TOPIC: 292003
KNOWLEDGE: K1.01 [2.9/3.0]
QID: B124

A reactor startup is in progress. Which one of the following statements describes the reactor response to control rod withdrawal when taking the reactor critical?

A. The nuclear instrumentation will take longer to stabilize at each new subcritical power level.

B. The reactor will be critical when the period and power level remain constant, with no further rod withdrawal.

C. Each complete control rod withdrawal will result in the same amount of change in subcritical power level.

D. Each control rod withdrawal results in an initial negative period followed by a strong positive period.

ANSWER: A.

TOPIC: 292003
KNOWLEDGE: K1.01 [2.9/3.0]
QID: B130

Which one of the following statements describes subcritical multiplication during a reactor startup?

A. Subcritical multiplication is the process of using source neutrons to maintain an equilibrium neutron population when K_{eff} is less than 1.

B. As K_{eff} approaches unity, a smaller change in neutron level occurs for a given change in K_{eff}.

C. The equilibrium subcritical neutron level is dependent on the source strength and the time between successive reactivity insertions.

D. As K_{eff} approaches unity, less time is required to reach the equilibrium neutron level for a given change in K_{eff}.

ANSWER: A.

TOPIC: 292003
KNOWLEDGE: K1.01 [2.9/3.0]
QID: B176

A reactor is being taken critical by periodically withdrawing control rods in equal reactivity increments. The initial K_{eff} was 0.85. Which one of the following statements describes reactor conditions as K_{eff} approaches unity?

A. The neutron level change for successive incremental rod withdrawal becomes smaller.

B. A longer period of time is required to reach an equilibrium neutron level after each rod withdrawal.

C. Each rod withdrawal will result in the reactor becoming slightly supercritical due to a "prompt jump" and then returning to a subcritical condition.

D. If the rod withdrawal is stopped for several hours, the neutron level will decrease to the neutron source level.

ANSWER: B.

TOPIC: 292003
KNOWLEDGE: K1.01 [2.9/3.0]
QID: B349

Of the following conditions, which group is necessary for subcritical multiplication to occur?

A. Neutron source, moderator, and fissionable material

B. Moderator, fission product decay, and K_{eff} less than one

C. K_{eff} less than one, gamma source, and fissionable material

D. Fissionable material, gamma source, and K_{eff} greater than one

ANSWER: A.

TOPIC: 292003
KNOWLEDGE: K1.01 [2.9/3.0]
QID: B350 (P347)

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

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

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

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

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

ANSWER: A.

TOPIC: 292003
KNOWLEDGE: K1.01 [2.9/3.0]
QID: B449

A reactor startup is being performed with xenon-free conditions. Rod withdrawal is stopped just prior to criticality and neutron count rate is allowed to stabilize. No additional operator actions are taken.

During the next 30 minutes, count rate will...

A. remain essentially constant.

B. decrease and stabilize, due to long-lived delayed neutron precursors.

C. decrease to its prestartup level, due to the buildup of xenon-135.

D. increase to criticality, due to long-lived delayed neutron precursors.

ANSWER: A.

TOPIC: 292003
KNOWLEDGE: K1.01 [2.9/3.0]
QID: B967 (P3149)

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

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

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

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

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

ANSWER: A.

TOPIC: 292003
KNOWLEDGE: K1.01 [2.9/3.0]
QID: B1170 (P1848)

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

The majority of the source range 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: 292003
KNOWLEDGE: K1.01 [2.9/3.0]
QID: B1549 (P1549)

Which one of the following neutron sources undergoes the most significant source strength reduction during the hour immediately following a reactor scram 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: 292003
KNOWLEDGE: K1.01 [2.9/3.0]
QID: B2150 (P2149)

Which one of the following is the neutron source that produces the greatest neutron flux for the first few days following a reactor scram 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: 292003
KNOWLEDGE: K1.01 [2.9/3.0]
QID: B7687 (P7687)

The total neutron flux in a shutdown reactor is constant at 5.0 x 10^3 n/cm^2-sec. If non-fission neutron sources are supplying a constant flux of 1.0 x 10^2 n/cm^2-sec, what is K_{eff}?

A. 0.98

B. 0.96

C. 0.94

D. Cannot be determined without additional information.

ANSWER: A.

TOPIC: 292003
KNOWLEDGE: K1.04 [2.5/2.5]
QID: B48

Which one of the following defines the delayed neutron fraction?

