
Proceedings Paper:
McDonagh, A and Byrne, MA Aerosol particle resuspension studies from human body surfaces for exposure assessment. In: UNSPECIFIED Annual Aerosol Science Conference (AASC) 2008, April 2008, Weetwood Hall, Leeds, UK. .

Aerosol Particle Resuspension Studies from Human Body Surfaces for Exposure Assessment

Ann McDonagh and Miriam Byrne

School of Physics and Centre for Climate & Air Pollution Studies (C-CAPS), Environmental Change Institute (ECI), National University of Ireland, Galway, Ireland.

Introduction

This abstract describes a study in progress which examines the process of resuspension of radioactive particles from human body surfaces for which limited data currently exist. Skin, hair and clothing are currently being 'contaminated' with tracer particles, which will then be worn by volunteers engaged in various everyday activities. Tests will then be carried out to determine the proportion of the original deposit which has been resuspended, as this increases a person's whole body dose following accidental or deliberate airborne radioactive releases. These data will be used to refine models for radiological exposure assessment.

******

In assessing population exposure to radioactive aerosol particles following a nuclear accident, research up to the early 1990s, focussed on inhalation as the only important route of exposure. In two EU funded projects[1,2], the contribution to whole body dose associated with radioactive particle deposition on the skin, hair and clothing of the human body was assessed. The findings of models indicated that for gamma and beta–emitting radionuclides, a significant proportion of the body's total dose arose from contamination deposited on the human body. It was suggested that the resuspension of contaminant material from human body surfaces could be a significant re-exposure component in certain scenarios, but extensive measurements and modelling was not carried out to elucidate this point.

In the current climate, a threat not only exists from accidental releases of artificial radioactive material, but there is also a real risk of deliberate release in the course of terrorist attacks on major population centres. In preparing for this latter scenario, accurate estimates of whole body exposure, arising from all exposure pathways is necessary in order to design effective countermeasures. One exposure pathway that merits investigation, and for which no comprehensive experimental data are available, is that of inhalation of contaminant material that was formerly deposited on the human skin, hair and clothing. This is especially important in the case where a person might be unwittingly contaminated and might spread this contamination to others via the process of resuspension from their skin, hair and clothing. This exposure pathway may also have significance for airborne pollutants that are non-radioactive, e.g. infectious aerosol that becomes re-entrained from disturbance of hospital bedding, etc.

Within the Centre for Climate & Air Pollution Studies, NUI, Galway, tracer labelled particles are generated in representative size ranges, using monodisperse silica which is dispersed with a dry powder disperser. As in earlier experiments in this research group[3,4], neutron activatable tracers and fluorescent labels are used; in this case, fluorescent particles are used to ensure uniform deposition on surfaces, and neutron activatable particles of identical size distribution are used for resuspension experiments. "Contamination" of clothing materials with these particles takes place within a $2.25m^3$ aluminium deposition chamber, where a small 2W fan is mounted 0.2m from the chamber ceiling, centrally aligned and orientated vertically downwards, to simulate real room mixing conditions. An open face filter air sampler is operational during deposition events.

Experiments are currently being carried out to ensure uniform levels of contamination are being deposited throughout the chamber. The particles used during these preliminary experiments are fluorescent labelled silica particles of 3µm and 10µm diameter. 15 identical 10cm^2 squares of aluminium foil are placed strategically on the chamber floor and fluorescent particles are injected into the chamber. The particles on the aluminium foil squares are then excited using blue light emitting diodes and viewed by a CCD camera with a bandpass filter. Uniform deposition can be concluded if the aluminium squares have consistent levels of deposit.

Using the set-up described above, it is intended that a wide range of clothing fabrics will be "contaminated", incorporating rough, smooth, synthetic and natural etc. The generation of contaminated samples involving hair (i.e. wigs) will also be considered. Samples will be generated with low and high particle loadings, and using sub-micron and super-micron particle size distributions. Experiments will then be carried out in a test room, whereby volunteers will have the "contaminated" clothing attached to them, and they will then participate in one of several pre-defined activity patterns (which include remaining stationary, walking at a pre-defined rate, vigorous activity, etc). Isokinetic sampling of the room air will allow the collection of filters, which can later be analysed by neutron activation analyses to determine the mass of resuspended tracer particles. In addition, real-time particle size spectrometry equipment will be present in the room, to allow an assessment of any shift, relative to the deposited particles, in size distribution of the resuspended particles.

Following data analysis, and in collaboration with scientists in the Nuclear Safety Section of the Riso National Laboratory, Denmark, Monte-Carlo simulations will be carried out to assess the importance of the dose contribution arising from resuspended particles. A range of exposure scenarios will be modelled for accidental and deliberate radiological releases, but it is anticipated that the data will also have relevance for exposure assessment in the context of infectious disease transmission,

Acknowledgement

The research described above is funded by the Radiological Protection Institute of Ireland, www.rpii.ie

References

[1] 'Airborne contamination in the indoor environment and its implications for dose'. Andersson, Roed, Byrne et al. Riso Report R-1462(EN).

[2] '*Radiation Dose Implications of Airborne Contaminant Deposition to Humans'.* Andersson, Fogh, Byrne, et al. Health Physics, 82, No.2, 2002, pp. 226-232.

[3] 'Stable Tracer Aerosol Deposition Measurements in a Test Chamber'. Byrne et al. Journal of Aerosol Science, Vol. 26, Issue 4, 1995, Pages 645-653.

[4] 'Measurement of contaminant removal from skin using a portable Fluorescence Scanning System'. Hession, Byrne et al. Journal of Environmental Radioactivity, Vol. 85, Issues 2-3, 2006, pp. 196-204.