPIC: Bkrs, Rlys, and Disconnects

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

If the generator breaker is closed just prior to the synchroscope pointer reaching the 12 o'clock position, which one of the following is most likely to occur?

A. The breaker will close and the generator will supply only MW to the grid.

B. The breaker will close and the generator will supply both MW and MVAR to the grid.

C. The breaker will close and then open due to overcurrent.

D. The breaker will close and then open due to reverse power.

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

A main generator is being connected to an infinite power grid. Which one of the following will occur if the generator output breaker is closed with generator frequency 0.1 Hz lower than power grid frequency? (Assume that no generator protection relay actuates.)

A. The generator will motorize.

B. The generator will accept too much load.

C. The voltage of the generator will decrease to compensate for the lower frequency.

D. The entire connected system will operate at the frequency of the lowest frequency (the oncoming) generator.

ANSWER: A.

TOPIC: Bkrs, Rlys, and Disconnects

A main generator is being prepared for paralleling with an infinite power grid. Which one of the following indicates that the main generator and grid voltages are in phase?

A. The synchroscope pointer is at the 12 o'clock position.

B. The frequency of the generator is equal to the frequency of the grid.

C. The synchroscope pointer is turning slowly in the clockwise direction.

D. The synchroscope pointer is turning slowly in the counterclockwise direction.

ANSWER: A.

TOPIC: Bkrs, Rlys, and Disconnects

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

A. Generator voltage is slightly higher than grid voltage.

B. Generator voltage is slightly lower than grid voltage.

C. The synchroscope is turning slowly in the clockwise direction.

D. The synchroscope is turning slowly in the counterclockwise direction.

ANSWER: A.

TOPIC: Bkrs, Rlys, and Disconnects

Two identical 1,000 MW electrical generators are being connected to the same electrical bus. Generator A is currently supplying the bus. Generator A and B output indications are as follows:

Generator A	Generator B
4,160 Volts	4,140 Volts
60.2 Hertz	60.8 Hertz
25 MW	0 MW
10 MVAR	0 MVAR

When the output breaker for generator B is closed, which generator is more likely to trip on reverse power?

A. Generator A, due to the higher initial voltage.

B. Generator A, due to the lower initial frequency.

C. Generator B, due to the lower initial voltage.

D. Generator B, due to the higher initial frequency.

ANSWER: B.

TOPIC: Bkrs, Rlys, and Disconnects

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

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

A. The breaker will remain closed and the generator will supply only MW to the grid.

B. The breaker will remain closed and the generator will supply both MW and MVAR to the grid.

C. The breaker will trip open due to overcurrent.

D. The breaker will trip open due to reverse power.

ANSWER: A.

TOPIC: Bkrs, Rlys, and Disconnects

A main generator is being prepared for paralleling with an infinite power grid. Which one of the following indicates that the generator and grid voltages are in phase?

A. The voltage of the generator is equal to the voltage of the grid.

B. The frequency of the generator is equal to the frequency of the grid.

C. The synchroscope pointer is turning slowly in the clockwise direction.

D. The synchroscope pointer is passing through the 12 o'clock position.

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

An isolated electrical bus is being supplied by generator A. Generator B is about to be connected to the same electrical bus. Generators A and B are both rated at 1,000 MW. Generator A and B output indications are as follows:

Generator A	Generator B
4,140 Volts	4,160 Volts
60.8 Hertz	60.2 Hertz
25 MW	0 MW
10 MVAR (out)	0 MVAR

When the output breaker for generator B is closed, which generator is more likely to trip on reverse power?

A. Generator A, due to the lower initial voltage.

B. Generator A, due to the higher initial frequency.

C. Generator B, due to the higher initial voltage.

D. Generator B, due to the lower initial frequency.

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

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

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

A. The breaker will remain closed and the generator will supply only MW to the grid.

B. The breaker will remain closed and the generator will supply both MW and MVAR to the grid.

C. The breaker will open due to overcurrent.

D. The breaker will open due to reverse power.

ANSWER: B.

TOPIC: Bkrs, Rlys, and Disconnects

A main generator is being prepared for paralleling with an infinite power grid. At which one of the following synchroscope pointer positions is the main generator output voltage the farthest out of phase with the grid voltage?

A. 3 o'clock

B. 6 o'clock

C. 9 o'clock

D. 12 o'clock

ANSWER: B.

TOPIC: Bkrs, Rlys, and Disconnects

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

Which one of the following is most likely to occur after the breaker is closed?

A. The breaker will remain closed and the generator will supply only MW to the grid.

B. The breaker will remain closed and the generator will supply both MW and MVAR to the grid.

C. The breaker will open due to overcurrent.

D. The breaker will open due to reverse power.

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

A main generator is about to be connected to an infinite power grid. Generator voltage is slightly higher than grid voltage and the synchroscope is rotating slowly in the clockwise direction. The generator breaker is closed just as the synchroscope pointer reaches the 3 o'clock position.

Which one of the following is most likely to occur after the breaker is closed?

A. The breaker will remain closed and the generator will supply only MW to the grid.

B. The breaker will remain closed and the generator will supply both MW and MVAR to the grid.

C. The breaker will open due to overcurrent.

D. The breaker will open due to reverse power.

ANSWER: C.

TOPIC: Bkrs, Rlys, and Disconnects

A main generator is being paralleled to an infinite power grid with the following conditions:

Generator frequency	=	59.9 Hz
Grid frequency	=	60.1 Hz
Generator voltage	=	114.8 KV
Grid voltage	=	115.1 KV

When the generator output breaker is closed, the generator will...

A. acquire real load and reactive load.

B. acquire real load, but become a reactive load to the grid.

C. become a real load to the grid, but acquire reactive load.

D. become a real load and a reactive load to the grid.

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

A main generator is about to be connected to an infinite power grid with the following conditions:

Generator frequency	=	60.1 Hz
Grid frequency	=	59.9 Hz
Generator voltage	=	115.1 KV
Grid voltage	=	114.8 KV

When the generator output breaker is closed, the generator will...

A. acquire real load and reactive load.

B. acquire real load, but become a reactive load to the grid.

C. become a real load to the grid, but acquire reactive load.

D. become a real load and a reactive load to the grid.

ANSWER: A.

TOPIC: Bkrs, Rlys, and Disconnects

A nuclear power plant was initially operating at 80 percent power in the middle of a fuel cycle with the main generator connected to an infinite power grid with the following main generator output parameters:

60 Hz
25 KV
300 MVAR (out)
800 MW

A hydraulic oil system malfunction occurred that caused the main turbine steam inlet valves to slowly drift closed. After 10 minutes, the main generator real load decreased to 600 MW. Assuming no operator actions were taken, how were the remaining main generator output parameters affected after the above 10 minute period?

	Frequency (Hz)	Voltage (KV)	Reactive Load (MVAR)
A.	Decreased	Decreased	No change
B.	Decreased	No change	Decreased
C.	No change	No change	No change
D.	No change	Decreased	Decreased

ANSWER: C.

TOPIC: Bkrs, Rlys, and Disconnects

Which one of the following will cause the most damage to the contact surfaces of a main generator output breaker?

A. An operator attempts to close the main generator output breaker with the generator and power grid frequencies matched but with voltages 180 degrees out of phase.

B. An operator attempts to close the main generator output breaker with the generator and power grid voltages in phase but with generator frequency 0.5 percent higher than power grid frequency.

C. The main generator output breaker automatically trips open on a loss of offsite power while the main generator is operating at its minimum rated load.

D. The main generator output breaker automatically trips open on a loss of offsite power while the main generator is operating at its maximum rated load.

ANSWER: A.

TOPIC: Bkrs, Rlys, and Disconnects

A main generator is about to be connected to an infinite power grid. The main generator has the following initial conditions:

Generator frequency	= 59.9 Hz	Generator voltage	= 115.1 KV
Grid frequency	= 60.1 Hz	Grid voltage	= 114.8 KV

When the generator output breaker is closed, the generator will...

A. acquire real load and reactive load.

B. acquire real load, but become a reactive load to the grid.

C. become a real load and a reactive load to the grid.

D. become a real load to the grid, but acquire reactive load.

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

During a routine inspection of a main generator output breaker, a technician discovers severely damaged main contact surfaces. Which one of the following is the most likely cause of the damaged contact surfaces?

A. The main generator breaker automatically tripped open after it was closed with the generator and power grid voltages 60 degrees out of phase.

B. The main generator breaker automatically tripped open due to a faulty trip relay actuation while the main generator was operating unloaded.

C. The main generator breaker automatically tripped open on a loss of offsite power while the main generator was operating at its maximum rated load.

D. The main generator breaker automatically tripped open after it was closed with the generator and power grid voltages in phase but with generator frequency 0.2 Hz lower than power grid frequency.

ANSWER: A.

TOPIC: Bkrs, Rlys, and Disconnects

A main generator is about to be connected to an infinite power grid. Generator output frequency is slightly higher than grid frequency and generator output voltage is equal to grid voltage.

Which one of the following situations will exist when the main generator electrical conditions stabilize immediately after the generator output breaker is closed? (Assume no additional operator actions are taken.)

A. Generator output current will be 0.

B. Generator power factor will be 0.

C. Generator output MVAR will be 0.

D. Generator output MW will be 0.

ANSWER: C.

TOPIC: Bkrs, Rlys, and Disconnects

A main generator is being connected to an infinite power grid. The following frequencies exist just prior to closing the generator output breaker:

Generator frequency = 59.9 Hz
Grid frequency = 60.1 Hz

When conditions stabilize just after the generator output breaker is closed, the generator frequency will be __________; and the grid frequency will be __________.

A. 59.9 Hz; 59.9 Hz

B. 59.9 Hz; 60.1 Hz

C. 60.0 Hz; 60.0 Hz

D. 60.1 Hz; 60.1 Hz

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

A diesel generator (DG) was initially operating at 80 percent of rated load supplying an isolated electrical bus when a malfunction caused the DG output breaker to trip. The breakers for all of the bus loads--all of which are large motors--remained closed, preparing the motors to restart upon restoration of power to the bus.

The DG output breaker has been repaired. With all of the bus load breakers still closed, which one of the following will occur when the DG output breaker is closed to reenergize the bus?

A. The DG will become lightly loaded.

B. The DG will return directly to its initial load.

C. The DG will experience slight overload conditions.

D. The DG will experience severe overload conditions.

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

A main generator output breaker is about to be closed to connect the main generator to the power grid via the main transformer. The main transformer voltage and frequency are as follows:

Voltage = 20,000 volts
Frequency = 60.0 Hz

Which combination of main generator voltage and frequency will ensure that the main generator will immediately supply real (MW) and reactive (MVAR) electrical power to the power grid when the main generator output breaker is closed?

A. 19,950 volts; 59.9 Hz

B. 19,950 volts; 60.1 Hz

C. 20,050 volts; 59.9 Hz

D. 20,050 volts; 60.1 Hz

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

If a main generator output breaker is closed when the generator output voltage is 5 degrees out of phase with the power grid voltage, the main generator will experience a __________ stress; if the breaker remains closed and no additional operator action is taken, the main generator voltage will __________ with the grid voltage.

A. minor; remain out of phase

B. minor; become locked into phase

C. potentially damaging; remain out of phase

D. potentially damaging; become locked into phase

ANSWER: B.

TOPIC: Bkrs, Rlys, and Disconnects

If a main generator output breaker is closed when the generator output voltage is 90 degrees out of phase with the power grid voltage, the main generator will experience a __________ stress; if the breaker remains closed and no additional operator action is taken, the main generator voltage will __________ with the grid voltage.

A minor; remain out of phase

B. minor; become locked into phase

C. potentially damaging; remain out of phase

D. potentially damaging; become locked into phase

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

The main generator output breaker was just closed to connect the main generator to the main transformer. Just before the breaker was closed, the following parameter values existed:

Main Generator	Main Transformer
20,000 volts	20,050 volts
60.0 Hz	59.9 Hz

With no additional operator action, the main generator stabilized with the following parameter values:

25 MW
15 MVAR (in)

Now consider this following alternate set of parameters values:

Main Generator	Main Transformer
20,020 volts	20,050 volts
60.1 Hz	59.9 Hz

If the alternate set of parameter values had existed just before the breaker was closed, the resulting main generator MW value would have been __________; and the resulting main generator MVAR (in) value would have been __________.

A. smaller; larger

B. smaller; smaller

C. larger; larger

D. larger; smaller

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

The main generator output breaker was just closed to connect the main generator to the main transformer. Just before the breaker was closed, the following parameter values existed:

Main Generator	Main Transformer
20,060 volts	20,020 volts
60.1 Hz	59.9 Hz

With no additional operator action, the main generator stabilized as follows:

25 MW
15 MVAR (out)

Now consider the following alternate set of parameters values:

Main Generator	Main Transformer
20,040 volts	20,020 volts
60.0 Hz	59.9 Hz

If the alternate set of parameter values existed just before the main generator output breaker was closed, the resulting main generator MW value would be __________; and the resulting main generator MVAR (out) value would be __________.

A. smaller; larger

B. smaller; smaller

C. larger; larger

D. larger; smaller

ANSWER: B.

TOPIC: Bkrs, Rlys, and Disconnects

The main generator output breaker was just closed to connect the main generator to the main transformer. Just before the breaker was closed, the following parameter values existed:

Main Generator	Main Transformer
20,000 volts	20,050 volts
60.1 Hz	59.9 Hz

With no additional operator action, the main generator stabilized with the following parameter values:

25 MW
15 MVAR (in)

Now consider this following alternate set of parameters values:

Main Generator	Main Transformer
20,020 volts	20,050 volts
60.0 Hz	59.9 Hz

If the alternate set of parameter values had existed just before the breaker was closed, the resulting main generator MW value would have been __________; and the resulting main generator MVAR (in) value would have been __________.

A. larger; larger

B. larger; smaller

C. smaller; larger

D. smaller; smaller

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

When a typical 4,160 volt breaker is racked to the TEST position, control power is __________ the breaker; and the breaker is __________ the load.

A. removed from; isolated from

B. removed from; connected to

C. available to; isolated from

D. available to; connected to

ANSWER: C.

TOPIC: Bkrs, Rlys, and Disconnects

Which one of the following functions or capabilities would remain following a loss of control power to a typical 480 VAC bus feeder breaker?

A. Remote breaker control capability.

B. Breaker closing spring automatic recharging capability.

C. Remote bus voltage indication.

D. Remote breaker position indication.

ANSWER: C.

TOPIC: Bkrs, Rlys, and Disconnects

Which one of the following statements describes the use of high-voltage disconnect switches?

A. Their use should be limited to normal load current interruption.

B. They may be used to isolate transformers in an unloaded network.

C. They trip open like circuit breakers, but must be manually closed.

D. They must be closed with caution when under load because of possible arcing.

ANSWER: B.

TOPIC: Bkrs, Rlys, and Disconnects

The function of high-voltage disconnect switches is to provide __________ electrical isolation of equipment during __________ conditions.

A. manual; no-load

B. manual; overload

C. automatic; no-load

D. automatic; overload

ANSWER: A.

TOPIC: Bkrs, Rlys, and Disconnects

High-voltage disconnect switches are used to...

A. adjust the output voltage range from a main power transformer.

B. protect bus feeder breakers by opening upon bus short-circuit faults.

C. provide equipment isolation under no-load conditions.

D. bypass and isolate an electrical bus while maintaining the downstream buses energized.

ANSWER: C.

TOPIC: Bkrs, Rlys, and Disconnects

What is an advantage of using high-voltage disconnect switches instead of breakers to isolate main power transformers?

A. Disconnect switches can be operated either locally or remotely.

B. Disconnect switches provide direct visual indication that the circuit is broken.

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

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

ANSWER: B.

TOPIC: Bkrs, Rlys, and Disconnects

Which one of the following describes a characteristic of high-voltage disconnect switches?

A. They close automatically requiring no operator action.

B. They should not be used to interrupt a circuit under load.

C. They require a remote means of indication to determine actual position.

D. They should be connected so that they ground the supply bus prior to opening a circuit.

ANSWER: B.

TOPIC: Bkrs, Rlys, and Disconnects

Typical high-voltage disconnect switches are designed to...

A. protect circuits during overcurrent conditions.

B. automatically trip open to protect breakers.

C. isolate equipment electrically during no-load conditions.

D. interrupt circuits under load.

ANSWER: C.

TOPIC: Bkrs, Rlys, and Disconnects

Typical high-voltage transformer disconnect switches are designed to...

A. automatically protect the transformer from overcurrent conditions.

B. automatically trip open prior to transformer output breaker trip.

C. manually isolate the transformer during no-load conditions.

D. manually interrupt the transformer output circuit under any load when grounds are detected.

ANSWER: C.

TOPIC: Bkrs, Rlys, and Disconnects

Refer to the simplified drawing of an electrical distribution system showing 7.2 KV switchgear, step-down transformers, and 480 V motor control centers (MCCs) (see figure below).

The high voltage side of each step-down transformer has a remote-operated disconnect to allow transformer maintenance while keeping the other transformers in service. The control circuit for each disconnect is position-interlocked with the associated MCC feeder breaker.

Which one of the following describes the purpose served by the interlock?

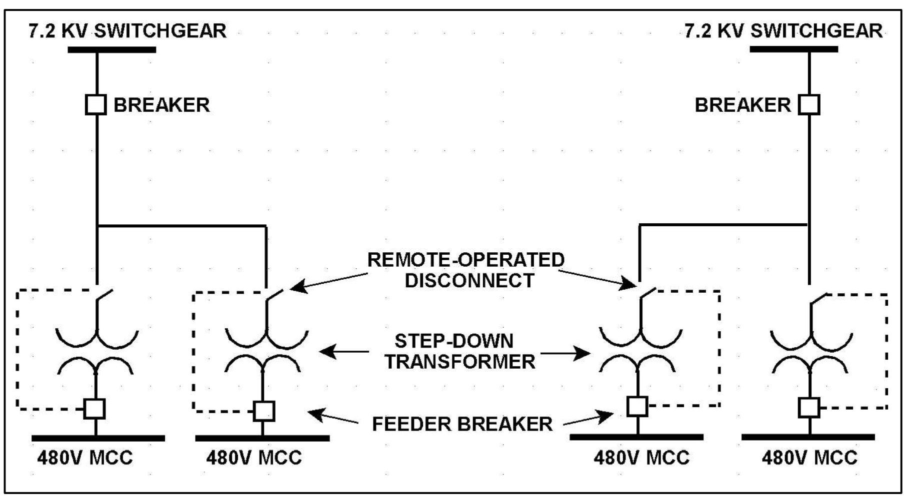
A. Prevent damage to the disconnect.

B. Prevent damage to the transformer.

C. Prevent damage to the feeder breaker.

D. Prevent damage to the 480V MCC.

ANSWER: A.



TOPIC: Bkrs, Rlys, and Disconnects

A 480 VAC motor control center supplies a load through a breaker and a manual disconnect switch. Which one of the following sequences will provide the greatest level of personnel safety when de-energizing the load for maintenance, and when re-energizing the load after the maintenance is complete?

	DE-ENERGIZING	RE-ENERGIZING
A.	Open breaker first	Shut breaker first
B.	Open breaker first	Shut disconnect switch first
C.	Open disconnect switch first	Shut breaker first
D.	Open disconnect switch first	Shut disconnect switch first

ANSWER: B.

TOPIC: Bkrs, Rlys, and Disconnects

Refer to the simplified drawing of an electrical distribution system showing 7.2 KV switchgear, step-down transformers, and 480 V motor control centers (MCCs) (see figure below).

The high voltage side of each step-down transformer has a remote-operated disconnect. The control circuit for each disconnect is position-interlocked with the associated MCC feeder breaker. Which one of the following describes the interlock operating scheme that will provide the greatest protection for the disconnect?

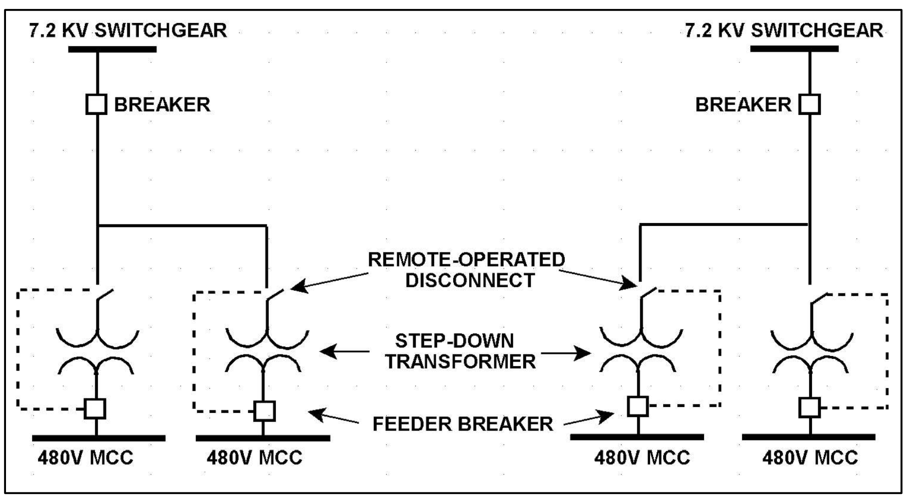
A. Permits opening the feeder breaker only if the disconnect is closed.

B. Permits opening the feeder breaker only if the disconnect is open.

C. Permits opening the disconnect only if the feeder breaker is closed.

D. Permits opening the disconnect only if the feeder breaker is open.

ANSWER: D.



TOPIC: Bkrs, Rlys, and Disconnects

The following remote indications are observed for a 480 VAC load center supply breaker. (The breaker is normally open.)

Red indicating light is lit.
Green indicating light is out.
Load center voltage indicates 0 volts.
Breaker incoming voltage indicates 480 volts.

What is the condition of the breaker?

A. Open and racked in

B. Closed and racked in

C. Open and racked to the TEST position

D. Closed and racked to the TEST position

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

The following indications are observed in the control room for a normally-open motor control center (MCC) breaker that directly starts/stops a 480 VAC motor:

Red position indicating light is out.
Green position indicating light is out.
Motor ammeter indicates normal load current.

Assuming one of the indicating lights is burned out, what is the condition of the breaker?

A. Open and racked in

B. Open and racked to the TEST position

C. Closed and racked in

D. Closed and racked to the TEST position

ANSWER: C.

TOPIC: Bkrs, Rlys, and Disconnects

The following indications are observed in the control room for a normally-open motor control center (MCC) breaker that directly starts/stops a 480 VAC motor:

Red position indicating light is lit.
Green position indicating light is out.
Motor load current indicates 0 amps.
MCC voltage indicates 480 volts.

What is the condition of the breaker?

A. Open and racked in

B. Closed and racked in

C. Open and racked to the TEST position

D. Closed and racked to the TEST position

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

The following indications are observed in the control room for a normally-open breaker that directly starts/stops a 480 VAC motor:

Red position indicating light is lit.
Green position indicating light is out.
Load current indicates 50 amps.
Supply voltage indicates 480 volts.

What is the condition of the breaker?

A. Open and racked to the TEST position

B. Closed and racked to the TEST position

C. Open and racked in

D. Closed and racked in

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

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

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

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

A. open; in

B. closed; in

C. open; out

D. closed; out

ANSWER: B.

TOPIC: Bkrs, Rlys, and Disconnects

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

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

Based on these indications, the operator can accurately report that the breaker is open and racked to __________ position.

A. the OUT

B. the IN

C. the TEST

D. an unknown

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

While remotely investigating the condition of a normally-open 480 VAC motor control center (MCC) feeder breaker, an operator observes the following indications:

Green breaker position indicating light is out.
Red breaker position indicating light is lit.
MCC voltmeter indicates 480 VAC.
MCC ammeter indicates zero amperes.

Based on these indications, the operator should report that the feeder breaker is __________ and racked __________.

A. open; in

B. closed; in

C. open; to the TEST position

D. closed; to the TEST position

ANSWER: B.

TOPIC: Bkrs, Rlys, and Disconnects

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

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

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

A. A ground fault caused an automatic breaker trip.

B. A loss of control power caused an automatic breaker trip.

C. An operator opened the breaker locally at the breaker cabinet.

D. An operator opened the breaker remotely from the control room.

ANSWER: C.

TOPIC: Bkrs, Rlys, and Disconnects

While remotely investigating the condition of a normally-open feeder breaker to a 480 VAC motor control center (MCC), a control room operator observes the following indications:

Green breaker position indicating light is out.
Red breaker position indicating light is lit.
MCC voltmeter indicates 0 VAC.
MCC ammeter indicates zero amperes.

Based on these indications, the operator should report that the feeder breaker is __________ and racked __________.

A. open; in

B. closed; out

C. open; to the TEST position

D. closed; to the TEST position

ANSWER: D.

TOPIC: Bkrs, Rlys, and Disconnects

While remotely investigating the condition of a normally-open 480 VAC motor control center (MCC) feeder breaker, an operator observes the following indications:

Green breaker position indicating light is out.
Red breaker position indicating light is lit.
MCC voltmeter indicates 480 VAC.
MCC ammeter indicates zero amperes.

Based on these indications, the operator should report that the feeder breaker is __________ and racked __________.

A. open; in

B. closed; in

C. open; to an unknown position

D. closed; to an unknown position

ANSWER: B.

TOPIC: Bkrs, Rlys, and Disconnects

Breaker local overcurrent trip flag indicators, when actuated, indicate that...

A. a breaker trip will occur unless current is reduced.

B. a breaker overcurrent condition is responsible for a breaker trip.

C. an overcurrent condition has cleared and the breaker can be closed.

D. the associated breaker has failed to trip open during an overcurrent condition.

ANSWER: B.

TOPIC: Bkrs, Rlys, and Disconnects

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

The local OPEN/CLOSED mechanical flag indicates OPEN.
A breaker overcurrent trip flag is actuated on one phase.
The line-side voltmeter indicates 4,160 VAC.
The load-side voltmeter indicates 0 VAC.

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

A. A ground fault caused an automatic breaker trip.

B. A loss of control power caused an automatic breaker trip.

C. An operator opened the breaker locally.

D. An operator opened the breaker from a remote location.

ANSWER: A.

TOPIC: Neutrons

Delayed neutrons are fission neutrons that...

A. are released at the instant of fission.

B. are responsible for the majority of U-235 fissions.

C. have reached thermal equilibrium with the surrounding medium.

D. are expelled at a lower average kinetic energy than most other fission neutrons.

ANSWER: D.

TOPIC: Neutrons

Delayed neutrons are neutrons that...

A. are responsible for the majority of U-235 fissions.

B. are expelled within 1.0 x 10^{-14} seconds of the fission event.

C. have reached thermal equilibrium with the surrounding medium.

D. are produced from the radioactive decay of certain fission fragments.

ANSWER: D.

TOPIC: Neutrons

Which one of the following is a characteristic of a prompt neutron?

A. Expelled with an average kinetic energy of 0.5 MeV.

B. Usually emitted by the excited nucleus of a fission product.

C. Accounts for more than 99 percent of fission neutrons.

D. Released an average of 13 seconds after the fission event.

ANSWER: C.

TOPIC: Neutrons

A neutron that is expelled 1.0 x 10^{-2} seconds after the associated fission event is a __________ neutron.

A. thermal

B. delayed

C. prompt

D. capture

ANSWER: B.

TOPIC: Neutrons

A neutron that is expelled 1.0 x 10^{-6} seconds after the associated fission event is a __________ neutron.

A. thermal

B. prompt

C. delayed

D. capture

ANSWER: C.

TOPIC: Neutrons

Which one of the following types of neutrons has an average neutron generation lifetime of 12.5 seconds?

A. Prompt

B. Delayed

C. Fast

D. Thermal

ANSWER: B.

TOPIC: Neutrons

In a comparison between a delayed neutron and a prompt neutron produced from the same fission event, the prompt neutron is more likely to... (Assume that both neutrons remain in the core.)

A. require a greater number of collisions to become a thermal neutron.

B. be captured by U-238 at a resonance energy peak between 1 eV and 1000 eV.

C. be expelled with a lower kinetic energy.

D. cause thermal fission of a U-235 nucleus.

ANSWER: A.

TOPIC: Neutrons

In a comparison between a delayed neutron and a prompt neutron produced from the same fission event, the prompt neutron is more likely to... (Assume that both neutrons remain in the core.)

A. cause fast fission of a U-238 nucleus.

B. be captured by a U-238 nucleus at a resonance energy between 1 eV and 1000 eV.

C. be captured by a Xe-135 nucleus.

D. cause thermal fission of a U-235 nucleus.

ANSWER: A.

TOPIC: Neutrons

A neutron that is released 1.0×10^{-10} seconds after the associated fission event is classified as a __________ fission neutron.

A. delayed

B. prompt

C. thermal

D. spontaneous

ANSWER: A.

TOPIC: Neutrons

In a comparison between a prompt neutron and a delayed neutron produced from the same fission event, the delayed neutron requires __________ collisions in the moderator to become thermal; and is __________ likely to cause fission of a U-238 nucleus. (Assume that both neutrons remain in the core.)

A. more; more

B. more; less

C. fewer; more

D. fewer; less

ANSWER: D.

TOPIC: Neutrons

In a comparison between a delayed neutron and a prompt neutron produced from the same fission event, the prompt neutron is more likely to...

A. be captured by a Xe-135 nucleus.

B. cause thermal fission of a U-235 nucleus.

C. leak out of the core while slowing down.

D. be captured by a U-238 nucleus at a resonance energy.

ANSWER: C.

TOPIC: Neutrons

In a comparison between a delayed neutron and a prompt neutron produced from the same fission event, the delayed neutron is more likely to...

A. leak out of the core.

B. cause fission of a U-238 nucleus.

C. become a thermal neutron.

D. cause fission of a Pu-240 nucleus.

ANSWER: C.

TOPIC: Neutrons

During a brief time interval in a typical reactor operating steady-state near the beginning of a fuel cycle, 1.0 x 10^3 delayed neutrons were emitted.

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

A. 1.5 x 10^5

B. 6.5 x 10^6

C. 1.5 x 10^7

D. 6.5 x 10^8

ANSWER: A.

TOPIC: Neutrons

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 until it interacts with a U-238 nucleus.)

A. A thermal neutron.

B. A prompt fission neutron beginning to slow down.

C. A delayed fission neutron beginning to slow down.

D. A fission neutron at a U-238 resonance energy.

ANSWER: B.

TOPIC: Neutrons

A neutron that appears 1.0×10^{-16} seconds after the associated fission event is classified as a __________ fission neutron.

A. delayed

B. prompt

C. thermal

D. spontaneous

ANSWER: B.

TOPIC: Neutrons

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

A. cause fission of a U-238 nucleus.

B. travel to an adjacent fuel assembly.

C. be absorbed in a B-10 nucleus.

D. leak out of the core.

ANSWER: C.

TOPIC: Neutrons

Which one of the following is the process that produces the majority of delayed neutrons in an operating nuclear power plant reactor?

A. A thermal neutron is absorbed by a fuel nucleus. After a period of time, the nucleus fissions and releases a delayed neutron.

B. A thermal neutron is absorbed by a fuel nucleus. The fuel nucleus fissions. During the decay process of the fission products, a delayed neutron is emitted.

C. A fast neutron is absorbed by a fuel nucleus. After a period of time, the nucleus fissions and releases a delayed neutron.

D. A fast neutron is absorbed by a fuel nucleus. The fuel nucleus fissions. During the decay process of the fission products, a delayed neutron is emitted.

ANSWER: B.

TOPIC: Neutrons

Which one of the following is the process that produces the majority of prompt neutrons in an operating nuclear power plant reactor?

A. A thermal neutron is absorbed by a fuel nucleus. Almost immediately, the nucleus fissions and emits one or more prompt neutrons.

B. A thermal neutron is absorbed by a fuel nucleus. Almost immediately, the fuel nucleus fissions and produces fission products. During the decay of the fission products, one or more prompt neutrons are emitted.

C. A fast neutron is absorbed by a fuel nucleus. Almost immediately, the nucleus fissions and emits one or more prompt neutrons.

D. A fast neutron is absorbed by a fuel nucleus. Almost immediately, the fuel nucleus fissions and produces fission products. During the decay of the fission products, one or more prompt neutrons are emitted.

ANSWER: A.

TOPIC: Neutrons

Which one of the following nuclei will cause the greater loss of kinetic energy from a 2.1 MeV fission neutron during a head-on collision? (Assume that each nucleus is stationary just prior to the collision and the neutron is elastically scattered in all cases.)

