JRC Reference Laboratory for Isotopic Measurements

Isotopic Reference Materials Certified by IRMM Catalogue 2003

Treaty of Roma	***Traité de Roma***
May 1957	***Mai 1957***
Article 8	Article 8
1. ... the Commission shall establish a Joint Nuclear Research Centre.	1. La Commission crée ... un Centre commun de recherches nucléaires.
This Centre shall	Le Centre ...
... ensure that a ... standard system of measurements [is] established	assure ... l'établissement ... d'un système d'étalonnage unique.
It shall set up a **Central Bureau for Nuclear Measurements.**	Il organise un **Bureau Central de Mesures Nucléaires.**
(since 1993 : **Institute for Reference Materials and Measurements**)	(dénommé à partir de 1993 : **Institut de Matériaux et Mesures de Référence**)
ANNEX V	ANNEXE V
I. Programme...	I. Programme ...
1. ...	1. ...
(c) a bureau of standards specialising in ... **isotope analysis** and absolute measurements of radiation and neutron absorption	(c) un bureau de standards spécialisé ... pour les **dosages d'isotopes** ainsi que les mesures absolues de rayonnement et d'absorptions neutroniques

Isotopic Reference Materials Certified by IRMM

Institute for Reference Materials and Measurements
European Commission - JRC
B-2440 GEEL (Belgium)

CONTENTS

PREFACE

This Catalogue lists certified Isotopic Reference Materials (IRMs) currently available or in preparation at the **Institute for Reference Materials and Measurements** (IRMM) (1959-1992 **:** Central Bureau for Nuclear Measurements - CBNM). All of these Reference Materials have a Certificate issued under the responsibility of IRMM, Isotope Measurements. Some of them have been examined by a nuclear experts committee because of their use in nuclear Safeguards and are certified as EC-NRM's (European Community - Nuclear Reference Materials).

The IRMs listed can be divided into two major groups**:**

- those certified for isotope amount ratios and hence suitable for calibration of measurements of isotope abundance ratios
- those certified for isotope amount content and hence suitable for direct use in isotope dilution as "spikes" against which an unknown amount of an isotope or an element can be measured.

These IRMs are also suitable for

- calibration of instruments for isotopic measurements
- calibration and evaluation of isotopic measurement procedures
- development of isotopic measurement methods
- nuclear material accountancy measurements

The IRMs are available to industrial and official laboratories, as well as to academic and research institutes or other users. As far as orders for nuclear materials from countries outside the EU are concerned, individual authorisation for delivery is required from the European Commission.

Each IRM is described by a number, matrix type and certified quantities and their values with their uncertainties. All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value. The uncertainties are evaluated from the ISO/BIPM Guide to Expression of Uncertainty in Measurement onwards.

All information given in this catalogue is indicative and does not replace the Certificates issued for each IRM.

Each IRM unit delivered is accompanied by a Certificate containing the following information: the certified quantities and value(s), the certified uncertainty assigned to each certified value, date of issue and a short indication of the scientific approach used to measure each certified quantity.

New certificates are issued when new Isotopic Reference Materials or replacements are prepared or when existing Isotopic Reference Materials are re-certified to smaller uncertainties.

A replacement for a given Isotopic Reference Material is selected such as to have approximately the same value for the certified characteristic as its predecessor. It is identified by a character after the Isotopic Reference Material number (e.g. IRMM-023A).

All values of the IRMM Isotopic Reference Materials are traceable to the SI (the international system of base quantities and base units).
Isotopic measurement results corrected by means of these Isotope Ratio Reference Materials will have reduced (ISO/BIPM) uncertainties.
Amount content measurements carried out using these Spike Reference Materials will be traceable to the SI, if carried out properly.

This Catalogue also lists Isotopic Certification Measurement Services (available to a limited extent), Consulting Services in matters of isotopes as well as in Traceability to the SI and Metrology in Chemistry.

It announces training possibilities through the Isotopic Measurement Training and Education Centre, IMTEC and information on isotopes through the Isotopic Data and Information Centre, ISDIC.

It has been prepared for the benefit of Isotopic measurements in the European Union and elsewhere.

Dr Philip Taylor
Head of Unit, Isotope Measurements
Email: philip.taylor@irmm.jrc.be

Dr Roger Wellum
IRMM Safeguards Coordinator
Email: roger.wellum@irmm.jrc.be

Institute for Reference Materials and Measurements
Joint Research Centre of the European Commission
B-2440 GEEL (Belgium)

For any additional information or for ordering, please contact:
Email: IMsales@irmm.jrc.be

André Verbruggen
Coordinator Isotopic Reference Materials
Tel. +32 14 571 617
Fax. +32 14 571 863
Email: andre.verbruggen@irmm.jrc.be

The information in this catalogue can also be found
on the IRMM Web site: http://www.irmm.jrc.be/mrm.html

1 ISOTOPIC REFERENCE MATERIALS CERTIFIED FOR ISOTOPE ABUNDANCE RATIO (Amount Ratio)

1.1 STABLE ISOTOPES

Code	Description	Isotope amount fraction (·100)					Amount ratios			Unit size
		^{64}Zn	^{66}Zn	^{67}Zn	^{68}Zn	^{70}Zn	$n(^{67}\text{Zn})/n(^{64}\text{Zn})$	$n(^{68}\text{Zn})/n(^{64}\text{Zn})$	$n(^{68}\text{Zn})/n(^{67}\text{Zn})$	
IRMM-007/1	In preparation						0.020 0	0.022 1	1.103 6	
IRMM-007/2							0.040 2	0.042 3	1.053 1	
IRMM-007/3							0.100 5	0.102 9	1.023 1	
IRMM-007/4							0.202 7	0.205 4	1.013 0	
IRMM-007/5							0.419 6	0.422 9	1.007 9	
IRMM-007/6							0.999 4	1.004 5	1.005 1	
IRMM-007/7							2.000 8	2.009 0	1.004 1	
IRMM-007/8							3.992 5	4.006 9	1.003 6	
IRMM-007/9							10.037 7	10.070 8	1.003 3	
IRMM-007/10							20.475 5	20.540 9	1.003 2	

