IAEA - USSR WHOLE BODY COUNTER INTERCOMPARISON

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ABSTRACT

As part of the IAEA programme to corroborate measurements of internal contamination levels ^{137}Cs in the effected population made by Soviet specialists following the 1986 accident at Chernobyl, the Agency has coordinated an intercomparison programme involving measurements at 8 Soviet whole body counting facilities. Additional measurements were made in the mobile van loaned to the Agency for use in the Soviet Union whole body counting programme by SCPRI, France; and whole body counters in Seibersdorf, Austria operated by the IAEA and the Austrian Research Centre.

INTRODUCTION

During a mission to the Soviet Union in August 1990 it was concluded that an intercomparison of USSR, IAEA and of the Austrian whole body counters used for *in vivo* measurement of ^{137}Cs would be valuable in corroborating large scale measurements of the USSR population.

The IAEA obtained use of a standard, adult phantom from the Battelle Pacific Northwest Laboratories in the United States. The phantom is a "Bush" or "Bottle" type, filled with solid, polyurethane tissue substitute and labelled uniformly with ^{137}Cs. The total quantity at the time of the intercomparison was 11,170 Bq (0.3 μCi). A solid matrix was necessary to avoid the practical problems of handling radioactive liquids during transport. Although accurate measurement of the caesium level in children is a major concern, it was not possible to locate a standard child phantom with a solid matrix.

INTERCOMPARISON SEQUENCE

Counting was performed in the SCPRI counting van, with the IAEA chair counter and with a whole body counter of the Austrian Research Centre during the week starting 17 September 1990. The phantom was then taken to the USSR and used there in various institutes. The intercomparison programme was completed in December 1990 with a final counting of two USSR phantom systems at Seibersdorf. The USSR institutes that participated in the intercomparison programme and the counter characteristics are listed in Table 1.

Table 1 - Counter characteristics of the participants in the IAEA whole body counting intercomparison programme

Institute	Location	Counter type	Detector	^{137}Cs background rate (counts/s)
Institute of Biophysics	Moscow	Stool, CIB-2 Chair, CIB-1	Ge, 100 cm^3 NaI, 350 cm^3	 1.2
Ministry of Public Health	Minsk Cherikov Krasnopolje	Stool, QBM-1 Chair, CIB-1 Chair, CIB-1 Stool	NE 110, 5100 cm^3 NaI, 1770 cm^3 NaI, 200 cm^3 NaI, 1310 cm^3	 24.8 4.9 3.2
Research Institute of Sea Transport Hygiene	Leningrad	Chair	NaI, 200 cm^3	1.8
Institute of Radiation Hygiene	Novozybkov	Chair, CIB-1	NaI, 200 cm^3	1.7
All Union Centre of Radiation Medicine	Kiev	Stool	NaI, 2060 cm^3	8.6
Ministry of Public Health	Kiev	Chair	NaI, 200 cm^3	5.1

USSR PHANTOM COUNTING, SEIBERSDORF

At the invitation of the IAEA, two USSR phantoms were brought for counting to Seibersdorf in December 1990; 1) a polyethylene block phantom with inertable ^{137}Cs loaded rods from the Leningrad Research Institute of Sea Transport Hygiene and 2) a flexible plastic manikin filled with dried cesium rich green peas grown in the Chernobyl region, provided by the All-Union Scientific Centre of Radiation Medicine. Equivalent configurations from both phantom systems were counted, representing (a) a small child, (b) a child of about age 10, and (c) a small adult. In addition, samples of the dried peas used in the Kiev phantom were assayed. Counting was done both in the IAEA chair counter and the counter of the Austrian Research Centre. It must be noted that the IAEA counter is intended only for adults, and it is not specifically calibrated for children. The Austrian Research Centre also normally only counts adults. Therefore, the results of the measurements made using the child phantoms should be viewed accordingly.

RESULTS

The results of the phantom intercomparison measurements are presented in Table 2. Under the conditions of the intercomparison, it was agreed that the results from the USSR counters would not be specifically identified. Therefore, the participating institutes in the USSR are indicated only by numbers in Table 2. However, each USSR facility has been provided a tabulation of the intercomparison results together with specific identification of its own data.

CONCLUSIONS

The IAEA does not have specific criteria for the acceptability of the performance of whole body counters. However, the quality of the intercomparison results can be compared with guidance provided in IAEA Safety Series No.84, *Basic Principles for Occupational Radiation Monitoring*, paragraph 4.1.5 [1], where it is stated that:

> "In the case of routine individual monitoring for external radiation relative uncertainties of -50% and +100% at the 95% confidence level are acceptable for annual dose equivalents in the range of one-fifth of the derived limit. If, however, values are of the order of the annual limits, the relative uncertainties should not exceed -33% and +50% at the 95% confidence level." ...
> "Similar requirements should, in principle, also apply in the case of routine individual monitoring for internal contamination, but in practice uncertainties as small as 50% are rarely possible."

In 5 of 36 measurements reported from institutes in the USSR (Table 2), the results were outside of a range of ± 30% compared with the reference values. One result was slightly more than 50% above the reference value. In the latter case, the measurement was made with an unshielded probe used with the phantom doubled over in the "Marinelli" position.

Based on the distribution of the intercomparison results, it can reasonably be concluded that the participating institutes are capable of performing internal caesium measurements within an accuracy that is acceptable and adequate for radiation-protection purposes.

It should also be noted that 4 out of the 5 instances of results outside the range of ± 30% from the reference value occurred with phantoms representing children. Although the differences are not excessive, they do suggest the need for additional attention to the calibration of counters for measurements of children.

REFERENCES

1. IAEA, 1987, Basic Principles for Occupational Radiation Monitoring, Safety Series No. 84, IAEA, Vienna.

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Table 2 - Whole body counter intercomparison results

Reporting institute and/or type of counter	Measured activity (Bq/kg)						
	Bottle phantom	Block phantom			Dried pea phantom		
	Adult 74 kg	Infant 10.8 kg	Child 24.3 kg	Adult 63 kg	Infant 15.5 kg	Child 27.7 kg	Adult 58.4 kg
USSR 1 [a]	148						
USSR 2	138						
USSR 3	190						
USSR 4	132	3420	3500	3120			
USSR 5	165	3390	3390	3330			
USSR 6	120	3900	3910	2840			
USSR 7	160	4210	4350	3900			
USSR 8	165						
USSR 9	90	4110	3340	3520			
USSR 10		4800		2640			
USSR 11		4450		2520			
USSR 12	172	3090	3060	3380			
USSR 13	109	3220	3340	2960			
Van 1 [b]	160						
Van 2	148						
Van 3	152						
Van 4	136						
IAEA [c]	120	2150	2360	2190	477	507	485
ARC [d]	130	3850	3810	3220	684	610	673
Ref. value	151	3190[e]	3190 [e]	3190 [e]	570[e], 587[f], 574[g]		

[a] Institutes in the USSR are designated only by number.
[b] Counter number in mobile van.
[c] Chair counter at IAEA Laboratory, Seibersdorf.
[d] Chair counter at Austrian Research Centre, Seibersdorf.
[e] USSR value.
[f] IAEA value
[g] Austrian Research Centre value.