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Summary of NPL Radiation Science Intercomparisons 1960 - 1995

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ABSTRACT

This report lists publications which summarise NPL's participation in a broad range of intercomparisons in the field of Ionising Radiation and Radioactivity Metrology. These have been organised under the auspices of the Consultative Committee for Standards in Measurement of Ionising Radiation (CCMIR), EUROMET, the European Radiation Dosimetry Group (EURADOS) or as multilateral or bilateral intercomparisons. This report covers the period 1960 to 1995. It is intended to update this report every three years.

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Approved on behalf of the Managing Director, NPL, by Dr P Christmas,
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INTERNATIONAL VALIDATION OF MEASUREMENT STANDARDS

1 INTRODUCTION

Measurement intercomparisons are carried out for several reasons: (1) to achieve a consistent international measurement system, (2) to determine systematic errors, (3) to study changes in a standard with time, (4) to compare measurement methods or instruments, (5) to compare corrections as evaluated in different laboratories, (6) to evaluate the state-of-the-art in measurement, (7) to provide confidence in standards, and finally, (8) to encourage scientists to make better measurements. This report lists publications which summarise NPL's participation in a broad range of intercomparisons in the field of Ionising Radiation and Radioactivity Metrology during the period 1960 to 1995. These intercomparisons have been organised under the auspices of the Consultative Committee for Standards in Measurement of Ionising Radiation (CCMIR), EUROMET, the European Radiation Dosimetry Group (EURADOS) or as multilateral or bilateral intercomparisons.

In the following, an '*' denotes an author from another organisation.

2. NEUTRON MEASUREMENTS

2.1 INTERCOMPARISONS OF NEUTRON FLUENCE MEASUREMENTS

*NAGGIAR, V.

Rapport sur la comparaison internationale de la mesure du taux d'émission de la source de neutrons Ra-Be(α,n) de Conseil National de Recherches No. 200-1 par la method de ralentissement des neutrons dans une solution de sulphate de manganese.

Recueil de travaux du BIPM, 1966-67, 1.

(Participants: NPL - UK, AEET - India, BCMN - Belgium, CENS - France, ETL - Japan, IKO - Netherlands, IMM - Russia, NBS - USA, NRC - Canada, SDE - Israel, BIPM (Sèvres)).

*NAGGIAR, V.

Comparison internationale des mesures de taux d'émission de la source de neutrons Ra-Be(α,n) No. 200-1 du Conseil National de Recherches.

Metrologia, 1967, 3, 51-52.

(Participants: NPL - UK, AEET - India, BCMN - Belgium, CENS - France, ETL - Japan, IKO - Netherlands, IMM - Russia, NBS - USA, NRC - Canada, SDE - Israel, BIPM (Sèvres)).

AXTON, E J.

Results of the intercomparison of the thermal neutron flux density unit (1966-1968).

Metrologia, 1970, 6, 25-32.

(Participants: NPL - UK, AAEC - Australia, ABA - Sweden, AEET - India, CEN - France, ETL - Japan, IMM - Russia, NBS - USA, NRC - Canada, IAEA (Vienna), BIPM (Sèvres)).

*MURPHY, W M, and *CASWELL, R S.

Analysis of results of the Bureau International des Poids et Mesures thermal neutron flux density intercomparison.

Metrologia, 1970, 6, 111-115.

(Participants: NPL - UK, AAEC - Australia, ABA - Sweden, AEET - India, CEN - France, ETL - Japan, IMM - Russia, NBS - USA, NRC - Canada, IAEA (Vienna), BIPM (Sèvres)).

*HUYNH, V D

International comparison of flux density measurements for monoenergetic fast neutrons.

Metrologia, 1980, 16, 31-49.

(Participants: NPL - UK, CBNM - Belgium, CEN - France, ETL - Japan, IMM - Russia, NBS - USA, NRC - Canada, PTB - Germany, BIPM (Sèvres)).

LEWIS, V E.

International intercomparison of d + T neutron fluence and energy using niobium and zirconium activation.

Metrologia, 1984, 20, 49-53.

(Participants: NPL - UK, BARC - India, CBNM - Belgium, ETL - Japan, IRK - Austria, AEI - China, NBS - USA, PTB - Germany, BIPM (Sèvres)).

*LISKIEN, H.

International fluence-rate intercomparison for 2.5 and 5.0 MeV neutrons.

Metrologia, 1984, 20, 55-59.

(Participants: NPL - UK, CBNM - Belgium, ETL - Japan, PTB - Germany, VNIIM - Russia, BIPM (Sèvres)).

*KLUGE H, *RASP, W, and HUNT, J B.
An intercomparison of the D₂O-moderated ²⁵²Cf reference neutron source at PTB and NPL.
 Radiat. Prot. Dosim., 1985, **11**, 61-63.
 (Participants: NPL - UK, PTB - Germany).

LEWIS, V E, and *LISKIEN H.
International fluence rate intercomparison for 2.5, 5.0 and 14 MeV neutrons.
 IAEA-TECDOC-335, 1985.
 (Participants: NPL - UK, CBNM - Belgium, ETL - Japan, PTB - Germany, VNIIM - Russia, BIPM (Sèvres)).

LEWIS, V E.
Neutron dosimetry intercomparison at the National Physical Laboratory.
 NPL Report RS(EXT)79, 1985.
 (Participants: NPL - UK, MRC Hammersmith Hospital - UK, NIST - USA, PTB - Germany, TNO/GSF - ENDIP, Western General Hospital - UK, BIPM (Sèvres)).

HUNT, J B.
Measurements performed at the National Physical Laboratory for an international intercomparison of neutron fluence rate measurements for monoenergetic fast neutrons using the In(n,γ) reaction.
 NPL Report RS(EXT)81, 1986.
 (Participants: NPL - UK, CBNM - Belgium, ETL - Japan, IAE - China, NRC - Canada, PTB - Germany).

AXTON, E J.
Intercomparison of neutron source emission rates (1979-1984).
 Metrologia, 1987, **23**, 129-144.
 (Participants: NPL -UK, ASMW - Germany, BARC - India, BLC - France, ENEA - Italy, ETL - Japan, IAEB/AEI - China, IMM - Russia, INEL - USA, LMRI - France, NBS - USA, PTB - Germany, VGKRI - Russia, BIPM (Sèvres)).

RYVES, T B.
International fluence-rate intercomparison for 144 and 565 keV neutrons.
 Metrologia, 1987, **24**, 27-37.
 (Participants: NPL - UK, CBNM - Belgium, ETL - Japan, IAE - China, NRC - Canada, PTB - Germany).

*HUYNH, V D.
Report on the BIPM neutron dosimetry intercomparison.
 BIPM Report BIPM-88/5, 1988. Presented at the 8th meeting of Section III of CCEMRI, Sèvres, 1988, CCEMRI(III)/88-5.
BIPM neutron dosimetry comparison based on the circulation of a set of transfer instruments.
 Radiat. Prot. Dosim., 1992, **44**, 111-113.
BIPM neutron-dosimetry intercomparison.
 Metrologia, 1992, **29**, 295-299.
 (Participants: NPL - UK, ETL - Japan, IAEB - China, NIM - China, NIST - USA, PTB - Germany, TNO - Netherlands, BIPM (Sèvres)).

