

A C T I V I T Y
of the Laboratory for the State Primary Standards
of Ionising Radiation in the Field of X-, Gamma-
Beta- and Electron Radiation Dosimetry
1999 – 2000

**D.I.Mendeleyev Institute for Metrology
St.Petersburg, Russia**

I.A.Kharitonov, N.D.Villevalde, A.V.Oborin, E.N.Yuriatin,
V.I.Fominykh, S.A.Fedina, E.N.Rumiantseva, I.I.Tsvetkov

Introduction

The basic directions of the dosimetry group's activity are:

- scientific and research work using the State Primary Standards of:
 - air kerma and air kerma rate of X- and γ -ray;
 - absorbed dose and absorbed dose rate to tissue of β -ray;
 - flux, flux density and fluence of electrons, flux energy, flux density energy and fluence of energy electron and bremsstrahlung radiation;
- international activity;
- calibration and varification of measuring instruments;
- type testing and sertification of measuring instruments on radiation safety;
- elaboration of normative documentation in the field of dosimetry.

1. Research Work

1.1. Preliminary measurements of X-ray spectra of VNIIM air kerma standards for reference qualities with photon energies in the ranges 10-50 keV and 50-300 keV including radiation qualities of the series H, N and L (ISO 4037) were carried out. The measurements were made using the X-ray spectrometer with HPGe-semiconducting detector with beryllium window (manufacturer is Baltic Scientific Instruments).

1.2. The modernization of unified measuring channels for X-, γ - and β -radiation Standard Dosimetric Units was completed. The new channel consists of the electrometer Keithley Model 6517A and the system for measuring of air temperature, pressure and humidity during the ionization measurements on the basis of digital precise barometer type BOP-1M (Russia) and multichannel thermometer type of CA-310 (Ukraine).

1.3. The experimental researches of metrological parameters and performances of State Primary Standard Complex of flux, flux density and fluence of electrons, flux energy, flux density energy and fluence of energy electron and bremsstrahlung radiations with energy from 0,1 to 50 MeV were carried out.

1.4. The researches of energy response dependence of sensitivity of new dosimetric instruments with detectors on the basis of organic and inorganic scintillators, Si-dides and Geiger-Muller counters of different modifications were conducted.

1.5. The experimental determining of effective doses for patients during standard diagnostic procedures on the modern X-ray units for fluoroscopy (Russia) were carried out using an

anthropometric phantom and instruments for X-ray bunch diagnostic jointly Institute of Physics Health.

2. International activity

2.1. The indirect bilateral comparisons of the State Primary Standard of the absorbed dose and absorbed dose rate to tissue for β -radiation belonging to VNIIM with the BNM-LNHB National Standard (France) have been completed. The comparisons were spent with fixed volume plate parallel ionization chamber type PK2-02 (construction VNIIM) in the field of β -radionuclide sources $^{90}\text{Sr}/^{90}\text{Y}$, ^{147}Pm , ^{204}Tl . By the comparisons results the joint publication is prepared. During comparisons the calibration factors for the chamber PK2-02 were determined in terms of Gy/C on the depth of tissue of 7 mg/cm^2 . The final comparisons results are shown in the table 1.

Table 1

Source	Distance "source-chamber"	Calibration factor, N, Gy/s		$(N_{\text{VNIIM}} - N_{\text{BNM}}) / N_{\text{BNM}},$ %
		VNIIM	BNM-LNHB	
$^{90}\text{Sr}+^{90}\text{Y}$	30	$22,8 \pm 0,4$	$22,9 \pm 0,5$	0,44
^{204}Tl	30	$23,3 \pm 0,5$	$23,3 \pm 0,5$	0
^{147}Pm	20	$17,1 \pm 0,3$	$17,2 \pm 0,4$	0,58

