TOPIC: 293009
KNOWLEDGE: K1.01 [2.1/2.5]
QID: B1092

In a reactor operating at full power, the fuel bundle with the highest power always has the...

A. greatest critical power ratio.

B. greatest radial peaking factor.

C. smallest linear heat generation rate.

D. smallest maximum average planar linear heat generation rate.

ANSWER: B.

TOPIC: 293009
KNOWLEDGE: K1.01 [2.1/2.5]
QID: B1592

The radial peaking factor for a fuel bundle is expressed mathematically as...

A. $\dfrac{\text{core average bundle power}}{\text{individual bundle power}}$

B. $\dfrac{\text{peak nodal power}}{\text{core average nodal power}}$

C. $\dfrac{\text{core average nodal power}}{\text{peak nodal power}}$

D. $\dfrac{\text{individual bundle power}}{\text{core average bundle power}}$

ANSWER: D.

TOPIC: 293009
KNOWLEDGE: K1.01 [2.1/2.5]
QID: B2392

In a reactor operating at full power, the fuel bundle with the lowest power always has the smallest...

A. critical power ratio.

B. radial peaking factor.

C. axial peaking factor.

D. critical heat flux.

ANSWER: B.

TOPIC: 293009
KNOWLEDGE: K1.01 [2.1/2.5]
K1.02 [2.2/2.6]
QID: B2592

A reactor is operating at steady-state 80 percent power near the beginning of a fuel cycle with core power distribution peaked radially in the center of the core and axially in the bottom half of the core. Only reactor recirculation flow rate adjustments will be used to maintain constant reactor power over the next two months.

Neglecting any change in reactor poison distribution, during the next two months the maximum radial peaking factor will __________; and the maximum axial peaking factor will __________.

A. increase; decrease

B. increase; increase

C. decrease; decrease

D. decrease; increase

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.01 [2.1/2.5]
QID: B2892

In a reactor operating at full power, the fuel bundle with the greatest radial peaking factor always has the...

A. greatest power.

B. greatest critical power ratio.

C. smallest axial peaking factor.

D. smallest linear heat generation rate.

ANSWER: A.

TOPIC: 293009
KNOWLEDGE: K1.01 [2.1/2.5]
K1.02 [2.2/2.6]
QID: B2992

A reactor is initially operating at steady-state 40 percent power with power distribution peaked both radially and axially in the center of the core. Reactor power is then increased to 70 percent over the next two hours using only reactor recirculation flow rate adjustments for reactivity control. Neglect any effect from changes in reactor poisons.

During the power increase, the location of the maximum core radial peaking factor will __________ of the core; and the location of the maximum core axial peaking factor will __________ of the core.

A. shift to the periphery; move toward the bottom

B. shift to the periphery; move toward the top

C. remain near the center; move toward the bottom

D. remain near the center; move toward the top

ANSWER: D.

TOPIC: 293009
KNOWLEDGE: K1.01 [2.1/2.5]
QID: B3492

A reactor is initially operating at steady-state 80 percent power with the radial power distribution peaked in the center of the core. Reactor power is then decreased to 60 percent over the next two hours by (1) reducing reactor recirculation flow rate by 10 percent, and (2) partially inserting a group of centrally-located deep control rods.

Compared with the initial operation at 80 percent power, when power is stabilized at 60 percent the value of the core maximum radial peaking factor will be __________; and the primary contributor to the change in the value of the core maximum radial peaking factor will be the change in __________.

A. smaller; recirculation flow rate

B. smaller; control rod position

C. larger; recirculation flow rate

D. larger; control rod position

ANSWER: B.

TOPIC: 293009
KNOWLEDGE: K1.02 [2.2/2.6]
QID: B892

The axial peaking factor for a node of a fuel bundle is expressed mathematically as...

A. $\frac{\text{core average bundle power}}{\text{peak nodal power}}$

B. $\frac{\text{peak nodal power}}{\text{core average bundle power}}$

C. $\frac{\text{bundle average nodal power}}{\text{nodal power}}$

D. $\frac{\text{nodal power}}{\text{bundle average nodal power}}$

ANSWER: D.

TOPIC: 293009
KNOWLEDGE: K1.03 [2.1/2.5]
QID: B1492

The ratio of the highest pin heat flux in a node to the average pin heat flux in the same node is called the __________ peaking factor.

A. local

B. radial

C. axial

D. total

ANSWER: A.

TOPIC: 293009
KNOWLEDGE: K1.04 [2.2/2.6]
QID: B3294

A BWR core consists of 30,000 fuel rods; each fuel rod has an active length of 12 feet. The core is producing 1,800 MW of thermal power. If the total peaking factor for a node is 2.0, what is the maximum local linear power density being produced in the node?

A. 4.0 kW/ft

B. 6.0 kW/ft

C. 8.0 kW/ft

D. 10.0 kW/ft

ANSWER: D.

TOPIC: 293009
KNOWLEDGE: K1.04 [2.2/2.6]
QID: B3793

A BWR core consists of 30,000 fuel rods. Each fuel rod has an active length of 12 feet. The core is producing 1,800 MW of thermal power. If the total peaking factor for a node is 1.6, what is the maximum local linear power density being produced in the node?

A. 4.0 kW/ft

B. 6.0 kW/ft

C. 8.0 kW/ft

D. 10.0 kW/ft

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.04 [2.2/2.6]
QID: B4447

A reactor is operating at its licensed thermal limit of 2,200 MW. The linear heat generation rate (LHGR) limit is 13.0 kW/ft.

Given:

- The reactor core contains 560 fuel bundles.
- Each bundle contains 62 fuel rods, each with an active length of 12.5 feet
- The highest total peaking factors are at the following core locations:

Location A: 2.9
Location B: 2.7
Location C: 2.5
Location D: 2.3

Which one of the following describes the operating condition of the core relative to the LHGR limit?

A. All locations in the core are operating below the LHGR limit.

B. Only location A has exceeded the LHGR limit while the remainder of the core is operating below the limit.

C. Locations A and B have exceeded the LHGR limit while the remainder of the core is operating below the limit.

D. Locations A, B, and C have exceeded the LHGR limit while the remainder of the core is operating below the limit.

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.04 [2.2/2.6]
QID: B4948

A BWR core consists of 30,000 fuel rods; each fuel rod has an active length of 12 feet. The core is producing 1,350 MW of thermal power. If the total peaking factor for a node is 1.6, what is the maximum local linear power density being produced in the node?

A. 4.0 kW/ft

B. 6.0 kW/ft

C. 8.0 kW/ft

D. 10.0 kW/ft

ANSWER: B.

