SNL Approach for Determining the Need for Air Sampling (NUREG 1400 Based)

Presented by

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Reasons for Air Sampling

Compliance with 10 CFR 835

- **Assess worker dose (internal exposure),** {835.402 (c) w/ .209 (b) & .702 (b)}
- **Warn of an immediate need to take action,** {835.403 (b)}
- **Evaluate the need for and level of respiratory protection,** {835.403 (a,2)}
- **Evaluate the effectiveness of engineered controls,** {835.401 (a,5)}
- **Support posting decisions,** {835.603 w/.1102}
- **Determine overall airborne radiological contaminant conditions.** {835.401 (a,2)}

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SNL Workplace Settings

- Continuous Production-like Processes
- Continuous Operations w/Variable Input
- Periodic Operations w/ Variable Activities/Inputs
- Discontinuous Operations w/Variable Activities & Inputs
- Roving Activities
- Not Otherwise Specified Work Settings w/Potential for Handling RAD

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Air Sampling Considerations

- **Where there is a relatively stable source term, process and operational environment over the long term (eg.: a year) determining the need for air sampling is simple.**
- **Many of SNL's workplace settings do not fit into this category.**
- **A method is necessary to evaluate individual work activities for the purpose of determining the need for air sampling (among other actions)**

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Air Sampling Considerations

- **There are activities at SNL where a potential for airborne radioactivity exists yet the potential for the individual short term job to yield intakes exceeding 40 DAC hrs. is small.**
- **However, the result of incremental intakes considered together over a year, from multiple short duration jobs has a much higher potential for exceeding the threshold for sampling/monitoring.**
- **Particularly where some or most of the source term is from alpha emitters, air sampling likely has superior sensitivity to bioassay.**

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Sources of Information

- Existing Air Sampling Data and/or Bioassay Info.
- Contamination Survey Data
- Process Knowledge
- Anticipated Source Term
- Modeling

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Basis for Sampling Threshold

- **Compliance with 10 CFR 835:**
  - **Monitoring of airborne radioactivity shall be performed where an individual is likely to receive an exposure of 40 or more DAC-hours in a year.**
  - **Dosimetry programs (bioassay or air monitoring) shall be conducted when individuals are likely to receive a committed effective dose of 0.1 rem (0.001 Sv) or more *from all occupational radionuclide intakes in a year.***
  - ***Unrecorded internal dose shall not exceed the above stated threshold.***

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Basis for Sampling Threshold

NUREG 1400 states:

"The need to perform surveys and monitoring is based on the need to limit dose to the workers", then notes that if uncertain, prediction of annual intake is needed

The NUREG essentially recommends that air sampling be considered *where annual material throughput exceeds* 1E+04 times the ALI which would unlikely cause intakes > 1% of ALI (Q > 1E+04 * ALI) or average concentrations > 1% DAC

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Initial Screening for Applicability

- **SNL chose NUREG 1400 criteria as the Technical Basis upon which criteria have been developed (> 1% of the ALI).**
- **Recognizing that the majority of our potential settings where air sampling may be needed involves short term, periodic, discontinuous rather than continuous (over a period of a year) operations, and inasmuch as the nuclides/mix as well as actual handling processes is apt to change between iterations, a time variable was determined necessary, relative to the period of operations within which the other variables would remain essentially constant.**

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Initial Screening for Applicability

- **As such, for any given job/campaign, etc., the threshold for accepting the premise that there is a reasonable potential for airborne radioactivity and therefore, air sampling must be considered is modified as follows:**

$$Q > 1E+04*ALI \quad \rightarrow \quad Q_i > 1E+04*ALI_i*t_y$$

Where Q_i **= total activity of radionuclide "i" handled during time** t_y

t_y **= duration of work as a fraction of a work-year**

ALI_i **= Annual Limit of intake for nuclide "i"**

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Initial Screening for Applicability

- **Since 10 CFR 835 does not provide ALIs, but does provide DACs (Appendix A), this reference is readily available, and the relationship between DAC and ALI is…**

$$ALI_i = (DAC_i \text{ uCi/ml})*(2400 \text{ m}^3)*(1E+06 \text{ ml/m}^3),$$

- **The threshold for considering air sampling becomes…**

$$Q_i > 2.4E+13*DAC_i*t_y$$

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Initial Screening for Applicability

- If the value for Q_i is less than or equal to the product of initial screening, air sampling is not required.
- If the value for Q_i is greater than the product of initial screening, detailed screening is necessary.

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Detailed Screening

Beginning with the general NUREG 1400 expression to determine potential annual intake:

$$I_p = Q * 1E\text{-}06 * R * C * D$$

where

I_p = potential annual intake

Q = annual throughput

R = release fraction

C = confinement factor

D = dispersibility

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Detailed Screening

If we set I_p at the threshold for sampling (50 mrem) and consider intake relative to the fraction of a year over which the project occurs,

$$ALI_i * 0.01 * t_y = Q_i * 1E\text{-}06 * R * C * D$$

Substituting for ALI_i

$$2.4E+13 * DAC_i * t_y = Q_i * R * C * D$$

Since this defines the threshold condition or threshold, v_i:

$$v_i = [(4.17E\text{-}14) * (Q_i * R * C * D)] / (DAC_i * t_y)$$

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Detailed Screening

- When applying this methodology for a given project, if the result of the determination is a value for v_i of 1 or greater, some level of air sampling is required.
- The degree of sampling/monitoring depends on how high the value is as summarized in the Airborne Hazard Decision Matrix.
- If the value for v_i is less than 1, some level of air sampling ***may*** still be required.

