UNITED STATES NUCLEAR REGULATORY COMMISSION
BOILING WATER REACTOR GENERIC FUNDAMENTALS EXAMINATION
JUNE 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 4.0 hours after the examination starts. This examination applies to a typical boiling water reactor (BWR) power plant.

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

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

_____
Applicant's Signature

RULES AND GUIDELINES FOR THE
GENERIC FUNDAMENTALS EXAMINATION

During the administration of this examination the following rules apply:

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

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

2. Fill in the name of your facility.

3. Fill in your individual docket number.

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

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

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

    (2) Steam tables provided by your proctor.

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

7. Scrap paper will be provided for calculations.

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

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

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

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

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

GENERIC FUNDAMENTALS EXAMINATION
EQUATIONS AND CONVERSIONS HANDOUT SHEET

EQUATIONS

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

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

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

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

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

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

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

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

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

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

$$1/M = CR_1/CR_X$$

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

$$A = \pi r^2$$

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

$$F = PA$$

$$SUR = 26.06/\tau$$

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

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

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

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

$$E = IR$$

$$Eff. = Net\ Work\ Out/Energy\ In$$

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

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

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

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

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

CONVERSIONS

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1 Mw = 3.41×10^6 Btu/hr	1 Curie = 3.7×10^{10} dps
1 hp = 2.54×10^3 Btu/hr	1 kg = 2.21 lbm
1 Btu = 778 ft-lbf	1 gal$_{water}$ = 8.35 lbm
°C = (5/9)(°F - 32)	1 ft$^3_{water}$ = 7.48 gal
°F = (9/5)(°C) + 32	

QUESTION: 1

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. blowdown.

B. accumulation.

C. set point tolerance.

D. set point deviation.

QUESTION: 2

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

Vessel A is completely filled with subcooled water and vessel B is in a saturated, two-phase condition. Both vessels are currently pressurized to 50 psig and are protected by identical relief valves.

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

A. A; A

B. A; B

C. B; A

D. B; B

PRESSURE VESSELS WITH RELIEF PROTECTION
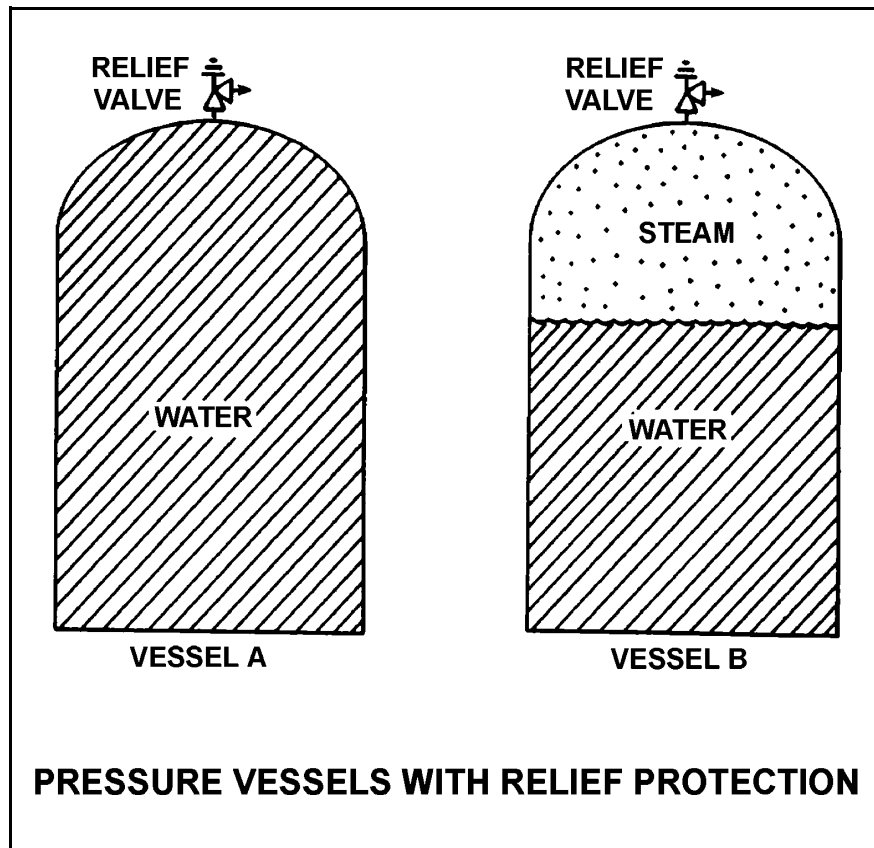
QUESTION: 3

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% open

QUESTION: 4

To verify a manual valve in an operating system is <u>closed</u>, 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.

QUESTION: 5

In a comparison between ball valves and butterfly valves in the same liquid process system application, the valves that typically would allow more leakage when fully closed and under high differential pressure are _____ valves, and the valves that typically would cause the higher system pressure drop when fully open are _____ valves.

A. ball; ball

B. ball; butterfly

C. butterfly; ball

D. butterfly; butterfly

QUESTION: 6

A venturi is being used to measure 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 _____. (Assume water is incompressible.)

A. increase; increase

B. increase; remain the same

C. decrease; decrease

D. decrease; remain the same

QUESTION: 7

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 approximate currently indicated flow rate?

A. 44 gpm

B. 67 gpm

C. 100 gpm

D. 120 gpm

QUESTION: 8

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
AD	A and D
BD	B and D
CD	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.

PIPE ELBOW - TOP VIEW
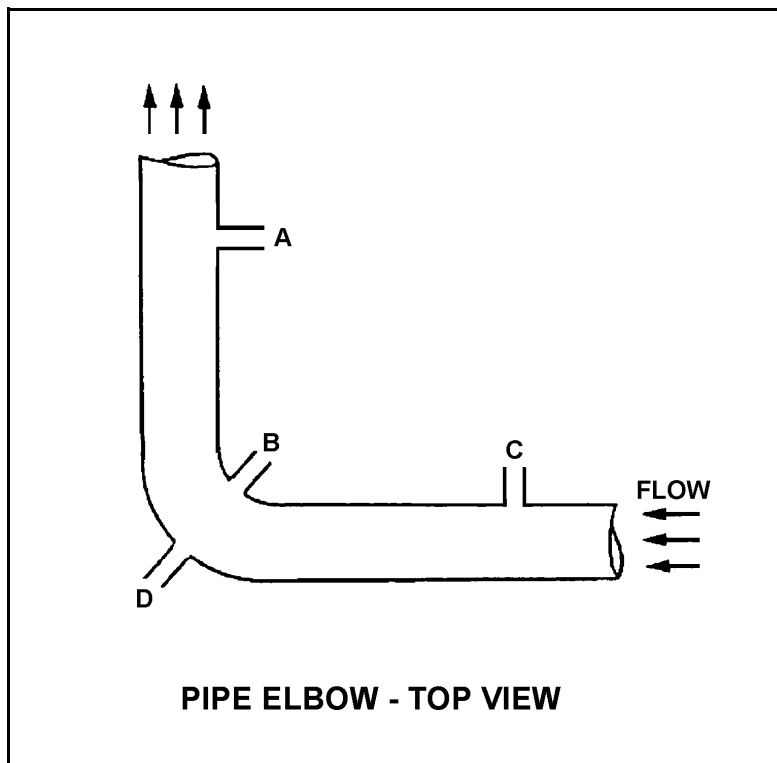
QUESTION: 9

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 not 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

