TOPIC: 292002
KNOWLEDGE: K1.07 [3.5/3.5]
KNOWLEDGE: K1.08 [2.7/2.8]
QID: B186 (P44)

A nuclear reactor is initially subcritical with the effective multiplication factor (K_{eff}) equal to 0.998. After a brief withdrawal of control rods, K_{eff} equals 1.002. The reactor is currently...

A. prompt critical.

B. supercritical.

C. exactly critical.

D. subcritical.

ANSWER: B.

TOPIC: 292002
KNOWLEDGE: K1.07 [3.5/3.5]
QID: B247 (P445)

Which one of the following conditions describes a nuclear reactor that is exactly critical?

A. $K_{eff} = 0$; $\Delta K/K = 0$

B. $K_{eff} = 0$; $\Delta K/K = 1$

C. $K_{eff} = 1$; $\Delta K/K = 0$

D. $K_{eff} = 1$; $\Delta K/K = 1$

ANSWER: C.

TOPIC: 292002
KNOWLEDGE: K1.08 [2.7/2.8]
QID: B46

Which one of the following does not affect K_{eff} ?

A. core dimensions.

B. core burnup.

C. moderator-to-fuel ratio.

D. installed neutron sources.

ANSWER: D.

TOPIC: 292002
KNOWLEDGE: K1.08 [2.7/2.8]
QID: B348

Which one of the following, if decreased, will not affect K_{eff}?

A. Fuel enrichment

B. Control rod worth

C. Neutron contribution from neutron sources

D. Shutdown margin when the reactor is subcritical

ANSWER: C.

TOPIC: 292002
KNOWLEDGE: K1.08 [2.7/2.8]
QID: B847 (P1846)

The effective multiplication factor (K_{eff}) describes the ratio of the number of fission neutrons at the end of one generation to the number of fission neutrons at the __________ of the __________ generation.

A. beginning; next

B. beginning; previous

C. end; next

D. end; previous

ANSWER: D.

TOPIC: 292002
KNOWLEDGE: K1.08 [2.7/2.8]
QID: B1447 (P1346)

The effective multiplication factor (K_{eff}) can be determined by dividing the number of neutrons in the third generation by the number of neutrons in the ____________ generation.

A. first

B. second

C. third

D. fourth

ANSWER: B.

TOPIC: 292002
KNOWLEDGE: K1.08 [2.7/2.8]
QID: B2647 (P2647)

A thermal neutron is about to interact with a U-238 nucleus in an operating nuclear reactor core. Which one of the following describes the most likely interaction and the effect on core K_{eff}?

A. The neutron will be scattered, thereby leaving K_{eff} unchanged.

B. The neutron will be absorbed and U-238 will undergo fission, thereby decreasing K_{eff}.

C. The neutron will be absorbed and U-238 will undergo fission, thereby increasing K_{eff}.

D. The neutron will be absorbed and U-238 will undergo radioactive decay to Pu-239, thereby increasing K_{eff}.

ANSWER: A.

TOPIC: 292002
KNOWLEDGE: K1.08 [2.7/2.8]
QID: B3147 (P3046)

A nuclear power plant 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 inherent reactivity feedback will maintain K_{eff} at 1.0.

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

ANSWER: D.

TOPIC: 292002
KNOWLEDGE: K1.09 [2.4/2.6]
QID: B1147

Which one of the following combinations of core conditions at 30% power indicates the largest amount of excess reactivity exists in the core?

	CONTROL ROD POSITION	REACTOR RECIRCULATION FLOW
A.	25% rod density	25%
B.	50% rod density	50%
C.	25% rod density	50%
D.	50% rod density	25%

ANSWER: D.

TOPIC: 292002
KNOWLEDGE: K1.09 [2.4/2.6]
QID: B1247

Which one of the following combinations of core conditions at 35% power indicates the least amount of excess reactivity exists in the core?