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Detailed Screening

- **Additional Monitoring Considerations**

  Other Factors to consider besides a priori estimates of intake:

  - **Heterogeneity**
  - **Reliability of Source Term Estimates**
  - **Assumption Confirmation**
  - **Relative Usefulness of Bioassay Vs. Air Sampling**
  - **Engineered Controls**
  - **Respiratory Protection**

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AIRBORNE HAZARD DECISION MATRIX

Air Sampling Threshold Coefficients		Required Air Sampling Actions	Potential Requirements, Best-Practice Air Sampling Actions	
<1		• Not Required Generally, see Potential Requirements	• General Area Air Sampling • Assessment of Engineered Controls Required	
1 to <2		• General Area Air Sampling, • Assessment of Engineered Controls	• BZ (may be required for very short jobs, e.g. < 1 h) • Bioassay	
2 to <30		• General Area Air Sampling, • BZ/Bioassay, • Assessment of Engineered Controls	• Continuous Air Monitoring • Evaluate Need for Additional Work Controls. ARA posting requires consideration of Resp. Protection and air sampling for down-post).	
30 or greater		• General Area Air Sampling, • BZ/Bioassay, • Respiratory Protection, • Continuous Air Monitoring (potential for 40 DAC hr/week) • Evaluate Need for Additional Work Controls • Post as ARA (air sampling for down-post)		

Cautions: **Regardless of where a determination falls in the matrix above:**

Adequacy of engineered controls used to mitigate internal exposures must be monitored,

If there is realistic potential to exceed DAC, posting as ARA required,

Where there is an ARA posted, evaluate to determine the need for respiratory protection.

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Example

Several drums of waste will be sorted inside a glove box with an estimated time of 3 weeks to process. The entire source term of 10 curies, ^{238}Pu oxide is believed to be potentially respirable.

Screening for Applicability:

$$Q_i > 2.4E+13 * DAC_i * t_y$$

where: $Q_i = 1E+07$ uCi

$t_y = 3/50 = 0.06$

$DAC_i = 5E-11$ uCi/ml

$1E+07 > 72$ **This is true, therefore, Detailed Screening**

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Example

Detailed Screening:

$v_i = [(4.17E\text{-}14)*(Q*R*C*D)] / (DAC*t_y)$

where v_i = potential annual intake

Q_i = 1E+07 uCi

R = 0.01 (release fraction for metal powder)

C = 0.01 (confinement factor for glove box)

D = 1 (dispersibility, no cutting/grinding, etc.)

$v_i = [(4.17E\text{-}14)*(1E+07*0.01*0.01*1)] / (5E\text{-}11*0.06)$

$v_i = 13.9$

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Example

With a v_i = 13.9, the Airborne Hazard Control Matrix requires…

- **General Area Sampling**
- **BZ sampling and/or bioassay (as appropriate)**
- **Evaluate the adequacy of engineered controls.**

The Matrix also suggests consideration of:

- **CAMs**
- **Respiratory Protection**

Selective use of CAMs might be of value, particularly based on results of the heterogeneity of the waste. Selective use of respirators would be of value, for instance, during glove change outs and drum exchanges. Performing an intake calculation (I_p = 1E-03 uCi) using ICRP 68 effective dose coefficient (1 u particle assumption) yields a potential CED of ~56 mrem.

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Summary and Comments

- **This approach accommodates short term projects that, individually, might appear not to require air sampling yet, when considered over the course of a year, the summed potential intakes would exceed the point where sampling should have been considered over the entire year. For SNL, these short term projects, discontinuous activities and work changing in scope, nuclides and curie content tend to be far more likely than a standard production facility scenario.**

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Summary and Comments

Adapting the basic NUREG screening criteria from an annual basis to an incremental approach

(e.g. Q_i > ALI*1E+04$_i$*t_y) may accommodate projects of any duration, as short as a single day, or longer ones running for weeks, months, etc..

- **While for SNL, a baseline of 50 mrem/yr was used for technical justification by linking to a nationally recognized document as well as allowing for non-conservative errors in estimating job duration, source terms, etc., the approach could just as easily settle on another baseline value.**

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Summary and Comments

- **SNL's RPTB also recognizes an analogous approach (determining v_i) in evaluating the need for air sampling based on existing air sampling data, provided the available data is adequately representative of anticipated work conditions/scope, material being handled, etc..**

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Summary and Comments

- **NUREG 1400 focuses on production facility type operations. Inclusion of such a methodology as outlined herein, to consider short term projects such as D&D, maintenance operations, experimental laboratory settings, discontinuous processes among others, is one refinement among numerous others (e.g., reconsideration of values for modifying factors), to consider for a document revision.**
- **Such an approach (complimentary with current content) might also enhance the usefulness of Draft ANSI/HPS N13.56, Section 4, for a broader audience.**

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