A. The fraction of the total number of delayed neutrons produced from fission that are emitted from delayed neutron precursors.

B. The fraction of the total number of fast neutrons produced from fission that are emitted from delayed neutron precursors.

C. The fraction of the total number of neutrons produced from fission that are emitted from delayed neutron precursors.

D. The fraction of the total number of thermal neutrons produced from fission that are emitted from delayed neutron precursors.

ANSWER: C.

TOPIC: 292003
KNOWLEDGE: K1.04 [2.5/2.5]
QID: B351

Which one of the following describes how and why the core effective delayed neutron fraction varies over core life?

A. Increases, due to the burnup of U-238.

B. Decreases, due to the buildup of Pu-239.

C. Increases, due to the buildup of Pu-239.

D. Decreases, due to the burnup of U-238.

ANSWER: B.

TOPIC: 292003
KNOWLEDGE: K1.04 [2.5/2.5]
QID: B371

Which one of the following lists the two isotopes that produce the most power in a reactor operating at 100 percent power near the end of a fuel cycle?

A. U-235 and U-238

B. Pu-241 and U-238

C. Pu-239 and U-238

D. Pu-239 and U-235

ANSWER: D.

TOPIC: 292003
KNOWLEDGE: K1.04 [2.5/2.5]
QID: B850

The effective delayed neutron fraction ($\bar{\beta}_{eff}$) can be defined in fractional form as...

A. $\frac{\text{number of neutrons born delayed}}{\text{total number of neutrons born from fission}}$

B. $\frac{\text{number of neutrons born delayed}}{\text{number of neutrons born prompt}}$

C. $\frac{\text{number of fissions caused by delayed neutrons}}{\text{total number of fissions caused by fission neutrons}}$

D. $\frac{\text{number of fissions caused by delayed neutrons}}{\text{number of fissions caused by prompt neutrons}}$

ANSWER: C.

TOPIC: 292003
KNOWLEDGE: K1.04 [2.5/2.5]
QID: B1050

Compared to the core effective delayed neutron fraction (β_{eff}), the core delayed neutron fraction (β)...

A. changes due to fuel depletion, whereas β_{eff} will remain constant over core life.

B. is based on a finite-sized reactor, whereas β_{eff} is based on an infinite-sized reactor.

C. describes the fraction of fission neutrons born delayed, whereas β_{eff} describes the fraction of fissions caused by delayed neutrons.

D. considers only the decay constant of the longest lived delayed neutron precursors, whereas β_{eff} considers the weighted average of all the decay constants.

ANSWER: C.

TOPIC: 292003
KNOWLEDGE: K1.04 [2.5/2.5]
QID: B1172 (P2272)

A reactor is operating at 100 percent power near the end of a fuel cycle. The greatest contribution to core heat production is being provided by the fission of...

A. U-235 and U-238.

B. U-238 and Pu-239.

C. U-235 and Pu-239.

D. U-238 and Pu-241.

ANSWER: C.

TOPIC: 292003
KNOWLEDGE: K1.04 [2.5/2.5]
QID: B1251

The effective delayed neutron fraction (β_{eff}) takes into account two factors <u>not</u> considered in calculating the delayed neutron fraction (β). These factors consider that:

Delayed neutrons are __________ likely to cause fast fission than prompt neutrons; and
Delayed neutrons are __________ likely to leak from the core than prompt neutrons.

A. less; more

B. less; less

C. more; more

D. more; less

ANSWER: B.

TOPIC: 292003
KNOWLEDGE: K1.04 [2.5/2.5]
QID: B2250 (P2249)

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

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

ANSWER: A.

TOPIC: 292003
KNOWLEDGE: K1.04 [2.5/2.5]
QID: B2349 (P2348)

Which one of the following distributions of fission percentages occurring in a reactor will result in the smallest effective delayed neutron fraction?

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

ANSWER: D.

TOPIC: 292003
KNOWLEDGE: K1.04 [2.5/2.5]
QID: B2469

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 percent.

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

ANSWER: A.

TOPIC: 292003
KNOWLEDGE: K1.04 [2.5/2.5]
QID: B2950 (P2948)

A nuclear power plant is operating at steady-state 50 percent power when a control rod is ejected from the core. Which one of the following distributions of fission percentages in the core would result in the shortest reactor period? (Assume the reactivity worth of the ejected control rod is the same for each distribution.)

