UNITED STATES NUCLEAR REGULATORY COMMISSION
BOILING WATER REACTOR GENERIC FUNDAMENTALS EXAMINATION
FEBRUARY 2001--FORM A

Please Print

Name: _____

Facility: _____

Docket No.: _____

Start Time: _____ Stop Time: _____

INSTRUCTIONS TO APPLICANT

Answer all the test items using the answer sheet provided. Each item has equal point value. A score of at least 80% is required to pass this portion of the written licensing examination. All examination papers will be collected 3.0 hours after the examination starts. This examination applies to a typical boiling water reactor (BWR) power plant.

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

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

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Applicant's Signature

RULES AND GUIDELINES FOR THE GENERIC FUNDAMENTALS EXAMINATION

During the administration of this examination the following rules apply:

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

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

2. Fill in the name of your facility.

3. Fill in your individual docket number.

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

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

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

   (2) Steam tables provided by your proctor.

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

7. Scrap paper will be provided for calculations.

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

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

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

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

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

GENERIC FUNDAMENTALS EXAMINATION
EQUATIONS AND CONVERSIONS HANDOUT SHEET

EQUATIONS

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

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

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

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

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

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

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

$SUR = 26.06/\tau$

$\tau = \dfrac{\overline{\beta} - \rho}{\lambda_{eff}\ \rho}$

$\rho = \dfrac{\ell^*}{\tau} + \dfrac{\overline{\beta}}{1 + \lambda_{eff}\tau}$

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

$\lambda_{eff} = 0.1\ seconds^{-1}$

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

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

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

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

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

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

$1/M = CR_1/CR_X$

$A = \pi r^2$

$F = PA$

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

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

$E = IR$

Eff. = Net Work Out/Energy In

$\upsilon(P_2 - P_1) + \dfrac{(\vec{v}_2^{\,2} - \vec{v}_1^{\,2})}{2g_c} + \dfrac{g(z_2 - z_1)}{g_c} = 0$

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

CONVERSIONS

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1 Mw = 3.41×10^6 Btu/hr

1 hp = 2.54×10^3 Btu/hr

1 Btu = 778 ft-lbf

°C = (5/9)(°F - 32)

°F = (9/5)(°C) + 32

1 Curie = 3.7×10^{10} dps

1 kg = 2.21 lbm

1 gal_{water} = 8.35 lbm

1 ft^3_{water} = 7.48 gal

QUESTION: 1

Which one of the following statements describes the operation of reactor pressure vessel safety valves?

A. An open safety valve will close when the pilot valve senses a reduced reactor pressure and isolates reactor pressure to the main valve disk.

B. An open safety valve will close when reactor pressure decreases enough for gravity and spring tension to overcome the effect of reactor pressure on the main valve disk.

C. When reactor pressure reaches the lift set point, the safety valve begins to open and will modulate to a position that is directly proportional to reactor pressure.

D. When reactor pressure reaches the lift set point, a pilot valve closes to create a ΔP across the main valve disk which overcomes gravity and spring tension to open the valve.

QUESTION: 2

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.

QUESTION: 3

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

A. cannot be shut remotely.

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

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

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

QUESTION: 4

In a comparison of butterfly valves with ball valves, _____ valves are generally more leak tight in high pressure applications, and _____ valves generally exhibit the lowest system pressure drop when fully open.

A. ball; ball

B. ball; butterfly

C. butterfly; ball

D. butterfly; butterfly

QUESTION: 5

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

A. lower; isolating

B. lower; throttling

C. higher; isolating

D. higher; throttling

QUESTION: 6

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

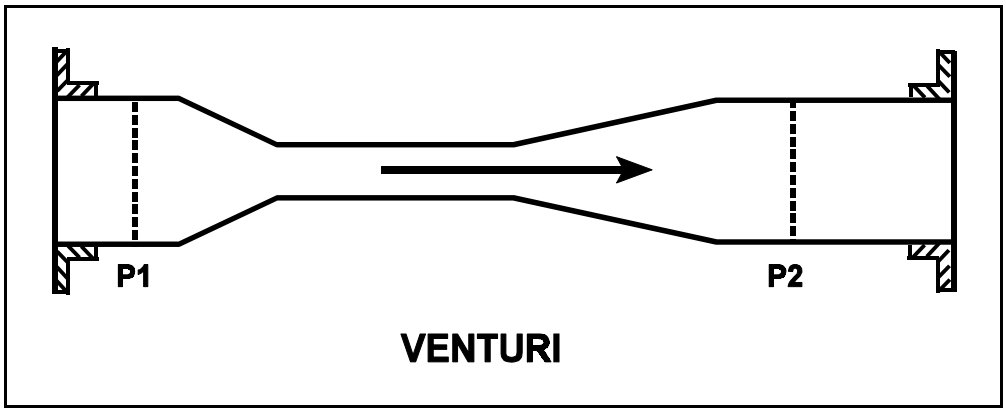
A subcooled fluid is flowing through a convergent-divergent venturi. Compared to conditions at the inlet of the venturi (P1), pressure at the outlet of the venturi (P2) has _____ and system mass flow rate has _____. (Assume "real" conditions.)

A. decreased slightly; decreased slightly

B. decreased slightly; remained the same

C. remained the same; decreased slightly

D. remained the same; remained the same



QUESTION: 7

A main steam flow rate measuring instrument uses a steam pressure input to produce main steam flow rate indication in lbm/hr. Assuming volumetric steam flow rate does not change, a steam pressure decrease will cause indicated steam flow rate to:

A. decrease because the density of the main steam has decreased.

B. increase because the specific volume of the main steam has increased.

C. remain the same because steam pressure does not affect the mass flow rate of main steam.

D. remain the same because the differential pressure across the flow rate measuring instrument has not changed.

QUESTION: 8

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 orifice erodes over time.