A. A helium-4 nucleus in the fuel rod fill gas.

B. An oxygen-16 nucleus in the reactor coolant.

C. A zirconium-90 nucleus in the fuel cladding.

D. A uranium-235 nucleus in a fuel pellet.

ANSWER: A.

TOPIC: Neutrons

Delayed neutrons are fission neutrons that...

A. have an average lifetime of about 80 seconds.

B. have an average kinetic energy of about 2 MeV.

C. are responsible for less than one percent of all fissions.

D. are in thermal equilibrium with the surrounding medium.

ANSWER: C.

TOPIC: Neutron Life Cycle

Initially, a reactor is subcritical with the effective multiplication factor (K_{eff}) equal to 0.998. After a brief withdrawal of control rods, K_{eff} equals 1.002. The reactor is currently...

A. prompt critical.

B. supercritical.

C. exactly critical.

D. subcritical.

ANSWER: B.

TOPIC: Neutron Life Cycle

Which one of the following conditions describes a reactor that is exactly critical?

A. $K_{eff} = 0$; $\Delta K/K = 0$

B. $K_{eff} = 0$; $\Delta K/K = 1$

C. $K_{eff} = 1$; $\Delta K/K = 0$

D. $K_{eff} = 1$; $\Delta K/K = 1$

ANSWER: C.

TOPIC: Neutron Life Cycle

The ratio of the number of neutrons in one generation to the number of neutrons in the previous generation is the...

A. effective multiplication factor.

B. fast fission factor.

C. nonleakage factor.

D. reproduction factor.

ANSWER: A.

TOPIC: Neutron Life Cycle

The effective multiplication factor (K_{eff}) can be determined by dividing the number of neutrons in the third generation by the number of neutrons in the __________ generation.

A. first

B. second

C. third

D. fourth

ANSWER: B.

TOPIC: Neutron Life Cycle

The effective multiplication factor (K_{eff}) describes the ratio of the number of fission neutrons at the end of one generation to the number of fission neutrons at the __________ of the __________ generation.

A. beginning; next

B. beginning; previous

C. end; next

D. end; previous

ANSWER: D.

TOPIC: Neutron Life Cycle

A thermal neutron is about to interact with a U-238 nucleus in an operating reactor. Which one of the following describes the most likely interaction and its effect on K_{eff}?

A. The neutron will be scattered, thereby leaving K_{eff} unchanged.

B. The neutron will be absorbed and the nucleus will fission, thereby decreasing K_{eff}.

C. The neutron will be absorbed and the nucleus will fission, thereby increasing K_{eff}.

D. The neutron will be absorbed and the nucleus will decay to Pu-239, thereby increasing K_{eff}.

ANSWER: A.

TOPIC: Neutron Life Cycle

A nuclear power plant is currently operating at steady-state 80 percent power near the end of its fuel cycle. During the next 3 days of steady-state power operation, no operator action is taken.

How will K_{eff} be affected during the 3-day period?

A. K_{eff} will gradually increase during the entire period.

B. K_{eff} will gradually decrease during the entire period.

C. K_{eff} will tend to increase, but inherent reactivity feedback will maintain K_{eff} at 1.0.

D. K_{eff} will tend to decrease, but inherent reactivity feedback will maintain K_{eff} at 1.0.

ANSWER: D.

TOPIC: Neutron Life Cycle

A 1.5 MeV neutron is about to interact with a U-238 nucleus in an operating reactor. Which one of the following describes the most likely interaction and its effect on K_{eff}?

A. The neutron will be scattered, thereby leaving K_{eff} unchanged.

B. The neutron will be absorbed and the nucleus will fission, thereby decreasing K_{eff}.

C. The neutron will be absorbed and the nucleus will fission, thereby increasing K_{eff}.

D. The neutron will be absorbed and the nucleus will decay to Pu-239, thereby increasing K_{eff}.

ANSWER: A.

TOPIC: Neutron Life Cycle

Which one of the following defines K-excess?

A. $K_{eff} - 1$

B. $K_{eff} + 1$

C. $(K_{eff} - 1)/K_{eff}$

D. $(1-K_{eff})/K_{eff}$

ANSWER: A.

TOPIC: Neutron Life Cycle

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

A. To compensate for the conversion of U-238 to Pu-239 during a fuel cycle.

B. To compensate for burnout of Xe-135 and Sm-149 during a power increase.

C. To ensure the fuel temperature coefficient remains negative during a fuel cycle.

D. To compensate for the negative reactivity added by the power coefficient during a power increase.

ANSWER: D.

TOPIC: Neutron Life Cycle

A reactor is operating at full power at the beginning of a fuel cycle. A neutron has just been absorbed by a U-238 nucleus at a resonance energy of 6.7 electron volts.

Which one of the following describes the most likely reaction for the newly formed U-239 nucleus and the effect of this reaction on K_{excess}?

A. Decays over several days to Pu-239, which increases K_{excess}.

B. Decays over several days to Pu-240, which increases K_{excess}.

C. Immediately undergoes fast fission, which decreases K_{excess}.

D. Immediately undergoes thermal fission, which decreases K_{excess}.

ANSWER: A.

TOPIC: Neutron Life Cycle

Which one of the following is a benefit of installing excess reactivity (K_{excess}) in a reactor?

A. Ensures that sufficient control rod negative reactivity is available to shut down the reactor.

B. Ensures that the reactor can be made critical during a peak xenon condition after a reactor trip.

C. Ensures that positive reactivity additions result in controllable reactor power responses.

D. Ensures that the U-235 fuel enrichment is the same at the beginning and the end of a fuel cycle.

ANSWER: B.

TOPIC: Neutron Life Cycle

The shutdown margin determination for an operating reactor assumes the complete withdrawal of…

A. a single control rod of high reactivity worth.

B. a symmetrical pair of control rods of high reactivity worth.

C. a single control rod of average reactivity worth.

D. a symmetrical pair of control rods of average reactivity worth.

ANSWER: A.

TOPIC: Neutron Life Cycle

A reactor is operating at steady-state 100 percent power with manual rod control about three months from the end of a fuel cycle. During the next two weeks of operation at 100 percent power, the available shutdown margin will... (Assume no operator actions are taken.)

A. continuously increase.

B. continuously decrease.

C. initially increase, and then decrease.

D. initially decrease, and then increase.

ANSWER: A.

TOPIC: Neutron Life Cycle

Reactivity is defined as the fractional change in...

A. reactor power per second.

B. neutron population per second.

C. reactor period from criticality.

D. the effective multiplication factor from criticality.

ANSWER: D.

TOPIC: Neutron Life Cycle

Which term is described by the following?

"The fractional change of the effective multiplication factor from criticality."

A. 1/M

B. K_{eff}

C. Reactor period

D. Reactivity

ANSWER: D.

TOPIC: Neutron Life Cycle

With K_{eff} equal to 0.985, how much reactivity must be added to make the reactor critical? (Round answer to the nearest 0.01 %ΔK/K.)

A. 1.48 %ΔK/K

B. 1.50 %ΔK/K

C. 1.52 %ΔK/K

D. 1.54 %ΔK/K

ANSWER: C.

TOPIC: Neutron Life Cycle

With K_{eff} equal to 0.987, how much reactivity must be added to make the reactor critical? (Round answer to the nearest 0.01 %ΔK/K.)

A. 1.01 %ΔK/K

B. 1.03 %ΔK/K

C. 1.30 %ΔK/K

D. 1.32 %ΔK/K

ANSWER: D.

TOPIC: Neutron Life Cycle

In a subcritical reactor, K_{eff} was increased from 0.85 to 0.95 by rod withdrawal. Which one of the following is the approximate amount of reactivity that was added to the core?

A. 0.099 $\Delta K/K$

B. 0.124 $\Delta K/K$

C. 0.176 $\Delta K/K$

D. 0.229 $\Delta K/K$

ANSWER: B.

TOPIC: Neutron Life Cycle

With K_{eff} equal to 0.982, how much positive reactivity is required to make the reactor critical? (Round answer to the nearest 0.01 %ΔK/K.)

A. 1.72 %ΔK/K

B. 1.77 %ΔK/K

C. 1.80 %ΔK/K

D. 1.83 %ΔK/K

ANSWER: D.

TOPIC: Neutron Life Cycle

With K_{eff} equal to 0.985, how much positive reactivity is required to make the reactor critical? (Round answer to the nearest 0.01 %ΔK/K.)

A. 1.49 %ΔK/K

B. 1.50 %ΔK/K

C. 1.52 %ΔK/K

D. 1.55 %ΔK/K

ANSWER: C.

TOPIC: Neutron Life Cycle

With K_{eff} equal to 0.983, how much positive reactivity must be added to make the reactor critical? (Round answer to the nearest 0.01 %ΔK/K.)

A. 1.70 %ΔK/K

B. 1.73 %ΔK/K

C. 3.40 %ΔK/K

D. 3.43 %ΔK/K

ANSWER: B.

TOPIC: Neutron Life Cycle

Initially, a reactor was shutdown at a stable power level of 2.0×10^{-5} percent. After a small positive reactivity addition, the current stable power level is 3.0×10^{-5} percent. If the initial K_{eff} was 0.982, what is the current K_{eff}?

A. 0.988

B. 0.992

C. 0.996

D. Cannot be determined without additional information.

ANSWER: A.

TOPIC: Neutron Life Cycle

A reactor was operating at steady-state 100 percent power with all control rods fully withdrawn and average coolant temperature (T_{ave}) at 588°F when a reactor trip occurred.

After the trip, T_{ave} stabilized at the no-load temperature of 557°F and all control rods were verified to be fully inserted.

Given the following information, select the current value of core reactivity. (Assume no operator actions and disregard any reactivity effects of xenon.)

Power coefficient	=	-0.015 %ΔK/K/percent
Control rod worth	=	-6.918 %ΔK/K
Moderator temperature coefficient	=	-0.0012 %ΔK/K/°F

A. -5.381 %ΔK/K

B. -5.418 %ΔK/K

C. -8.383 %ΔK/K

D. -8.418 %ΔK/K

ANSWER: B.

TOPIC: Neutron Life Cycle

A reactor is operating at steady-state 90 percent power with all control rods fully withdrawn and average coolant temperature (T_{ave}) at 580°F. A reactor trip occurs, after which T_{ave} stabilizes at the no-load temperature of 550°F and all control rods are verified to be fully inserted.

Given the following information, calculate the current value of core reactivity. (Assume no operator actions and disregard any reactivity effects of changes in xenon-135.)

Power coefficient	= -0.01 %ΔK/K/percent
Control rod worth	= -6.918 %ΔK/K
Moderator temperature coefficient	= -0.01 %ΔK/K/°F

A. -5.718 %ΔK/K

B. -6.018 %ΔK/K

C. -7.518 %ΔK/K

D. -7.818 %ΔK/K

ANSWER: B.

TOPIC: Neutron Life Cycle

Reactors A and B are identical except that reactor A is operating at steady-state 80 percent power, while reactor B is operating at steady-state 100 percent power. Initial control rod positions are the same for both reactors.

How will the shutdown margins (SDM) compare for the two reactors following a reactor trip? (Assume no post-trip operator actions are taken that would affect SDM.)

A. Immediately after the reactor trip, reactor A will have the greater SDM.

B. Immediately after the reactor trip, reactor B will have the greater SDM.

C. When sufficient time has passed to allow both cores to become xenon-free, the SDMs will be equal.

D. Within a few minutes after the reactors have tripped, when all parameters have returned to normal post-trip conditions, the SDMs will be equal.

ANSWER: A.

TOPIC: Neutron Life Cycle

A reactor is initially operating at steady-state 60 percent power near the end of a fuel cycle 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 available shutdown margin (SDM), the current available SDM is __________; and compared to the initial core K_{eff}, the current core K_{eff} is __________.

A. the same; smaller

B. the same; the same

C. less negative; smaller

D. less negative; the same

ANSWER: B.

TOPIC: Neutron Life Cycle

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

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

A. Reactor A, because the power coefficient is less negative near the BOC.

B. Reactor A, because the concentration of U-235 in the fuel rods is higher near the BOC.

C. Reactor B, because the power coefficient is more negative near the EOC.

D. Reactor B, because the concentration of U-235 in the fuel rods is lower near the EOC.

ANSWER: A.

TOPIC: Neutron Life Cycle

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

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

A. Reactor A, because the pre-trip reactor coolant boron concentration is lower near the BOC.

B. Reactor A, because the power coefficient adds less positive reactivity after a trip near the BOC.

C. Reactor B, because the pre-trip reactor coolant boron concentration is higher near the EOC.

D. Reactor B, because the power coefficient adds more positive reactivity after a trip near the EOC.

ANSWER: D.

TOPIC: Neutron Life Cycle

A nuclear reactor is shut down with the reactor vessel head removed for refueling. The core is covered by 23 feet of refueling water at 100°F. Source range count rate indicates 100 cps.

How will the source range count rate be affected if refueling water temperature increases to 120°F?

A. The count rate will increase, because the positive effect of increased core neutron leakage more than offsets the negative effect of a smaller K_{eff}.

B. The count rate will increase, because the positive effect of increased core neutron leakage adds to the positive effect of a greater K_{eff}.

C. The count rate will decrease, because the negative effect of decreased core neutron leakage more than offsets the positive effect of a greater K_{eff}.

D. The count rate will decrease, because the negative effect of decreased core neutron leakage adds to the negative effect of a smaller K_{eff}.

ANSWER: B.

TOPIC: Neutron Life Cycle

A reactor is currently operating at steady-state 100 percent power near the beginning of a fuel cycle (BOC). When the <u>same</u> reactor is operating at steady-state 100 percent power near the end of a fuel cycle (EOC), how will the BOC and EOC shutdown margins compare? Assume the control rods are fully withdrawn, and the total reactivity worths of the control rods are the same at BOC and EOC.

A. The EOC shutdown margin will be more negative because the power defect will add less positive reactivity immediately after a reactor trip near the EOC.

B. The EOC shutdown margin will be less negative because the power defect will add more positive reactivity immediately after a reactor trip near the EOC.

C. The EOC shutdown margin will be more negative because xenon-135 will add more negative reactivity immediately after a reactor trip near the EOC.

D. The EOC shutdown margin will be less negative because xenon-135 will add less negative reactivity immediately after a reactor trip near the EOC.

ANSWER: B.

TOPIC: Reactor Kinetics and Neutron Sources

Which one of the following is a characteristic of subcritical multiplication?

A. The subcritical neutron level is directly proportional to the neutron source strength.

B. Doubling the indicated count rate by reactivity additions will reduce the margin to criticality by approximately one quarter.

C. For equal reactivity additions, it takes less time for the new equilibrium source range count rate to be reached as K_{eff} approaches unity.

D. An incremental withdrawal of any given control rod will produce an equivalent equilibrium count rate increase, whether K_{eff} is 0.88 or 0.92.

ANSWER: A.

TOPIC: Reactor Kinetics and Neutron Sources

A nuclear power plant has been operating at 100 percent power for 2 months when a reactor trip occurs. Two months after the reactor trip, with all control rods still fully inserted, a stable count rate of 20 cps is indicated on the source range nuclear instruments.

The majority of the source range count rate is being caused by the interaction of __________ with the detector.

A. intrinsic source neutrons

B. fission gammas from previous power operation

C. fission neutrons from subcritical multiplication

D. delayed fission neutrons from previous power operation

ANSWER: C.

TOPIC: Reactor Kinetics and Neutron Sources

The total neutron flux in a shutdown reactor is constant at 5.0×10^3 n/cm^2-sec. If non-fission neutron sources are supplying a constant flux of 1.0×10^2 n/cm^2-sec, what is K_{eff}?

A. 0.98

B. 0.96

C. 0.94

D. Cannot be determined without additional information.

ANSWER: A.

TOPIC: Reactor Kinetics and Neutron Sources

Reactor power was increased from 1.0 x 10^{-9} percent to 1.0 x 10^{-6} percent in 6 minutes. The average startup rate was __________ decades per minute.

A. 0.5

B. 1.3

C. 2.0

D. 5.2

ANSWER: A.

TOPIC: Reactor Kinetics and Neutron Sources

Reactor power increases from 1.0×10^{-8} percent to 5.0×10^{-7} percent in two minutes. What was the average startup rate during the power increase?

A. 0.95 DPM

B. 0.90 DPM

C. 0.85 DPM

D. 0.82 DPM

ANSWER: C.

TOPIC: Reactor Kinetics and Neutron Sources

During a reactor startup, reactor power increases from 1.0×10^{-8} percent to 2.0×10^{-8} percent in two minutes. What was the average reactor period during the power increase?

A. 173 seconds

B. 235 seconds

C. 300 seconds

D. 399 seconds

ANSWER: A.

TOPIC: Reactor Kinetics and Neutron Sources

During a reactor startup, reactor power increases from 3.0×10^{-6} percent to 5.0×10^{-6} percent in two minutes. What was the average reactor period during the power increase?

A. 357 seconds

B. 235 seconds

C. 155 seconds

D. 61 seconds

ANSWER: B.

TOPIC: Reactor Kinetics and Neutron Sources

A small amount of positive reactivity is added to a reactor that is critical in the source range. The amount of reactivity added is much less than the effective delayed neutron fraction.

Which one of the following will have the most significant effect on the magnitude of the stable reactor period achieved for this reactivity addition while the reactor is in the source range?

A. Prompt neutron lifetime

B. Fuel temperature coefficient

C. Moderator temperature coefficient

D. Effective delayed neutron precursor decay constant

ANSWER: D.

TOPIC: Reactor Kinetics and Neutron Sources

A nuclear power plant is operating at steady-state 50 percent power in the middle of a fuel cycle. Which one of the following will initially produce a positive startup rate?

A. Main turbine runback.

B. Unintentional boration.

C. Increase in main turbine load.

D. Closure of a letdown isolation valve.

ANSWER: C.

TOPIC: Reactor Kinetics and Neutron Sources

The magnitude of the stable startup rate achieved for a given positive reactivity addition to a critical reactor is dependent on the __________ and __________.

A. prompt neutron lifetime; axial neutron flux distribution

B. prompt neutron lifetime; effective delayed neutron fraction

C. effective delayed neutron precursor decay constant; effective delayed neutron fraction

D. effective delayed neutron precursor decay constant; axial neutron flux distribution

ANSWER: C.

TOPIC: Reactor Kinetics and Neutron Sources

A reactor is critical at 1.0×10^{-8} percent power during a reactor startup. $\bar{\beta}_{eff}$ for this reactor is 0.0072. Which one of the following is the approximate amount of positive reactivity that must be added to the core by control rod withdrawal to attain a stable startup rate of 1.0 DPM?

A. 0.2 %ΔK/K

B. 0.5 %ΔK/K

C. 1.0 %ΔK/K

D. 2.0 %ΔK/K

ANSWER: A.

TOPIC: Reactor Kinetics and Neutron Sources

A reactor is being started for the first time following a refueling outage. Reactor Engineering has determined that during the upcoming fuel cycle, $\bar{\beta}_{eff}$ will range from a maximum of 0.007 to a minimum of 0.005.

Once the reactor becomes critical, control rods are withdrawn to increase reactivity by 0.1 %ΔK/K. Assuming <u>no</u> other reactivity additions, what will the stable reactor period be for this reactor until the point of adding heat is reached?

A. 20 seconds

B. 40 seconds

C. 60 seconds

D. 80 seconds

ANSWER: C.

TOPIC: Reactor Kinetics and Neutron Sources

Reactors A and B are identical except that the reactors are operating at different times in core life. The reactor A effective delayed neutron fraction is 0.007, and the reactor B effective delayed neutron fraction is 0.005. Both reactors are currently subcritical with neutron flux level stable in the source range.

Given:

Reactor A $K_{eff} = 0.999$
Reactor B $K_{eff} = 0.998$

If positive 0.003 $\Delta K/K$ is suddenly added to each reactor, how will the resulting stable startup rates (SUR) compare? (Consider only the reactor response while power is below the point of adding heat.)

A. Reactor A stable SUR will be greater.

B. Reactor B stable SUR will be smaller.

C. Reactors A and B will have the same stable SUR because both reactors will remain subcritical.

D. Reactors A and B will have the same stable SUR because both reactors received the same amount of positive reactivity.

ANSWER: A.

TOPIC: Reactor Kinetics and Neutron Sources

Given the following stable initial conditions for a reactor:

Power level = 1.0×10^{-8} percent
K_{eff} = 0.999
Core $\bar{\beta}_{eff}$ = 0.006

What will the stable reactor period be following an addition of positive 0.15 %ΔK/K reactivity to the reactor? (Assume the stable reactor period occurs before the reactor reaches the point of adding heat.)

A. 30 seconds

B. 50 seconds

C. 80 seconds

D. 110 seconds

ANSWER: D.

TOPIC: Reactor Kinetics and Neutron Sources

Given the following stable initial conditions for a reactor:

Power level = 1.0×10^{-8} percent
K_{eff} = 0.999
Core $\bar{\beta}_{eff}$ = 0.006

What will the stable startup rate be following an addition of positive 0.2 %ΔK/K reactivity to the reactor? (Assume the stable startup rate occurs before the reactor reaches the point of adding heat.)

A. 0.24 DPM

B. 0.33 DPM

C. 0.52 DPM

D. 1.30 DPM

ANSWER: C.

TOPIC: Reactor Kinetics and Neutron Sources

A nuclear power plant has just completed a refueling outage and a reactor startup is in progress. Reactor engineers have determined that during the upcoming fuel cycle, $\bar{\beta}_{eff}$ will range from a minimum of 0.0052 to a maximum of 0.0064.

After the reactor becomes critical, control rods are withdrawn further to increase reactivity by an additional 0.1 %ΔK/K. Assuming <u>no</u> other reactivity changes occur, what will the approximate stable startup rate be for this reactor until the point of adding heat is reached?

A. 1.0 DPM

B. 0.6 DPM

C. 0.5 DPM

D. 0.3 DPM

ANSWER: C.

TOPIC: Reactor Kinetics and Neutron Sources

During a fuel cycle, plutonium isotopes are produced with delayed neutron fractions that are __________ than the delayed neutron fractions for uranium isotopes, thereby causing reactor power transients to be __________ near the end of a fuel cycle.

A. larger; slower

B. larger; faster

C. smaller; slower

D. smaller; faster

ANSWER: D.

TOPIC: Reactor Kinetics and Neutron Sources

Following a reactor trip, when does the startup rate initially stabilize at –1/3 DPM?

A. When decay gamma heating starts adding negative reactivity.

B. When the long-lived delayed neutron precursors have decayed away.

C. When the installed neutron source contribution to the total neutron flux becomes significant.

D. When the short-lived delayed neutron precursors have decayed away.

ANSWER: D.

TOPIC: Reactor Kinetics and Neutron Sources

Delayed neutrons contribute more to reactor stability than prompt neutrons because they __________ the average neutron generation time and are born at a __________ kinetic energy.

A. increase; lower

B. increase; higher

C. decrease; lower

D. decrease; higher

ANSWER: A.

TOPIC: Reactor Kinetics and Neutron Sources

Which one of the following statements describes the effect of changes in the delayed neutron fraction from the beginning of a fuel cycle (BOC) to the end of a fuel cycle (EOC)?

A. A given reactivity addition to a shutdown reactor at EOC yields a larger change in shutdown margin (SDM) than at BOC.

B. A given reactivity addition to a shutdown reactor at EOC yields a smaller change in SDM than at BOC.

C. A given reactivity addition to an operating reactor at EOC results in a higher startup rate (SUR) than at BOC.

D. A given reactivity addition to an operating reactor at EOC results in a lower SUR than at BOC.

ANSWER: C.

TOPIC: Reactor Kinetics and Neutron Sources

Delayed neutrons are important for reactor control because...

A. they are produced with a higher average kinetic energy than prompt neutrons.

B. they prevent the moderator temperature coefficient from becoming positive.

C. they are the largest fraction of the neutrons produced from fission.

D. they greatly extend the average lifetime of each neutron generation.

ANSWER: D.

TOPIC: Reactor Kinetics and Neutron Sources

Two reactors are identical except that reactor A is near the end of a fuel cycle and reactor B is near the beginning of a fuel cycle. Both reactors are operating at 100 percent power when a reactor trip occurs at the same time on each reactor.

If no operator action is taken and the reactor systems for both reactors respond identically to the trip, reactor A will attain a negative __________ second stable period; and reactor B will attain a negative __________ second stable period.

A. 80; 56

B. 80; 80

C. 56; 56

D. 56; 80

ANSWER: B.

TOPIC: Reactor Kinetics and Neutron Sources

Two reactors are identical except that reactor A is near the end of a fuel cycle and reactor B is near the beginning of a fuel cycle. Both reactors are critical at 1.0×10^{-5} percent power.

If the same amount of positive reactivity is added to each reactor at the same time, the point of adding heat will be reached first by reactor __________ because it has a __________ effective delayed neutron fraction.

A. A; smaller

B. A; larger

C. B; smaller

D. B; larger

ANSWER: A.

TOPIC: Reactor Kinetics and Neutron Sources

Two reactors are identical except that reactor A is near the end of core life and reactor B is near the beginning of core life. Both reactors are operating at 100 percent power when a reactor trip occurs at the same time on each reactor. The trips insert equal amounts of negative reactivity, and <u>no</u> operator actions are taken.

For the conditions above, a power level of 1.0×10^{-5} percent will be reached first by reactor __________ because it has the __________ effective delayed neutron fraction.

A. A; larger

B. B; larger

C. A; smaller

D. B; smaller

ANSWER: C.

TOPIC: Reactor Kinetics and Neutron Sources

Which one of the following is the reason that delayed neutrons are so effective at controlling the rate of reactor power changes?

A. Delayed neutrons make up a large fraction of the fission neutrons compared to prompt neutrons.

B. Delayed neutrons have a long mean generation time compared to prompt neutrons.

C. Delayed neutrons produce a large amount of fast fission compared to prompt neutrons.

D. Delayed neutrons are born with high kinetic energy compared to prompt neutrons.

ANSWER: B.

TOPIC: Reactor Kinetics and Neutron Sources

Which one of the following distributions of fission percentages occurring in a reactor will result in the largest effective delayed neutron fraction?

	U-235	U-238	Pu-239
A.	90%	7%	3%
B.	80%	6%	14%
C.	70%	7%	23%
D.	60%	6%	34%

ANSWER: A.

TOPIC: Reactor Kinetics and Neutron Sources

Which one of the following distributions of fission percentages occurring in a reactor will result in the smallest effective delayed neutron fraction?

	U-235	U-238	Pu-239
A.	90%	7%	3%
B.	80%	6%	14%
C.	70%	7%	23%
D.	60%	6%	34%

ANSWER: D.

TOPIC: Reactor Kinetics and Neutron Sources

Two reactors are identical except that reactor A is near the beginning of core life and reactor B is near the end of core life. Both reactors are critical at 10^{-5} percent power.

If the same amount of positive reactivity is added to each reactor at the same time, the point of adding heat will be reached first by reactor __________ because it has a __________ effective delayed neutron fraction.

A. A; smaller

B. A; larger

C. B; smaller

D. B; larger

ANSWER: C.

TOPIC: Reactor Kinetics and Neutron Sources

A nuclear power plant is operating at steady-state 50 percent power when a control rod is ejected from the core. Which one of the following distributions of fission percentages in the core would result in the highest startup rate? (Assume the reactivity worth of the ejected control rod is the same for each distribution.)

	U-235	U-238	Pu-239
A.	90%	8%	2%
B.	80%	7%	13%
C.	70%	7%	23%
D.	60%	8%	32%

ANSWER: D.

TOPIC: Reactor Kinetics and Neutron Sources

Two reactors are identical except that reactor A is near the end of core life and reactor B is near the beginning of core life. Both reactors are operating at 100 percent power when a reactor trip occurs at the same time on each reactor. No operator action is taken and the reactor systems for both reactors respond identically to the trip.

Ten minutes after the trip, the greater thermal neutron flux will exist in reactor __________ because it has a __________ effective delayed neutron fraction.

A. A; larger

B. B; larger

C. A; smaller

D. B; smaller

ANSWER: B.

TOPIC: Reactor Kinetics and Neutron Sources

Two reactors are identical except that reactor A is near the beginning of core life and reactor B is near the end of core life. Both reactors are operating at 100 percent power when a reactor trip occurs at the same time on each reactor. No operator action is taken and the reactor systems for both reactors respond identically to the trip.

Ten minutes after the trip, the greater thermal neutron flux will exist in reactor __________ because it has a __________ effective delayed neutron fraction.

A. A; larger

B. B; larger

C. A; smaller

D. B; smaller

ANSWER: A.

TOPIC: Reactor Kinetics and Neutron Sources

A step positive reactivity addition of 0.001 $\Delta K/K$ is made to a reactor with a stable neutron flux and an initial K_{eff} of 0.99. Consider the following two cases:

Case 1: The reactor is near the beginning of a fuel cycle.
Case 2: The reactor is near the end of a fuel cycle.

Assume the initial neutron flux is the same for each case.

Which one of the following correctly compares the prompt jump in neutron flux levels and the final stable neutron flux levels for the two cases?

A. The prompt jump will be greater for case 1, but the final stable neutron flux level will be the same for both cases.

B. The prompt jump will be greater for case 2, but the final stable neutron flux level will be the same for both cases.

C. The prompt jump will be the same for both cases, but the final stable neutron flux level will be greater for case 1.

D. The prompt jump will be the same for both cases, but the final stable neutron flux level will be greater for case 2.

ANSWER: B.

TOPIC: Reactor Kinetics and Neutron Sources

A reactor is critical in the source range during the initial reactor startup immediately following a refueling outage. The effective delayed neutron fraction is 0.0062. The operator adds positive reactivity to establish a stable 0.5 DPM startup rate.

If the reactor had been near the end of a fuel cycle with an effective delayed neutron fraction of 0.005, what would the approximate stable startup rate be after the addition of the same amount of positive reactivity?

A. 0.55 DPM

B. 0.65 DPM

C. 0.75 DPM

D. 0.85 DPM

ANSWER: B.

TOPIC: Reactor Kinetics and Neutron Sources

The following data is given for the fuel in an operating reactor:

Nuclide	Delayed Neutron Fraction	Fraction of Total Fuel Composition	Fraction of Total Fission Rate
U-235	0.0065	0.03	0.73
U-238	0.0148	0.96	0.07
Pu-239	0.0021	0.01	0.20

What is the delayed neutron fraction for this reactor?

A. 0.0052

B. 0.0054

C. 0.0062

D. 0.0068

ANSWER: C.

TOPIC: Reactor Kinetics and Neutron Sources

The following data is given for the fuel in an operating reactor:

Nuclide	Delayed Neutron Fraction	Fraction of Total Fuel Composition	Fraction of Total Fission Rate
U-235	0.0065	0.023	0.63
U-238	0.0148	0.965	0.07
Pu-239	0.0021	0.012	0.30

What is the delayed neutron fraction for this reactor?

A. 0.0052

B. 0.0058

C. 0.0072

D. 0.0078

ANSWER: B.

TOPIC: Reactor Kinetics and Neutron Sources

Which characteristic of delayed neutrons is primarily responsible for enhancing the stability of a reactor following a reactivity change?

A. They are born at a lower average energy than prompt neutrons.

B. They are more likely to experience resonance absorption than prompt neutrons.

C. They comprise a smaller fraction of the total neutron flux than prompt neutrons.

D. They require more time to be produced following a fission event than prompt neutrons.

ANSWER: D.

TOPIC: Reactor Kinetics and Neutron Sources

For an operating reactor, the effective delayed neutron fraction may differ from the delayed neutron fraction because, compared to prompt neutrons, delayed neutrons...

A. are less likely to leak out of the reactor core, and are less likely to cause fast fission.

B. are less likely to cause fast fission, and require more time to complete a neutron generation.

C. require more time to complete a neutron generation, and spend less time in the resonance absorption energy region.

D. spend less time in the resonance absorption energy region, and are less likely to leak out of the reactor core.

ANSWER: A.

TOPIC: Reactor Kinetics and Neutron Sources

Given the following data for a reactor:

- The average delayed neutron fraction is 0.0068.
- The effective delayed neutron fraction is 0.0065.

The above data indicates that this reactor is operating near the __________ of a fuel cycle; and a typical delayed neutron is __________ likely than a typical prompt neutron to cause another fission in this reactor.

A. beginning; less

B. beginning; more

C. end; less

D. end; more

ANSWER: A.