	U-235	U-238	Pu-239
A.	90%	8%	2%
B.	80%	7%	13%
C.	70%	7%	23%
D.	60%	8%	32%

ANSWER: D.

TOPIC: 292003
KNOWLEDGE: K1.04 [2.5/2.5]
QID: B4425 (P4425)

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

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

What is the delayed neutron fraction for this reactor?

A. 0.0052

B. 0.0054

C. 0.0062

D. 0.0068

ANSWER: C.

TOPIC: 292003
KNOWLEDGE: K1.04 [2.5/2.5]
QID: B5425 (P5425)

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

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

What is the delayed neutron fraction for this reactor?

A. 0.0052

B. 0.0058

C. 0.0072

D. 0.0078

ANSWER: B.

TOPIC: 292003
KNOWLEDGE: K1.04 [2.5/2.5]
QID: B5725 (P5725)

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

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

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

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

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

ANSWER: A.

TOPIC: 292003
KNOWLEDGE: K1.04 [2.5/2.5]
QID: B5825 (P5825)

Given the following data for a reactor:

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

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

A. beginning; less

B. beginning; more

C. end; less

D. end; more

ANSWER: A.

TOPIC: 292003
KNOWLEDGE: K1.04 [2.5/2.5]
QID: B6525 (P6525)

Which one of the following is the major cause for the change in the 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: 292003
KNOWLEDGE: K1.04 [2.5/2.5]
QID: B7025 (P7025)

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

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

What is the delayed neutron fraction for this reactor?

A. 0.0044

B. 0.0055

C. 0.0063

D. 0.0071

ANSWER: B.

TOPIC: 292003
KNOWLEDGE: K1.04 [2.5/2.5]
QID: B7325 (P7325)

A nuclear reactor is operating at steady-state 100 percent power in the middle of a fuel cycle. Which one of the following changes would cause the core effective delayed neutron fraction to increase?

A. The fast nonleakage factor increases.

B. The fast nonleakage factor decreases.

C. The thermal utilization factor increases.

D. The thermal utilization factor decreases.

ANSWER: B.

TOPIC: 292003
KNOWLEDGE: K1.04 [2.5/2.5]
QID: B7617 (P7617)

Given the following data for a reactor:

- The average delayed neutron fraction is 0.0052.
- The effective delayed neutron fraction is 0.0054.

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

A. beginning; less

B. beginning; more

C. end; less

D. end; more

ANSWER: D.

TOPIC: 292003
KNOWLEDGE: K1.05 [3.7/3.7]
K1.06 [3.7/3.7]
QID: B3551 (P3548)

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

Given:

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

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

A. Reactor A stable period will be shorter.

B. Reactor B stable period will be shorter.

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

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

ANSWER: A.

TOPIC: 292003
KNOWLEDGE: K1.06 [3.7/3.7]
QID: B250

Without delayed neutrons in the neutron cycle, when positive reactivity is added to a critical reactor, the reactor will...

A. experience a prompt jump in power level followed by a decrease to the initial power level.

B. experience a rapid but controllable power increase.

C. begin an uncontrollable rapid power increase.

D. not be able to attain criticality.

ANSWER: C.

TOPIC: 292003
KNOWLEDGE: K1.06 [3.7/3.7]
QID: B451 (P47)

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

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

A. Prompt neutron lifetime

B. Fuel temperature coefficient

C. Moderator temperature coefficient

D. Effective delayed neutron precursor decay constant

ANSWER: D.

TOPIC: 292003
KNOWLEDGE: K1.06 [3.7/3.7]
QID: B1250 (P1548)

Two reactors are identical except that reactor A is near the end of a fuel cycle and reactor B is near the beginning of a fuel cycle. Both reactors are critical at 1.0 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 __________ effective delayed neutron fraction.

A. A; smaller

B. A; larger

C. B; smaller

D. B; larger

ANSWER: A.

TOPIC: 292003
KNOWLEDGE: K1.06 [3.7/3.7]
QID: B1349 (P1248)

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

If no operator action is taken and the reactor systems for both reactors respond identically to the scram, reactor A will attain a negative __________ second stable period; and reactor B will attain a negative __________ second stable period.

A. 80; 56

B. 80; 80

C. 56; 56

D. 56; 80

ANSWER: B.

