TOPIC: 192003
KNOWLEDGE: K1.01 [2.7/2.8]
QID: P347 (B350)

Which one of the following statements is a characteristic of subcritical multiplication?

A. The subcritical neutron level is directly proportional to the neutron source strength.

B. Doubling the indicated count rate by reactivity additions will reduce the margin to criticality by approximately one quarter.

C. For equal reactivity additions, it takes less time for the new equilibrium source range count rate to be reached as K_{eff} approaches unity.

D. An incremental withdrawal of a given control rod will produce an equivalent equilibrium count rate increase, whether K_{eff} is 0.88 or 0.92.

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.01 [2.7/2.8]
QID: P448 (B1949)

A subcritical nuclear reactor has an initial source/startup range count rate of 150 cps with a shutdown reactivity of -2.0 %ΔK/K. How much positive reactivity must be added to establish a stable count rate of 300 cps?

A. 0.5 %ΔK/K

B. 1.0 %ΔK/K

C. 1.5 %ΔK/K

D. 2.0 %ΔK/K

ANSWER: B.

TOPIC: 192003
KNOWLEDGE: K1.01 [2.7/2.8]
QID: P848 (B2149)

A subcritical nuclear reactor has an initial K_{eff} of 0.8 with a stable source range count rate of 100 cps. If positive reactivity is added until K_{eff} equals 0.95, at what value will the source range count rate stabilize?

A. 150 cps

B. 200 cps

C. 300 cps

D. 400 cps

ANSWER: D.

TOPIC: 192003
KNOWLEDGE: K1.01 [2.7/2.8]
QID: P1348 (B1449)

A nuclear reactor is shutdown by 1.8 %ΔK/K. Positive reactivity is added which increases stable neutron count rate from 15 to 300 cps.

Assuming the reactor is still subcritical, what is the current value of K_{eff}?

A. 0.982

B. 0.990

C. 0.995

D. 0.999

ANSWER: D.

TOPIC: 192003
KNOWLEDGE: K1.01 [2.7/2.8]
QID: P1448 (B1849)

A subcritical nuclear reactor has an initial source/startup range count rate of 150 cps with a shutdown reactivity of -2.0 %ΔK/K. Approximately how much positive reactivity must be added to establish a stable count rate of 600 cps?

A. 0.5 %ΔK/K

B. 1.0 %ΔK/K

C. 1.5 %ΔK/K

D. 2.0 %ΔK/K

ANSWER: C.

TOPIC: 192003
KNOWLEDGE: K1.01 [2.7/2.8]
QID: P1748

A subcritical nuclear reactor has an initial source/startup range count rate of 60 cps with a shutdown reactivity of -2.0 %ΔK/K. How much positive reactivity must be added to establish a stable count rate of 300 cps?

A. 0.4 %ΔK/K

B. 0.6 %ΔK/K

C. 1.4 %ΔK/K

D. 1.6 %ΔK/K

ANSWER: D.

TOPIC: 192003
KNOWLEDGE: K1.01 [2.7/2.8]
QID: P1848 (B1170)

A nuclear power plant that has been operating at 100 percent power for two months experiences a reactor trip. Two months after the reactor trip, with all control rods still fully inserted, a stable count rate of 20 cps is indicated on the source/startup range nuclear instruments.

The majority of the source/startup range detector output is being caused by the interaction of ____________ with the detector.

A. intrinsic source neutrons

B. fission gammas from previous power operation

C. fission neutrons from subcritical multiplication

D. delayed fission neutrons from previous power operation

ANSWER: C.

TOPIC: 192003
KNOWLEDGE: K1.01 [2.7/2.8]
QID: P2248 (B2249)

Two nuclear reactors are currently shut down with a reactor startup in progress. The two reactors are identical except that reactor A has a source neutron strength of 100 neutrons per second and reactor B source neutron strength is 200 neutrons per second. Control rods are stationary and K_{eff} is 0.98 in both reactors. Core neutron level has reached equilibrium in both reactors.

Which one of the following lists the core neutron level (neutrons per second) in reactors A and B?

	Reactor A	Reactor B
A.	5,000	10,000
B.	10,000	20,000
C.	10,000	40,000
D.	20,000	40,000

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.01 [2.7/2.8]
QID: P2448 (B2649)

A nuclear 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 1,000 cps. No additional operator actions are taken.

Which one of the following describes the count rate 20 minutes after rod withdrawal is stopped?

A. 1,000 cps and constant.

B. Less than 1,000 cps and decreasing toward the prestartup count rate.

C. Less than 1,000 cps and stable above the prestartup count rate.

D. Greater than 1,000 cps and increasing toward criticality.

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.01 [2.7/2.8]
QID: P3048 (B3049)

A nuclear 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

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.01 [2.7/2.8]
QID: P3348

A xenon-free shutdown nuclear power plant is slowly cooling down due to an unisolable steam leak. The leak began when reactor coolant temperature was 400°F and the readings on all source range channels were 80 cps. Currently, reactor coolant temperature is 350°F and all source range channels indicate 160 cps.