2.2. The bilateral comparisons of the VNIIM State Primary Standard of absorbed dose and adsorbed dose rate to tissue for β -radiation with the PTB National Standard were carried out with use the PTB plate parallel ionization chamber of fixed volume type ND 1009 (OMX construction). The comparisons were made in the fields of β -radiation radionuclide sources $^{90}\text{Sr}+^{90}\text{Y}$, ^{204}Tl , ^{147}Pm on the "source-chamber" distances 30 cm and 20 cm without aligning filters. The diameter of an active part of VNIIM sources were 50 mm ($^{90}\text{Sr}+^{90}\text{Y}$ and ^{147}Pm) and 40 mm (^{204}Tl). The preliminary results of comparisons indicated the agreement of the chamber ND 1009 calibration factors in the limits of 1% for $^{90}\text{Sr}+^{90}\text{Y}$ and ^{204}Tl and 5,5% for ^{147}Pm . The analysis of the measured data for ^{147}Pm is the basic point of the further joint research programme.

3. Calibration and varification of measuring instruments

3.1. During 1999-2000 the calibrations more than 240 dosimetric measuring instruments and radionuclide sources including ^{192}Ir , ^{153}Cd , ^{75}Se and ^{226}Ra were carried out.

3.2. The comparison of gamma-radiation (^{137}Cs and ^{60}Co) units from the Secondary Standard of air kerma and air kerma rate of the Department Metrological Service with the VNIIM Primary Standard was carried out by the comparator-set of ionisation chambers M30001, TM23361 and TM32002. Summary experimental standard deviation (S_{Σ}) was equal to 0,9%.

3.3. The measurements of the radiation fields qualities of the industrial accelerator "ELY-4" ("Electronica") and two medical accelerators "LYEV-15M" were carried out.

4. Trials of measuring instruments types and certified tests for radiation safety

4.1. Trials of the 18 types of dosimetric measuring instruments of Russian and foreign corporations were carried out during that period. They are universal dosimeters DKC-AT1121 and DKC-AT1123, individual direct-reading digital dosimeters DKG-AT2503 and DKC-AT3509 manufactured by “Atomtex”, dosimetric system of radiation monitoring AAM-90 by “Rados Tecnology Oy” (Finland), dosimeters Victoreen 450B and 530 by “Victoreen Inc.”(USA) and the others.

The trials of instruments were carrying out for its correspondence to the Russian and International basic standard documents with the purpose of its including in the State Register of Measuring Instruments of Russia and to permit of its use on the Russian Federation territory.

4.2. Manufactures and measuring instruments of 13 types generating X-ray radiation or containing radionuclide sources were certificated

for the radiation safety. Among them are impulsing X-ray defecto-scopes “Shmel-250”, customs examining units “Shmel-TV”, “Shmel-240TV”, “Shmel-90TV” manufactured by “Flash Electronics Ltd” (Russia), medical X-ray apparatuses “Explor X-65” and “Rotograf-230”

by “VILLA S.M.S.p.A”(Italy), X-ray structural analysators of various modifications as “X’Pert PRO MPD/MRD”, “Cubi’x XRD”, “DCD II/II H”, “RD-100” by “Philips Analytical B.V.” (the Netherlands), diffractometers “XSTRESS 3000” by “Stresstech Oy” (Finland).

5. Elaboration of the basic standard documents in dosimetry

5.1. More than 15 methodical documents for verification and calibration of the dosimetric measuring instruments and 11 documents for measurements fulfilment with using of dosimetric measuring instruments by the operating conditions of maintenance were elaborated during 1999-2000. They are “Procedure of fulfilment of air kerma rate measurements under certification of closed radio-nuclide sources of ^{192}Ir ”, “Procedure of fulfilment of external irradiation dose measurements under radiation monitoring and personal monitoring by TLD method”, “Procedure of fulfilment of photon radiation equivalent dose rate measurements under radiation monitoring of scrap” and the others.

5.2. The Intergovernmental Standard “Standard X-ray and gamma- radiation dosimetric setups. Methods and means of calibration in the units of exposure dose rate and air kerma rate” was elaborated.

5.3. The Intergovernmental Standard “State verification schedule for the measuring means of flux, flux density and fluence of electrons, flux energy, flux density energy and fluence of energy electron and bremsstrahlung radiations with energy from 0,1 to 50 MeV” was designed.

5.4. The programme of trials for definition of parameters and qualities of radiation field of medical accelerator “CL 75-5M” was elaborated.