B. Debris becomes lodged in the orifice.

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

D. The flow detector equalizing valve is inadvertently opened.

QUESTION: 9

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
AD	A and D
BD	B and D
CD	C and D

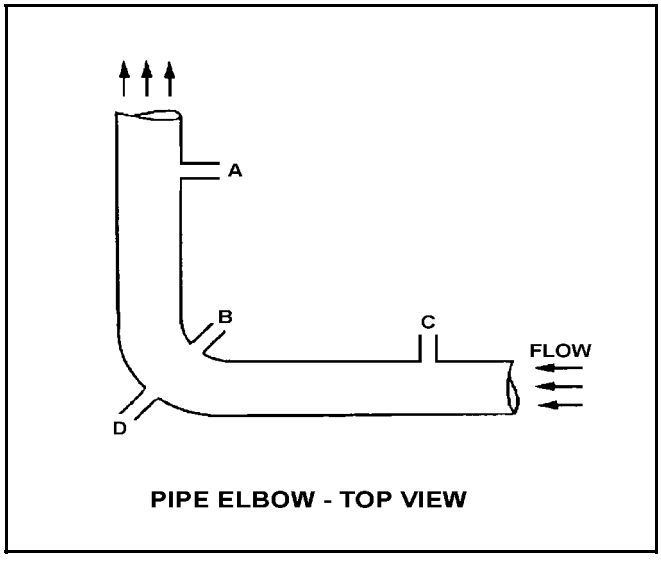
Assume that water is incompressible and there is no head loss in this section of pipe. How will the detectors be affected if system flow rate remains the same while system pressure increases from 1000 psig to 1200 psig?

A. Detector indication will not change.

B. Only one detector will indicate higher flow.

C. Only two detectors will indicate higher flow.

D. All detectors will indicate higher flow.



PIPE ELBOW - TOP VIEW

QUESTION: 10

Refer to the drawing of a tank with differential pressure (D/P) level detector (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 not change.

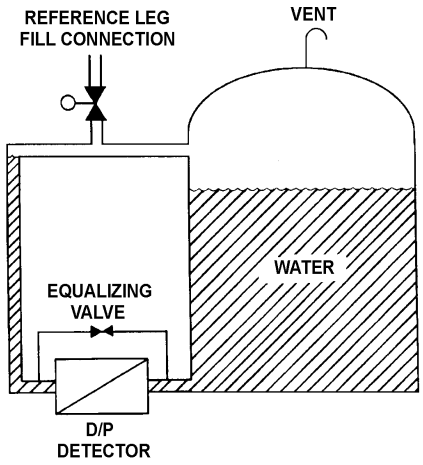
If the temperature of the water in the tank increases by 20°F, the D/P sensed by the detector will _____ as long as the water _____ is maintained constant.

A. increase; level

B. decrease; level

C. increase; mass

D. decrease; mass



TANK DIFFERENTIAL PRESSURE LEVEL DETECTOR

QUESTION: 11

Refer to the drawing of four tank differential pressure 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.

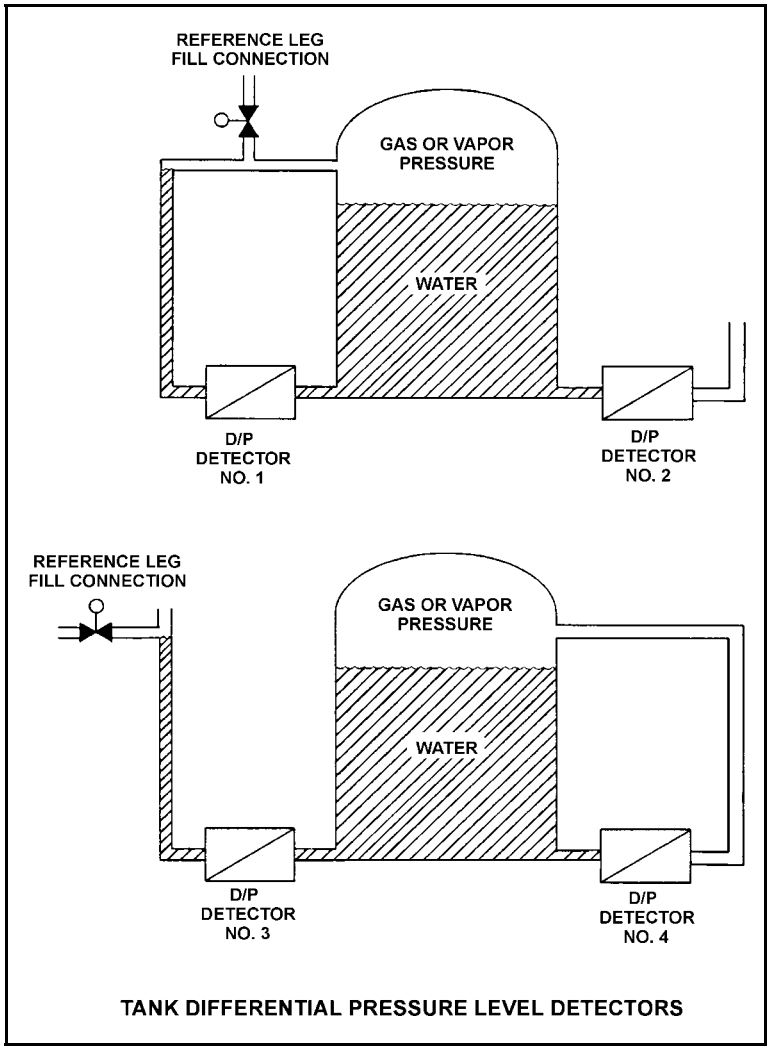
Which detectors will provide the most accurate level indication following an increase in external (ambient) temperature from 70°F to 100°F? (Assume tank contents temperatures and external pressure do not change.)

A. 1 and 3

B. 1 and 4

C. 2 and 3

D. 2 and 4



TANK DIFFERENTIAL PRESSURE LEVEL DETECTORS

QUESTION: 12

The water pressure within a containment cooling water system is 100 psig, as indicated by a bourdon tube pressure detector located within the containment. The pressure detector case is vented to the containment, which is currently at atmospheric pressure.

If a steam line rupture raises containment pressure by 20 psig, the water system pressure indication will:

(Disregard any temperature effect on the detector.)