TOPIC: 292003
KNOWLEDGE: K1.06 [3.7/3.7]
QID: B1649 (P1649)

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

If no operator action is taken and the reactor systems for both reactors respond identically to the scram, a power level of 1.0 x 10^{-5} percent will be reached first by reactor __________ because it has the __________ effective delayed neutron fraction.

A. A; larger

B. B; larger

C. A; smaller

D. B; smaller

ANSWER: C.

TOPIC: 292003
KNOWLEDGE: K1.06 [3.7/3.7]
QID: B1751 (P1749)

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

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

B. Delayed neutrons have a long mean generation time compared to prompt neutrons.

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

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

ANSWER: B.

TOPIC: 292003
KNOWLEDGE: K1.06 [3.7/3.7]
QID: B1950 (P48)

During a fuel cycle, plutonium isotopes are produced with delayed neutron fractions that are __________ than the delayed neutron fractions for uranium isotopes, thereby causing reactor power transients to be __________ near the end of a fuel cycle.

A. larger; slower

B. larger; faster

C. smaller; slower

D. smaller; faster

ANSWER: D.

TOPIC: 292003
KNOWLEDGE: K1.06 [3.7/3.7]
QID: B2450 (P348)

Which one of the following statements describes the effect of changes in the delayed neutron fraction from the beginning of a fuel cycle (BOC) to the end of a fuel cycle (EOC)?

A. A given reactivity addition to a shutdown reactor at EOC yields a larger change in shutdown margin (SDM) than at BOC.

B. A given reactivity addition to a shutdown reactor at EOC yields a smaller change in SDM than at BOC.

C. A given reactivity addition to an operating reactor at EOC results in a longer reactor period than at BOC.

D. A given reactivity addition to an operating reactor at EOC results in a shorter reactor period than at BOC.

ANSWER: D.

TOPIC: 292003
KNOWLEDGE: K1.06 [3.7/3.7]
QID: B2651 (P1149)

Delayed neutrons are important for reactor control because...

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

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

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

D. they greatly extend the average lifetime of each neutron generation.

ANSWER: D.

TOPIC: 292003
KNOWLEDGE: K1.06 [3.7/3.7]
QID: B2850 (P2849)

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

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

A. A; smaller

B. A; larger

C. B; smaller

D. B; larger

ANSWER: C.

TOPIC: 292003
KNOWLEDGE: K1.06 [3.7/3.7]
QID: B3249 (P3248)

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

Ten minutes after the scram, the greater thermal neutron flux will exist in reactor __________ because it has a __________ effective delayed neutron fraction.

A. A; larger

B. B; larger

C. A; smaller

D. B; smaller

ANSWER: B.

TOPIC: 292003
KNOWLEDGE: K1.06 [3.7/3.7]
QID: B3650 (P3648)

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

Ten minutes after the scram, the greater thermal neutron flux will exist in reactor __________ because it has a __________ effective delayed neutron fraction.

A. A; larger

B. B; larger

C. A; smaller

D. B; smaller

ANSWER: A.

TOPIC: 292003
KNOWLEDGE: K1.06 [3.7/3.7]
QID: B3749 (P3748)

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

Case 1: The reactor is near the beginning of a fuel cycle.
Case 2: The reactor is near the end of a fuel cycle.

Assume the initial neutron flux is the same for each case.

Which one of the following correctly compares the prompt jump in neutron flux levels and the final stable neutron flux levels for the two cases?

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

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

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

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

ANSWER: B.

TOPIC: 292003
KNOWLEDGE: K1.06 [3.7/3.7]
QID: B5525 (P5525)

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

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

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

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

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

ANSWER: D.

TOPIC: 292003
KNOWLEDGE: K1.06 [3.7/3.7]
QID: B5925 (P5925)

A reactor is initially critical at a stable power level below the point of adding heat (POAH) and remains below the POAH for 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: 292003
KNOWLEDGE: K1.06 [3.7/3.7]
QID: B6225 (P6225)

Two identical reactors, A and B, are critical at 1.0×10^{-8} percent power near the beginning of a fuel cycle. Simultaneously, positive 0.001 ΔK/K is added to reactor A, and negative 0.001 ΔK/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: 292003
KNOWLEDGE: K1.06 [3.7/3.7]
QID: B6325 (P6325)

The following data is given for the fuel in an operating reactor just prior to a refueling shutdown.

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

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

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

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

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

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

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

ANSWER: C.

