科目： 192007
知能類：K1.01 [2.1/2.5]
序號： P362 (B364)

Which one of the following is not a function performed by burnable poisons in an operating nuclear reactor?

A. Provide neutron flux shaping.

B. Provide more uniform power density.

C. Counteract the effects of control rod burnout.

D. Allow higher fuel enrichment of initial core load.

ANSWER: C.

下列何者並非可燃性毒物在運轉中反應器內的功用？

A. 提供中子通率分佈(flux shaping)。

B. 提供更均勻的功率密度。

C. 抵消控制棒的燃耗。

D. 讓初始爐心裝填較高濃縮度的燃料。

答案：C.

科目： 192007
知能類：K1.01 [2.1/2.5]
序號： P864

Instead of using a higher concentration of soluble boric acid, burnable poisons are installed in a new nuclear reactor core to...

A. prevent boron precipitation during normal operation.

B. establish a more negative moderator temperature coefficient.

C. allow control rods to be withdrawn farther upon initial criticality.

D. maintain reactor coolant pH above a minimum acceptable value.

ANSWER: B.

核子反應器的新爐心使用可燃性毒物，來取代濃度較高的硼酸溶液，旨在……

A. 避免硼酸在正常運轉期間沈澱。

B. 建立負值較大的緩和劑溫度係數。

C. 初次臨界時，能將控制棒抽出更多。

D. 讓反應器冷卻水的 pH 值，維持在可接受數值之上。

答案：B.

科目： 192007
知能類：K1.01 [2.1/2.5]
序號： P1664

Why are burnable poisons installed in a new nuclear reactor core instead of using a larger reactor coolant boron concentration?

A. To prevent boron precipitation during normal operation.

B. To establish a more negative moderator temperature coefficient.

C. To minimize the distortion of the neutron flux distribution caused by soluble boron.

D. To allow the loading of excessive reactivity in the form of higher fuel enrichment.

ANSWER: B.

核子反應器的新爐心為何置入可燃性毒物，來取代硼濃度較高的反應器冷卻水？

A. 避免硼在正常運轉期間沈澱。

B. 建立負值較大的緩和劑溫度係數。

C. 降低硼酸溶液造成的中子通率分佈扭曲度。

D. 藉由較高的燃料濃度以加入過剩反應度。

答案：B.

科目： 192007
知能類：K1.04 [3.1/3.4]
序號： P64

A nuclear reactor is near the end of its fuel cycle. Reactor power and coolant temperature are being allowed to "coast down."

Why is RCS boron dilution no longer used to compensate for fuel depletion?

A. RCS boron concentration has become so high that a very large amount of boron must be added to produce a small increase in boron concentration.

B. The reactivity worth of the boron has decreased so much that a very large amount of water must be added to the RCS to make a small positive reactivity addition to the core.

C. Boron concentration has become so low that a very large amount of water must be added to the RCS to produce a small decrease in boron concentration.

D. The reactivity worth of the boron has increased so much that reactivity changes from RCS boron dilution cannot be safely controlled by the operator.

ANSWER: C.

一部核子反應器接近燃料週期末期，其反應器功率和冷卻水溫度得以「減載(coast down)」。

為什麼不再以稀釋 RCS 硼濃度的方式來彌補燃料耗盡量？

A. RCS 硼濃度變得甚高，必須加入大量硼，才能讓硼濃度小幅增加。

B. 硼反應度本領降低甚多，必須在 RCS 加入大量水，才能在爐心加入少量正反應度。

C. 硼濃度變得甚低，必須在 RCS 加入大量水，才能讓硼濃度小幅降低。

D. 硼反應度本領增加甚多，導致運轉員無法安全控制稀釋 RCS 硼濃度而產生的反應度變化。

答案：C.

科目： 192007
知能類：K1.04 [3.1/3.4]
序號： P264 (B564)

Just prior to a refueling outage, a nuclear power plant is operating at 100% power with a reactor coolant boron concentration of 50 ppm. After the refueling outage, the 100% boron concentration is approximately 1,000 ppm.

Which one of the following is the primary reason for the large increase in full-power boron concentration?