HUNT, J B, *CHAMPLONG, P, *CHEMTOB, M, *KLUGE, H and *SCHWARTZ, R B.
Intercomparison of calibrations carried out at NIST, NPL, PTB and CEA-ETCA using two different survey meters as transfer devices..
 Radiat. Prot. Dosim., 1989, **27**, 103 - 110.
 (Participants: NPL - UK, CEA/ETCA - France, NIST - USA, PTB - Germany).

*KLUGE, H, *WEISE, K, and HUNT, J B.

Calibration of neutron-sensitive spherical devices with bare and D₂O-moderated ²⁵²Cf sources in rooms of different sizes.

Radiat. Prot. Dosim., 1990, **32**, 233-244.

(Participants: NPL - UK, PTB - Germany).

*GAYTHER, D B.

International intercomparison of fast neutron fluence rate measurements using fission chamber transfer instruments.

Metrologia, 1990, **27**, 221-231.

(Participants: NPL - UK, CBNM - Belgium, ETL - Japan, AEA Harwell - UK, NBS - USA, PTB - Germany, BIPM (Sèvres)).

BARDELL, A G, ZIEBA, K J, *BOTTGER, R, and *KLEIN, H.

EUROMET project: Absolute measurement of neutron source emission rate.

EUROMET Workshop on Ionising Radiation and Radioactivity, held at NPL, 7 to 10 October 1990, Report published by NPL, Appendix C.

EUROMET Project No. 211 Final Report: Bilateral intercomparison of the neutron emission rate of a ²⁵²Cf spontaneous fission source between the NPL and PTB.

NPL Report RSA(EXT)47, 1994.

(Participants: NPL - UK, PTB - Germany).

*WINKLER, G R, LEWIS, V E, RYVES, T B, KOLKOWSKI, P and HOOLEY, A C.

EUROMET project: Comparative measurements using a ²³⁸U deposit.

EUROMET Workshop on Ionising Radiation and Radioactivity, held at NPL, 7 to 10 October 1990, Report published by NPL, Appendix C.

(Participants: NPL - UK, IRK - Austria).

*CASWELL, R S and LEWIS, V E.

Neutron measurement intercomparisons sponsored by CCEMRI, Section III (Neutron Measurements).

Radiat. Prot. Dosim., 1992, **44**, 105-110.

(Summary of neutron measurement intercomparisons sponsored by CCEMRI, Section III from 1961 to 1992).

AXTON, E J.

Report on the intercomparison of neutron fluence using two Bonner spheres as transfer instruments.

Presented at the 9th meeting of Section III of CCEMRI, Sèvres, 1991, CCEMRI(III)/91-4.

Report on the intercomparison of neutron fluence using two Bonner spheres as transfer instruments.

Presented at the 10th meeting of Section III of CCEMRI, Sèvres, 1993, CCEMRI(III)/92-2.

(Participants: NPL - UK, CBNM - Belgium, PTB - Germany, BIPM (Sèvres)).

BARDELL, A G.

EUROMET project: The application of a MnSO₄ bath to neutron source measurements and the associated corrections.

Second EUROMET Workshop on Ionising Radiation and Radioactivity, held at NPL, 10 to 12 October 1994, Report published by NPL, Appendix 3.

(Participants: NPL - UK, LPRI - France).

***YOUNG, J G.**

Report on a visit to the Neutron Metrology Laboratories at PTB, NPL and NRPB.

Australian Radiation Laboratory Report, ARL/TR118, May 1995.

(Participants: NPL - UK, ARL - Australia, PTB - Germany).

2.2 INTERCOMPARISONS OF NEUTRON SPECTROMETRY AND DOSIMETRY MEASUREMENTS

THOMAS, D J and BARDELL, A G.

Bonner sphere neutron spectrometry measurements performed at the SILENE reactor, Valduc, France.

NPL Report RSA (RES) 8, 1991.

(Participants: NPL - UK, AEA Technology - UK, CEA Fontenay - France).

*MEDIONI, R and *DELAFIELD, H J.

An intercomparison of criticality accident dosimetry systems at the SILENE reactor, Valduc, Dijon, France, 7-18 June 1993; Part 1: Reactor and reference dosimetry of radiation fields.

AEA Technology Report HPS/TR/H/1(95), April 1995.

(Participants: NPL - UK, AEA Technology - UK, CEA Fontenay - France).

*MURPHY, M F.

A review of neutron spectrometry measurements in the ASPIS reference fields.

AEA Technology Report AEA-RS-5548, September 1994.

(Participants: NPL - UK, AEA Technology (Winfrith) - UK, AEA Technology (Harwell) UK, IAR (Lausanne) - Switzerland, NRPB - UK, ZFK/KAI - Germany).

*KLEIN, H and *LINDBORG, L

Determination of the neutron and photon dose equivalent at workplaces in nuclear facilities of Sweden; An SSI-EURADOS comparison exercise. Part 1: Measurements and data analysis. Swedish Radiation Protection Institute Report SSI-rapport 95-15, August 1995.

(Participants: (a) Neutron spectrometers: NPL - UK, GSF - Germany, IAR (Lausanne) - Switzerland, PTB - Germany, ZFK/KAI - Germany).

*LINDBORG, L, *BARTLETT, D, *DRAKE, P, *KLEIN, H, *SCHMIT, T and *TICHY, M.

Determination of the neutron and photon dose equivalent at workplaces in nuclear facilities of Sweden; An SSI-EURADOS comparison exercise.

Radiat. Prot. Dosim., 1995, **61**, 89-100.

(Participants: (a) Neutron spectrometers: NPL - UK, GSF - Germany, IAR (Lausanne) - Switzerland, PTB - Germany, ZFK/KAI - Germany).

THOMAS, D J, *CHARTIER, J-L, *KLEIN, H, NAISMITH, O F, *POSNY, F and TAYLOR, G C.

Results of a large scale neutron spectrometry and dosimetry comparison exercise at the CADARACHE moderator assembly.

Presented at the Eighth Symposium on Neutron Dosimetry, held in Sèvres, November 1995.

To be published in Radiation Protection Dosimetry.

(Participants:

(a) Neutron spectrometers: NPL - UK, AECL - Canada, BIS - Germany, CMI - Czech Republic, GSF - Germany, IPSN/FAR - France, IPSN/Cadarache - France, IRA (Lausanne) - Switzerland, NRI - Czech Republic, PTB - Germany, ZFK/KAI - Germany;

(b) Tissue equivalent proportional counters (TEPCs): NPL - UK, AECL - Canada, CEA Grenoble - France, CERN - Switzerland, GSF - Germany, IPSN/FAR - France, PTB - Germany, SSI - Sweden, ZFU - Germany;

(c) Area survey meters: NPL - UK, IPSN/FAR - France, KfZ - Germany, NPI - Czech Republic, PTB - Germany).

2.3 INTERCOMPARISONS OF NEUTRON FLUENCE MEASUREMENTS AND NEUTRON SPECTROMETRY IN NPROGRESS OR PLANNED FOR THE FUTURE

- (a) Intercomparison of neutron fluence measurements at 25 keV.
Scheduled to be completed under the auspices of BIPM with NMS funding, September 1998.
- (b) Intercomparison of thermal neutron fluence measurements.
Scheduled to be completed under the auspices of BIPM with NMS funding, September 1998.
- (c) Intercomparison of neutron source emission rate measurements.
Bilateral intercomparison with LPRI (France): scheduled to be completed by September 1998.