TOPIC: 292003
KNOWLEDGE: K1.06 [3.7/3.7]
QID: B7697 (P7697)

A reactor core has a delayed neutron importance factor of 1.02. If the average delayed neutron fraction in the core is 0.0057, the effective delayed neutron fraction is...

A. equal to 0.0057.

B. less than 0.0057.

C. greater than 0.0057.

D. unpredictable without additional information.

ANSWER: C.

TOPIC: 292003
KNOWLEDGE: K1.06 [3.7/3.7]
QID: B7707 (P7707)

Which one of the following is the primary reason that delayed neutrons are more effective than prompt neutrons at controlling the rate of reactor power changes?

A. Delayed neutrons have a longer mean generation time than prompt neutrons.

B. Delayed neutrons produce a larger amount of core fissions than prompt neutrons.

C. Delayed neutrons make up a larger fraction of fission neutrons than prompt neutrons.

D. Delayed neutrons are born with a lower average kinetic energy than prompt neutrons.

ANSWER: A.

TOPIC: 292003
KNOWLEDGE: K1.07 [3.3/3.3]
QID: B251

As a reactor core ages, the amount of positive reactivity required to make the reactor prompt critical will __________ because the effective delayed neutron fraction __________.

A. increase; decreases

B. decrease; increases

C. decrease; decreases

D. increase; increases

ANSWER: C.

TOPIC: 292003
KNOWLEDGE: K1.07 [3.3/3.3]
QID: B551

A reactor is operating at 50 percent power with the following conditions:

Power defect	=	-0.03 %ΔK/K
Shutdown margin	=	-0.05 %ΔK/K
Effective delayed neutron fraction	=	0.007
Effective prompt neutron fraction	=	0.993

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

A. 0.03 %ΔK/K

B. 0.05 %ΔK/K

C. 0.7 %ΔK/K

D. 0.993 %ΔK/K

ANSWER: C.

TOPIC: 292003
KNOWLEDGE: K1.07 [3.3/3.3]
QID: B664

A critical reactor will become prompt critical if positive reactivity is added equal to the effective...

A. delayed neutron decay constant.

B. delayed neutron fraction.

C. prompt neutron decay constant.

D. prompt neutron fraction.

ANSWER: B.

TOPIC: 292003
KNOWLEDGE: K1.07 [3.3/3.3]
QID: B950

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

Total control rod worth	=	-0.0753 ΔK/K
Shutdown margin	=	-0.0042 ΔK/K
Effective delayed neutron fraction	=	0.0058
Effective prompt neutron fraction	=	0.9942

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

A. 0.0042 ΔK/K

B. 0.0058 ΔK/K

C. 0.0753 ΔK/K

D. 0.9942 ΔK/K

ANSWER: B.

TOPIC: 292003
KNOWLEDGE: K1.07 [3.3/3.3]
QID: B1150 (P1948)

Positive reactivity is continuously added to a critical reactor. Which one of the following values of 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: 292003
KNOWLEDGE: K1.07 [3.3/3.3]
QID: B1850

A reactor is critical at 10^{-5} percent power with a xenon-free core. The operator continuously withdraws control rods until a 60-second reactor period is reached, and then stops control rod motion.

When rod withdrawal is stopped, reactor period will immediately...

A. stabilize at 60 seconds until power reaches the point of adding heat (POAH).

B. lengthen, and then stabilize at a value greater than 60 seconds until power reaches the POAH.

C. shorten, and then slowly and continuously lengthen until power reaches the POAH.

D. lengthen, and then slowly and continuously shorten until power reaches the POAH.

ANSWER: B.

TOPIC: 292003
KNOWLEDGE: K1.07 [3.3/3.3]
QID: B2051

A reactor with a xenon-free core is critical at the point of adding heat. Reactor vessel temperature is 175°F. The operator inserts control rods until a negative 100-second period is attained, and then stops control rod motion.

When rod motion is stopped, reactor period will immediately __________ until power approaches the equilibrium subcritical multiplication source range level, where it will approach __________.

A. stabilize at negative 100 seconds; infinity

B. stabilize at negative 100 seconds; zero

C. lengthen and then stabilize; infinity

D. lengthen and then stabilize; zero

ANSWER: C.

TOPIC: 292003
KNOWLEDGE: K1.07 [3.3/3.3]
QID: B2550 (P2549)

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

A. The total control rod worth

B. The differential control rod worth

C. The duration of control rod withdrawal

D. The magnitude of the fuel temperature coefficient

ANSWER: B.