TOPIC: 293009
KNOWLEDGE: K1.04 [2.2/2.6]
QID: B5247

A reactor is operating at 3,400 MW thermal power. The linear heat generation rate (LHGR) limit is 14.7 kW/ft.

Given:

- The reactor core contains 640 fuel bundles.
- Each bundle contains 62 fuel rods, each with an active length of 12.5 feet
- The highest total peaking factors are at the following core locations:

Location A: 2.4
Location B: 2.3
Location C: 2.2
Location D: 2.1

Which one of the following describes the operating conditions in the core relative to the LHGR limit?

A. All locations in the core are operating below the LHGR limit.

B. Location A has exceeded the LHGR limit while the remainder of the core is operating below the limit.

C. Locations A and B have exceeded the LHGR limit while the remainder of the core is operating below the limit.

D. Locations A, B, and C have exceeded the LHGR limit while the remainder of the core is operating below the limit.

ANSWER: D.

TOPIC: 293009
KNOWLEDGE: K1.04 [2.2/2.6]
QID: B6247 (P6249)

A reactor is operating at steady-state conditions in the power range with the following average temperatures in a core plane:

$T_{coolant}$ = 550°F
$T_{fuel\ centerline}$ = 1,680°F

Assume that the fuel rod heat transfer coefficients and reactor coolant temperatures are equal throughout the core plane. If the maximum total peaking factor in the core plane is 2.1, what is the maximum fuel centerline temperature in the core plane?

A. 2,923°F

B. 3,528°F

C. 4,078°F

D. 4,683°F

ANSWER: A.

TOPIC: 293009
KNOWLEDGE: K1.05 [3.3/3.5]
QID: B1893 (P1395)

Thermal limits are established to protect the reactor, and thereby protect the public during nuclear power plant operations, which include...

A. normal operations only.

B. normal and abnormal operations only.

C. normal, abnormal, and postulated accident operations only.

D. normal, abnormal, postulated and unpostulated accident operations.

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.06 [3.4/3.8]
QID: B94

Linear heat generation rate is the...

A. ratio of the average power per fuel rod divided by the associated fuel bundle power.

B. ratio of the power produced in a given fuel bundle divided by total core thermal power.

C. sum of the power produced by all fuel rods in a given fuel bundle at a specific planar cross section.

D. sum of the power per unit area for each unit area of the fuel cladding for a unit length of a fuel rod.

ANSWER: D.

TOPIC: 293009
KNOWLEDGE: K1.06 [3.4/3.8]
QID: B296

The linear heat generation rate (LHGR) for a reactor core is acceptable if __________ is being maintained at __________.

A. $LHGR_{limit}/LHGR_{measured}$; 0.95

B. $LHGR_{measured}/LHGR_{limit}$; 1.05

C. $LHGR_{limit}/LHGR_{measured}$; 1.10

D. $LHGR_{measured}/LHGR_{limit}$; 1.15

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.07 [2.8/3.6]
QID: B295

Operating a reactor below the linear heat generation rate thermal limit prevents...

A. cracking of the fuel cladding, due to high stress from fuel pellet expansion.

B. melting of the fuel cladding, due to cladding temperature exceeding 2,200°F during an anticipated transient without a scram.

C. cracking of the fuel cladding, due to a lack of cooling caused by departure from nucleate boiling.

D. melting of the fuel cladding, due to a lack of cooling following a loss of coolant accident.

ANSWER: A.

TOPIC: 293009
KNOWLEDGE: K1.07 [2.8/3.6]
QID: B392

Which one of the following limits takes into consideration fuel pellet swell effects?

A. Average gain adjustment factor

B. Maximum linear heat generation rate

C. Rated thermal power

D. Minimum critical power ratio

ANSWER: B.

TOPIC: 293009
KNOWLEDGE: K1.07 [2.8/3.6]
QID: B894

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

A. Average planar linear heat generation rate

B. Linear heat generation rate

C. Minimum critical power ratio safety limit

D. Minimum critical power ratio operating limit

ANSWER: B.

TOPIC: 293009
KNOWLEDGE: K1.07 [2.8/3.6]
QID: B1093

Which one of the following is responsible for the fuel cladding failure that results from operating the reactor above the limit for linear heat generation rate?

A. Fission product gas expansion causes fuel rod internal design pressure to be exceeded.

B. Corrosion buildup on the cladding surface reduces heat transfer and promotes transition boiling.

C. The zircaloy-steam reaction causes accelerated oxidation of the cladding at high temperatures.

D. The difference between thermal expansion rates of the fuel pellets and the cladding causes severe stress.

ANSWER: D.

TOPIC: 293009
KNOWLEDGE: K1.07 [2.8/3.6]
QID: B1692

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

A. peak cladding temperature after a design basis loss of coolant accident will not exceed 2,200°F.

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

C. plastic strain of the cladding will not exceed 1 percent.

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

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.08 [3.0/3.4]
QID: B592

If the linear heat generation rate (LHGR) limiting condition for operation is exceeded, the most probable type of fuel cladding failure is...

A. cracking, due to high stress.

B. gross failure, due to a lack of cooling.

C. embrittlement, due to excessive oxidation.

D. distortion, due to inadequate cooling.

ANSWER: A.

TOPIC: 293009
KNOWLEDGE: K1.10 [3.3/3.7]
QID: B297

The amount of heat stored in the fuel, resulting from the operating kW/foot in the fuel prior to a scram, is measured by the...

A. average planar linear heat generation rate (APLHGR).

B. linear heat generation rate (LHGR) multiplied by the total peaking factor.

C. core fraction of limiting power density.

D. APLHGR-to-MAPLHGR ratio.

ANSWER: A.

TOPIC: 293009
KNOWLEDGE: K1.11 [2.8/3.6]
QID: B195

Which one of the following must be maintained within limits to ensure that peak cladding temperature will not exceed 2,200°F after a design basis loss of coolant accident?

A. Linear heat generation rate

B. Average planar linear heat generation rate

C. Minimum critical power ratio

D. Maximum fraction of limiting critical power ratio

ANSWER: B.

TOPIC: 293009
KNOWLEDGE: K1.11 [2.8/3.6]
QID: B1393

Maintaining the average planar linear heat generation rate (APLHGR) below the technical specification limit ensures that...

A. plastic strain (deformation) of the cladding will not exceed 1 percent.

B. axial peaking factors will not exceed those assumed in the safety analyses.

C. during transients, more than 99.9 percent of the fuel rods are expected to avoid transition boiling.

D. cladding temperature after a design basis loss of coolant accident will not exceed 2,200°F.

ANSWER: D.