	CONTROL ROD POSITION	REACTOR RECIRCULATION FLOW
A.	50% inserted	50%
B.	50% inserted	25%
C.	25% inserted	50%
D.	25% inserted	25%

ANSWER: C.

TOPIC: 292002
KNOWLEDGE: K1.09 [2.4/2.6]
QID: B1848 (P646)

Which one of the following defines K-excess?

A. $K_{eff} - 1$

B. $K_{eff} + 1$

C. $(K_{eff}-1)/K_{eff}$

D. $(1-K_{eff})/K_{eff}$

ANSWER: A.

TOPIC: 292002
KNOWLEDGE: K1.09 [2.4/2.6]
QID: B2048 (P1246)

Which one of the following is a reason for installing excess reactivity (K_{excess}) in a reactor core?

A. To compensate for burnout of Xe-135 and Sm-149 during power changes.

B. To ensure the fuel temperature coefficient remains negative throughout core life.

C. To compensate for the negative reactivity added by the power coefficient during a power increase.

D. To compensate for the conversion of U-238 to Pu-239 over core life.

ANSWER: C.

TOPIC: 292002
KNOWLEDGE: K1.09 [2.4/2.6]
QID: B2747 (P2847)

A nuclear reactor is operating at full power at the beginning of a fuel cycle. A neutron has just been absorbed by a U-238 nucleus at a resonance energy of 6.7 electron volts.

Which one of the following describes the most likely reaction for the newly formed U-239 nucleus and the effect of this reaction on K_{excess}?

A. Decays over several days to Pu-239, which increases K_{excess}.

B. Decays over several days to Pu-240, which increases K_{excess}.

C. Immediately undergoes fast fission, which decreases K_{excess}.

D. Immediately undergoes thermal fission, which decreases K_{excess}.

ANSWER: A.

TOPIC: 292002
KNOWLEDGE: K1.09 [2.4/2.6]
QID: B2947

The following are combinations of critical conditions that may exist for the same nuclear reactor operating at 50% power at different times in core life. Which one of the following combinations indicates the largest amount of excess reactivity present in the reactor fuel?

	CONTROL ROD POSITION	REACTOR RECIRCULATION FLOW
A.	25% rod density	75%
B.	50% rod density	50%
C.	25% rod density	50%
D.	50% rod density	75%

ANSWER: B.

TOPIC: 292002
KNOWLEDGE: K1.09 [2.4/2.6]
QID: B3447

The following are combinations of critical conditions that existed for the same nuclear reactor operating at 50% power at different times in core life. Which one of the following combinations indicates the smallest amount of excess reactivity present in the reactor fuel?

	CONTROL ROD POSITION	REACTOR RECIRCULATION FLOW
A.	25% rod density	75%
B.	50% rod density	50%
C.	25% rod density	50%
D.	50% rod density	75%

ANSWER: A.

TOPIC: 292002
KNOWLEDGE: K1.09 [2.4/2.6]
QID: B3547 (P3547)

Which one of the following is a benefit of installing excess reactivity (K_{excess}) in a nuclear reactor core?

A. Ensures that sufficient control rod negative reactivity is available to shut down the reactor.

B. Ensures that the reactor can be made critical during a peak xenon condition after a reactor scram.

C. Ensures that positive reactivity additions result in controllable reactor power responses.

D. Ensures that the U-235 fuel enrichment is the same at the beginning and the end of a fuel cycle..

ANSWER: B.

TOPIC: 292002
KNOWLEDGE: K1.10 [3.2/3.5]
QID: B248 (P245)

When determining the shutdown margin for an operating nuclear reactor, how many control rod assemblies are assumed to remain fully withdrawn?

A. A single control rod of the highest reactivity worth.

B. A symmetrical pair of control rods of the highest reactivity worth.

C. A single control rod of average reactivity worth.

D. A symmetrical pair of control rods of average reactivity worth.

ANSWER: A.