TOPIC: 292003
KNOWLEDGE: K1.07 [3.3/3.3]
QID: B2951 (P2949)

A reactor is operating at steady-state 75 percent power with the following conditions:

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: 292003
KNOWLEDGE: K1.07 [3.3/3.3]
QID: B3250 (P3249)

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

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

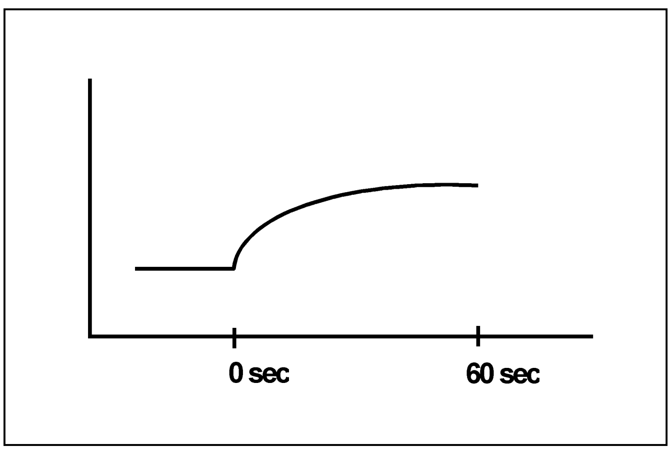
A. reactor period; subcritical

B. reactor period; critical

C. reactor fission rate; subcritical

D. reactor fission rate; critical

ANSWER: C.



TOPIC: 292003
KNOWLEDGE: K1.07 [3.3/3.3]
QID: B3351 (P549)

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

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

B. Fissions are occurring so rapidly that the effective delayed neutron fraction approaches zero.

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

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

ANSWER: D.

TOPIC: 292003
KNOWLEDGE: K1.07 [3.3/3.3]
QID: B3450 (P3449)

Two reactors are critical at the same power level well below the point of adding heat. The reactors are identical except that reactor A is near the beginning of a fuel cycle (BOC) and reactor B is near the end of a fuel cycle (EOC).

If a step addition of positive 0.001 $\Delta K/K$ is added to each reactor, the size of the prompt jump in power level observed in reactor B (EOC) will be __________ than in reactor A (BOC); and the stable reactor period observed in reactor B (EOC) will be __________ than in reactor A (BOC). (Assume the power level in each reactor remains below the point of adding heat.)

A. smaller; longer

B. smaller; shorter

C. larger; longer

D. larger; shorter

ANSWER: D.

TOPIC: 292003
KNOWLEDGE: K1.07 (3.3/3.3)
QID: B3651 (P3649)

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

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

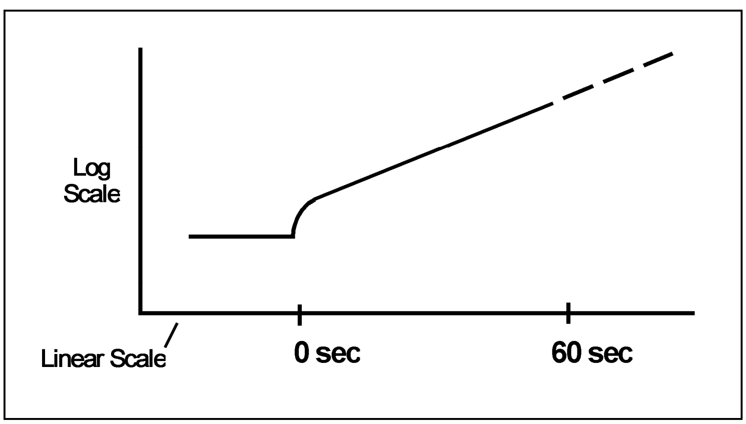
A. reactor period; exactly critical

B. reactor period; supercritical

C. reactor fission rate; exactly critical

D. reactor fission rate; supercritical

ANSWER: D.



TOPIC: 292003
KNOWLEDGE: K1.07 [3.3/3.3]
QID: B3750 (P3749)

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

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

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

A. 0.0067 ΔK/K

B. 0.0176 ΔK/K

C. 0.0234 ΔK/K

D. 0.9933 ΔK/K

ANSWER: A.