TOPIC: Reactor Kinetics and Neutron Sources

Initially, a reactor is critical at a stable power level well below the point of adding heat (POAH). When considering the following two cases, assume the reactor remains below the POAH.

Case 1: A step addition of <u>positive</u> 1.0×10^{-4} ΔK/K.
Case 2: A step addition of <u>negative</u> 1.0×10^{-4} ΔK/K.

The time required for reactor power to change by a factor of 10 will be greater for case _____, because delayed neutrons are more effective at slowing reactor power changes when reactor power is __________.

A. 1; increasing

B. 1; decreasing

C. 2; increasing

D. 2; decreasing

ANSWER: D.

TOPIC: Reactor Kinetics and Neutron Sources

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

A. Reactor A, because delayed neutrons are less effective at slowing down power changes when the fission rate is increasing.

B. Reactor B, because delayed neutrons are less effective at slowing down power changes when the fission rate is decreasing.

C. The periods in both reactors will be the same because their effective delayed neutron fractions are the same.

D. The periods in both reactors will be the same because the absolute values of the reactivity additions are the same.

ANSWER: A.

TOPIC: Reactor Kinetics and Neutron Sources

The following data is given for the fuel in an operating reactor just prior to a refueling shutdown.

Nuclide	Delayed Neutron Fraction	Fraction of Total Fission Rate
U-235	0.0065	0.64
U-238	0.0148	0.07
Pu-239	0.0021	0.29

During the refueling, one-third of the fuel assemblies were offloaded and replaced with new fuel assemblies consisting of uranium having an average U-235 enrichment of 3.5 percent by weight.

Which one of the following describes how the above data will change as a result of completing the refueling outage?

A. The delayed neutron fraction for U-235 will decrease.

B. The delayed neutron fraction for Pu-239 will decrease.

C. The fraction of the total fission rate attributed to U-235 will increase.

D. The fraction of the total fission rate attributed to Pu-239 will increase.

ANSWER: C.

TOPIC: Reactor Kinetics and Neutron Sources

Given the following data for the fuel in an operating reactor:

Nuclide	Delayed Neutron Fraction	Cross Section for Thermal Fission	Fraction of Total Fission Rate
U-235	0.0065	531 barns	0.58
U-238	0.0148	< 1 barn	0.06
Pu-239	0.0021	743 barns	0.32
Pu-241	0.0049	1009 barns	0.04

What is the delayed neutron fraction for this reactor?

A. 0.0044

B. 0.0055

C. 0.0063

D. 0.0071

ANSWER: B.

TOPIC: Reactor Kinetics and Neutron Sources

A nuclear reactor is operating at steady-state 100 percent power in the middle of a fuel cycle. Which one of the following changes would cause the core effective delayed neutron fraction to increase?

A. The fast nonleakage factor increases.

B. The fast nonleakage factor decreases.

C. The thermal utilization factor increases.

D. The thermal utilization factor decreases.

ANSWER: B.

TOPIC: Reactor Kinetics and Neutron Sources

Given the following data for a reactor:

- The average delayed neutron fraction is 0.0052.
- The effective delayed neutron fraction is 0.0054.

The above data indicates that the reactor is operating near the __________ of a fuel cycle, and that a typical delayed neutron is __________ likely than a typical prompt neutron to cause another fission in this reactor.

A. beginning; less

B. beginning; more

C. end; less

D. end; more

ANSWER: D.

TOPIC: Reactor Kinetics and Neutron Sources

A reactor core has a delayed neutron importance factor of 1.02. If the average delayed neutron fraction in the core is 0.0057, the effective delayed neutron fraction is...

A. equal to 0.0057.

B. less than 0.0057.

C. greater than 0.0057.

D. unpredictable without additional information.

ANSWER: C.

TOPIC: Reactor Kinetics and Neutron Sources

Which one of the following is the primary reason that delayed neutrons are more effective than prompt neutrons at controlling the rate of reactor power changes?

A. Delayed neutrons have a longer mean generation time than prompt neutrons.

B. Delayed neutrons produce a larger amount of core fissions than prompt neutrons.

C. Delayed neutrons make up a larger fraction of fission neutrons than prompt neutrons.

D. Delayed neutrons are born with a lower average kinetic energy than prompt neutrons.

ANSWER: A.

TOPIC: Reactor Kinetics and Neutron Sources

Two identical reactors, A and B, with identical fuel compositions, are initially critical at 1.0×10^{-8} percent power. Then, suddenly and simultaneously, positive 0.001 $\Delta K/K$ is added to reactor A while negative 0.001 $\Delta K/K$ is added to reactor B.

One minute later, which reactor will have the shorter period, and why? (Note: λ_{eff} is the effective delayed neutron precursor decay constant.)

A. Reactor A, because the value of λ_{eff} shifts toward the value of the decay constant for the shorter-lived delayed neutron precursors when reactivity is positive.

B. Reactor A, because the value of λ_{eff} shifts toward the value of the decay constant for the longer-lived delayed neutron precursors when reactivity is positive.

C. Reactor B, because the value of λ_{eff} shifts toward the value of the decay constant for the shorter-lived delayed neutron precursors when reactivity is negative.

D. Reactor B, because the value of λ_{eff} shifts toward the value of the decay constant for the longer-lived delayed neutron precursors when reactivity is negative.

ANSWER: A.

TOPIC: Reactor Kinetics and Neutron Sources

A reactor is critical at a constant power level of 1.0×10^{-8} percent. Consider the following two cases:

Case 1: A step addition of <u>positive</u> 0.001 $\Delta K/K$.
Case 2: A step addition of <u>negative</u> 0.001 $\Delta K/K$.

Which case will produce the faster rate of power change one minute after the reactivity addition, and why?

A. Case 1, because the effective delayed neutron fraction is smaller during a power increase.

B. Case 1, because the effective delayed neutron precursor decay constant is larger during a power increase.

C. Case 2, because the effective delayed neutron fraction is smaller during a power decrease.

D. Case 2, because the effective delayed neutron precursor decay constant is larger during a power decrease.

ANSWER: B.

TOPIC: Reactor Kinetics and Neutron Sources

Which one of the following describes a condition in which a reactor is <u>prompt</u> critical?

A. A very long reactor period makes reactor control very sluggish and unresponsive.

B. Fissions are occurring so rapidly that the effective delayed neutron fraction approaches zero.

C. Any increase in reactor power requires a reactivity addition equal to the fraction of prompt neutrons in the core.

D. The net positive reactivity in the core is greater than or equal to the magnitude of the effective delayed neutron fraction.

ANSWER: D.

TOPIC: Reactor Kinetics and Neutron Sources

A critical reactor will become <u>prompt</u> critical when the reactivity is equal to the...

A. shutdown margin.

B. effective delayed neutron fraction.

C. effective decay constant.

D. worth of the most reactive rod.

ANSWER: B.

TOPIC: Reactor Kinetics and Neutron Sources

A reactor is operating at 75 percent power with the following conditions:

Power defect	=	-0.0157 Δ/K/K
Shutdown margin	=	0.0241 Δ/K/K
Effective delayed neutron fraction	=	0.0058
Effective prompt neutron fraction	=	0.9942

How much positive reactivity must be added to make the reactor prompt critical?

A. 0.0157 ΔK/K

B. 0.0241 ΔK/K

C. 0.0058 ΔK/K

D. 0.9942 ΔK/K

ANSWER: C.

TOPIC: Reactor Kinetics and Neutron Sources

A reactor with a xenon-free core is critical several decades below the point of adding heat (POAH). The operator continuously withdraws control rods until a positive 0.5 DPM startup rate (SUR) is reached and then stops control rod motion.

When rod motion is stopped, the SUR will immediately... (Ignore any reactivity effects from fission product poisons.)

A. stabilize at 0.5 DPM until power reaches the POAH.

B. decrease, and then stabilize at a value less than 0.5 DPM until power reaches the POAH.

C. stabilize at 0.5 DPM, and then slowly and continuously decrease until power reaches the POAH.

D. decrease, and then continue to slowly decrease until power reaches the POAH.

ANSWER: B.

TOPIC: Reactor Kinetics and Neutron Sources

Which one of the following is the smallest listed value of K_{eff} that will result in a prompt critical reactor?

A. 1.0001

B. 1.001

C. 1.01

D. 1.1

ANSWER: C.

TOPIC: Reactor Kinetics and Neutron Sources

A reactor initially has a stable positive 1.0 DPM startup rate with no control rod motion several decades below the point of adding heat (POAH). Control rods are inserted until a positive 0.5 DPM startup rate is attained and then stopped.

When rod insertion is stopped, startup rate will immediately...

A. stabilize at 0.5 DPM until power reaches the POAH.

B. increase, and then stabilize at a value greater than 0.5 DPM until power reaches the POAH.

C. continuously decrease until startup rate becomes zero when power reaches the POAH.

D. increase, and then slowly and continuously decrease until startup rate becomes zero when power reaches the POAH.

ANSWER: B.

TOPIC: Reactor Kinetics and Neutron Sources

A reactor was stable at 80 percent power when the operator withdrew a control rod continuously for 2 seconds. Which one of the following affects the amount of a prompt jump @ increase in reactor power for the control rod withdrawal?

A. The total control rod worth

B. The differential control rod worth

C. The duration of control rod withdrawal

D. The magnitude of the fuel temperature coefficient

ANSWER: B.

TOPIC: Reactor Kinetics and Neutron Sources

A reactor is operating at steady-state 75 percent power with the following conditions:

Power defect	=	-0.0185 $\Delta K/K$
Shutdown margin	=	-0.0227 $\Delta K/K$
Effective delayed neutron fraction	=	0.0061
Effective prompt neutron fraction	=	0.9939

How much positive reactivity must be added to make the reactor prompt critical?

A. 0.0061 $\Delta K/K$

B. 0.0185 $\Delta K/K$

C. 0.0227 $\Delta K/K$

D. 0.9939 $\Delta K/K$

ANSWER: A.

TOPIC: Reactor Kinetics and Neutron Sources

Refer to the partially labeled reactor response curve shown below for a reactor that was initially stable in the source range. Both axes have linear scales. A small amount of positive reactivity was added at time = 0 sec.

The response curve shows __________ versus time for a reactor that was initially __________.

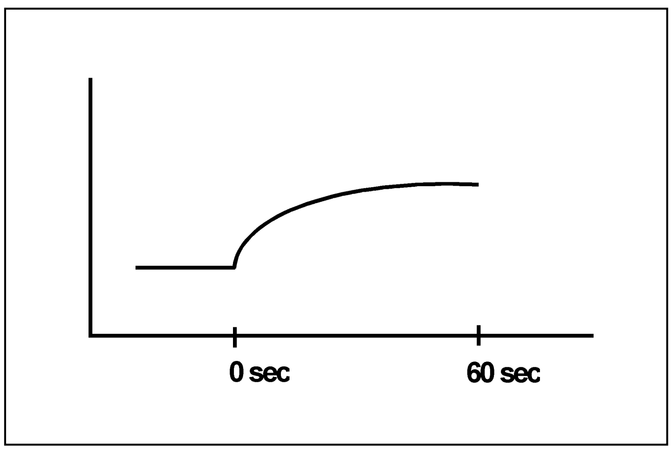
A. startup rate; subcritical

B. startup rate; critical

C. reactor fission rate; subcritical

D. reactor fission rate; critical

ANSWER: C.



TOPIC: Reactor Kinetics and Neutron Sources

Two reactors are critical at the same power level well below the point of adding heat. The reactors are identical except that reactor A is near the beginning of a fuel cycle (BOC) and reactor B is near the end of a fuel cycle (EOC).

If a step addition of positive 0.001 $\Delta K/K$ is added to each reactor, the size of the prompt jump in power level observed in reactor B (EOC) will be __________ than in reactor A (BOC); and the stable startup rate observed in reactor B (EOC) will be __________ than in reactor A (BOC). (Assume the power level in each reactor remains below the point of adding heat.)

A. smaller; smaller

B. smaller; larger

C. larger; smaller

D. larger; larger

ANSWER: D.

TOPIC: Reactor Kinetics and Neutron Sources

Refer to the partially labeled reactor response curve shown below for a reactor that was initially subcritical in the source range and remained below the point of adding heat. 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) __________.

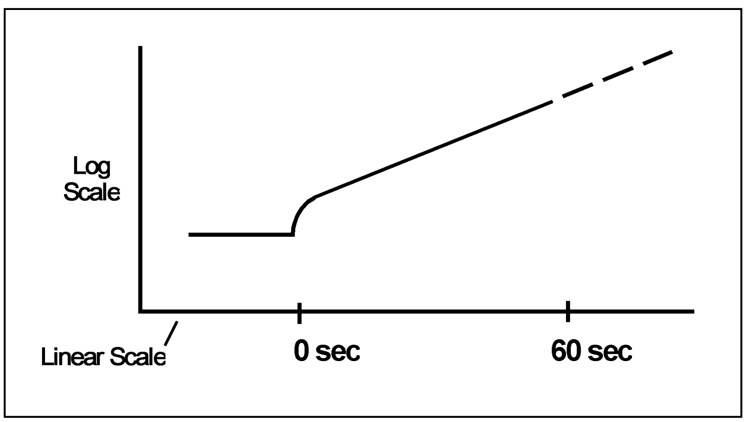
A. startup rate; exactly critical

B. startup rate; supercritical

C. reactor fission rate; exactly critical

D. reactor fission rate; supercritical

ANSWER: D.



TOPIC: Reactor Kinetics and Neutron Sources

A reactor is operating at equilibrium 75 percent power with the following conditions:

Total power defect	= -0.0176 ΔK/K
Shutdown margin	= -0.0234 ΔK/K
Effective delayed neutron fraction	= 0.0067
Effective prompt neutron fraction	= 0.9933

How much positive reactivity must be added to make the reactor prompt critical?

A. 0.0067 ΔK/K

B. 0.0176 ΔK/K

C. 0.0234 ΔK/K

D. 0.9933 ΔK/K

ANSWER: A.

TOPIC: Reactor Kinetics and Neutron Sources

Given the following information for a reactor:

Reactivity (ρ)	= 0.0060
Average delayed neutron fraction ($\bar{\beta}$)	= 0.0058
Effective delayed neutron fraction ($\bar{\beta}_{eff}$)	= 0.0062

The reactor is __________, and the reactor fission rate is __________.

A. prompt critical; constant

B. prompt critical; increasing

C. <u>not</u> prompt critical; constant

D. <u>not</u> prompt critical; increasing

ANSWER: D.

TOPIC: Reactor Kinetics and Neutron Sources

Which one of the following is a characteristic of a neutron source installed in a reactor?

A. Maintains the production of neutrons high enough to allow the reactor to achieve criticality.

B. Provides a means to allow reactivity changes to occur in a subcritical reactor.

C. Generates a sufficient neutron population to start the fission process and initiate subcritical multiplication.

D. Provides a neutron level that is detectable on the source range nuclear instrumentation.

ANSWER: D.

TOPIC: Reactor Kinetics and Neutron Sources

Which one of the following neutron reactions yields the highest neutron production rate immediately following a reactor trip from extended power operations during the tenth fuel cycle? (Ignore any contribution from an installed neutron source.)

A. Alpha-neutron reactions

B. Beta-neutron reactions

C. Photo-neutron reactions

D. Spontaneous fission

ANSWER: C.

TOPIC: Reactor Kinetics and Neutron Sources

Which one of the following neutron sources undergoes the most significant source strength reduction during the hour immediately following a reactor trip from steady-state 100 percent power?

A. Spontaneous fission reactions

B. Photo-neutron reactions

C. Alpha-neutron reactions

D. Transuranic isotope decay

ANSWER: B.

TOPIC: Reactor Kinetics and Neutron Sources

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

A. Spontaneous neutron emission from the control rods.

B. Photo-neutron reactions in the moderator.

C. Spontaneous fission in the fuel.

D. Alpha-neutron reactions in the fuel.

ANSWER: B.

TOPIC: Reactor Kinetics and Neutron Sources

Which one of the following describes the purpose of a neutron source that is installed in a reactor during refueling for the third fuel cycle?

A. Ensures shutdown neutron level is large enough to be detected by nuclear instrumentation.

B. Provides additional excess reactivity to increase the length of the fuel cycle.

C. Amplifies the electrical noise fluctuations observed in source range instrumentation during shutdown.

D. Supplies the only shutdown source of neutrons available to begin a reactor startup.

ANSWER: A.

TOPIC: Reactivity Coefficients

The coolant temperature coefficient describes the change in reactivity per degree change in...

A. fuel temperature.

B. fuel cladding temperature.

C. reactor vessel temperature.

D. reactor coolant temperature.

ANSWER: D.

TOPIC: Reactivity Coefficients

Which one of the following contains two isotopes that add significant negative reactivity when fuel temperature increases near the end of a fuel cycle?

A. U-235 and Pu-239

B. U-235 and Pu-240

C. U-238 and Pu-239

D. U-238 and Pu-240

ANSWER: D.

TOPIC: Reactivity Coefficients

Why does the fuel temperature coefficient becomes <u>less</u> negative at higher fuel temperatures?

A. As reactor power increases, the rate of increase in the fuel temperature diminishes.

B. Neutrons penetrate deeper into the fuel, resulting in an increase in the fast fission factor.

C. The amount of self-shielding increases, resulting in less neutron absorption by the inner fuel.

D. The amount of Doppler broadening per degree change in fuel temperature diminishes.

ANSWER: D.

TOPIC: Reactivity Coefficients

Which one of the following will cause the Doppler power coefficient to become <u>more</u> negative?

A. Increased clad creep

B. Increased pellet swell

C. Lower power level

D. Higher coolant poison concentration

ANSWER: C.

TOPIC: Reactivity Coefficients

A reactor is operating continuously at steady-state 100 percent power. As core burnup increases, the fuel temperature coefficient becomes __________ negative because the average fuel temperature __________.

A. more; decreases

B. more; increases

C. less; decreases

D. less; increases

ANSWER: A.

TOPIC: Reactivity Coefficients

Which one of the following pairs of nuclides is responsible for most of the negative reactivity associated with a fuel temperature increase near the end of a fuel cycle?

A. U-235 and Pu-239

B. U-235 and Pu-240

C. U-238 and Pu-239

D. U-238 and Pu-240

ANSWER: D.

TOPIC: Reactivity Coefficients

Compared to operation at a low power level, the fuel temperature coefficient of reactivity at a high power level is __________ negative due to __________.

A. less; improved pellet-to-clad heat transfer

B. more; buildup of fission product poisons

C. less; higher fuel temperature

D. more; increased neutron flux

ANSWER: C.

TOPIC: Reactivity Coefficients

Refer to the curve of microscopic cross section for absorption versus neutron energy for a resonance peak in U-238 (see figure below).

If fuel temperature increases, the area under the curve will __________; and negative reactivity will be added to the core because __________.

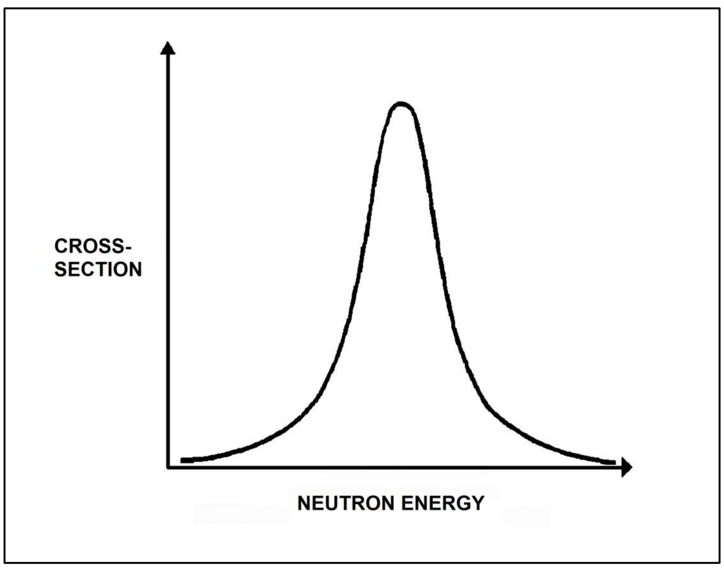
A. increase; neutrons of a wider range of energies will be absorbed by U-238

B. increase; more neutrons will be absorbed by U-238 at the resonance neutron energy

C. remain the same; neutrons of a wider range of energies will be absorbed by U-238

D. remain the same; more neutrons will be absorbed by U-238 at the resonance neutron energy

ANSWER: C.



TOPIC: Reactivity Coefficients

Which one of the following describes how the magnitude of the fuel temperature coefficient of reactivity is affected as the core ages?

A. It remains essentially constant over core life.

B. It becomes more negative, due to the buildup of Pu-240.

C. It becomes less negative, due to the decrease in RCS boron concentration.

D. It becomes more negative initially due to buildup of fissions product poisons, then less negative due to fuel depletion.

ANSWER: B.

TOPIC: Reactivity Coefficients

In a comparison of the fuel temperature coefficient at the beginning and end of a fuel cycle, the fuel temperature coefficient is more negative at the __________ of a fuel cycle because __________. (Assume the same initial fuel temperature throughout the fuel cycle.)

A. end; more Pu-240 is in the core

B. end; more fission product poisons are in the core

C. beginning; more U-238 is in the core

D. beginning; less fission product poisons are in the core

ANSWER: A.

TOPIC: Reactivity Coefficients

Refer to the curve of microscopic cross section for absorption versus neutron energy for a 6.7 electron volt (eV) resonance peak in U-238 for a reactor operating at 50 percent power (see figure below).

If fuel temperature decreases by 50°F, the area under the curve will __________; and positive reactivity will be added to the core because __________.

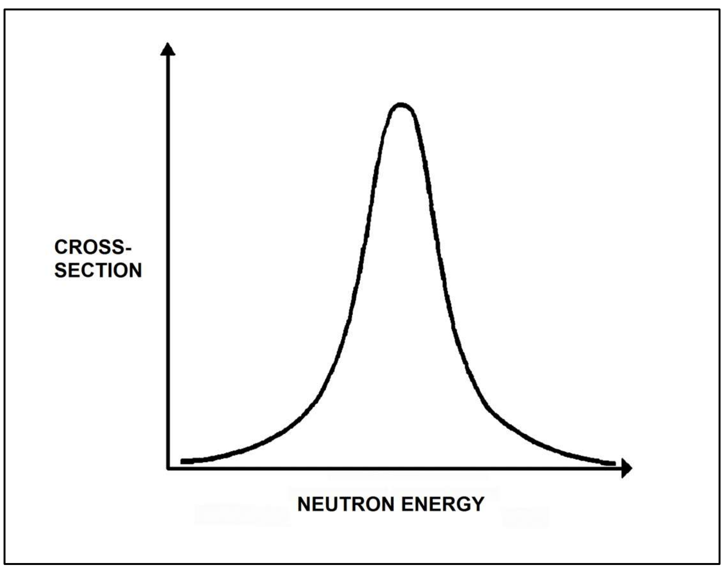
A. decrease; fewer neutrons will be absorbed by U-238 overall

B. decrease; fewer 6.7 eV neutrons will be absorbed by U-238 at the resonance energy

C. remain the same; fewer neutrons will be absorbed by U-238 overall

D. remain the same; fewer 6.7 eV neutrons will be absorbed by U-238 at the resonance energy

ANSWER: C.



TOPIC: Reactivity Coefficients

Refer to the curve of microscopic cross section for absorption versus neutron energy for a resonance peak in U-238 in a reactor operating at 80 percent power (see figure below).

If reactor power is increased to 100 percent, the height of the curve will __________; and the area under the curve will __________.

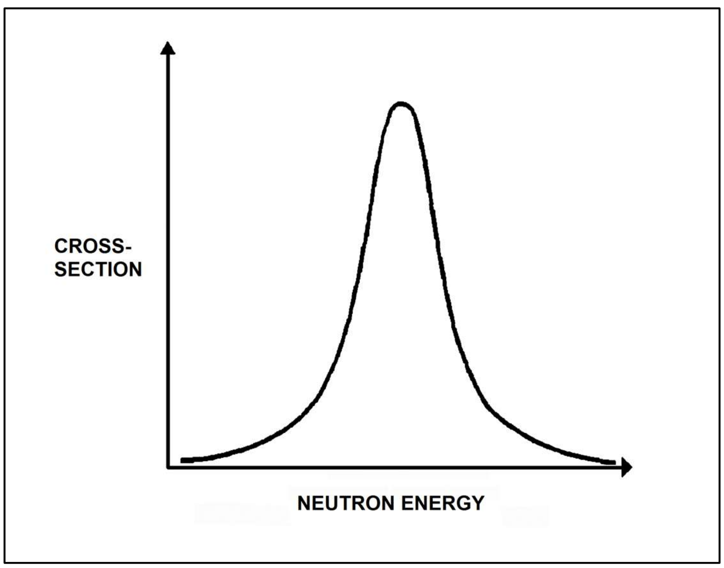
A. increase; increase

B. increase; remain the same

C. decrease; decrease

D. decrease; remain the same

ANSWER: D.



TOPIC: Reactivity Coefficients

Refer to the drawing of a curve showing the neutron absorption characteristics of a typical U-238 nucleus at a resonance neutron energy (see figure below). The associated reactor is currently operating at steady-state 80 percent power.

During a subsequent reactor power decrease to 70 percent, the curve will become __________; and the percentage of the core neutron population lost to resonance capture by U-238 will __________.

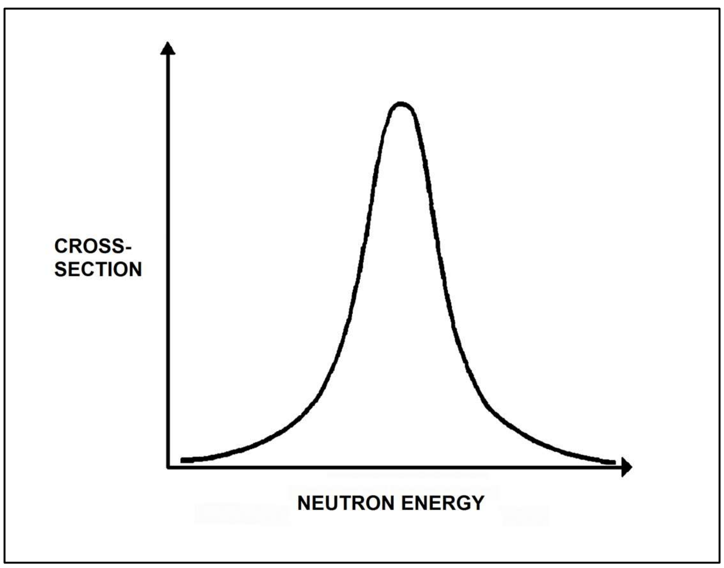
A. shorter and broader; increase

B. shorter and broader; decrease

C. taller and more narrow; increase

D. taller and more narrow; decrease

ANSWER: D.



TOPIC: Reactivity Coefficients

Refer to the curve of microscopic cross section for absorption versus neutron energy for a resonance peak in U-238 in a reactor operating at 80 percent power (see figure below).

If reactor power is decreased to 60 percent, the height of the curve will __________; and the area under the curve will __________.

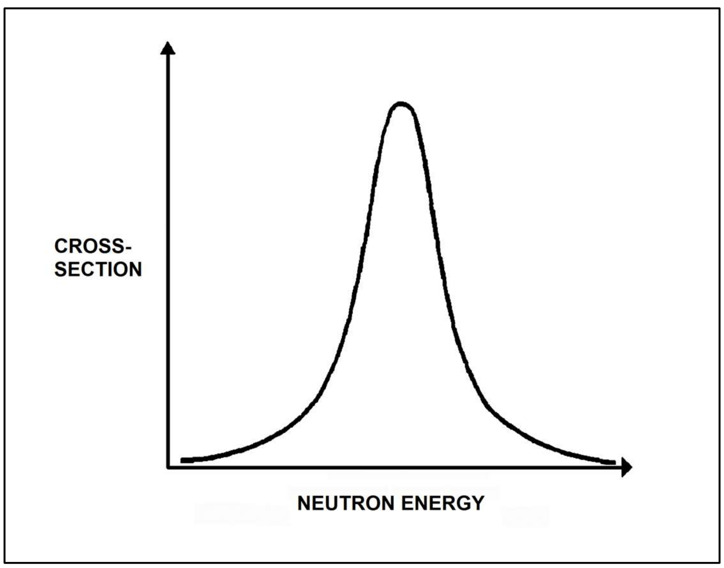
A. increase; increase

B. increase; remain the same

C. decrease; decrease

D. decrease; remain the same

ANSWER: B.



TOPIC: Reactivity Coefficients

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

A. increase; increase

B. increase; decrease

C. decrease; increase

D. decrease; decrease

ANSWER: B.

TOPIC: Reactivity Coefficients

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

A. increase; increase

B. increase; decrease

C. decrease; increase

D. decrease; decrease

ANSWER: C.

TOPIC: Reactivity Coefficients

Refer to the drawing of a curve showing the neutron absorption cross-section for U-238 at a resonance energy (see figure below). The reactor associated with the curve is operating at 80 percent power.

If reactor power is increased to 90 percent over the next few hours, the curve will become ________; and the percentage of the core neutron population lost to resonance capture by U-238 will ________.

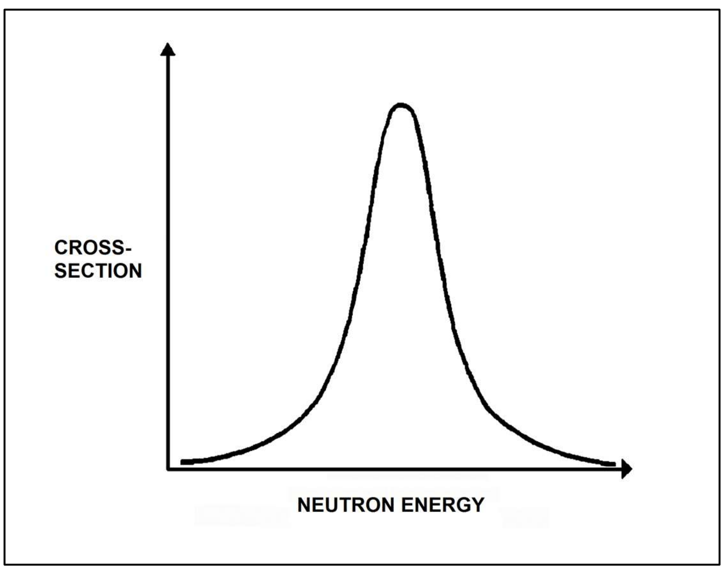
A. shorter and broader; increase

B. shorter and broader; decrease

C. taller and more narrow; increase

D. taller and more narrow; decrease

ANSWER: A.



TOPIC: Reactivity Coefficients

A reactivity coefficient measures a/an __________ change in reactivity, while a reactivity defect measures a __________ change in reactivity.

A. integrated; total

B. integrated; differential

C. unit; total

D. unit; differential

ANSWER: C.

TOPIC: Reactivity Coefficients

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

A. 3 percent to 5 percent

B. 5 percent to 15 percent

C. 15 percent to 30 percent

D. 30 percent to 60 percent

ANSWER: D.

TOPIC: Reactivity Coefficients

Ignoring the effects of changes in fission product poisons, which one of the following power changes requires the <u>smallest</u> amount of positive reactivity addition?

A. 2 percent to 5 percent

B. 5 percent to 15 percent

C. 15 percent to 30 percent

D. 30 percent to 50 percent

ANSWER: A.

TOPIC: Reactivity Coefficients

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

A. 3 percent to 10 percent

B. 10 percent to 25 percent

C. 25 percent to 60 percent

D. 60 percent to 100 percent

ANSWER: D.

TOPIC: Reactivity Coefficients

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

A. 3 percent to 10 percent

B. 10 percent to 25 percent

C. 25 percent to 65 percent

D. 65 percent to 100 percent

ANSWER: C.

TOPIC: Reactivity Coefficients

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

A. 3 percent to 10 percent

B. 10 percent to 15 percent

C. 15 percent to 30 percent

D. 30 percent to 40 percent

ANSWER: B.

TOPIC: Control Rods

A reactor is initially critical well below the point of adding heat (POAH) during a reactor startup. Control rods are withdrawn for 20 seconds to establish a 0.5 DPM startup rate.

In response to the control rod withdrawal, reactor power will initially increase, and then...

A. continue increasing until the control rods are reinserted.

B. stabilize at a value slightly below the POAH.

C. stabilize at the POAH.

D. stabilize at a value slightly above the POAH.

ANSWER: D.