A. Reactivity from power defect at beginning of core life (BOL) is much greater than at end of core life (EOL).

B. Differential boron worth at BOL is much less than at EOL.
[Inverse boron worth at BOL is much greater than at EOL.]

C. The excess reactivity in the core at BOL is much greater than at EOL.

D. The integral control rod worth at BOL is much less than at EOL.

ANSWER: C.

核能電廠在更換燃料大修前，原以100%功率運轉，反應器冷卻水硼濃度為50 ppm。更換燃料大修後，100%功率時的硼濃度約為1,000 ppm。

下列何者為硼濃度於全功率時大幅增加的主因？

A. 來自功率欠缺的反應度，在爐心壽命初期(BOL)比在爐心壽命末期(EOL)大的多。

B. 爐心壽命初期的微分硼本領，遠小於爐心壽命末期的微分硼本領。[爐心壽命初期的逆硼本領，遠大於爐心壽命末期的逆硼本領]。

C. 爐心的過剩反應度在爐心壽命初期比在爐心壽命末期大的多。

D. 積分控制棒本領在爐心壽命初期比在爐心壽命末期小的多。

答案：C.

科目： 192007
知能類：K1.04 [3.1/3.4]
序號： P464

During a six-month period of continuous full power reactor operation, the reactor coolant boron concentration must be decreased steadily to compensate for...

A. buildup of fission product poisons and decreasing control rod worth.

B. fuel depletion and buildup of fission product poisons.

C. decreasing control rod worth and burnable poison burnout.

D. burnable poison burnout and fuel depletion.

ANSWER: B.

核子反應器以全功率連續運轉六個月，在這段期間必須持續降低反應器冷卻水硼濃度，以彌補……

A. 分裂產物毒素累積及控制棒本領減少。

B. 燃料耗竭及分裂產物毒素累積。

C. 控制棒本領減少及可燃性毒物燃耗。

D. 可燃性毒物燃耗及燃料耗竭。

答案：B.

科目： 192007
知能類：K1.04 [3.1/3.4]
序號： P1264 (B1163)

Refer to the drawing of K_{eff} versus core age for a nuclear reactor core following a refueling outage (see figure below).

Which one of the following is responsible for the majority of the decrease in K_{eff} from point 1 to point 2?

A. Depletion of fuel

B. Burnout of burnable poisons

C. Initial heat-up of the reactor

D. Buildup of fission product poisons

ANSWER: D.

核子反應器於更換燃料大修後，其K_{eff}與爐心壽命關係如下圖所示。

下列何者為導致K_{eff}從點1降到點2的主要原因？

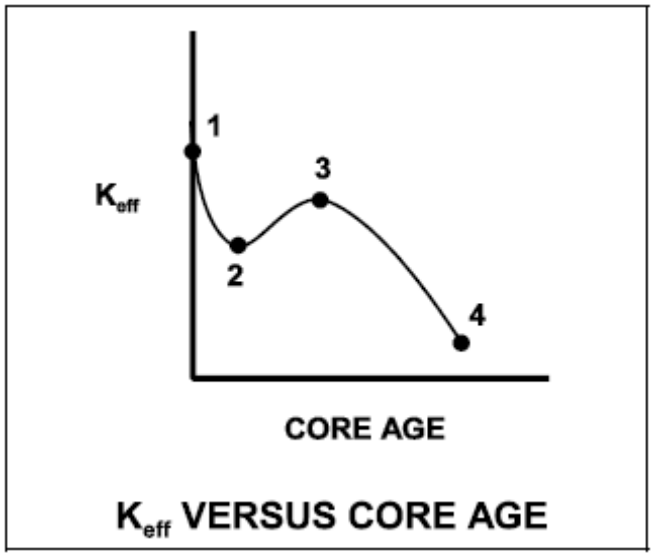
A. 燃料燃耗。

B. 可燃性毒物燃耗。

C. 反應爐起始升溫。

D. 分裂產物毒素累積。

答案：D.



科目： 192007
知能類：K1.04 [3.1/3.4]
序號： P1563 (B1563)

Refer to the graph of critical boron concentration versus burnup for a nuclear reactor core following a refueling outage (See figure below.).

Which one of the following is primarily responsible for the shape of the curve from the middle of core life to the end of core life?

A. Fuel depletion

B. Fission product buildup

C. Burnable poison burnout

D. Conversion of U-238 to Pu-239

ANSWER: A.

