Example of "Not Suitable for Matrix" Presentation

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OCAS-TIB-009

- Rev. 0, “Estimation of Ingestion Intakes,” issued April 13, 2004
- Provides approach to estimating ingestion intakes for workers without bioassay monitoring data
- Used to estimate ingestion intakes during both operational and residual contamination periods
- Relies on ambient air concentration measurements to estimate the amount of daily ingestion in the workplace

SC&A's review of OCAS-TIB-009

- SC&A reviewed OCAS-TIB-009 in June 2006
- SC&A identified a set of related findings that were later consolidated into the BRS as TIB-009 finding 1
- **BRS TIB-009 finding 1:** The fundamental scientific approach to reconstructing ingestion exposures has flaws that could lead to an underestimate of ingestion doses under certain circumstances
- SPR determined that this TIB-009 finding was an overarching issue, and the finding was transferred to BRS issue NIOSH-OVER-0002, rev. 00, "Workplace Ingestion"

NIOSH's response to SC&A's TIB-009 review

- NIOSH issued its approach to estimating ingestion intakes in a white paper on October 23, 2012, and presented its results at the November 1, 2012, SPR meeting
- NIOSH concurred that parameters used in the TIB-009 model are based on assumptions that have not been empirically demonstrated to be valid
- NIOSH agreed to revise its approach to deriving radionuclide ingestion rates
- NIOSH characterized SC&A's findings into two issues:
  - **Issue 1:** The possible lack of an association between measured air concentrations in the workplace and surface contamination
  - **Issue 2:** The modeled transfer of the surface contamination to the GI tract through inadvertent ingestion

Issue 1: NIOSH summary of SC&A findings on surface contamination

- Surface contamination levels are likely orders of magnitude higher than predicted by the settling velocity of airborne contaminants assumed at 5 microns
  - Airborne particulates at uranium rolling mills likely range from a few microns to large or visible particles
  - For larger particles, settling velocities increase dramatically, and there are no limitations for their ingestion
- Surface contamination likely builds up over time that may extend to weeks, months, or longer before reaching equilibrium
- NIOSH's assumption that equilibrium is reached in a 24-hour period is without scientific basis and highly unconservative
- For select processes, surface contamination may not be the result of settling, but may include:
  - liquid spills
  - results from milling, grinding, cutting, welding, etc.

NIOSH on issue 1: Relationship between air and surface contamination levels

- NIOSH analyzed air and smear sampling from:
  - Simonds Saw and Bethlehem Steel uranium rolling operations
  - Superior Steel during a test rolling
  - Vitro Manufacturing (~240 air samples and 150 contamination smears)
- Paired data were plotted and showed measured surface contamination levels are proportional to air contamination
- Linear regression analysis showed estimated level of surface contamination (dpm/m^2) equals 116.7 times measured air concentration (dpm/m^3)

Issue 2: NIOSH summary of SC&A findings on modeled transfer

- The modeled transfer of surface contaminations to the mouth that assumes a 10% transfer from the surface area of one hand during a full workday appears unrealistic
- In a hot and dusty work environment, a radiologically uninformed or untrained worker is likely to contact or wipe their face with both hands repeatedly over the course of a full workday
- Ingestion may involve other modes of intake, such as direct deposition on lips, smoking of cigarettes, etc.

NIOSH on issue 2: Determine daily ingestion rate for loose surface contamination

- NRC computer program RESRAD-BUILD has an ingestion parameter based on an extensive review and analysis of the literature
- In this model, the hourly ingestion rate (dpm/h) equals the surface contamination measured in the workplace (dpm/m^2) times effective transfer rate for ingestion of removable contamination (m^2/h)
- NUREG/CR-5512, volume 3, considered the average value of 1.1×10^{-4} m^2/hr (corresponding to an ingestion of about 0.5 mg/day) to represent the default ingestion transfer rate
- Corresponding ingestion rate for an 8-hour workday would be 8.8×10^{-4} m^2/d

Relationship between air concentration and surface contamination, and default daily ingestion

Using the NIOSH-derived surface contamination level and NUREG/CR-5512 default ingestion value results in the following equation:

$$I_d = 116.7 \times A_m \times GO$$

$$I_d = 0.103 \times A_m$$

where I_d = the daily ingestion of loose radioactive material in dpm/d

A_m = the measured air concentration in the workplace in dpm/m^3

GO = the NUREG/CR-5512 default for ingestion in the workplace in $m^2/d = 8.8 \times 10^{-4}$ m^2/d