TOPIC: 292002
KNOWLEDGE: K1.10 [3.2/3.5]
QID: B1348

Shutdown margin for an operating nuclear reactor is the amount of reactivity by which a xenon-free reactor at 68°F would be subcritical if all control rods were...

A. withdrawn, assuming an average worth rod remains fully inserted.

B. inserted, assuming an average worth rod remains fully withdrawn.

C. withdrawn, assuming the highest worth rod remains fully inserted.

D. inserted, assuming the highest worth rod remains fully withdrawn.

ANSWER: D.

TOPIC: 292002
KNOWLEDGE: K1.11 [3.2/3.3]
QID: B47

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

A. beta.

B. lambda.

C. reactivity.

D. K-effective.

ANSWER: C.

TOPIC: 292002
KNOWLEDGE: K1.12 [2.4/2.5]
QID: B648 (P1946)

In a subcritical reactor, K_{eff} was increased from 0.85 to 0.95 by rod withdrawal. Which one of the following is the approximate amount of reactivity that was added to the core?

A. 0.099 ΔK/K

B. 0.124 ΔK/K

C. 0.176 ΔK/K

D. 0.229 ΔK/K

ANSWER: B.

TOPIC: 292002
KNOWLEDGE: K1.12 [2.4/2.5]
QID: B748 (P3347)

With K_{eff} equal to 0.983, how much positive reactivity must be added to make the reactor exactly critical? (Round answer to nearest 0.01% ΔK/K.)

A. 1.70% ΔK/K

B. 1.73% ΔK/K

C. 3.40% ΔK/K

D. 3.43% ΔK/K

ANSWER: B.

TOPIC: 292002
KNOWLEDGE: K1.12 [2.4/2.5]
QID: B1548 (P446)

With core K_{eff} equal to 0.987, how much reactivity must be added to make a reactor exactly critical? (Answer options are rounded to the nearest 0.01% ΔK/K.)

A. 1.01% ΔK/K

B. 1.03% ΔK/K

C. 1.30% ΔK/K

D. 1.32% ΔK/K

ANSWER: D.

TOPIC: 292002
KNOWLEDGE: K1.12 [2.4/2.5]
QID: B1947 (P2447)

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

A. 1.487% ΔK/K

B. 1.500% ΔK/K

C. 1.523% ΔK/K

D. 1.545% ΔK/K

ANSWER: C.

TOPIC: 292002
KNOWLEDGE: K1.12 [2.4/2.5]
QID: B2848 (P2146)

With K_{eff} = 0.982, how much positive reactivity is required to make the reactor critical?

A. 1.720% ΔK/K

B. 1.767% ΔK/K

C. 1.800% ΔK/K

D. 1.833% ΔK/K

ANSWER: D.

TOPIC: 292002
KNOWLEDGE: K1.14 [2.6/2.9]
QID: B548

The shutdown margin (SDM), upon full insertion of all control rods following a reactor scram from full power, is _________________ the SDM immediately prior to the scram.

A. equal to

B. less than

C. greater than

D. independent of

ANSWER: A.

TOPIC: 292002
KNOWLEDGE: K1.14 [2.6/2.9]
QID: B948

Which one of the following core changes will <u>decrease</u> shutdown margin?

A. Fuel depletion during reactor operation

B. Buildup of Sm-149 after a reactor scram

C. Increasing moderator temperature 10°F while shutdown

D. Depletion of gadolinium during reactor operation

ANSWER: D.

TOPIC: 292002
KNOWLEDGE: K1.14 [2.6/2.9]
QID: B1048

One hour ago, a nuclear reactor scrammed from 100% steady state power due to an instrument malfunction. All systems operated normally. Given the following absolute values of reactivities added since the scram, assign a (+) or (-) as appropriate and choose the current value of core reactivity.