Assume that the moderator temperature coefficient remains constant throughout the cooldown, and no operator action is taken. What will be the status of the reactor when reactor coolant temperature reaches 290°F?

A. Subcritical, with source range count rate below 320 cps.

B. Subcritical, with source range count rate above 320 cps.

C. Supercritical, with source range count rate below 320 cps.

D. Supercritical, with source range count rate above 320 cps.

ANSWER: D.

TOPIC: 192003
KNOWLEDGE: K1.01 [2.7/2.8]
QID: P3848 (B3849)

A nuclear reactor is shutdown with a K_{eff} of 0.8. The source range count rate is stable at 800 cps. What percentage of the core neutron population is being contributed directly by neutron sources other than neutron-induced fission?

A. 10 percent

B. 20 percent

C. 80 percent

D. 100 percent

ANSWER: B.

TOPIC: 192003
KNOWLEDGE: K1.01 [2.7/2.8]
QID: P3925 (B3925)

A nuclear reactor startup is in progress at a nuclear power plant with core K_{eff} equal to 0.90. By what factor will the core neutron level have increased when the reactor is stabilized with core K_{eff} equal to 0.99?

A. 10

B. 100

C. 1,000

D. 10,000

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.01 [2.7/2.8]
QID: P4225 (B4225)

A nuclear reactor is shutdown with a K_{eff} of 0.96 and a stable source range indication of 50 counts per second (cps) when a reactor startup is commenced. Which one of the following will be the stable source range indication when K_{eff} reaches 0.995?

A. 400 cps

B. 800 cps

C. 4,000 cps

D. 8,000 cps

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.01 [2.7/2.8]
QID: P4525 (B4525)

A nuclear power plant is being cooled down from 500°F to 190°F. Just prior to commencing the cooldown, the readings for all source range nuclear instruments were stable at 32 counts per second (cps). After two hours, with reactor coolant temperature at 350°F, the source range count rate is stable at 64 cps.

Assume that the moderator temperature coefficient remains constant throughout the cooldown, reactor power remains below the point of adding heat, and no reactor protection actions occur.

Without additional operator action, what will be the status of the reactor when reactor coolant temperature reaches 190°F?

A. Subcritical, with source range count rate below 150 cps

B. Subcritical, with source range count rate above 150 cps

C. Exactly critical

D. Supercritical

ANSWER: D.

TOPIC: 192003
KNOWLEDGE: K1.01 [2.7/2.8]
QID: P5025

A nuclear power plant is initially shutdown with an effective multiplication factor (K_{eff}) of 0.92 and a stable source range count rate of 200 cps. Then, a reactor startup is initiated. All control rod motion is stopped when K_{eff} equals 0.995. The instant that rod motion stops, source range count rate is 600 cps.

When source range count rate stabilizes, count rate will be approximately...

A. 600 cps

B. 650 cps

C. 1,800 cps

D. 3,200 cps

ANSWER: D.

TOPIC: 192003
KNOWLEDGE: K1.01 [2.7/2.8]
QID: P5225 (B5225)

A nuclear power plant was initially shutdown with a stable source range count rate of 30 cps. Using many small additions of positive reactivity, a total of 0.1 %ΔK/K was added to the core and stable source range count rate is currently 60 cps.

What was the stable source range count rate after 0.05 %ΔK/K was added to the core?

A. 40 cps

B. 45 cps

C. 50 cps

D. 55 cps

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.01 [2.7/2.8]
QID: P5625

A PWR nuclear power plant has been shut down for two weeks and has the following stable initial conditions:

Reactor coolant temperature:	550°F
Reactor coolant boron concentration:	800 ppm
Source range count rate:	32 cps

A reactor coolant boron dilution is commenced. After two hours, with reactor coolant boron concentration stable at 775 ppm, the source range count rate is stable at 48 cps.

Assume the boron differential reactivity worth remains constant throughout the dilution. Also assume that reactor coolant temperature remains constant, control rod position does not change, and no reactor protection actuations occur.

If the reactor coolant boron concentration is reduced further to750 ppm, what will be the status of the reactor?

A. Subcritical, with a stable source range count rate of approximately 64 cps.

B. Subcritical, with a stable source range count rate of approximately 96 cps.

C. Critical, with a stable source range count rate of approximately 64 cps.

D. Critical, with a stable source range count rate of approximately 96 cps.

ANSWER: B.

TOPIC: 192003
KNOWLEDGE: K1.05 [2.7/2.8]
QID: P548

Reactor power was increased from 10^{-9} percent to 10^{-6} percent in 6 minutes. The average startup rate was _________ decades per minute.