TOPIC: 293009
KNOWLEDGE: K1.11 [2.8/3.6]
QID: B1793 (P396)

The 2,200°F maximum fuel cladding temperature limit is imposed because...

A. 2,200°F is approximately 500°F below the fuel cladding melting temperature.

B. the rate of the zircaloy-steam reaction increases significantly at temperatures above 2,200°F.

C. any cladding temperature higher than 2,200°F correlates to a fuel centerline temperature above the fuel melting point.

D. the thermal conductivity of zircaloy decreases rapidly at temperatures above 2,200°F.

ANSWER: B.

TOPIC: 293009
KNOWLEDGE: K1.11 [2.8/3.6]
QID: B2194 (P2194)

Which one of the following describes the basis for the 2,200°F maximum fuel cladding temperature limit?

A. 2,200°F is approximately 500°F below the fuel cladding melting temperature.

B. The material strength of zircaloy decreases rapidly at temperatures above 2,200°F.

C. The rate of the zircaloy-water reaction increases significantly at temperatures above 2,200°F.

D. At the normal operating pressure of the reactor vessel, a cladding temperature above 2,200°F indicates that the critical heat flux has been exceeded.

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.11 [2.8/3.6]
QID: B2292 (P2995)

Which one of the following describes the basis for the 2,200°F maximum fuel cladding temperature limit?

A. 2,200°F is approximately 500°F below the fuel cladding melting temperature.

B. The rate of the zircaloy-steam reaction increases significantly above 2,200°F.

C. If fuel cladding temperature reaches 2,200°F, the onset of transition boiling is imminent.

D. The differential expansion between the fuel pellets and the fuel cladding becomes excessive at temperatures greater than 2,200°F.

ANSWER: B.

TOPIC: 293009
KNOWLEDGE: K1.11 [2.8/3.6]
QID: B7670

Which one of the following parameters is limited to protect against fuel rod failure from brittle fracture when emergency cooling is initiated during a loss of coolant accident?

A. Linear heat generation rate (LHGR)

B. Average planar linear heat generation rate (APLHGR)

C. Critical power ratio (CPR)

D. Fraction of limiting critical power ratio (FLCPR)

ANSWER: B.

TOPIC: 293009
KNOWLEDGE: K1.12 [3.1/3.6]
QID: B2595

If a reactor is operating above its maximum average planar linear heat generation rate (MAPLHGR) prior to a loss of coolant accident, fuel pellet centerline temperature may reach 4,200°F and fuel cladding temperature may reach 2,300°F during the accident.

Which one of the following describes the likely cladding failure mechanism if the above temperatures are reached?

A. Excessive fuel pellet expansion.

B. Excessive plastic strain in the cladding.

C. Excessive embrittlement of the cladding.

D. Excessive cadmium and iodine attack on the cladding.

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.13 [3.1/3.6]
QID: B97

Operating a reactor within the limits specified by the maximum average planar linear heat generation rate (MAPLHGR) prevents...

A. exceeding 1 percent plastic strain in the cladding.

B. exceeding a peak fuel temperature of 2,200°F.

C. the onset of transition boiling in the upper core.

D. exceeding a peak cladding temperature of 2,200°F.

ANSWER: D.

TOPIC: 293009
KNOWLEDGE: K1.13 [3.1/3.6]
QID: B896

Which one of the following is indicated when the average planar linear heat generation rate (APLHGR)-to-maximum APLHGR ratio is less than 1.0?

A. Linear heat generation rate (LHGR) limit has not been exceeded.

B. LHGR limit has been exceeded.

C. APLHGR limit has not been exceeded.

D. APLHGR limit has been exceeded.

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.13 [3.1/3.6]
QID: B1595

Which one of the following is indicated when the maximum average power ratio (MAPRAT) is greater than 1.0?

A. The linear heat generation rate (LHGR) limit has not been exceeded.

B. The average planar linear heat generation rate (APLHGR) limit has not been exceeded.

C. The LHGR limit has been exceeded.

D. The APLHGR limit has been exceeded.

ANSWER: D.

TOPIC: 293009
KNOWLEDGE: K1.13 [3.1/3.6]
QID: B1795

Which one of the following is indicated when the maximum average power ratio (MAPRAT) is less than 1.0?

A. The linear heat generation rate (LHGR) limit has been exceeded.

B. The average planar linear heat generation rate (APLHGR) limit has been exceeded.

C. The APLHGR limit has not been exceeded.

D. The LHGR limit has not been exceeded.

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.14 [2.2/2.7]
QID: B393

At high core exposures, the maximum average planar linear heat generation rate (MAPLHGR) limit decreases with increasing core exposure. What is the reason for this decrease?

A. Cracking of fuel pellets at higher core exposures permits additional volume for fission product gases.

B. The zirconium-steam chemical reaction in cladding requires higher temperatures at higher core exposures.

C. Fission product decay heat level decreases at higher core exposures.

D. Fission product gases lower the overall heat transfer coefficient of the fuel rod fill gas.

ANSWER: D.

TOPIC: 293009
KNOWLEDGE: K1.15 [2.6/3.1]
QID: B792

During a loss of coolant accident, which one of the following modes of heat transfer provides the most core cooling when fuel rods are <u>not</u> in contact with the coolant?

A. Radiation

B. Emission

C. Convection

D. Conduction

ANSWER: A.

TOPIC: 293009
KNOWLEDGE: K1.16 [2.4/2.8]
QID: B394 (P383)

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

Given the following initial core parameters:

Reactor power = 100 percent
$T_{coolant}$ = 500°F
$T_{fuel\ centerline}$ = 3,000°F

What would the fuel centerline temperature be if the total fuel-to-coolant thermal conductivity doubled? (Assume reactor power and $T_{coolant}$ are constant.)

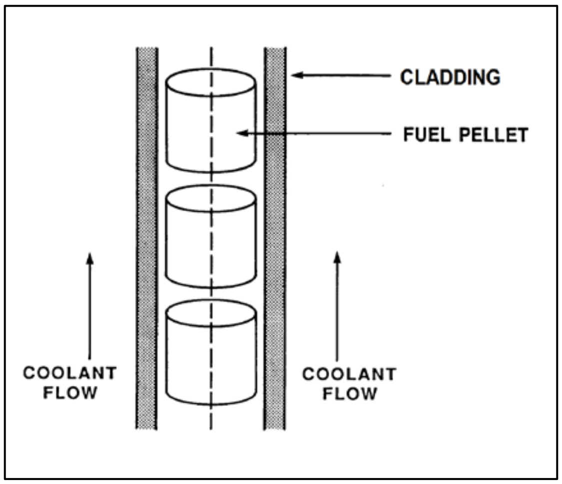
A. 1,000°F

B. 1,250°F

C. 1,500°F

D. 1,750°F

ANSWER: D.