Xenon	= ( ) 1.0% ΔK/K
Fuel temperature	= ( ) 2.0% ΔK/K
Control rods	= ( ) 14.0% ΔK/K
Voids	= ( ) 3.0% ΔK/K

A. -8.0% ΔK/K

B. -10.0% ΔK/K

C. -14.0% ΔK/K

D. -20.0% ΔK/K

ANSWER: B.

TOPIC: 292002
KNOWLEDGE: K1.14 [2.6/2.9]
QID: B1248

Which one of the following will increase the reactivity margin to criticality for a subcritical nuclear reactor operating at 250°F in the middle of a fuel cycle?

A. Decay of Samarium-149

B. Increased core recirculation flow rate

C. Reactor coolant heatup

D. Control rod withdrawal

ANSWER: C.

TOPIC: 292002
KNOWLEDGE: K1.14 [2.6/2.9]
QID: B1648

A nuclear reactor scrammed from 100% steady state power due to an instrument malfunction 16 hours ago. All systems operated normally.

Given the following absolute values of reactivities added since the scram, assign a (+) or (-) as appropriate and choose the current value of core reactivity.

Xenon	= ( ) 1.5% ΔK/K
Fuel temperature	= ( ) 2.5% ΔK/K
Control rods	= ( ) 14.0% ΔK/K
Voids	= ( ) 3.5% ΔK/K

A. -6.5% ΔK/K

B. -9.5% ΔK/K

C. -11.5% ΔK/K

D. -13.5% ΔK/K

ANSWER: B.

TOPIC: 292002
KNOWLEDGE: K1.14 [2.6/2.9]
QID: B1748

Twelve hours ago, a nuclear reactor scrammed from 100% steady state power due to an instrument malfunction. All systems operated normally. Given the following absolute values of reactivities added since the scram, assign a (+) or (-) as appropriate and choose the current value of core reactivity.

Xenon	= ( ) 2.0% ΔK/K
Fuel temperature	= ( ) 2.5% ΔK/K
Control rods	= ( ) 14.0% ΔK/K
Voids	= ( ) 4.5% ΔK/K

A. -5.0% ΔK/K

B. -9.0% ΔK/K

C. -14.0% ΔK/K

D. -23.0% ΔK/K

ANSWER: B.

TOPIC: 292002
KNOWLEDGE: K1.14 [2.6/2.9]
QID: B2148

A reactor scram from 100% steady-state power occurred 36 hours ago due to an instrument malfunction. All systems operated normally.

Given the following absolute values of reactivities added since the scram, assign a (+) or (-) as appropriate and choose the current value of core reactivity.

Xenon	= ( ) 1.0% ΔK/K
Fuel temperature	= ( ) 2.0% ΔK/K
Control rods	= ( ) 14.0% ΔK/K
Voids	= ( ) 3.0% ΔK/K

A. -8.0% ΔK/K

B. -10.0% ΔK/K

C. -14.0% ΔK/K

D. -20.0% ΔK/K

ANSWER: A.

TOPIC: 292002
KNOWLEDGE: K1.14 [2.6/2.9]
QID: B2248

Sixteen hours ago, a nuclear reactor scrammed from 100% steady state power due to an instrument malfunction. All systems operated normally. Given the following absolute values of reactivities added since the scram, assign a (+) or (-) as appropriate and choose the current value of core reactivity.

Xenon	= ( ) 2.0% ΔK/K
Fuel temperature	= ( ) 3.0% ΔK/K
Control rods	= ( ) 12.0% ΔK/K
Voids	= ( ) 4.0% ΔK/K

A. -5.0% ΔK/K

B. -7.0% ΔK/K

C. -9.0% ΔK/K

D. -11.0% ΔK/K

ANSWER: B.

TOPIC: 292002
KNOWLEDGE: K1.14 [2.6/2.9]
QID: B2348 (P2347)

Which one of the following core changes will <u>decrease</u> shutdown margin in a nuclear reactor core? Assume no operator actions.