A. 0.5

B. 1.3

C. 2.0

D. 5.2

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.05 [2.7/2.8]
QID: P648

Reactor power increases from 1.0×10^{-8} percent to 5.0×10^{-7} percent in two minutes. What is the average startup rate?

A. 0.95 dpm

B. 0.90 dpm

C. 0.85 dpm

D. 0.82 dpm

ANSWER: C.

TOPIC: 192003
KNOWLEDGE: K1.05 [2.7/2.8]
QID: P2349

During a nuclear reactor startup, reactor power increases from 1.0 x 10^{-8} percent to 2.0 x 10^{-8} percent in 2 minutes with no operator action. Which one of the following is the average reactor period during the power increase?

A. 173 seconds

B. 235 seconds

C. 300 seconds

D. 399 seconds

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.05 [2.7/2.8]
QID: P2648

During a nuclear reactor startup, reactor power increases from 3×10^{-6} percent to 5×10^{-6} percent in 2 minutes with no operator action. Which one of the following was the average reactor period during the power increase?

A. 357 seconds

B. 235 seconds

C. 155 seconds

D. 61 seconds

ANSWER: B.

TOPIC: 192003
KNOWLEDGE: K1.06 [3.2/3.3]
QID: P47 (B451)

A small amount of positive reactivity is added to a critical reactor in the source range. The amount of reactivity added is much less than the core effective delayed neutron fraction.

Which one of the following will have a significant effect on the magnitude of the stable reactor period achieved for this reactivity addition while the reactor is in the source range?

A. Moderator temperature coefficient

B. Fuel temperature coefficient

C. Prompt neutron lifetime

D. Effective decay constant

ANSWER: D.

TOPIC: 192003
KNOWLEDGE: K1.06 [3.2/3.3]
QID: P126

A nuclear power plant is operating steady-state at 50 percent power at middle of core life. Which one of the following conditions will initially produce a positive startup rate?

A. Increase in turbine loading

B. Unintentional boration

C. Turbine runback

D. Closure of a letdown isolation valve

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.06 [3.2/3.3]
QID: P248

The magnitude of the stable startup rate achieved for a given positive reactivity addition to a critical nuclear reactor is dependent on the ________________ and ________________.

A. prompt neutron lifetime; axial flux distribution

B. prompt neutron lifetime; effective delayed neutron fraction

C. effective decay constant; effective delayed neutron fraction

D. effective decay constant; axial flux distribution

ANSWER: C.

TOPIC: 192003
KNOWLEDGE: K1.06 [3.2/3.3]
QID: P2748 (B2751)

A nuclear reactor is exactly critical at 1.0 x 10^{-8} percent power during a reactor startup. $\overline{\beta}_{eff}$ for this reactor is 0.0072. Which one of the following is the approximate amount of positive reactivity that must be added to the core by control rod withdrawal to initiate a reactor power increase toward the point of adding heat with a stable startup rate of 1.0 dpm?

A. 0.2 %ΔK/K

B. 0.5 %ΔK/K

C. 1.0 %ΔK/K

D. 2.0 %ΔK/K

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.06 [3.2/3.3]
QID: P3148 (B3151)

A nuclear 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 %ΔK/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. 20 seconds

B. 40 seconds

C. 60 seconds

D. 80 seconds

ANSWER: C.

TOPIC: 192003
KNOWLEDGE: K1.06 [3.2/3.3]
QID: P3548 (B3551)

Nuclear reactors A and B are identical except that the reactor cores are operating at different times in core life. The reactor A effective delayed neutron fraction is 0.007, and the reactor B effective delayed neutron fraction is 0.005. Both reactors are currently subcritical with neutron flux level stable in the source range.

Given:

Reactor A K_{eff} = 0.999
Reactor B K_{eff} = 0.998

If positive 0.003 ΔK/K is suddenly added to each reactor, how will the resulting stable reactor startup rates (SUR) compare? (Consider only the reactor response while power is below the point of adding heat.)

A. Reactor A stable SUR will be higher because it will have the higher positive reactivity in the core.

B. Reactor B stable SUR will be higher because it has the smaller effective delayed neutron fraction.

C. Reactors A and B will have the same stable SUR because both reactors will remain subcritical.

D. Reactors A and B will have the same stable SUR because both reactors received the same amount of positive reactivity.

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.06 [3.2/3.3]
QID: P6825 (B6825)

Given the following stable initial conditions for a nuclear reactor:

Power level: 1.0×10^{-8} percent
K_{eff} : 0.999
Core $\overline{\beta}_{eff}$: 0.006

What will the stable reactor period be following an addition of positive 0.15 %ΔK/K reactivity to the reactor? (Assume the stable reactor period occurs before the reactor reaches the point of adding heat.)

A. 30 seconds

B. 50 seconds

C. 80 seconds

D. 110 seconds

ANSWER: D.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P48 (B1950)

Over core life, plutonium isotopes are produced with delayed neutron fractions that are ______________ than uranium delayed neutron fractions, thereby causing reactor power transients to be ______________ near the end of core life.