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

STABLE ISOTOPES (continued)

Code	Description	Isotope amount fraction (·100)			Amount ratios			Unit size
		^{40}Ca	^{42}Ca	^{44}Ca	$n(^{42}Ca)/n(^{40}Ca)$	$n(^{44}Ca)/n(^{40}Ca)$	$n(^{42}Ca)/n(^{44}Ca)$	
IRMM-008/1	In preparation				12.203 8	12.197 6	1.000 5	
IRMM-008/2					5.997 4	5.994 3	1.000 5	
IRMM-008/3					3.014 9	3.013 3	1.000 5	
IRMM-008/4					1.505 6	1.504 8	1.000 5	
IRMM-008/5					0.701 1	0.700 8	1.000 5	
IRMM-008/6					0.301 8	0.301 6	1.000 5	
IRMM-008/7					0.099 7	0.099 6	1.000 5	
IRMM-008/8					0.052 7	0.052 7	1.000 5	
IRMM-008/9					0.010 0	0.010 0	1.000 4	
IRMM-008/10					0.005 0	0.005 0	1.000 3	

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

STABLE ISOTOPES (continued)

Code	Description	Amount ratios	Unit size
		$n(^{41}Ca)/n(^{40}Ca)$	
IRMM-3701/1	In preparation 0.6 M HNO_3 solution	1.00E-06	25 mL
IRMM-3701/2		1.00E-07	
IRMM-3701/3		1.00E-08	
IRMM-3701/4		1.00E-09	
IRMM-3701/5		1.00E-10	
IRMM-3701/6		1.00E-11	
IRMM-3701/7		1.00E-12	
IRMM-3701/8		1.00E-13	

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

STABLE ISOTOPES (continued)

Code	Description	Isotope amount fraction (·100)						Amount ratios			Unit size
IRMM-009	0.2 M HNO_3 solution	**^{24}Mg**	**^{25}Mg**	**^{26}Mg**				***n*(^{25}Mg)/*n*(^{24}Mg)**	***n*(^{26}Mg)/*n*(^{24}Mg)**		10^{-3} mol·kg^{-1} 4 mL
		78.992(25)	10.003(9)	11.005(19)				0.126 63(13)	0.139 32(26)		
IRMM-010	Pt metal	**^{190}Pt**	**^{192}Pt**	**^{194}Pt**	**^{195}Pt**	**^{196}Pt**	**^{197}Pt**	***n*(^{194}Pt)/*n*(^{195}Pt)**	***n*(^{196}Pt)/*n*(^{195}Pt)**	***n*(^{198}Pt)/*n*(^{195}Pt)**	30 mg (wire)
		0.011 7(12)	0.782(16)	32.86(25)	33.78(13)	25.21(10)	7.356(82)	0.973(11)	0.746 4(82)	0.217 8(24)	
IRMM-011	H_3BO_3 solid	**^{10}B**	**^{11}B**					***n*(^{10}B)/*n*(^{11}B)**			1 g
		19.824 (20)	80.176(20)					0.247 26(32)			
IRMM-012	1 M HCl solution	**^{50}Cr**	**^{52}Cr**	**^{53}Cr**	**^{54}Cr**			***n*(^{50}Cr)/*n*(^{52}Cr)**	***n*(^{53}Cr)/*n*(^{52}Cr)**	***n*(^{54}Cr)/*n*(^{52}Cr)**	0.2 mmol Cr·kg^{-1} 5 mL
		4.345(9)	83.789(2)	9.501(11)	2.365(5)			0.051 86(10)	0.113 39(15)	0.028 22(06)	
IRMM-013	D_2O solution	**D_2O**	**HDO**								on request
		≥ 99	≤ 1								
IRMM-014	Fe metal	**^{54}Fe**	**^{56}Fe**	**^{57}Fe**	**^{58}Fe**			***n*(^{54}Fe)/*n*(^{56}Fe)**	***n*(^{57}Fe)/*n*(^{56}Fe)**	***n*(^{58}Fe)/*n*(^{56}Fe)**	50 mg (wires) or 250 mg (cubes)
		5.845(23)	91.754(24)	2.119 1(66)	0.281 9(28)			0.063 70(27)	0.023 096(72)	0.003 071(29)	
IRMM-015	Li_2CO_3 Solid	**^{6}Li**	**^{7}Li**					***n*(^{6}Li)/*n*(^{7}Li)**			50 mg
		95.610(20)	4.390(20)					21.78(12)			
IRMM-016	Li_2CO_3 solid	**^{6}Li**	**^{7}Li**					***n*(^{6}Li)/*n*(^{7}Li)**			1 g
		7.589(24)	92.411(24)					0.082 12(28)			
IRMM-017	Si Solid	**^{28}Si**	**^{29}Si**	**^{30}Si**				***n*(^{29}Si)/*n*(^{28}Si)**	***n*(^{30}Si)/*n*(^{28}Si)**		50 mg
		92.228 77(86)	4.682 59(58)	3.088 64(70)				0.050 771 5(66)	0.033 488 9(78)		
IRMM-018	SiO_2 solid	**^{28}Si**	**^{29}Si**	**^{30}Si**				***n*(^{29}Si)/*n*(^{28}Si)**	***n*(^{30}Si)/*n*(^{28}Si)**		5 g
		92.214 40(70)	4.688 57(42)	3.097 03(58)				0.050 844 2(48)	0.033 585 1(66)		

