The determination of when routine internal dosimetry monitoring is required

Gareth Roberts, Nuvia Ltd
2010

Nuvia Ltd Approved Dosimetry Services

- Providing dosimetry services since 1948
- Laboratories and offices based at
  - Dounreay
  - Windscale
  - Harwell
  - Winfrith
- Primary role to assess and record radiation doses to workers at various sites and projects
- Approved (licensed) by the Health and Safety Executive
- Services provided for 5000 workers employed by 200 companies and government departments

Introduction

Existing guidance

Current risk assessment methods

Practical application

Illustrative case studies

Existing guidance

Existing Guidance

ICRP Publication 60

Individual monitoring for intakes of radioactive material … should be used routinely only for workers who are employed in areas that are designated as controlled areas specifically in relation to the control of contamination and in which there are grounds for expecting significant intakes.

ICRP Publication 78

Routine monitoring would only be required in conditions of essentially continuous risk of contamination of the workplace as a result of normal operations

Existing Guidance

IAEA Basic Safety Standard

For any worker who is normally employed in a controlled area, or who occasionally works in a controlled area and may receive significant occupational exposure, individual monitoring shall be undertaken where appropriate, adequate and feasible

ISO 20553

The purpose of monitoring, in general, is to verify and document that the worker is protected adequately against risks from radionuclide intakes and the protection complies with legal requirements….(it) starts with an assessment to identify work situations in which there is a risk of radionuclide intake by workers, and to quantify the likely intake of radioactive material

Existing Guidance

UK Regulation: Approved Code of Practice

If dose assessments are made for exposure to external gamma radiation or X-rays, the employer may have to decide whether additional components of dose should be assessed as well. These components might include, for example, dose from neutrons or committed dose from internal radiation. The employer's decision will depend on the expected magnitude and variations in that component. Normally, effective doses from an additional component which can reasonably be expected to exceed about 1 millisievert a year would be regarded as significant in this context for that component of dose…

Existing Guidance

Summary

(to paraphrase)

Prior knowledge is required of the 'expected' risk or dose

For continuing and unchanged operations this may be evaluated from past data

New or changed operations need to rely on risk assessments

Current risk assessment methods

Current risk assessment methods

Four published methods reviewed which relate a source term (total activity processed) to potential annual dose:

- IAEA. *Assessment of occupational exposure due to intakes of radionuclides*. Safety Standards Series no. RS-G-1.2 (1999)
- U.S. Nuclear Regulatory Commission (NRC). *Air Sampling in the Workplace*. NUREG-1400 (1993)
- UKAEA. *Safety Assessment Handbook*. (2007)
- NRPB *Memorandum – Guidance on Monitoring and Dose Assessment for Internal Exposure of Workers*. NRPB-M900 (1998)

NB: each uses a different method to derive a relationship

Current risk assessment methods

Applied to hypothetical scenario:

- **^{239}Pu operations in fume-hood**
- **plutonium likely to be in dry powder form**
- **operational controls limit activity processed to 100 kBq / year**

Current risk assessment methods

Results:

Predicted potential exposure (mSv/yr)			
IAEA	**NRC**	**UKAEA**	**NRPB**
8.4	**8.4E-7**	**4.0**	**0.04**

- It is not obvious which method (if any) is most appropriate
- Evaluation of ‘source term’ is often difficult

Practical application

Developement of practical applications for performing risk assessments

Proposed principles

- *The null hypothesis*: determine that risks do not need monitoring, rather than whether monitoring is needed
- A ‘good’ risk assessment is implicitly capable of being falsified
- Monitoring the risk, not the dose

Developement of practical applications for performing risk assessments

Implications

- The default assumption (for classified workers employed in controlled areas) is that routine monitoring is required…
- … unless this is shown to be unnecessary - **by logic, not maths;**
- otherwise some monitoring is still required as an integral part of the risk assessment,
- but this monitoring is designed to test the risk assessment, not to assess the dose…
- … and, thereby, may be less onerous and less costly than routine individual dosimetry monitoring.