A. larger; slower

B. larger; faster

C. smaller; slower

D. smaller; faster

ANSWER: D.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P129

When does the power decrease rate initially stabilize at negative one-third decade per minute following a reactor trip?

A. When decay gamma heating starts adding negative reactivity

B. When the long-lived delayed neutron precursors have decayed away

C. When the installed neutron source contribution to the total neutron flux becomes significant

D. When the short-lived delayed neutron precursors have decayed away

ANSWER: D.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P249

Delayed neutrons contribute more to nuclear reactor stability than prompt neutrons because they __________ the average neutron generation time and are born at a __________ kinetic energy.

A. increase; lower

B. increase; higher

C. decrease; lower

D. decrease; higher

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P348 (B2450)

Which one of the following statements describes the effect of changes in the core delayed neutron fraction from beginning of core life (BOL) to end of core life (EOL)?

A. A given set of plant parameters at EOL yields a greater shutdown margin (SDM) than at BOL.

B. A given set of plant parameters at EOL yields a smaller SDM than at BOL.

C. A given reactivity addition at EOL results in a higher startup rate (SUR) than it would at BOL.

D. A given reactivity addition at EOL results in a lower SUR than it would at BOL.

ANSWER: C.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P1149 (B2651)

Delayed neutrons are important for nuclear reactor control because...

A. they are produced with higher average kinetic energy than prompt neutrons.

B. they prevent the moderator temperature coefficient from becoming positive.

C. they are the largest fraction of the neutrons produced from fission.

D. they greatly extend the average neutron generation lifetime.

ANSWER: D.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P1248 (B1349)

Two nuclear reactors are identical except that reactor A is near the end of a fuel cycle and reactor B is near the beginning of a fuel cycle. Both reactors are operating at 100 percent power when a reactor trip occurs at the same time on each reactor.

If the reactor systems for each reactor respond identically to the trip and no operator action is taken, reactor A will attain a negative ________ second stable period and reactor B will attain a negative ________ second stable period. (Assume control rod worth equals -0.97 $\Delta K/K$ and λ_{eff} equals 0.0124 seconds^{-1} for both reactors.)

A. 80; 56

B. 80; 80

C. 56; 56

D. 56; 80

ANSWER: B.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P1548 (B1250)

Two nuclear reactors are identical except that reactor A is near the end of a fuel cycle and reactor B is near the beginning of a fuel cycle. Both reactors are critical at 1.0 x 10^{-5} percent power.

If the same amount of positive reactivity is added to each reactor at the same time, the point of adding heat will be reached first by reactor ______ because it has a ___________ delayed neutron fraction.

A. A; smaller

B. A; larger

C. B; smaller

D. B; larger

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P1649 (B1649)

Two nuclear reactors are identical in every way except that reactor A is near the end of core life and reactor B is near the beginning of core life. Both reactors are operating at 100 percent power when a reactor trip occurs at the same time on each reactor.

If the reactor systems for each reactor respond identically to the trip and no operator action is taken, a power level of 10^{-5} percent will be reached first by reactor _____ because it has a ____________ delayed neutron fraction.

A. A; larger

B. B; larger

C. A; smaller

D. B; smaller

ANSWER: C.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P1749 (B1751)

Which one of the following is the reason that delayed neutrons are so effective at controlling the rate of reactor power changes?

A. Delayed neutrons make up a large fraction of the fission neutrons in the core compared to prompt neutrons.

B. Delayed neutrons have a long mean lifetime compared to prompt neutrons.

C. Delayed neutrons produce a large amount of fast fission compared to prompt neutrons.

D. Delayed neutrons are born with high kinetic energy compared to prompt neutrons.

ANSWER: B.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P2249 (B2250)

Which one of the following distributions of fission percentages in a nuclear reactor will result in the largest reactor core effective delayed neutron fraction?

	U-235	U-238	Pu-239
A.	90%	7%	3%
B.	80%	6%	14%
C.	70%	7%	23%
D.	60%	6%	34%

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P2348 (B2349)

Which one of the following percentages of fission, by fuel, occurring in a nuclear reactor will result in the smallest reactor core effective delayed neutron fraction?

	U-235	U-238	Pu-239
A.	90%	7%	3%
B.	80%	6%	14%
C.	70%	7%	23%
D.	60%	6%	34%

ANSWER: D.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P2849 (B2850)

Two nuclear reactors are identical in every way except that reactor A is near the beginning of core life and reactor B is near the end of core life. Both reactors are critical at 10^{-5} percent power.

If the same amount of positive reactivity is added to each reactor at the same time, the point of adding heat will be reached first by reactor ______ because it has a ___________ delayed neutron fraction.