It is intended that NPL will participate in any relevant international intercomparison organised under the auspices of either CCEMRI Section III, EUROMET or EURADOS, as and when they are agreed and organised.

3. RADIOACTIVITY MEASUREMENTS

3.1 INTERCOMPARISONS OF THE CALIBRATION OF 'HONIGSCHMID' RADIUM STANDARDS

PERRY, W E.

Comparison of British and United States national radium standards

Proc. Phys. Soc. London, 1955, **68**, 942-944.

(Participants: NPL - UK, NBS - USA).

*MICHEL, W S and *WHYTE, G N.

International comparison of the Canadian primary radium standard.

Can. J of Phys., 1955, **33**, 521-528.

(Participants: NPL - UK, NBS - USA, NRC - Canada).

*LOFTUS, T P, *MANN, W B, *PAOLELLN, F F, *STOCKMANN, L L and *YOU DEN, W J.

International comparisons of the United States national radium standard.

J. Res. Nat. Bureau Standards, 1957, **58**, 169-174.

(Participants: NPL - UK, NBS - USA, NRC - Canada, PTB - Germany).

*MANN, W B.

Radium standards.

Proceedings of a Conference on Measurements and Standards of Radioactivity, Easton, Maryland, USA, 1957. Nuclear Science Series Report No. 24, National Academy of Sciences - National Research Council Publication 573, 1958, 17-22.

(Participants: NPL - UK, NBS - USA, NRC - Canada, PTB - Germany).

CHRISTMAS, P, CROSS, P, *GUBKIN, E, *HOLNOVA, E A, and *YUDIN, M E.

An intercomparison of the radium mass standards of the UK and the USSR.

NPL Report RS(EXT)103, 1988.

(Participants: NPL - UK, VNIIM - Russia).

3.2 INTERCOMPARISONS OF MEASUREMENTS OF ACTIVITY OF RADIONUCLIDES

***RYTZ, A.**

Results of an intercomparison of ^{32}P .

Presented at the 4th Session of CCEMRI, Sèvres, 1963, CCEMRI(II)/63-Annex 2.

(Participants: NPL - UK, AWRE Aldermaston - UK, BCMN - Belgium, CENS - France, IAR - Germany, IFM - Chile, IKO - Netherlands, IMM - Russia, KBBG - Germany, LNE - France, NBS - USA, NPRL - South Africa, NRC - Canada, PTB - Germany, IAEA (Vienna)).

***BAERG, A P.**

Report on an international intercomparison of ^{131}I .

Presented at the 4th Session of CCEMRI, Sèvres, 1963, CCEMRI(II)/63-Annex 3.

(Participants: NPL - UK, AECL - Canada, AWRE Aldermaston - UK, BCMN - Belgium, CENS - France, DAECRE - Denmark, ETL - Japan, GWI - Sweden, IAR - Germany, IFM - Chile, IKO - Netherlands, KIA - Norway, KR - Germany, LNE - France, NBS - USA, NPRL - South Africa, NRC - Canada, PTB - Germany, IAEA (Vienna)).

CAMPION, P J.

Report on an international intercomparison of ^{198}Au .

Presented at the 4th Session of CCEMRI, Sèvres, 1963, CCEMRI(II)/63-Annex 4.

(Participants: NPL - UK, AECL - Canada, AEET - India, BCMN - Belgium, CENS - France, CFN - Portugal, CNEA - Argentina, DAECRE - Denmark, ETL - Japan, IAR - Germany, IFM - Chile, IKO - Netherlands, IPA - Romania, IRK - Austria, ISN - Yugoslavia, JEN - Spain, KIA - Norway, LNE - France, NBS - USA, NPRL - South Africa, NRC - Canada, PTB - Germany, UVVVR - Czechoslovakia, IAEA (Vienna), BIPM (Sèvres)).

***KOTCHINE, A E.**

Report on an international intercomparison of ^{60}Co .

Presented at the 4th Session of CCEMRI, Sèvres, 1963, CCEMRI(II)/63-Annex 5.

(Participants: NPL - UK, AECL - Canada, AEE - India, BCMN - Belgium, CFNI - Portugal, DAECRE - Denmark, ETL - Japan, IAR - Germany, IFM - Chile, IKO - Netherlands, IMM - Russia, IPA - Romania, IR - Austria, IRPAR - Czechoslovakia, LNE - France, NBS - USA, NPRL - South Africa, NRC - Canada, PTB - Germany, IAEA (Vienna), BIPM (Sèvres)).

***ROY, J C and *CAVALLO, L.**

Report on an international intercomparison of ^{204}Tl .

Presented at the 4th Session of CCEMRI, Sèvres, 1963, CCEMRI(II)/63-Annex 6.

(Participants: NPL - UK, AAEC - Australia, AECL - Canada, BCMN - Belgium, CENS - France, CFN - Portugal, DAECRE - Denmark, GWI - Sweden, IAR - Germany, IKO - Netherlands, IMM - Russia, IPA - Romania, IRK - Austria, JEN - Spain, LNE - France, NBS - USA, NRC - Canada, PTB - Germany, UVVVR - Czechoslovakia, IAEA (Vienna), BIPM (Sèvres)).

***RYTZ, A.**

Report on an international intercomparison of ^{241}Am .

Presented at the 5th Session of CCEMRI, Sèvres, 1964, CCEMRI(II)/64-page 49.

BIPM Report, December 1964.

(Participants: NPL - UK, AAEC - Australia, AECL - Canada, BCMN - Belgium, DAECRE - Denmark, ETL - Japan, IAR - Germany, IKO - Netherlands, IMM - Russia, IRK - Austria, ISN - Yugoslavia, JEN - Spain, LNE - France, NBS - USA, NPRL - South Africa, NRC - Canada, OMH - Hungary, PTB - Germany, UVVVR - Czechoslovakia, IAEA (Vienna), BIPM (Sèvres)).

*ROY, J C and *RYTZ, A.

Analysis of the results of an international intercomparison of ^{35}S .

Presented at the 5th Session of CCEMRI, Sèvres, 1964, CCEMRI(II)/64-page 28.

BIPM Report, February 1965.

(Participants: NPL - UK, AECL - Canada, BCMN - Belgium, CENS - France, CNAM - France, ETL - Japan, IAR - Germany, IKO - Netherlands, IPA - Romania, ISN - Yugoslavia, NBS - USA, NPRL - South Africa, NRC - Canada, PTB - Germany, UVVVR - Czechoslovakia, IAEA (Vienna), BIPM (Sèvres)).

*RYTZ, A.

International intercomparison of a solution of $^{90}\text{Sr} + ^{90}\text{Y}$ by the $4\pi\beta(\text{CP})$ method.

BIPM Report, September 1964.

Part II: Analysis of the results.

BIPM Report, June 1967.

(Participants: NPL - UK, AAEC - Australia, AEET - India, BCMN - Belgium, CENS - France, CNAM - France, ETL - Japan, GWI - Sweden, IAR - Germany, IMM - Russia, IPA - Romania, ISN - Yugoslavia, JEN - Spain, NBS - USA, NPRL - South Africa, NRC - Canada, OMH - Hungary, PTB - Germany, UVVVR - Czechoslovakia, BIPM (Sèvres)).

*WEISS, H M.

Summary of an international intercomparison of a ^{54}Mn solution.