QUESTION: 10

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

Thermocouple temperature indication is currently 150°F. If a small steam leak occurs that raises both the measuring (hot) junction and reference (cold) junction temperatures by 20°F, the resultant temperature indication will be:

A. 130°F.

B. 150°F.

C. 170°F.

D. 190°F.

SIMPLE THERMOCOUPLE CIRCUIT
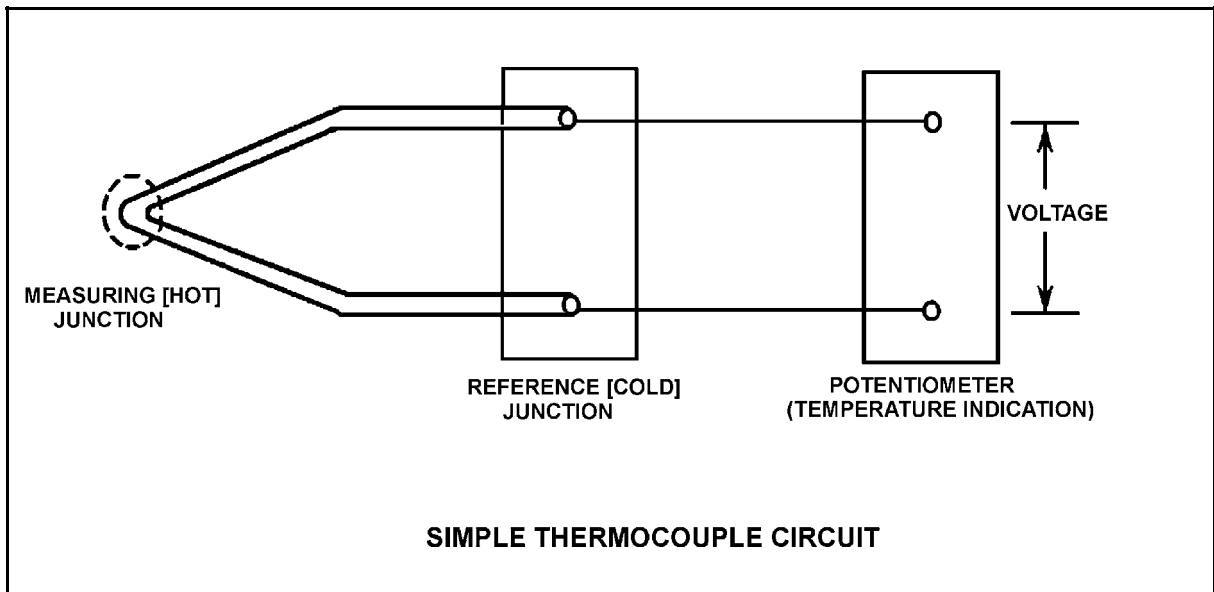
QUESTION: 11

An automatic tank level controller has a potentiometer for manual adjustment of the level set point. The level set point and the tank level are currently at 40%. An operator lowers the potentiometer setting to raise the level set point signal to 50%. However, actual tank level stabilizes at 60%.

The most likely cause is that the potentiometer:

A. wiper and slide bar have developed a partial short circuit, thereby decreasing the resistance of the potentiometer.

B. slide bar has developed a thin film of corrosion, thereby increasing the resistance of the potentiometer.

C. wiper has lost contact with the slide bar, thereby allowing only fine setpoint adjustments.

D. locking device has not been released, thereby allowing only coarse set point adjustments.

QUESTION: 12

Fission chamber detectors are used to monitor reactor power/neutron level in a shutdown reactor as well as a reactor operating at full power (and all power levels in between). At what power levels, and why is it necessary to compensate the output of the detectors for gamma interactions with the fission chambers?

A. At all power levels, because gamma interactions produce larger detector pulses than neutron interactions.

B. At all power levels, because gamma interactions produce smaller detector pulses than neutron interactions.

C. Only when shutdown or at low power levels, because gamma flux is not proportional to reactor power at low power levels.

D. Only when operating at high power levels, because gamma flux is not proportional to reactor power at high power levels.

QUESTION: 13

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.

QUESTION: 14

Which one of the following types of radiation is the major contributor to the dose indication on a self-reading pocket dosimeter (SRPD)? (Also called SRD, PIC, and direct reading dosimeter)

A. Alpha

B. Beta

C. Gamma

D. Neutron

QUESTION: 15

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

A. speed; air

B. speed; fuel

C. load; air

D. load; fuel

QUESTION: 16

The level in a drain collection tank is being controlled by an automatic level controller and is initially at the controller set point. 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, a new, steady-state tank level at 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 derivative only

C. proportional plus integral only

D. proportional plus integral plus derivative

QUESTION: 17

An air-operated isolation valve requires 3,600 lbf 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

QUESTION: 18

Which one of the following describes gas binding of a centrifugal pump?

A. Pump capacity is reduced due to the presence of steam or air in the pump impeller.

B. Pump capacity is reduced due to windage losses between the pump impeller and pump casing.

C. Pump motor current increases due to the compression of gases in the pump volute.

D. Pump motor current increases due to the high head requirements for pumping a fluid saturated with dissolved gases.

QUESTION: 19

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

Valve "A" will close when pump:

A. discharge pressure increases above a setpoint.

B. discharge pressure decreases below a setpoint.

C. flow rate increases above a setpoint.

D. flow rate decreases below a setpoint.

PUMP WITH RECIRCULATION LINE
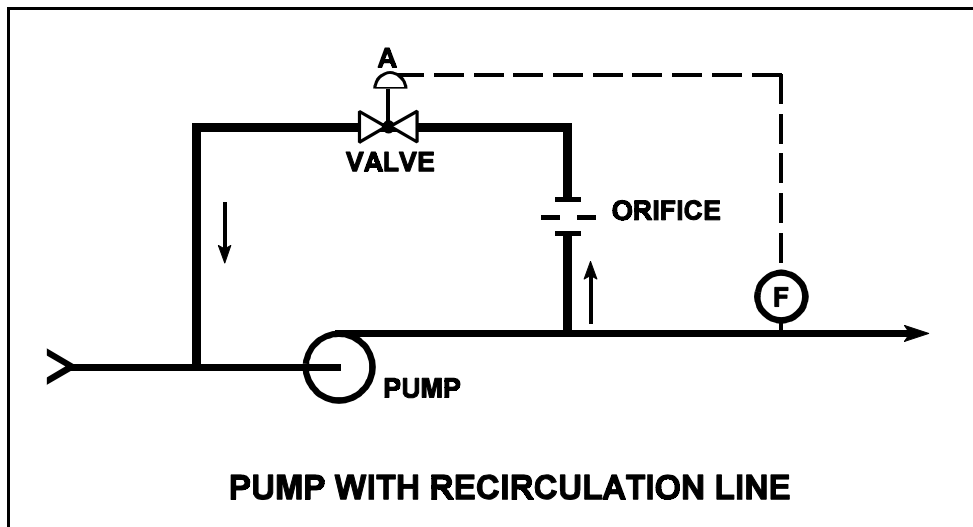
QUESTION: 20

A centrifugal pump is taking suction on an open storage tank that is 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 through a fire hose.

Given:

• The pump is currently operating at its design flow rate of 200 gpm and a total developed head of 100 feet.
• The pump requires 6 feet of net positive suction head (NPSH).

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 6 feet.

B. Flow rate will remain constant until the pump begins to cavitate when the tank becomes empty.

C. Flow rate will gradually decrease until the pump begins to cavitate at a tank level of about 6 feet.

D. Flow rate will gradually decrease until the pump begins to cavitate when the tank becomes empty.

QUESTION: 21

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

A. Discharge valve fully open to reduce duration of motor starting current

B. Discharge valve throttled to reduce duration of motor starting current

C. Discharge valve fully open to ensure adequate pump net positive suction head

D. Discharge valve throttled to ensure adequate pump net positive suction head

QUESTION: 22

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.

QUESTION: 23

A centrifugal pump is susceptible to overheating and cavitation while operating with its discharge valve <u>closed</u>, unless:

A. the pump is steam driven.

B. minimum flow protection is provided.

C. pump seal cooling is provided.

D. the suction valve is also closed.

QUESTION: 24

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. 41 rpm.

D. 62 rpm.

QUESTION: 25

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

QUESTION: 26

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 no change in system flow rate

C. Lower than normal running current and motor breaker trips

D. Lower than normal running current and no change in system flow rate

QUESTION: 27

Which one of the following describes the relationship between the current supplied to an ac induction motor and the amount of heat generation (kW) in the motor windings?

A. Heat generation is linearly 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.

QUESTION: 28

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.

QUESTION: 29

What unit of measurement is used to describe the rate of electron flow?

A. Volt-amp reactive (VAR)

B. Ohm

C. Volt

D. Ampere

QUESTION: 30

A plant is operating at 80% power in the middle of a fuel cycle. The main generator is connected to the electrical grid with the following initial main generator output parameters:

Frequency: 60 Hz
Voltage: 25 KV
Reactive Load: 300 MVAR (out)
Real Load: 800 MW

A hydraulic oil system malfunction causes the main turbine steam inlet valves to begin to slowly drift closed. Over the next 10 minutes, the main generator real load decreases to 300 MW. Assuming no operator actions were taken during the above 10 minutes, how have the following main generator output parameters been affected?

	Frequency	Voltage	Reactive Load
A.	Decreased	Decreased	No change
B.	Decreased	No change	Decreased
C.	No change	No change	No change
D.	No change	Decreased	Decreased

QUESTION: 31

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

Valves A, B, and C are fully open. Valve D is 80% open. All temperatures are as shown. If valve D is then throttled to 50%, the temperature at point:

A. 3 will decrease.

B. 4 will increase.

C. 5 will increase.

D. 6 will decrease.

WATER CLEANUP SYSTEM
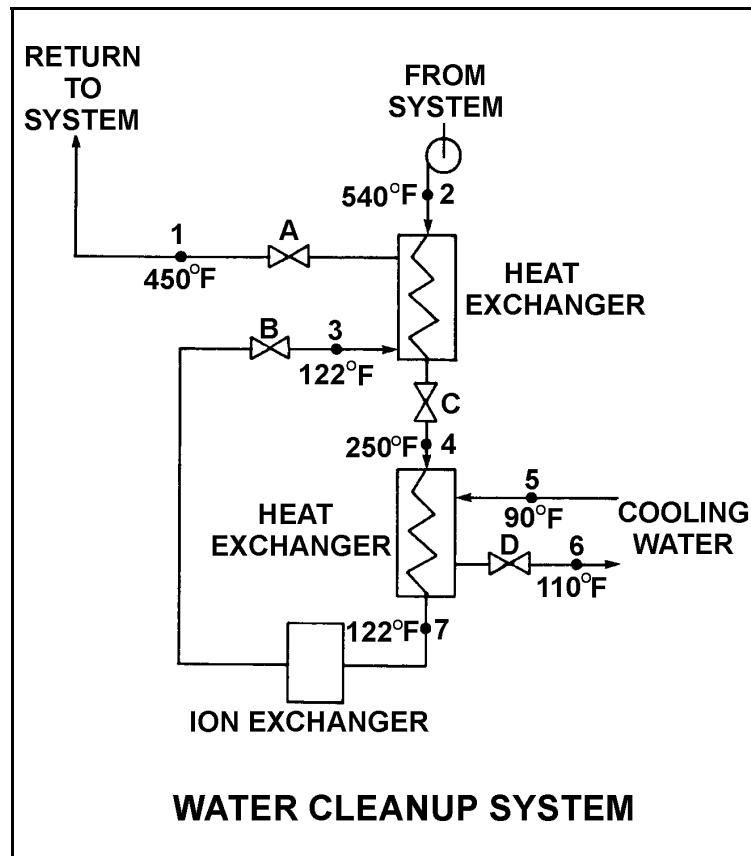
QUESTION: 32

Steam has been admitted to a condenser for 25 minutes with no cooling water during a condenser startup. Initiating cooling water at this time will:

A. reduce the stress on the condenser shell because the shell has been pre-warmed.

B. reduce the stress on the condenser tubes by gradually cooling the tubes.

C. induce large thermal stresses on the junctions between the condenser tubes and the tubesheet.

D. induce large thermal stresses on the condenser shell.

QUESTION: 33

Which one of the following changes will result in <u>increased</u> subcooling of the condensate water in the condenser hot well?