A. decrease to 80 psig.

B. decrease by a small, but indeterminate amount.

C. increase by a small, but indeterminate amount.

D. increase to 120 psig.

QUESTION: 13

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

Thermocouple temperature indication is 410°F with the reference (cold) junction at 125°F. If an ambient temperature decrease lowers reference junction temperature to 110°F, the new thermocouple temperature indication will be:

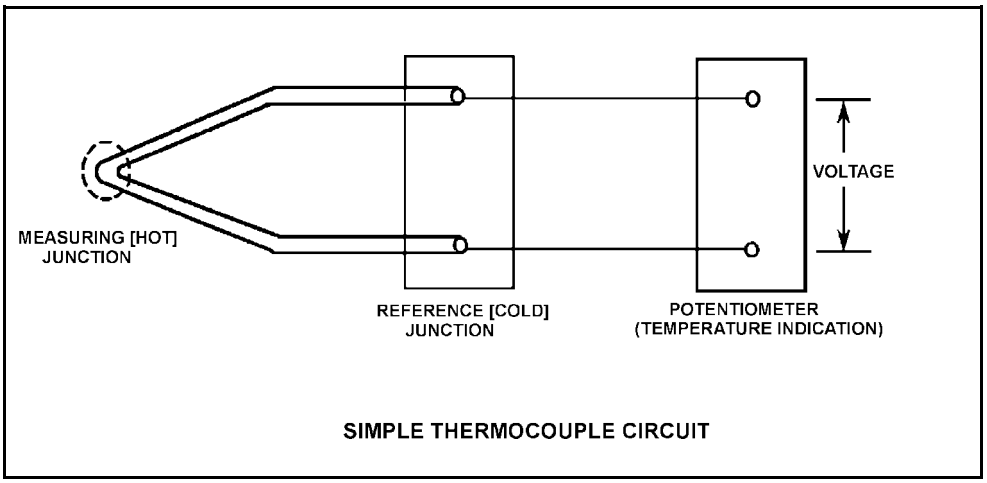
(Assume measuring junction temperature remains constant.)

A. 380°F.

B. 395°F.

C. 410°F.

D. 425°F.



SIMPLE THERMOCOUPLE CIRCUIT

QUESTION: 14

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

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

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

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

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

QUESTION: 15

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

A. Gain

B. Offset

C. Dead time

D. Time constant

QUESTION: 16

Refer to the drawing of a pressure bistable in an alarm circuit (see figure below).

Assume the orientation of the bistable symbol indicates the characteristics of the bistable. The bistable turns on to actuate an alarm at a system pressure of 100 psig. The bistable has a 5 psig dead band, or neutral zone.

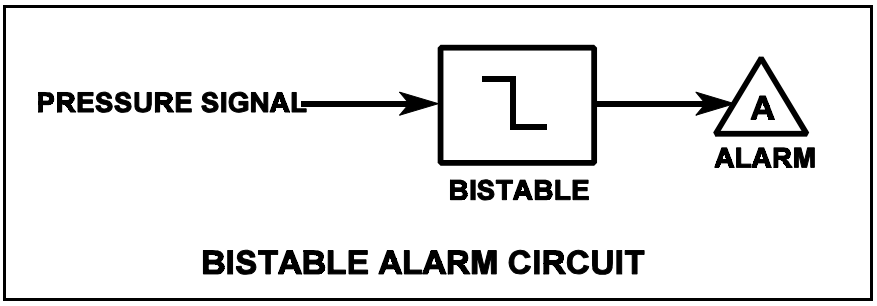
If current system pressure is 90 psig, which one of the following describes the alarm response as system pressure is slowly increased to 110 psig?

A. The alarm is currently actuated and will turn off at 95 psig.

B. The alarm is currently actuated and will turn off at 105 psig.

C. The alarm will actuate at 100 psig and will NOT turn off.

D. The alarm will actuate at 100 psig and will turn off at 105 psig.



QUESTION: 17

The purpose of a valve positioner in a typical pneumatic control system is to:

A. convert the valve controller pneumatic output signal to a mechanical force to position the valve.

B. convert the valve controller pneumatic output signal to an electrical output to position the valve.

C. compare valve controller pneumatic output signal to setpoint error, and adjust valve actuator air supply pressure to position the valve.

D. compare valve controller pneumatic output signal to valve position, and adjust valve actuator air supply pressure to position the valve.

QUESTION: 18

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

A. increased; decreased

B. increased; increased

C. decreased; decreased

D. decreased; increased

QUESTION: 19

The discharge head of a centrifugal pump will decrease if the:

A. speed of the pump increases.

B. pump suction pressure increases.

C. discharge valve is throttled closed.

D. temperature of the fluid being pumped increases.

QUESTION: 20

A cooling water pump is operating with pump suction parameters as follows:

Suction Temperature: 124°F
Suction Pressure: 11.7 psia

What is the approximiate 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

QUESTION: 21

Many large centrifugal pumps are interlocked so that the pump will not start unless its discharge valve is at least 90% closed. This interlock is provided to minimize the:

A. pump discharge pressure.

B. required net positive suction head.

C. loading on the pump thrust bearing.

D. duration of the pump motor starting current.

QUESTION: 22

A centrifugal pump is needed to take suction on a hot water storage tank and deliver high pressure hot 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 be _____ suction.

A. a single; single

B. a single; double

C. multiple opposed; single

D. multiple opposed; double

QUESTION: 23

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

QUESTION: 24

Which one of the following describes the typical purpose of minimum flow piping for a centrifugal pump?

A. Prevent pump runout during high flow conditions

B. Ensure adequate pump cooling during low flow conditions

C. Prevent vortexing at the pump suction during high flow conditions

D. Ensure adequate net positive suction head during low flow conditions

QUESTION: 25

A pump is needed to supply fuel oil from a day tank to a diesel 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 1900 psig.

Which one of the following types of pumps would typically be used in this application?

A. Axial flow centrifugal

B. Radial flow centrifugal

C. Rotary positive displacement

D. Reciprocating positive displacement

QUESTION: 26

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. Increases due to increased pump work

B. Decreases due to decreased pump work

C. Increases due to decreased counter electromotive force

D. Decreases due to decreased counter electromotive force

QUESTION: 27

Which one of the following will result from prolonged operation of ac motor windings at excessively high 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 ground resistance due to breakdown of winding insulation

D. Increased electrical ground resistance due to breakdown of winding insulation

QUESTION: 28

The main generator is paralleled to the grid with VARs currently at zero. If generator field excitation increases, generator VARs will become _____ and generator power factor value will _____.

A. negative (VARs in); increase

B. negative (VARs in); decrease

C. positive (VARs out); increase

D. positive (VARs out); decrease

QUESTION: 29

The starting current in a typical ac induction motor is much higher than the full-load running current because:

A. starting torque is much lower than running torque.

B. starting torque is much higher than 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.

QUESTION: 30

If the voltage supplied by an ac generator to an isolated electrical bus is held constant while loads (kW) are added to the bus, the current supplied by the generator will increase in direct proportion to the _____ of the change in kW. (Assume power factor does not change.)