A. Depletion of fuel during reactor operation

B. Depletion of burnable poisons during reactor operation

C. Buildup of Sm-149 following a reactor power transient

D. Buildup of Xe-135 following a reactor power transient

ANSWER: B.

TOPIC: 292002
KNOWLEDGE: K1.14 [2.6/2.9]
QID: B2448

A nuclear reactor scrammed from 100% steady state power due to an instrument malfunction 30 hours ago. All systems operated normally.

Given the following absolute values of reactivities added since the scram, assign a (+) or (-) as appropriate and choose the current value of core reactivity.

Xenon	= ( ) 1.5% ΔK/K
Fuel temperature	= ( ) 2.5% ΔK/K
Control rods	= ( ) 14.0% ΔK/K
Voids	= ( ) 3.5% ΔK/K

A. -6.5% ΔK/K

B. -9.5% ΔK/K

C. -11.5% ΔK/K

D. -13.5% ΔK/K

ANSWER: A.

TOPIC: 292002
KNOWLEDGE: K1.14 [2.6/2.9]
QID: B3648 (P3647)

A nuclear reactor is initially operating at steady-state 60% power near the end of core life when a fully withdrawn control rod suddenly inserts completely into the core. No operator action is taken and the plant control systems stabilize the reactor at a power level in the power range.

Compared to the initial shutdown margin (SDM), the new steady-state SDM is ___________; compared to the initial 60% power core K_{eff}, the new steady-state core K_{eff} is ___________.

A. the same; smaller

B. the same; the same

C. less negative; smaller

D. less negative; the same

ANSWER: B.

TOPIC: 292002
KNOWLEDGE: K1.14 [2.6/2.9]
QID: B3748 (P3747)

A nuclear power plant has just completed a refueling outage. Reactor engineers have predicted a control rod configuration at which the reactor will become critical during the initial reactor startup following the refueling outage based on the expected core loading. However, the burnable poisons scheduled to be loaded were inadvertently omitted.

Which one of the following describes the effect of the burnable poison omission on achieving reactor criticality during the initial reactor startup following the refueling outage?

A. The reactor will become critical before the predicted critical control rod configuration is achieved.

B. The reactor will become critical after the predicted critical control rod configuration is achieved.

C. The reactor will be unable to achieve criticality because the fuel assemblies contain insufficient positive reactivity to make the reactor critical.

D. The reactor will be unable to achieve criticality because the control rods contain insufficient positive reactivity to make the reactor critical.

ANSWER: A.

TOPIC: 292002
KNOWLEDGE: K1.14 [2.6/2.9]
QID: B4924

Nuclear reactors A and B are identical except that reactor A is operating near the beginning of a fuel cycle (BOC) and reactor B is operating near the end of a fuel cycle (EOC). Both reactors are operating at 100% thermal power.

Which reactor would have the lower K_{eff} five minutes after a reactor scram?

A. Reactor A, because the control rods will add more negative reactivity near the BOC.

B. Reactor A, because the power coefficient is more negative near the BOC.

C. Reactor B, because the control rods will add more negative reactivity near the EOC.

D. Reactor B, because the power coefficient is more negative near the EOC.

ANSWER: C.

TOPIC: 292002
KNOWLEDGE: K1.14 [2.6/2.9]
QID: B5224

A nuclear reactor was initially operating at steady state 100% power when it was shut down and cooled down to 200 °F over a three-day period.

Given the following absolute values of reactivities added during the shutdown and cooldown, assign a (+) or (−) as appropriate and choose the current value of core reactivity.

Control rods	= ( )12.50% ΔK/K
Voids	= ( ) 3.50% ΔK/K
Xenon	= ( ) 2.50% ΔK/K
Fuel temperature	= ( ) 2.00% ΔK/K
Moderator temperature	= ( ) 0.50% ΔK/K

A. -3.0% ΔK/K

B. -4.0% ΔK/K

C. -8.0% ΔK/K

D. -9.0% ΔK/K

ANSWER: B.