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

1.2 FISSILE ISOTOPES

1.2.1 URANIUM

Uranium Hexafluoride

Code	Description	Isotope amount fraction (·100)				Amount ratio $n(^{235}U)/n(^{238}U)$	Unit size
		^{234}U	^{235}U	^{236}U	^{238}U		
IRMM-019	UF_6 solid	0.000 70(01)	0.167 13(28)	0.003 73(01)	99.828 44(29)	0.001 674 2(28)	20 g
IRMM-020	UF_6 solid	0.001 22(01)	0.208 80(23)	0.029 04(13)	99.760 94(29)	0.002 093 0(23)	20 g
IRMM-021	UF_6 solid	0.002 51(01)	0.438 42(22)	0.000 004(04)	99.559 07(22)	0.004 403 6(22)	20 g
IRMM-022	UF_6 solid	0.005 50(04)	0.720 09(36)	0.000 10(2)	99.274 31(36)	0.007 253 5(36)	20 g
IRMM-023	UF_6 solid	0.032 67(14)	3.274 3(16)	0.000 011 4(7)	96.693 0(16)	0.033 863(17)	20 g
IRMM-023A	UF_6 solid	0.033 0(07)	3.276 1(16)	< 0.000 1	96.690 9(17)	0.033 882(17)	20 g
IRMM-024	UF_6 solid	0.027 4(03)	5.050 6(24)	0.048 6(01)	94.873 4(25)	0.053 235(27)	20 g
IRMM-025	UF_6 solid	0.011 86(15)	2.001 19(96)	0.014 34(19)	97.972 61(10)	0.020 426(10)	20 g
IRMM-026	UF_6 solid	0.014 4(04)	2.501 2(12)	0.020 0(06)	97.464 4(14)	0.025 663(13)	20 g
IRMM-027	UF_6 solid	0.022 5(02)	3.999 6(19)	0.037 5(02)	95.940 4(20)	0.041 688(21)	20 g
IRMM-028	UF_6 solid	0.058 7(05)	3.599 9(18)	0.498 0(20)	95.843 4(26)	0.037 560(19)	20 g
IRMM-029	UF_6 solid	0.080 2(06)	4.172 5(20)	1.000 8(34)	94.746 5(38)	0.044 039(22)	20 g

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

Uranium solutions

Code	Description	Isotope amount fraction (·100)					Amount ratios		Unit size
		^{233}U	^{234}U	^{235}U	^{236}U	^{238}U	$n(^{235}U)/n(^{238}U)$	$n(^{233}U)/n(^{238}U)$	
IRMM-183	5 M HNO_3 solution	< 0.000 01	0.002 01(12)	0.320 49(16)	0.014 60(86)	99.662 90(88)	0.003 215 7(16)		1 g U in 5 mL
IRMM-184	5 M HNO_3 solution	< 0.000 01	0.005 24(31)	0.720 96(22)	0.000 02(01)	99.273 78(38)	0.007 262 3(22)		1 g U in 5 mL
IRMM-185	5 M HNO_3 solution	< 0.000 01	0.017 25(98)	1.965 75(58)	0.000 28(05)	98.016 7(11)	0.020 055 2(60)		1 g U in 5 mL
IRMM-186	5 M HNO_3 solution	< 0.000 01	0.028 0(16)	2.984 32(87)	0.003 26(23)	96.984 4(18)	0.030 771 1(92)		1 g U in 5 mL
IRMM-187	5 M HNO_3 solution	< 0.000 01	0.036 3(19)	4.516 7(13)	0.006 87(38)	95.440 2(23)	0.047 325(14)		1 g U in 5 mL
EC-NRM-199	5 M HNO_3 solution	33.306 4(59)	0.068 3(03)	33.311 0(40)	0.008 2(03)	33.306 1(49)	1.000 15(20)	1.000 01(30)	10 mg U in 5 mL

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

Certified Isotopic Reference Material set to test the response of mass spectrometers

Code	Description	Amount ratios			Unit size
		$n(^{233}U)/n(^{235}U)$	$n(^{233}U)/n(^{238}U)$	$n(^{235}U)/n(^{238}U)$	
IRMM-073/1	5 M HNO_3 solution	1.000 33	0.991 36	0.991 03	2 µg U in 1 g
IRMM-073/2		0.699 67	0.693 85	0.991 68	
IRMM-073/3		0.499 85	0.495 91	0.992 12	
IRMM-073/4		0.299 87	0.297 63	0.992 56	
IRMM-073/5		0.100 01	0.099 313	0.992 99	
IRMM-073/6		0.050 091	0.049 746	0.993 10	
IRMM-073/7		0.019 994	0.019 857	0.993 17	
IRMM-073/8		0.010 165	0.010 095	0.993 19	
IRMM-073/9		0.005 000 0	0.004 966 0	0.993 20	
IRMM-073/10		0.002 001 2	0.001 987 6	0.993 21	
IRMM-073/11		0.000 968 92	0.000 962 34	0.993 21	
IRMM-073/12		0.000 500 88	0.000 497 48	0.993 21	
IRMM-073/13		0.000 101 82	0.000 101 13	0.993 21	
IRMM-073/14		0.000 019 996	0.000 019 860	0.993 21	
IRMM-073/15		0.000 001 999 5	0.000 001 985 9	0.993 21	

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

Code	Description	Isotope amount fraction (·100)				Amount ratio	Unit size
		^{234}U	^{235}U	^{236}U	^{238}U	$n(^{235}U)/n(^{238}U)$	
IRMM-171/031	U_3O_8 solid	0.002 0(02)	0.320 6(02)	0.014 7(03)	99.662 7(04)	0.003 216 9(20)	200 g
IRMM-171/071	U_3O_8 solid	0.005 3(02)	0.720 9(05)	<0.000 02	99.273 8(04)	0.007 261 7(51)	200 g
IRMM-171/194	U_3O_8 solid	0.017 4(02)	1.966 4(14)	0.000 3(01)	98.015 9(18)	0.020 062(15)	200 g
IRMM-171/295	U_3O_8 solid	0.028 4(04)	2.985 7(21)	0.003 3(02)	96.982 6(29)	0.030 786(22)	200 g
IRMM-171/446	U_3O_8 solid	0.036 5(03)	4.516 8(32)	0.006 9(02)	95.439 8(32)	0.047 326(35)	200 g