BIPM Report, October 1968.

(Participants: NPL - UK, AAEC - Australia, AECL - Canada, BCMN - Belgium, CENS - France, CNAM - France, IAR - Germany, IKO - Netherlands, IMM - Russia, JEN - Spain, NBS - USA, NPRL - South Africa, NRC - Canada, PTB - Germany, IAEA (Vienna), BIPM (Sèvres)).

*DeVOLPI, A.

International intercomparison of ^{56}Mn activity in 1968.

Argonne National Laboratory Report, ANL-7642, December 1968.

(Participants: NPL - UK, AECL - Canada, ANL - USA, BCMN - Belgium, IKO - Netherlands, BIPM (Sèvres)).

*LE GALLIC, Y and *THENARD, M.

Validity of standards of radioactivity - ^{24}Na .

Commissariat à l'Energie Atomique Report CEA-R-3975 (1970).

(Participants: NPL - UK, AECL - Canada, CENS/LMR - France, DAECRE - Denmark, ETL - Japan, IAR - Germany, NBS - USA, NPRL - South Africa, NRC - Canada, PTB - Germany).

*MULLER, J W and *RYTZ, A.

Report on the intercomparison of dilution and source preparation methods by means of ^{60}Co .

Part 1: Results of individual laboratories.

BIPM Report, September 1967.

BCMNI Report, EUR 477e, 1964.

Nucl. Instrum. Methods, 1973, **112**, 41 -45.

(Participants: NPL - UK, AAEC - Australia, AECL - Canada, BARC - India, BCMNI - Belgium, CENS - France, CNAM - France, DAEC - Denmark, ETL - Japan, IAP - Switzerland, IAR - Germany, IBJ - Poland, IEA - Brazil, IMM - Russia, IPA - Romania, ISN - Yugoslavia, ISS - Italy, JEN - Spain, NBS - USA, NPRL - South Africa, OMH - Hungary, PTB - Germany, UVVVR - Czechoslovakia, IAEA (Vienna), BIPM (Sèvres)).

SMITH, D, WILLIAMS, A and WOODS, M J.

International intercomparison of ^{134}Cs by liquid scintillation counting.

Presented at the 4th meeting of Section II of CCEMRI, Sèvres, 1977, CCEMRI(I)/77-12.

(Participants: NPL - UK, LMRI - France, NBS - USA, NPRL - South Africa).

WILLIAMS, A and WOODS, M J.

Report on ^{57}Co 'mini-intercomparison' organised by NPL on behalf of BIPM.

Presented at the 4th meeting of Section II of CCEMRI, Sèvres, 1977, CCEMRI(I)/77-3.
(Participants: NPL - UK, AECL - Canada, BCMN - Belgium, LMRI - France, OMH - Hungary, PTB - Germany).

SMITH, D, WILLIAMS, A and WOODS, M J.

Report on the intercomparison of 'high count rate' ^{60}Co 4π sources, organised by NPL on behalf of BIPM.

Presented at the 4th meeting of Section II of CCEMRI, Sèvres, 1977, CCEMRI(I)/77-6.
(Participants: NPL - UK, AECL - Canada, BCMN - Belgium, IER - Switzerland, LMRI - France, PTB - Germany, UVVVR - Czechoslovakia, BIPM (Sèvres)).

*RYTZ, A.

International comparison of activity measurements of a solution of ^{139}Ce (March 1979).

Presented at the 4th meeting of Section II of CCEMRI, Sèvres, 1977, CCEMRI(II)/77-4.
Nucl. Instrum. Methods, 1978, 157, 131-135.

(Participants: NPL - UK, AAEC - Australia, AECL - Canada, ASWM - Germany, BARC - India, BCMN - Belgium, ETL - Japan, IBJ - Poland, IEA - Brazil, IER - Switzerland, IMM - Russia, IPA - Romania, IRK - Austria, LMRI - France, NBS - USA, NPRL - South Africa, NRC - Canada, OMH - Hungary, PTB - Germany, SCK/CEN - Belgium, UVVVR - Czechoslovakia, IAEA (Vienna), BIPM (Sèvres)).

*RYTZ, A.

Activity measurements of a solution of ^{134}Cs : Report of an international intercomparison.

Presented at the 4th meeting of Section II of CCEMRI, Sèvres, 1977, CCEMRI(II)/77-4.

Presented at the 5th meeting of Section II of CCEMRI, Sèvres, 1979, CCEMRI(II)/79-1.

Presented at the 6th meeting of Section II of CCEMRI, Sèvres, 1981, CCEMRI(II)/81-1.
Nucl. Instrum. Methods, 1982, 192, 427-431.

(Participants: NPL - UK, AAEC - Australia, AECL - Canada, ASWM - Germany, BARC - India, BCMN - Belgium, ETL - Japan, IBJ - Poland, IEA - Brazil, IER - Switzerland, IMM - Russia, INPE - Romania, IRK - Austria, LMRI - France, NAC - South Africa, NBS - USA, NIM - China, NRC - Canada, OMH - Hungary, PTB - Germany, SCK/CEN - Belgium, UVVVR - Czechoslovakia, IAEA (Vienna), BIPM (Sèvres)).

SMITH, D.

International comparison of activity measurements of a solution of ^{55}Fe .

Presented at the 7th meeting of Section II of CCEMRI, Sèvres, 1982, CCEMRI(II)/82-2.
Nucl. Instrum. Methods, 1982, 200, 383-387.

(Participants: NPL - UK, AECL - Canada, BCMN - Belgium, IBJ - Poland, IMM - Russia, LMRI - France, NAC - South Africa, NBS - USA, NRC - Canada, PTB - Germany, IAEA (Vienna)).

*REHER, D F G, *VANINBROUKX, R, *CHAUVENET, B, *MOREL, J, *VATIN, R, WOODS, M J, LUCAS, S E M, *BALLAUX, C, and *JACQUEMIN, R.

Standardisation of ^{123}I .

Int. J. Appl. Radiat. Isot., 1984, 10, 923-926.

(Participants: NPL - UK, CBNM - Belgium, LMRI - France, SCK/CEN - Belgium, IRE Belgium).

*RYTZ, A.

Activity concentration of a solution of ^{137}Cs : An international comparison.

Rapport BIPM - 80/3, 1980.

Rapport BIPM - 83/8, 1983.

Nucl. Instrum. Methods, 1985, **228**, 506-512.

(Participants: NPL - UK, AAEC - Australia, AECL - Canada, BARC - India, BCMN - Belgium, ETL - Japan, IER - Switzerland, IFIN - Romania, LMRI - France, NAC - South Africa, NBS - USA, NIM - China, NRC - Canada, OMH - Hungary, PDS - Indonesia, PTB - Germany, SCK/CEN - Belgium, UVVVR - Czechoslovakia, BIPM (Sèvres)).

*RYTZ, A.

International comparison of activity measurements of a solution of ^{133}Ba (March 1984).

BIPM Report BIPM-85/11, November 1985.

Nucl. Instrum. Methods, 1992, **A316**, 318-323.

(Participants: NPL - UK, AAEC - Australia, AECL - Canada, ASMW - Germany, BCMN - Belgium, ETL - Japan, IER - Switzerland, IMM - Russia, IPEN - Brazil, IRK - Austria, KSRI - Korea, LMRI - France, NAC - South Africa, NBS - USA, OMH - Hungary, PTB - Germany, UVVVR - Czechoslovakia, BIPM (Sèvres)).