A. A; smaller

B. A; larger

C. B; smaller

D. B; larger

ANSWER: C.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P2948 (B2950)

A typical PWR nuclear power plant is operating at equilibrium 50 percent power when a control rod is ejected from the core. Which one of the following combinations of fission percentages, by fuel, would result in the highest reactor startup rate? (Assume the reactivity worth of the ejected control rod is the same for each case.)

	U-235	U-238	Pu-239
A.	60%	6%	34%
B.	70%	7%	23%
C.	80%	6%	14%
D.	90%	7%	3%

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P3248 (B3249)

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

Ten minutes after the trip, the higher fission rate will exist in reactor ______ because it has a ___________ delayed neutron fraction.

A. A; larger

B. B; larger

C. A; smaller

D. B; smaller

ANSWER: B.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P3648 (B3650)

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

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

A. A; larger

B. B; larger

C. A; smaller

D. B; smaller

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P3748 (B3749)

A step positive reactivity addition of 0.001 ΔK/K is made to a nuclear reactor with a stable neutron population and an initial core K_{eff} of 0.99. Consider the following two cases:

Case 1: The reactor is near the beginning of core life.
Case 2: The reactor is near the end of core life.

Assume the initial core neutron population is the same for each case. Which one of the following correctly compares the prompt jump in core neutron population and the final stable core neutron population for the two cases?

A. The prompt jump will be greater for case 1, but the final stable neutron population will be the same for both cases.

B. The prompt jump will be greater for case 2, but the final stable neutron population will be the same for both cases.

C. The prompt jump will be the same for both cases, but the final stable neutron population will be greater for case 1.

D. The prompt jump will be the same for both cases, but the final stable neutron population will be greater for case 2.

ANSWER: B.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P3849

A nuclear reactor is critical in the source range during the initial reactor startup immediately following a refueling outage. The core effective delayed neutron fraction is 0.0062. The operator adds positive reactivity to establish a stable 0.5 dpm startup rate.

If the reactor had been near the end of core life with a core effective delayed neutron fraction of 0.005, what would be the approximate stable startup rate after the addition of the same amount of positive reactivity?

A. 0.55 dpm

B. 0.65 dpm

C. 0.75 dpm

D. 0.85 dpm

ANSWER: B.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P4425 (B4425)

The following data is given for the fuel in an operating nuclear reactor core:

Nuclide	Delayed Neutron Fraction	Fraction of Total Fuel Composition	Fraction of Total Fission Rate
U-235	0.0065	0.03	0.73
U-238	0.0148	0.96	0.07
Pu-239	0.0021	0.01	0.20

What is the approximate core delayed neutron fraction for this reactor?

A. 0.0052

B. 0.0054

C. 0.0062

D. 0.0068

ANSWER: C.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P5425 (B5425)

The following data is given for the fuel in an operating nuclear reactor core:

Nuclide	Delayed Neutron Fraction	Fraction of Total Fuel Composition	Fraction of Total Fission Rate
U-235	0.0065	0.023	0.63
U-238	0.0148	0.965	0.07
Pu-239	0.0021	0.012	0.30

What is the core delayed neutron fraction for this reactor?

A. 0.0052

B. 0.0058

C. 0.0072

D. 0.0078

ANSWER: B.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P5525 (B5525)

Which characteristic of delayed neutrons is primarily responsible for enhancing the stability of a nuclear reactor following a reactivity change?

A. They are born at a lower average energy than prompt neutrons.

B. They are more likely to experience resonance absorption than prompt neutrons.

C. They comprise a smaller fraction of the total neutron flux than prompt neutrons.

D. They require more time to be produced following a fission event than prompt neutrons.

ANSWER: D.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P5725 (B5725)

For an operating nuclear reactor, the “effective” core delayed neutron fraction may differ from the core delayed neutron fraction because, compared to prompt neutrons, delayed neutrons...

A. are less likely to leak out of the reactor core, and they are less likely to cause fast fission.

B. are less likely to cause fast fission, and they require more time to complete a neutron generation.

C. require more time to complete a neutron generation, and they spend less time in the resonance absorption energy region.

D. spend less time in the resonance absorption energy region, and they are less likely to leak out of the reactor core.

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P5825 (B5825)

Given the following data for a nuclear reactor:

The core average delayed neutron fraction is 0.0068.
The core effective delayed neutron fraction is 0.0065.

The above data indicates that the reactor core is operating near the _________ of a fuel cycle and that a typical delayed neutron is _________ likely than a typical prompt neutron to cause another fission in the core described above.

A. beginning; less

B. beginning; more

C. end; less

D. end; more

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P5925 (B5925)

A reactor is initially critical below the point of adding heat (POAH) and remains below the POAH. Consider the following two cases:

Case 1: An operator adds positive 1.0×10^{-4} ΔK/K reactivity to the reactor.
Case 2: An operator adds negative 1.0×10^{-4} ΔK/K reactivity to the reactor.

The time required for reactor power to change by a factor of 10 will be greater in case ___ because delayed neutrons are more effective at slowing reactor power changes when reactor power is _________.