TOPIC: Control Rods

A reactor is initially critical below the point of adding heat during a reactor startup. If control rods are manually inserted for 5 seconds, reactor power will decrease...

A. to a lower power level determined by subcritical multiplication.

B. temporarily, then return to the original power level due to subcritical multiplication.

C. temporarily, then return to the original power level due to a decrease in moderator temperature.

D. until inherent positive reactivity feedback causes the reactor to become critical at a lower power level.

ANSWER: A.

TOPIC: Control Rods

A reactor is initially critical below the point of adding heat (POAH) during a reactor startup. If control rods are manually withdrawn for 5 seconds, reactor power will initially increase and then...

A. stabilize at a critical power level below the POAH.

B. decrease and stabilize at the original value.

C. stabilize at a critical power level at the POAH.

D. decrease and stabilize below the original value.

ANSWER: C.

TOPIC: Control Rods

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

A. increase and stabilize above the original level.

B. increase, then decrease and stabilize at the original level.

C. increase, then decrease and stabilize above the original level.

D. remain the same during and after the withdrawal.

ANSWER: A.

TOPIC: Control Rods

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

A. remain the same.

B. increase and stabilize at a new higher level.

C. increase temporarily then return to the original level.

D. increase exponentially until the operator reinserts the center control rod.

ANSWER: B.

TOPIC: Control Rods

Criticality has been achieved during a reactor startup. The core neutron flux level is low in the intermediate range with a stable 0.5 DPM startup rate (SUR). The operator begins inserting control rods in an effort to stabilize the core neutron flux level near its current value. The operator stops inserting control rods when the SUR indicates exactly 0.0 DPM.

Immediately after the operator stops inserting the control rods, the SUR will become __________; and the core neutron flux level will __________.

A. positive; increase exponentially

B. positive; increase linearly

C. negative; decrease exponentially

D. negative; decrease linearly

ANSWER: A.

TOPIC: Control Rods

The total amount of reactivity added by a control rod position change from a reference height to any other rod height is called...

A. differential rod worth.

B. excess reactivity.

C. integral rod worth.

D. reference reactivity.

ANSWER: C.

TOPIC: Control Rods

Integral control rod worth can be described as the change in __________ for a __________ change in rod position.

A. reactor power; total

B. reactivity; unit

C. reactor power; unit

D. reactivity; total

ANSWER: D.

TOPIC: Control Rods

Integral rod worth is the...

A. change in reactivity per unit change in control rod position.

B. rod worth associated with the most reactive control rod.

C. change in worth of a control rod per unit change in reactor power.

D. reactivity added by moving a control rod from one position to another position.

ANSWER: D.

TOPIC: Control Rods

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

A. DRW is the area under the IRW curve at a given rod position.

B. DRW is the slope of the IRW curve at a given rod position.

C. DRW is the IRW at a given rod position.

D. DRW is the square root of the IRW at a given rod position.

ANSWER: B.

TOPIC: Control Rods

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

A. Core radial neutron flux distribution

B. Core axial neutron flux distribution

C. Core xenon distribution

D. Burnable poison distribution

ANSWER: B.

TOPIC: Control Rods

During normal full power operation, the differential control rod worth is less negative at the top and bottom of the core compared to the center regions due to the effects of...

A. reactor coolant boron concentration.

B. neutron flux distribution.

C. xenon concentration.

D. fuel temperature distribution.

ANSWER: B.

TOPIC: Control Rods

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

A. IRW is the slope of the DRW curve.

B. IRW is the inverse of the DRW curve.

C. IRW is the sum of the DRWs between the initial and final control rod positions.

D. IRW is the sum of the DRWs of all control rods at a specific control rod position.

ANSWER: C.

TOPIC: Control Rods

As moderator temperature increases, the differential rod worth becomes more negative because...

A. moderator density decreases, which causes more neutron leakage out of the core.

B. the moderator temperature coefficient decreases, which causes decreased competition for neutrons.

C. fuel temperature also increases, which decreases the rate of neutron absorption in the fuel.

D. moderator density decreases, which increases the neutron migration length.

ANSWER: D.

TOPIC: Control Rods

A nuclear power plant is operating at 50 percent power with one group of control rods partially inserted into the core. If the moderator temperature decreases by 5°F, the group differential control rod worth will become...

A. more negative, due to better moderation of neutrons.

B. less negative, due to shorter neutron migration lengths.

C. more negative, due to increased moderator absorption of neutrons.

D. less negative, due to increased resonance absorption of neutrons.

ANSWER: B.

TOPIC: Control Rods

As moderator temperature increases, the differential rod worth becomes...

A. more negative due to longer neutron diffusion lengths.

B. more negative due to decreased resonance absorption of neutrons.

C. less negative due to reduced moderation of neutrons.

D. less negative due to decreased moderator absorption of neutrons.

ANSWER: A.

TOPIC: Control Rods

A reactor startup is in progress from a cold shutdown condition. During the reactor coolant heatup phase of the startup, the differential control rod worth will become __________ negative; and during the complete withdrawal of the initial bank of control rods, the differential control rod worth will become __________.

A. more; more negative initially and then less negative

B. more; less negative initially and then more negative

C. less; more negative during the entire withdrawal

D. less; less negative during the entire withdrawal

ANSWER: A.

TOPIC: Control Rods

The main reason for designing and operating a reactor with a flattened neutron flux distribution is to...

A. provide even burnup of control rods.

B. reduce neutron leakage from the core.

C. achieve a higher average power density.

D. provide more accurate nuclear power indication.

ANSWER: C.

TOPIC: Control Rods

Which one of the following is a reason for neutron flux shaping in a reactor core?

A. To minimize local power peaking by more evenly distributing the core thermal neutron flux.

B. To reduce thermal neutron leakage by decreasing the neutron flux at the periphery of the reactor core.

C. To reduce the size and number of control rods needed to shut down the reactor during a reactor trip.

D. To increase differential control rod worth by peaking the thermal neutron flux at the top of the reactor core.

ANSWER: A.

TOPIC: Control Rods

Which one of the following includes two reasons for control rod bank/group overlap?

A. Provides a more uniform differential rod worth, and minimizes axial neutron flux peaking.

B. Provides a more uniform differential rod worth, and allows dampening of xenon-induced neutron flux oscillations.

C. Ensures that all rods remain within the allowable tolerance between their individual position indicators and their group counters, and ensures rod insertion limits are <u>not</u> exceeded.

D. Ensures that all rods remain within their allowable tolerance between individual position indicators and their group counters, and provides a more uniform axial flux distribution.

ANSWER: A.

TOPIC: Control Rods

Which one of the following includes two reasons for control rod bank/group overlap?

A. Provide a more uniform axial power distribution and provide a more uniform differential rod worth.

B. Provide a more uniform differential rod worth and provide a more uniform radial power distribution.

C. Provide a more uniform radial power distribution and maintain individual and group rod position indicators within allowable tolerances.

D. Maintain individual and group rod position indicators within allowable tolerances and provide a more uniform axial power distribution.

ANSWER: A.

TOPIC: Control Rods

One purpose of using control rod bank/group overlap is to...

A. ensure adequate shutdown margin.

B. provide a more uniform differential rod worth.

C. allow dampening of xenon-induced neutron flux oscillations.

D. ensure control rod insertion limits are <u>not</u> exceeded.

ANSWER: B.

TOPIC: Control Rods

A reactor was restarted following a refueling outage and is currently at the point of adding heat. Which one of the following describes the change in axial power distribution as reactor power is increased to 5 percent by control rod withdrawal?

A. Shifts toward the bottom of the core.

B. Shifts toward the top of the core.

C. Shifts from the center of the core toward the top and bottom of the core.

D. Shifts from the top and bottom of the core toward the center of the core.

ANSWER: B.

TOPIC: Control Rods

By maintaining the radial and axial core power distributions within their prescribed limits, the operator is assured that __________ will remain within acceptable limits.

A. power density (kW/foot)

B. shutdown margin

C. core delta-T

D. rod insertion limits

ANSWER: A.

TOPIC: Control Rods

Consider a reactor core with four quadrants: A, B, C, and D. The reactor is operating at steady-state 90 percent power when a fully withdrawn control rod in quadrant C drops to the bottom of the core. Assume that no operator actions are taken and reactor power stabilizes at 88 percent.

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

A. Upper core value decreases while lower core value increases.

B. Upper core value increases while lower core value decreases.

C. Both upper and lower core values decrease.

D. Both upper and lower core values increase.

ANSWER: D.

TOPIC: Control Rods

After a control rod is fully inserted (from the fully withdrawn position), the effect on the axial flux shape is minimal. This is because...

A. the differential rod worth is constant along the length of the control rod.

B. the fully inserted control rod is an axially uniform poison.

C. a control rod only has reactivity worth if it is moving.

D. a variable poison distribution exists throughout the length of the control rod.

ANSWER: B.

TOPIC: Control Rods

The control rod insertion limits generally rise as reactor power increases because…

A. the power defect becomes more negative as power increases.

B. the control rod worth becomes more negative as power increases.

C. the fuel temperature coefficient becomes more negative as power increases.

D. the equilibrium xenon-135 reactivity becomes more negative as power increases.

ANSWER: A.

TOPIC: Control Rods

Control rod insertion limits are established for power operation for all the following reasons except…

A. adversely affect core power distribution.

B. provide adequate shutdown margin.

C. cause reduced control rod lifetime.

D. minimize the consequences of an uncontrolled rod withdrawal.

ANSWER: C.

TOPIC: Control Rods

Control rod insertion limits ensure that control rods will be more withdrawn as reactor power __________ to compensate for the change in __________.

A. increases; xenon reactivity

B. decreases; xenon reactivity

C. increases; power defect

D. decreases; power defect

ANSWER: C.

TOPIC: Control Rods

Why are control rod insertion limits established for power operation?

A. To minimize the worth of a dropped control rod.

B. To maintain a negative moderator temperature coefficient.

C. To provide adequate shutdown margin after a reactor trip.

D. To ensure sufficient positive reactivity is available to compensate for the existing power defect.

ANSWER: C.

TOPIC: Control Rods

A reactor has been operating at 80 percent power for four weeks with the secondary control rods inserted 10 percent from the fully withdrawn position.

Which one of the following will be most affected by inserting the secondary control rods an additional 5 percent? (Assume steady-state reactor power does not change.)

A. Rod insertion limits

B. Radial power distribution

C. Quadrant (azimuthal) power distribution

D. Axial power distribution

ANSWER: D.

TOPIC: Control Rods

A reactor is operating at steady-state 75 percent power. Assuming the reactor does not trip, which one of the following compares the effects of dropping (full insertion) a center control rod to the effects of partially inserting (50 percent) the same control rod?

A. A dropped rod causes a greater change in shutdown margin.

B. A dropped rod causes a smaller change in shutdown margin.

C. A dropped rod causes a greater change in axial power distribution.

D. A dropped rod causes a greater change in radial power distribution.

ANSWER: D.

TOPIC: Control Rods

A reactor is operating at steady-state 75 percent power. Assuming the reactor does <u>not</u> trip, which one of the following compares the effects of dropping (full insertion) a center control rod to the effects of partially inserting (50 percent) the same control rod?

A. A partially inserted rod causes a greater change in axial power distribution.

B. A partially inserted rod causes a greater change in radial power distribution.

C. A partially inserted rod causes a greater change in shutdown margin.

D. A partially inserted rod causes a smaller change in shutdown margin.

ANSWER: A.

TOPIC: Control Rods

A reactor is operating at steady-state 75 percent power. Assuming the reactor power does not trip, which one of the following compares the effects of dropping (full insertion) a center control rod to the effects of partially inserting (50 percent) the same control rod?

A. A dropped rod causes a smaller change in axial power distribution.

B. A dropped rod causes a smaller change in radial power distribution.

C. A dropped rod causes a smaller change in shutdown margin.

D. A dropped rod causes a greater change in shutdown margin.

ANSWER: A.

TOPIC: Control Rods

A reactor is operating at steady-state 85 percent power. Assuming the reactor does <u>not</u> trip, which one of the following compares the effects of partially inserting (50 percent) a center control rod to the effects of dropping (full insertion) the same control rod?

A. A partially inserted rod causes a smaller change in axial power distribution.

B. A partially inserted rod causes a smaller change in radial power distribution.

C. A partially inserted rod causes a greater change in shutdown margin.

D. A partially inserted rod causes a smaller change in shutdown margin.

ANSWER: B.

TOPIC: Control Rods

A reactor is operating at steady-state 100 percent power at the beginning of a fuel cycle. Assuming the reactor does not trip, which one of the following compares the effects of dropping a control rod in the center of the core to dropping an identical control rod at the periphery of the core?

A. Dropping a center control rod causes a greater change in shutdown margin.

B. Dropping a center control rod causes a smaller change in shutdown margin.

C. Dropping a center control rod causes a greater change in axial power distribution.

D. Dropping a center control rod causes a greater change in radial power distribution.

ANSWER: D.

TOPIC: Control Rods

A reactor is operating at steady-state 100 percent power when one control rod at the core periphery falls completely into the core. Assuming no reactor trip and no operator action, which one of the following will change significantly as a result of the dropped rod?

A. Axial power distribution only.

B. Axial power distribution and shutdown margin.

C. Radial power distribution only.

D. Radial power distribution and shutdown margin.

ANSWER: C.

TOPIC: Reactor Operational Physics

During a reactor startup, the first reactivity addition caused the stable source range count rate to increase from 20 cps to 40 cps. The second reactivity addition caused the stable count rate to increase from 40 cps to 160 cps.

Which one of the following statements accurately compares the two reactivity additions?

A. The first reactivity addition was larger.

B. The second reactivity addition was larger.

C. The first and second reactivity additions were equal.

D. There is <u>not</u> enough information given to compare the reactivity values.

ANSWER: A.

TOPIC: Reactor Operational Physics

During a reactor startup, the first positive reactivity addition caused the stable source range count rate to increase from 20 cps to 30 cps. The second positive reactivity addition caused the stable count rate to increase from 30 cps to 60 cps. K_{eff} was 0.97 prior to the first reactivity addition.

Which one of the following statements accurately compares the reactivity additions?

A. The first and second reactivity additions were approximately equal.

B. The first reactivity addition was approximately twice as large as the second.

C. The second reactivity addition was approximately twice as large as the first.

D. There is not enough information given to compare the reactivity values.

ANSWER: A.

TOPIC: Reactor Operational Physics

While withdrawing control rods during a reactor startup, the stable source range count rate doubled. If the same amount of reactivity that caused the first doubling is added again, the stable count rate will __________; and the reactor will be __________.

A. more than double; subcritical

B. more than double; critical

C. double; subcritical

D. double; critical

ANSWER: B.

TOPIC: Reactor Operational Physics

A reactor startup is in progress and the reactor is subcritical in the source range. Assuming the reactor remains subcritical, a short control rod withdrawal will cause the reactor startup rate indication to increase sharply in the positive direction, and then...

A. rapidly decrease and stabilize at a negative 1/3 DPM.

B. gradually decrease and stabilize at 0 DPM.

C. stabilize until the point of adding heat (POAH) is reached; then decrease to 0 DPM.

D. continue increasing until the POAH is reached; then decrease to 0 DPM.

ANSWER: B.

TOPIC: Reactor Operational Physics

A subcritical reactor has a stable source range count rate of 150 cps with a shutdown reactivity of -2.0 %ΔK/K. How much positive reactivity must be added to establish a stable count rate of 300 cps?

A. 0.5 %ΔK/K

B. 1.0 %ΔK/K

C. 1.5 %ΔK/K

D. 2.0 %ΔK/K

ANSWER: B.

TOPIC: Reactor Operational Physics

A subcritical reactor has an initial K_{eff} of 0.8 with a stable source range count rate of 100 cps. If positive reactivity is added until K_{eff} equals 0.95, at what value will the count rate stabilize?

A. 150 cps

B. 200 cps

C. 300 cps

D. 400 cps

ANSWER: D.

TOPIC: Reactor Operational Physics

During a reactor startup, equal amounts of positive reactivity are being sequentially added, and the source range count rate is allowed to reach equilibrium after each addition. Which one of the following statements applies for each successive reactivity addition?

A. The time required to reach equilibrium count rate is the same.

B. The time required to reach equilibrium count rate is shorter.

C. The numerical change in equilibrium count rate is greater.

D. The numerical change in equilibrium count rate is the same.

ANSWER: C.

TOPIC: Reactor Operational Physics

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

A. The prompt jump in count rate will be the same, and the increase in stable count rate will be the same.

B. The prompt jump in count rate will be greater with K_{eff} at 0.99, but the increase in stable count rate will be the same.

C. The prompt jump in count rate will be the same, but the increase in stable count rate will be greater with K_{eff} at 0.99.

D. The prompt jump in count rate will be greater with K_{eff} at 0.99, and the increase in stable count rate will be greater with K_{eff} at 0.99.

ANSWER: D.

TOPIC: Reactor Operational Physics

A subcritical reactor has a stable source range count rate of 150 cps with a shutdown reactivity of -2.0 %ΔK/K. Approximately how much positive reactivity must be added to establish a stable count rate of 600 cps?

A. 0.5 %ΔK/K

B. 1.0 %ΔK/K

C. 1.5 %ΔK/K

D. 2.0 %ΔK/K

ANSWER: C.

TOPIC: Reactor Operational Physics

A subcritical reactor has a stable source range count rate of 60 cps with a shutdown reactivity of -2.0 %ΔK/K. How much positive reactivity must be added to establish a stable count rate of 300 cps?

A. 0.4 %ΔK/K

B. 0.6 %ΔK/K

C. 1.4 %ΔK/K

D. 1.6 %ΔK/K

ANSWER: D.

TOPIC: Reactor Operational Physics

A reactor startup is in progress with the reactor currently subcritical.

Which one of the following describes the change in source range count rate resulting from a short control rod withdrawal with K_{eff} at 0.95 compared to an identical control rod withdrawal with K_{eff} at 0.98? (Assume the reactivity additions are equal and the reactor remains subcritical.)

A. Both the prompt jump in count rate and the increase in stable count rate will be the same for both values of K_{eff}.

B. Both the prompt jump in count rate and the increase in stable count rate will be smaller with K_{eff} at 0.95.

C. The prompt jump in count rate will be smaller with K_{eff} at 0.95, but the increase in stable count rates will be the same.

D. The prompt jump in count rates will be the same, but the increase in stable count rate will be smaller with K_{eff} at 0.95.

ANSWER: B.

TOPIC: Reactor Operational Physics

A reactor startup is being performed by adding equal amounts of positive reactivity and waiting for source range count rate to stabilize. As the reactor approaches criticality, the numerical change in stable count rate resulting from each reactivity addition will __________; and the time required for the count rate to stabilize after each reactivity addition will __________.

A. increase; remain the same

B. increase; increase

C. remain the same; remain the same

D. remain the same; increase

ANSWER: B.

TOPIC: Reactor Operational Physics

A reactor startup is being performed. Control rod withdrawal is stopped when K_{eff} equals 0.995. Source range count rate stabilizes at 1,000 cps. No additional operator actions are taken.

Which one of the following describes the count rate 20 minutes after rod withdrawal is stopped?

A. Less than 1,000 cps and decreasing toward the prestartup count rate.

B. Less than 1,000 cps and stable above the prestartup count rate.

C. Greater than 1,000 cps and increasing toward criticality.

D. 1,000 cps and constant.

ANSWER: D.

TOPIC: Reactor Operational Physics

A reactor startup is in progress. The reactor is slightly subcritical with a constant startup rate of 0.0 DPM. If control rods are inserted for a few seconds, the startup rate will become negative initially, and then...

A. gradually become less negative and return to 0.0 DPM.

B. gradually become more negative until source neutrons become the only significant contributor to the neutron population, and then return to 0.0 DPM.

C. stabilize until source neutrons become the only significant contributor to the neutron population, and then return to 0.0 DPM.

D. stabilize at -1/3 DPM until fission neutrons are no longer a significant contributor to the neutron population, and then return to 0.0 DPM.

ANSWER: A.

TOPIC: Reactor Operational Physics

A reactor startup is being commenced with the initial source range count rate stable at 20 cps. After a period of control rod withdrawal, count rate stabilizes at 80 cps.

If the total reactivity added by the above control rod withdrawal is 4.5 %ΔK/K, how much additional positive reactivity must be inserted to make the reactor critical?

A. 1.5 %ΔK/K

B. 2.0 %ΔK/K

C. 2.5 %ΔK/K

D. 3.0 %ΔK/K

ANSWER: A.

TOPIC: Reactor Operational Physics

A reactor is shutdown with a K_{eff} of 0.96 and a stable source range count rate of 50 cps when a reactor startup is commenced. Which one of the following will be the stable count rate when K_{eff} reaches 0.995?

A. 400 cps

B. 800 cps

C. 4,000 cps

D. 8,000 cps

ANSWER: A.

TOPIC: Reactor Operational Physics

A nuclear power plant is being cooled down from 500°F to 190°F. Just prior to commencing the cooldown, the source range count rate was stable at 32 cps. After two hours, with reactor coolant temperature at 350°F, the source range count rate is stable at 64 cps.

Assume the moderator temperature coefficient remains constant throughout the cooldown and reactor power remains below the point of adding heat.

Without additional operator action, what will the status of the reactor be when reactor coolant temperature reaches 190°F?

A. Subcritical, with source range count rate below 150 cps.

B. Subcritical, with source range count rate above 150 cps.

C. Exactly critical.

D. Supercritical.

ANSWER: D.

TOPIC: Reactor Operational Physics

Initially, a nuclear power plant was shut down with a K_{eff} of 0.92, and a stable source range count rate of 200 cps. Then a reactor startup was initiated. All control rod motion was stopped when K_{eff} reached 0.995. The instant that control rod motion stopped, the source range count rate was 1,800 cps.

When the source range count rate stabilizes, the count rate will be approximately...

A. 1,800 cps

B. 3,200 cps

C. 3,400 cps

D. 5,000 cps

ANSWER: B.

TOPIC: Reactor Operational Physics

Initially, a reactor was shut down with a stable source range count rate of 30 cps. Using many small positive reactivity additions, a total of 0.1 %ΔK/K was added to the reactor. Currently, the source range count rate is stable at 60 cps.

What was the stable source range count rate after only 0.05 %ΔK/K was added to the reactor during the above process?

A. 40 cps

B. 45 cps

C. 50 cps

D. 55 cps

ANSWER: A.

TOPIC: Reactor Operational Physics

Refer to the drawing that shows a graph of fission rate versus time (see figure below). Both axes have linear scales.

Which one of the following events, initiated at 0 seconds, could cause the reactor response shown on the graph?

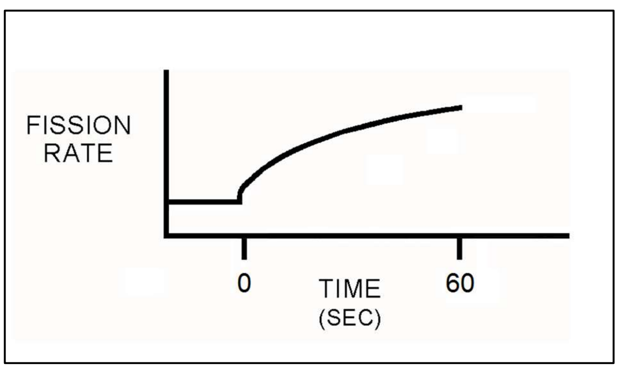
A. A step addition of positive reactivity to a reactor that is initially subcritical in the source range, and remains subcritical for the duration of the 60-second interval shown.

B. A step addition of positive reactivity to a reactor that is initially critical in the source range, and remains below the point of adding heat for the duration of the 60-second interval shown.

C. A continuous addition of positive reactivity at a constant rate to a reactor that is initially subcritical in the source range, and remains subcritical for the duration of the 60-second interval shown.

D. A continuous addition of positive reactivity at a constant rate to a reactor that is initially critical in the source range, and remains below the point of adding heat for the duration of the 60-second interval shown.

ANSWER: A.



TOPIC: Reactor Operational Physics

At the beginning of a reactor startup, K_{eff} was 0.97 and the stable source range count rate was 40 cps. After several incremental control rod withdrawals, the stable source range count rate was 400 cps. The next incremental control rod withdrawal resulted in a stable source range count rate of 600 cps. What is the current K_{eff}?

A. 0.98

B. 0.988

C. 0.998

D. There is <u>not</u> enough information given to calculate the current K_{eff}.

ANSWER: C.

TOPIC: Reactor Operational Physics

During a reactor startup, the operator adds 1.0 %ΔK/K of positive reactivity by withdrawing control rods, thereby increasing the stable source range count rate from 220 cps to 440 cps.

Approximately how much additional positive reactivity is required to raise the stable count rate to 880 cps?

A. 4.0 %ΔK/K

B. 2.0 %ΔK/K

C. 1.0 %ΔK/K

D. 0.5 %ΔK/K

ANSWER: D.

TOPIC: Reactor Operational Physics

Initially, a reactor is subcritical with a K_{eff} of 0.97 and a stable source range count rate of 500 cps.

Which one of the following will be the approximate final steady-state count rate following a rod withdrawal that adds 1.05 $\%\Delta K/K$?

A. 750 cps

B. 1,000 cps

C. 2,000 cps

D. 2,250 cps

ANSWER: A.

TOPIC: Reactor Operational Physics

During a reactor startup, control rods are withdrawn such that K_{eff} increases from 0.98 to 0.99. If the stable source range count rate before the rod withdrawal was 500 cps, which one of the following will be the final stable count rate?

A. 707 cps

B. 1,000 cps

C. 1,500 cps

D. 2,000 cps

ANSWER: B.

TOPIC: Reactor Operational Physics

As a reactor approaches criticality during a reactor startup, it takes longer to reach an equilibrium source range count rate after each control rod withdrawal due to the increased...

A. length of time required to complete a neutron generation.

B. number of neutron generations required to reach a stable neutron level.

C. length of time from neutron birth to absorption.

D. fraction of delayed fission neutrons being produced.

ANSWER: B.

TOPIC: Reactor Operational Physics

During a reactor startup, the first reactivity addition caused the stable source range count rate to increase from 20 cps to 40 cps. The second reactivity addition caused the stable count rate to increase from 40 cps to 80 cps. K_{eff} was 0.92 prior to the first reactivity addition.

Which one of the following statements describes the magnitude of the reactivity additions?

A. The first reactivity addition was approximately twice as large as the second.

B. The second reactivity addition was approximately twice as large as the first.

C. The first and second reactivity additions were approximately the same.

D. There is not enough data given to determine the relationship between reactivity values.

ANSWER: A.

TOPIC: Reactor Operational Physics

With K_{eff} at 0.92 during a reactor startup, the stable source range count rate is noted to be 780 cps. Later in the same startup, the stable count rate is 4,160 cps.

What is the current value of K_{eff}?

A. 0.945

B. 0.950

C. 0.975

D. 0.985

ANSWER: D.

TOPIC: Reactor Operational Physics

Two reactors are currently shut down with reactor startups in progress. The reactors are identical except that reactor A has a source neutron strength of 100 neutrons per second and reactor B has a source neutron strength of 200 neutrons per second. The control rods are stationary and K_{eff} is 0.98 in both reactors. Core neutron levels have stabilized in both reactors.

Which one of the following lists the core neutron levels (neutrons per second) in reactors A and B?

	Reactor A (n/sec)	Reactor B (n/sec)
A.	5,000	10,000
B.	10,000	20,000
C.	10,000	40,000
D.	20,000	40,000

ANSWER: A.

TOPIC: Reactor Operational Physics

With K_{eff} at 0.95 during a reactor startup, source range indication is stable at 100 cps. After a number of control rods have been withdrawn, source range indication stabilizes at 270 cps. What is the current value of K_{eff}?

A. 0.963

B. 0.972

C. 0.981

D. 0.990

ANSWER: C.

TOPIC: Reactor Operational Physics

A reactor startup is in progress with a current K_{eff} of 0.95 and a stable source range count rate of 120 cps. Which one of the following stable count rates will occur when K_{eff} becomes 0.97?

A. 200 cps

B. 245 cps

C. 300 cps

D. 375 cps

ANSWER: A.

TOPIC: Reactor Operational Physics

A reactor startup is in progress with a current K_{eff} of 0.95 and a stable source range count rate of 150 cps. Which one of the following stable count rates will occur when K_{eff} becomes 0.98?

A. 210 cps

B. 245 cps

C. 300 cps

D. 375 cps

ANSWER: D.

TOPIC: Reactor Operational Physics

With K_{eff} at 0.95 during a reactor startup, source range indication is stable at 120 cps. After a period of control rod withdrawal, source range indication stabilizes at 600 cps.

What is the current value of K_{eff}?

A. 0.96

B. 0.97

C. 0.98

D. 0.99

ANSWER: D.

TOPIC: Reactor Operational Physics

During a reactor startup, positive reactivity addition X caused the stable source range count rate to increase from 20 cps to 40 cps. Later in the startup, after several more additions of positive reactivity, positive reactivity addition Y caused the stable source range count rate to increase from 320 cps to 640 cps.

Which one of the following statements describes how the magnitudes of the two positive reactivity additions (X and Y) compare?

A. Reactivity addition X was several times greater in magnitude than reactivity addition Y.

B. Reactivity addition X was several times smaller in magnitude than reactivity addition Y.

C. Reactivity additions X and Y were about equal in magnitude.

D. There is not enough information given to determine the relationship between the reactivity additions.

ANSWER: A.

TOPIC: Reactor Operational Physics

During a reactor startup, positive reactivity addition X caused the stable source range count rate to increase from 15 cps to 30 cps. Later in the startup, after several more positive reactivity additions, positive reactivity addition Y caused the stable source range count rate to increase from 60 cps to 120 cps.

With the reactor still subcritical, which one of the following statements describes how the magnitudes of positive reactivity additions X and Y compare?

A. Positive reactivity addition X was smaller than positive reactivity addition Y.

B. Positive reactivity addition X was greater than positive reactivity addition Y.

C. Positive reactivity additions X and Y were about equal in magnitude.

D. There is <u>not</u> enough information given to compare the positive reactivity additions.

ANSWER: B.

TOPIC: Reactor Operational Physics

As criticality is approached during a reactor startup, equal insertions of positive reactivity result in a __________ numerical change in the stable source range count rate and a __________ time to reach each new stable count rate.

A. larger; longer

B. larger; shorter

C. smaller; longer

D. smaller; shorter

ANSWER: A.

TOPIC: Reactor Operational Physics

A reactor startup is in progress with a stable source range count rate and the reactor is near criticality. Which one of the following statements describes count rate characteristics during and after a 5-second control rod withdrawal? (Assume the reactor remains subcritical.)

A. There will be no change in count rate until criticality is achieved.

B. The count rate will rapidly increase (prompt jump) to a stable higher value.

C. The count rate will rapidly increase (prompt jump), then gradually increase and stabilize at a higher value.

D. The count rate will rapidly increase (prompt jump), then gradually decrease and stabilize at the original value.

ANSWER: C.

TOPIC: Reactor Operational Physics

Refer to the drawing of three 1/M plots labeled A, B, and C (see figure below). Each axis has linear units.

The least conservative approach to criticality is represented by plot __________; which could possibly result from recording source range count rates at __________ time intervals after incremental fuel loading steps as compared to the conditions represented by the other plots.

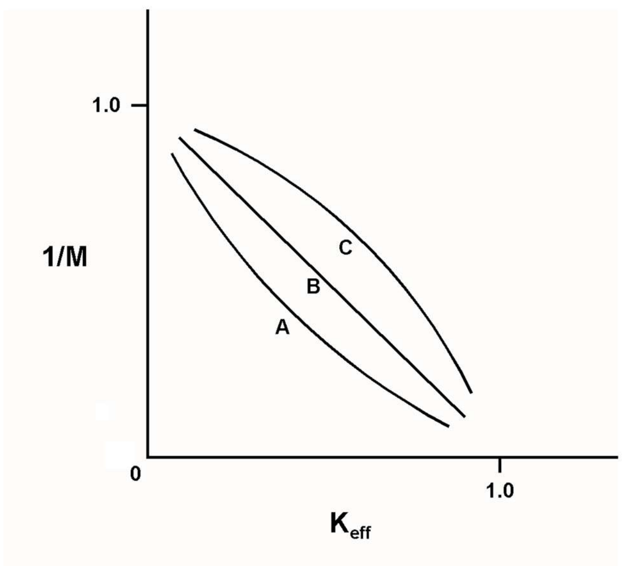
A. A; shorter

B. A; longer

C. C; shorter

D. C; longer

ANSWER: C.