A. cube

B. square

C. amount

D. square root

QUESTION: 31

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

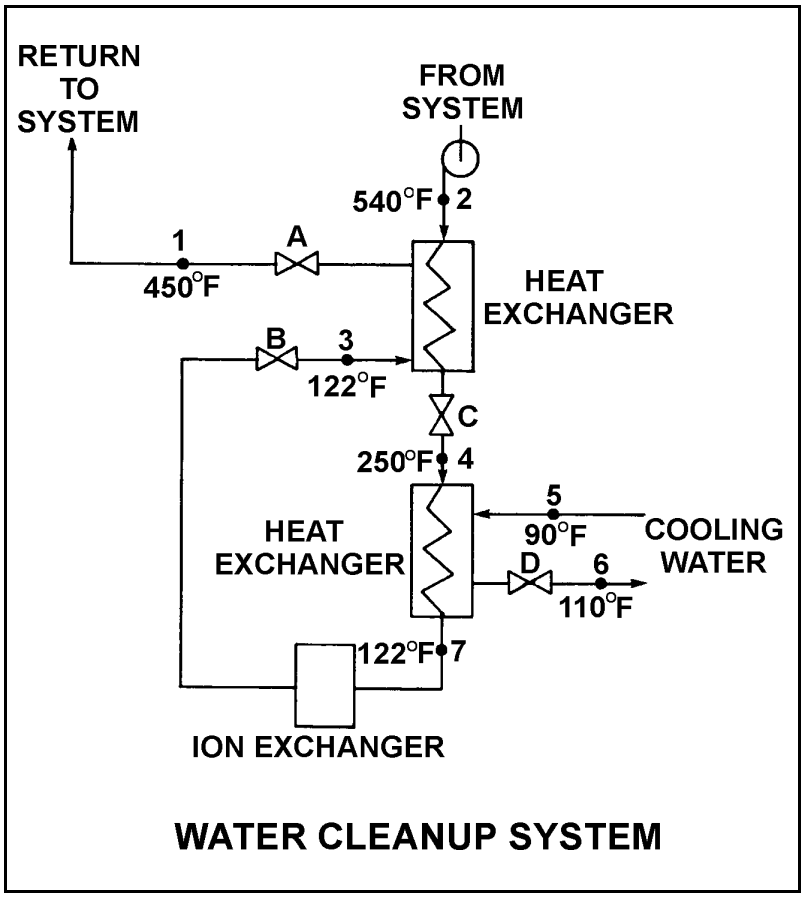
All valves are identical and are initially 50% open. To raise the temperature at point 1, the operator can adjust valve _____ in the _____ direction.

A. A; shut

B. B; open

C. C; shut

D. D; open



QUESTION: 32

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

QUESTION: 33

A counter-flow lube oil cooler is located inside a machinery room that is maintained at 80°F. The cooler has been isolated for several days. When the cooler is returned to service, it will be supplied with seawater at 45°F to cool lube oil from 125°F to 105°F.

To minimize the thermal shock experienced by the cooler when it is returned to service, the lube oil flow rate should be _____ increased to design flow rate, while the cooling water flow rate is _____ increased to design flow rate.

A. quickly; subsequently

B. quickly; simultaneously

C. gradually; subsequently

D. gradually; simultaneously

QUESTION: 34

The primary reason for slowly opening the discharge valves of large motor-driven centrifugal cooling water pumps after starting the pumps is to minimize the:

A. potential for a water hammer.

B. potential for pump cavitation.

C. motor running current requirements.

D. net positive suction head requirements.

QUESTION: 35

A nuclear plant is operating at steady-state 100% power when air inleakage causes main condenser vacuum to decrease from 28 inches Hg to 27 inches Hg. Assume the mass flow rate of steam through the main turbine remains unchanged and that condenser cooling water inlet temperature and flow rate do not change.

When the plant stabilizes, turbine exhaust quality will be_____ and turbine exhaust temperature will be _____.

A. lower; lower

B. lower; higher

C. higher; lower

D. higher; higher

QUESTION: 36

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

A. Increased condenser vacuum

B. Increased condensate conductivity

C. Decreased condensate pump flow rate

D. Decreased condensate pump net positive suction head

QUESTION: 37

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. 75%

B. 88%

C. 96%

D. 99%

QUESTION: 38

A condensate demineralizer differential pressure (D/P) gauge indicates 4 psid at 50% flow. Over the next two days plant power changes have caused condensate flow to vary between 25% and 100%.

Which one of the following combinations of condensate flow and demineralizer D/P, observed during the power changes, indicates an increase in the accumulation of corrosion products in the demineralizer?

	CONDENSATE FLOW	DEMINERALIZER D/P (PSID)
A.	25%	2.0
B.	60%	5.0
C.	75%	9.0
D.	100%	15.0

QUESTION: 39

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

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

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

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

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

QUESTION: 40

Which one of the following is the definition of a thermal overload device?

A. An in-line heater coil that, when subjected to a sustained high current, overheats and actuates a circuit-interrupting device.

B. A balanced circuit that compares actual current to a fixed overcurrent signal which, when exceeded, actuates a tripping relay.

C. A temperature monitor that senses the temperature of the operating load and trips the circuit breaker if the temperature exceeds preset limits.

D. An in-line induction coil that generates a secondary current proportional to the primary current, closing the trip circuit contacts for an overcurrent condition.

QUESTION: 41

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 follow the standard convention for control circuit drawings.)

