

QUESTION 10

You are a health physicist at a nuclear power plant. The plant is shutting down for refueling shortly. The plant manager asks you to assess some of the expected radiological conditions during the shutdown.

GIVEN

Reactor coolant system (RCS) data (average data for 90 days prior to shutdown):

- Reactor coolant volume = 60,000 gal
- Reactor coolant ^{131}I concentration = $0.01 \mu\text{Ci mL}^{-1}$
- Reactor coolant ^{133}Xe concentration = $10 \mu\text{Ci mL}^{-1}$
- RCS leak rate to containment atmosphere = 0.5 gal min^{-1}
- Reactor coolant cleanup rate = 100 gal min^{-1}
- Reactor coolant cleanup efficiency = 90 %
- Containment ^{131}I concentration = $8 \times 10^{-9} \mu\text{Ci cm}^{-3}$

Containment data:

- Containment free air volume = $2 \times 10^6 \text{ ft}^3$ or $6 \times 10^{10} \text{ cm}^3$
- Containment atmosphere pressure reduction ventilation rate = $2000 \text{ ft}^3 \text{ min}^{-1}$
- Containment atmosphere charcoal filters cleanup flow rate = $15,000 \text{ ft}^3 \text{ min}^{-1}$
- Containment atmosphere charcoal filter efficiency = 95%
- Ambient containment radiation level = 5 mrem h^{-1}

Additional data:

- 1 gal = 3800 cm^3
- Half-life of ^{131}I = 8 d
- Half-life of ^{58}Co = 71 d
- DAC for ^{131}I = $2 \times 10^{-8} \mu\text{Ci cm}^{-3}$
- Specific gamma-ray exposure constant for ^{58}Co , Γ , = $5.5 (\text{R cm}^2 \text{ mCi}^{-1} \text{ hr}^{-1})$
- w_T (thyroid) = 0.03

POINTS

STATE ALL ASSUMPTIONS

- 25 A. List five considerations when estimating the ^{131}I airborne concentration in containment 24 hours after shutdown. **Number your responses. Only the first five will be graded.**
- 20 B. Determine the committed dose equivalent (CDE) to the worker's thyroid from a 10-hour exposure to an ^{131}I containment atmosphere of $8 \times 10^{-9} \mu\text{Ci cm}^{-3}$. The worker did not use respiratory protection. **State all assumptions and show all calculations.** Also determine the worker's committed effective dose equivalent (CEDE). **State all assumptions and show all calculations.**
- 20 C. List four factors that should be considered in the pre-job analysis for a containment entry after shutdown in order to keep the worker's total effective dose equivalent ALARA. **Number your responses. Only the first four will be graded.**
- 25 D. The plant manager considers H_2O_2 treatment of the RCS. H_2O_2 will be added at Mode 5 initiation and will increase the level of soluble ^{58}Co in the RCS. The solubilized ^{58}Co is removed by the RCS demineralizers. You expect the level of ^{58}Co in the RCS to increase to $1 \mu\text{Ci ml}^{-1}$ as a result.
- 1) State three methods for reducing the RCS ^{58}Co cleanup time. **Number your responses. Only the first three responses will be graded.**
 - 2) State two benefits of adding H_2O_2 to the RCS at the onset of a refueling. **Number your responses. Only the first two responses will be graded.**
- 10 E. Given an exposure rate of 0.25 mR hr^{-1} at 2 meters away on the center line of a 2 m long pipe containing uniform concentration of ^{58}Co , calculate the total activity contained in the pipe. **State all assumptions and show all calculations.**