TOPIC: Reactor Operational Physics

Refer to the drawing of a 1/M plot with curves A and B (see figure below). 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 __________.

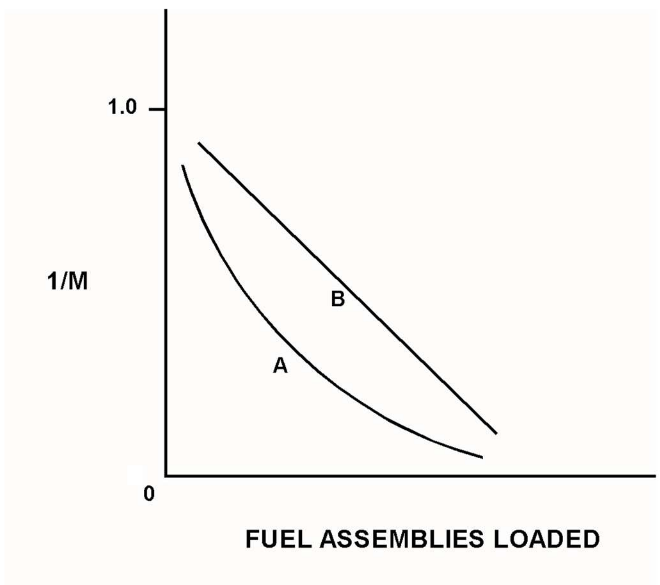
A. small; fuel enrichment

B. small; reactivity

C. large; fuel enrichment

D. large; reactivity

ANSWER: D.



TOPIC: Reactor Operational Physics

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

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

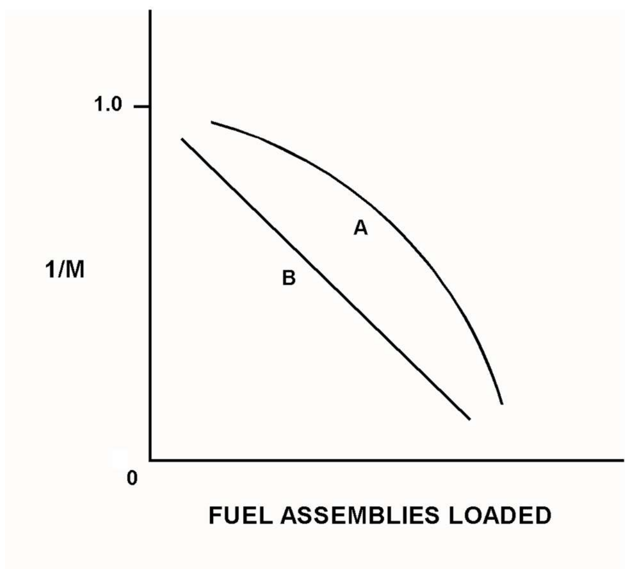
A. small; fuel enrichment

B. small; reactivity

C. large; fuel enrichment

D. large; reactivity

ANSWER: B.



TOPIC: Reactor Operational Physics

During a reactor startup, as K_{eff} increases toward 1.0 the value of 1/M...

A. decreases toward zero.

B. decreases toward 1.0.

C. increases toward infinity.

D. increases toward 1.0.

ANSWER: A.

TOPIC: Reactor Operational Physics

The following data was obtained under stable conditions during a reactor startup:

Control Rod Position (units withdrawn)	Source Range Count Rate (cps)
0	20
10	25
15	28
20	33
25	40
30	50

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

A. 66 to 75 units withdrawn

B. 56 to 65 units withdrawn

C. 46 to 55 units withdrawn

D. 35 to 45 units withdrawn

ANSWER: C.

TOPIC: Reactor Operational Physics

The following data was obtained under stable conditions during a reactor startup:

Control Rod Position (units withdrawn)	Source Range Count Rate (cps)
0	180
10	210
15	250
20	300
25	360
30	420

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

A. 35 to 45 units withdrawn

B. 46 to 55 units withdrawn

C. 56 to 65 units withdrawn

D. 66 to 75 units withdrawn

ANSWER: B.

TOPIC: Reactor Operational Physics

The following data was obtained under stable conditions during a reactor startup:

Control Rod Position (units withdrawn)	Source Range Count Rate (cps)
0	180
5	200
10	225
15	257
20	300
25	360
30	450

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

A. 40 units withdrawn

B. 50 units withdrawn

C. 60 units withdrawn

D. 70 units withdrawn

ANSWER: B.

TOPIC: Reactor Operational Physics

The following data was obtained under stable conditions during a reactor startup:

Control Rod Position (units withdrawn)	Source Range Count Rate (cps)
10	360
15	400
20	450
25	514
30	600
35	720
40	900

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

A. 50 units withdrawn

B. 60 units withdrawn

C. 70 units withdrawn

D. 80 units withdrawn

ANSWER: B.

TOPIC: Reactor Operational Physics

An estimated critical rod position (ECP) has been calculated for criticality to occur 15 hours after a reactor trip that ended three months of operation at 100 percent power.

Which one of the following will result in criticality occurring at a rod position that is lower than the calculated ECP?

A. A malfunction resulting in temperature raising 2°F.

B. A malfunction resulting in control rod speed being slower than normal speed.

C. Moving the time of startup from 15 hours to 12 hours following the trip.

D. Using a pretrip reactor power of 90 percent to determine power defect.

ANSWER: D.

TOPIC: Reactor Operational Physics

With K_{eff} at 0.985, how much reactivity must be added to make a reactor <u>exactly</u> critical?

A. 1.48 %ΔK/K

B. 1.50 %ΔK/K

C. 1.52 %ΔK/K

D. 1.54 %ΔK/K

ANSWER: C.

TOPIC: Reactor Operational Physics

When a reactor is critical, reactivity is...

A. infinity.

B. undefined.

C. 0.0 $\Delta K/K$.

D. 1.0 $\Delta K/K$.

ANSWER: C.

TOPIC: Reactor Operational Physics

During a reactor startup, if the startup rate is constant and positive without any further reactivity addition, then the reactor is...

A. critical.

B. supercritical.

C. subcritical.

D. prompt critical.

ANSWER: B.

TOPIC: Reactor Operational Physics

A reactor startup is being performed following a one-month shutdown period. If the reactor is taken critical and then stabilized at 10,000 cps in the source range, over the next 10 minutes the count rate will...

A. remain constant.

B. decrease linearly.

C. decrease geometrically.

D. decrease exponentially.

ANSWER: A.

TOPIC: Reactor Operational Physics

A reactor startup is in progress following a one-month shutdown. Upon reaching criticality, the operator establishes a positive 0.5 DPM startup rate and stops control rod motion.

After an additional five minutes, reactor power will be __________ and startup rate will be __________. (Assume reactor power remains below the point of adding heat.)

A. constant; constant

B. constant; increasing

C. increasing; constant

D. increasing; increasing

ANSWER: C.

TOPIC: Reactor Operational Physics

A reactor is critical near the end of a fuel cycle with power level stable at 1.0×10^{-10} percent. Which one of the following is the smallest listed amount of positive reactivity that is capable of increasing reactor power level to the point of adding heat?

A. 0.001 %ΔK/K

B. 0.003 %ΔK/K

C. 0.005 %ΔK/K

D. 0.007 %ΔK/K

ANSWER: A.

TOPIC: Reactor Operational Physics

A reactor and plant startup is in progress. Reactor power is currently 5.0×10^{-5} percent and increasing, with a constant startup rate of 0.2 DPM. Reactivity is <u>not</u> changing.

The reactor is currently __________, at a power level that is __________ the point of adding heat.

A. critical; less than

B. critical; greater than

C. supercritical; less than

D. supercritical; greater than

ANSWER: C.

TOPIC: Reactor Operational Physics

Which one of the following indicates that a reactor has achieved criticality during a normal reactor startup?

A. Constant positive startup rate during rod withdrawal.

B. Increasing positive startup rate during rod withdrawal.

C. Constant positive startup rate with no rod motion.

D. Increasing positive startup rate with no rod motion.

ANSWER: C.

TOPIC: Reactor Operational Physics

A reactor startup is in progress. Control rod withdrawal was stopped several minutes ago to assess criticality. Which one of the following is a combination of indications that together support a declaration that the reactor has reached criticality?

A. Startup rate is stable at 0.0 DPM; source range count rate is stable.

B. Startup rate is stable at 0.2 DPM; source range count rate is stable.

C. Startup rate is stable at 0.0 DPM; source range count rate is slowly increasing.

D. Startup rate is stable at 0.2 DPM; source range count rate is slowly increasing.

ANSWER: D.

TOPIC: Reactor Operational Physics

A reactor startup is in progress following a one-month shutdown. Upon reaching criticality, the operator establishes a stable positive 1.0 DPM startup rate and stops rod motion.

After an additional 30 seconds, reactor power will be __________ and startup rate will be __________. (Assume reactor power remains below the point of adding heat.)

A. increasing; increasing

B. increasing; constant

C. constant; increasing

D. constant; constant

ANSWER: B.

TOPIC: Reactor Operational Physics

A reactor is critical several decades below the point of adding heat (POAH) when a small amount of positive reactivity is added to the core. If the exact same amount of negative reactivity is then added prior to reaching the POAH, reactor power will stabilize...

A. higher than the initial power level but below the POAH.

B. lower than the initial power level.

C. at the initial power level.

D. at the POAH.

ANSWER: A.

TOPIC: Reactor Operational Physics

A reactor is exactly critical two decades below the point of adding heat when -0.01 %ΔK/K of reactivity is added. If +0.01 %ΔK/K is added 2 minutes later, reactor power will stabilize at...

A. the point of adding heat.

B. the initial power level.

C. somewhat lower than the initial power level.

D. an equilibrium subcritical power level.

ANSWER: C.

TOPIC: Reactor Operational Physics

A reactor is critical at the point of adding heat (POAH) when a small amount of negative reactivity is added. If the same amount of positive reactivity is added approximately 5 minutes later, reactor power will...

A. increase and stabilize at the POAH.

B. quickly stabilize at a power level below the POAH.

C. continue to decrease with a -1/3 DPM startup rate until an equilibrium shutdown neutron level is reached.

D. continue to decrease with an unknown startup rate until an equilibrium shutdown neutron level is reached.

ANSWER: B.

TOPIC: Reactor Operational Physics

A reactor was operating at 1.0×10^{-3} percent power with a positive 0.6 DPM startup rate when an amount of negative reactivity was inserted that caused reactor power to decrease with a negative 0.4 DPM startup rate.

If an equal amount of positive reactivity is added 5 minutes later, reactor power will...

A. increase and stabilize at the point of adding heat.

B. increase and stabilize at 1.0×10^{-3} percent power.

C. continue to decrease with a negative 0.4 DPM startup rate until an equilibrium shutdown neutron level is reached.

D. continue to decrease with an unknown startup rate until an equilibrium shutdown neutron level is reached.

ANSWER: A.

TOPIC: Reactor Operational Physics

A reactor is slightly supercritical during a reactor startup. A short control rod withdrawal is performed to establish the desired positive startup rate. 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 startup rate will initially decrease and then...

A. stabilize at a positive value.

B. turn and slowly increase.

C. stabilize at zero.

D. continue to slowly decrease.

ANSWER: A.

TOPIC: Reactor Operational Physics

Refer to the figure below for the following question. The axes on each graph have linear scales.

Initially, a reactor is critical in the source range. At 0 seconds, a constant rate addition of positive reactivity commences. Assume that reactor power remains below the point of adding heat for the entire time interval shown.

The general response of startup rate to this event is shown on graph _____; and the general response of reactor power to this event is shown on graph _____. (Note: Either graph may be chosen once, twice, or not at all.)

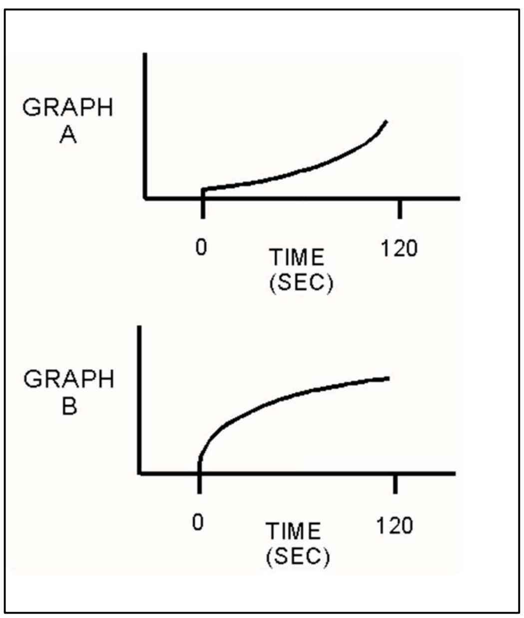
A. A; A

B. A; B

C. B; A

D. B; B

ANSWER: A.



TOPIC: Reactor Operational Physics

Refer to the drawing that shows a graph of startup rate versus time (see figure below). Both axes have linear scales.

Which one of the following events, initiated at 0 seconds, would cause the reactor response shown on the graph?

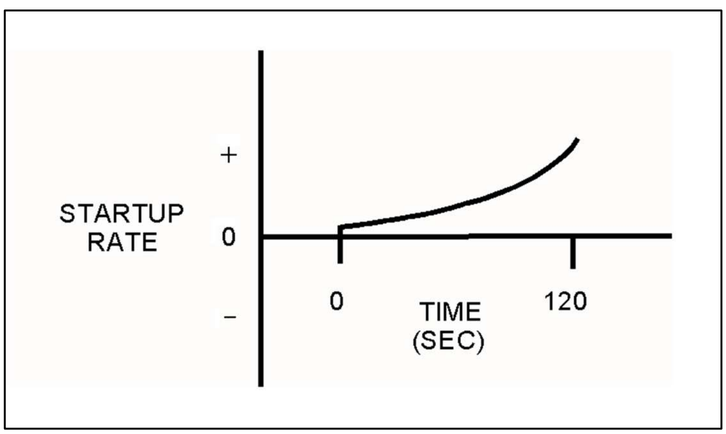
A. A step addition of positive reactivity to a reactor that is initially stable in the power range and remains in the power range for the duration of the 120-second interval shown.

B. A constant rate of positive reactivity addition to a reactor that is initially stable in the power range and remains in the power range for the duration of the 120-second interval shown.

C. A step addition of positive reactivity to a reactor that is initially critical in the source range and remains below the point of adding heat for the duration of the 120-second interval shown.

D. A constant rate of positive reactivity addition to a reactor that is initially critical in the source range and remains below the point of adding heat for the duration of the 120-second interval shown.

ANSWER: D.



TOPIC: Reactor Operational Physics

Refer to the drawing that shows a graph of fission rate versus time (see figure below). Both axes have linear scales.

Which one of the following events, initiated at 0 seconds, would cause the reactor response shown on the graph?

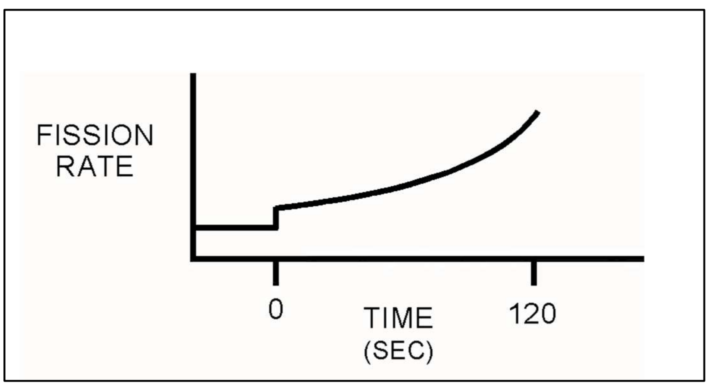
A. A step addition of positive reactivity to a reactor that is initially subcritical in the source range and remains subcritical for the duration of the 120-second interval shown.

B. A step addition of positive reactivity to a reactor that is initially critical in the source range and remains below the point of adding heat for the duration of the 120-second interval shown.

C. A step addition of positive reactivity to a reactor that is initially critical in the power range and remains in the power range for the duration of the 120-second interval shown.

D. A constant rate of positive reactivity addition to a reactor that is initially critical in the power range and remains in the power range for the duration of the 120-second interval shown.

ANSWER: B.



TOPIC: Reactor Operational Physics

Refer to the drawing that shows a graph of startup rate versus time (see figure below) for a reactor. Both axes have linear scales.

Which one of the following events, initiated at 0 seconds, would cause the startup rate response shown on the graph?

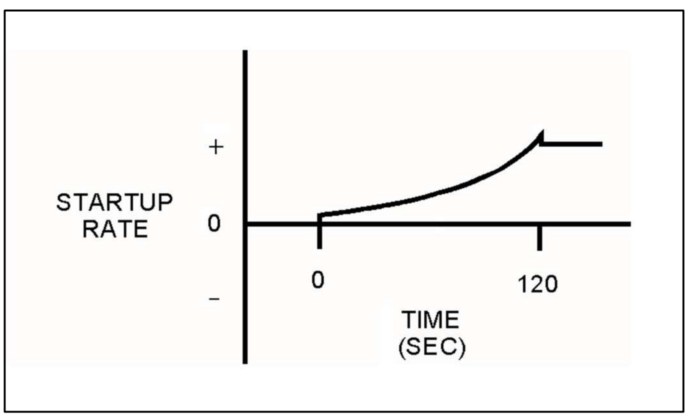
A. A step addition of positive reactivity to a reactor that is initially critical in the source range. Reactor power enters the power range at 120 seconds.

B. A step addition of positive reactivity to a reactor that is initially stable in the power range. A step addition of negative reactivity is inserted at 120 seconds.

C. A controlled constant rate of positive reactivity addition to a reactor that is initially critical in the source range and remains below the point of adding heat. The positive reactivity addition ends at 120 seconds.

D. A controlled constant rate of positive reactivity addition to a reactor that is initially stable in the power range and remains in the power range. The positive reactivity addition ends at 120 seconds.

ANSWER: C.



TOPIC: Reactor Operational Physics

For a slightly supercritical reactor operating below the point of adding heat (POAH), what reactivity effects are associated with reaching the POAH?

A. There are no reactivity effects.

B. An increase in fuel temperature will begin to create a positive reactivity effect.

C. A decrease in fuel temperature will begin to create a negative reactivity effect.

D. An increase in fuel temperature will begin to create a negative reactivity effect.

ANSWER: D.

TOPIC: Reactor Operational Physics

A reactor startup is in progress near the end of a fuel cycle. Reactor power is 5×10^{-2} percent and increasing slowly with a stable 0.3 DPM startup rate. Assuming no operator action, no reactor trip, and no change in temperature, what will reactor power be after 10 minutes?

A. 100 percent

B. 50 percent

C. 10 percent

D. 1 percent (point of adding heat)

ANSWER: D.

TOPIC: Reactor Operational Physics

A reactor startup is in progress near the end of a fuel cycle. Reactor power is 5×10^{-3} percent and increasing slowly with a stable 0.3 DPM startup rate. Assuming no operator action, no reactor trip, and no change in temperature, what will reactor power be after 10 minutes?

A. Below the point of adding heat (POAH).

B. At the POAH.

C. Above the POAH but less than 50 percent.

D. Greater than 50 percent.

ANSWER: B.

TOPIC: Reactor Operational Physics

A reactor is critical at 2.0×10^{-8} percent power. The operator withdraws rods as necessary to immediately establish and maintain a positive 0.1 DPM startup rate. How long will it take the reactor to reach 7.0×10^{-8} percent power?

A. 2.4 minutes

B. 5.4 minutes

C. 7.4 minutes

D. 10.4 minutes

ANSWER: B.

TOPIC: Reactor Operational Physics

A reactor is critical at 3.0×10^{-8} percent power. The operator withdraws rods as necessary to immediately establish and maintain a positive 0.1 DPM startup rate. How long will it take the reactor to reach 7.0×10^{-8} percent power?

A. 3.7 minutes

B. 5.4 minutes

C. 6.7 minutes

D. 8.4 minutes

ANSWER: A.

TOPIC: Reactor Operational Physics

A reactor startup is in progress and criticality has just been achieved. After recording the critical rod heights, the operator withdraws control rods for 20 seconds to establish a stable positive 0.5 DPM startup rate (SUR). One minute later (prior to reaching the point of adding heat), the operator inserts the same control rods for 25 seconds.

During the rod insertion, when will the SUR become negative?

A. Immediately when the control rod insertion is initiated.

B. After the control rods pass through the critical rod height.

C. Just as the control rods pass through the critical rod height.

D. Prior to the control rods passing through the critical rod height.

ANSWER: D.

TOPIC: Reactor Operational Physics

Shortly after a reactor trip, reactor power indicates 5.0×10^{-2} percent when a stable negative startup rate is attained. Approximately how much additional time is required for reactor power to decrease to 5.0×10^{-3} percent?

A. 90 seconds

B. 180 seconds

C. 270 seconds

D. 360 seconds

ANSWER: B.

TOPIC: Reactor Operational Physics

A nuclear power plant has been operating at 100 percent power for several weeks when a reactor trip occurs. How much time will be required for core decay heat production to decrease to one percent power following the trip?

A. 1 to 8 seconds

B. 1 to 8 minutes

C. 1 to 8 hours

D. 1 to 8 days

ANSWER: C.

TOPIC: Reactor Operational Physics

Which one of the following determines the value of the stable negative startup rate observed shortly after a reactor trip?

A. The shortest-lived delayed neutron precursors.

B. The longest-lived delayed neutron precursors.

C. The shutdown margin just prior to the trip.

D. The worth of the inserted control rods.

ANSWER: B.

TOPIC: Reactor Operational Physics

Shortly after a reactor trip, reactor power indicates 1.0×10^{-3} percent when a stable negative startup rate is attained. Reactor power will decrease to 1.0×10^{-4} percent in approximately _______ seconds.

A. 380

B. 280

C. 180

D. 80

ANSWER: C.

TOPIC: Reactor Operational Physics

Following a reactor trip, reactor power indicates 0.1 percent when the typical post-trip stable startup rate is observed. Approximately how much additional time is required for reactor power to decrease to 0.05 percent?

A. 24 seconds

B. 55 seconds

C. 173 seconds

D. 240 seconds

ANSWER: B.

TOPIC: Reactor Operational Physics

Which one of the following approximates the fission product decay heat produced in a reactor at one second and one hour following a reactor scram from long-term operation at 100 percent power?

	One Second	One Hour
A.	7 percent	1 percent
B.	7 percent	0.1 percent
C.	3 percent	1 percent
D.	3 percent	0.1 percent

ANSWER: A.

TOPIC: Reactor Operational Physics

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

Which reactor, if any, will have the smaller negative startup rate five minutes after the trip, and why?

A. Reactor A, due to the greater shutdown reactivity.

B. Reactor B, due to the smaller shutdown reactivity.

C. Both reactors will have the same startup rate because both reactors will be stable at a power level low in the source range.

D. Both reactors will have the same startup rate because only the longest-lived delayed neutron precursors will be releasing fission neutrons.

ANSWER: D.

TOPIC: Reactor Operational Physics

Reactors A and B are identical and have operated at 100 percent power for six months when a reactor trip occurs simultaneously on both reactors. All reactor A control rods fully insert, while one reactor B control rod sticks fully withdrawn.

Which reactor, if any, will have the smaller negative startup rate five minutes after the trip, and why?

A. Reactor A, because its delayed neutron fraction will be smaller.

B. Reactor B, because its delayed neutron fraction will be larger.

C. Both reactors will have the same startup rate because both reactors will be stable at a power level low in the source range.

D. Both reactors will have the same startup rate because only the longest-lived delayed neutron precursors will be releasing fission neutrons.

ANSWER: D.

TOPIC: Reactor Operational Physics

Reactors A and B are identical and have operated at 100 percent power for six months when a reactor trip occurs simultaneously on both reactors. All reactor A control rods fully insert. One reactor B control rod sticks fully withdrawn, but all others fully insert.

Five minutes after the trip, when compared to reactor B the fission rate in reactor A will be __________; and the startup rate in reactor A will be __________.

A. the same; more negative

B. the same; the same

C. smaller; more negative

D. smaller; the same

ANSWER: D.

TOPIC: Reactor Operational Physics

A reactor is critical just below the point of adding heat when an inadvertent reactor trip occurs. All control rods fully insert except for one rod, which remains fully withdrawn. Five minutes after the reactor trip, with reactor startup rate (SUR) stable at approximately -1/3 DPM, the remaining withdrawn control rod suddenly drops (fully inserts).

Which one of the following describes the reactor response to the drop of the last control rod?

A. SUR will remain stable at approximately -1/3 DPM.

B. SUR will immediately become more negative, and then return to and stabilize at approximately -1/3 DPM.

C. SUR will immediately become more negative, and then turn and stabilize at a value more negative than -1/3 DPM.

D. SUR will immediately become more negative, and then turn and stabilize at a value less negative than -1/3 DPM.

ANSWER: B.

TOPIC: Reactor Operational Physics

A nuclear power plant is operating at steady-state 100 percent power when a reactor trip occurs. As a result of the trip, the core neutron flux will initially decrease at a startup rate that is much __________ negative than -1/3 DPM; the startup rate will become approximately -1/3 DPM about __________ minutes after the trip.

A. less; 3

B. less; 30

C. more; 3

D. more; 30

ANSWER: C.

TOPIC: Reactor Operational Physics

Refer to the graph of neutron flux versus time (see figure below) for a nuclear power plant reactor that experienced a reactor trip from extended full power operation at 0 seconds.

Which section(s) of the curve has/have a slope that is primarily determined by the production rate of delayed neutrons?

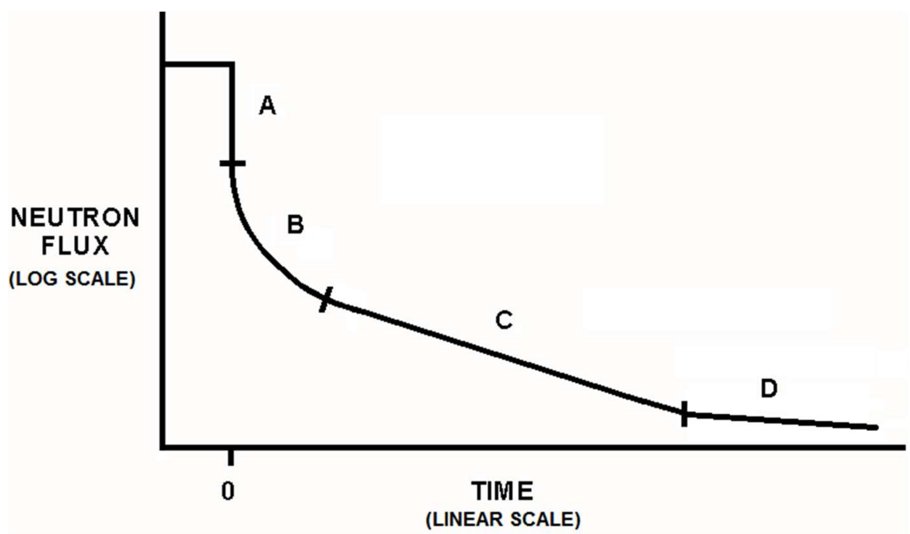
A. B only

B. B and C

C. C only

D. C and D

ANSWER: B.



TOPIC: Reactor Operational Physics

Refer to the graph of neutron flux versus time (see figure below) for a nuclear power plant that experienced a reactor trip from extended full power operation at time = 0 seconds.

In which section of the curve does the production rate of source neutrons primarily determine the slope of the curve?

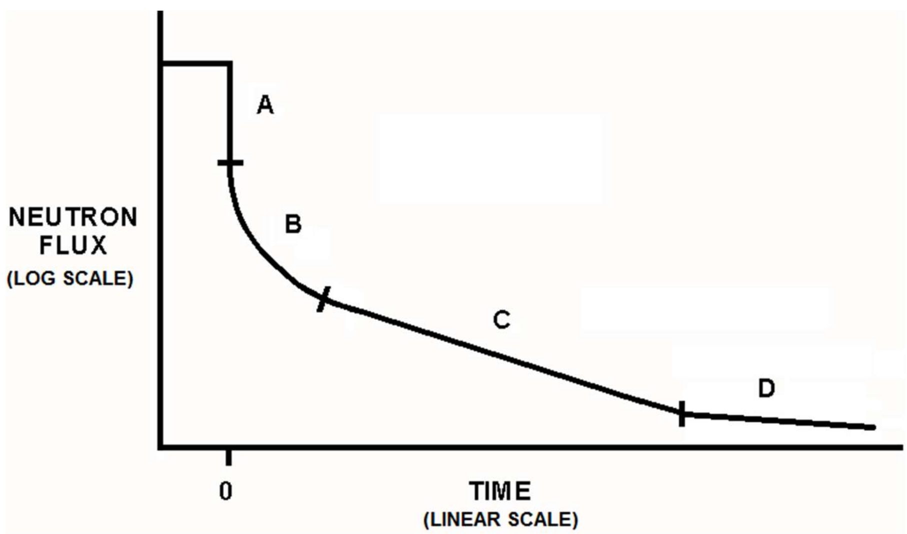
A. A

B. B

C. C

D. D

ANSWER: D.



TOPIC: Reactor Operational Physics

A reactor was operating for several months at 100 percent power when a reactor trip occurred. Which one of the following is primarily responsible for the startup rate value 2 minutes after the trip?

A. The K_{eff} in the core.

B. The rate of source neutron production in the core.

C. The effective delayed neutron fraction in the core.

D. The decay rates of the delayed neutron precursors in the core.

ANSWER: D.

TOPIC: Reactor Operational Physics

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

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

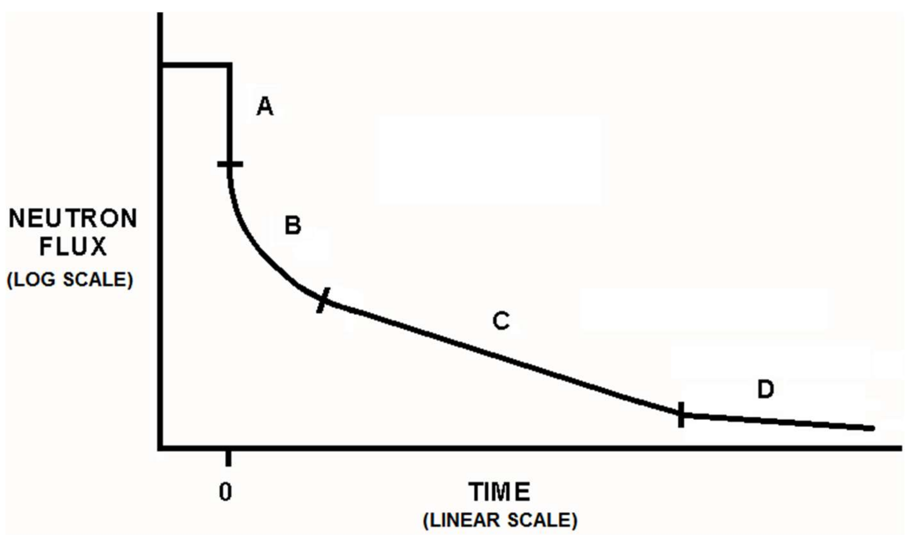
A. intrinsic source neutrons.

B. prompt fission neutrons.

C. delayed fission neutrons.

D. delayed fission neutron precursors.

ANSWER: B.



TOPIC: Reactor Operational Physics

A reactor was operating for several months at steady-state 100 percent power when a reactor trip occurred. Which one of the following lists the two factors most responsible for the value of the core neutron flux level 1 hour after the trip?

A. K_{eff} and the rate of source neutron production.

B. K_{eff} and the effective delayed neutron fraction.

C. The decay rates of the delayed neutron precursors and the rate of source neutron production.

D. The decay rates of the delayed neutron precursors and the effective delayed neutron fraction.

ANSWER: A.