*REHER, D F G, *HANSEN, H H, *VANINBROUKX, R, WOODS, M J, GRANT, C E, LUCAS, S E M, *BOUCHARD, J, *MOREL, J, and *VATIN, R.

The decay of ^{45}Sc .

Int. J. Appl. Radiat. Isot., 1986, **37**, 973-978.

(Participants: NPL - UK, BCMN - Belgium, LMRI - France).

*RATEL, G.

International comparison of activity measurements of a solution of ^{109}Cd (March 1986).

BIPM Report BIPM-88/4.

Nucl. Instrum. Methods, 1994, **A345**, 289-295.

(Participants: NPL - UK, AECL - Canada, BCMN - Belgium, ETL - Japan, IEA - Poland, IER - Switzerland, IFIN - Romania, IMM - Russia, IPEN - Brazil, KSRI - Korea, LMRI - France, NAC - South Africa, NBS - USA, NIM - China, OMH - Hungary, PTB - Germany, UVVVR - Czechoslovakia, IAEA (Vienna), BIPM (Sèvres)).

*CHAUVENET, B.

EUROMET project: Standardisation of ^{129}I .

EUROMET Workshop on Ionising Radiation and Radioactivity, held at NPL, 7 to 10 October 1990, Report published by NPL, Appendix C.

(Participants: NPL - UK, LMRI - France, PTB - Germany).

*FUNCH, E, *SCHOTZIG, U, WOODS, M J, SEPHTON, J P, MUNSTER, A S, DEAN, J C J, *BLANCHIS, P and *CHAUVENET, J P

EUROMET project: Standardisation of radionuclides: ^{56}Co .

EUROMET Workshop on Ionising Radiation and Radioactivity, held at NPL, 7 to 10 October 1990, Report published by NPL, Appendix C.

Nucl. Instrum. Methods, 1992, **A312**, 334-338.

(Participants: NPL - UK, LMRI - France, PTB - Germany, SCK/CEN - Belgium).

MAKEPEACE, J L, CLARK, F E, *PICOLO, J L, *COURSOL, N, *GUNTHER, E, and *UNTERWEGER, M P.

EUROMET project: Intercomparison of gas counting of krypton-85 and tritium.

EUROMET Workshop on Ionising Radiation and Radioactivity, held at NPL, 7 to 10 October 1990, Report published by NPL, Appendix C.

Intercomparison of internal gas proportional counting of ^{85}Kr and ^3H .

Conference and International Symposium on Radionuclide Metrology and its Applications, Teddington, (1993).

Nucl. Instrum. and Meths., 1994, A339, 343 - 348.

(Participants: NPL - UK, LPRI - France, NIST - USA, PTB - Germany).

*CHAUVENET, B and SMITH, D.

EUROMET project: Standardisation of ^{99}Tc .

EUROMET Workshop on Ionising Radiation and Radioactivity, held at NPL, 7 to 10 October 1990, Report published by NPL, Appendix C.

(Participants: NPL - UK, LMRI - France).

Activity measurements of a ^{75}Se solution in the frame of an international comparison.

Rapport BIPM - 93/14, 1992.

Submitted for publication to Nucl. Instrum. Methods.

(Participants: NPL - UK, AECL - Canada, BARC - India, CNEA - Argentina, ETL - Japan, IFIN - Romania, IIR - Czech Republic, KSRI - Korea, LNMRI - Brazil, LPRI - France, NAC - South Africa, NIM - China, NIRH - Denmark, NIST - USA, NRC - Canada, OMH - Hungary, PSPKR - Poland, PTB - Germany, VNIIM - Russia, IAEA (Vienna), BIPM (Sèvres)).

*REHER, D F G, *AALBERS, A H L, *BJERKE, H, *DRUGGE, N, *GENKA, G, ROSSITER, M J, *SANTRY, D, SEPHTON, J P, *SIBBENS, G, *SEUNTJENS, J, *THIERENS, H, *VERHAEGEN, F, WILLIAMS, T T, and WOODS, M J.

Second EUROMET comparison of air kerma rate and activity measurements of ^{192}Ir brachytherapy wires.

Conference and International Symposium on Radionuclide Metrology and its Applications, Teddington, (1993).

EUROMET project: Metrology of ^{192}Ir brachytherapy sources.

Second EUROMET Workshop on Ionising Radiation and Radioactivity, held at NPL, 10 to 12 October 1994, Report published by NPL, Appendix 3.

Nucl. Instrum. and Meths., 1994, A339, 386 - 390.

(Participants: (i) Air kerma measurements: NPL - UK, NIRP - Sweden, NMi - Netherlands, NRPA - Norway, RUG - Belgium; (ii) Activity measurements: NPL - UK, IRMM - Belgium, JAERI - Japan, NRC Canada, NRPA - Norway).

DEAN, J C J, and BURKE, M.

An intercomparison of ^{222}Rn measurement systems in European laboratories.

Nucl. Instrum. Meths., 1994, A339, 264-270.

(Participants: ARC - Austria, BEV - Austria, ENEA - Italy, IRK - Austria, LPRI - France, NCSR - Greece, NIST - USA, PTB - Germany, RPII - Eire, SCK/CEN - Belgium, RPI - Sweden).

MAKEPEACE, J M.

EUROMET project: Standardisation of ^{133}Xe .

Second EUROMET Workshop on Ionising Radiation and Radioactivity, held at NPL, 10 to 12 October 1994, Report published by NPL, Appendix 3.

(Participants: NPL - UK, LPRI - France, PTB - Germany).

MAKEPEACE, J M.

EUROMET project: Intercomparison of measurements of tritiated water by gas counting.

Second EUROMET Workshop on Ionising Radiation and Radioactivity, held at NPL,
10 to 12 October 1994, Report published by NPL, Appendix 3.

(Participants: NPL - UK, NIST - USA, PTB - Germany).

3.3 INTERCOMPARISONS OF RADIOACTIVITY MEASUREMENTS IN PROGRESS OR PLANNED FOR THE FUTURE

- (a) Intercomparison of measurements of samples of ^{133}Xe .
Scheduled to be completed as a EUROMET project with NMS funding, September 1998.
- (b) Intercomparison of measurements of ^{237}Np sources.
Scheduled to be completed as a EUROMET project with NMS funding, September 1998.
- (c) Intercomparison of ^{192}Ir brachytherapy wire source standardisation.
Scheduled to be completed as a EUROMET project with NMS funding, September 1998.
- (d) Intercomparison of standardisation measurements of ^{90}Sr .
Scheduled to be completed under the auspices of BIPM with NMS funding, September 1998.
- (e) Intercomparison of standardisation measurements of ^{204}Tl .
Scheduled to be completed under the auspices of BIPM with NMS funding, September 1998.
- (f) Intercomparison of measurements of tritiated water samples.
Scheduled to be completed as a multilateral intercomparison with NMS funding, September 1998.

It is intended that NPL will participate in any relevant international intercomparison organised under the auspices of either CCEMRI Section II or EUROMET, as and when they are agreed and organised.

3.4 BIPM INTERNATIONAL REFERENCE SYSTEM (SIR)

Summarised in individual radionuclide report sheets available from BIPM and:

*REHER, D F G.