Practical illustrations

Practical application – illustrations
Example 1

High integrity containment facility with remote handling operations

Risk Assessment:

- the engineered controls are cited as ‘evidence’ that significant exposures are not expected

Monitoring:

- workplace surveys used to confirm integrity of containment
- individual monitoring is not required unless workplace surveys indicate loss of containment

Practical application – illustrations
Example 2

Facility where the potential sources of exposure are restricted to specific areas and operations, but where there is the potential for transport of contamination to other 'general' areas

Risk Assessment (general areas):

- potential for low exposures, but magnitude and variability is not significant

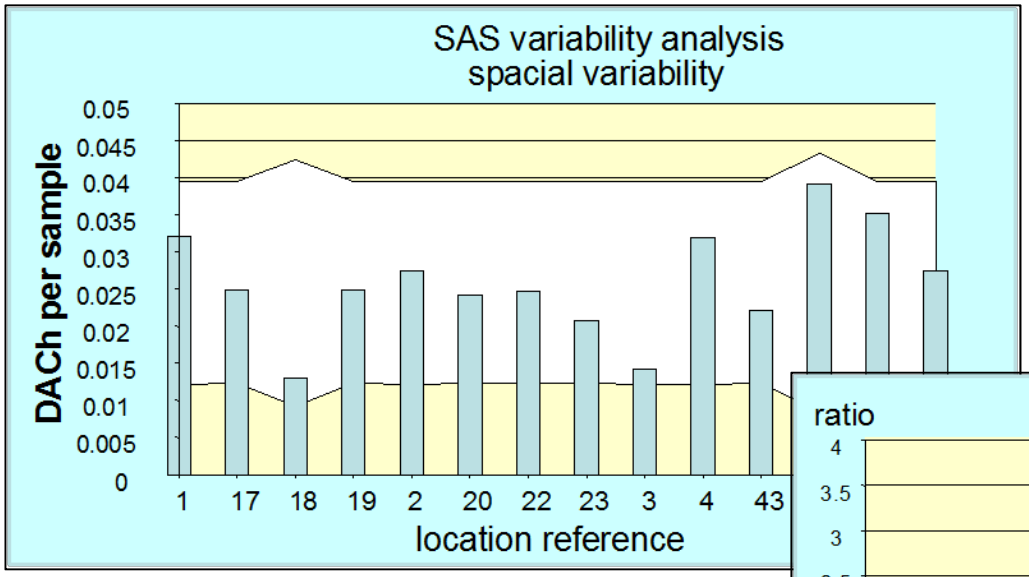
Monitoring:

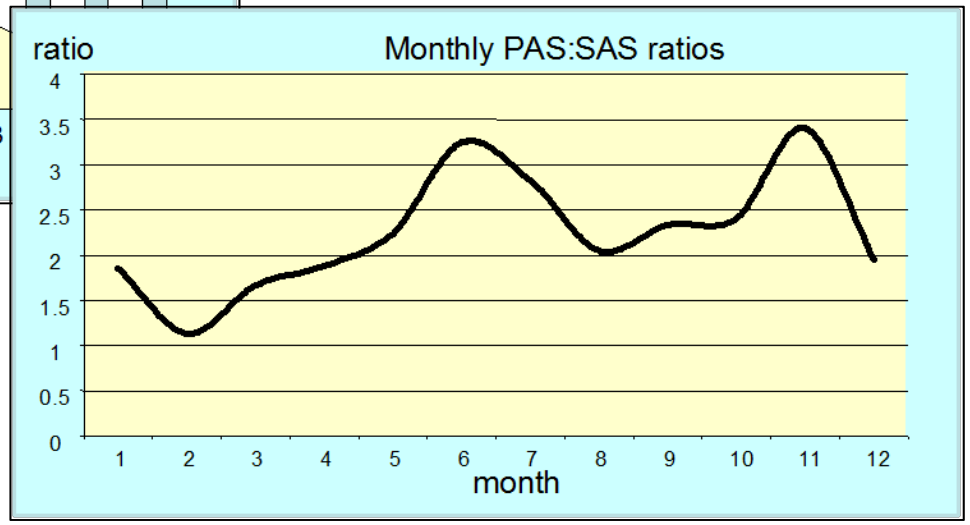
Three different approaches considered

a) workplace, static air sampling (SAS)
b) personal air sampling (PAS)
c) limited individual monitoring

