

EVALUATION OF SURFACE CONTAMINATION BASED ON CERTIFIABLY  
TRACEABLE, INTERNATIONALLY ACCREDITABLE MEASUREMENTS

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ABSTRACT

National Accreditation and Measurement Service (NAMAS) adopted by the EUROMET agreement requires that the calibration of monitoring instruments be traceable internationally with the objective that radiation hazard assessment be improved. This objective is achieved for Tritium surface contamination by employing calibration sources and evaluation methods which comply with ISO standards including the measurement of activity removable by volatilisation as well as dust. Consideration should be given to organic binding of Tritium in the skin with its implications in the event of litigation.

INTRODUCTION

The basis of Radiological Protection is currently in a state of change. A requirement of the new ICRP regulation relates hazard to individuals instead of collective dose. Most European countries have signed the EUROMET agreement, by which the calibration of Monitoring Instruments has to be traceable to NAMAS accredited calibration laboratories with the objective that radiation hazard assessment be improved as a consequence of being based upon accreditable measurements. Independently, standards organisations pursue the same logic and have produced ISO 8769-"Reference Sources" and ISO 7503-"Evaluation of Surface Contamination", which describe the calibration and the method.

Individually and collectively this calls for a review of radiological protection practices to meet these new demands if only to show evidence of competence in the event of litigation. Current legislation requiring the measurement of activity removable (which detaches) from the surface in normal use can not be satisfied by measuring only active dust. Many forms of Tritium contamination are volatile, and removal by volatilisation has to be accounted for particularly as it presents a greater hazard than removable dust. Research has shown localised organic binding of Tritium in organs of the skin<sup>1</sup>, and the implications of this should be considered.

Using the evaluation of surface contamination by Tritium as an example, the practical application of the regulations, national objectives, and associated international standards are covered in the following protocol.

## THE REFERENCE SOURCE

A reference source with a certified emission rate traceable to measurements by a national standards laboratory has to be of a form which accords to ISO 8769 "Reference Sources".

A Tritium source constructed to this standard is available. Its size is 100 mm x 150 mm, and the activity has been deposited by the Langmuir-Blodgett technique in the form of a homogeneous monolayer of tritiated molecules<sup>2</sup>. There is therefore, no self absorption, and the classic spectrum of energies of the emitted beta particles is unmodified other than by backscattered betas the effect of which can be calculated. Figure 1.

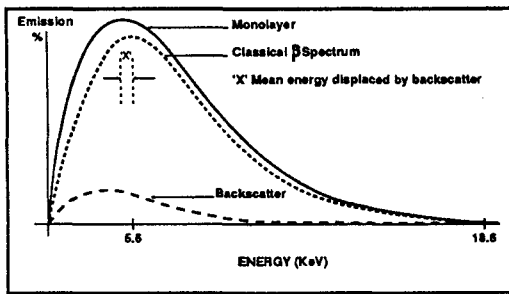


Fig. 1. Monolayer Tritium Beta Emission Spectra

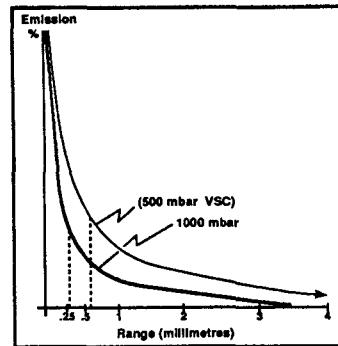


Fig. 2. Tritium Beta Absorption in Air

The source has to be suitable for calibrating all manner of Tritium surface contamination measuring instruments, and should not introduce distance variation errors into the calibration. This calls for a surface flatness of  $\pm 0.025$  mm because, even though the maximum range in air of the measuring energy Tritium beta (18.6 KeV) is approximately 4 mm, the mean range of Tritium betas is only 0.25 mm (approximately half the thickness of a finger nail). Figure 2. This source is used to establish a valid calibration of the measuring instrument.

