European Intercomparison of *in vivo* Monitoring Systems

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1. INTRODUCTION

With the implementation of the Internal Market workers are guaranteed freedom of movement within the European Union. With regard to the practical application of the Council Directives on the Basic Safety Standards [1] and on the operational protection of outside workers exposed to ionizing radiation as a result of their work in controlled areas, the so-called 'Outside Workers' Directive [2] lays down that internal doses shall be included in the Union's radiation monitoring system (Art. 4, annex I, part III). Therefore it is especially important to ensure a common quality standard in performing measurements to attain consistent results and facilitate effective interpretation. Furthermore, article 25 of the Basic Safety Standard Directive requires that measurement instruments for radiation protection are regularly checked and tested to ensure their effectiveness and correct use. One of the established methods for the fulfillment of this requirement is by intercomparison, normally performed at a national level. International intercomparisons provide the opportunity to harmonize radiation protection measures at a wider level. The European Commission has therefore decided to fund an Europeanwide Intercomparison of *in vivo* Monitoring Systems which is organized and carried out by the Institut für Strahlenhygiene (part of the German Bundesamt für Strahlenschutz, BfS). Taking part in this intercomparison are 44 institutions in 19 states (the 15 Member States of the European Union and Hungary, Czech Republic, Switzerland and Norway). In addition to the purely technical part of the intercomparison, the methods and underlying assumptions of deriving dose estimates from the measured activities are also examined. The institutions are asked to calculate doses on the basis of given (but not complete) information on fictitious *in vivo* measurements and state the assumptions and equations used. To complete the overview, the various regulations regarding incorporation monitoring are also reported.

2. OBJECTIVES OF THE INTERCOMPARISON

The study seeks to compare aspects of *in vivo* dose evaluation between the nominated representatives of the 15 European Union member states and 4 non-EU countries.

The primary objective of this study is to compare the performance of European whole body counters under normal working conditions. To carry out this intercomparison, each participating institute measures a phantom filled with unknown, mixed radionuclides. Paramount to the success of the study is that the normal measurement routine for humans is used at all times, in particular that the normal measuring time is not exceeded. A representative of the BfS is therefore travelling with the phantom to supervise the measurement routine and to ensure that the phantom is assembled in the correct way. In addition to the whole body measurement, the following aspects of dose evaluation are considered in this study: (i) the measurement of I-125 and/or I-131 in a thyroid phantom (optional), (ii) the calculation of committed dose for cases where either full or partial work history is known (case studies), and (iii) the legal mechanisms in each country which regulate detection and measurement of incorporated radionuclides in the workplace.

3. THE PHANTOMS USED FOR THE INTERCOMPARISON

3.1 WHOLE BODY PHANTOM

The Whole Body Phantom used for this intercomparison was developed by the 'Research Institute for Industrial and Sea Hygiene' and produced by the 'Scientific and Technical Centre -Protection Ltd.-' both in St Petersburg, Russia. The St Petersburg phantoms are made from up to 120 small, interchangable, plastic bricks, held together with hollow aluminium connection pieces. The plastic bricks are supplied in two sizes representing 1 kg and 0.5 kg of body mass. Four holes are drilled through the length of each brick so that rods containing known amounts of user defined radionuclides may be inserted (see Fig. 1).

