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A Comparison of True Alpha Activities in Air Filter Samples with Values Obtained from Radioactivity in-air Monitors

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1. Introduction

Measurements of alpha activity on air filters from the workplace are routinely carried out for RP and discharge monitoring purposes. In many cases, however, the source(s) used to calibrate the filter monitor are not in the same physical form as actual samples. The latter suffer from alpha absorption due to effects such as entrapment of the particle within the filter and accumulations of dust. This can result in underestimation of alpha activity and therefore underestimation of committed internal doses to workers. Investigations into the magnitude of this effect are needed.

2. Objective

To measure the ratio of 'true to apparent activity' for a set of contaminated filter papers from nuclear sites.

3. Methods

NPL obtained 19 contaminated air filters from 3 UK nuclear sites. The filter types are given in Table 1. The filters (except IM090187, which was very dirty) were measured as follows:

Non-destructive measurements

- High-resolution gamma spectrometer (initial screening measurement only)
- Canberra[1] 'iSolo' α/β counting system (39 % alpha efficiency assumed)
- JCS scaler/timer and Harwell 'drawer' counter (34 % alpha efficiency assumed)
- Thermo[2] Mini 900EP15 β and γ probe (uncorrected cps used)
- Thermo[2] AP2 α probe (uncorrected cps used)

Destructive measurements

Radiochemical analysis for:

- ^{241}Am
- ^{238}Pu
- ^{239}Pu/^{240}Pu
- ^{233}U/^{234}U
- ^{235}U/^{236}U
- ^{238}U

- HF/HNO_3 and microwave treatment
- Am, Pu and U separated by ion-exchange
- Alpha spectrometry
- Traceable sources

The total alpha activity on each filter was calculated and divided by the 'apparent' activity (or counts per second) from the four monitors. The results are plotted in Figures 1 to 4 and are colour-coded by donor laboratory.

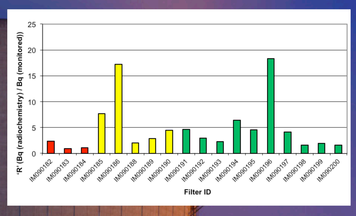

Figure 1 – Ratio 'R' using iSolo instrument

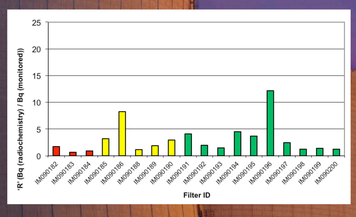

Figure 2 – Ratio 'R' using JCS/Harwell 'drawer' counter

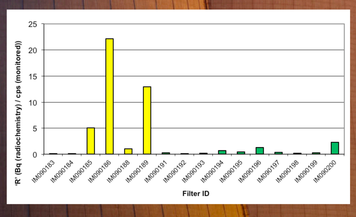

Figure 3 – Ratio 'R' using EP15 monitor

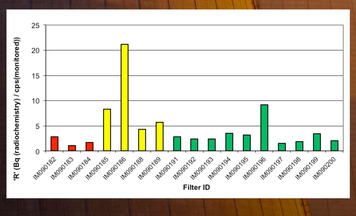

Figure 4 – Ratio 'R' using AP2 monitor

Table 1 – List of filters and filter type

Filter ID	Type
IM090182	25 mm GFA
IM090183	60 mm GFA
IM090184	25 mm GFA
IM090185	40 mm Bird and Tole filter card
IM090186	55 mm 541 Whatman filter paper
IM090187	55 mm 541 Whatman filter paper
IM090188	GFA 'Harwell card'
IM090189	GFA 'Harwell card'
IM090190	55 mm GFA
IM090191	40 mm Whatman GFA or 25 mm Fluoropore
IM090192	
IM090193	
IM090194	
IM090195	
IM090196	
IM090197	
IM090198	
IM090199	
IM090200	

4. Discussion

The ratio R is typically in the range 1 – 5, but values of the order of 20 were observed in a few cases. There is no obvious correlation between filter type and R.

Stevens and Toureau[3] and Luetzelschwab et al.[4] recommended that alpha detection efficiency losses of up to 40% should be assumed for direct filter measurements, depending on factors such as particle size, face velocity, filter type and dust loading.

Barnett et al.[5] measured 'correction factors' for alpha-emitters on Versapor 3000 47 mm filters using gas-flow proportional counting before and after acid digestion. A mean ratio of counts before digestion to counts after digestion of 2.1 ± 2.9 (2σ) was obtained. Note that they effectively calculated the inverse of the parameter 'R' from the NPL study. Curiously, the results suggest initial monitoring can overestimate true activity.

5. Conclusions

Given the wide range of 'correction factors' obtained in this study and elsewhere, it is recommended that further studies of this kind should be carried out on sets of filters from nuclear sites to help establish factors specific to those sites. The establishment of a UK radioactive aerosol facility would complement such studies. Further research of this type would lead to greater confidence in estimating doses in the nuclear workplace.

6. Acknowledgements

The authors thank the laboratories who donated filters and gratefully acknowledge the financial support of the National Measurement System.

7. References

1. Canberra website: www.canberra.com

2. Thermo Scientific website: www.thermo.com

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4. Luetzelschwab, J. W., Story, C., Zraly, K. and Dussinger, D. Health Phys., **79**, 425-430 (2000).

5. Barnett, J. M., Cullinan, V. I., Barnett, D. S., Trang-Le, T. L. T., Bliss, M., Greenwood, L. R. and Ballinger, M. Y., Health Phys., **97** (5 Suppl.), S161-S168 (2009).

National Measurement System

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