## THE SURFACE MEASURING INSTRUMENT

The instrument must be so constructed that the conditions and geometry for calibration measurements can be reproduced identically or within a predictable approximation when taking measurements of the surface.

Essentially, the detector must be sensitive to the low energy Tritium betas. This means that no protective or gas retaining "window" can be incorporated because even the maximum energy beta (18.6 KeV) is absorbed in 8 microns ( $10^{-6}$  M) of unit density material, and the mean range of the beta emission is 0.2 microns.

In addition, the International Standard ISO 7503 "Evaluation of Surface Contamination Part 2 Tritium" shows a

detector with a minimum area of 100 cm<sup>2</sup> is preferred. An instrument, which meets all these requirements is the Hughes Whitlock Ltd. Vacuum Scintillation Counter (VSC).

#### ACTIVITY PER UNIT AREA

Estimating the surface contamination level, in terms of activity in Bq cm<sup>-2</sup> from the number of emissions recorded as counts by the measuring instrument, requires careful consideration.

Prior to decontamination, the source may be infinitely thick in terms of Tritium contamination. The method used for decontamination might itself have caused the formation of thick sources because dissolving the activity in a solvent could change its form to one likely to be absorbed by the surface.

Although in these circumstances, direct measurements do not enable the calculation of activity cm<sup>-2</sup>, they do indicate activity build up and reveal the need to decontaminate the surface as well as promote more diligent and or alternative decontamination techniques. Normally, after decontamination, the form of the contamination remaining on surfaces acceptable for radiological purposes then approximates to the monolayer calibration source<sup>3</sup> and the measurements are traceable.

#### EVALUATION BY WIPE ASSAY

Where the surface is not flat enough to make direct measurements, wipe assay is used but they should be made according to ISO 7503, which requires that a wipe collection factor be established.

The 10% collection factor can only be applied to indicate the presence of active dust on smooth, non-porous surfaces. It cannot be assumed to apply to all removable activity, and certainly not to total activity assessment. Care should be taken that the collected dust does not produce a thick source on the wipe or be absorbed into it as these states can cause gross measurements errors.

When an acceptably flat area for direct measurement can not be found, wipe collection factors can still be obtained by preparing a facsimile of the surface, and applying experimental quantities of activity for direct measurement and wipe assay.

#### REMOVABLE ACTIVITY-DUST AND VOLATILES

'Removable' activity is that which can be caused to be detached from the surface by any working practice. This does not allow the evaluation of 'removable' to be confined to the evaluation of only dust particles. Dust is a form of activity that is 'removable' but a form of 'removable' that should be of greater concern is volatile activity. Volatile fractions can be released (removed) by a change in temperature or

pressure e.g. the heat from a hand placed on the surface. Inhalation and ingestion routes are the same as for dust. In addition, in the case of Tritium, it can be absorbed through the skin over the whole body surface.

It has been shown that organic binding of Tritium takes place in the skin particularly in the region of the glands e.g. hair follicles<sup>1</sup>. Tritium betas emitted from these sites >8 microns from the surface are not detectable externally, and would not show in urine measurements because any slow exchange would be masked by the rapid excretion rate of the majority of inhaled or absorbed activity. The regulatory requirement to monitor 'removable' activity automatically embraces volatiles as well as dust as a removable form. Making the measurements to meet the regulations is the licensee's responsibility.

#### DETECTING VOLATILE ACTIVITY

During measurement, the VSC creates a partial vacuum (500 millibars) in the measuring chamber, one part of which is the surface being measured. If a volatile form of Tritium is present, the reduced pressure causes volatilisation to take place, and diffusion to occur in the contamination and surface materials. Air absorption is reduced, and the change in geometry is detected by the instrument to differentiate volatiles from other surface contamination.

#### CONCLUSIONS

Current practices in Radiation Protection do not satisfy the legislative requirement to measure activity removable by all means. Accredited measurements using Certified Sources and International Standard methods not only satisfy legislation but create a less hazardous working environment supporting the ALARA principle. The means are available and there is no excuse in the case of litigation for not applying them.

#### ACKNOWLEDGEMENTS

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