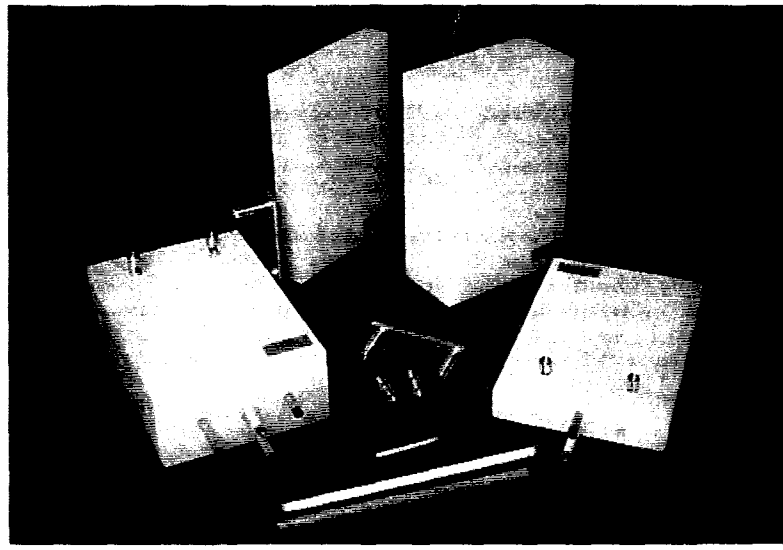
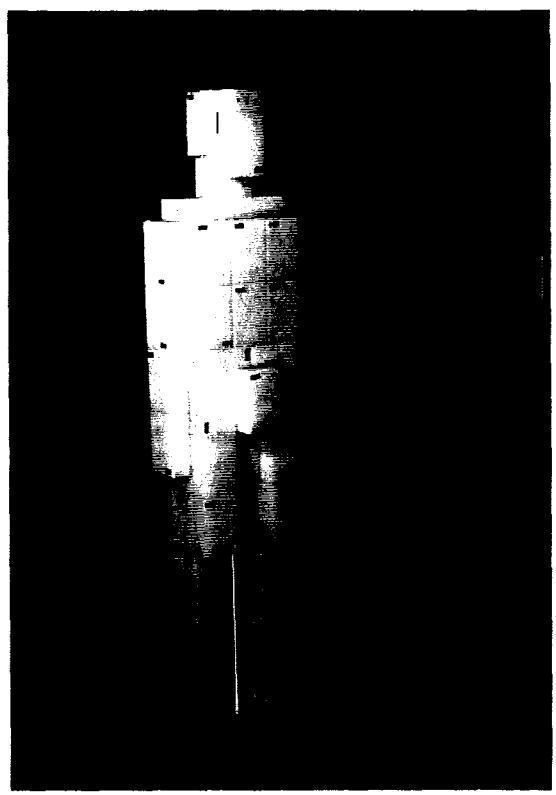


Fig. 1 1 kg and 0.5 kg bricks showing rods and connecting pieces

The St Petersburg Phantom can be assembled into representations (in terms of scattering) of 12 kg, 24 kg, 50 kg, 70 kg, 90kg and 110 kg persons (P1, P2, P3, P4, P5 and P6 respectively) in either stretch, chair or bending geometry. The stretch geometry may also be used in a "standing" position, when supported by a custom built aluminium stand. For the ongoing intercomparison, the St Petersburg phantom P4 is being used, representing the 70 kg reference man (Figure 2).

Fig. 2: Phantom P4 standing geometry



3.2 THYROID PHANTOM

The acrylic glass thyroid phantom which is made available to the participating institutions was developed as part of a research project on intercomparison of iodine counters in Germany funded by the German Federal Ministry of Environment, Nature Conservation and Nuclear Safety [3]. Intensive test measurements led to the conclusion that the chosen design provides an accurate representation of the thyroid gland for the purpose of measuring radio-iodine.The phantom was involved in a German intercomparison, and has been used by the majority of German iodine counters for calibration. The phantom is made of acrylic glass and incorporates 6 holes into which iodine samples may be placed. The holes are positioned in three pairs of two and each pair, representing the two lobes of the thyroid gland, is a specified distance from the surface of the phantom. For this intercomparison, the holes which are 20 mm from the surface of the phantom (smallest neck thickness) are used. The vials provided to the participating institutions are smaller in diameter than the holes in the phantom, and so acrylic glass tubes are used to maintain a uniform measurement geometry. The four holes which are not used during a measurement are filled with acrylic glass blocks.

4. RESULTS

More than half the measurements have been carried out and preliminary results show that most participating institutions measured the activities within 20% of the actual values. However, some institutions could not identify all radionuclides in the phantom.
The experimental part of the intercomparison is expected to continue until mid 1996. The analysis of the results and the evaluation of the answers to the questionnaires on legal requirements and dose assessment should be concluded by the end of 1996 and will be presented in spring 1997.

Acknowledgement

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References

[1] Council Directive 84/467/EURATOM of 3 Sep. 1984 amending Directive 80/836/EURATOM as regards the basic safety standards for the health protection of the general public and workers against the dangers of ionizing radiation (OJ No L 265, 05.10.1984, p.4)

[2] Council Directive 90/641/EURATOM of 4 Dec 1990 on the operational protection of outside workers exposed to the risk of ionizing radiation during their activities in controlled areas (OJ No L 349, 13.12.1990, p.21)

[3] Fachverband für Strahlenschutz e.V. , Publikations Serie FORTSCHRITTE IM STRAHLENSCHUTZ, Physik und Messtechnik Band II, 26. Jahrestagung Karlsruhe, 24. - 26. Mai 1994, Seite 461 ff

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