Critical evaluation of SIR results: A first step.

IRMM Report GE/R/RN/03/95, April 1995.

Nuclide	NPL Date of submission	No. of other national laboratories submitted
	1976	13
⁴⁶ Sc	1981	6
	1980	11
	1976	12
	1991	1
	1976	15
	1991	4
⁵⁹ Fe	1979	7
⁶⁰ Co	1976	22
⁶⁵ Zn	1979	8
⁸⁵ Sr	1981	7
⁸⁸ Y	1977	4
⁹⁵ Nb	1977	12
¹⁰⁹ Cd	1980	5
^{110m} Ag	1993	2
¹¹¹ In	1982	5
¹³¹ I	1980	13
¹³³ Ba	1982	14
¹³⁴ Cs	1977	12
¹³⁷ Cs	1977	13
¹³⁹ Ce	1981	8
¹⁴⁴ Ce	1984	4
¹⁵⁴ Eu	1990	1

	1993	0
	1990	5
	1979	5
²⁴¹ Am	1980	5
²⁴³ Am	1993	0

NPL will continue to submit standardised ampoules of radionuclides to the SIR as and when they are available.

4. ABSORBED DOSE MEASUREMENTS

4.1 INTERCOMPARISON OF ABSORBED DOSE CALIBRATIONS FOR BETA-RADIATION

OWEN, B.

Intercomparison of beta-dosimetry NPL/PTB and NPL/VNIIM.

Presented at the 5th meeting of Section I of CCEMRI, Sèvres, 1979, CCEMRI(I)/79-32.
(Participants: NPL - UK, PTB - Germany, VNIIM - USSR).

OWEN, B.

Summary of the comparison of NPL and VNIIM absorbed dose standards for beta-radiation

Presented at the 7th meeting of Section I of CCEMRI, Sèvres, 1981, CCEMRI(I)/81-21
(Participants: NPL - UK, VNIIM - USSR).

OWEN, B.

Comparison of the NPL and PTB absorbed dose rate standards for beta ray radiation at protection levels - Contract 1161/1 - 80/L/V.

NPL Report RS(EXT)57, November 1981.

(Participants: NPL - UK, PTB - Germany).

4.2 INTERCOMPARISON OF ABSORBED DOSE TO WATER AND ABSORBED DOSE TO GRAPHITE STANDARDS AT THERAPY-LEVELS FOR ^{60}Co GAMMA RADIATION

BURNS, J E.

Comparison of standards of absorbed dose by transfer chamber.

Presented at the 9th meeting of Section I of CCEMRI, Sèvres, 1988, CCEMRI(I)/88-9.
(Participants: NPL - UK, BIPM).

BURNS, J E and OWEN, B.

NPL/BIPM intercomparison of absorbed dose 1987 - 1988.

Presented at the 9th meeting of Section I of CCEMRI, Sèvres, 1988, CCEMRI(I)/88-14.
(Participants: NPL - UK, BIPM).

DuSAUTOY, A R, SHARPE, P H G, BURNS, J E, *BERYLYAND, V A, and
*BREGADZE, J I.

Intercomparison of standards of absorbed dose between the USSR and the UK.

NPL Report RSA(EXT)17, 1991.

(Participants: NPL - UK, VNIIFTRI - USSR).

OWEN, B and *GRIMBERGEN, T W M

Report on an intercomparison of absorbed dose standards of the Netherlands and the United Kingdom.

Presented at the 11th meeting of Section I of CCEMRI, Sèvres, 1993, CCEMRI(I)/93-23.
(Participants: NPL - UK, NMi - Netherlands).

- 5.3 INTERCOMPARISONS OF STANDARDS OF X-RAY EXPOSURE AND/OR AIR KERMA IN PROGRESS OR PLANNED FOR THE FUTURE
- (a) Intercomparison of calibration factors for ^{192}Ir brachytherapy sources.
Scheduled to be completed as a EUROMET project, with NMS funding, September 1998 (participants yet to be finalised).
 - (b) Intercomparison of air kerma standards (50 kV, 300 kV and 2 MV) at therapy qualities with BIPM.
Scheduled to be completed as a bilateral intercomparison with BIPM with NMS funding, September 1998.
 - (c) Intercomparison of air kerma standards for mammographic and diagnostic radiology.
Scheduled to be completed as a EUROMET project with NMS funding, September 1998 (participants yet to be finalised).
 - (d) Intercomparison of air kerma standards for 2 MV X-rays and ^{60}Co gamma-rays at therapy-level dose rates.
Scheduled to be completed as a EUROMET project with NMS funding, September 1998 (participants include: NPL - UK, DPSR - Portugal, LPRI - France, NIRH - Denmark, NMI - Netherlands, NRPA - Norway, SSI - Sweden, STUK - Finland, IAEA (Vienna)).

It is intended that NPL will participate in any relevant international intercomparison organised under the auspices of either CCEMRI Section I or EUROMET, as and when they are agreed and organised.

4.3 INTERCOMPARISON OF ABSORBED DOSE TO WATER AND ABSORBED DOSE TO GRAPHITE STANDARDS AT THERAPY-LEVELS FOR ^{60}Co GAMMA RADIATION AND X-RADIATION FROM 4 MV TO 19 MV

OWEN, B.

A summary of high-energy photon absorbed dose to water comparisons.

Presented at the 10th meeting of Section I of CCEMRI, Sèvres, 1991, CCEMRI(I)/91-2. (Participants: NPL - UK, NRC - Canada, PTB - Germany, BIPM).

OWEN, B.

Revision of the NPL/BIPM Cobalt-60 comparison of absorbed dose to water.

Presented at the 11th meeting of Section I of CCEMRI, Sèvres, 1993, CCEMRI(I)/93-2. (Participants: NPL - UK, BIPM).

OWEN, B.

Summary of NPL, BIPM, PTB and NRC absorbed dose to water comparisons.

Presented at the 11th meeting of Section I of CCEMRI, Sèvres, 1993, CCEMRI(I)/93-4. (Participants: NPL - UK, NRC - Canada, PTB - Germany, BIPM).

*BOUTILLON, M, *COURSEY, B M, *HOHLFELD, K, OWEN, B, and

*ROGERS, D W O.

Comparison of primary water absorbed dose standards.

Proceedings of an International Symposium on Measurement Assurance in Dosimetry, organised by the International Atomic Energy Agency, held in Vienna, May 1993. IAEA Publication STI/PUB/930 (IAEA-SM-330/48), 1994, 95 - 111.

(Participants: NPL - UK, NIST - USA, NRC - Canada, PTB - Germany, BIPM).

*PERROCHE, A M and *BOUTILLON, M.

Comparison and calibrations at the BIPM (1993-95).

Presented at the 12th meeting of Section I of CCEMRI, Sèvres, 1995, CCEMRI(I)/95-1. (Summary of intercomparisons of standards of absorbed dose in graphite for ^{60}Co gamma radiation carried out during the period 1977 to 1994).

*PERROCHE, A M and *BOUTILLON, M.

Comparison and calibrations at the BIPM (1993-95).

Presented at the 12th meeting of Section I of CCEMRI, Sèvres, 1995, CCEMRI(I)/95-1. (Summary of intercomparisons of standards of absorbed dose in water for ^{60}Co gamma radiation carried out during the period 1977 to 1994).

*GRIMBERGEN, T W M.