TOPIC: 292003
KNOWLEDGE: K1.08 [2.7/2.8]
QID: B49

A reactor is initially critical with a stable source range count rate of 100 cps. Sufficient positive reactivity is added to establish a 120-second period. How much time will it take for the count rate to increase to 10,000 cps with no additional operator action?

A. 1.2 minutes

B. 4.0 minutes

C. 9.2 minutes

D. 15.8 minutes

ANSWER: C.

TOPIC: 292003
KNOWLEDGE: K1.08 [2.7/2.8]
QID: B127

A reactor is operating at a very low power level when a control rod is fully inserted, resulting in a stable negative 80-second period. If the initial power level was 120 watts, what will the approximate reactor power level be two minutes after rod insertion stops?

A. 27 watts

B. 32 watts

C. 49 watts

D. 54 watts

ANSWER: A.

TOPIC: 292003
KNOWLEDGE: K1.08 [2.7/2.8]
QID: B249

During a reactor startup, the intermediate range monitor readings increased from 30 percent to 65 percent in 2 minutes. What was the average reactor period during the power increase?

A. 357 seconds

B. 173 seconds

C. 155 seconds

D. 120 seconds

ANSWER: C.

TOPIC: 292003
KNOWLEDGE: K1.08 [2.7/2.8]
QID: B851

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

A. negative 80 seconds.

B. positive 80 seconds.

C. negative 130 seconds.

D. positive 130 seconds.

ANSWER: C.

TOPIC: 292003
KNOWLEDGE: K1.08 [2.7/2.8]
QID: B1252

During a continuous rod withdrawal accident, reactor power increased from 387 MW to 553 MW in 10 seconds. What was the average reactor period for this power increase?

A. 3 seconds

B. 24 seconds

C. 28 seconds

D. 35 seconds

ANSWER: C.

TOPIC: 292003
KNOWLEDGE: K1.08 [2.7/2.8]
K1.05 [3.7/3.7]
QID: B1651

During a reactor startup, the intermediate range monitor readings increased from 30 percent to 50 percent in 2 minutes. What was the average reactor period during the power increase?

A. 357 seconds

B. 235 seconds

C. 155 seconds

D. 61 seconds

ANSWER: B.

TOPIC: 292003
KNOWLEDGE: K1.08 [2.7/2.8]
QID: B2351

During a reactor startup, the intermediate range monitor readings increased from 20 percent to 40 percent in 2 minutes. What was the average reactor period during the power increase?

A. 173 seconds

B. 235 seconds

C. 300 seconds

D. 399 seconds

ANSWER: A.

TOPIC: 292003
KNOWLEDGE: K1.08 [2.7/2.8]
QID: B2751 (P2748)

A reactor is critical at 1.0 x 10^{-8} percent power during a reactor startup. $\bar{\beta}_{eff}$ for this reactor is 0.0072. Which one of the following is the approximate amount of positive reactivity that must be added to the core by control rod withdrawal to attain a stable reactor period of 26 seconds?

A. 0.2 %ΔK/K

B. 0.5 %ΔK/K

C. 1.0 %ΔK/K

D. 2.0 %ΔK/K

ANSWER: A.

TOPIC: 292003
KNOWLEDGE: K1.08 [2.7/2.8]
QID: B3151 (P3148)

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

Once the reactor becomes critical, control rods are withdrawn to increase reactivity by 0.1 %ΔK/K. Assuming no other reactivity additions, what will the stable reactor period be for this reactor until the point of adding heat is reached?

A. 20 seconds

B. 40 seconds

C. 60 seconds

D. 80 seconds

ANSWER: C.

TOPIC: 292003
KNOWLEDGE: K1.08 [2.7/2.8]
QID: B3451 (P3467)

A reactor is critical well below the point of adding heat during a plant startup. A small amount of positive reactivity is then added to the core, and a stable positive reactor period is established.

With the stable positive reactor period, the following power levels are observed:

Time	Power Level
0 sec	3.16×10^{-7} percent
90 sec	1.0×10^{-5} percent

Which one of the following will be the reactor power level at time = 120 seconds?

A. 3.16×10^{-5} percent

B. 5.0×10^{-5} percent

C. 6.32×10^{-5} percent

D. 1.0×10^{-4} percent

ANSWER: A.