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

1.2.2 PLUTONIUM

^{239}Pu Isotope Abundance Certified Isotopic Reference Material for Gamma Spectrometric Measurements

Code	Description	Isotope amount fraction (·100)					Amount ratio	Unit size
		^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	$n(^{240}\text{Pu})/n(^{239}\text{Pu})$	
IRMM-271/61	PuO_2 solid	1.204 5(26)	62.656 2(28)	25.352 6(24)	6.637 6(88)	4.149 1(64)	0.404 63(50)	6.6 g
IRMM-271/70	PuO_2 solid	0.850 6(18)	73.424 8(98)	18.244 5(88)	5.425 7(34)	2.054 4(24)	0.248 48(14)	6.6 g
IRMM-271/84	PuO_2 solid	0.070 60(60)	84.398 5(84)	14.157 8(86)	1.019 7(18)	0.353 4(10)	0.167 75(12)	6.6 g
IRMM-271/93	PuO_2 solid	0.011 70(20)	93.439 2(40)	6.288 6(40)	0.221 50(40)	0.039 00(30)	0.067 302(46)	6.6 g

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

Certified Pu Isotopic Reference Materials for Mass Spectrometric Measurements

Code	Description	Amount ratio $n(^{239}Pu)/n(^{242}Pu)$	Unit size
IRMM-290/G1	Plutonium-nitrate solid	0.101 358(11)	A set consists of seven samples, one of each category A through G
IRMM-290/E1		0.232 119(15)	1 mg
IRMM-290/C1		0.466 521(33)	
IRMM-290/A1		1.025 140(83)	
IRMM-290/B1		2.310 08(15)	
IRMM-290/D1		4.656 74(31)	
IRMM-290/F1		10.057 4(11)	

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

Certified Pu Isotopic Reference Materials for Mass Spectrometric Measurements

Code	Description	Amount ratio $n(^{239}Pu)/n(^{242}Pu)$	Unit size
IRMM-290a/G2	Plutonium-Nitrate solid	0.101 884(11)	1 mg
IRMM-290a/E2		0.235 754(16)	
IRMM-290a/C2		0.476 282(33)	
IRMM-290a/A2		1.013 450(82)	A set consists of seven units, one of each category A through G
IRMM-290a/B2		2.286 91(16)	
IRMM-290a/D2		4.545 68(30)	
IRMM-290a/F1		10.057 4(11)	

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

Code	Description	Amount ratio $n(^{239}Pu)/n(^{242}Pu)$	Unit size
IRMM-290b/G3	Plutonium-nitrate solid	0.099 926(11)	1 mg
IRMM-290b/E3		0.229 387(16)	
IRMM-290b/C3		0.477 061(33)	
IRMM-290b/A3		1.000 730(82)	A set consists of seven units, one of each category A through G
IRMM-290b/B3		2.253 69(16)	
IRMM-290b/D3		4.787 77(32)	
IRMM-290b/F1		10.057 4(11)	

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

1.2.3 THORIUM

Code	Description	Isotope amount fraction (·100)		Amount ratio $n(^{230}Th)/n(^{232}Th)$	Unit size
		^{230}Th	^{232}Th		
IRMM-035	1 M HNO_3 solution	0.001 148 1(78)	99.998 851 9(78)	0.000 011 481(78)	1 mg Th in 1 mL
IRMM-036	1 M HNO_3 solution	0.000 311 3(78)	99.999 688 7(78)	0.000 003 113(78)	1 mg Th in 1 mL

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value

2 ISOTOPIC REFERENCE MATERIALS CERTIFIED FOR ISOTOPE AMOUNT CONTENT

2.1 STABLE ISOTOPES

Code	Description	Isotope amount content			Isotope enrichment		Unit size
IRMM-610	H_3BO_3 aqueous solution	3.683 11(88)	µmol	$^{10}B \cdot g^{-1}$	$n(^{10}B)/n(B)$	= 0.950	5 mL
IRMM-611	H_3BO_3 aqueous solution	4.025(40)	µmol	$^{11}B \cdot g^{-1}$	$n(^{11}B)/n(B)$	= 0.802	5 mL
IRMM-615	0.5 M HCl solution	3.825(27)	µmol	$^{6}Li \cdot g^{-1}$	$n(^{6}Li)/n(Li)$	= 0.956	5 mL
IRMM-618	0.5 M HNO_3 solution	0.112 13(17)	µmol	$^{87}Rb \cdot g^{-1}$	$n(^{87}Rb)/n(Rb)$	= 0.980	5 mL
IRMM-619	0.5 M HNO_3 solution	0.085 00(24)	µmol	$^{85}Rb \cdot g^{-1}$	$n(^{85}Rb)/n(Rb)$	= 0.722	5 mL
IRMM-620	4.5 M HCl solution	0.173 35(16)	µmol	$^{57}Fe \cdot g^{-1}$	$n(^{57}Fe)/n(Fe)$	= 0.952	5 mL

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

STABLE ISOTOPES (continued)

