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Down-Posting an Airborne Radioactivity Area Using CAMs and Math

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Topics to be Covered

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- CAM Set-Point Determination
- Down-Posting of an Airborne Radioactivity Area (ARA) using CAMs and Math

CAM Set-Point Determination

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- CAM Use
- Alpha-7
- Practical CAM Set-Point Considerations
- Definition of Airborne Radioactivity Area (10CFR835.2)
- Set-Point Example

CAM Use

- CAMs used primarily for worker protection (PPE control), posting of an ARA is more compliance (administrative control).

Alpha-7 CAM

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- User options
  - Concentration in DAC
  - Dose in DAC-hr
  - Release rate in pCi/min

- Each user option can have two alarm settings based on the time window:
  - Fast (acute)
  - Slow (chronic)

Alpha-7 CAM

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- The SNL Radioactive and Mixed Waste Management Facility (RMWMF) uses Concentration in DAC and the two alarm set points primarily for worker protection and secondarily for compliance.
- All other options are disabled

Practical CAM
Set-Point Considerations

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- Background MDC/MDA relative to alarm levels
- DAC vs. time window considerations
  - Room flow-rate
- Radiological controls
  - Respirator type and protection factor

More CAM Practical Considerations

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- Perception considerations to internal dose
  - Is the Line willing to accept the idea of internal dose
- ALARA

Even More CAM Considerations

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- 10CFR835 ARA posting considerations
  - Must be conceptually aware of the ARA posting requirements if you intend for CAMs to assist in the down-post
- Not an exact science, iterative approach

Definition of Airborne Radioactivity Area (10CFR835.2)

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- Airborne Radioactivity Area (ARA) 10CFR835.2:

  1) concentration of airborne is or is likely to exceed 1DAC

  OR

  2) An individual present without respiratory protection could receive an intake exceeding 12DAC*hrs per week

Airborne Radioactivity Area

- ARA posted based on a long-term (chronic) OR short-term (acute) condition

$$1)\ 1DAC * \frac{2000hr}{work\ year} = \frac{5rem}{work\ year}$$

$$2)\ \frac{12DAC*hr}{week} * \frac{2.5mrem}{DAC-hr} = \frac{30mrem}{week}$$

Respirator Required? (primary question)

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- CAM settings are related to respirator requirements.
  - DAC concentration Fast (acute) set-point
    - Respirator
  - DAC concentration Slow (chronic) set-point
    - No respirator

Example

- Fast Set-Point (DAC-hr), Acute Exposure, Respirator Required

Fast Set-Point (respirator required)

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- Fast Concentration Alarm set to 2000 DAC in a 2 minute window
- $2000DAC * 2min * \frac{1hr}{60min}$ = 66.7DAC-hr
- 66.7 DAC-hr*$\frac{2.5mrem}{DAC-hr}$ = 167mrem

Fast Set-Point (respirator required) con't

- $\frac{167\ mrem}{respirator\ PF} = \frac{167\ mrem}{50\ (APR)}$ = 3.3 mrem

If exposed to 2000DAC for 2minutes while wearing an APR with a PF of 50, the resulting calculated dose would be 3.3 mrem.

Down-Posting of an ARA Using CAMs and Math

- Practice
- Why Use CAMs and Math to Down-Post
- Basic Equations
- Example

Practice

- Up-post based on potential
- Up-Posting and down-posting is based around “concentration of airborne is or is likely to exceed 1DAC”
- A posted ARA requires a respirator for entry, respirator requires lapel air sampler, lapel air sampler requires bioassay evaluation.
- It is in our best interest to down post an ARA as early as possible.

Why Use CAMs and Math to Down-Post

- Math remains unbiased
- Take advantage high flow-rate in rooms
- Eliminate air sampler placement issues
- More time efficient
  - H810 takes ~8.5 min. to collect a 1000L sample
  - Eliminate sampling, analysis, and data review

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And Now the

MATH

Room Ventilation

- Room airborne contaminants decrease as an exponential :

$$I = I_0 \, e^{-\lambda t}$$

- Where:
  - $I_0 = initial\ fast\ CAM\ set\text{-}point\ DAC\text{-}hr$
  - $I = \ desired\ DAC\text{-}hr\ \ for\ \ ARA\ posting$
  - $\lambda \ = \ air\ removal\ rate\ constant\ \ (minute^{-1})$
  - t = time (minute)

Air Removal Rate Constant Determination

- λ = room ventilation rate(s) (ft^3/minute)/ room volume (ft^3)

- $\lambda = \frac{ft^3/minute}{ft^3} = minute^{-1}$

  - Room volume from engineer diagrams
  - Room ventilation rate(s) from all sources as measured by Kirk Air

Solve for Time (t)

- $I = I_0 e^{-\lambda t}$
- $\frac{I}{I_0} = e^{-\lambda t}$
- $\text{LN}[\frac{I}{I_0}] = -\lambda t$

Solution

$$\frac{\mathrm{LN}[\frac{I}{I_o}]}{-\lambda} = t$$

Example

- Determine the time required to down-post Building 6920, room 119 if posted as an Airborne Radioactivity Area

6920
Room 119

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- λ =
  - Room ventilation, three sources:
    - Room vent = 44 ft^3/min.
    - Glove Box and secondary room vent = 1,105 ft^3/min.
    - Total ventilation rate = 1,149 ft^3/min.
  - Empty room volume 2,280ft^3

- $\lambda = \frac{1{,}149\ ft^3/min}{2{,}280\ ft^3} = 0.50\ min^{-1}$

Populate Variables

- $I_0 =$ fast CAM set-point $66.7 DAC\text{-}hr$
- $I =$ desired for down-posting an ARA $1\ DAC\text{-}hr$
- $\lambda =$ air removal rate constant $0.50\ min^{-1}$

Solve for time

- $\frac{\mathrm{LN}[\frac{I}{I_0}]}{-\lambda} = t$

- $\frac{\mathrm{LN}\left[\frac{1\ DAC-hr}{66.7\ DAC-hr}\right]}{-0.50}$ = 8.4minutes

  - 66.7 DAC-hr would decrease to 1 DAC-hr in 8.4 minutes in 6920, room 119

Conservative

- Assumes:
  - room volume is empty
  - initial air is at the maximum that would not alarm the CAM, fast CAM set-point
  - Round up the time to the next highest ‘convenient’ value, 8.4 minutes becomes 10 minutes

Controls

- Not applicable if CAM alarms
  - Don’t know the maximum DAC-hr value

- Time starts when the source for airborne has been removed
  - Containerization of the material, the container does not need to be removed

Compliance with 10CFR835.2 ARA

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- Post an ARA when: “1) concentration of airborne is or is likely to exceed 1DAC”
  - Conservatively up-post based on potential
  - Down-post based on solving the exponential
    - Conservative assumptions


That's all Folks!