TOPIC: 293009
KNOWLEDGE: K1.16 [2.4/2.8]
QID: B495 (P495)

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

Given the following initial core parameters:

Reactor power = 100 percent
$T_{coolant}$ = 500°F
$T_{fuel\ centerline}$ = 2,500°F

What would the fuel centerline temperature be if the total fuel-to-coolant thermal conductivity doubled? (Assume reactor power and $T_{coolant}$ are constant.)

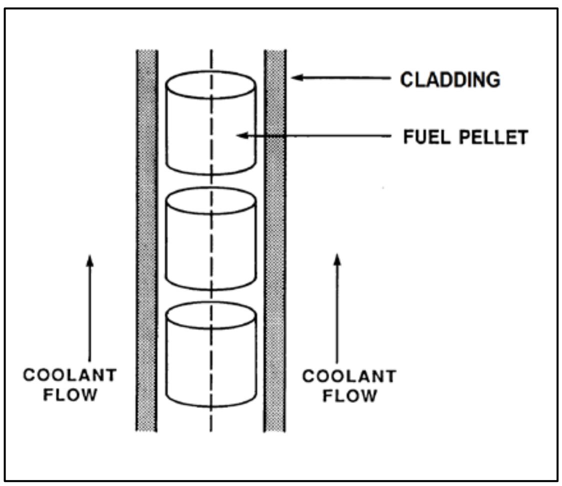
A. 1,250°F

B. 1,300°F

C. 1,400°F

D. 1,500°F

ANSWER: D.



TOPIC: 293009
KNOWLEDGE: K1.16 [2.4/2.8]
QID: B1395 (P1894)

Which one of the following describes the fuel-to-coolant thermal conductivity for a fuel rod at the end of a fuel cycle (EOC) when compared to the beginning of the same fuel cycle (BOC)?

A. Smaller at EOC, due to fuel pellet densification.

B. Smaller at EOC, due to contamination of fill gas with fission product gases.

C. Larger at EOC, due to reduction in gap between the fuel pellets and cladding.

D. Larger at EOC, due to a greater temperature difference between the fuel pellets and coolant.

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.16 [2.4/2.8]
QID: B1594 (P1594)

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

Given the following initial core parameters:

Reactor power = 100 percent
$T_{coolant}$ = 500°F
$T_{fuel\ centerline}$ = 2,700°F

What would the fuel centerline temperature be if the total fuel-to-coolant thermal conductivity doubled? (Assume reactor power and $T_{coolant}$ are constant.)

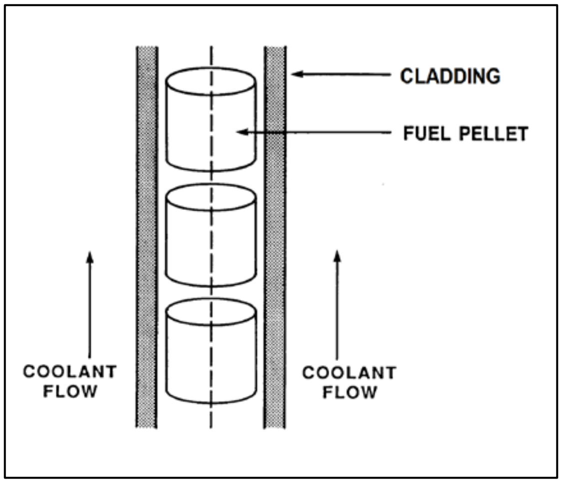
A. 1,100°F

B. 1,350°F

C. 1,600°F

D. 1,850°F

ANSWER: C.



TOPIC: 293009
KNOWLEDGE: K1.16 [2.4/2.8]
QID: B1697 (P3395)

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

Given the following initial core parameters:

Reactor power = 50 percent
$T_{coolant}$ = 550°F
$T_{fuel\ centerline}$ = 2,750°F

What will the fuel centerline temperature be if the total fuel-to-coolant thermal conductivity doubles? (Assume reactor power and $T_{coolant}$ are constant.)

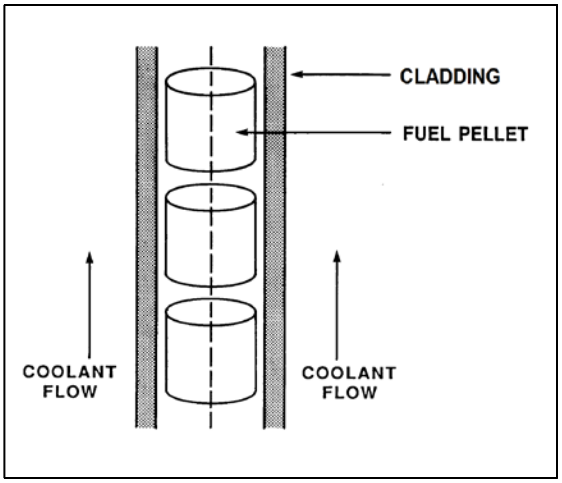
A. 1,100°F

B. 1,375°F

C. 1,525°F

D. 1,650°F

ANSWER: D.



TOPIC: 293009
KNOWLEDGE: K1.16 [2.4/2.8]
QID: B1995 (P1994)

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

Given the following initial core parameters:

Reactor power = 80 percent
$T_{coolant}$ = 540°F
$T_{fuel\ centerline}$ = 2,540°F

What would the fuel centerline temperature be if the total fuel-to-coolant thermal conductivity doubled? (Assume reactor power and $T_{coolant}$ are constant.)

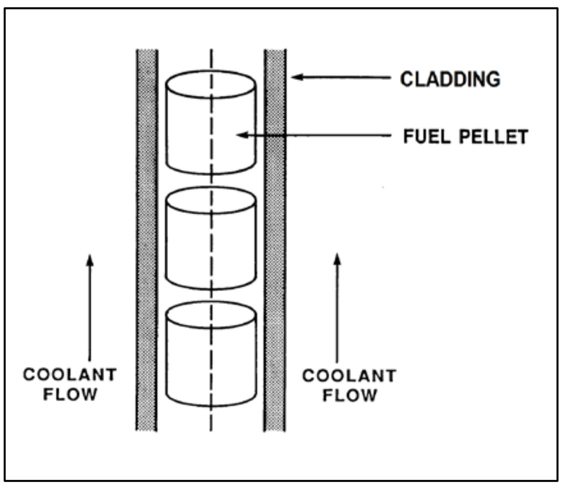
A. 1,270°F

B. 1,370°F

C. 1,440°F

D. 1,540°F

ANSWER: D.