TOPIC: Reactor Operational Physics

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

The shape of section B of the curve is determined primarily by the decreasing production rate of…

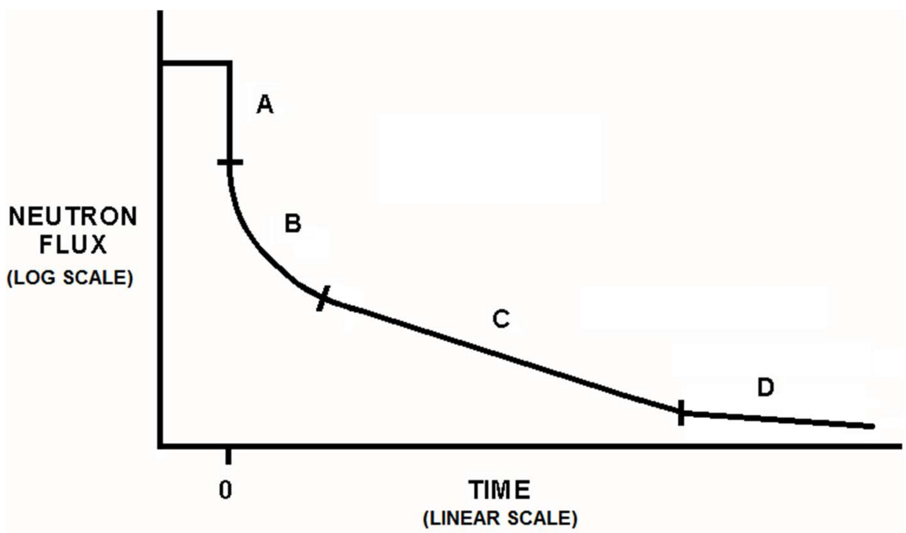
A. prompt fission neutrons.

B. delayed fission neutrons.

C. intrinsic source neutrons.

D. installed source neutrons.

ANSWER: B.



TOPIC: Reactor Operational Physics

A reactor is critical below the point of adding heat when a fully withdrawn control rod fully inserts into the core. Assuming no operator or automatic actions, core neutron flux will slowly decrease to...

A. zero.

B. an equilibrium value less than the source neutron flux.

C. an equilibrium value greater than the source neutron flux.

D. a slightly lower value, then slowly return to the initial value.

ANSWER: C.

TOPIC: Reactor Operational Physics

A reactor is critical just below the point of adding heat when a single fully withdrawn control rod drops into the core. Assuming no operator or automatic actions occur, when the plant stabilizes reactor power will be __________; and average reactor coolant temperature will be __________.

A. the same; the same

B. the same; lower

C. lower; the same

D. lower; lower

ANSWER: C.

TOPIC: Reactor Operational Physics

Initially, a reactor is critical in the source range during a reactor startup when the control rods are inserted a small amount. Reactor startup rate stabilizes at -0.15 DPM. Assuming startup rate remains constant, how long will it take for source range count rate to decrease by one-half?

A. 0.3 minutes

B. 2.0 minutes

C. 3.3 minutes

D. 5.0 minutes

ANSWER: B.

TOPIC: Reactor Operational Physics

Which one of the following describes how control rods are inserted during a normal reactor shutdown, and why?

A. One rod at a time, to maintain acceptable power distribution.

B. One rod at a time, to maintain a rapid shutdown capability from the remainder of the control rods.

C. In a reverse sequence, to maintain a relatively constant differential control rod worth.

D. In a reverse sequence, to limit the amount of positive reactivity added during a rod ejection accident.

ANSWER: C.

TOPIC: Reactor Operational Physics

After one month of operation at 100 percent power, the fraction of rated thermal power being produced from the decay of fission products in a reactor is...

A. greater than 10 percent.

B. greater than 5 percent, but less than 10 percent.

C. greater than 1 percent, but less than 5 percent.

D. less than 1 percent.

ANSWER: B.

TOPIC: Reactor Operational Physics

The magnitude of decay heat generation is determined primarily by...

A. core burnup.

B. power history.

C. final power at shutdown.

D. control rod worth at shutdown.

ANSWER: B.

TOPIC: Reactor Operational Physics

Following a reactor shutdown from three months of operation at 100 percent power, the core decay heat production rate will depend on the...

A. amount of fuel that has been depleted.

B. decay rate of the fission product poisons.

C. time elapsed since K_{eff} decreased below 1.0.

D. decay rate of the photoneutron source.

ANSWER: C.

TOPIC: Reactor Operational Physics

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

A. 1 percent to 2 percent

B. 3 percent to 5 percent

C. 6 percent to 8 percent

D. 9 percent to 11 percent

ANSWER: B.

TOPIC: Reactor Operational Physics

A nuclear power plant had been operating at 100 percent power for six months when a reactor trip occurred. Which one of the following describes the source(s) of core heat generation 30 minutes after the reactor trip?

A. Fission product decay is the only significant source of core heat generation.

B. Delayed neutron-induced fission is the only significant source of core heat generation.

C. Fission product decay and delayed neutron-induced fission are both significant sources and produce approximately equal rates of core heat generation.

D. Fission product decay and delayed neutron-induced fission are both insignificant sources and generate core heat at rates that are less than the rate of ambient heat loss from the core.

ANSWER: A.

TOPIC: Reactor Operational Physics

A nuclear power plant has been operating at 100 percent power for six months when a reactor trip occurs. Which one of the following describes the source(s) of core heat generation 1 minute after the reactor trip?

A. Fission product decay is the <u>only</u> heat source capable of increasing fuel temperature.

B. Delayed neutron-induced fission is the <u>only</u> heat source capable of increasing fuel temperature.

C. <u>Both</u> fission product decay <u>and</u> delayed neutron-induced fission are capable of increasing fuel temperature.

D. <u>Neither</u> fission product decay <u>nor</u> delayed neutron-induced fission are capable of increasing fuel temperature.

ANSWER: C.

TOPIC: Thermodynamic Units and Properties

An atmospheric pressure of 15.0 psia is equivalent to...

A. 30.0 psig.

B. 29.4 psig.

C. 14.7 psig.

D. 0.0 psig.

ANSWER: D.

TOPIC: Thermodynamic Units and Properties

A pressure gauge on a condenser reads 27.0 inches Hg vacuum. What is the absolute pressure corresponding to this vacuum? (Assume a standard atmospheric pressure of 15.0 psia.)

A. 14.0 psia

B. 13.5 psia

C. 1.5 psia

D. 1.0 psia

ANSWER: C.

TOPIC: Thermodynamic Units and Properties

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

A. 2.5 psia.

B. 5.0 psia.

C. 10.0 psia.

D. 12.5 psia.

ANSWER: D.

TOPIC: Thermodynamic Units and Properties

If a pressure gauge reads 900 psig, what is the absolute pressure?

A. 870 psia

B. 885 psia

C. 915 psia

D. 930 psia

ANSWER: C.

TOPIC: Thermodynamic Units and Properties

Which one of the following is equivalent to 5 psia?

A. 20 psig

B. 10 psig

C. 10 inches of mercury (Hg) vacuum

D. 20 inches of mercury (Hg) vacuum

ANSWER: D.

TOPIC: Thermodynamic Units and Properties

Which one of the following is arranged from the lowest pressure to the highest pressure?

A. 8 psia, 20 inches Hg absolute, 2 psig

B. 8 psia, 2 psig, 20 inches Hg absolute

C. 20 inches Hg absolute, 2 psig, 8 psia

D. 20 inches Hg absolute, 8 psia, 2 psig

ANSWER: A.

TOPIC: Thermodynamic Units and Properties

Which one of the following is arranged from the highest pressure to the lowest pressure?

A. 2 psig, 20 inches Hg absolute, 8 psia

B. 2 psig, 8 psia, 20 inches Hg absolute

C. 8 psia, 20 inches Hg absolute, 2 psig

D. 8 psia, 2 psig, 20 inches Hg absolute

ANSWER: A.

TOPIC: Thermodynamic Units and Properties

Which one of the following is approximately equivalent to 2 psig?

A. 11 psia

B. 13 psia

C. 15 psia

D. 17 psia

ANSWER: D.

TOPIC: Thermodynamic Units and Properties

Which one of the following is arranged from the lowest pressure to the highest pressure?

A. 2 psig, 12 inches Hg absolute, 8 psia

B. 2 psig, 18 inches Hg absolute, 8 psia

C. 12 psia, 20 inches Hg absolute, 2 psig

D. 12 psia, 30 inches Hg absolute, 2 psig

ANSWER: D.

TOPIC: Thermodynamic Units and Properties

Which one of the following is the approximate condenser vacuum when condenser pressure is 16 inches Hg absolute?

A. 4 inches Hg vacuum

B. 8 inches Hg vacuum

C. 12 inches Hg vacuum

D. 14 inches Hg vacuum

ANSWER: D.

TOPIC: Thermodynamic Units and Properties

Which one of the following is arranged left-to-right from the highest pressure to the lowest pressure?

A. 2 psig, 12 inches Hg absolute, 8 psia

B. 2 psig, 18 inches Hg absolute, 8 psia

C. 12 psia, 20 inches Hg absolute, 2 psig

D. 12 psia, 30 inches Hg absolute, 2 psig

ANSWER: B.

TOPIC: Thermodynamic Units and Properties

Refer to the drawing of two water storage tanks with four differential pressure (D/P) level detectors (see figure below).

The tanks are identical and are being maintained at the same constant water level with 17 psia gas pressure above the water. The tanks are surrounded by standard atmospheric pressure. The temperature of the water in the tanks and reference legs is 70°F.

Which one of the level detectors is sensing the greatest D/P?

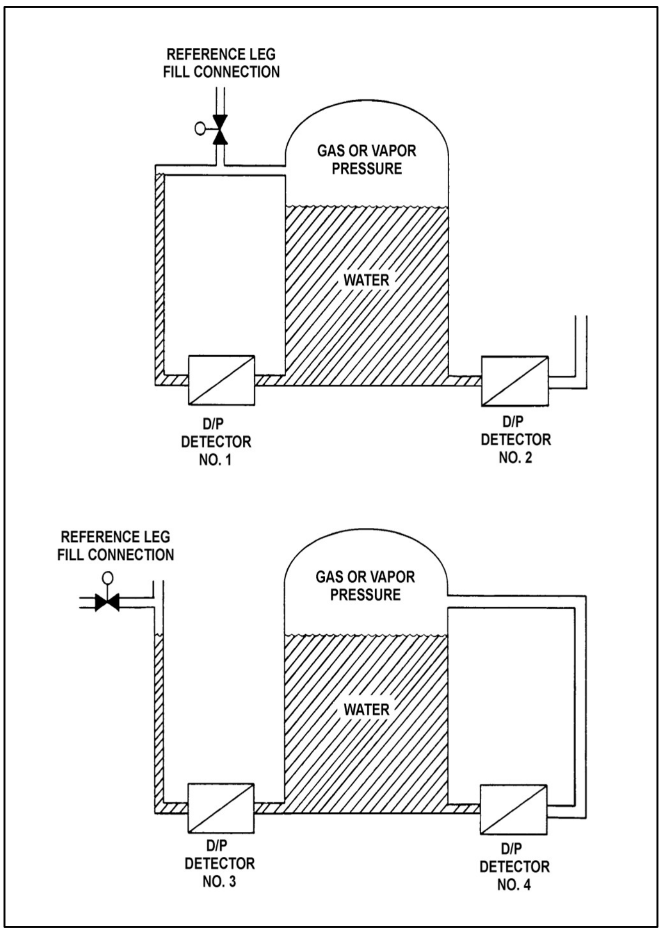
A. No. 1

B. No. 2

C. No. 3

D. No. 4

ANSWER: B.



TOPIC: Thermodynamic Units and Properties

A closed water tank is pressurized with nitrogen. A differential pressure detector is used to measure the tank water level.

To achieve the most accurate water level measurement, the low pressure side of the detector should sense which one of the following?

A. The pressure at the midline of the tank.

B. The pressure of the atmosphere surrounding the tank.

C. The pressure of a column of water external to the tank.

D. The pressure of the gas space at the top of the tank.

ANSWER: D.

TOPIC: Thermodynamic Units and Properties

Refer to the drawing of two water storage tanks with four differential pressure (D/P) level detectors (see figure below).

The tanks are identical and are being maintained at 17 psia gas pressure. The tanks are located in a building that is currently at atmospheric pressure. All level detectors are producing level indications of 70 percent.

If a malfunction in the building ventilation system decreases the pressure surrounding the tanks, which level detectors will produce the lowest level indications?

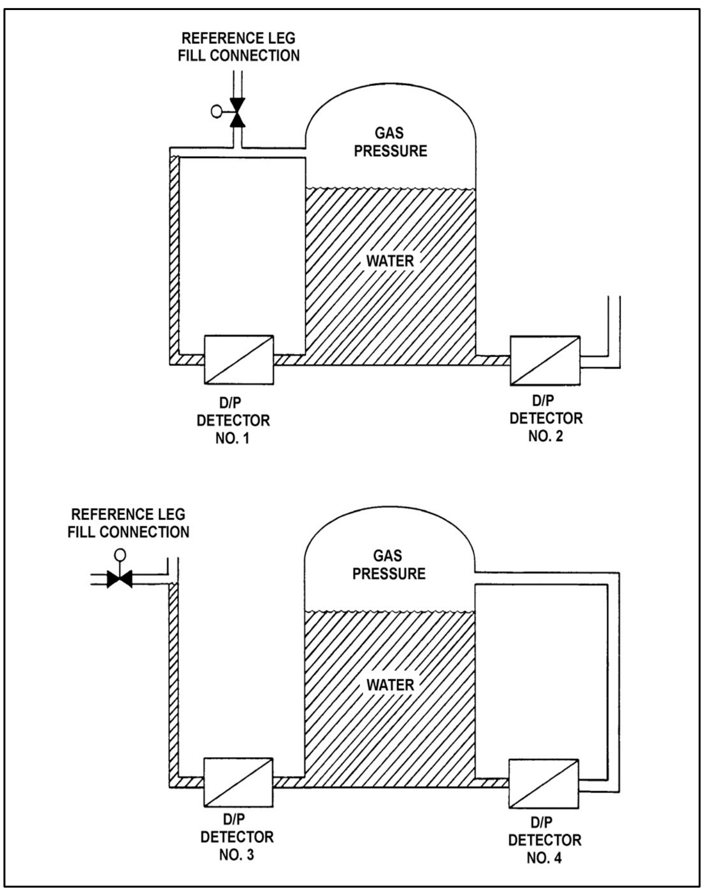
A. 1 and 3

B. 1 and 4

C. 2 and 3

D. 2 and 4

ANSWER: B.



TOPIC: Thermodynamic Units and Properties

Refer to the drawing of two water storage tanks with four differential pressure (D/P) level detectors (see figure below).

The tanks are identical and are being maintained at 2 psig overpressure, the same constant water level, and a temperature of 60°F. They are surrounded by atmospheric pressure.

If a leak in the top of each tank causes a complete loss of overpressure, which detector(s) will produce a lower level indication?

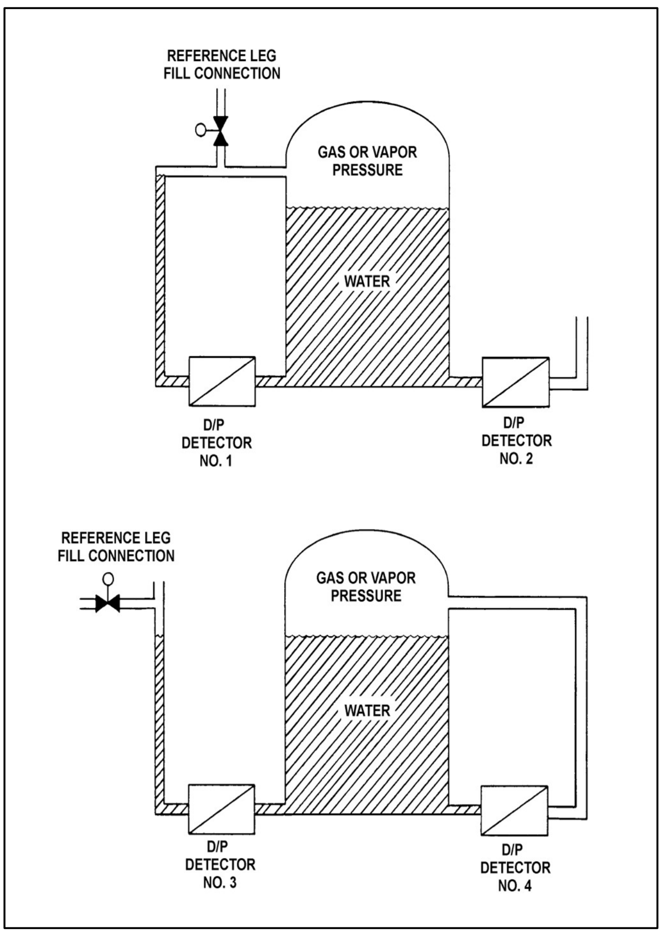
A. No. 1 only

B. No. 2 only

C. No. 1 and 4

D. No. 2 and 3

ANSWER: D.



TOPIC: Thermodynamic Units and Properties

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

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

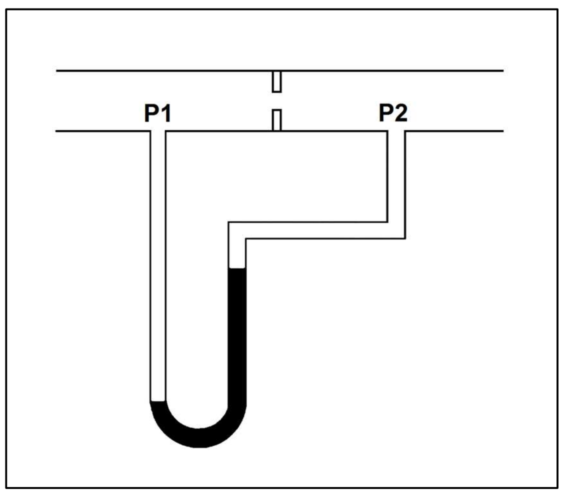
A. greater; left to right

B. greater; right to left

C. less; left to right

D. less; right to left

ANSWER: A.



TOPIC: Thermodynamic Units and Properties

Refer to the drawing of two water storage tanks with four differential pressure (D/P) level detectors (see figure below).

The tanks are identical with equal water levels and 20 psia gas pressure above the water. The tanks are surrounded by standard atmospheric pressure. The temperature of the water in the tanks and reference legs is 70°F.

If each detector experiences a ruptured diaphragm, which detector(s) will produce a reduced level indication? (Assume that actual tank and reference leg water levels do <u>not</u> change.)

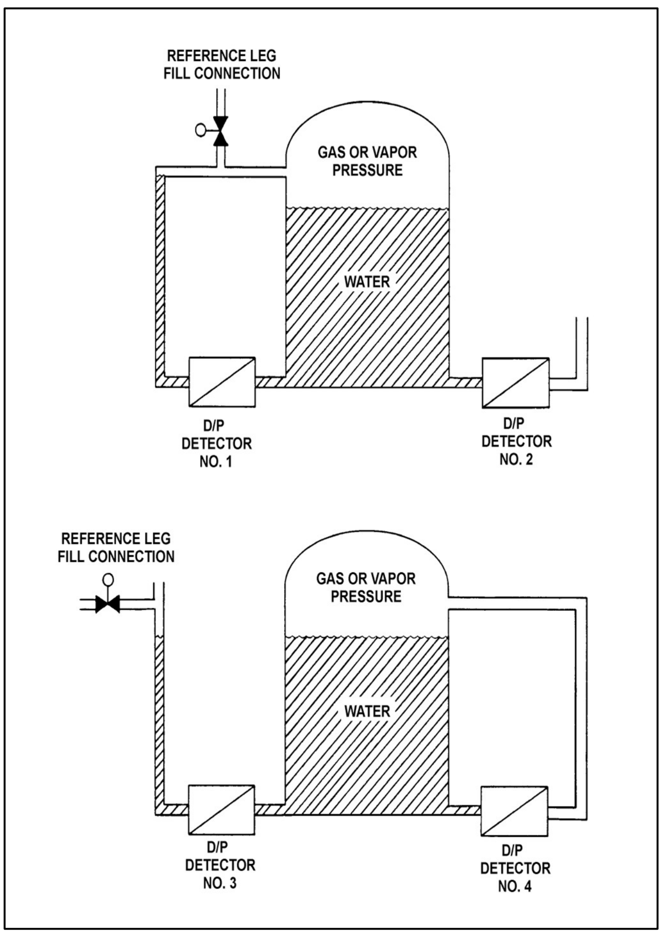
A. No. 1 only

B. No. 2 only

C. No. 1, 2, and 3

D. No. 2, 3, and 4

ANSWER: D.



TOPIC: Thermodynamic Units and Properties

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

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

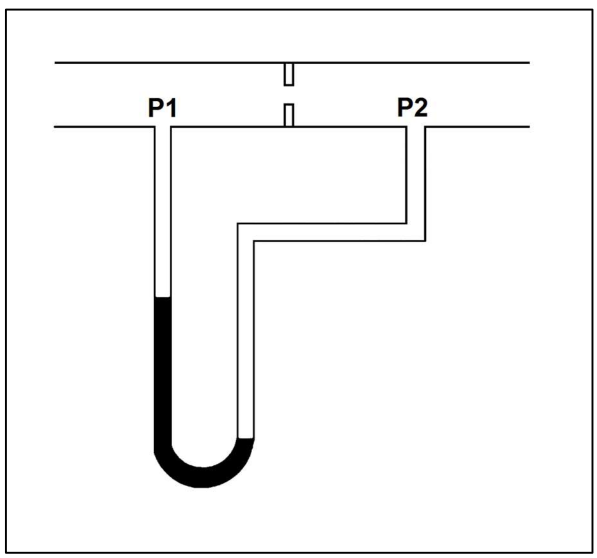
A. less; right to left

B. less; left to right

C. greater; right to left

D. greater; left to right

ANSWER: A.



TOPIC: Thermodynamic Units and Properties

A water storage tank is vented to atmosphere. The tank is located at sea level and contains 100,000 gallons of 80°F water. A pressure gauge at the bottom of the tank reads 5.6 psig. What is the approximate water level in the tank?

A. 13 feet

B. 17 feet

C. 21 feet

D. 25 feet

ANSWER: A.

TOPIC: Thermodynamic Units and Properties

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 60°F, what is the approximate D/P sensed by the detector?

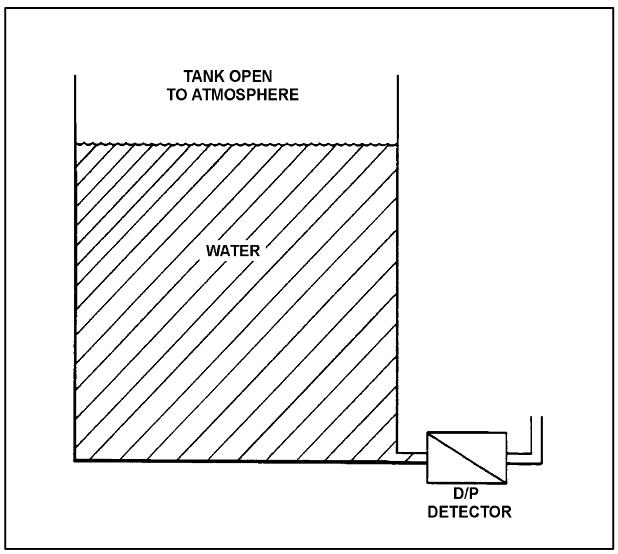
A. 7 psid

B. 13 psid

C. 20 psid

D. 28 psid

ANSWER: B.



TOPIC: Thermodynamic Units and Properties

A water storage tank is vented to atmosphere. The tank is located at sea level and contains 100,000 gallons of water at 80°F. A pressure gauge at the bottom of the tank reads 7.3 psig. What is the approximate water level in the tank?

A. 13 feet

B. 17 feet

C. 21 feet

D. 25 feet

ANSWER: B.

TOPIC: Thermodynamic Units and Properties

A water storage tank is vented to atmosphere. The tank is located at sea level and contains 100,000 gallons of water at 80°F. A pressure gauge at the bottom of the tank reads 9.0 psig. What is the approximate water level in the tank?

A. 13 feet

B. 17 feet

C. 21 feet

D. 25 feet

ANSWER: C.

TOPIC: Thermodynamic Units and Properties

Refer to the drawing of two water storage tanks with four differential pressure (D/P) level detectors (see figure below).

The tanks are identical and are being maintained at 2 psig overpressure, the same constant water level, and a temperature of 60°F. The tanks are surrounded by atmospheric pressure. All level detectors have been calibrated and are producing the same level indication.

If a leak in the top of each tank causes a complete loss of overpressure in both tanks, which detector(s) will produce the highest level indication(s)?

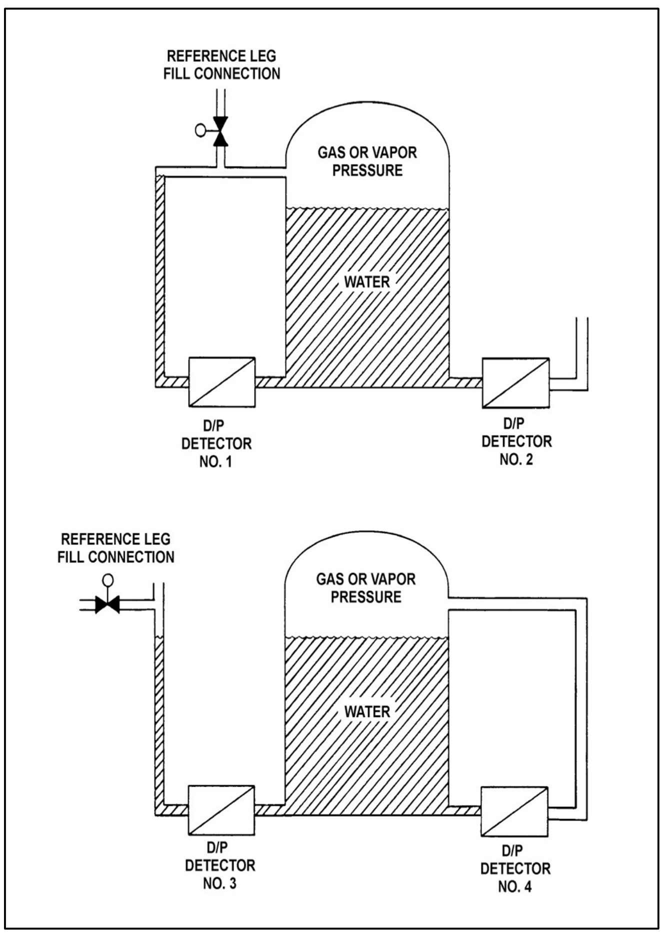
A. No. 1 only

B. No. 2 only

C. No. 1 and 4

D. No. 2 and 3

ANSWER: C.



TOPIC: Thermodynamic Units and Properties

Refer to the drawing of an open water storage tank with a differential pressure (D/P) level indicator that is vented to atmosphere (see figure below). Both the tank and the level indicator are surrounded by standard atmospheric pressure. Tank water temperature is 70°F.

The D/P level indicator is sensing a differential pressure of 4.0 psi. What is the water level in the tank above the instrument penetration?

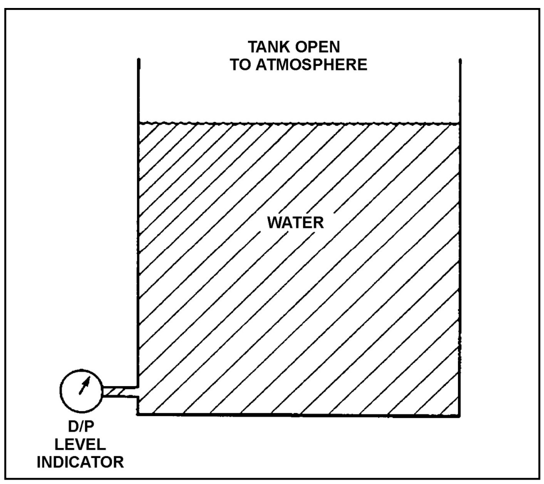
A. 9.2 feet

B. 16.7 feet

C. 24.7 feet

D. 43.2 feet

ANSWER: A.



TOPIC: Basic Energy Concepts

Refer to the drawing of a section of 6-inch diameter pipe containing subcooled water flowing from left to right at 100 gpm (see figure below).

The pipe is frictionless and no heat transfer is occurring. Point B is 10 feet higher in elevation than point A.

How does the enthalpy of the water at point A compare to point B?

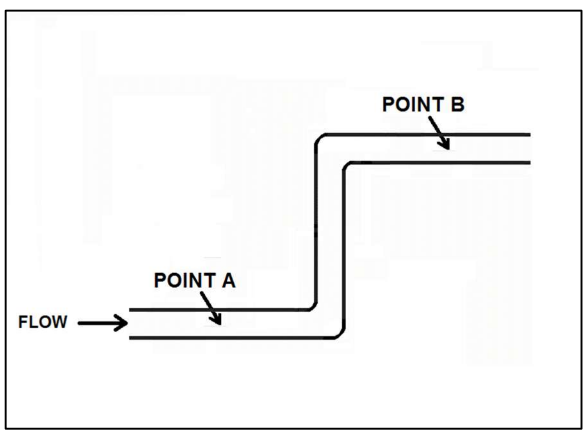
A. The enthalpy of the water at point A is smaller, because some of the water's kinetic energy is converted to enthalpy as it flows to point B.

B. The enthalpy of the water at point A is greater, because some of the water's enthalpy is converted to potential energy as it flows to point B.

C. The enthalpy of the water at points A and B is the same, because the pipe is frictionless and no heat transfer is occurring.

D. The enthalpy of the water at points A and B is the same, because the total energy of the water does not change from point A to point B.

ANSWER: B.



TOPIC: Basic Energy Concepts

For which of the following ideal processes, if any, is the fluid outlet enthalpy greater than the fluid inlet enthalpy? (Assume horizontal fluid flow in each process.)

(A) Cooling water flowing through a fixed convergent nozzle.
(B) Cooling water flowing through an operating lube oil heat exchanger.

A. (A) only

B. (B) only

C. Both (A) and (B)

D. Neither (A) nor (B)

ANSWER: B.

TOPIC: Thermodynamic Processes

Which one of the following is essentially a constant enthalpy process?

A. Steam flowing through an <u>ideal</u> convergent nozzle.

B. Condensation of turbine exhaust in a main condenser.

C. Expansion of main steam through the stages of an <u>ideal</u> turbine.

D. Throttling of main steam through a main turbine steam inlet valve.

ANSWER: D.

TOPIC: Thermodynamic Processes

Refer to the drawing of two 1,000 ft^3 pressure vessels with installed relief valves (see figure below).

Both vessels are in saturated conditions at 281°F and approximately 35 psig. Vessel X is completely filled with saturated water. Vessel Y contains one-half saturated steam (100 percent quality) and one-half saturated water (0 percent quality) by volume. Both vessels are protected by identical relief valves.

If both relief valves begin to leak at a rate of 0.1 percent of design flow, the higher temperature fluid will initially be leaving the relief valve of vessel _____. And, if 100 lbm of fluid is released through both relief valves, the larger pressure decrease will occur in vessel _____.

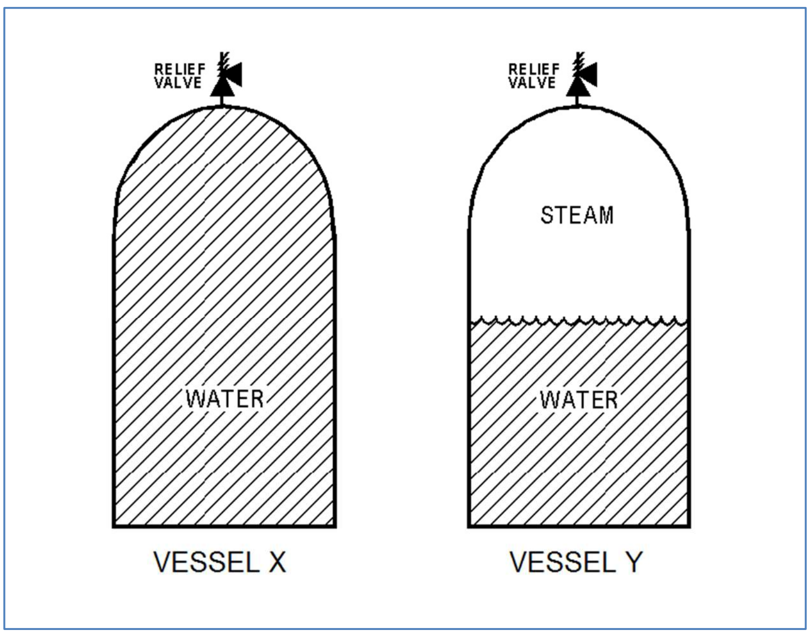
A. X; X

B. X; Y

C. Y; X

D. Y; Y

ANSWER: D.