Practical application – illustrations
Example 2

2(a) Monitoring by SAS

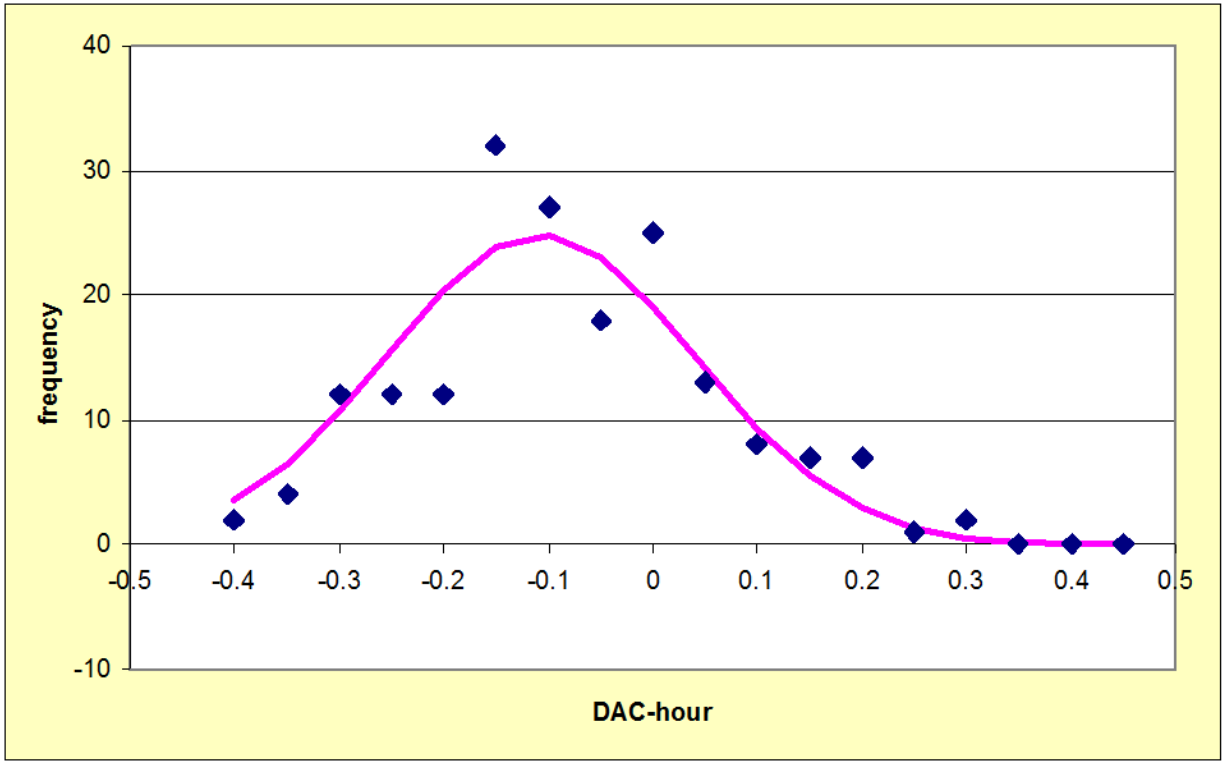




Practical application – illustrations
Example 2

2(b) Monitoring by PAS

Provisional results



distribution of PAS sample results (points) and normal distribution (line)

Practical application – illustrations
Example 2

2(c) Limited individual monitoring

Isotopic fingerprint

Isotope	Inventory (% Bq)	Lung-Type	Dose Coef (Sv/Bq)	Normalized hazard
^{241}Am	0.04	M	2.70E-05	4.42E-01
^{60}Co	30	S	1.70E-08	2.09E-01
^{137}Cs	69.92	F	6.70E-09	1.92E-01
^{238}Pu	0.02	S	1.10E-05	9.00E-02
^{239}Pu	0.02	S	8.30E-06	6.79E-02

- annual whole body monitor for ^{137}Cs and ^{60}Co; investigation level at 200 Bq
- dose sensitivity = 0.3 mSv / year (for all isotopes)
- risk assessment critically dependent on reliability of inventory assessment

Summary

Closing remarks

Existing publications provide guidance for determining when routine individual monitoring should be considered. Nuvia ADS has considered methods for the practical implementation of this guidance; these methods are based on simple principles which are intended to provide an objective application:

- *Determine that risks do not need monitoring, rather than whether monitoring is needed*
- *A 'good' risk assessment should be capable of being falsified*
- *Monitor to verify the risk assessment, not to assess dose*

Thank you