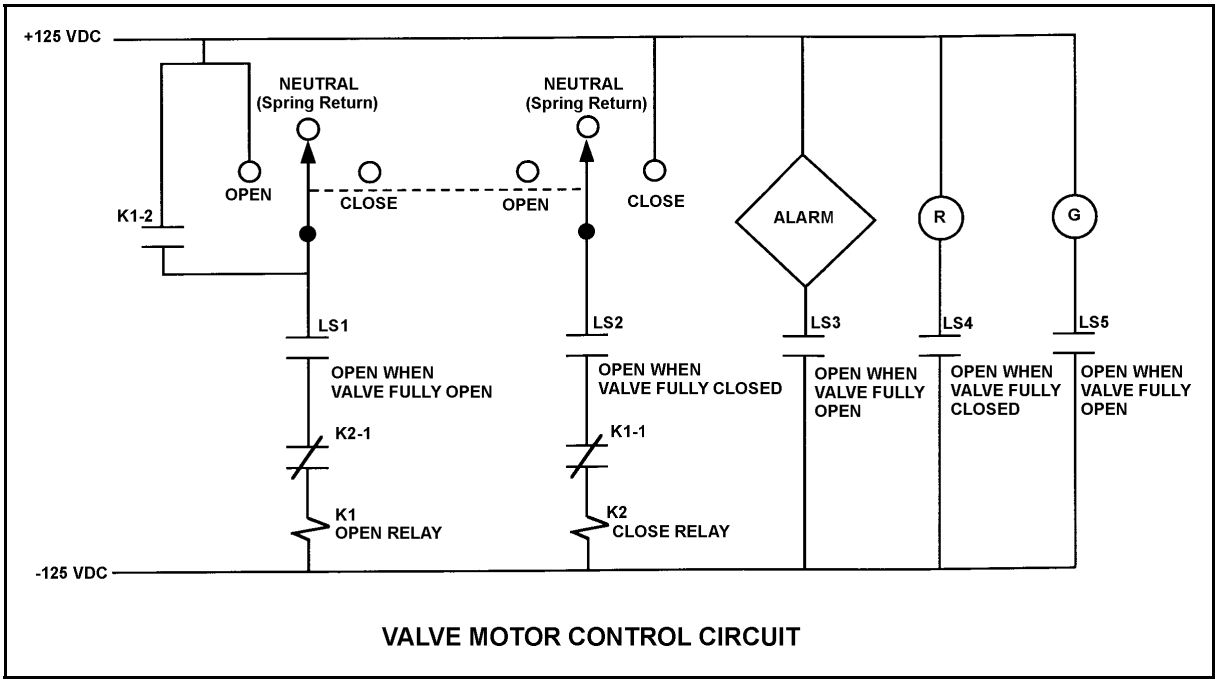
Which one of the following describes the valve response if the control switch is taken to the "Close" position for two seconds and then released?

A. The valve will not move.

B. The valve will close fully.

C. The valve will begin to close and then open fully.

D. The valve will begin to close and then stop moving.



VALVE MOTOR CONTROL CIRCUIT

QUESTION: 42

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

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

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

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

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

QUESTION: 43

Two identical 1000 MW electrical 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 increase continuously toward a maximum of 25 KV. 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.

QUESTION: 44

What is an advantage of using high voltage electrical disconnects instead of only breakers to isolate a plant's main power transformers?

A. Disconnects can be operated either locally or remotely.

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

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

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

QUESTION: 45

Which one of the following ranges contains the energy level of thermal neutrons in a reactor operating at full power?

A. 0.001 to 0.01 eV

B. 0.01 to 0.1 eV

C. 0.1 to 1 eV

D. 1 to 10 eV

QUESTION: 46

The ideal moderator has a _____ macroscopic absorption cross section and a _____ average logarithmic energy decrement.

A. large; small

B. large; large

C. small; small

D. small; large

QUESTION: 47

Which one of the following does <u>not</u> affect K_{eff}?

A. core burnup.

B. core dimensions.

C. moderator-to-fuel ratio.

D. installed neutron sources.

QUESTION: 48

With $K_{eff} = 0.985$, how much positive reactivity is required to make the reactor exactly critical?

A. 1.487% ΔK/K

B. 1.500% ΔK/K

C. 1.523% ΔK/K

D. 1.545% ΔK/K

QUESTION: 49

A reactor startup is being commenced with initial source (startup) 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

QUESTION: 50

A refueling outage has just been completed in which one-third of the core was replaced with new fuel assemblies. A reactor startup has been performed to mark the beginning of the sixth fuel cycle and power is being increased to 100%.

Which one of the following pairs of reactor fuels will be providing the greatest contribution to core heat production when the reactor reaches 100% power?

A. U-235 and U-238

B. U-235 and Pu-239

C. U-238 and Pu-239

D. U-238 and Pu-241

QUESTION: 51

A reactor startup is in progress with the reactor at normal operating temperature and pressure. With reactor power stable at the point of adding heat, a control rod malfunction causes an inadvertent rod withdrawal that results in adding 0.3 %ΔK/K reactivity.

Given:

All rod motion has been stopped.
No automatic system or operator actions occur to inhibit the power increase.
Power coefficient = -0.04 %ΔK/K / % power
Average effective delayed neutron fraction = 0.006

What is the approximate power level increase required to offset the reactivity added by the inadvertent rod withdrawal?

A. 3.0%

B. 5.0%

C. 6.7%

D. 7.5%

QUESTION: 52

Which one of the following is a characteristic of Doppler broadening?

A. As reactor coolant temperature increases, less moderator molecules will be present in the core to thermalize neutrons.

B. As reactor fuel temperature increases, neutrons from a wider energy spectrum will be captured in the fuel.

C. As moderator void percentage increases, neutrons will travel farther in the core before being absorbed or scattered.

D. As control rods are withdrawn, additional reactor fuel will be exposed and result in a power increase.

QUESTION: 53

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

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

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

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

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

QUESTION: 54

Rod position indication shows that a control rod is at position 22. If the control rod is then moved to position 12, it is being:

A. inserted 30 inches.

B. withdrawn 30 inches.

C. inserted 60 inches.

D. withdrawn 60 inches.

QUESTION: 55

A reactor is critical below the point of adding heat (POAH) during a reactor startup at the end of core life. Control rods are withdrawn for 20 seconds to establish a positive 30-second reactor period.

Reactor power will increase:

A. continuously until control rods are reinserted.

B. and stabilize at a value slightly below the POAH.

C. temporarily, and then stabilize at the original value.

D. and stabilize at a value equal to or above the POAH.

QUESTION: 56

Rod density is a measure of the:

A. percentage of control rods inserted into the core.

B. percentage of control rods withdrawn from the core.

C. number of control rods fully inserted divided by the number of control rods fully withdrawn.

D. number of control rods fully withdrawn divided by the number of control rods fully inserted.

QUESTION: 57

A reactor is operating at 60% power with thermal neutron flux peaked in the bottom half of the core. Partial withdrawal of a deep control rod will generally affect total (versus local) core power because _____ is relatively high in the area of withdrawal.

A. void content

B. fuel enrichment

C. thermal neutron flux

D. moderator temperature

QUESTION: 58

Which one of the following exhibits the greatest microscopic cross section for absorption of a thermal neutron in an operating reactor?