TOPIC: 293009
KNOWLEDGE: K1.16 [2.4/2.8]
QID: B2192 (P2195)

Which one of the following describes the fuel-to-coolant thermal conductivity for a fuel rod at the beginning of a fuel cycle (BOC) compared to the end of a fuel cycle (EOC)?

A. Greater at BOC, due to a higher fuel pellet density.

B. Greater at BOC, due to lower contamination of fuel rod fill gas with fission product gases.

C. Smaller at BOC, due to a larger gap between the fuel pellets and cladding.

D. Smaller at BOC, due to a smaller corrosion film on the surface of the fuel rods.

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.16 [2.4/2.8]
QID: B2394 (P2395)

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

The reactor is shut down with the following parameter values:

$T_{coolant}$ = 320°F
$T_{fuel\ centerline}$ = 780°F

What would the fuel centerline temperature be if the total fuel-to-coolant thermal conductivity doubled? (Assume core decay heat level and $T_{coolant}$ are constant.)

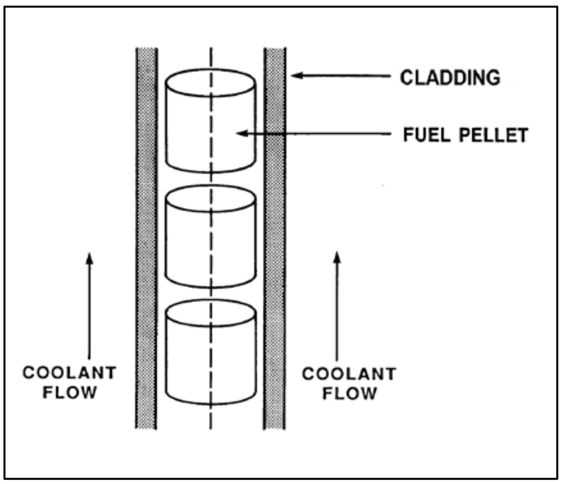
A. 550°F

B. 500°F

C. 450°F

D. 400°F

ANSWER: A.



TOPIC: 293009
KNOWLEDGE: K1.16 [2.4/2.8]
QID: B2696 (P2296)

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

Given the following initial core parameters:

Reactor power = 60 percent
$T_{coolant}$ = 560°F
$T_{fuel\ centerline}$ = 2,500°F

What would the fuel centerline temperature be if the total fuel-to-coolant thermal conductivity doubled? (Assume reactor power and $T_{coolant}$ are constant.)

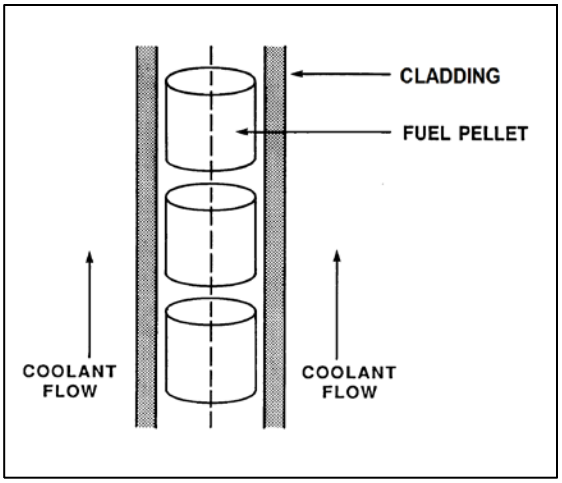
A. 1,080°F

B. 1,250°F

C. 1,530°F

D. 1,810°F

ANSWER: C.



TOPIC: 293009
KNOWLEDGE: K1.16 [2.4/2.8]
QID: B2794

Given the following initial core parameters for a segment of a fuel rod:

Power density = 2 kW/ft
$T_{coolant}$ = 540°F
$T_{fuel\ centerline}$ = 1,200°F

Reactor power is increased such that the following core parameters now exist for the fuel rod segment:

Power density = 3 kW/ft
$T_{coolant}$ = 540°F
$T_{fuel\ centerline}$ = ?

Assuming void fraction surrounding the fuel rod segment does not change, what will be the new stable $T_{fuel\ centerline}$?

A. 1,380°F

B. 1,530°F

C. 1,670°F

D. 1,820°F

ANSWER: B.

TOPIC: 293009
KNOWLEDGE: K1.16 [2.4/2.8]
QID: B2896

Given the following initial core parameters for a segment of a fuel rod:

Power density = 2 kW/ft
$T_{coolant}$ = 540°F
$T_{fuel\ centerline}$ = 1,800°F

Reactor power is increased such that the following core parameters now exist for the fuel rod segment:

Power density = 4 kW/ft
$T_{coolant}$ = 540°F
$T_{fuel\ centerline}$ = ?

Assuming void fraction surrounding the fuel rod segment does not change, what will be the new stable $T_{fuel\ centerline}$?

A. 2,520°F

B. 2,780°F

C. 3,060°F

D. 3,600°F

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.16 [2.4/2.8]
QID: B3193 (P3195)

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

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

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

What will the fuel centerline temperature be at the end of the fuel cycle with the same coolant temperature and reactor decay heat conditions if the total fuel-to-coolant thermal conductivity doubles?

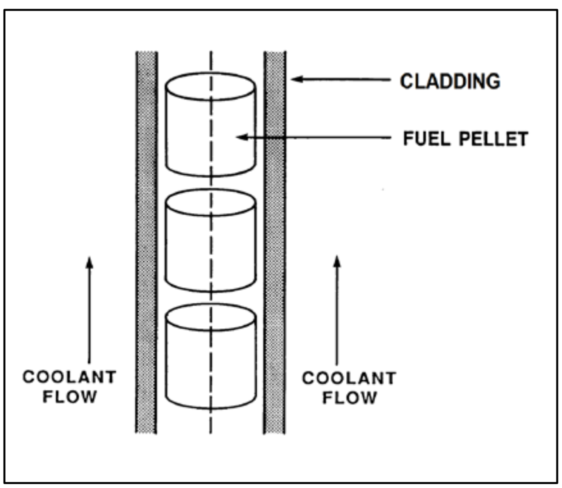
A. 610°F

B. 580°F

C. 550°F

D. 520°F

ANSWER: A.



TOPIC: 293009
KNOWLEDGE: K1.16 [2.4/2.8]
QID: B3893

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

Given the following initial stable core parameters:

Reactor power = 50 percent
$T_{coolant}$ = 550°F
$T_{fuel\ centerline}$ = 1,250°F

Assume the total heat transfer coefficient and the reactor coolant temperature do <u>not</u> change. What will the stable fuel centerline temperature be if reactor power is increased to 75 percent?