TOPIC: Thermodynamic Cycles

If the moisture content of the steam supplied to a turbine decreases, the steam cycle thermal efficiency will increase because the...

A. enthalpy of the steam supplied to the turbine has increased.

B. mass flow rate of the steam through the turbine has increased.

C. reheat capacity of the turbine extraction steam has increased.

D. the operating temperature of the turbine blades has increased.

ANSWER: A.

TOPIC: Thermodynamic Cycles

Initially, a main turbine is being supplied with inlet steam containing 0.25 percent moisture content. If the inlet steam moisture content increases to 0.5 percent at the same pressure and mass flow rate, the main turbine work output will…

A. increase, due to the increased enthalpy of the inlet steam.

B. increase, due to the increased momentum transfer from water droplets impacting the turbine blading.

C. decrease, due to the decreased temperature of the inlet steam.

D. decrease, due to the increased braking action from water droplets impacting the turbine blading.

ANSWER: D.

TOPIC: Thermodynamic Cycles

Initially, a main turbine is being supplied with inlet steam containing 0.5 percent moisture content. If the inlet steam moisture content decreases to 0.25 percent at the same pressure and mass flow rate, the main turbine work output will…

A. increase, due to the increased temperature of the inlet steam.

B. increase, due to the decreased braking action from water droplets impacting the turbine blading.

C. decrease, due to the decreased enthalpy of the inlet steam.

D. decrease, due to the decreased momentum transfer from water droplets impacting the turbine blading.

ANSWER: B.

TOPIC: Fluid Statics and Dynamics

The possibility of water hammer in a liquid system is <u>minimized</u> by...

A. maintaining temperature above the saturation temperature.

B. starting centrifugal pumps with the casing vent valve fully open.

C. starting positive displacement pumps with the discharge valve closed.

D. venting systems prior to starting centrifugal pumps.

ANSWER: D.

TOPIC: Fluid Statics and Dynamics

Which one of the following methods will increase the possibility and/or severity of water hammer?

A. Opening and closing system valves slowly.

B. Venting fluid systems prior to starting a pump.

C. Starting a centrifugal pump with the discharge valve fully open.

D. Starting a centrifugal pump with the discharge valve fully closed.

ANSWER: C.

TOPIC: Fluid Statics and Dynamics

A sudden stop of fluid flow in a piping system, due to rapid closure of an isolation valve, will most likely result in...

A. check valve slamming.

B. pump runout.

C. water hammer.

D. pressurized thermal shock.

ANSWER: C.

TOPIC: Fluid Statics and Dynamics

One reason for keeping condensate out of the steam lines is to...

A. minimize corrosion buildup.

B. reduce heat losses.

C. eliminate steam traps.

D. prevent water/steam hammer.

ANSWER: D.

TOPIC: Fluid Statics and Dynamics

To minimize the possibility of water hammer when initiating flow in a system, the operator should...

A. vent the system prior to initiating flow.

B. vent the system only after flow has been initiated.

C. fully open the pump discharge valve prior to starting a pump.

D. rapidly open the pump discharge valve after the pump is running.

ANSWER: A.

TOPIC: Fluid Statics and Dynamics

Which one of the following operating practices minimizes the possibility of water hammer?

A. Change valve positions as rapidly as possible.

B. Start centrifugal pumps with the discharge valve throttled.

C. Start positive displacement pumps with the discharge valve closed.

D. Vent systems only after initiating system flow.

ANSWER: B.

TOPIC: Fluid Statics and Dynamics

Which one of the following will result in a higher probability and/or severity of water hammer in a flowing water system?

A. Gradual pipe bends rather than sharp pipe bends.

B. Shorter pipe lengths rather than longer pipe lengths.

C. Lower initial flow rates rather than higher initial flow rates.

D. Shorter valve stroke times rather than longer valve stroke times.

ANSWER: D.

TOPIC: Fluid Statics and Dynamics

An 85 gpm leak to atmosphere has developed from a cooling water system that is operating at 100 psig. Which one of the following will be the approximate leak rate when system pressure has decreased to 50 psig?

A. 33 gpm

B. 41 gpm

C. 52 gpm

D. 60 gpm

ANSWER: D.

TOPIC: Fluid Statics and Dynamics

Mass flow rate equals volumetric flow rate times...

A. specific volume.

B. density.

C. specific gravity.

D. velocity.

ANSWER: B.

TOPIC: Fluid Statics and Dynamics

A 55 gpm leak to atmosphere has developed from a cooling water system that is operating at 100 psig. Which one of the following will be the approximate leak rate when system pressure has decreased to 50 psig?

A. 28 gpm

B. 32 gpm

C. 39 gpm

D. 45 gpm

ANSWER: C.

TOPIC: Fluid Statics and Dynamics

A 75 gpm leak to atmosphere has developed from a cooling water system that is operating at 80 psig. Which one of the following will be the approximate leak rate when system pressure has decreased to 40 psig?

A. 38 gpm

B. 44 gpm

C. 53 gpm

D. 59 gpm

ANSWER: C.

TOPIC: Fluid Statics and Dynamics

A 60 gpm leak to atmosphere has developed from a cooling water system that is operating at 150 psig. Which one of the following will be the approximate leak rate when system pressure has decreased to 75 psig?

A. 15 gpm

B. 30 gpm

C. 42 gpm

D. 53 gpm

ANSWER: C.

TOPIC: Fluid Statics and Dynamics

A 100 gpm leak to atmosphere has developed from a cooling water system that is operating at 60 psig. Which one of the following will be the approximate leak rate when system pressure has decreased to 20 psig?

A. 33 gpm

B. 53 gpm

C. 58 gpm

D. 71 gpm

ANSWER: C.

TOPIC: Fluid Statics and Dynamics

A 100 gpm leak to atmosphere has developed from a cooling water system that is operating at 45 psig. Which one of the following will be the approximate leak rate when system pressure has decreased to 30 psig?

A. 25 gpm

B. 50 gpm

C. 67 gpm

D. 82 gpm

ANSWER: D.

TOPIC: Fluid Statics and Dynamics

A 47 gpm leak to atmosphere has developed from a cooling water system that is operating at 150 psig. Which one of the following will be the approximate leak rate when system pressure has decreased to 75 psig?

A. 24 gpm

B. 33 gpm

C. 39 gpm

D. 46 gpm

ANSWER: B.

TOPIC: Fluid Statics and Dynamics

An 80 gpm leak to atmosphere has developed from a cooling water system that is operating at 100 psig. Which one of the following will be the approximate leak rate when system pressure has decreased to 75 psig?

A. 69 gpm

B. 60 gpm

C. 51 gpm

D. 40 gpm

ANSWER: A.

TOPIC: Fluid Statics and Dynamics

A 60 gpm leak to atmosphere has developed from a cooling water system that is operating at 150 psig. Which one of the following will be the approximate leak rate when system pressure has decreased to 100 psig?

A. 27 gpm

B. 35 gpm

C. 40 gpm

D. 49 gpm

ANSWER: D.

TOPIC: Fluid Statics and Dynamics

An 80 gpm leak to atmosphere has developed from a cooling water system that is operating at 150 psig. Which one of the following will be the approximate leak rate when system pressure has decreased to 75 psig?

A. 20 gpm

B. 40 gpm

C. 49 gpm

D. 57 gpm

ANSWER: D.

TOPIC: Fluid Statics and Dynamics

An 80 gpm leak to atmosphere has developed from a cooling water system that is operating at 150 psig. Which one of the following will be the approximate leak rate when system pressure has decreased to 100 psig?

A. 36 gpm

B. 53 gpm

C. 56 gpm

D. 65 gpm

ANSWER: D.

TOPIC: Fluid Statics and Dynamics

A 75 gpm leak to atmosphere has developed from a cooling water system that is operating at 100 psig. Which one of the following will be the approximate leak rate when system pressure has decreased to 80 psig?

A. 26 gpm

B. 39 gpm

C. 56 gpm

D. 67 gpm

ANSWER: D.

TOPIC: Fluid Statics and Dynamics

A heat exchanger has the following <u>initial</u> cooling water inlet temperature and differential pressure (ΔP) parameters:

Inlet Temperature = 70°F
Heat Exchanger ΔP = 10 psi

Six hours later, the <u>current</u> heat exchanger cooling water parameters are:

Inlet Temperature = 85°F
Heat Exchanger ΔP = 10 psi

In comparison to the initial cooling water mass flow rate, the current mass flow rate is...

A. lower, because the density of the cooling water has decreased.

B. higher, because the velocity of the cooling water has increased.

C. the same, because the changes in cooling water velocity and density offset.

D. the same, because the heat exchanger cooling water ΔP is the same.

ANSWER: A.

TOPIC: Fluid Statics and Dynamics

An 80 gpm leak to atmosphere has developed from a cooling water system that is operating at 150 psig. Which one of the following will be the approximate leak rate when system pressure has decreased to 100 psig?

A. 70 gpm

B. 65 gpm

C. 53 gpm

D. 47 gpm

ANSWER: B.

TOPIC: Fluid Statics and Dynamics

Refer to the drawing of two lengths of 6-inch diameter pipe, each containing an identical automatic isolation valve. The actual pipe lengths are proportional to their symbols in the drawing

Water at 65°F is flowing at 1,000 gpm through each pipe. If isolation valves A and B instantly close, the pressure spike experienced by valve A will be __________ the pressure spike experienced by valve B; and the pressure spike will dissipate faster in the __________ length of pipe.

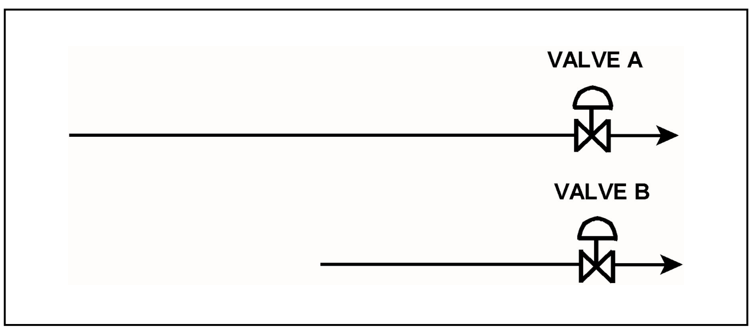
A. equal to; shorter

B. equal to; longer

C. less than; shorter

D. less than; longer

ANSWER: A.



TOPIC: Fluid Statics and Dynamics

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

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

Case 1: The water temperature upstream of both valves is 65°F.
Case 2: The water temperature is 65°F upstream of valve A, and 85°F upstream of valve B.

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

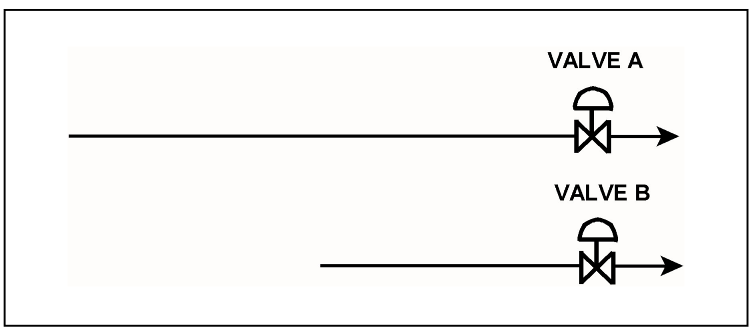
A. Case 1 only

B. Case 2 only

C. Both cases

D. Neither case

ANSWER: B.



TOPIC: Fluid Statics and Dynamics

A centrifugal water pump was returned to service after maintenance. However, the operator failed to vent the pump.

Compared to normal pump operating conditions, after the pump is started the operator will see a __________ flow rate and a __________ discharge head.

A. higher; lower

B. higher; higher

C. lower; lower

D. lower; higher

ANSWER: C.

TOPIC: Fluid Statics and Dynamics

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

Centrifugal pump A is circulating water at 100°F. Which one of the following will cause the centrifugal pump to operate closer to a condition in which gas/vapor binding can occur?

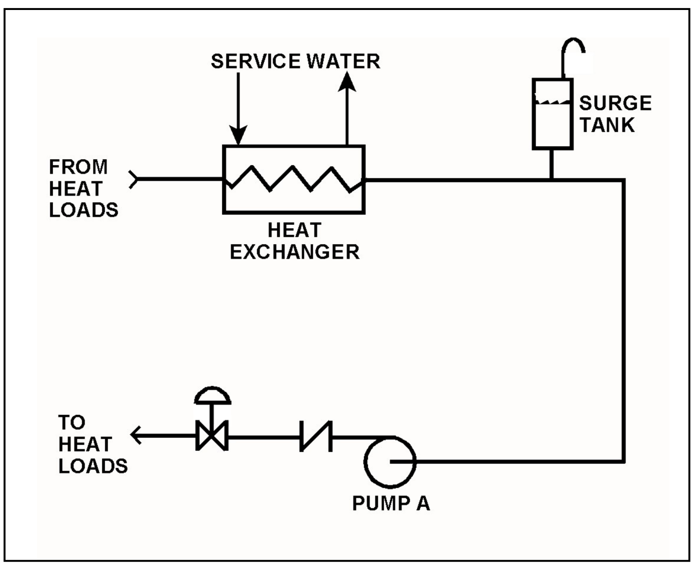
A. Surge tank level is raised by 5 percent.

B. Service water flow rate is decreased by 5 percent.

C. The pump discharge valve is repositioned to decrease cooling water system flow rate by 5 percent.

D. Makeup water containing a high concentration of total dissolved solids is added to the cooling water system.

ANSWER: B.



TOPIC: Fluid Statics and Dynamics

If a valve closure suddenly stops fluid flow, the resulting piping system pressure transient is referred to as...

A. cavitation.

B. shutoff head.

C. water hammer.

D. valve chatter.

ANSWER: C.

TOPIC: Fluid Statics and Dynamics

The <u>major</u> 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.

ANSWER: B.

TOPIC: Fluid Statics and Dynamics

Which one of the following will increase the possibility of water hammer?

A. Opening and closing system valves very slowly.

B. Venting liquid systems only after initiating system flow.

C. Starting centrifugal pumps with the discharge valve closed.

D. Starting positive displacement pumps with the discharge valve open.

ANSWER: B.

TOPIC: Fluid Statics and Dynamics

The primary reason for slowly opening the discharge valve of a large motor-driven centrifugal cooling water pump after starting the pump is to minimize the...

A. net positive suction head requirements.

B. potential for a water hammer.

C. motor running current requirements.

D. potential for pump cavitation.

ANSWER: B.

TOPIC: Fluid Statics and Dynamics

Cavitation in an operating pump can be caused by...

A. lowering the pump suction temperature.

B. throttling the pump suction valve.

C. increasing the pump backpressure.

D. increasing the pump suction pressure.

ANSWER: B.

TOPIC: Fluid Statics and Dynamics

Cavitation of a centrifugal pump in an open system is indicated by __________ discharge pressure and __________ flow rate.

A. low; low

B. high; high

C. low; high

D. high; low

ANSWER: A.

TOPIC: Fluid Statics and Dynamics

Which one of the following is most likely to cause cavitation in an operating centrifugal pump?

A. Lowering the suction temperature.

B. Throttling the pump suction valve.

C. Throttling the pump discharge valve.

D. Decreasing the pump speed.

ANSWER: B.

TOPIC: Fluid Statics and Dynamics

While on surveillance rounds, an operator notices that a centrifugal pump is making a great deal of noise (like marbles rattling inside the pump casing) and the pump discharge pressure is fluctuating.

This set of conditions indicates that the pump is experiencing...

A. runout.

B. cavitation.

C. bearing deterioration.

D. packing deterioration.

ANSWER: B.

TOPIC: Fluid Statics and Dynamics

Indications of pump cavitation include abnormally _________ pump discharge pressure and abnormally _________ pump flow rate.

A. low; low

B. low; high

C. high; low

D. high; high

ANSWER: A.

TOPIC: Fluid Statics and Dynamics

Cavitation is the formation of vapor bubbles in the __________ of a pump; with the subsequent collapse of the vapor bubbles in the __________ of the pump.

A. impeller; casing

B. impeller; discharge piping

C. volute; casing

D. volute; discharge piping

ANSWER: A.

TOPIC: Fluid Statics and Dynamics

Cavitation is the formation of vapor bubbles in the __________ pressure area of a pump followed by the __________ of these bubbles within the pump casing.

A. low; expansion

B. low; collapse

C. high; expansion

D. high; collapse

ANSWER: B.

TOPIC: Fluid Statics and Dynamics

Pump cavitation occurs when vapor bubbles are formed at the eye of a pump impeller...

A. because the localized flow velocity exceeds sonic velocity for the existing fluid temperature.

B. because the localized pressure exceeds the vapor pressure for the existing fluid temperature.

C. and enter a high pressure region of the pump where they collapse causing damaging pressure pulsations.

D. and are discharged from the pump where they expand into larger bubbles causing damaging pressure pulsations.

ANSWER: C.

TOPIC: Fluid Statics and Dynamics

In an operating cooling water system with a constant water velocity, if water temperature decreases, system volumetric flow rate (gpm) will...

A. remain the same, because the density of the water has not changed.

B. increase, because the density of the water has increased.

C. remain the same, because the water velocity has not changed.

D. increase, because the viscosity of the water has increased.

ANSWER: C.

TOPIC: Fluid Statics and Dynamics

A cooling water system is supplying 1.0 x 10^6 lbm/hour of flow at 100°F. Assuming volumetric flow rate does not change, which one of the following will be the mass flow rate in the system if cooling water temperature increases to 140°F?

A. 7.5 x 10^5 lbm/hr

B. 8.3 x 10^5 lbm/hr

C. 9.0 x 10^5 lbm/hr

D. 9.9 x 10^5 lbm/hr

ANSWER: D.

TOPIC: Fluid Statics and Dynamics

A reactor coolant system is supplying 1.0×10^8 lbm/hour of coolant flow at a temperature of 100°F. Assuming volumetric flow rate does not change, which one of the following is the approximate mass flow rate that will be supplied by the system if cooling water temperature increases to 400°F?

A. 1.2×10^8 lbm/hr

B. 1.1×10^8 lbm/hr

C. 9.2×10^7 lbm/hr

D. 8.7×10^7 lbm/hr

ANSWER: D.

TOPIC: Fluid Statics and Dynamics

A reactor coolant system is supplying 1.0×10^8 lbm/hr of coolant flow at a temperature of 100°F. Assuming volumetric flow rate does not change, which one of the following is the approximate mass flow rate that will be supplied by the system if coolant temperature increases to 500°F?

A. 1.2×10^8 lbm/hr

B. 1.1×10^8 lbm/hr

C. 8.7×10^7 lbm/hr

D. 7.9×10^7 lbm/hr

ANSWER: D.

TOPIC: Fluid Statics and Dynamics

A cooling water system is supplying 2,000 lbm/min coolant flow at a temperature of 100°F. Assuming volumetric flow rate does not change, which one of the following is the approximate mass flow rate that will be supplied by the system if cooling water temperature increases to 140°F?

A. 1,964 lbm/min

B. 1,980 lbm/min

C. 2,020 lbm/min

D. 2,036 lbm/min

ANSWER: B.

TOPIC: Fluid Statics and Dynamics

The volumetric flow rate of cooling water entering a heat exchanger is 500 gpm.

Given the following:

- Cooling water pressure entering and leaving the heat exchanger is 10 psig.
- Cooling water inlet temperature is 90°F.
- Cooling water outlet temperature is 160°F.
- Heat exchanger inlet and outlet piping have the same diameter.

What is the approximate volumetric flow rate of the cooling water exiting the heat exchanger?

A. 496 gpm

B. 500 gpm

C. 504 gpm

D. 509 gpm

ANSWER: D.

TOPIC: Fluid Statics and Dynamics

Operating two pumps in parallel instead of operating a single pump will result in a...

A. large increase in pump head and a small increase in pump flow rate.

B. small increase in pump head and a small increase in pump flow rate.

C. small increase in pump head and a large increase in pump flow rate.

D. large increase in pump head and a large increase in pump flow rate.

ANSWER: C.

TOPIC: Fluid Statics and Dynamics

The <u>major</u> effect of starting a second centrifugal pump in parallel with an operating centrifugal pump in an open system is increased...

A. system pressure.

B. system flow rate.

C. pump discharge pressure.

D. pump flow rate.

ANSWER: B.

TOPIC: Fluid Statics and Dynamics

To decrease the flow rate through an operating positive displacement pump, an operator should...

A. throttle the pump discharge valve partially closed.

B. throttle the pump suction valve partially closed.

C. decrease the pump’s available net positive suction head.

D. decrease the pump’s speed.

ANSWER: D.

TOPIC: Fluid Statics and Dynamics

Which one of the following will decrease the head loss occurring in an operating cooling water system?

A. Starting a second pump in parallel with the operating pump.

B. Shifting two heat exchangers from parallel to series operation.

C. Replacing a 10 foot section of 10-inch diameter pipe with a 20 foot section of 10-inch diameter pipe.

D. Replacing a 20 foot section of 10-inch diameter pipe with a 20 foot section of 12-inch diameter pipe.

ANSWER: D.

TOPIC: Fluid Statics and Dynamics

Two centrifugal pumps and two positive displacement pumps are able to be cross-connected to provide makeup water flow to a system. Each pump will produce 100 gpm at a system pressure of 1,000 psig.

If system pressure is 1,200 psig, which one of the following combinations will produce the greatest flow rate to the system?

A. Two positive displacement pumps in series

B. Two positive displacement pumps in parallel

C. Two centrifugal pumps in series

D. Two centrifugal pumps in parallel

ANSWER: B.

TOPIC: Fluid Statics and Dynamics

Two centrifugal pumps and two positive displacement pumps are able to be cross-connected to provide makeup water flow to a system. Each pump will produce 100 gpm at a system pressure of 1,000 psig backpressure.

If system pressure is 800 psig, which one of the following combinations will produce the greatest flow rate to the system?

A. Two centrifugal pumps in parallel.

B. Two centrifugal pumps in series.

C. Two positive displacement pumps in parallel.

D. Two positive displacement pumps in series.

ANSWER: A.

TOPIC: Fluid Statics and Dynamics

Two identical centrifugal pumps (CPs) and two identical 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 1,000 psig.

Given the following information:

<u>Centrifugal Pumps</u>

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

<u>Positive Displacement Pumps</u>

Maximum design pressure	= 2,000 psig

Which one of the following pump configurations will supply the <u>lowest</u> makeup water flow rate to the system if system pressure is 1,700 psig?

A. Two CPs in series

B. Two CPs in parallel

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

D. One PDP and one CP in parallel

ANSWER: B.

TOPIC: Fluid Statics and Dynamics

Two identical centrifugal pumps (CPs) and two identical 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 1,000 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 pump configurations will supply the highest makeup flow rate to the system if system pressure is 800 psig?

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

B. One PDP and one CP in parallel

C. Two CPs in series

D. Two CPs in parallel

ANSWER: D.

TOPIC: Fluid Statics and Dynamics

Water at 90°F and 50 psig is flowing through a 10-inch diameter pipe at 100 lbm/sec. The pipe then splits into two pipes, a 4-inch diameter pipe and an 8-inch diameter pipe.

Disregarding any flow restrictions other than pipe size, which one of the following lists the approximate flow rates through the 4-inch and 8-inch diameter pipes? (Assume that water velocity is the same in each pipe.)

	4-inch Pipe (lbm/sec)	8-inch Pipe (lbm/sec)
A.	20	80
B.	25	75
C.	30	70
D.	33	67

ANSWER: A.

TOPIC: Fluid Statics and Dynamics

Two identical centrifugal pumps (CPs) and two identical 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 pump configurations will supply the highest makeup flow rate to the system if system pressure is 500 psig?

A. Two CPs in series

B. Two CPs in parallel

C. Two PDPs in parallel

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

ANSWER: B.

TOPIC: Fluid Statics and Dynamics

Water at 90°F and 50 psig is flowing through a 10-inch diameter pipe at 100 lbm/sec. The pipe then splits into two pipes, a 3-inch diameter pipe and a 6-inch diameter pipe.

Disregarding any flow restrictions other than pipe size, which one of the following lists the approximate flow rates through the 3-inch and 6-inch diameter pipes. (Assume that water velocity is the same in each pipe.)

	3-inch Pipe (lbm/sec)	6-inch Pipe (lbm/sec)
A.	10	90
B.	20	80
C.	25	75
D.	33	67

ANSWER: B.

TOPIC: Fluid Statics and Dynamics

Water at 90°F and 50 psig is flowing through a 10-inch diameter pipe at 100 lbm/sec. The pipe then splits into two pipes, a 6-inch diameter pipe and an 8-inch diameter pipe.

Disregarding any flow restrictions other than pipe size, which one of the following lists the approximate flow rates through the 6-inch and 8-inch diameter pipes? (Assume that water velocity is the same in each pipe.)

	6-inch Pipe (lbm/sec)	8-inch Pipe (lbm/sec)
A.	24	76
B.	32	68
C.	36	64
D.	40	60

ANSWER: C.

TOPIC: Fluid Statics and Dynamics

Two identical centrifugal pumps (CPs) and two identical 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 pump configurations will supply the highest makeup flow rate to the cooling water system if system pressure is 1,700 psig?

A. Two CPs in series

B. Two CPs in parallel

C. Two PDPs in parallel

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

ANSWER: C.

TOPIC: Fluid Statics and Dynamics

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:

<u>Centrifugal Pumps</u>

Discharge pressure at shutoff head	= 1,500 psig
Maximum design pressure	= 2,000 psig
Flow rate with no backpressure	= 180 gpm

<u>Positive Displacement Pumps</u>

Maximum design pressure	= 2,000 psig

Which one of the following pump configurations will supply the <u>highest</u> 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 CP and one PDP in series (CP supplying PDP)

ANSWER: B.

TOPIC: Fluid Statics and Dynamics

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

Discharge pressure at 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 pump configurations will supply the lowest initial flow rate of makeup water 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 CP and one PDP in series (CP supplying PDP)

ANSWER: D.

TOPIC: Fluid Statics and Dynamics

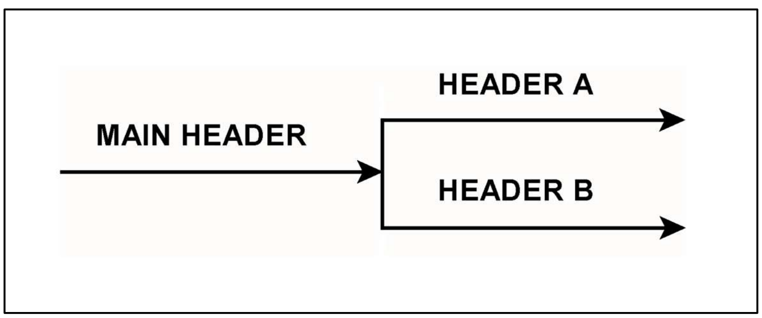
Refer to the drawing of a main water header that splits into two parallel headers (see figure below).

Header A has a 2-inch diameter and header B has a 3-inch diameter. The velocity of the water in both headers is the same.

If the main water header has a flow rate of 500 gpm, what is the approximate flow rate in each of the parallel headers?

	Header A (gpm)	Header B (gpm)
A.	125	375
B.	154	346
C.	200	300
D.	222	278

ANSWER: B.



TOPIC: Fluid Statics and Dynamics

A length of pipe in a cooling water system uses a reducer fitting to decrease the pipe diameter from 6 inches to 4 inches. The flow rate in the 6-inch diameter section of pipe is 200 gpm. What is the flow rate in the 4-inch diameter section of pipe?

A. 133 gpm

B. 200 gpm

C. 300 gpm

D. 450 gpm

ANSWER: B.

TOPIC: Fluid Statics and Dynamics

A vented water storage tank contains 60 feet of water at 70°F. A cracked weld at the bottom of the tank results in a leak rate of 12 gpm. If makeup water flow rate is 5 gpm, at what water level will the tank stabilize?

A. 38.7 feet

B. 25.0 feet

C. 10.4 feet

D. 0.0 feet

ANSWER: C.

TOPIC: Fluid Statics and Dynamics

A vented water storage tank contains 64 feet of water at 70°F. A cracked weld at the bottom of the tank results in a leak rate of 12 gpm. At what water level will the leak rate be 3 gpm?

A. 48 feet

B. 32 feet

C. 16 feet

D. 4 feet

ANSWER: D.

TOPIC: Fluid Statics and Dynamics

An ideal positive displacement pump is operating in an open system with the following initial parameters:

Suction pressure	=	10 psig
Discharge pressure	=	25 psig
Flow rate	=	100 gpm

If the pump discharge pressure increases to 40 psig, the pump flow rate will...

A. remain constant.

B. decrease in direct proportion to the change in pump differential pressure.

C. decrease in direct proportion to the square of the change in pump differential pressure.

D. decrease in direct proportion to the square root of the change in pump differential pressure.

ANSWER: A.

TOPIC: Fluid Statics and Dynamics

A centrifugal pump is operating at a constant speed in a closed system with the following initial parameters:

Suction pressure = 10 psig
Discharge pressure = 25 psig
Pump flow rate = 500 gpm

If the pump discharge flow control valve is throttled such that the pump discharge pressure increases to 40 psig, the change in pump flow rate will be...

A. directly proportional to the square of the change in pump differential pressure.

B. directly proportional to the square root of the change in pump differential pressure.

C. inversely proportional to the square root of the change in pump differential pressure.

D. impossible to determine from the provided information.

ANSWER: D.

TOPIC: Fluid Statics and Dynamics

Which one of the following will increase the head loss occurring in an operating cooling water system?

A. Shifting two heat exchangers from parallel to series operation.

B. Increasing the flow rate in the system by throttling open a flow control valve.

C. Replacing a 20 foot section of 10-inch diameter pipe with a 10 foot section of 10-inch diameter pipe.

D. Replacing a 20 foot section of 10-inch diameter pipe with a 20 foot section of 12-inch diameter pipe.

ANSWER: A.

TOPIC: Fluid Statics and Dynamics

Which one of the following changes to an operating cooling water system will decrease the head loss occurring in the system?

A. Positioning a flow control valve more open.

B. Shifting two heat exchangers from parallel to series operation.

C. Replacing a 10 foot length of 10-inch diameter pipe with a 20 foot length of 10-inch diameter pipe.

D. Replacing a 20 foot length of 12-inch diameter pipe with a 20 foot length of 10-inch diameter pipe.

ANSWER: A.

TOPIC: Fluid Statics and Dynamics

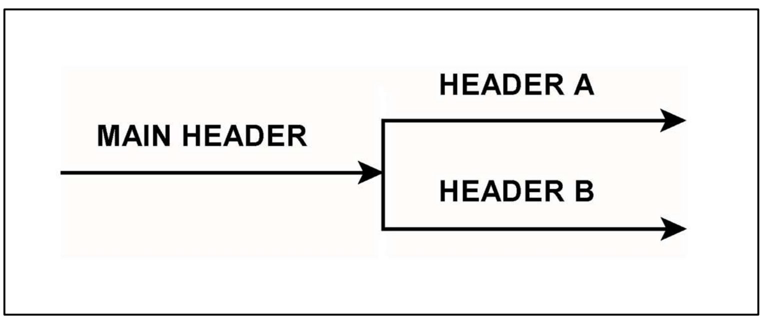
Refer to the drawing of a main water header that splits into two parallel headers (see figure below).

Header A has a 2-inch diameter and header B has a 4-inch diameter. The velocity of the water in both headers is the same.

If the main water header has a flow rate of 500 gpm, what is the approximate flow rate in each of the parallel headers?

	Header A (gpm)	Header B (gpm)
A.	100	400
B.	125	375
C.	167	333
D.	200	300

ANSWER: A.



TOPIC: Fluid Statics and Dynamics

A vented water storage tank contains 30 feet of water at 70°F. A cracked weld at the bottom of the tank causes an initial leak rate of 12 gpm. If makeup water flow rate is 8 gpm, at what water level will the tank stabilize?

A. 24.5 feet

B. 20.0 feet

C. 13.3 feet

D. 0.0 feet

ANSWER: C.

TOPIC: Fluid Statics and Dynamics

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

Which one of the following will increase the mass flow rate in the system with a corresponding increase in the total system head loss?

