(19.11) The radiometric sensitivities for discovering ^{59}Fe, ^{131}I, and ^{90}Sr are 75, 25, and 0.74 kBq m^{-3} of water. In the Würgassen plant the total permitted aqueous annual release is 17 Ci β-emitters. Assume an activity ratio in the cooling water of 100:10:1 for the three nuclides above and that none of these activities exceed 1% of the permissible release. How many times must a liquid sample taken each day be concentrated to meet these requirements?

Data, constants, and units:

$Bq := sec^{-1}$ $\qquad$ $Ci := 3.7 \cdot 10^{10} \cdot Bq$

Data given in the text:

$p_{hrlevel} := 17 \cdot Ci \cdot yr^{-1}$ $\qquad$ $V_{cooling} := 95000 \cdot m^3 \cdot hr^{-1}$

$R_{59Fe} := 75 \cdot 10^3 \cdot Bq \cdot m^{-3}$ $\qquad$ $R_{131I} := 25 \cdot 10^3 \cdot Bq \cdot m^{-3}$ $\qquad$ $R_{90Sr} := 0.74 \cdot 10^3 \cdot Bq \cdot m^{-3}$

Calculations:

$p_{real} := p_{hrlevel} \cdot \frac{1}{100}$ $\qquad$ 1% of permitted release level for any nuclide; ^{59}Fe will be the limiting case for activity concentrations.

$S_{59Fe} := \frac{p_{real}}{V_{cooling}}$ $\qquad$ $S_{59Fe} = 7.553 \cdot m^{-3} \cdot Bq$

$S_{131I} := \frac{p_{real}}{V_{cooling}} \cdot \frac{1}{10}$ $\qquad$ $S_{131I} = 0.755 \cdot m^{-3} \cdot Bq$

$S_{90Sr} := \frac{p_{real}}{V_{cooling}} \cdot \frac{1}{100}$ $\qquad$ $S_{90Sr} = 0.076 \cdot m^{-3} \cdot Bq$

$Conc59Fe := \frac{R_{59Fe}}{S_{59Fe}}$ $\qquad$ $Conc59Fe = 9.929 \cdot 10^3$

$Conc131I := \frac{R_{131I}}{S_{131I}}$ $\qquad$ $Conc131I = 3.31 \cdot 10^4$

$Conc90Sr := \frac{R_{90Sr}}{S_{90Sr}}$ $\qquad$ $Conc90Sr = 9.797 \cdot 10^3$

Answer: ^{131}I is the critical nuclide, requires concentration 33100 times; *i.e*. about 33000 times