Code	Description	Isotope amount content			Isotope enrichment		Unit size
IRMM-621	1 M HNO_3 solution	97.35(15)	nmol	$^{111}Cd \cdot g^{-1}$	$n(^{111}Cd)/n(Cd)$	= 0.957	4 mL
IRMM-622	1 M HNO_3 solution	9.739(18)	nmol	$^{111}Cd \cdot g^{-1}$	$n(^{111}Cd)/n(Cd)$	= 0.957	4 mL
IRMM-623 (in prep.)	1 M HNO_3 solution	~ 0.1	µmol	$^{nat}Cd \cdot g^{-1}$			5 mL
IRMM-624	1 M HCl solution	0.174 84(42)	µmol	$^{50}Cr \cdot g^{-1}$	$n(^{50}Cr)/n(Cr)$	= 0.937	5 mL
IRMM-625	1 M HCl solution	0.144 233(90)	µmol	$^{52}Cr \cdot g^{-1}$	$n(^{52}Cr)/n(Cr)$	= 0.838	5 mL
IRMM-626 (in prep.)	1 M HCl solution	0.2	µmol	$^{53}Cr \cdot g^{-1}$	$n(^{53}Cr)/n(Cr)$	= 0.97	5 mL
IRMM-627 (in prep.)	10^{-4} M NaOH (pH = 10) solution	3.124(80)	µmol	$^{15}NO_3^- \cdot g^{-1}$	$n(^{15}N)/n(N)$	= 0.66	5 mL
IRMM-628 (in prep.)	H_2O (pH = 6) solution	3.238 5(4)	µmol	$^{nat}NO_3^- \cdot g^{-1}$	$n(^{14}N)/n(N)$	= 0.994	5 mL
IRMM-629 (in prep.)	10^{-4} M NaOH (pH = 10) solution	3.884 9(58)	µmol	$^{15}NO_3^- \cdot g^{-1}$	$n(^{15}N)/n(N)$	= 0.99	5 mL
IRMM-630a (in prep.)	1 M HCl solution	82.890(92)	nmol	$^{194}Pt \cdot g^{-1}$	$n(^{194}Pt)/n(Pt)$	= 0.96	5 mL

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

STABLE ISOTOPES (continued)

Code	Description	Isotope amount content	Isotope enrichment	Unit size
IRMM-631 (in prep.)	1 M HCl solution	100.41(12) nmol $^{nat}Pt \cdot g^{-1}$		5 mL
IRMM-632	1 M HNO_3 solution	100 nmol $^{65}Cu \cdot g^{-1}$	$n(^{65}Cu)/n(Cu) = 0.997$	5 mL
IRMM-633	1 M HNO_3 solution	10 µmol $^{nat}Cu \cdot g^{-1}$		4 - 5 mL
IRMM-634	1.8 M HCl solution	0.163 61(38) µmol $^{56}Fe \cdot g^{-1}$	$n(^{56}Fe)/n(Fe) = 0.917$	5 mL
IRMM-635	1 M HNO_3 solution	58.131(37) nmol $^{84}Sr \cdot g^{-1}$	$n(^{84}Sr)/n(Sr) = 0.999$	5 mL
IRMM-637	0.2 M HNO_3 solution	0.079 137(30) nmol $^{24}Mg \cdot g^{-1}$	$n(^{24}Mg)/n(Mg) = 0.790$	5 mL
IRMM-638	0.1 M HNO_3 solution	0.085 74(34) nmol $^{26}Mg \cdot g^{-1}$	$n(^{26}Mg)/n(Mg) = 0.996$	5 mL
IRMM-639	0.5 M HCl solution	0.118 91(50) nmol $^{nat}Hg \cdot g^{-1}$		5 mL
IRMM-640	0.5 M HCl solution	0.147 1(11) nmol $^{202}Hg \cdot g^{-1}$	$n(^{202}Hg)/n(Hg) = 0.977$	5 mL

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

STABLE ISOTOPES (continued)

Code	Description	Isotope amount content			Isotope enrichment		Unit size
IRMM-641	0.5 M HCl solution	18.959(15)	µmol	$^{35}Cl \cdot g^{-1}$	$n(^{35}Cl)/n(Cl)$	= 0.758	4 - 5 mL
IRMM-642	0.5 M HCl solution	4.375(26)	µmol	$^{37}Cl \cdot g^{-1}$	$n(^{37}Cl)/n(Cl)$	= 0.981	4 - 5 mL
IRMM-643 (in prep.)	2.8 M HNO_3 solution	0.35	µmol	$^{nat}S \cdot g^{-1}$	$n(^{32}S)/n(S)$	= 0.950	4 - 5 mL
IRMM-644 (in prep.)	3.2 M HNO_3 solution	0.37	µmol	$^{nat}S \cdot g^{-1}$	$n(^{32}S)/n(S)$	= 0.949	4 - 5 mL
IRMM-645 (in prep.)	2.7 M HNO_3 solution	0.39	µmol	$^{nat}S \cdot g^{-1}$	$n(^{32}S)/n(S)$	= 0.952	4 - 5 mL
IRMM-646 (in prep.)	2.7 M HNO_3 solution	4.7	µmol	$^{34}S \cdot g^{-1}$	$n(^{34}S)/n(S)$	= 0.96	4 - 5 mL
IRMM-647	1 M HNO_3 solution	0.19	mmol	$^{nat}Cu \cdot g^{-1}$			4 - 5 mL
IRMM-649	1 M HNO_3 solution	0.836 88(27)	µmol	$^{205}Tl \cdot g^{-1}$	$n(^{205}Tl)/n(Tl)$	= 0.705	4 - 5 mL
IRMM-650 (in prep.)			mmol	$^{53}Cr \cdot g^{-1}$			

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

STABLE ISOTOPES (continued)

Code	Description	Isotope amount content	Isotope enrichment	Unit size
IRMM-651 (in prep.)		0.15 µmol $^{nat}Zn \cdot g^{-1}$		5 mL
IRMM-652 (in prep.)		0.15 µmol $^{64}Zn \cdot g^{-1}$	$n(^{64}Zn)/n(Zn) = 0.993$	5 mL
IRMM-653 (in prep.)		0.15 µmol $^{67}Zn \cdot g^{-1}$	$n(^{67}Zn)/n(Zn) = 0.919$	5 mL
IRMM-654 (in prep.)		0.15 µmol $^{68}Zn \cdot g^{-1}$	$n(^{68}Zn)/n(Zn) = 0.993$	5 mL
IRMM-655 (in prep.)	0.5 M HNO_3 solution	6 µmol $^{nat}Ca \cdot g^{-1}$		5 mL
IRMM-656 (in prep.)	0.5 M HNO_3 solution	8 µmol $^{40}Ca \cdot g^{-1}$	$n(^{40}Ca)/n(Ca) = 0.995$	5 mL
IRMM-657 (in prep.)	0.5 M HNO_3 solution	2.4 µmol $^{42}Ca \cdot g^{-1}$	$n(^{42}Ca)/n(Ca) = 0.937$	5 mL
IRMM-658 (in prep.)	0.5 M HNO_3 solution	7.3 µmol $^{44}Ca \cdot g^{-1}$	$n(^{44}Ca)/n(Ca) = 0.9855$	5 mL
IRMM-659 (in prep.)	0.5 M HNO_3 solution	~ 5 µmol $^{48}Ca \cdot g^{-1}$	$n(^{48}Ca)/n(Ca) = 0.91$	5 mL