A. Boron-10

B. Xenon-135

C. Samarium-149

D. Uranium-235

QUESTION: 59

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

Which reactor has the greatest core Xe-135 concentration?

A. Reactor A due to the smaller 100% power thermal neutron flux

B. Reactor A due to the greater 100% power thermal neutron flux

C. Reactor B due to the smaller 100% power thermal neutron flux

D. Reactor B due to the greater 100% power thermal neutron flux

QUESTION: 60

Which one of the following values most closely approximates the half-life of Xe-135?

A. 19 seconds

B. 6.6 hours

C. 9.1 hours

D. 30 hours

QUESTION: 61

A reactor has been operating at full power for one month following a refueling outage with core axial neutron flux distribution peaked in the bottom half of the core. An inadvertent reactor scram occurs. The reactor is restarted, with criticality occurring 6 hours after the scram. Reactor power is increased to 60% over the next 4 hours and stabilized.

How will core axial neutron flux distribution be affected during the 1-hour period immediately following the return to 60% power?

The core axial neutron flux peak will be located _____ in the core than the pre-scram peak location, and the flux peak will be moving _____.

A. higher; upward

B. higher; downward

C. lower; upward

D. lower; downward

QUESTION: 62

Which one of the following reactor prescram conditions requires the greater amount of control rod withdrawal to perform a reactor startup during peak xenon conditions after a reactor scram?

A. Beginning of core life (BOL) and low power

B. End of core life (EOL) and low power

C. BOL and high power

D. EOL and high power

QUESTION: 63

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

Considering only the reactivity effects of core xenon-135 changes, which one of the following describes reactor power 30 hours after the power change?

A. Less than 75% and increasing slowly

B. Less than 75% and decreasing slowly

C. Greater than 75% and increasing slowly

D. Greater than 75% and decreasing slowly

QUESTION: 64

Which one of the following functions is <u>not</u> performed by burnable poisons in an operating reactor?

A. Provide neutron flux shaping.

B. Provide more uniform power density.

C. Counteract the effects of control rod burnout.

D. Allow higher fuel enrichment of initial core load.

QUESTION: 65

A reactor startup is in progress following a one-month shutdown. Upon reaching criticality, the operator establishes a positive 80-second period and stops rod motion.

After an additional 30 seconds, reactor power will be _____ and reactor period will be _____. (Assume reactor power remains below the point of adding heat.)

A. constant; constant

B. constant; increasing

C. increasing; constant

D. increasing; increasing

QUESTION: 66

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

A. Reactor power and reactor period

B. Reactor pressure and turbine load

C. Reactor water level and core flow rate

D. Reactor pressure and reactor water level

QUESTION: 67

A reactor is critical and a heat-up is in progress with reactor temperature currently at 140°F. If the point of adding heat was 1% reactor power, and reactor power is held constant at 3% during the heat-up, which one of the following describes the heat-up rate (HUR) from 140°F to 200°F?

A. HUR will initially increase and then decrease.

B. HUR will slowly decrease during the entire period.

C. HUR will slowly increase during the entire period.

D. HUR will remain the same during the entire period.

QUESTION: 68

After taking critical data during a reactor startup, the operator establishes a stable 34-second reactor period to increase power to the point of adding heat (POAH). Which one of the following is the approximate amount of reactivity that must be added to stabilize reactor power at the POAH? (Assume $\overline{\beta}_{eff} = 0.0066$.)

A. -0.10 %ΔK/K

B. -0.12 %ΔK/K

C. -0.15 %ΔK/K

D. -0.28 %ΔK/K

QUESTION: 69

Following a reactor shutdown from three-months operation at full power, core heat production will continue for a period of time. The rate of core heat production will be dependent upon the:

A. amount of fuel that has been depleted.

B. amount of time that has elapsed since K_{eff} decreased below 1.0.

C. amount of time required for the reactor pressure vessel to cool down.

D. rate at which the photoneutron source strength decays following shutdown.

QUESTION: 70

A plant is operating at 85% power when a failure of the steam pressure control system opens the turbine control valves to admit 10% more steam flow to the main turbine. No operator actions occur and no protective system actuations occur.

How will reactor power respond? (Assume the valves remain in the failed position.)

A. Increase until reactor power matches the new steam demand

B. Increase continuously and exceed reactor protection set points

C. Decrease and stabilize at a lower power level and steaming rate

D. Decrease and stabilize at a critical power level below the point of adding heat

QUESTION: 71

During continuous reactor power operation, rod pattern exchanges are performed periodically to:

A. increase the rod worth of control rods that are nearly fully withdrawn.

B. prevent the development of individual control rods with very high worths.

C. ensure some control rods remain inserted as deep control rods until late in the core cycle.

D. allow the local power range monitoring nuclear instruments to be asymmetrically installed in the core.

QUESTION: 72

A reactor is operating at 70% power when one recirculation pump trips. Reactor power will initially _____ because of the effects of the _____ coefficient.

A. increase; void

B. decrease; void

C. increase; moderator temperature

D. decrease; moderator temperature

QUESTION: 73

Subcooled 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. Orifice

B. Flow restrictor

C. Divergent nozzle

D. Convergent nozzle

QUESTION: 74

A reactor plant is operating at 100% rated power. Steam is escaping to atmosphere through a flange leak in a steam supply line to the low pressure section of the main turbine.

Given:

- Steam line pressure is 300 psia.
- Steam line temperature is 440°F.

What is the approximate temperature of the steam as it reaches atmospheric pressure?

A. 212°F

B. 268°F

C. 322°F

D. 358 °F

QUESTION: 75

The temperature of a saturated steam-water mixture is 467°F.

Which one of the following additional parameter values, when paired with the temperature, provides <u>insufficient</u> data to determine the approximate steam quality of the mixture?

A. Pressure at 499.96 psia

B. Enthalpy at 977.33 Btu/lbm

C. Entropy at 1.17 Btu/lbm -°R

D. Specific volume at 0.817 ft^3/lbm

QUESTION: 76

Refer to the drawing of a steam-jet air ejector (see figure below).