核子反應器爐心於更換燃料大修後，其臨界硼濃度與爐心燃耗關係如下圖所示。

造成硼濃度從爐心壽命中期至末期其曲線變化的主因為何？

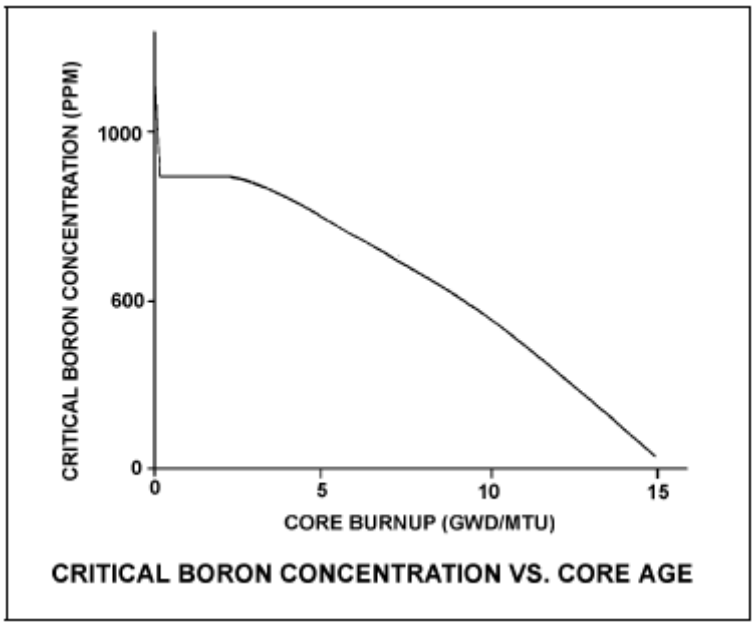
A. 燃料燃耗。

B. 分裂產物累積。

C. 可燃性毒物燃耗。

D. U-238轉變成Pu-239。

答案：A.



科目： 192007
知能類：K1.04 [3.1/3.4]
序號： P1864 (B1364)

Refer to the graph of critical boron concentration versus core burnup for a nuclear reactor core during its first fuel cycle (see figure below).

Which one of the following explains why reactor coolant critical boron concentration becomes relatively constant early in core life?

A. Buildup of fission product poisons is being offset by burnable poison burnout and fuel depletion.

B. Burnable poison burnout and fuel depletion are being offset by buildup of fission product poisons.

C. Fuel depletion is being offset by the buildup of fissionable plutonium and fission product poison buildup.

D. Fission product poison buildup and fuel depletion are being offset by burnable poison burnout.

ANSWER: D.

核子反應器爐心處於第一燃料週期時，其臨界硼濃度與爐心燃耗關係如下圖所示。

下列何者說明了在爐心壽命初期，反應器冷卻水臨界硼濃度為何變得相對穩定？

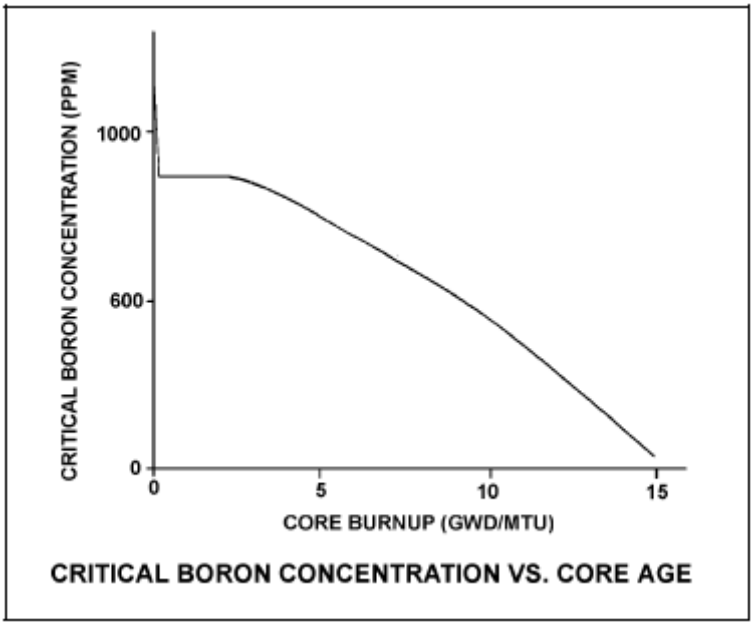
A. 可燃性毒物燃耗與燃料耗竭，抵銷了累積的分裂產物毒素。

B. 分裂產物毒素的累積，抵銷了可燃性毒物燃耗與燃料耗竭。

C. 可分裂鈽(fissionable plutonium)與分裂產物毒素的累積，抵銷了燃料耗竭。

D. 可燃性毒物的燃耗，抵銷了分裂產物毒素累積與燃料耗竭。

答案：D.