The publication for 1999-2000 in the dosimetry range of photon and beta radiation

(the enumeration includes papers in journals, performances on national and international conferences and engineering reports)

1. N.D.Villevaude, A.V.Oborin, E.N.Yurjatin **“Participation in international comparisons of national standards in the range of dosimetry - key factor of certainly of radiation monitorings”**. *Proceedings of the International Workshop “Actual Problems of Dosimetry”, Minsk, 27-29 October, 1999.*
2. I.A.Kharitonov, N.D.Villevaude, A.V.Oborin **“Trials of instrumentation of radiation control in the State System of support of traceability”**. *Proceedings of II International Conference “Radiation Safety”, St.Petersburg, 9-12 November, 1999.*
1. N.D.Villevaude, A.V.Oborin, I.A.Kharitonov, E.N.Yurjatin **“Some aspects designing unified channels for current and charge measurements intended for Standard Dosimetric Setups”**. *J. “Measuring technique”, ? 11, 1999.*
4. R.Cruz.Suarez, V.E.Aleinicov, P.Ambrosi, J.Böhm, L.Buermann, D.T.Barlett, D.R.McClure, I.Csete, V.I.Fominykh, A.V.Oborin, H.Stadtman **“IAEA Intercomperison for individual monitoring of external exposure from photon radiation”**. *IAEA-TECDOC-1126, Vienna, 1999.*
5. I.A.Kharitonov, N.D.Villevaude, A.V.Oborin **“Classification of screen monitors among the means for contorl of radiation conditions”**. *Proceedings of International Conference “Radiation Safety: the Trasportation of Radiactive Materials”, St.Petersburg, 31 October - 4 November, 2000.*
6. N.D.Villevaude, A.V.Oborin, I.A.Kharitonov, E.N.Yurjatin **“Demands of domestic and international normative documents for metrological performances of photon and beta radiation dosimeters for radiation protection”**. *Proceedings of International Conference “Radiation Safety: the Trasportation of Radiactive Materials”, St.Petersburg, 31 October - 4 November, 2000.*
7. I.A.Uryaev, E.N.Rumyantseva, N.D.Villevaude, (VNIIM), C.Lecante, B.Cauvenet, (BNM-LNHB) **“Intercomparison of extrapolation chamber measurements of absorbed dose rate in beta radiation”**. *In printing.*
8. N.D.Villevaude, A.V.Oborin, I.A.Kharitonov **“Some aspects of metrological ensuring of X- and gamma-radiation measurements in public health services”**. *Proceedings of I All-Russian Scientific and Technical Meeting “The Problems of Metrological Safety in Public Health Services and in Manufacturing of Medical Equipment”, Moscow, 15-17 November,2000.*
9. N.D.Villevaude, I.A.Kharitonov, I.I.Tsvetkov, A.P.Kozlov, U.N.Gavrish, U.V.Mjasnikov **“Metrological ensuring of measurements in beta-dosimetry”**. *Proceedings of I All-Russian Scientific and Technical Meeting “The Problems of Metrological Safety in Public Health Services and in Manufacturing of Medical Equipment”, Moscow, 15-17 November, 2000.*
10. S.A.Fedina, V.I.Fominykh, G.Ja.Ljutina, L.I.Ljalina **“Metrological audit of radiation therapy by TLD-method”**. *Proceedings of I All-Russian Scientific and Technical Meeting “The Problems of Metrological Safety in Public Health Services and in Manufacturing of Medical Equipment”, Moscow, 15-17 November, 2000.*
11. N.A.Matz, A.K.Sokolov, I.M.Haikovich, N.D.Villevaude, A.V.Oborin, E.N.Yurjatin **“A Scintillating dosemeter in the automized radiation monitoring system”**. *“Ecological system and unstruments”, ? 6, 2000.*
12. D.T.Burns (BIPM), N.D.Villevaude, A.V.Oborin, E.N.Yurjatin (VNIIM) **“Comparison of the air kerma standards of the VNIIM and the BIPM in the medium energy X-ray range”**. *In printing.*