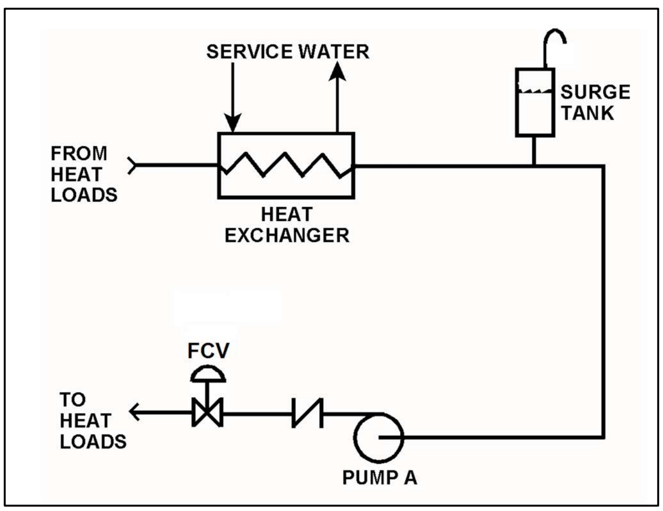
A. Shifting operating pump A to a higher speed.

B. Positioning the flow control valve (FCV) more open.

C. Replacing a 20 foot length of 10-inch diameter pipe with a 10 foot length of 10-inch diameter pipe.

D. Replacing a 20 foot length of 10-inch diameter pipe with a 20 foot length of 12-inch diameter pipe.

ANSWER: A.



TOPIC: Fluid Statics and Dynamics

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

The centrifugal pump is operating with the flow control valve (FCV) fully open. If the system flow rate is decreased by partially closing the FCV, the pump differential pressure will __________; and the heat exchanger cooling water differential pressure will __________.

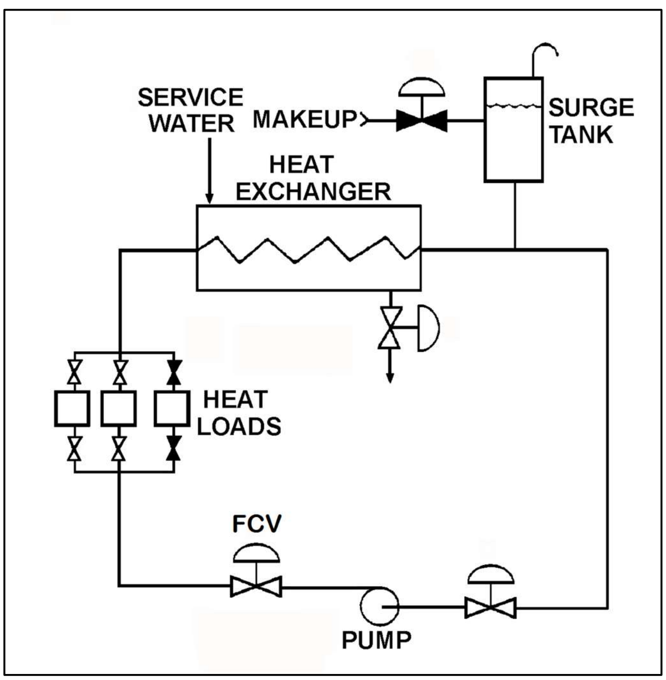
A. increase; increase

B. increase; decrease

C. decrease; increase

D. decrease; decrease

ANSWER: B.



TOPIC: Fluid Statics and Dynamics

An operating centrifugal water pump has a 26-inch diameter suction nozzle and a 24-inch diameter discharge nozzle. For this pump, the discharge water velocity is __________ the suction water velocity; and the discharge water volumetric flow rate is __________ the suction water volumetric flow rate. (Assume water is incompressible and the suction and discharge water temperatures are the same.)

A. greater than; greater than

B. greater than; equal to

C. less than; greater than

D. less than; equal to

ANSWER: B.

TOPIC: Fluid Statics and Dynamics

Refer to the drawing of a cooling water system using 10-inch diameter pipe (see figure below). Only centrifugal pump A is operating and the flow control valve (FCV) is 80 percent open.

Which one of the following actions will increase the total head loss in the system?

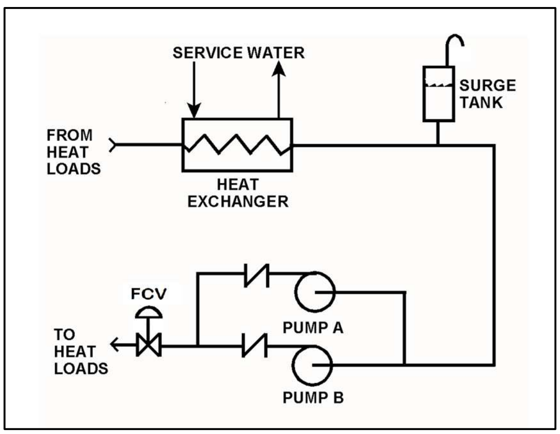
A. Increase the system flow rate by starting centrifugal pump B.

B. Increase the system flow rate by opening the flow control valve more.

C. Replace a 20 foot section of 10-inch diameter pipe with a 10 foot section of 10-inch diameter pipe.

D. Replace a 20 foot section of 10-inch diameter pipe with a 20 foot section of 12-inch diameter pipe.

ANSWER: A.



TOPIC: Heat Transfer

The transfer of heat from the reactor fuel pellets to the fuel cladding during normal plant operation is primarily accomplished via __________ heat transfer.

A. conduction

B. convection

C. radiant

D. two-phase

ANSWER: A.

TOPIC: Heat Transfer

During a loss-of-coolant accident, which one of the following heat transfer methods provides the most core cooling when fuel rods are <u>not</u> in contact with the coolant?

A. Radiation

B. Emission

C. Convection

D. Conduction

ANSWER: A.

TOPIC: Heat Transfer

Reactor fuel rods are normally charged with __________ gas; which improves heat transfer by __________.

A. helium; convection

B. helium; conduction

C. nitrogen; convection

D. nitrogen; conduction

ANSWER: B.

TOPIC: Heat Transfer

If excessive amounts of air are entrained/dissolved in the cooling water passing through a heat exchanger, the overall heat transfer coefficient of the heat exchanger will decrease because the...

A. laminar layer thickness will decrease.

B. laminar layer thickness will increase.

C. thermal conductivity of the cooling fluid will decrease.

D. thermal conductivity of the cooling fluid will increase.

ANSWER: C.

TOPIC: Heat Transfer

Why is bulk boiling in the tubes of a single-phase heat exchanger undesirable?

A. The bubble formation will break up the laminar layer in the heat exchanger tubes.

B. The thermal conductivity of the heat exchanger tubes will decrease.

C. The differential temperature across the tubes will decrease through the heat exchanger.

D. The turbulence will restrict fluid flow through the heat exchanger tubes.

ANSWER: D.

TOPIC: Heat Transfer

Which one of the following pairs of fluids undergoing heat transfer in identical heat exchangers will yield the greatest heat exchanger overall heat transfer coefficient?

A. Oil to water.

B. Air to water.

C. Steam to water.

D. Water to water.

ANSWER: C.

TOPIC: Heat Transfer

Which one of the following pairs of fluids undergoing heat transfer in identical heat exchangers will yield the smallest heat exchanger overall heat transfer coefficient?

A. Oil to water.

B. Air to water.

C. Steam to water.

D. Water to water.

ANSWER: B.

TOPIC: Heat Transfer

Which one of the following pairs of fluids undergoing heat transfer in identical heat exchangers will yield the greatest heat exchanger overall heat transfer coefficient?

A. Oil to water.

B. Steam to water.

C. Air to water.

D. Water to water.

ANSWER: B.

TOPIC: Heat Transfer

A reactor is currently producing 200 MW of core thermal power. Reactor coolant pumps are adding an additional 10 MW of thermal power to the reactor coolant system. The core is rated at 1,330 MW.

Which one of the following is the current core thermal power output in percent?

A. 14.0 percent

B. 14.3 percent

C. 15.0 percent

D. 15.8 percent

ANSWER: C.

TOPIC: Heat Transfer

A reactor is operating with the following parameters:

Reactor power	=	100 percent
Core ΔT	=	42°F
Reactor coolant system flow rate	=	100 percent
Average reactor coolant temperature	=	587°F

A station blackout occurs and natural circulation is established with the following stable parameters:

Decay heat rate	=	2 percent
Core ΔT	=	28°F
Average reactor coolant temperature	=	572°F

What is the core mass flow rate in percent?

A. 2.0 percent

B. 2.5 percent

C. 3.0 percent

D. 4.0 percent

ANSWER: C.

TOPIC: Heat Transfer

A nuclear power plant is initially operating at 80 percent power with a core ΔT of 48°F when a station blackout occurs. Natural circulation is established and core ΔT stabilizes at 40°F. If reactor coolant mass flow rate is 3 percent, which one of the following is the current core decay heat level?

A. 1 percent

B. 2 percent

C. 3 percent

D. 4 percent

ANSWER: B.

TOPIC: Heat Transfer

A nuclear power plant is operating with the following parameters:

Reactor power	=	100 percent
Core ΔT	=	60°F
Reactor coolant system flow rate	=	100 percent
Average coolant temperature	=	587°F

A station blackout occurs and natural circulation is established with the following stable parameters:

Decay heat	=	1 percent
Core ΔT	=	30°F
Average coolant temperature	=	572°F

What is the core mass flow rate in percent?

A. 2.0 percent

B. 2.5 percent

C. 3.0 percent

D. 4.0 percent

ANSWER: A.

TOPIC: Thermal Hydraulics

Subcooled water enters the bottom of an operating reactor core. As the water flows upward past the fuel assemblies, steam bubbles form on the surface of a few fuel rods and are swept away.

If the coolant at the surface of the affected fuel rods had remained subcooled, average fuel temperature in the affected fuel rods would have been __________ because single-phase convection is a __________ efficient method of heat transfer than boiling.

A. higher; more

B. higher; less

C. lower; more

D. lower; less

ANSWER: B.

TOPIC: Thermal Hydraulics

The heat transfer coefficient for the core will be directly increased if: (Assume bulk coolant subcooling.)

A. the coolant temperature is decreased.

B. the coolant flow rate is decreased.

C. nucleate boiling occurs in the coolant.

D. the coolant flow is laminar instead of turbulent.

ANSWER: C.

TOPIC: Thermal Hydraulics

Increasing the coolant flow rate through a reactor core affects the heat transfer rate from the fuel, because a higher coolant flow rate results in a __________ laminar film thickness and a __________ coolant temperature adjacent to the fuel.

A. greater; higher

B. greater; lower

C. smaller; higher

D. smaller; lower

ANSWER: D.

TOPIC: Thermal Hydraulics

Which one of the following will minimize core heat transfer?

A. Laminar flow with no nucleate boiling.

B. Turbulent flow with no nucleate boiling.

C. Laminar flow with nucleate boiling.

D. Turbulent flow with nucleate boiling.

ANSWER: A.

TOPIC: Thermal Hydraulics

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

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

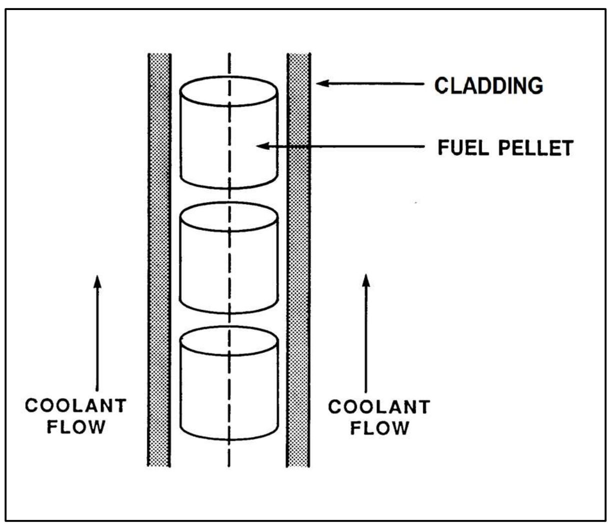
A. Fuel slug centerline-to-pellet surface

B. Fuel slug surface-to-cladding gap

C. Fuel cladding

D. Coolant laminar layer

ANSWER: B.



TOPIC: Thermal Hydraulics

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

Given:

- Pressure at P_1 is 24 psig.
- Pressure at P_2 is 16 psig.
- Pressure change due to change in velocity is 2 psig.
- Pressure change due to change in elevation is 10 psig.

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

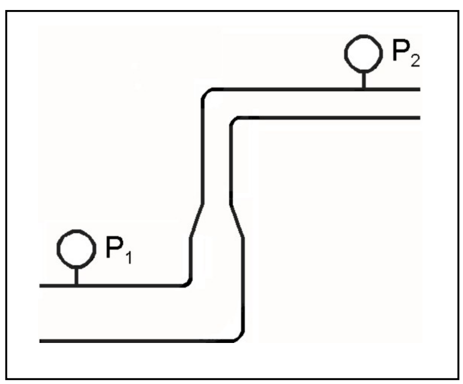
A. 2 psig; left to right

B. 2 psig; right to left

C. 4 psig; left to right

D. 4 psig; right to left

ANSWER: D.



TOPIC: Thermal Hydraulics

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

Given:

- Pressure at P_1 is 26 psig.
- Pressure at P_2 is 34 psig.
- Pressure change due to change in velocity is 2 psig.
- Pressure change due to change in elevation is 8 psig.

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

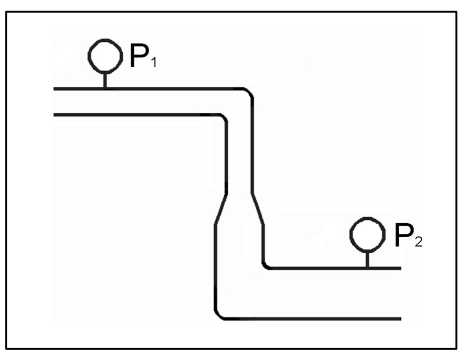
A. 2 psig; left to right

B. 2 psig; right to left

C. 4 psig; left to right

D. 4 psig; right to left

ANSWER: A.



TOPIC: Thermal Hydraulics

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

Given:

- Pressure at P_1 is 30 psig.
- Pressure at P_2 is 32 psig.
- Pressure change due to change in velocity is 2 psig.
- Pressure change due to change in elevation is 2 psig.

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

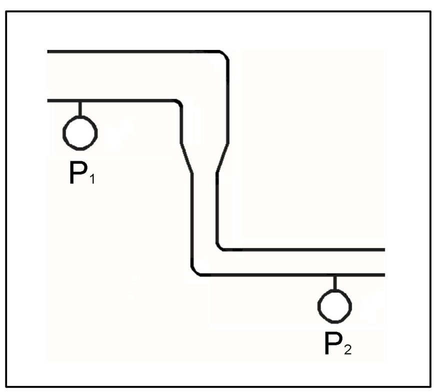
A. 2 psig; left to right

B. 2 psig; right to left

C. 6 psig; left to right

D. 6 psig; right to left

ANSWER: B.



TOPIC: Thermal Hydraulics

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

Given:

- Pressure at P_1 is 34 psig.
- Pressure at P_2 is 20 psig.
- Pressure change due to change in velocity is 2 psig.
- Pressure change due to change in elevation is 8 psig.

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

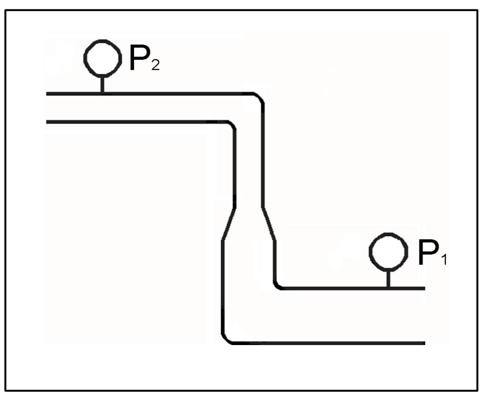
A. 2 psig; left to right

B. 2 psig; right to left

C. 4 psig; left to right

D. 4 psig; right to left

ANSWER: D.



TOPIC: Thermal Hydraulics

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

Given:

- The pressure at P_1 is 20 psig.
- The pressure at P_2 is 20 psig.
- The pressure change caused by the change in velocity is 2 psig.
- The pressure change caused by the change in elevation is 8 psig.

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

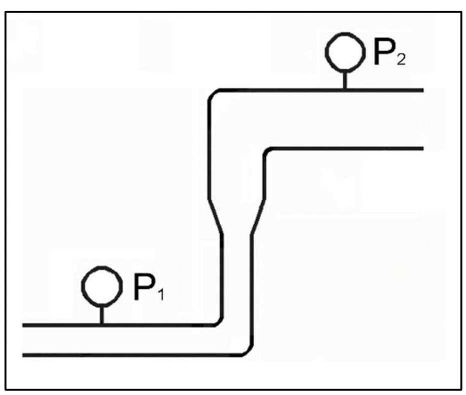
A. 6 psig; left to right

B. 6 psig; right to left

C. 10 psig; left to right

D. 10 psig; right to left

ANSWER: B.



TOPIC: Thermal Hydraulics

A reactor is producing 3,400 MW of thermal output with a reactor vessel differential temperature (ΔT) of 60°F and a reactor vessel mass flow rate of 1.4 x 10^8 lbm/hr. If core ΔT is 63.6°F, what is core bypass mass flow rate? (Assume bypass flow ΔT equals 0°F.)

A. 7.92 x 10^6 lbm/hr

B. 8.40 x 10^6 lbm/hr

C. 1.26 x 10^8 lbm/hr

D. 1.32 x 10^8 lbm/hr

ANSWER: A.

TOPIC: Thermal Hydraulics

A reactor is producing 3,400 MW of thermal output with a reactor vessel differential temperature (ΔT) of 60°F and a reactor vessel mass flow rate of 1.0 x 10^8 lbm/hr. If core ΔT is 63.6°F, what is core bypass mass flow rate? (Assume bypass flow ΔT equals 0°F.)

A. 5.66 x 10^6 lbm/hr

B. 8.40 x 10^6 lbm/hr

C. 3.60 x 10^7 lbm/hr

D. 9.43 x 10^7 lbm/hr

ANSWER: A.

TOPIC: Thermal Hydraulics

A reactor is producing 3,400 MW of thermal output with a reactor vessel differential temperature (ΔT) of 60°F and a reactor vessel mass flow rate of 1.1×10^8 lbm/hr. If core ΔT is 63.6°F, what is core bypass mass flow rate? (Assume bypass flow ΔT equals 0°F.)

A. 5.66×10^6 lbm/hr

B. 6.23×10^6 lbm/hr

C. 5.66×10^7 lbm/hr

D. 6.23×10^7 lbm/hr

ANSWER: B.

TOPIC: Thermal Hydraulics

Adequate core bypass flow is needed to...

A. cool the excore nuclear instrument detectors.

B. provide cooling to core structural components.

C. provide primary sodium pump minimum flow requirements.

D. prevent stratification of coolant below the cover gas.

ANSWER: B.

TOPIC: Thermal Hydraulics

Which one of the following describes a function of core bypass flow?

A. Provides a means of measuring core flow rate.

B. Provide primary sodium pump minimum flow requirements.

C. Prevents excessive reactor vessel wall differential temperature.

D. Provides cooling to various reactor vessel internal components.

ANSWER: D.

TOPIC: Thermal Hydraulics

Which one of the following is a function of core bypass flow?

A. Provides cooling to core structural components.

B. Provides even coolant flow distribution through the fuel.

C. Ensures natural circulation will be initiated when forced circulation is lost.

D. Ensures core exit thermocouple readings represent average fuel temperatures.

ANSWER: A.

TOPIC: Thermal Hydraulics

Which one of the following must exist for natural circulation flow to occur?

A. The heat source must be larger than the heat sink.

B. The heat source must be located higher than the heat sink.

C. The heat sink must be larger than the heat source.

D. The heat sink must be located higher than the heat source.

ANSWER: D.

TOPIC: Thermal Hydraulics

The driving head for natural circulation flow through the core is developed by differences in ___________ between the heat sink and the heat source.

A. fluid density

B. fluid volume

C. pipe diameter

D. pipe length

ANSWER: A.

TOPIC: Thermal Hydraulics

A reactor is shut down with natural circulation core cooling. Decay heat generation is equivalent to 1.0 percent of rated thermal power. Stable natural circulation mass flow rate is 1,000 gpm.

When decay heat generation decreases to 0.5 percent of rated thermal power, stable natural circulation flow rate will be approximately...

A. 125 gpm.

B. 250 gpm.

C. 707 gpm.

D. 794 gpm.

ANSWER: D.

TOPIC: Thermal Hydraulics

A reactor is shut down with natural circulation core cooling. Decay heat generation is equivalent to 1.0 percent of rated thermal power. Core differential temperature (ΔT) has stabilized at 16°F.

When decay heat generation decreases to 0.5 percent of rated thermal power, core ΔT will be approximately...

A. 2°F.

B. 4°F.

C. 8°F.

D. 10°F.

ANSWER: D.

TOPIC: Thermal Hydraulics

Sustained natural circulation requires that the heat sink is __________ in elevation than the heat source and that there is a __________ difference between the heat sink and the heat source.

A. lower; pressure

B. lower; temperature

C. higher; pressure

D. higher; temperature

ANSWER: D.

TOPIC: Thermal Hydraulics

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

A. Subcooling of the fluid.

B. A phase change in the fluid.

C. A density change in the fluid.

D. Radiative heat transfer to the fluid.

ANSWER: C.

TOPIC: Thermal Hydraulics

A reactor is shut down with natural circulation core cooling. Decay heat generation is equivalent to 1.0 percent of rated thermal power. Core differential temperature (ΔT) has stabilized at 16°F.

When decay heat generation decreases to 0.333 percent of rated thermal power, core ΔT will be approximately...

A. 2°F.

B. 4°F.

C. 8°F.

D. 10°F.

ANSWER: C.

TOPIC: Thermal Hydraulics

A reactor is shut down with natural circulation core cooling. Decay heat generation is equivalent to 1.0 percent of rated thermal power. Core differential temperature (ΔT) has stabilized at 13°F.

When decay heat generation decreases to 0.5 percent of rated thermal power, core ΔT will be approximately...

A. 4°F.

B. 6°F.

C. 8°F.

D. 10°F.

ANSWER: C.

TOPIC: Thermal Hydraulics

A reactor is shut down with natural circulation core cooling. Decay heat generation is equivalent to 1.0 percent of rated thermal power. Stable natural circulation flow rate is 800 gpm.

When decay heat generation decreases to 0.5 percent of rated thermal power, stable natural circulation flow rate will be approximately...

A. 400 gpm.

B. 565 gpm.

C. 635 gpm.

D. 696 gpm.

ANSWER: C.

TOPIC: Thermal Hydraulics

Sustained natural circulation requires that the heat source is __________ in elevation than the heat sink; and that there is a __________ difference between the heat source and the heat sink.

A. lower; phase

B. lower; temperature

C. higher; phase

D. higher; temperature

ANSWER: B.

TOPIC: Thermal Hydraulics

A reactor had been operating at 100 percent power for 3 months when a loss of offsite power occurred, causing a reactor trip and a loss of forced reactor coolant flow. If forced reactor coolant flow is not restored, which one of the following describes the relationship between reactor coolant hot leg and cold leg temperatures one hour after the reactor trip?

A. Hot leg temperature will be greater than cold leg temperature because natural circulation cooling flow occurs in the same direction as forced reactor coolant flow.

B. Hot leg temperature will be less than cold leg temperature because natural circulation cooling flow occurs in the opposite direction as forced reactor coolant flow.

C. Hot leg temperature will be approximately the same as cold leg temperature because only the density of the reactor coolant changes during natural circulation cooling.

D. Hot leg temperature will be approximately the same as cold leg temperature because the reactor does not produce a significant amount of heat one hour after a reactor trip.

ANSWER: A.

TOPIC: Thermal Hydraulics

Natural circulation flow can be enhanced by...

A. increasing the elevation of the heat source to equal that of the heat sink.

B. increasing the temperature difference between the heat source and the heat sink.

C. decreasing the temperature difference between the heat source and the heat sink.

D. decreasing the elevation difference between the heat source and the heat sink.

ANSWER: B.

TOPIC: Core Thermal Limits

A PWR core consists of 50,000 fuel rods; each fuel rod has an active length of 12 feet. The core is producing 1,800 MW of thermal power. If the total heat flux hot channel factor (also called the total core peaking factor) is 2.0, what is the maximum linear power density being produced in the core?

A. 4.5 kW/ft

B. 6.0 kW/ft

C. 9.0 kW/ft

D. 12.0 kW/ft

ANSWER: B.

TOPIC: Core Thermal Limits

A PWR core consists of 50,000 fuel rods; each fuel rod has an active length of 12 feet. The core is producing 1,800 MW of thermal power. If the total heat flux hot channel factor (also called the total core peaking factor) is 1.5, what is the maximum linear power density being produced in the core?

A. 4.5 kW/ft

B. 6.0 kW/ft

C. 9.0 kW/ft

D. 12.0 kW/ft

ANSWER: A.

TOPIC: Core Thermal Limits

A PWR core consists of 50,000 fuel rods; each fuel rod has an active length of 12 feet. The core is producing 1,800 MW of thermal power. If the total heat flux hot channel factor (also called the total core peaking factor) is 3.0, what is the maximum linear power density being produced in the core?

A. 4.5 kW/ft

B. 6.0 kW/ft

C. 9.0 kW/ft

D. 12.0 kW/ft

ANSWER: C.

TOPIC: Core Thermal Limits

A reactor is operating at 3,400 MW thermal power. The core linear power density limit is 12.2 kW/ft.

Given:

- The reactor core contains 198 fuel assemblies.
- Each fuel assembly contains 262 fuel rods, each with an active length of 12 feet.
- The highest total peaking factors measured in the core are as follows:

  Location A: 2.5
  Location B: 2.4
  Location C: 2.3
  Location D: 2.2

Which one of the following describes the operating conditions in the core relative to the linear power density limit?

A. All locations in the core are operating below the linear power density limit.

B. Location A has exceeded the linear power density limit while locations B, C, and D are operating below the limit.

C. Locations A and B have exceeded the linear power density limit while locations C and D are operating below the limit.

D. Locations A, B, and C have exceeded the linear power density limit while location D is operating below the limit.

ANSWER: D.

TOPIC: Core Thermal Limits

A reactor is operating at 3,300 MW thermal power. The core linear power density limit is 12.4 kW/ft.

Given:

- The reactor core contains 198 fuel assemblies.
- Each fuel assembly contains 262 fuel rods, each with an active length of 12 feet.
- The highest total peaking factors measured in the core are as follows:

  Location A: 2.5
  Location B: 2.4
  Location C: 2.3
  Location D: 2.2

Which one of the following describes the operating conditions in the core relative to the linear power density limit?

A. All locations in the core are operating below the linear power density limit.

B. Location A has exceeded the linear power density limit while locations B, C, and D are operating below the limit.

C. Locations A and B have exceeded the linear power density limit while locations C and D are operating below the limit.

D. Locations A, B, and C have exceeded the linear power density limit while location D is operating below the limit.

ANSWER: C.

TOPIC: Core Thermal Limits

What is the basis for the limit on maximum linear power density (kW/ft)?

A. To provide assurance of fuel integrity.

B. To prevent xenon-135 oscillations.

C. To allow for fuel pellet manufacturing tolerances.

D. To prevent nucleate boiling.

ANSWER: A.

TOPIC: Core Thermal Limits

If a reactor is operated within the core thermal limits, then...

A. plant thermal efficiency is optimized.

B. fuel cladding integrity is ensured.

C. pressurized thermal shock will be prevented.

D. reactor vessel thermal stresses will be minimized.

ANSWER: B.

TOPIC: Core Thermal Limits

During normal operation, fuel cladding integrity is ensured by...

A. the primary system relief valves.

B. core bypass flow restrictions.

C. the secondary system relief valves.

D. operating within core thermal limits.

ANSWER: D.

TOPIC: Core Thermal Limits

Maximum fuel cladding integrity is maintained by...

A. always operating below 110 percent of reactor coolant system design pressure.

B. actuation of the reactor protection system upon a reactor accident.

C. ensuring that actual heat flux is always less than critical heat flux.

D. ensuring operation above the critical heat flux during all operating conditions.

ANSWER: C.

TOPIC: Core Thermal Limits

Peaking (or hot channel) factors are used to establish a maximum reactor power level such that fuel cladding temperature is limited to prevent __________ of the fuel cladding during most analyzed transients and abnormal conditions.

A. melting

B. excessive oxidation

C. excessive chemical interaction

D. excessive mechanical interaction

ANSWER: C.

TOPIC: Core Thermal Limits

Reactor thermal limits are established to...

A. ensure the integrity of the reactor fuel.

B. prevent exceeding reactor vessel mechanical limitations.

C. minimize the coolant temperature rise across the core.

D. establish control rod insertion limits.

ANSWER: A.

TOPIC: Core Thermal Limits

Thermal limits are established to protect the reactor, and thereby protect the public during nuclear power plant operations, which include...

A. normal operations only.

B. normal and abnormal operations only.

C. normal, abnormal, and postulated accident operations only.

D. normal, abnormal, postulated and unpostulated accident operations.

ANSWER: C.

TOPIC: Core Thermal Limits

Which one of the following describes the basis for the 2,200°F maximum fuel cladding temperature limit?

A. 2,200°F is approximately 500°F below the fuel cladding melting temperature.

B. The material strength of cladding decreases rapidly at temperatures above 2,200°F.

C. The rate of the cladding reaction increases significantly at temperatures above 2,200°F.

D. At the normal operating pressure of the reactor vessel, a cladding temperature above 2,200°F indicates that the critical heat flux has been exceeded.

ANSWER: C.

TOPIC: Core Thermal Limits

Which one of the following describes the basis for the 2,200°F maximum fuel cladding temperature limit?

A. 2,200°F is approximately 500°F below the fuel cladding melting temperature.

B. The rate of the cladding reaction increases significantly above 2,200°F.

C. If fuel cladding temperature reaches 2,200°F, the onset of transition boiling is imminent.

D. The differential expansion between the fuel pellets and the fuel cladding becomes excessive at temperatures greater than 2,200°F.

ANSWER: B.

TOPIC: Core Thermal Limits

The pellet-to-cladding gap in fuel rod construction is designed to...

A. decrease fuel pellet densification and elongation.

B. reduce fission product gas pressure buildup.

C. increase heat transfer rate.

D. reduce internal cladding strain.

ANSWER: D.

TOPIC: Core Thermal Limits

A reactor is operating at steady-state 80 percent power with all control rods fully withdrawn and in manual control. Compared to a 50 percent insertion of one control rod, a 50 percent insertion of a group (or bank) of control rods will cause a __________ increase in the maximum axial peaking factor and a __________ increase in the maximum radial peaking factor. (Assume reactor power remains constant.)

A. smaller; smaller

B. smaller; larger

C. larger; smaller

D. larger; larger

ANSWER: C.

TOPIC: Core Thermal Limits

A reactor is operating at 80 percent power with all control rods fully withdrawn. Compared to a 50 percent insertion of a group (or bank) of control rods, a 50 percent insertion of a single control rod will cause a __________ increase in the maximum axial peaking factor; and a __________ increase in the maximum radial peaking factor. (Assume reactor power remains constant.)

A. larger; larger

B. larger; smaller

C. smaller; larger

D. smaller; smaller

ANSWER: C.

TOPIC: Core Thermal Limits

Which one of the following describes the fuel-to-coolant thermal conductivity for a fuel rod at the end of a fuel cycle (EOC) when compared to the beginning of the same fuel cycle (BOC)?

A. Smaller at EOC, due to fuel pellet densification.

B. Smaller at EOC, due to contamination of fill gas with fission product gases.

C. Larger at EOC, due to reduction in gap between the fuel pellets and cladding.

D. Larger at EOC, due to a greater temperature difference between the fuel pellets and coolant.

ANSWER: C.

TOPIC: Core Thermal Limits

Which one of the following describes the fuel-to-coolant thermal conductivity for a fuel rod at the beginning of a fuel cycle (BOC) compared to the end of a fuel cycle (EOC)?

A. Greater at BOC, due to a higher fuel pellet density.

B. Greater at BOC, due to lower contamination of fuel rod fill gas with fission product gases.

C. Smaller at BOC, due to a larger gap between the fuel pellets and cladding.

D. Smaller at BOC, due to a smaller corrosion film on the surface of the fuel rods.

ANSWER: C.