CRITICAL BORON CONCENTRATION VS. CORE AGE

科目： 192007
知能類：K1.04 [3.1/3.4]
序號： P2763 (N/A)

During continuous full-power nuclear reactor operation in the middle of a fuel cycle, the reactor coolant boron concentration must be decreased periodically to compensate for fuel depletion. What other core age-related factor requires a periodic decrease in reactor coolant boron concentration?

A. Decreasing control rod worth

B. Buildup of fission product poisons

C. Burnout of burnable poisons

D. Decreasing fuel temperature

ANSWER: B.

處於燃料週期中期的核子反應器，在以全功率連續運轉期間，必須定期調降反應器冷卻水硼濃度以彌補燃料耗竭。請問還有哪些爐心老化相關因素，需要定期調降反應器冷卻水硼濃度？

A. 控制棒本領降低。

B. 分裂產物毒素累積。

C. 可燃性毒物燃耗。

D. 燃料溫度降低。

答案：B.

科目： 192007
知能類：K1.04 [3.1/3.4]
序號： P2964 (N/A)

A nuclear reactor has been operating at 100% power for three months following a refueling outage. If the reactor is operated at 100% power without making RCS boron additions or dilutions for the next month, RCS boron concentration will...

A. decrease because boron atoms decompose at normal RCS operating temperatures.

B. decrease because irradiated boron-10 atoms undergo a neutron-alpha reaction.

C. remain constant because irradiated boron-10 atoms become stable boron-11 atoms.

D. remain constant because irradiated boron-10 atoms still have large absorption cross sections for thermal neutrons.

ANSWER: B.

一部核子反應器於更換燃料大修後，以 100%功率運轉三個月。反應器若在不加入硼酸亦不稀釋 RCS 硼濃度下，繼續以 100%功率運轉一個月，RCS 硼濃度將……

A. 降低，因為硼原子於 RCS 正常運轉溫度下解構。

B. 降低，因為被照射的(irradiated)硼-10 原子發生中子-阿伐反應。

C. 維持不變，因為被照射的硼-10 原子變成穩定的硼-11 原子。

D. 維持不變，因為被照射的硼-10 原子仍具備龐大的熱中子吸收截面。

答案：B.

科目： 192007
知能類：K1.05 [3.0/3.2]
序號： P1964

Which one of the following describes whether reactor power can be increased from 50% to 100% in a controlled manner faster near the beginning of core life (BOL) or near the end of core life (EOL)? (Assume all control rods are fully withdrawn just prior to beginning the power increase.)

A. Faster near EOL due to faster changes in boron concentration

B. Faster near EOL due to greater control rod worth

C. Faster near BOL due to faster changes in boron concentration

D. Faster near BOL due to greater control rod worth

ANSWER: C.

若以控制方式將反應器功率從 50%增至 100%，請問在接近爐心壽命初期(BOL)時的增加速率較快？還是接近爐心壽命末期(EOL)時的增加速率較快？(假設所有控制棒就在功率開始增加前全部抽出)

A. 接近爐心壽命末期時較快，因為硼濃度變化較快。

B. 接近爐心壽命末期時較快，因為控制棒本領較大。

C. 接近爐心壽命初期時較快，因為硼濃度變化較快。

D. 接近爐心壽命初期時較快，因為控制棒本領較大。

答案：C.

科目： 192007
知能類：K1.05 [3.0/3.2]
序號： P2053

Which one of the following correctly compares the rates at which reactor power can be increased from 80% to 100% at the beginning of core life (BOL) and at the end of core life (EOL)?

A. Slower at EOL due to a lower maximum rate of reactor coolant boron dilution.

B. Slower at EOL due to lower control rod worth.

C. Slower at BOL due to a lower maximum rate of reactor coolant boron dilution.

D. Slower at BOL due to lower control rod worth.

ANSWER: A.