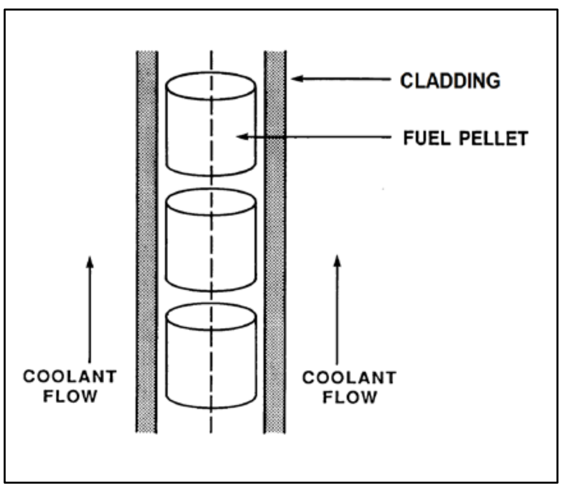
A. 1,425°F

B. 1,600°F

C. 1,750°F

D. 1,875°F

ANSWER: B.



TOPIC: 293009
KNOWLEDGE: K1.17 [3.3/3.7]
QID: B145

The fuel bundle power that will cause the onset of transition boiling somewhere in the fuel bundle is the...

A. technical specification limit.

B. critical power.

C. maximum fraction of limiting power density.

D. maximum power density.

ANSWER: B.

TOPIC: 293009
KNOWLEDGE: K1.17 [3.3/3.7]
QID: B1997

Which one of the following is most likely to result in fuel cladding damage?

A. Operating at 110 percent of reactor vessel design pressure.

B. An inadvertent reactor scram from 100 percent power.

C. Operating with a fuel bundle power greater than the critical power.

D. Operating with saturated nucleate boiling occurring in a fuel bundle.

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.18 [3.2/3.7]
QID: B298

Which one of the following is a mathematical expression for the critical power ratio?

A. Critical power/Actual bundle power

B. Actual bundle power/Critical power

C. Average bundle power/Critical power

D. Critical power/Average bundle power

ANSWER: A.

TOPIC: 293009
KNOWLEDGE: K1.19 [2.8/3.6]
QID: B597

Which one of the following adverse conditions is avoided primarily by maintaining the minimum critical power ratio within specified limits?

A. Excessive plastic strain on the fuel cladding

B. Excessive cladding creep

C. Excessive decay heat in the fuel

D. Excessive fuel cladding temperatures

ANSWER: D.

TOPIC: 293009
KNOWLEDGE: K1.19 [2.8/3.6]
QID: B694

The purpose of maintaining the critical power ratio greater than 1.0 is to...

A. prevent fuel cladding failure during analyzed accident conditions.

B. avoid the onset of transition boiling during expected operating transients.

C. limit peak cladding temperatures to less than 2,200°F during analyzed accident conditions.

D. prevent melting at the fuel pellet centerline during expected operating transients.

ANSWER: B.

TOPIC: 293009
KNOWLEDGE: K1.19 [2.8/3.6]
QID: B798

Which thermal limit is maintained to ensure the core does not experience transition boiling?

A. Minimum critical power ratio

B. Maximum average planar linear heat generation ratio (MAPLHGR)

C. Maximum fraction of limiting power density

D. APLHGR-to-MAPLHGR ratio

ANSWER: A.

TOPIC: 293009
KNOWLEDGE: K1.19 [2.8/3.6]
QID: B2796

If a reactor is operating with the minimum critical power ratio (MCPR) at its transient limit (or safety limit), which one of the following is indicated?

A. None of the fuel rods are experiencing critical heat flux.

B. A small fraction of the fuel rods may be experiencing critical heat flux.

C. All radioactive fission products are being contained within the reactor fuel.

D. All radioactive fission products are being contained within either the reactor fuel or the reactor vessel.

ANSWER: B.

TOPIC: 293009
KNOWLEDGE: K1.20 [3.1/3.6]
QID: B1196

Bundle critical power ratio must be maintained __________ 1.0; the limit is imposed to prevent fuel damage caused by a rapid increase in the temperature of the __________.

A. greater than; fuel pellets

B. less than; fuel pellets

C. greater than; fuel cladding

D. less than; fuel cladding

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.23 [2.8/3.2]
QID: B96

Which one of the following parameter changes will initially increase the critical power of a fuel bundle?

A. The subcooling of the coolant entering the bundle decreases.

B. The local peaking factor increases.

C. The coolant flow rate through the bundle increases.

D. The axial power peak shifts from the bottom to the top of the bundle.

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.23 [2.8/3.2]
QID: B2498

A nuclear power plant is operating at 90 percent power near the end of a fuel cycle when reactor recirculation flow rate suddenly decreases by 10 percent. Assuming the reactor does not scram immediately, critical power will initially __________; and reactor power will initially __________.

A. increase; increase

B. increase; decrease

C. decrease; increase

D. decrease; decrease

ANSWER: D.

TOPIC: 293009
KNOWLEDGE: K1.24 [2.7/3.2]
QID: B995

During normal power operations, a reactor pressure increase causes critical power to __________ because the latent heat of vaporization for the reactor coolant __________.

A. increase; decreases

B. decrease; decreases

C. increase; increases

D. decrease; increases

ANSWER: B.

TOPIC: 293009
KNOWLEDGE: K1.24 [2.7/3.2]
QID: B1297

A nuclear power plant is operating at 100 percent load when a turbine trip occurs with no steam bypass valve actuation. Assuming the reactor does not scram immediately, critical power ratio will initially...

A. increase, due to an increased latent heat of vaporization.

B. decrease, due to a decreased latent heat of vaporization.

C. increase, due to an increased reactor power.

D. decrease, due to a decreased reactor power.

ANSWER: B.

TOPIC: 293009
KNOWLEDGE: K1.24 [2.7/3.2]
QID: B2398

A nuclear power plant is operating at 90 percent power near the end of a fuel cycle when a turbine control system malfunction opens the turbine control valves an additional 5 percent. Assuming the reactor does not scram immediately, the critical power ratio will initially __________ due to a(n) __________ latent heat of vaporization for the reactor coolant.

A. increase; increased

B. increase; decreased

C. decrease; increased

D. decrease; decreased

ANSWER: A.

TOPIC: 293009
KNOWLEDGE: K1.24 [2.7/3.2]
QID: B2998

A nuclear power plant is operating at 90 percent power near the end of a fuel cycle when a signal error causes the turbine control system to throttle the turbine control valves 5 percent in the closed direction. Assuming the turbine control valves stabilize in their new position and the reactor does not scram, the critical power ratio will initially...