Review of comparisons of the absorbed dose to graphite standards of the Netherlands, The United Kingdom and the BIPM.

Presented at the 12th meeting of Section I of CCEMRI, Sèvres, 1995, CCEMRI(I)/95-23. (Participants: NPL - UK, NMi - Netherlands, BIPM (Sèvres)).

4.4 INTERCOMPARISON OF ABSORBED DOSE TO WATER STANDARDS AT STERILISATION AND INDUSTRIAL DOSE LEVELS

ELLIS, S C.

Processing-level standards.

Presented at the 5th meeting of Section I of CCEMRI, Sèvres, 1979, CCEMRI(I)/79-30. (Participants: NPL - UK, ETL - Japan, LMRI - France, NBS - USA, NIM - China, NIRP - Sweden, NRC - Canada, PTB - Germany, IAEA).

ELLIS, S C, BARRETT, J H, and SHARPE, P H G.

Preliminary report on an intercomparison of Fricke dosimetry systems.

Presented at the 6th meeting of Section I of CCEMRI, Sèvres, 1981, CCEMRI(I)/81-18. (Participants: NPL - UK, LMRI - France, NBS - USA, NIRP - Sweden, NIRS - Japan, RIV - Netherlands, IAEA).

*NAM, J W.

Dosimetry for industrial processing: Intercomparison studies.

Presented at the 6th meeting of Section I of CCEMRI, Sèvres, 1981, CCEMRI(I)/81-4. (Participants: NPL - UK, ETL - Japan, LMRI - France, NBS - USA, IAEA).

SHARPE, P H G.

Preliminary report on Fricke intercomparison between NPL and NRC, Canada.

Presented at the 8th meeting of Section I of CCEMRI, Sèvres, 1985, CCEMRI(I)/85-20. (Participants: NPL - UK, NRC - Canada).

SHARPE, P H G.

Report on the NPL Fricke intercomparison with the Australian Atomic Energy Commission Laboratory, Lucas Heights.

Presented at the 8th meeting of Section I of CCEMRI, Sèvres, 1985, CCEMRI(I)/85-21. (Participants: NPL - UK, AAEC - Australia).

SHARPE, P H G.

Intercomparison of the high-dose-rate cobalt-60 irradiation fields at NPL and NBS.

Presented at the 8th meeting of Section I of CCEMRI, Sèvres, 1985, CCEMRI(I)/85-23. (Participants: NPL - UK, NBS - USA).

SHARPE, P H G.

Fricke intercomparisons between NPL and BIPM, 1985 - 1988.

Presented at the 9th meeting of Section I of CCEMRI, Sèvres, 1988, CCEMRI(I)/88-8. (Participants: NPL - UK, BIPM).

SHARPE, P H G.

NPL/BIPM Fricke intercomparisons of absorbed dose to water using ^{60}Co radiation.

Presented at the 9th meeting of Section I of CCEMRI, Sèvres, 1988, CCEMRI(I)/88-20. (Participants: NPL - UK, BIPM).

*SCHNEIDER, M K H.

EUROMET project: NPL - Fricke dosimetry service.

EUROMET Workshop on Ionising Radiation and Radioactivity, held at NPL, 7 to 10 October 1990, Report published by NPL, Appendix C. (Participants: NPL - UK, PTB - Germany).

SHARPE, P H G and *MILLER, A.

EUROMET project: Dichromate dosimetry.

EUROMET Workshop on Ionising Radiation and Radioactivity, held at NPL, 7 to 10 October 1990, Report published by NPL, Appendix C.

(Participants: NPL - UK, RISO - Denmark).

BURNS, D T and *MILLER, A.

EUROMET project: Dosimetry for electron-beam radiation processing.

EUROMET Workshop on Ionising Radiation and Radioactivity, held at NPL, 7 to 10 October 1990, Report published by NPL, Appendix C.

(Participants: NPL - UK, RISO - Denmark).

*ZSDANSZKY, K.

IAEA High dose intercomparison in the ^{60}Co radiation field.

Presented at the 14th meeting of Section I of CCEMRI, Sèvres, 1995, CCEMRI(I)/95-15.

(Participants: NPL - UK, DAMRI - France, ENEA - Italy, JAERI - Japan, NIM - China, NIST - USA, Nordian International - Canada, RISO - Denmark, VNIIFTRI - Russia).

4.5 INTERCOMPARISONS OF MEASUREMENTS OF ABSORBED DOSE IN PROGRESS OR PLANNED FOR THE FUTURE

- (a) Intercomparison of high-dose dosimetry via alanine.
Report of an IAEA Co-ordinated Research Programme carried out during 1993 to 1995 (participants: NPL - UK, AECL - Canada, JAERI - Japan, LPRI - France, NIST - USA, RISO - Denmark, VNIIFTRI - Russia).
- (b) Intercomparison of absorbed dose measurements.
Scheduled to be completed as a multilateral intercomparison with BIPM and with three other national standards laboratories, with NMS funding, September 1998.
- (c) Intercomparison of the standardisation of surface absorbed dose rate from Sr-90 ophthalmic applicators.
Scheduled to be completed as a EUROMET project with NMS funding, September 1998.
- (d) Intercomparison of absorbed dose standards for beta-radiation.
Scheduled to be completed as a EUROMET project with NMS funding, September 1998.

Intercomparison of absorbed dose to graphite and water in ^{60}Co gamma-rays and megavoltage X-rays, between NPL - UK and ARL - Australia.
Scheduled to be completed as a bilateral intercomparison, September 1998.
- (f) Intercomparison of absorbed dose to water calibration accuracy between secondary standard laboratories and primary laboratories (NPL - UK and NMi - Netherlands).
Scheduled to be completed as a EUROMET project with NMS funding, September 1998.

Comparison of procedure to convert absorbed dose calibrations from graphite to water in ^{60}Co and (possibly) megavoltage X-rays.
Proposed EUROMET project with NMS funding, completion date to be agreed.
- (h) Determination of beam quality index for absorbed dose intercomparisons and evaluation of k_q -factors.
Proposed EUROMET project with NMS funding, completion date to be agreed.
- (i) Intercomparison of absorbed dose transfer standards in graphite and in water in ^{60}Co gamma-rays and megavoltage X-rays.
Proposed EUROMET project with NMS funding, completion date to be agreed.
- (j) Proposed intercomparison of absorbed dose to water standards between NPL and NRC.
Proposed EUROMET project with NMS funding, completion date to be agreed.

It is intended that NPL will participate in any relevant international intercomparison organised under the auspices of either CCEMRI Section I or EUROMET, as and when they are agreed and organised.

5. X-RAY EXPOSURE AND AIR KERMA

5.1 INTERCOMPARISON OF EXPOSURE AND AIR KERMA PRIMARY STANDARDS OR LOW AND MEDIUM ENERGY X-RAY QUALITIES

ASTON, G H and *ATTIX, F H.

An intercomparison of the roentgen standards of Great Britain and the United States of America.

Acta Radiologica, 1956, **46**, 747.

(Participants: NPL - UK, NBS - USA).

*WYCKOFF, H O, *ALLISY, A, ASTON, G H, BARNARD, G P *HUBNER, W, *LOFTUS, T and *TAUPIN, G.

Intercomparison of national roentgen and gamma-ray exposure standards.

Acta Radiologica, 1963, **1** (New Series), 57.