A. 1; increasing

B. 1; decreasing

C. 2; increasing

D. 2; decreasing

ANSWER: D.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P6225 (B6225)

Two identical reactors, A and B, are critical at 1.0 x 10^{-8} percent power near the beginning of a fuel cycle. Simultaneously, positive 0.001 $\Delta K/K$ is added to reactor A, and negative 0.001 $\Delta K/K$ is added to reactor B. One minute later, which reactor, if any, will have the shorter period and why?

A. Reactor A, because delayed neutrons are less effective at slowing down power changes when the fission rate is increasing.

B. Reactor B, because delayed neutrons are less effective at slowing down power changes when the fission rate is decreasing.

C. The periods in both reactors will be the same because their effective delayed neutron fractions are the same.

D. The periods in both reactors will be the same because the absolute values of the reactivity additions are the same.

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P6325 (B6325)

The following data applies to a nuclear reactor core just prior to a refueling shutdown.

Nuclide	Delayed Neutron Fraction	Fraction of Total Fission Rate
U-235	0.0065	0.64
U-238	0.0148	0.07
Pu-239	0.0021	0.29

During the refueling, one-third of the fuel assemblies were offloaded and replaced with new fuel assemblies consisting of uranium having an average U-235 enrichment of 3.5 percent by weight.

Which one of the following describes how the above data will change as a result of completing the refueling outage?

A. The delayed neutron fraction for U-235 will decrease.

B. The delayed neutron fraction for Pu-239 will decrease.

C. The fraction of the total fission rate attributed to U-235 will increase.

D. The fraction of the total fission rate attributed to Pu-239 will increase.

ANSWER: C.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P6525 (B6525)

Which one of the following is the major cause for the change in the core delayed neutron fraction from the beginning to the end of a fuel cycle?

A. Burnup of the burnable poisons.

B. Changes in the fuel composition.

C. Buildup of fission product poisons.

D. Shift in the core axial power distribution.

ANSWER: B.

TOPIC: 192003
KNOWLEDGE: K1.07 [3.0/3.0]
QID: P7025 (B7025)

Given the following data for the fuel in an operating nuclear reactor core:

Nuclide	Delayed Neutron Fraction	Cross section for thermal fission	Fraction of Total Fission Rate
U-235	0.0065	531 barns	0.58
U-238	0.0148	< 1 barn	0.06
Pu-239	0.0021	743 barns	0.32
Pu-241	0.0049	1009 barns	0.04

What is the core delayed neutron fraction for this reactor?

A. 0.0044

B. 0.0055

C. 0.0063

D. 0.0071

ANSWER: B.

TOPIC: 192003
KNOWLEDGE: K1.08 [2.8/2.9]
QID: P549 (B3351)

Which one of the following describes a condition in which a nuclear reactor is prompt critical?

A. A very long reactor period makes reactor control very sluggish and unresponsive.

B. The fission process is occurring so rapidly that the delayed neutron fraction approaches zero.

C. Any increase in reactor power requires a reactivity addition equal to the fraction of prompt neutrons in the core.

D. The net positive reactivity in the core is greater than or equal to the magnitude of the effective delayed neutron fraction.

ANSWER: D.

TOPIC: 192003
KNOWLEDGE: K1.08 [2.8/2.9]
QID: P748

A critical nuclear reactor will become prompt critical when reactivity is added equal in magnitude to the...

A. shutdown margin.

B. effective delayed neutron fraction.

C. effective decay constant.

D. worth of the most reactive rod.

ANSWER: B.

TOPIC: 192003
KNOWLEDGE: K1.08 [2.8/2.9]
QID: P949

A nuclear reactor is operating at 75 percent power with the following conditions:

Power defect	= -0.0157 Δ/K/K
Shutdown margin	= 0.0241 Δ/K/K
Effective delayed neutron fraction	= 0.0058
Effective prompt neutron fraction	= 0.9942

How much positive reactivity must be added to take the reactor "prompt critical"?

A. 0.0157 ΔK/K

B. 0.0241 ΔK/K

C. 0.0058 ΔK/K

D. 0.9942 ΔK/K

ANSWER: C.

TOPIC: 192003
KNOWLEDGE: K1.08 [2.8/2.9]
QID: P1449

A nuclear reactor is exactly critical several decades below the point of adding heat (POAH) with a xenon-free core. The operator continuously withdraws control rods until a positive 0.5 decades per minute (dpm) startup rate (SUR) is reached and then stops control rod motion.

When rod motion is stopped, SUR will immediately... (Neglect any reactivity effects of fission products.)

A. stabilize at 0.5 dpm until power reaches the POAH.

B. decrease, and then stabilize at a value less than 0.5 dpm until power reaches the POAH.

C. stabilize at 0.5 dpm, and then slowly and continuously decrease until power reaches the POAH.

D. decrease, and then continue to slowly decrease until power reaches the POAH.

ANSWER: B.