A. increase, because reactor power initially increases.

B. decrease, because reactor power initially decreases.

C. increase, because the reactor coolant latent heat of vaporization initially increases.

D. decrease, because the reactor coolant latent heat of vaporization initially decreases.

ANSWER: D.

TOPIC: 293009
KNOWLEDGE: K1.24 [2.7/3.2]
QID: B4749

A nuclear power plant is operating at 90 percent power at the end of core life when a signal error causes the turbine control system to open the turbine control valves an additional 5 percent. Assuming the reactor does not scram, the critical power ratio will initially...

A. increase, because reactor power initially increases.

B. decrease, because reactor power initially decreases.

C. increase, because the reactor coolant latent heat of vaporization initially increases.

D. decrease, because the reactor coolant latent heat of vaporization initially decreases.

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.26 [2.6/3.1]
QID: B897

For a reactor operating at 100 percent power, which one of the following combinations of axial power distribution and recirculation system flow rate will result in the smallest critical power ratio in a given fuel bundle? (Assume the maximum linear heat generation rate in the fuel bundle is the same for all cases.)

	Axial Power Distribution	Recirculation System Flow Rate
A.	Top-peaked	Low
B.	Top-peaked	High
C.	Bottom-peaked	Low
D.	Bottom-peaked	High

ANSWER: A.

TOPIC: 293009
KNOWLEDGE: K1.26 [2.6/3.1]
QID: B1396

If the axial power distribution in a fuel bundle shifts from bottom-peaked to top-peaked, the critical power will…

A. decrease to a new lower value.

B. decrease temporarily, then return to its initial value.

C. increase to a new higher value.

D. increase temporarily, then return to its initial value.

ANSWER: A.

TOPIC: 293009
KNOWLEDGE: K1.26 [2.6/3.1]
QID: B7740

A reactor was initially operating at steady-state 100 percent power with a top-peaked axial power distribution. Reactor power was reduced and a control rod pattern exchange was completed to establish a bottom-peaked distribution. Reactor power was returned to 100 percent and is currently at steady-state.

Compared to the initial (top-peaked) critical power for a given fuel bundle at steady-state 100 percent power, the current (bottom-peaked) critical power is…

A. higher, because the highest linear heat generation rate is occurring in the region of the fuel bundle with the highest mass flow rate of coolant.

B. higher, because the greatest coolant enthalpy rise is occurring in the region of the fuel bundle that contains subcooled or low-quality coolant.

C. lower, because the highest linear heat generation rate is occurring in the region of the fuel bundle with the highest mass flow rate of coolant.

D. lower, because the greatest coolant enthalpy rise is occurring in the region of the fuel bundle that contains subcooled or low-quality coolant.

ANSWER: B.

TOPIC: 293009
KNOWLEDGE: K1.27 [2.7/3.3]
QID: B795

For what operational condition does the flow biasing correction factor (K_f) adjust the minimum critical power ratio?

A. Operation at less than rated steam flow rate.

B. Operation at greater than rated steam flow rate.

C. Operation at less than rated core flow rate.

D. Operation at greater than rated core flow rate.

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.29 [2.4/2.7]
QID: B996

The fuel thermal time constant describes the amount of time required for...

A. the fuel to change its rate of heat generation by 63 percent.

B. the fuel centerline temperature to undergo 63 percent of its total change resulting from a given power change.

C. the fuel cladding temperature to undergo 63 percent of its total change resulting from a given change in fuel temperature.

D. reactor power to undergo 63 percent of its total change resulting from a given reactivity insertion.

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.29 [2.4/2.7]
QID: B2496

The fuel thermal time constant specifies the amount of time required for...

A. a fuel pellet to achieve equilibrium temperature following a power change.

B. a fuel bundle to achieve equilibrium temperature following a power change.

C. the fuel cladding temperature to undergo most of its total change following a power change.

D. the fuel centerline temperature to undergo most of its total change following a power change.

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.30 [2.3/2.7]
QID: B1596

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

Which one of the following was the approximate fuel rod surface temperature 6 seconds after the power change?

A. 571°F

B. 569°F

C. 565°F

D. 561°F

ANSWER: B.

TOPIC: 293009
KNOWLEDGE: K1.30 [2.3/2.7]
QID: B2095

A step increase in reactor power caused a fuel rod surface temperature increase from 560°F to 590°F at steady-state conditions. The fuel thermal time constant is 6 seconds.

Which one of the following was the approximate fuel rod surface temperature 6 seconds after the power change?

A. 579°F

B. 575°F

C. 570°F

D. 567°F

ANSWER: A.

TOPIC: 293009
KNOWLEDGE: K1.30 [2.3/2.7]
QID: B2193

A step increase in reactor power caused a fuel rod surface temperature increase from 555°F to 585°F at steady-state conditions. The fuel thermal time constant is 6 seconds.

Which one of the following was the approximate fuel rod surface temperature 6 seconds after the power change?

A. 574°F

B. 570°F

C. 567°F

D. 563°F

ANSWER: A.

TOPIC: 293009
KNOWLEDGE: K1.30 [2.3/2.7]
QID: B2297

A step increase in reactor power caused a fuel rod surface temperature increase from 570°F to 590°F at steady-state conditions. The fuel thermal time constant is 6 seconds.

Which one of the following was the approximate fuel rod surface temperature 6 seconds after the power change?

A. 574°F

B. 577°F

C. 580°F

D. 583°F

ANSWER: D.

TOPIC: 293009
KNOWLEDGE: K1.31 [3.0/3.4]
QID: B396 (P394)

The pellet-to-cladding gap in fuel rod construction is designed to...

A. decrease fuel pellet densification and elongation.

B. reduce fission product gas pressure buildup.

C. increase heat transfer rate.

D. reduce internal cladding strain.

ANSWER: D.

TOPIC: 293009
KNOWLEDGE: K1.32 [2.9/3.3]
QID: B99

Which one of the following describes why the threshold power for pellet-clad interaction changes as fuel burnup increases?

A. The fuel pellet thermal conductivity is reduced significantly by irradiation.

B. Zirconium hydriding increases significantly as the oxide layer builds up on the cladding.

C. The buildup of certain fission product gases causes chemical embrittlement of the cladding.

D. Fuel pellet densification causes the middle of the pellet to expand outward against the cladding as the pellet length shrinks.

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.32 [2.9/3.3]
QID: B497

The presence of embrittling isotopes is one of the initiating factors of pellet-cladding interaction. Which one of the following describes the primary source of the embrittling isotopes?