(Participants: NPL - UK, LD - France, NBS - USA, PTB - Germany).

*SOMERWIL, A.

Intercomparison of exposure standards using a transfer standard chamber.

Presented at the 1st meeting of Section I of CCEMRI, Sèvres, 1970, CCEMRI(I)/70-R3.

(Participants: NPL - UK, RIV - Netherlands, PTB - Germany).

*LOEVINGER, R.

NPL - NBS intercomparison of exposure standards.

Presented at the 3rd meeting of Section I of CCEMRI, Sèvres, 1975, CCEMRI(I)/75-9C.

(Participants: NPL - UK, NBS - USA).

MARSH, A R S and MORETTI, C J.

Intercomparison of primary standard exposure standards.

Presented at the 5th meeting of Section I of CCEMRI, Sèvres, 1979, CCEMRI(I)/79-6.

(Participants: NPL - UK, BIPM).

CCEMRI SECTION I.

Intercomparison of primary standard exposure standards over the range 10 to 50 kV.

Presented at the 5th meeting of Section I of CCEMRI, Sèvres, 1979, CCEMRI(I)/79-R(I)4.

(Participants: NPL - UK, ETL - Japan, NBS - USA, NRC - Canada, OMH - Hungary, RIV - Netherlands, BIPM).

MARSH, A R S and MORETTI, C J.

BIPM-NPL aperture intercomparison.

Presented at the 8th meeting of Section I of CCEMRI, Sèvres, 1983, CCEMRI(I)/83-23.

(Participants: NPL - UK, BIPM).

MARSH, A R S and MORETTI, C J.

Comparison of exposure standards for medium energy X-radiation using a transfer instrument.

Presented at the 8th meeting of Section I of CCEMRI, Sèvres, 1983, CCEMRI(I)/83-14.

(Participants: NPL - UK, BIPM).

OWEN, B and ROSSITER, M J

Comparison of the NPL and RIV protection-level exposure standards - CEC Contract 1185/2-81/L/V.

NPL Report RS(EXT)61, November 1988.

(Participants: NPL - UK, RIV - Netherlands).

MORETTI, C J.

Intercomparison of low-energy free air standards.

Presented at the 10th meeting of Section I of CCEMRI, Sèvres, 1991, CCEMRI(I)/91-23.
(Participants: NPL - UK, ENEA - Italy).

MORETTI, C J

Intercomparison of medium-energy free air standards.

Presented at the 10th meeting of Section I of CCEMRI, Sèvres, 1991, CCEMRI(I)/91-24.
(Participants: NPL - UK, ENEA - Italy).

MORETTI, C J, HEATON, J A, *LAITANO, R F and *TONI, M P.

Intercomparison of the medium-energy primary standards for X-ray exposure of the NPL and ENEA, Italy.

NPL Report RSA(EXT)18, 1991.

(Participants: NPL - UK, ENEA - Italy).

MORETTI, C J, HEATON, J A, *LAITANO, R F and *TONI, M P.

Intercomparison of the low-energy primary standards for X-ray exposure of the NPL and ENEA, Italy.

NPL Report RSA(EXT)19, 1991.

(Participants: NPL - UK, ENEA - Italy).

MORETTI, C J, HEATON, J A, *STUCKI, G and DUANE, S.

Intercomparison of the United Kingdom and the Swiss primary standards of X-ray exposure and air kerma for 50 kV X-rays.

Proceedings of an International Symposium on Measurement Assurance in Dosimetry, organised by the International Atomic Energy Agency, held in Vienna, May 1993. IAEA Publication STI/PUB/930 (IAEA-SM-330/36), 1994, 119 - 129.

Second EUROMET Workshop on Ionising Radiation and Radioactivity, held at NPL, 10 to 12 October 1994, Report published by NPL, Appendix 3.

(Participants: NPL - UK, OFM - Switzerland).

*REHER, D F G.

EUROMET project: Metrology of ^{192}Ir brachytherapy sources.

Second EUROMET Workshop on Ionising Radiation and Radioactivity, held at NPL, 10 to 12 October 1994, Report published by NPL, Appendix 3.

(Participants: NPL - UK, IRMM - Belgium, JAERI - Japan, LPRI - France, NRC - Canada, NRPA - Norway, RUG - Belgium, SSI/NIRP - Sweden).

5.2 INTERCOMPARISON OF EXPOSURE AND AIR KERMA PRIMARY STANDARDS FOR 2 MV X-RADIATION AND ^{60}Co GAMMA RADIATION

*RAKOW, A, *WILL, W, *YUDIN, M, *KONONOVA, R, MARSH, A R S and DALE, J W G.

International comparisons of ionisation chamber for absolute measurements of the roentgen at photon energies of about 1 MeV.

Acta Radiologica, 1970, 9, 144-154.

(Participants: NPL - UK, DAW - Germany, VNIIM - Russia).

*MOTZ, J W.

A report to Section I of the CCEMRI on the intercomparison of the NBS standards for the measurement of cobalt-60 gamma rays in exposure units with the BIPM, LMRI and NPL standards.

Presented at the 2nd meeting of Section I of CCEMRI, Sèvres, 1972, CCEMRI(I)/72-5.

(Participants: NPL - UK, LMRI - France, NBS - USA, BIPM).

MARSH, A R S and MORETTI, C J.

New NPL primary standard for 2 MV X-radiation and cobalt-60 gamma radiation.

Presented at the 8th meeting of Section I of CCEMRI, Sèvres, 1983, CCEMRI(I)/83-13.

(Participants: NPL - UK, BIPM).

*REHER, D F G, *AALBERS, A H L, *BJERKE, H, *DRUGGE, N, *GENKA, G, ROSSITER, M J, *SANTRY, D, SEPHTON, J P, *SIBBENS, G, *SEUNTJENS, J, *THIERENS, H, *VERHAEGEN, F, WILLIAMS, T T and WOODS, M J.

Second EUROMET comparison of air kerma rate and activity measurements of ^{192}Ir brachytherapy wires.

Conference and International Symposium on Radionuclide Metrology and its Applications, Teddington, (1993).

Nucl. Instrum. and Meths., 1994, A339, 386 - 390.

(Participants: (i) Air kerma measurements: NPL - UK, NIRP - Sweden, NMi - Netherlands, NRPA - Norway, RUG - Belgium; (ii) Activity measurements: NPL - UK, IRMM - Belgium, JAERI - Japan, NRC Canada, NRPA - Norway).

*PERROCHE, A M and *BOUTILLON, M.

Comparison and calibrations at the BIPM (1993-95).

Presented at the 12th meeting of Section I of CCEMRI, Sèvres, 1995, CCEMRI(I)/95-1.

(Summary of air kerma intercomparisons for ^{60}Co gamma radiation carried out during the period 1971 to 1994).

1. The first part of the paper discusses the importance of the study and the objectives of the research. It also provides a brief overview of the literature review and the methodology used in the study.

2. The second part of the paper presents the results of the study. It includes a detailed analysis of the data collected and the findings of the research. The results are presented in a clear and concise manner, with appropriate use of tables and figures.

3. The third part of the paper discusses the implications of the study and the conclusions drawn from the research. It also provides a brief summary of the key findings and the overall contribution of the study to the field.

4. The final part of the paper includes a list of references and a list of figures. The references are listed in alphabetical order, and the figures are numbered according to their position in the text.