A. Decrease circulating water flow.

B. Increase circulating water temperature.

C. Decrease the main turbine generator MW load.

D. Isolate one bay of the condenser circulating water system.

QUESTION: 34

What is the reason for ensuring that a piping system is completely filled and vented <u>prior</u> to initiating system flow?

A. To minimize the system head losses

B. To ensure all noncondensible gases are removed from the piping system to reduce system corrosion

C. To preclude a reduction in the overall system heat transfer coefficient

D. To minimize the potential for water hammer

QUESTION: 35

Refer to the drawing of a 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?

A. High pressure (HP) fluid inventory will increase.

B. Pressure in the low pressure (LP) system will decrease.

C. Temperature in the low pressure (LP) system will increase.

D. Level in the surge tank will decrease.

COOLING WATER SYSTEM
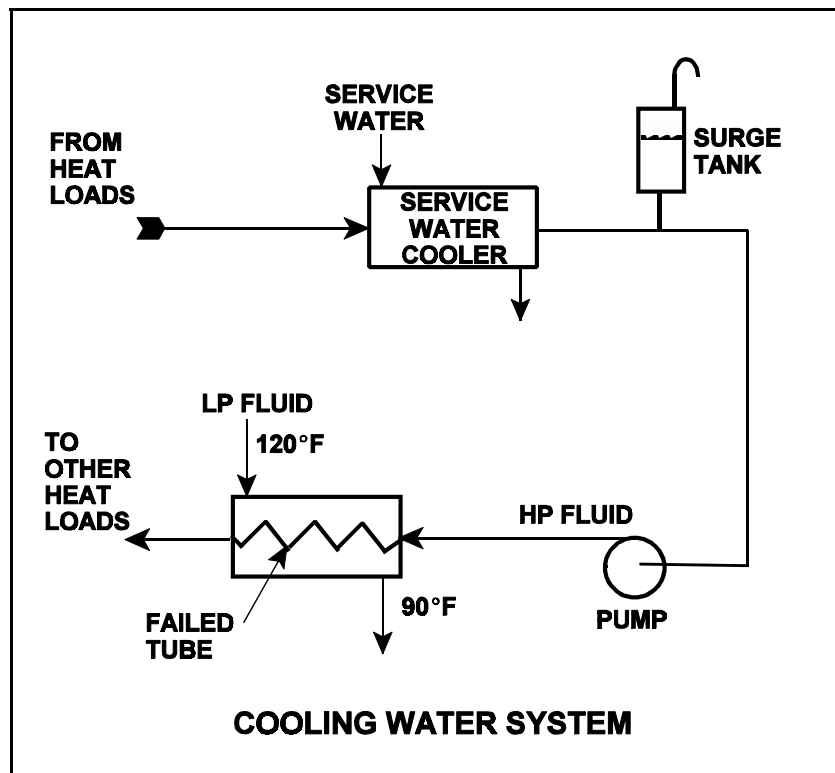
QUESTION: 36

Why does air entry into the main condenser reduce the efficiency of the steam cycle?

A. Steam flow rate through the main turbine increases.

B. Condensate subcooling in the main condenser increases.

C. Low pressure turbine exhaust steam enthalpy increases.

D. The air mixes with the steam and enters the condensate.

QUESTION: 37

Which one of the following refers to the condition in which large portions of a demineralizer resin bed are bypassed, thereby allowing waterborne impurities to reach the outlet?

A. Channeling

B. Leaching

C. Exhaustion

D. Mineralization

QUESTION: 38

The demineralization factor of a demineralizer can be expressed as:

A. (Outlet Conductivity) ÷ (Inlet Conductivity).

B. (Inlet Conductivity) ÷ (Outlet Conductivity).

C. (Outlet Conductivity) - (Inlet Conductivity).

D. (Inlet Conductivity) - (Outlet Conductivity).

QUESTION: 39

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

A. conductivity at the demineralizer outlet.

B. decontamination factor across the demineralizer.

C. differential pressure across the demineralizer.

D. pH at the demineralizer outlet.

QUESTION: 40

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.

QUESTION: 41

Which one of the following is an <u>unsafe</u> practice if performed when 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.

QUESTION: 42

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. 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.

QUESTION: 43

When a typical 4160 Vac 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

QUESTION: 44

Typical high voltage transformer electrical disconnects 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.

QUESTION: 45

During a brief time interval in a typical commercial nuclear reactor operating at the beginning of a fuel cycle, 10^3 delayed neutrons were emitted.

Approximately how many prompt neutrons were emitted during this same time interval?

A. 1.5×10^5

B. 6.5×10^6

C. 1.5×10^7

D. 6.5×10^8

QUESTION: 46

The best neutron moderator is _____ and is composed of _____ atoms.

A. dense; large

B. not dense; large

C. dense; small

D. not dense; small

QUESTION: 47

A reactor is currently operating at equilibrium 80% power near the end of its fuel cycle. During the next 3 days of equilibrium power operation <u>no</u> operator action is taken.

How will core K_{eff} be affected during the 3-day period?

A. Core K_{eff} will gradually increase during the entire period.

B. Core K_{eff} will gradually decrease during the entire period.

C. Core K_{eff} will tend to increase, but reactivity feedback mechanisms will maintain core K_{eff} at 1.0.

D. Core K_{eff} will tend to decrease, but reactivity feedback mechanisms will maintain core K_{eff} at 1.0.

QUESTION: 48

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

A. beta.

B. K_{eff}.

C. lambda.

D. reactivity.

QUESTION: 49

A reactor startup is being performed with xenon-free conditions. Control rod withdrawal is stopped when K_{eff} equals 0.995 and count rate stabilizes at 1000 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 1000 cps and decreasing toward the prestartup count rate.

B. Less than 1000 cps and stable above the prestartup count rate.

C. Greater than 1000 cps and increasing toward criticality.

D. 1000 cps and constant.

QUESTION: 50

A refueling outage has just been completed in which the entire core was offloaded and replaced with new fuel. A reactor startup has been performed to mark the beginning of the next 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-238 and Pu-239

C. U-235 and Pu-239

D. U-235 and Pu-241

QUESTION: 51

A reactor is being started for the first time following a refueling outage. Reactor Engineering has determined that during the upcoming fuel cycle $\overline{\beta}_{eff}$ will range from a maximum of 0.007 to a minimum of 0.005.

Once the reactor becomes critical control rods are withdrawn to insert a net positive reactivity of 0.1% $\Delta K/K$ into the reactor core. Assuming no other reactivity additions, what will be the approximate stable reactor period for this reactor until the point of adding heat is reached?