A. Created during fission of the reactor fuel.

B. Introduced during the fuel manufacturing process.

C. Migrates from the reactor coolant through the cladding.

D. Produced as corrosion products inside the fuel rod.

ANSWER: A.

TOPIC: 293009
KNOWLEDGE: K1.32 [2.9/3.3]
QID: B2195

Which one of the following operations is most likely to cause significant pellet-cladding interaction?

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

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

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

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

ANSWER: D.

TOPIC: 293009
KNOWLEDGE: K1.33 [2.4/2.8]
QID: B796

Which one of the following is the primary purpose of the gap between the fuel pellets and the cladding.

A. Prevent contact between the fuel pellets and the cladding.

B. Increase heat transfer from the fuel pellets to the cladding.

C. Accommodate different expansion rates between the fuel pellets and the cladding.

D. Reduce diffusion of fission product gases through the cladding into the reactor coolant.

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.33 [2.4/2.8]
QID: B1696

What is the primary purpose of the gap between a fuel pellet and the surrounding cladding?

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

B. To provide a collection volume for fission product gases.

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

D. To accommodate different expansion rates of the fuel pellets and the cladding.

ANSWER: D.

TOPIC: 293009
KNOWLEDGE: K1.34 [2.3/2.6]
QID: B797

Which one of the following causes a reduction in the size of the gap between the fuel pellets and the fuel cladding over core life.

A. Contraction of the fuel rod, due to zirconium hydriding.

B. Expansion of the fuel pellets, due to fission product buildup.

C. Contraction of the fuel rod, due to fuel rod internal vacuum.

D. Expansion of the fuel pellets, due to densification.

ANSWER: B.

TOPIC: 293009
KNOWLEDGE: K1.34 [2.3/2.6]
QID: B6449 (P6449)

Consider a new fuel rod operating at a constant power level for several weeks. During this period, fuel pellet densification in the fuel rod causes the heat transfer rate from the fuel pellets to the cladding to __________; this change causes the average fuel temperature in the fuel rod to __________.

A. decrease; increase

B. decrease; decrease

C. increase; increase

D. increase; decrease

ANSWER: A.

TOPIC: 293009
KNOWLEDGE: K1.34 [2.3/2.6]
QID: B7630

If fuel pellet densification occurs in a fuel rod producing a constant power output, the average linear heat generation rate in the fuel rod will __________ because pellet densification causes fuel pellets to __________.

A. decrease; swell

B. decrease; shrink

C. increase; swell

D. increase; shrink

ANSWER: D.

TOPIC: 293009
KNOWLEDGE: K1.35 [2.2/2.6]
QID: B397

Studies of nuclear fuel rod damage revealed that two essential criteria for pellet-cladding interaction fuel damage are cladding stress and an embrittling interaction between two chemical agents and the zircaloy cladding.

What are the two chemical agents?

A. Iodine and cadmium

B. Cadmium and bromine

C. Bromine and ruthenium

D. Ruthenium and iodine

ANSWER: A.

TOPIC: 293009
KNOWLEDGE: K1.40 [2.8/3.3]
QID: B696

Gross cladding failure is avoided during a design basis loss of coolant accident by operation below the limit for...

A. total peaking factor.

B. linear heat generation rate.

C. operating critical power ratio.

D. average planar linear heat generation rate.

ANSWER: D.

TOPIC: 293009
KNOWLEDGE: K1.40 [2.8/3.3]
QID: B1497

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

A. linear heat generation rate limit.

B. maximum average planar linear heat generation rate limit.

C. minimum critical power ratio limit.

D. preconditioning interim operating management recommendations.

ANSWER: B.

TOPIC: 293009
KNOWLEDGE: K1.41 [2.8/3.3]
QID: B697

During a rapid increase in core flow rate in a reactor operating at 100 percent power, the most limiting thermal limit is the...

A. total peaking factor.

B. critical power ratio.

C. average planar linear heat generation rate.

D. linear heat generation rate.

ANSWER: B.

TOPIC: 293009
KNOWLEDGE: K1.41 [2.8/3.3]
QID: B1098

A nuclear power plant is operating at 60 percent reactor power. Which one of the following will result in the highest critical power ratio? (Assume neutron flux distribution does not change.)

A. A 25 percent power increase using only recirculation flow.

B. A 25 percent power increase using only control rods.

C. A 25 percent power decrease using only recirculation flow.

D. A 25 percent power decrease using only control rods.

ANSWER: D.

TOPIC: 293009
KNOWLEDGE: K1.41 [2.8/3.3]
QID: B1598

A nuclear power plant is operating at 60 percent reactor power. Which one of the following will result in the lowest critical power ratio? (Assume core neutron flux distribution does not change.)

A. A 25 percent power increase using only control rods.

B. A 25 percent power decrease using only control rods.

C. A 25 percent power increase using only recirculation flow.

D. A 25 percent power decrease using only recirculation flow.

ANSWER: A.

TOPIC: 293009
KNOWLEDGE: K1.42 [2.8/3.3]
QID: B498

In a reactor operating at 100 percent power, reactor pressure suddenly increases. Which one of the following is the most limiting thermal limit for these conditions?

A. Linear heat generation rate

B. Average planar linear heat generation rate

C. Critical power ratio

D. Preconditioning interim operating management recommendations

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.43 [2.9/3.4]
QID: B698

If cold water is suddenly injected into the reactor vessel while operating at 50 percent power, critical power will initially __________; and bundle power will initially __________.

A. increase; increase

B. decrease; increase

C. increase; decrease

D. decrease; decrease

ANSWER: A.

TOPIC: 293009
KNOWLEDGE: K1.43 [2.9/3.4]
QID: B1298

If reactor feedwater temperature suddenly decreases by 10°F during operation at 75 percent power, critical power will initially __________; and bundle power will initially __________.

A. increase; increase

B. decrease; increase

C. increase; decrease

D. decrease; decrease

ANSWER: A.

TOPIC: 293009
KNOWLEDGE: K1.43 [2.9/3.4]
QID: B1498

The most limiting thermal limit for a loss of feedwater heating transient is the...

A. average planar linear heat generation rate.

B. linear heat generation rate.

C. critical power ratio.

D. core thermal power.

ANSWER: C.

TOPIC: 293009
KNOWLEDGE: K1.43 [2.9/3.4]
QID: B2298

If reactor feedwater temperature suddenly increases by 10°F during operation at 75 percent power, critical power will initially __________; and bundle power will initially __________.

A. increase; increase

B. increase; decrease

C. decrease; increase

D. decrease; decrease

ANSWER: D.