TOPIC: 192003
KNOWLEDGE: K1.08 [2.8/2.9]
QID: P1948 (B1150)

Positive reactivity is continuously added to a critical nuclear reactor. Which one of the following values of core K_{eff} will first result in a prompt critical reactor?

A. 1.0001

B. 1.001

C. 1.01

D. 1.1

ANSWER: C.

TOPIC: 192003
KNOWLEDGE: K1.08 [2.8/2.9]
QID: P2049

A nuclear reactor has a stable positive 1.0 dpm startup rate with no control rod motion several decades below the point of adding heat (POAH). The operator then inserts control rods until a positive 0.5 dpm startup rate is attained and then stops control rod motion.

When rod insertion is stopped, reactor startup rate will immediately...

A. stabilize at 0.5 dpm until power reaches the POAH.

B. increase, and then stabilize at a value greater than 0.5 dpm until power reaches the POAH.

C. stabilize, and then slowly and continuously decrease until startup rate is zero when power reaches the POAH.

D. increase, and then slowly and continuously decrease until startup rate is zero when power reaches the POAH.

ANSWER: B.

TOPIC: 192003
KNOWLEDGE: K1.08 [2.8/2.9]
QID: P2549 (B2550)

A nuclear reactor was stable at 80 percent power when the reactor operator withdrew control rods continuously for 2 seconds. Which one of the following affects the amount of “prompt jump” increase in reactor power for the control rod withdrawal?

A. The duration of control rod withdrawal.

B. The differential control rod worth.

C. The total control rod worth.

D. The magnitude of the fuel temperature coefficient.

ANSWER: B.

TOPIC: 192003
KNOWLEDGE: K1.08 [2.8/2.9]
QID: P2949 (B2951)

A nuclear reactor is operating at equilibrium 75 percent power with the following conditions:

Total power defect	= -0.0185 ΔK/K
Shutdown margin	= 0.0227 ΔK/K
Effective delayed neutron fraction	= 0.0061
Effective prompt neutron fraction	= 0.9939

How much positive reactivity must be added to make the reactor "prompt critical"?

A. 0.0061 ΔK/K

B. 0.0185 ΔK/K

C. 0.0227 ΔK/K

D. 0.9939 ΔK/K

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.08 [2.8/2.9]
QID: P3249 (B3250)

Refer to the unlabeled nuclear reactor response curve shown below for a reactor that was initially stable in the source range. Both axes have linear scales. A small amount of positive reactivity was added at time = 0 sec.

The response curve shows ___________ versus time for a reactor that was initially _________.

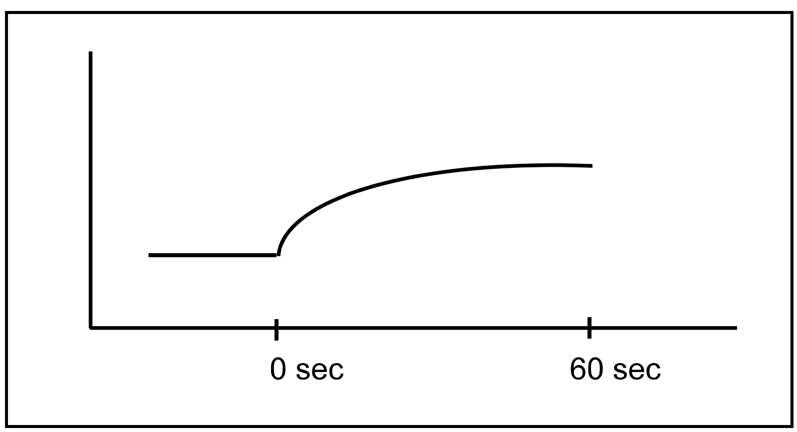
A. startup rate; subcritical

B. startup rate; critical

C. reactor fission rate; subcritical

D. reactor fission rate; critical

ANSWER: C.



TOPIC: 192003
KNOWLEDGE: K1.08 [2.8/2.9]
QID: P3449 (B3450)

Two nuclear reactors, A and B, are exactly critical low in the intermediate range (well below the point of adding heat). The reactors are identical except that reactor A is near the beginning of core life (BOL) and reactor B is near the end of core life (EOL). Assume that a step addition of positive reactivity (0.001 $\Delta K/K$) is added to each reactor. Select the combination below that completes the following statement.

The size of the prompt jump in core power observed for reactor B (EOL) will be ___________ than reactor A (BOL); and the stable startup rate observed for reactor B (EOL) will be ___________ than reactor A (BOL).

A. larger; larger

B. larger; smaller

C. smaller; larger

D. smaller; smaller

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.08 [2.8/2.9]
QID: P3649 (B3651)

Refer to the partially labeled nuclear reactor response curve shown below for a reactor that was initially subcritical in the source range and remained below the point of adding heat. A small amount of positive reactivity was added at time = 0 sec.