A. 50 seconds

B. 60 seconds

C. 70 seconds

D. 80 seconds

QUESTION: 52

How does control rod withdrawal affect the moderator temperature coefficient in an undermoderated reactor core?

A. The initially negative MTC becomes more negative.

B. The initially negative MTC becomes less negative.

C. The initially positive MTC becomes more positive.

D. The initially positive MTC becomes less positive.

QUESTION: 53

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

A. Uranium-235

B. Uranium-238

C. Samarium-149

D. Xenon-135

QUESTION: 54

Which one of the following materials is used in control rods primarily for thermal neutron absorption?

A. C-12.

B. B-10.

C. Xe-135.

D. U-235.

QUESTION: 55

Rod density is a measure of the total number of control rod notches _____ the core divided by the total number of control rod notches _____ the core.

A. inserted into; available in

B. inserted into; withdrawn from

C. withdrawn from; available in

D. withdrawn from; inserted into

QUESTION: 56

The reactor is operating at 85% power with control rod X-Y inserted 20%. Which one of the following will cause the differential control rod worth of control rod X-Y to become more negative? (Assume that control rod X-Y remains 20% inserted for each case.)

A. Fuel temperature increases as fission product gases accumulate in a fuel rod.

B. Reactor vessel pressure drifts from 900 psig to 880 psig.

C. Core Xe-135 builds up in the lower half of the core.

D. An adjacent control rod is fully withdrawn from the core.

QUESTION: 57

Which one of the following describes where neutron flux shaping is predominantly used in a reactor core to reduce radial power peaking?

A. In the center of the core where peaking is caused by a high number density of fuel assemblies.

B. At the periphery of the core where peaking is caused by moderator reflection of thermal leakage neutrons.

C. Throughout the core where peaking is caused by uneven burnout of control rod poison material.

D. Throughout the core where peaking is caused by loading fuel assemblies of various fuel enrichments.

QUESTION: 58

Fission fragments or daughters that have a substantial neutron absorption cross section and are not fissionable are called:

A. fissile materials.

B. fission product poisons.

C. fissionable nuclides.

D. burnable poisons.

QUESTION: 59

The primary method of xenon-135 production during reactor operation at steady state full power is by _____ and the primary method of samarium-149 production is by _____.

A. fission of U-235; fission of U-235

B. fission of U-235; decay of Pm-149

C. decay of I-135; fission of U-235

D. decay of I-135; decay of Pm-149

QUESTION: 60

Which one of the following equilibrium 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 100% power

B. End of core life (EOL) and 100% power

C. BOL and 20% power

D. EOL and 20% power

QUESTION: 61

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

A. They can cause excessively short reactor periods and can prevent a reactor startup following a reactor scram.

B. They can cause excessively short reactor periods and can require operation below full rated power.

C. They can adversely affect core power distribution and can prevent a reactor startup following a reactor scram.

D. They can adversely affect core power distribution and can require operation below full rated power.

QUESTION: 62

A reactor is initially operating at 100% power with equilibrium core xenon-135. Power is decreased to 50% over a 2-hour period. No subsequent operator actions are taken.

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

A. Less than 50% and decreasing slowly

B. Less than 50% and increasing slowly

C. Greater than 50% and decreasing slowly

D. Greater than 50% and increasing slowly

QUESTION: 63

A plant has been operating at 100% power for two months when a reactor scram occurs. Shortly after the reactor scram a reactor startup is commenced. Six hours after the scram, reactor power is at 2%. To maintain power stable at 2% over the next hour, the operator must add:

A. positive reactivity because core xenon-135 is building up.

B. negative reactivity because core xenon-135 is building up.

C. positive reactivity because core xenon-135 is decaying away.

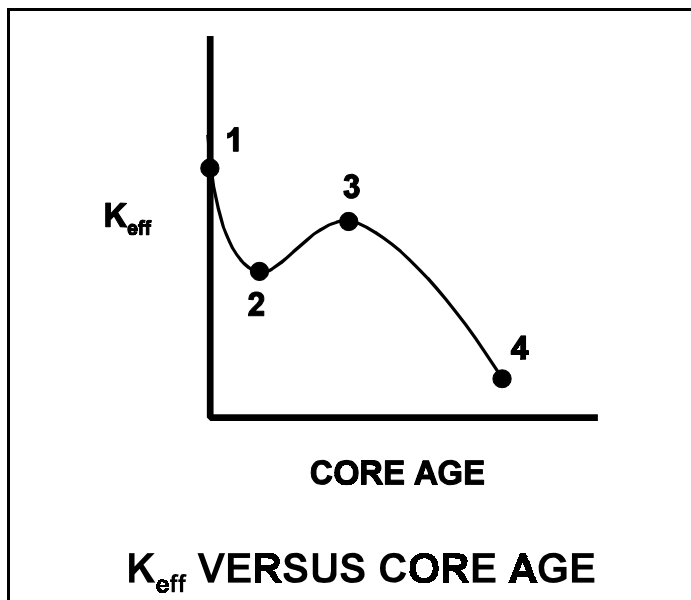D. negative reactivity because core xenon-135 is decaying away.

QUESTION: 64

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

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

A. depletion of U-235.

B. depletion of U-238.

C. burnout of burnable poisons.

D. buildup of fission product poisons.

K_{eff} VERSUS CORE AGE

QUESTION: 65

Refer to the drawing of three 1/M plots labeled A, B, and C (see figure below).

A core refueling is in progress with an installed neutron source. During the early stages of the refueling, reactor criticality would be predicted earliest by plot _____ and could possibly be the result of using nuclear instrumentation that is located too _____ the neutron source.

