



Savannah River

Nuclear Solutions, LLC

A Fluor Daniel PartnershipSM

Field Air Sample Calculations

Dennis Hadlock, RRPT, CHMM, CHP

Fellow Health Physicist

May 7, 2009

SRNS-J6700-2009-00047

Air Monitoring Users Group

Las Vegas, NV

Overview

- **What is a Field Calculation?**
- **Purpose of Field Calculation.**
- **DAC Field Calculations**
- **DAC-Hr Field Calculations**
- **'Requirements' for Field Calculations**
- **Group Discussion**

What is a Field Calculation?

- The determination of DAC or DAC-hr by Health Physics Technicians while radiological work is in progress. This is a near real time calculation using a typical retrospective filter paper air sampler and portable count rate instruments (e.g., 110 beta-gamma probe and/or AC-3 alpha probe).



Purpose of Field Calculations

- **The Field Calculations are compared to the Radiation Work Permit (RWP) Suspension Guide to determine if the job should be suspended.**
 - Airborne Suspension Guides determined during the job planning process and specified in the RWP.
 - Limited by respiratory protection worn.

DAC Field Calculations

- **SRS previously controlled all airborne work by calculating peak 15 minute DAC values.**
- **The DAC calculation was simplified to facilitate field use.**
- **Portable survey instruments used to determine the amount of radioactivity on the filter paper.**

DAC Field Calculations

- **Radon-Thoron contribution to the activity on the filter paper subtracted out by allowing filter to run for several hours to provide a baseline equilibrium value.**
 - Problems with changing Rn-Tn values in environment.
 - Problems when background sample in one area and work in another (e.g., changing ventilation zones within a facility).

DAC Field Calculations

$$DAC = \frac{(\text{dpm}) \left(4.5E - 07 \frac{\mu\text{Ci}}{\text{dpm}} \right)}{\left(V(\text{ft}^3) \right) \left(28,320 \frac{\text{cc}}{\text{ft}^3} \right) (\text{CE})(\text{SA})(\text{DAC}_i)}$$

Pull out the constants and you get:

$$DAC = \left(\frac{4.5E - 07}{(28,320)(\text{SA})(\text{CE})(\text{DAC}_i)} \right) \frac{\text{dpm}}{V}$$

DAC Field Calculations

Calculate the constants for specific samplers/Isotopes

| Sample Media | Pu-239 | Pu-238 | Uranium | Sr-90 |
|-----------------------------|---------------|---------------|----------------|--------------|
| Filter Paper | 3.972 | 3.310 | 0.284 | 0.003 |
| Impactor¹ | 4.226 | 3.522 | 0.302 | 0.003 |
| HVAM² | 5.885 | 4.904 | 0.420 | 0.004 |

¹Kinetic Impactor grab sampler; greased metal planchet; 30 minute sample time; 35 cfm.

²Kinetic Impactor CAM, greased plastic planchet; 24 hour sample time, 40 cfm.

DAC Field Calculations

Round to usable numbers and then simplify the formula

| Sample Media | Pu-239 | Pu-238 | Uranium | Sr-90 |
|--------------|--------|--------|---------|-------|
| Filter Paper | 4 | 3 | 0.3 | 0.003 |
| Impactor | 4 | 4 | 0.3 | 0.003 |
| HVAM | 6 | 5 | 0.4 | 0.004 |

$$\text{DAC} = (Y) \frac{\text{dpm}}{V}$$

Where Y is from the above table

DAC-Hr Field Calculations

- **In June of 2003 SRS changed to DAC-hr for controlling airborne work.**
 - DAC-hr matched with CAM alarm setpoints.
 - DAC-hr a better measure of the risk to worker
 - Simplified the Field Calculation.

DAC-Hr Field Calculations

$$DAC - hr = \frac{(\text{dpm}) \left(4.5E - 07 \frac{\mu\text{Ci}}{\text{dpm}} \right) (T_E \text{ (hr)})}{\left(\dot{V} \frac{\text{ft}^3}{\text{min}} \right) (T_S \text{ (hr)}) \left(28,320 \frac{\text{cc}}{\text{ft}^3} \right) \left(60 \frac{\text{min}}{\text{hr}} \right) (\text{SA}) (\text{CE}) (DAC_i)}$$

Worst Case: assume $T_E = T_S$

$$DAC - hr = \frac{(\text{dpm}) \left(4.5E - 07 \frac{\mu\text{Ci}}{\text{dpm}} \right)}{\left(\dot{V} \frac{\text{ft}^3}{\text{min}} \right) \left(28,320 \frac{\text{cc}}{\text{ft}^3} \right) \left(60 \frac{\text{min}}{\text{hr}} \right) (\text{SA}) (\text{CE}) (DAC_i)}$$

DAC-Hr Field Calculations

In this case, everything can be considered a constant except dpm

$$DAC - hr = \frac{dpm}{Z}$$

Where Z is determined by:

$$Z = \frac{\left(\dot{V} \right) (28,320) (60) (CE) (SA) (DAC_i)}{4.5E-07}$$

DAC-Hr Field Calculations

Table of (rounded) Z values for various flow rates and isotopes

| Equipment | Flow (ft³/min) | Pu-239 | Pu-238 | Uranium | Sr-90 |
|------------------|--------------------------------------|---------------|---------------|----------------|---------------|
| RASr | 2 | 30 | 40 | 400 | 40000 |
| | 3 | 50 | 50 | 600 | 65000 |
| | 4 | 60 | 70 | 800 | 85000 |
| | 5 | 80 | 90 | 1000 | 110000 |
| Impactor | 35 | 500 | 600 | 7000 | 700000 |
| HVAM | 40 | 300 | 300 | 4000 | 400000 |

RCI Quick Card for DAC-hr

| Sample Flow (cfm) | Pu-239 | Pu-238 | U | Sr-90 | Co-60 |
|----------------------|--------|--------|-------|---------|-----------|
| 1 | 15 | 20 | 200 | 20,000 | 90,000 |
| 2 | 30 | 40 | 400 | 40,000 | 200,000 |
| 3 | 50 | 50 | 600 | 60,000 | 300,000 |
| 4 | 60 | 70 | 800 | 80,000 | 400,000 |
| 5 | 80 | 90 | 1,000 | 100,000 | 500,000 |
| Impactor (35) | 500 | 600 | 7,000 | 700,000 | 3,000,000 |
| HVAM (40) | 300 | 300 | 4,000 | N/A | N/A |

$$DAC - hr = \frac{dpm}{Z}$$

$$dpm = (DAC - hr)(Z)$$

Requirement for Field Calculations

Although there is no regulatory requirement to perform near real-time analysis of air samples to ensure the adequacy of respiratory protection devices during the task, it is the position of SRS that when the air sampler used lends itself to this type of analysis it will be performed...using portable survey instruments to probe the air sample medium at the start of work, frequently during the work, and when the sample is completed.

Requirement for Field Calculations

- The urban myth at SRS is that you are “required” to perform Field Calculations anytime a worker is wearing a respirator.
 - One internal assessor believed Field calculations were required by 10CFR835.403(a)(2).
 - Cannot perform Field DAC-hrs with a Personal Air Sampler (lapel).
 - Some tasks prevent Field Calculations as you cannot sample the environment of the worker.





Discussion Points

- **How many Sites routinely perform Field Calculations on Air Samples?**
- **If yes, do you use DAC or DAC-hr?**
 - How do you compensate for Rn-Tn?
 - Diurnal change compensation?
- **If no, do you compensate with CAMs?**
 - Anyone ever question your practice?
- **Do you think this is overkill, about right, need to do more?**



??Other Questions??