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

2.2 FISSILE ISOTOPES

2.2.1 URANIUM

Code	Description	Isotope amount content			Isotope enrichment	Unit size
IRMM-040a	5 M HNO_3 solution	4.027 8(71)	µmol	$^{233}U \cdot g^{-1}$	$n(^{233}U)/n(U)$ = 0.980	10 mL
IRMM-050	5 M HNO_3 solution	4.254 3(11)	nmol	$^{235}U \cdot g^{-1}$	$n(^{235}U)/n(U)$ = 0.999	10 mL
IRMM-051	5 M HNO_3 solution	10.101(18)	nmol	$^{233}U \cdot g^{-1}$	$n(^{233}U)/n(U)$ = 0.980	5 mL
IRMM-052	5 M HNO_3 solution	5.301 3(26)	µmol	$^{238}U \cdot g^{-1}$	$n(^{238}U)/n(U)$ = 0.993	5 mL
IRMM-053	5 M HNO_3 solution	0.211 94(26)	µmol	$^{238}U \cdot g^{-1}$	$n(^{238}U)/n(U)$ = 0.993	5 mL
IRMM-054	5 M HNO_3 solution	3.954 3(12)	µmol	$^{235}U \cdot g^{-1}$	$n(^{235}U)/n(U)$ = 0.932	5 mL
IRMM-056	5 M HNO_3 solution	4.172 4(13)	µmol	$^{238}U \cdot g^{-1}$	$n(^{238}U)/n(U)$ = 0.993	10 mL

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

URANIUM (continued)

Code	Description	Isotope amount content	Isotope enrichment	Unit size
IRMM-057	5 M HNO_3 solution	4.181 2(56) nmol $^{233}U \cdot g^{-1}$	$n(^{233}U)/n(U)$ = 0.9996	5 mL
IRMM-058	5 M HNO_3 solution	9.013(12) pmol $^{233}U \cdot g^{-1}$	$n(^{233}U)/n(U)$ = 0.9996	5 mL

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

2.2.2 PLUTONIUM

Code	Description	Isotope amount content			Isotope enrichment	Unit size
IRMM-042a	5 M HNO_3 solution	3.749 0(76)	nmol	$^{244}Pu \cdot g^{-1}$	$n(^{244}Pu)/n(Pu) = 0.979$	10 mL
IRMM-043	5 M HNO_3 solution	0.182 79(55)	nmol	$^{242}Pu \cdot g^{-1}$	$n(^{242}Pu)/n(Pu) = 0.878$	10 mL
IRMM-044	5 M HNO_3 solution	38.060(57)	nmol	$^{242}Pu \cdot g^{-1}$	$n(^{242}Pu)/n(Pu) = 0.999$	10 mL
IRMM-049c	5 M HNO_3 solution	0.366 65(49)	µmol	$^{242}Pu \cdot g^{-1}$	$n(^{242}Pu)/n(Pu) = 0.941$	10 mL
IRMM-081	5 M HNO_3 solution	0.482 00(26)	µmol	$^{239}Pu \cdot g^{-1}$	$n(^{239}Pu)/n(Pu) = 0.954$	5 mL
IRMM-082	5 M HNO_3 solution	49.265(27)	nmol	$^{239}Pu \cdot g^{-1}$	$n(^{239}Pu)/n(Pu) = 0.954$	5 mL
IRMM-083	5 M HNO_3 solution	3.406 4(22)	µmol	$^{240}Pu \cdot g^{-1}$	$n(^{240}Pu)/n(Pu) = 0.9897$	1 mL
IRMM-084	5 M HNO_3 solution	37.494(78)	pmol	$^{244}Pu \cdot g^{-1}$	$n(^{244}Pu)/n(Pu) = 0.979$	5 mL
IRMM-085	5 M HNO_3 solution	39.098(60)	pmol	$^{242}Pu \cdot g^{-1}$	$n(^{242}Pu)/n(Pu) = 0.999$	5 mL

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

2.2.3 URANIUM PLUTONIUM MIXTURES

Code	Description	Isotope amount content	Isotope enrichment	Unit size
IRMM-1027f	U-Pu solid spike (dried nitrate)	16.506 2(43) µmol $^{235}U \cdot g^{-1}$ 3.348 1(14) µmol $^{239}Pu \cdot g^{-1}$	$n(^{235}U)/n(U) = 0.198$ $n(^{239}Pu)/n(Pu) = 0.978$	2.5 g
IRMM-1029a	U-Pu solid spike (dried nitrate)	6.556 6(98) µmol $^{235}U \cdot g^{-1}$ 3.160 0(32) µmol $^{239}Pu \cdot g^{-1}$	$n(^{235}U)/n(U) = 0.199$ $n(^{239}Pu)/n(Pu) = 0.941$	2.5 g
IRMM-1030 (in prep.)	U metal + Gd-Pu-Nd alloy	0.825 75(83) mmol $^{235}U \cdot g^{-1}$ metal 0.246 81(32) mmol $^{239}Pu \cdot g^{-1}$ alloy	$n(^{235}U)/n(U) = 0.196$ $n(^{239}Pu)/n(Pu) = 0.991$	~ 90 mg U metal ~ 55 mg alloy

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value .