A. A; far from

B. A; close to

C. C; far from

D. C; close to

1/M PLOT
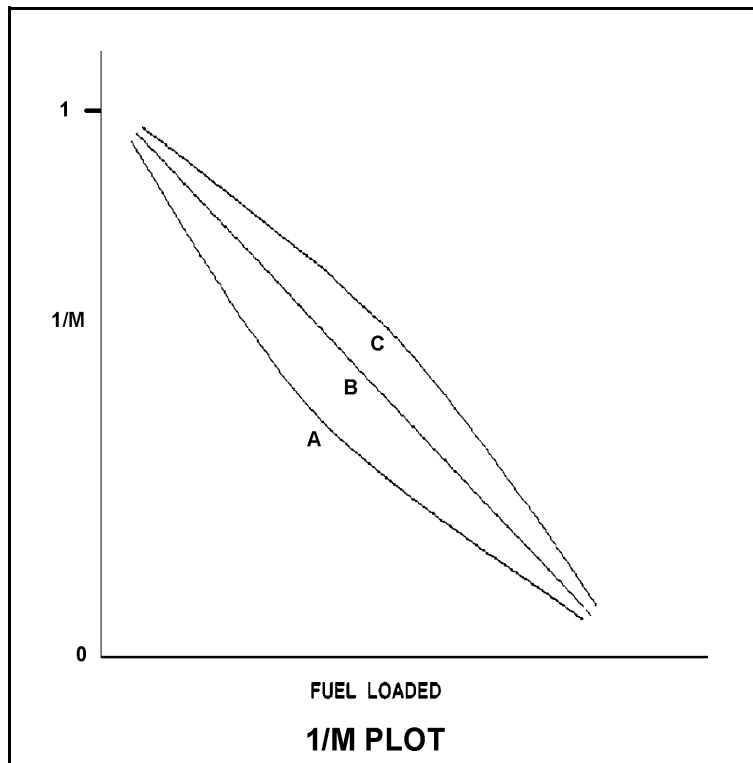
QUESTION: 66

A reactor is being started up with a stable positive 100-second period and power is entering the intermediate range (below the point of adding heat). Assuming no operator action, which one of the following describes the response of reactor period?

A. The heat produced by the reactor through all ranges of the intermediate range indication, is insufficient to raise the fuel or moderator temperatures, and reactor period remains constant throughout the intermediate range.

B. As heat production in the reactor exceeds ambient losses, the temperature of the fuel and moderator will increase, adding negative reactivity, and reactor period will approach infinity.

C. As heat production in the reactor exceeds ambient losses, positive reactivity added by the fuel temperature increase counteracts the negative reactivity added by the moderator temperature increase, and reactor period remains constant throughout the intermediate range.

D. Prior to reaching the point of adding heat, the fuel temperature increase will add negative reactivity and reactor period will approach infinity.

QUESTION: 67

During a reactor heat-up, a center control rod is notched outward with no subsequent operator action. The heat-up rate will:

A. increase initially, then gradually decrease.

B. decrease initially, then gradually increase.

C. increase and stabilize at a new higher value.

D. decrease and stabilize at a new lower value.

QUESTION: 68

During a reactor plant startup, reactor pressure is increased from 5 psig to 50 psig in a 2-hour period. What was the average heat-up rate?

A. 35°F/hr

B. 60°F/hr

C. 70°F/hr

D. 120°F/hr

QUESTION: 69

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

A. Decrease, because the rate of neutron absorption in the moderator initially increases.

B. Decrease, because the rate of neutron absorption at U-238 resonant energies initially increases.

C. Increase, because the rate of neutron absorption in the moderator initially decreases.

D. Increase, because the rate of neutron absorption at U-238 resonant energies initially decreases.

QUESTION: 70

A plant is operating normally at 50% power when a steam break occurs that releases 5% of rated steam flow. Assume no operator or protective actions occur, automatic pressure control returns reactor pressure to its initial value, and feed water injection temperature remains the same.

How will turbine power respond?

A. Decrease and stabilize at a lower power level

B. Increase and stabilize at a higher power level

C. Decrease, then increase and stabilize at the previous power level

D. Increase, then decrease and stabilize at the previous power level

QUESTION: 71

A reactor is exactly critical in the source range when a fully withdrawn control rod fully inserts into the core.

If no operator or automatic actions occur, how will source range count rate respond?

A. Decrease to zero.

B. Decrease to the value of the source neutron strength.

C. Decrease to a value above source neutron strength.

D. Decrease initially and then slowly increase and stabilize at the initial value.

QUESTION: 72

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

A. 1% to 2%

B. 3% to 5%

C. 6% to 8%

D. 9% to 11%

QUESTION: 73

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

QUESTION: 74

An open vessel contains one pound-mass of water at 206°F and atmospheric pressure. Which one of the following will be caused by the addition of 3 Btu to the water?

A. The water temperature will rise by 3°F.

B. 3% of the water mass will vaporize.

C. The water density will decrease by 3%.

D. The water will become superheated by 3°F.

QUESTION: 75

A steam line is carrying saturated steam vapor at 500 psia and 467°F. Approximately how much heat addition to the steam vapor is necessary to achieve 60°F of superheat?

A. 31 Btu/lbm

B. 45 Btu/lbm

C. 58 Btu/lbm

D. 71 Btu/lbm

QUESTION: 76

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

At which of the following locations is the <u>lowest</u> pressure experienced?

A. 1

B. 2

C. 3

D. 4

STEAM INLET

DISCHARGE

STEAM & AIR

AIR & STEAM

STEAM-JET AIR EJECTOR
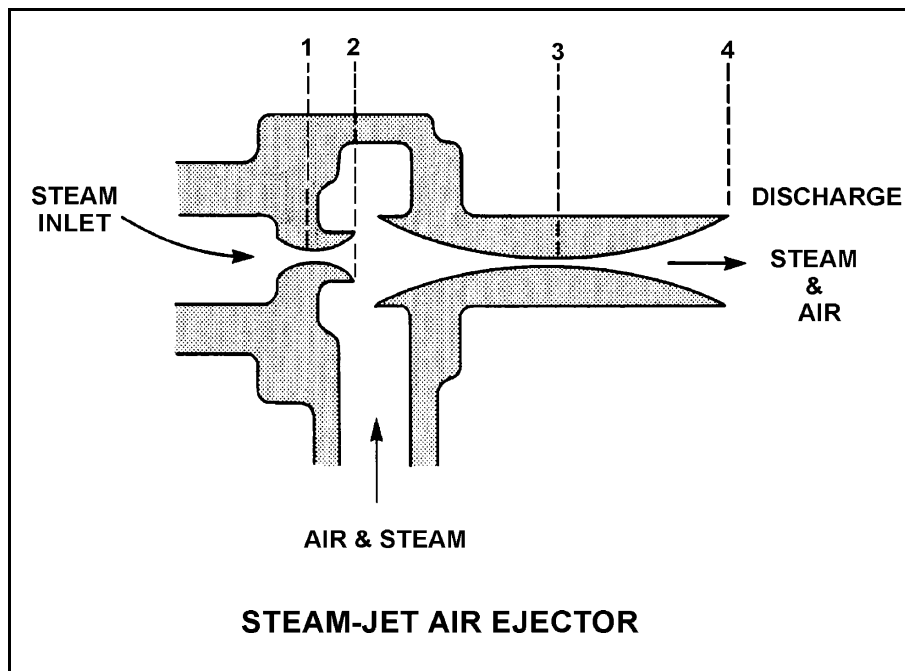
QUESTION: 77

Main condenser pressure is 1.0 psia. During the cooling process in the condenser, the temperature of the steam exiting the low pressure turbine decreases to 100°F, at which time it is a:

A. saturated liquid.

B. saturated vapor.

C. subcooled liquid.

D. superheated vapor.

QUESTION: 78

If the moisture content of the steam supplied to a turbine decreases, steam cycle efficiency will increase because the:

A. enthalpy of the steam being 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 blading has increased.

QUESTION: 79

Complete the following statement.