TOPIC: 292003
KNOWLEDGE: K1.08 [2.7/2.8]
QID: B3851

A reactor is critical in the source range during the initial reactor startup immediately following a refueling outage. The effective delayed neutron fraction is 0.007. The operator adds positive reactivity to establish a stable positive 60-second reactor period.

Later in core life, with an effective delayed neutron fraction of 0.005, what will be the approximate stable reactor period after an addition of the same amount of positive reactivity?

A. 28 seconds

B. 32 seconds

C. 36 seconds

D. 40 seconds

ANSWER: D.

TOPIC: 292003
KNOWLEDGE: K1.08 [2.7/2.8]
QID: B4625

During a reactor startup, source range count rate is observed to double every 30 seconds with <u>no</u> operator action. Which one of the following is the approximate reactor period?

A. 80 seconds

B. 67 seconds

C. 56 seconds

D. 43 seconds

ANSWER: D.

TOPIC: 292003
KNOWLEDGE: K1.08 [2.7/2.8]
QID: B5025

A reactor has a stable positive period of 140 seconds with core neutron level currently in the source range.

Given the following:

Initial reactor coolant temperature is 150°F.
Moderator temperature coefficient is -0.5×10^{-4} ΔK/K/°F.
Effective delayed neutron fraction is 0.006.

If the reactor coolant is allowed to heat up, at what approximate reactor coolant temperature will the reactor period reach infinity? (Ignore any reactivity effects from changes in fission product poisons and fuel temperature.)

A. 151°F

B. 158°F

C. 200°F

D. 230°F

ANSWER: B.

TOPIC: 292003
KNOWLEDGE: K1.08 [2.7/2.8]
QID: B6825 (P6825)

Given the following stable initial conditions for a reactor:

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

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

A. 30 seconds

B. 50 seconds

C. 80 seconds

D. 110 seconds

ANSWER: D.

TOPIC: 292003
KNOWLEDGE: K1.08 [2.7/2.8]
QID: B7125

Given the following stable initial conditions for a reactor:

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

What will the stable reactor period be following an addition of positive 0.2 %ΔK/K reactivity to the reactor? (Assume the stable reactor period occurs before the reactor reaches the point of adding heat.)

A. 20 seconds

B. 50 seconds

C. 80 seconds

D. 110 seconds

ANSWER: B.

TOPIC: 292003
KNOWLEDGE: K1.08 [2.7/2.8]
QID: B7607

A nuclear power plant has just completed a refueling outage and a reactor startup is in progress. Reactor engineers have determined that during the upcoming fuel cycle, $\bar{\beta}_{eff}$ will range from a minimum of 0.0052 to a maximum of 0.0064.

After the reactor becomes critical, control rods are withdrawn further to increase reactivity by an additional 0.1 %ΔK/K. Assuming no other reactivity changes occur, what will the stable reactor period be for this reactor until the point of adding heat is reached?

A. 26 seconds

B. 42 seconds

C. 54 seconds

D. 80 seconds

ANSWER: C.

TOPIC: 292003
KNOWLEDGE: K1.09 [2.5/2.6]
QID: B50

During a reactor startup, the reactor is critical at 3,000 cps. A control rod is then notched out, resulting in a stable doubling time of 85 seconds. How much time is required for the reactor to reach 888,000 cps?

A. 341 seconds

B. 483 seconds

C. 697 seconds

D. 965 seconds

ANSWER: C.

TOPIC: 292003
KNOWLEDGE: K1.09 [2.5/2.6]
QID: B352

If reactor power increases at a constant rate from 50 kW to 370 kW in 2 minutes, what is the approximate doubling time?

A. 42 seconds

B. 60 seconds

C. 86 seconds

D. 120 seconds

ANSWER: A.

TOPIC: 292003
KNOWLEDGE: K1.09 [2.5/2.6]
QID: B1451

During a startup, a reactor has a stable doubling time of 115.2 seconds. What is the approximate reactor period?

A. 56 seconds

B. 80 seconds

C. 126 seconds

D. 166 seconds

ANSWER: D.

TOPIC: 292003
KNOWLEDGE: K1.09 [2.5/2.6]
QID: B5125

A reactor is initially critical in the source range during a reactor startup when a control rod is notched inward. Reactor period stabilizes at -180 seconds. Assuming reactor period remains constant, how long will it take for source range count rate to decrease by one-half?

A. 90 seconds

B. 125 seconds

C. 180 seconds

D. 260 seconds

ANSWER: B.