URANIUM PLUTONIUM MIXTURES (continued)

Code	Description	Isotope amount content	Isotope enrichment	Unit size
IRMM-046b	5 M HNO_3 solution	4.112 6(62) µmol $^{233}U \cdot g^{-1}$ 0.465 71(70) µmol $^{242}Pu \cdot g^{-1}$	$n(^{233}U)/n(U) = 0.980$ $n(^{242}Pu)/n(Pu) = 0.943$	10 mL
IRMM-090	5 M HNO_3 solution	4.186 8(63) µmol $^{233}U \cdot g^{-1}$ 41.820(67) nmol $^{242}Pu \cdot g^{-1}$	$n(^{233}U)/n(U) = 0.976$ $n(^{242}Pu)/n(Pu) = 0.942$	10 mL

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

2.2.4 THORIUM

Code	Description	Isotope amount content	Isotope enrichment	Unit size
IRMM-060	5 M HNO_3 solution	0.175 5(13) µmol $^{230}Th \cdot g^{-1}$	$n(^{230}Th)/n(Th) = 0.9985$	10 mL
IRMM-061	5 M HNO_3 solution	2.474(18) nmol $^{230}Th \cdot g^{-1}$	$n(^{230}Th)/n(Th) = 0.9985$	5 mL

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

2.2.5 K-edge REFERENCE MATERIAL

Code	Description	Isotope amount content	Isotope enrichment	Comment	Unit size
IRMM-3501	3 M HNO_3 solution	6.542 6(94) µmol $^{239}Pu \cdot g^{-1}$ 0.706 4(11) mmol $^{238}U \cdot g^{-1}$	$n(^{239}Pu)/n(Pu) = 0.941$ $n(^{238}U)/n(U) = 0.993$	~ 2.5 g $Pu \cdot L^{-1}$ ~ 250 g $U \cdot L^{-1}$	10 mL

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

3 PRIMARY ISOTOPIC GAS STANDARDS "PIGS"

Code	Matrix	Isotope amount fraction (·100)									Unit size
IRMM-PIGS	high purity	^{124}Xe	^{126}Xe	^{128}Xe	^{129}Xe	^{130}Xe	^{131}Xe	^{132}Xe	^{134}Xe	^{136}Xe	
2000	Xe	0.095 15(22	0.089 01(13	1.910 22(54	26.400 6(56)	4.071 01(90)	21.232 4(20)	26.908 6(22)	10.435 7(14)	8.857 3(28)	1 L
IRMM-PIGS	high purity	^{32}S	^{33}S	^{34}S	^{36}S						
2010	SF_6	94.964 6(25)	0.754 56(60	4.266 6(15)	0.014 2(19)						1 L
IRMM-PIGS		^{10}B	^{11}B								
2020 in prep.	BF_3										
IRMM-PIGS	high purity	^{78}Kr	^{80}Kr	^{82}Kr	^{83}Kr	^{84}Kr	^{86}Kr				
2030	Kr	0.355 18(32	2.285 60(96	11.593 0(62)	11.499 6(58)	56.987 7(58)	17.279 0(32)				1 L
IRMM-PIGS		^{12}C	^{13}C								
2040 in prep.	CF_4										
IRMM-PIGS		^{12}C	^{13}C								
2041 in prep.											
IRMM-PIGS		^{12}C	^{13}C								
2042 in prep.											
IRMM-PIGS	high purity	^{14}N	^{15}N								
2050 in prep.	N_2										

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.
For amount ratios, see next pages.

PRIMARY ISOTOPIC GAS STANDARDS "PIGS" (continued)

Code	Matrix	Isotope amount fraction (·100)									Unit size
IRMM-PIGS	high purity	^{16}O	^{17}O	^{18}O							
2060 in prep.	O_2										
IRMM-PIGS	high purity	^{20}Ne	^{21}Ne	^{22}Ne							
2070 in prep.	Ne										
IRMM-PIGS	high purity	^{36}Ar	^{38}Ar	^{40}Ar							
2080 in prep.	Ar										
IRMM-PIGS	high purity	^{3}He	^{4}He								
2090 in prep.	He										

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.
For amount ratios, see next pages.

PRIMARY ISOTOPIC GAS STANDARDS "PIGS" (continued)

Code	Isotope amount ratios							
IRMM-PIGS	$n(^{124}Xe)/n(^{132}Xe)$	$n(^{126}Xe)/n(^{132}Xe)$	$n(^{128}Xe)/n(^{132}Xe)$	$n(^{129}Xe)/n(^{132}Xe)$	$n(^{130}Xe)/n(^{132}Xe)$	$n(^{131}Xe)/n(^{132}Xe)$	$n(^{134}Xe)/n(^{132}Xe)$	$n(^{136}Xe)/n(^{132}Xe)$
2000	0.003 536 2(79	0.003 307 7(48	0.070 989(20)	0.981 12(27)	0.151 290(31)	0.789 055(51)	0.387 819(46)	0.329 16(11)
IRMM-PIGS	$n(^{33}S)/n(^{32}S)$	$n(^{34}S)/n(^{32}S)$	$n(^{36}S)/n(^{32}S)$					
2010	0.007 945 7(63	0.044 928(17)	0.000 15(2)					
IRMM-PIGS	$n(^{10}B)/n(^{11}B)$							
2020 in prep.								
IRMM-PIGS	$n(^{78}Kr)/n(^{84}Kr)$	$n(^{80}Kr)/n(^{84}Kr)$	$n(^{82}Kr)/n(^{84}Kr)$	$n(^{83}Kr)/n(^{84}Kr)$	$n(^{86}Kr)/n(^{84}Kr)$			
2030	0.006 232 5(55	0.040 107(17)	0.203 43(12)	0.201 79(11)	0.303 205(59)			
IRMM-PIGS	$n(^{13}C)/n(^{12}C)$							
2040 in prep.								
IRMM-PIGS	$n(^{13}C)/n(^{12}C)$							
2041in prep.								
IRMM-PIGS	$n(^{13}C)/n(^{12}C)$							
2042 in prep.								
IRMM-PIGS	$n(^{29}N)/n(^{28}N)$	$n(^{30}N)/n(^{28}N)$						
2050 in prep.								