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.

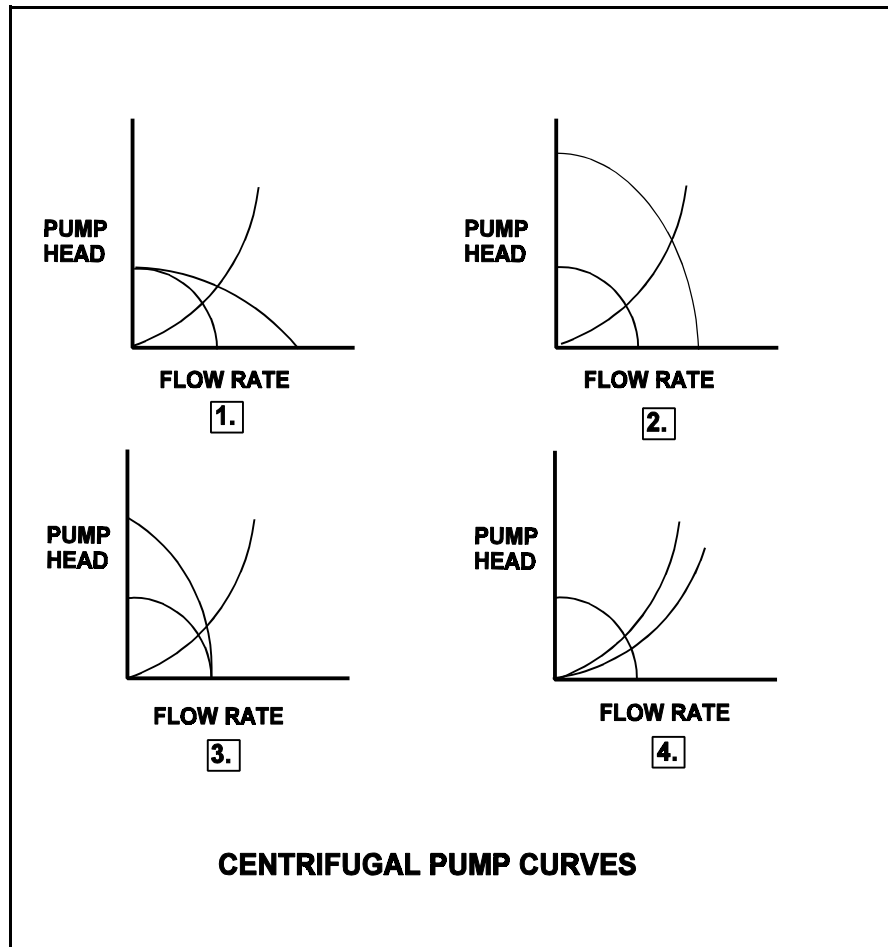QUESTION: 80

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

A two-speed centrifugal pump is operating in low speed in a cooling water system and discharging through a heat exchanger. The pump is then switched to high speed.

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

A. 1.

B. 2.

C. 3.

D. 4.

CENTRIFUGAL PUMP CURVES

QUESTION: 81

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. 26.5 gpm

B. 38.9 gpm

C. 56.4 gpm

D. 67.1 gpm

QUESTION: 82

Which one of the following actions will <u>decrease</u> plant efficiency?

A. Reducing turbine inlet steam moisture content

B. Reducing condensate depression

C. Increasing turbine exhaust pressure

D. Increasing temperature of feed-water entering the reactor vessel

QUESTION: 83

Which one of the following is the most accurate indication of mass flow rate through the reactor for calculating core thermal power during reactor power operation?

A. Core flow rate

B. Steam flow rate

C. The sum of both recirculation loop flow rates

D. The sum of feed water and control rod drive flow rates

QUESTION: 84

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

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

A. 587 MWt

B. 629 MWt

C. 671 MWt

D. 733 MWt

QUESTION: 85

Subcooled reactor coolant flows into the bottom of a fuel assembly coolant channel and exits the top of the channel as a saturated steam-water mixture with a 98% moisture content. How does the convective heat transfer coefficient in the coolant channel change as the coolant travels upward along the channel?

A. Increases only

B. Increases, then decreases

C. Decreases only

D. Decreases, then increases

QUESTION: 86

Which one of the following is indicated by a rapid increase in the fuel clad-to-coolant ΔT and a decrease in heat flux from the fuel?

A. Bulk boiling is occurring.

B. Departure from nucleate boiling has been reached.

C. Critical heat flux is increasing.

D. Nucleate boiling is occurring.

QUESTION: 87

Which one of the following will be the initial cause of fuel damage if a fuel rod exceeds the critical heat flux at 100% power?

A. Excessive fuel clad temperature

B. Excessive fuel pellet temperature

C. Excessive fuel rod internal pressure

D. Excessive fuel rod thermal stress

QUESTION: 88

Which one of the following is the quality of the steam leaving a cyclone separator at 985 psig and 1171 Btu/lb? (Answer should be rounded to the nearest whole number.)

A. 95%

B. 96%

C. 97%

D. 98%

QUESTION: 89

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

At 100% reactor power, the <u>greatest</u> temperature difference in a fuel channel radial temperature profile will occur across the:

A. fuel centerline to fuel surface.

B. fuel-to-clad gap.

C. zircaloy cladding.

D. flow channel boundary (laminar) layer.

FUEL ROD AND COOLANT FLOW CHANNEL
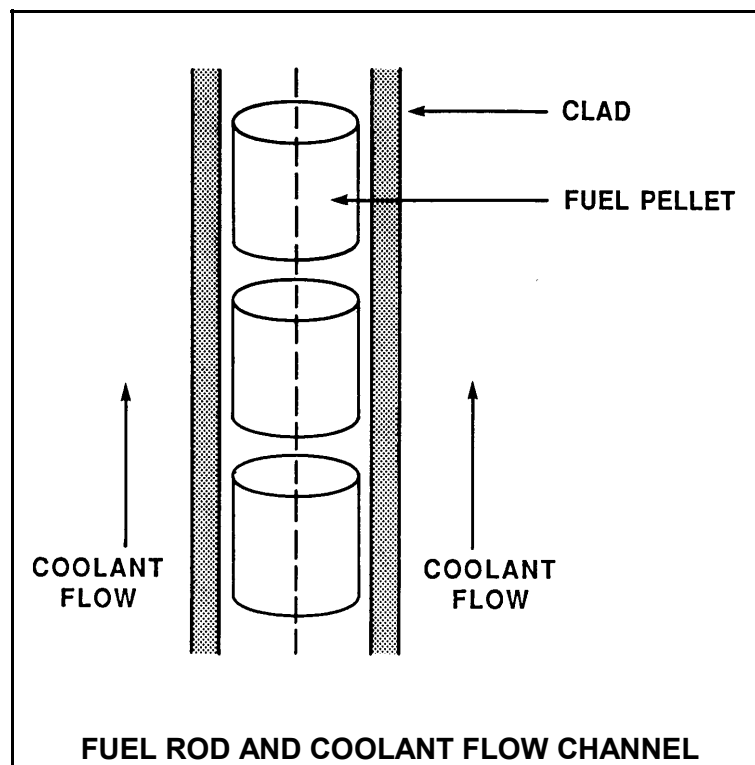
QUESTION: 90

A reactor is operating at 100% power. Recirculation flow is decreased from 100% to 80%. During the flow reduction, the boiling boundary will move _____ in the core because each pound-mass (lbm) of water flowing through the core is required to remove _____ heat from the fuel rods.

A. upward; less

B. upward; more

C. downward; less

D. downward; more

QUESTION: 91

A reactor is operating at 100% rated power with 100% of design core flow rate. Reactor power is decreased and stabilized at 75% using only control rods for reactivity control. Core flow rate is maintained at 100%.

During the power decrease, core bypass flow rate _____ because core pressure drop _____.

A. decreased; increased

B. decreased; decreased

C. increased; increased

D. increased; decreased

QUESTION: 92

Maintaining the linear heat generation rate below the thermal limit ensures that:

A. peak cladding temperature after the design basis loss of coolant accident will not exceed 2200°F.

B. during transients, more than 99.97% of the fuel rods will avoid transition boiling.

C. plastic strain (deformation) of the cladding will not exceed 1%.

D. peaking factors will not exceed those assumed in the safety analysis.

QUESTION::   93

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

The reactor is shut down at the beginning of a fuel cycle with the following average parameter values:

$T_{coolant}$ $= 440°F$
$T_{fuel\ centerline}$ $= 780°F$

If the total fuel-to-coolant thermal conductivity doubles over core life, what will the fuel centerline temperature be with the same coolant temperature and reactor decay heat conditions at the end of the fuel cycle?

A. 610°F

B. 580°F

C. 550°F

D. 520°F

FUEL ROD AND COOLANT FLOW CHANNEL
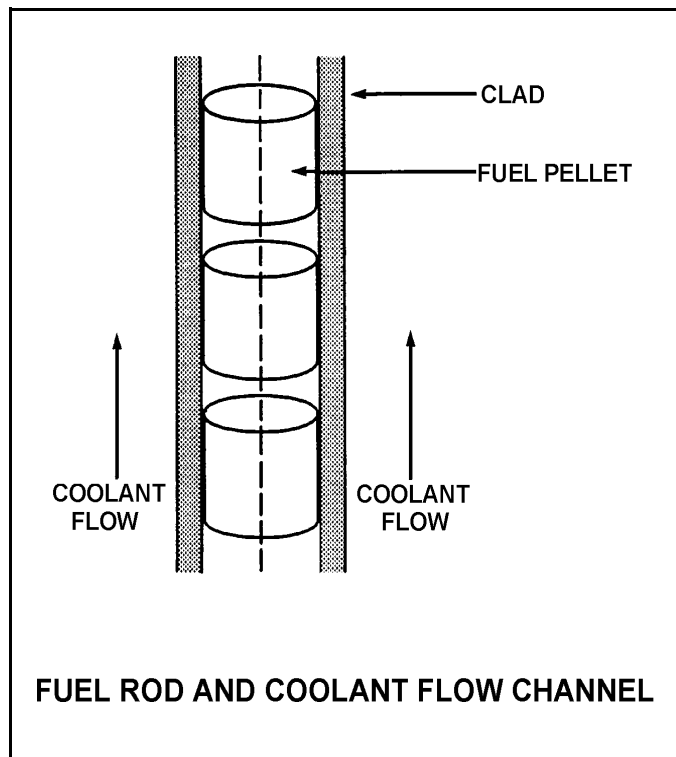
QUESTION: 94

In a reactor operating at full power, the fuel bundle with the <u>greatest</u> radial peaking factor always has the:

A. greatest power.

B. greatest critical power ratio.

C. smallest linear heat generation rate.

D. smallest maximum average planar linear heat generation rate.

QUESTION: 95

How is critical power affected when the axial power distribution in a fuel bundle shifts from bottom-peaked to top-peaked?

A. Critical power increases to a new, higher value.

B. Critical power increases temporarily, then returns to its initial value.

C. Critical power decreases to a new, lower value.

D. Critical power decreases temporarily, then returns to its initial value.

QUESTION: 96

A step increase in reactor power results in a fuel cladding surface temperature increase from 560°F to 590°F. 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. 579°F

B. 575°F

C. 570°F

D. 567°F

QUESTION: 97

Which one of the following is most likely to result in fuel failure due to pellet-clad interaction?

A. Increasing reactor power from 20% to 50% near the beginning of a fuel cycle

B. Increasing reactor power from 20% to 50% near the end of a fuel cycle

C. Increasing reactor power from 70% to 100% near the beginning of a fuel cycle

D. Increasing reactor power from 70% to 100% near the end of a fuel cycle

QUESTION: 98

If cold water is suddenly injected into the reactor vessel while operating at 50% power, critical power will _____ and bundle power will _____.

A. increase; decrease

B. increase; increase

C. decrease; decrease

D. decrease; increase

QUESTION: 99

Brittle fracture of low-carbon steel can only occur when the temperature of the steel is _____ the nil ductility temperature, and will normally occur when the applied stress is _____ the steel's yield strength (or yield stress).

A. greater than; greater than

B. greater than; less than

C. less than; greater than

D. less than; less than

QUESTION: 100

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

Which one of the following conclusions is warranted?

A. The test results are credible and the reactor vessel is <u>more</u> likely to experience brittle fracture now than after the last refueling.

B. The test results are credible and the reactor vessel is <u>less</u> likely to experience brittle fracture now than after the last refueling.

C. The test results are questionable because the specimen NDT temperature would <u>not</u> decrease during the described 18-month period of operation.

D. The test results are questionable because the specimen NDT temperature would decrease by <u>more</u> than 2°F during the described 18-month period of operation.

*** FINAL ANSWER KEY ***

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

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