TIB-009 guidance

TIB-009 recommends estimating daily ingestion intake using the following relationship:

$$I_d = 0.2 \times A_m$$

where I_d = the daily ingestion rate in dpm/d

A_m = the measured air concentration in the workplace in dpm/m^3

NIOSH conclusion on TIB-009 guidance

- Using empirical data and mean value for *GO* (slide 9 equation), ingestion intakes are predicted that are approximately half those using the TIB-009 approach
- Even though parameters and assumptions used in TIB-009 were somewhat simplistic, the model produces estimates of ingestion that are in reasonable agreement with the NUREG predictions
- It should also be considered that the 20% multiplier used in TIB-009 includes an ingestion source term for a contaminated beverage or food item, which was not considered in the development of *GO* in the NUREG
- Given the uncertainty inherent in these values, it is not unreasonable for NIOSH to continue using the TIB-009 approach for estimating intakes

Additional NIOSH ingestion considerations

- Under the TIB-009 approach, ingestion will always be a fraction of the inhalation exposure (1 dpm/m^3 of air activity results in daily inhalation and ingestion exposures of 9.6 dpm and 0.2 dpm/day, respectively)
- For uranium intakes, the uptake across the gastrointestinal tract is low
- The ingestion pathway contributes less than 0.6% to the dose for soft tissues under all solubility types
- The maximum contribution for ingestion would be to organs of the gastrointestinal tract
- For these organs, the highest contribution to a dose is 3.4% for lower large intestine when insoluble material (type S) is inhaled
- Additionally, NIOSH applies a geometric standard deviation associated with ingestion that has a minimum value of 3 and in some cases 5

NIOSH on using TIB-009 guidance for residual period

- It was discovered TIB-009 has been improperly applied during the residual period at Dupont Deepwater Works and other sites
- After the cessation of AEC activities, it is inappropriate to use a resuspension factor to estimate an air concentration and then multiply that value by 0.2 to calculate a daily ingestion intake
  - The reason is that the relationship between air concentration and surface activity in TIB-009 assumes an active source or process is generating the airborne activity
  - Airborne activity predicted using a resuspension factor (e.g., 1 $x10^{-6}$/m) would grossly underrepresent the airborne activity that actually deposited the surface contamination
- To apply TIB-009 during residual periods, air concentration on the first day of the residual contamination period should be equal to that present during the end of operations
- Ingestion can then be decreased over time using ORAUT-OTIB-0070 source depletion techniques
- NIOSH will comprehensively review estimation of ingestion during the residual contamination period at all sites and issue PERs as appropriate

SC&A's response to NIOSH's TIB-009 ingestion assessment

November 1, 2012, SPR meeting: SC&A identified:

- Majority of data on inadvertent ingestion from hand-to-mouth behavior are in residential setting and may not represent industrial environment
- Data in NUREG/CR-5512 and RESRAD came from Pacific Northwest Laboratory and represent one set of data
- An independent EPA study on World Trade Center (WTC) workers used a model for transferring pesticides hand to mouth
  - EPA study found on soft surfaces ingestion was 2.25 cm^2/hr, which agrees with NIOSH
  - EPA's hard surface values were 11.25 cm^2/hr

NIOSH's response to WTC study

January 4, 2013: NIOSH provided an email response to WTC study:

- EPA document was developed to identify contaminants of primary health concern in support of planned residential cleanup efforts
- EPA's methodology is oriented toward the screening analysis of exposures to residents living in the vicinity of the WTC and not toward the quantification of exposure to WTC cleanup workers
- Considering this, DCAS believes that the occupational ingestion parameters in the RESRAD program remain the best set of data from which to estimate ingestion exposures under EEOICPA

Closure of BRS finding 1 for TIB-009 and OVER-0002

- SC&A concluded:
  - Considering (1) the differences between the WTC study and TIB-009 and (2) all the uncertainties involved, the amount of agreement between the hand-to-mouth effective transfer rates is reasonable
  - Difference in hand-to-mouth ingestion model between workers and residents is due to exposure durations assumed, not the effective transfer rates
    - e.g., a worker duration might be 8 hr/day, 250 days/year, and 20 years, while a resident's duration might be 12 hr/day, 365 days/year, and 30 years
- SC&A therefore recommended closure
- Considering all discussions, SPR closed TIB-009 and OVER-0002 finding 1 at the February 5, 2013, meeting

Discussion on presentation approach