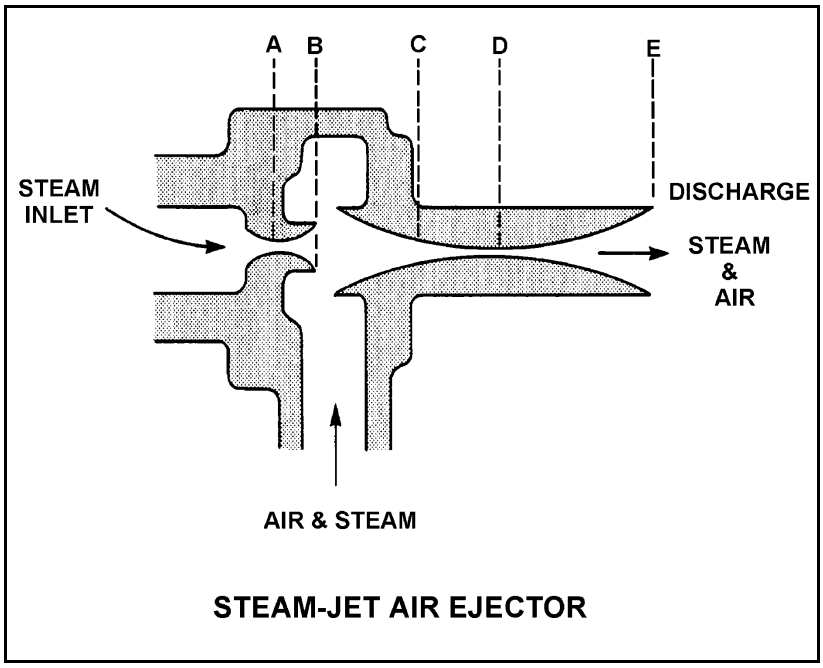
In the figure of an operating steam jet air ejector, steam flowing from D to E undergoes a pressure _____ and a velocity _____.

A. decrease; decrease

B. decrease; increase

C. increase; increase

D. increase; decrease



STEAM-JET AIR EJECTOR

QUESTION: 77

Which one of the following will be caused by a decrease in main condenser vacuum (higher absolute pressure) on a plant operating at full power? (Assume main steam flow rate and condenser circulating water flow rate are unchanged.)

A. Decrease in the condensate temperature

B. Decrease in the ideal steam cycle efficiency

C. Decrease in the condensate pump required NPSH

D. Decrease in the mass of noncondensable gas in the condenser

QUESTION: 78

A steam plant main turbine consists of a high-pressure (HP) unit and several low-pressure (LP) units. The main turbine is most likely to experience stress-related failures of the _____ unit _____ stages.

A. HP; inlet

B. HP; outlet

C. LP; inlet

D. LP; outlet

QUESTION: 79

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

A centrifugal pump is operating in a closed water system and discharging through a heat exchanger. A second heat exchanger, in parallel with the first, is then placed in service.

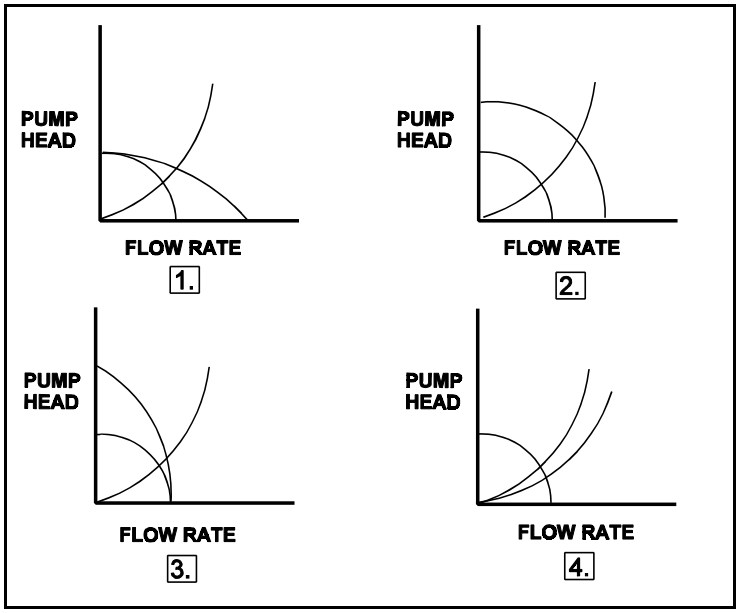
Which set of curves illustrates the initial and final operating conditions?

A. 1.

B. 2.

C. 3.

D. 4.



QUESTION: 80

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

High pressure coolant injection (HPCI) pumps: 1200 psia
Low pressure coolant injection (LPCI) pumps: 200 psia

Which pumps must be stopped quickly and why?

A. LPCI pumps to avoid pump overheating caused by low flow

B. LPCI pumps to avoid motor overheating caused by low flow

C. HPCI pumps to avoid pump overheating caused by high flow

D. HPCI pumps to avoid motor overheating caused by high flow

QUESTION: 81

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

QUESTION: 82

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

Given the following lube oil cooling system conditions:

- The lube oil flow rate in the lube oil heat exchanger is 200 lbm/min.
- The lube oil enters the heat exchanger at 140ºF.
- The lube oil leaves the heat exchanger at 100ºF.
- The specific heat of the lube oil is 0.8 Btu/lbm-ºF.
- The cooling water flow rate is 400 lbm/min.
- The cooling water enters the lube oil heat exchanger at 60ºF.
- The specific heat of the cooling water is 1.0 Btu/lbm-ºF.

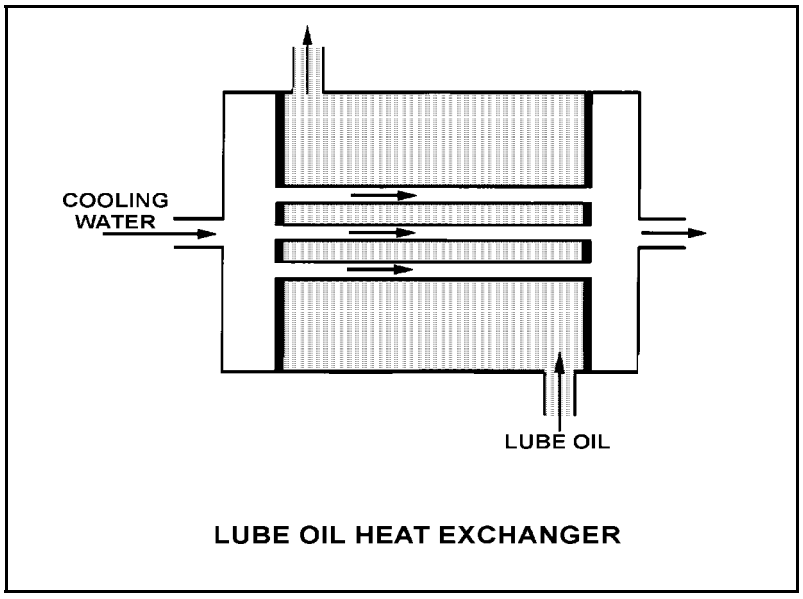
What is the approximate temperature of the cooling water leaving the lube heat exchanger?