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

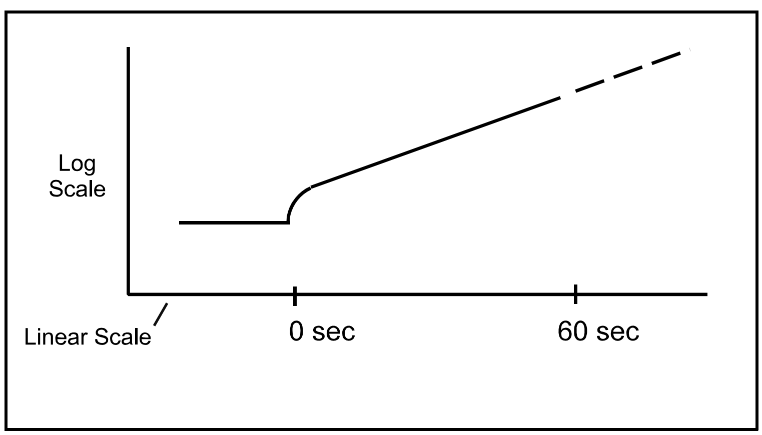
A. reactor period; exactly critical

B. reactor period; supercritical

C. reactor fission rate; exactly critical

D. reactor fission rate; supercritical

ANSWER: D.



TOPIC: 192003
KNOWLEDGE: K1.08 [2.8/2.9]
QID: P3749 (B3750)

A nuclear reactor is operating at equilibrium 75 percent power with the following conditions:

Total power defect	= -0.0176 $\Delta K/K$
Shutdown margin	= 0.0234 $\Delta K/K$
Effective delayed neutron fraction	= 0.0067
Effective prompt neutron fraction	= 0.9933

How much positive reactivity must be added to make the reactor "prompt critical"?

A. 0.0067 $\Delta K/K$

B. 0.0176 $\Delta K/K$

C. 0.0234 $\Delta K/K$

D. 0.9933 $\Delta K/K$

ANSWER: A.

TOPIC: 192003
KNOWLEDGE: K1.11 [2.7/2.8]
QID: P49

An installed neutron source...

A. maintains the production of neutrons high enough to allow the reactor to achieve criticality.

B. provides a means to allow reactivity changes to occur in a subcritical reactor.

C. generates a sufficient neutron population to start the fission process and initiate subcritical multiplication.

D. provides a neutron level that is detectable on the source range nuclear instrumentation.

ANSWER: D.

TOPIC: 192003
KNOWLEDGE: K1.11 [2.7/2.8]
QID: P349

Neutron sources are installed in the nuclear reactor core for which one of the following reasons?

A. To decrease the amount of fuel load required for criticality

B. To compensate for those neutrons absorbed in burnable poisons

C. To augment shutdown neutron population to allow detection on nuclear instrumentation

D. To provide enough neutrons in a shutdown reactor to start a chain reaction for reactor startup

ANSWER: C.

TOPIC: 192003
KNOWLEDGE: K1.11 [2.7/2.8]
QID: P1249

Which one of the following neutron reactions produces the largest contribution to the intrinsic source neutron level immediately following a reactor trip from extended power operations during the tenth fuel cycle? (Neglect any contribution from an installed neutron source.)

A. Alpha-neutron reactions

B. Beta-neutron reactions

C. Photo-neutron reactions

D. Spontaneous fission

ANSWER: C.

TOPIC: 192003
KNOWLEDGE: K1.11 [2.7/2.8]
QID: P1549 (B1549)

Which one of the following intrinsic/natural neutron sources undergoes the most significant source strength reduction during the 1-hour period immediately following a reactor trip from steady-state 100 percent power?

A. Spontaneous fission reactions

B. Photo-neutron reactions

C. Alpha-neutron reactions

D. Transuranic isotope decay

ANSWER: B.

TOPIC: 192003
KNOWLEDGE: K1.11 [2.7/2.8]
QID: P2149 (B2150)

Which one of the following is the intrinsic source that produces the greatest neutron flux for the first few days following a reactor trip from extended high power operations?

A. Spontaneous neutron emission from control rods.

B. Photo-neutron reactions in the moderator.

C. Spontaneous fission in the fuel.

D. Alpha-neutron reactions in the fuel.

ANSWER: B.

TOPIC: 192003
KNOWLEDGE: K1.11 [2.7/2.8]
QID: P3149 (B967)

Which one of the following describes the purpose of a neutron source that is installed in a nuclear reactor during refueling for the third fuel cycle?

A. Ensures shutdown neutron level is large enough to be detected by nuclear instrumentation.

B. Provides additional excess reactivity to increase the length of the fuel cycle.

C. Amplifies the electrical noise fluctuations observed in source/startup range instrumentation during shutdown.

D. Supplies the only shutdown source of neutrons available to begin a reactor startup.

ANSWER: A.