Application of a Simplified Carbon-14 Gaseous Effluent Dose Screening Spreadsheet

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Regulatory Guide 1.109

- Gaseous effluent dose for C-14 assumes inhalation and ingestion pathways; immersion and ground deposition negligible
- Inhalation dose calculated via Equation C-3
- Ingestion pathway doses assume incorporation of C-14 into vegetation, as described in Equation C-8; once incorporated into vegetation, additional exposure pathways of milk and meat ingestion can be calculated

Regulatory Guide 1.109 (continued)

- Both Equations C-3 and C-8 are driven by the X/Q dispersion factor at the receptor location
- RG-1.109 states that C-14 is assumed to be released in the oxide form, either monoxide or dioxide; other forms ignored by RG-1.109
- Only the dioxide form of C-14 is available for incorporation into the food chain via plant photosynthesis

Dose Calculation Spreadsheet
Assumptions/Approach

- Uses RG-1.109 equations to predict concentrations of C-14 in air, vegetation, milk, and meat as a function of C-14 gaseous release and X/Q at receptor location
- Uses RG-1.109 age-specific usage factors and dose conversion factors to estimate resulting dose
  - Inhalation DCFs based on *WRONG* chemical form; however, inhalation dose negligible
- ICRP-72 Effective Dose Equivalent (EDE) is also calculated for comparison

Dose Calculation Spreadsheet Input Parameters

- Reactor type: used to determine normalized release rate and CO2 fraction
  - Provision to override normalized release rate and CO2 fraction based on individual plant assumptions
- Reactor power: used to scale normalized release factors
- Equivalent days of full-power operation over period of interest (annual)

Dose Calculation Spreadsheet
Input Parameters (continued)

- Length of growing/production seasons for leafy vegetables, fruits+vegetable+grain, milk pasture, meat pasture: used to calculate resulting media concentrations
  - Individual ingestion pathways can be “toggled off” by setting season length to zero
- X/Q at receptor location of interest: used to calculate resulting media concentrations

Dose Calculation Spreadsheet Output Parameters

- Total C-14 released (Ci/yr), as well as CO2 form released (Ci/yr)
- Resulting maximum dose (mrem/yr) to RG-1.109 critical organ (bone), RG-1.109 “total body”, and ICRP-72 EDE, along with age class
- Additional information available:
  - Resulting media concentrations (pCi/m^3, pCi/kg, pCi/L)
  - Age-specific intake (pCi/yr) by exposure pathway
  - Age-specific dose (mrem/yr) by exposure pathway

Summary

- C-14 dose screening spreadsheet provides for quick assessment of resulting dose based on minimum input requirements
- Resulting dose from C-14 is significant (>1%) dose contributor; may even exceed dose from all other gaseous effluents combined, including tritium
- Most critical input parameter appears to be receptor location X/Q value... need to select realistic X/Q value, as opposed to overly conservative site boundary “fence-post” value

Summary

- Most critical exposure pathways appear to be vegetable and fruit ingestion, followed by milk ingestion... need to make realistic assumptions based on existing pathways at receptor location
- Inhalation dose is negligible
- Dose is dominated by RG-1.109/ICRP-2 bone dose, which is overly conservative compared to modern dosimetric models based on ICRP-30 or ICRP-72

Questions?