若將反應器功率從 80%增至 100%，請比較在接近爐心壽命初期(BOL)時的增加速率，以及接近爐心壽命末期(EOL)時的增加速率，下列何者正確？

A. 爐心壽命末期時較慢，因為最高反應器冷卻水硼酸稀釋率較小。

B. 爐心壽命末期時較慢，因為控制棒本領較小。

C. 爐心壽命初期時較慢，因為最高反應器冷卻水硼酸稀釋率較小。

D. 爐心壽命初期時較慢，因為控制棒本領較小。

答案：A.

科目： 192007
知能類：K1.05 [3.0/3.2]
序號： P3364 (N/A)

A nuclear reactor has been shut down for 8 hours following a loss of offsite power. A reactor coolant system (RCS) cooldown on single-phase natural circulation is in progress.

Compared to adding boric acid to the RCS during forced circulation, adding boric acid during natural circulation requires _____ time to achieve complete mixing in the RCS; and, once completely mixed at a given coolant temperature, a 1 ppm increase in RCS boron concentration during natural circulation will cause a/an _____ change in core reactivity.

A. more; smaller

B. more; equal

C. less; smaller

D. less; equal

ANSWER: B.

核子反應器在喪失外電後停機 8 小時。反應器冷卻水系統(RCS)開始以單相自然循環降溫。

相較於在強制循環期間加入硼酸至 RCS，若在自然循環期間加入硼酸，需要_____時間才能讓其在 RCS 徹底混合；而且，硼酸一旦在已知冷卻水溫度下徹底混合，RCS 硼濃度在自然循環期間每增加 1 ppm，將對爐心反應度造成_____的變化。

A. 較多；較小

B. 較多；相同

C. 較少；較小

D. 較少；相同

答案：B.

科目/題號：192007/1 (2016 新增)
知能類：K1.04〔3.1/3.4〕
序號：P4832

Just prior to a refueling outage, the reactor coolant boron concentration at 100 percent power was 50 ppm. Burnable poisons were installed during the outage. Immediately following the outage, the boron concentration at 100 percent power was 1,000 ppm. Which one of the following contributes to the need for a much higher 100 percent power reactor coolant boron concentration after the outage?

A. The negative reactivity from burnable poisons after the outage is greater than before the outage.
B. The negative reactivity from fission product poisons after the outage is smaller than before the outage.
C. The positive reactivity from the fuel in the core after the outage is smaller than before the outage.
D. The positive reactivity from a unit withdrawal of a typical control rod after the outage is greater than before the outage.

ANSWER: B.

更換燃料停機前，反應器功率 100%時冷卻水硼酸濃度為 50ppm。在更換燃料停機時安裝了可燃耗毒素。在大修後 100%功率硼酸濃度為 1000ppm。
下列何者為在停機後必須提供比停機前，100%功率時更高的反應器冷卻水硼酸濃度的理由？
A.大修後可燃耗毒素的負反應度將比停機前更大
B.大修後分裂產物毒素的負反應度將比停機前更小
C.大修後爐心燃料的正反應度將比停機前更小
D.大修後從機組單位控制棒所抽出之正反應度將比停機前更大

答案： B

科目/題號：192007/2 (2016 新增)
知能類：K1.04〔3.1/3.4〕
序號：P7532

A nuclear power plant had been shut down for two weeks near the middle of a fuel cycle when a reactor startup was commenced. Twelve hours later, reactor power is 100 percent, where it is being maintained. Which one of the following is the primary reason for periodically reducing the reactor coolant boron concentration during the next 36 hours?
A. To offset the buildup of xenon-135.
B. To offset the depletion of the reactor fuel.
C. To maintain an adequate shutdown margin.
D. To maintain reactor heat flux below the critical heat flux.
ANSWER: A.

核能電廠運轉在接近燃料週期中期時，停機 2 星期。當反應器進行啟動 12 小時後，功率達 100%並維持在此運轉。在未來 36 小時，下列何者是週期性降低反應器冷卻水硼酸濃度的主要原因？
A.為補償氙-135 毒逐漸增加
B.為補償反應器燃料的燃耗
C.為維持足夠停機餘裕
D.為了維持反應器熱通量低於臨界熱通量

答案： A