A. 76ºF

B. 85ºF

C. 92ºF

D. 124ºF



LUBE OIL HEAT EXCHANGER

QUESTION: 83

Which one of the following statements explains why condensate subcooling is necessary in the steam condensing phase of a plant cycle?

A. To increase overall secondary efficiency

B. To provide an improved condenser vacuum

C. To allow use of a higher circulating water temperature

D. To provide net positive suction head to the condensate pumps

QUESTION: 84

A reactor plant is operating at 100% rated power. Main turbine extraction steam is being supplied to a feedwater heater. Extraction steam parameters are as follows:

Steam pressure: 750 psia
Steam flow rate: 7.5×10^5 lbm/hr
Steam enthalpy: 1150 Btu/lbm

Saturated liquid condensate at 448°F leaves the feedwater heater via a drain line.

What is the approximate heat transfer rate from the extraction steam to the feedwater in the feedwater heater?

A. 3.8×10^7 Btu/hr

B. 8.6×10^7 Btu/hr

C. 5.4×10^8 Btu/hr

D. 7.2×10^8 Btu/hr

QUESTION: 85

How does the convective heat transfer coefficient vary from the bottom to the top of a fuel rod if subcooled reactor coolant enters the coolant channel and exits as superheated steam?

A. Increases continuously

B. Decreases continuously

C. Increases, then decreases

D. Decreases, then increases

QUESTION: 86

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

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

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

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

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

D. Raise vessel water level above the bottom of the steam separators to provide a liquid flow path from the inside to the outside of the core shroud.

QUESTION: 87

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

A. in the downcomer area

B. in the core inlet plenum

C. in the lower fuel channel area

D. at the feedwater pump discharge

QUESTION: 88

Single-phase coolant flow resistance in a reactor core is proportional to coolant _____ and inversely proportional to _____.

A. velocity; bundle length

B. velocity; orifice diameter

C. temperature; bundle length

D. temperature; orifice diameter

QUESTION: 89

Two reactors have the same rated power level and are currently operating at 50% power with a normal neutron flux distribution in each core. The reactors are identical except that one core has core orifices and the other core does not. Each reactor has the same core mass flow rate.

The orificed core will have the _____ critical power and the _____ core differential pressure.

A. higher; higher

B. higher; lower

C. lower; higher

D. lower; lower

QUESTION: 90

How does critical heat flux vary from the bottom to the top of a typical fuel bundle during normal full power operation?

A. Increases continuously

B. Increases, then decreases

C. Decreases continuously

D. Decreases, then increases

QUESTION: 91

A reactor is shut down with all reactor recirculating pumps stopped. Which one of the following explains why it is important to monitor reactor vessel skin temperatures?

A. Significant differential temperature between the upper and lower elevation reactor vessel skin indicates that thermal stratification is occurring.

B. Significant differential temperature between the top and bottom reactor vessel heads will result in excessive thermal stresses in the reactor vessel wall.

C. These temperatures provide the best indication of the accuracy of the shutdown reactor water level instruments due to the temperature variance from instrument calibration conditions.

D. These temperatures provide a backup indication of reactor water level because the skin temperatures detected above vessel water level will be lower than those below vessel water level.

QUESTION: 92

A reactor is operating at 65% of rated thermal power with power distribution peaked radially in the center of the core and axially toward the bottom of the core. Reactor power is then increased to 75% over the next 2 hours using only shallow control rods that are centrally-located.

Neglecting any effect from reactor poisons, when power is stabilized at 75%, the radial peaking factors generally will have increased in the _____ half of the center fuel bundles and the axial peaking factors generally will have increased in the _____ half of the center fuel bundles.

A. top; top

B. top; bottom

C. bottom; top

D. bottom; bottom

QUESTION: 93

Thermal limits are established to protect the reactor core, and thereby protect the public during 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.

QUESTION: 94

Which one of the following must be maintained within the technical specification limit to ensure that fuel cladding plastic strain (deformation) is limited to 1%?

A. Linear heat generation rate

B. Average planar linear heat generation rate

C. Minimum critical power ratio safety limit

D. Minimum critical power ratio operating limit

QUESTION: 95

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

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

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

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

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

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

QUESTION: 96

A step increase in reactor power results in a fuel cladding surface temperature increase from 550°F to 580°F at steady state conditions. The fuel thermal time constant is 6 seconds.

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

A. 571°F

B. 569°F

C. 565°F

D. 561°F

QUESTION: 97

The primary purpose of the gap between a fuel pellet and the surrounding cladding is to:

A. allow insertion of fuel pellets into the fuel rods.

B. provide a collection volume for fission product gases.

C. maintain the design fuel thermal conductivity throughout the fuel cycle.

D. accommodate differential expansion of the pellet and cladding to preclude excessive cladding stress.

QUESTION: 98

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

A. linear heat generation rate

B. minimum critical power ratio

C. average planar linear heat generation rate

D. preconditioning interim operating management recommendations

QUESTION: 99

Brittle fracture of the reactor vessel (RV) is least likely to occur during a _____ of the RV when RV temperature is _____ the reference temperature for nil-ductility transition (RT_{NDT}).

A. heatup; above

B. heatup; below

C. cooldown; above

D. cooldown; below

QUESTION: 100

After several years of operation the maximum allowable stress to the reactor pressure vessel is more limited by the inner wall than the outer wall because:

A. the inner wall has a smaller surface area than the outer wall.

B. the inner wall experiences more tensile stress than the outer wall.

C. there is a temperature gradient across the reactor pressure vessel wall.

D. the inner wall experiences more neutron-induced embrittlement than the outer wall.

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

FEBRUARY 2001 NRC GENERIC FUNDAMENTALS EXAMINATION
BOILING WATER REACTOR - ANSWER KEY

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