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

PRIMARY ISOTOPIC GAS STANDARDS "PIGS" (continued)

Code	Isotope amount ratios							
IRMM-PIGS	$n(^{33}O)/n(^{32}O)$	$n(^{34}O)/n(^{32}O)$						
2060 in prep.	0.000 770 83	0.004 074 60						
IRMM-PIGS	$n(^{21}Ne)/n(^{20}Ne)$	$n(^{22}Ne)/n(^{20}Ne)$						
2070 in prep.	0.002 939 5	0.102 370						
IRMM-PIGS	$n(^{36}Ar)/n(^{40}Ar)$	$n(^{38}Ar)/n(^{40}Ar)$						
2080 in prep.	0.003 365 6	0.000 630 7						
IRMM-PIGS	$n(^{3}He)/n(^{4}He)$							
2090 in prep.								

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

4 REFERENCE MATERIALS CERTIFIED FOR ELEMENT AMOUNT CONTENT

Code	Description	Element amount content			Unit size
EC-NRM-101	natural uranium metal	999.85(5)	mg	$U \cdot g^{-1}$	0.65 – 1.75 g
EC-NRM-106	natural uranium dioxide pellets (10 g each)	881.43(24)	mg	$U \cdot g^{-1}$	150 g
EC-NRM-110	depleted uranium dioxide pellets (1 g each)	881.34(13)	mg	$U \cdot g^{-1}$	25 g

All uncertainties indicated are ISO/BIPM expanded standard uncertainties $U = k \cdot u_c$ where u_c is the combined uncertainty. They are given in parentheses and include a coverage factor k=2. They apply to the last digit(s) of the value.

5 ISOTOPIC CERTIFICATION MEASUREMENT SERVICES

5.1 MEASUREMENTS AGAINST ISOTOPE MIXTURES

Isotope amount ratio in:

Boron
Plutonium
Plutonium (irradiated)
Silicon
Nitrate
Platinum
Uranium
Uranium (irradiated)
Uraniumhexafluoride

Isotope amount content by IDMS:

Boron
Iron
Lithium
Magnesium
Nitrate
Platinum
Plutonium
Uranium

5.2 MEASUREMENTS AGAINST ISOTOPIC REFERENCE MATERIALS

Cadmium
Calcium
Chromium
Copper
Lead
Strontium
Rubidium

5.3 MEASUREMENTS ON REQUEST

On request

6 CONSULTANCY SERVICES

The Isotope Measurements Unit offers the following consultancy services:

1. consultancy on the use of isotopic techniques (measurements and tracing), in the areas of food and drink, illicit drugs, environmental and clinical chemistry

2. training in the use of isotope dilution applied as a Primary Method of Measurement (PMM)

3. training in the concepts and realisation of traceability to the SI (the international system of base quantities and base units)

4. training in the preparation of Isotopic Reference Materials (IRMs), for use in both non-nuclear and nuclear applications (amount ratio- as well as Spike IRMs)

5. training in performing uncertainty calculations in Primary Methods of Measurement from the ISO/BIPM and EURACHEM Guides onwards

6. training in carrying out calculations of mixing of isotopes up to the final values with their uncertainties

7. training in the actual preparation of synthetic isotope mixtures

8. training in calibrated gas isotopic measurements

7 ISOTOPIC MEASUREMENT TRAINING AND EDUCATION CENTRE - IMTEC

The Isotope Measurements Unit offers the training and education services in:

1. Isotopic Measurements including the required sample preparation: theory and practice
2. Concepts for traceability in chemical measurement
3. Metrology in chemistry
4. Uncertainty evaluation (ISO/BIPM guide)
5. Applications of isotopic measurements
6. External quality evaluation programmes (REIMEP®[1], IMEP®[2], NUS-IMEP®[3])

[1] Regular European Interlaboratory Measurement Evaluation Programme
[2] International Measurement Evaluation Programme
[3] Nuclear Signatures - Interlaboratory Measurement Evaluation Programme

8 ISOTOPIC DATA AND INFORMATION CENTRE - ISDIC

The Isotope Measurements Unit provides isotopic data and information on:

1. the official data-base for IUPAC on Isotopic Composition of the Elements

2. the complete literature of all measurements of Isotopic Composition of the Elements from which the IRMM Isotope Measurements Unit is the official depository

3. the suppliers of enriched isotopes

9 INDEX TO IRMM CERTIFICATES FOR ISOTOPIC REFERENCE MATERIALS

This index provides a numerical listing of IRMM certificates with date of issue. Copies of certificates for current and out-of-stock Isotopic Reference Materials are available upon request. In the case of re-certification both the original and re-certification dates are stated on the Certificate.

IRMM No.	Certification Date
007	in preparation
008	in preparation
009	December 1998 / revised June 2001
010	February 1999 / revised June 2001
011	June 1984 / revised June 2001
012	February 2000 / revised June 2001
013	-
014	December 1991 / revised June 1999
015	February 1986 / revised July 1993
016	September 1984
017	May 1989 / revised November 1993
018	May 1989 / revised November 1993
019	July 1987
020	July 1987
021	September 1984 / revised July 1993
022	September 1984 / revised July 1993
023	September 1984 / revised July 1993
023A	June 1988 / revised July 1993
024	September 1984 / revised July 1993
025	July 1993
026	July 1993
027	July 1993
028	May 1996
029	May 1996
029bis	March 2000
035	April 1997
036	April 1997
040	September 1984
040a	July 1991 / revised March 2001
040-1	June 1984
041-1	June 1984
041-2	June 1984
042	September 1987 / revised February 1993
042a	September 1987
043	September 1985 / revised February 1993
044	September 1987 / revised October 1998
046-1	June 1984

IRMM No.	Certification Date
046-2	June 1984
046b	March 1995
047	July 1984
047a	December 1985
049	September 1989
049c	May 1997
050	June 1990 / revised October 1998
051	January 1993 / revised June 1998
052	May 1993
053	May 1993
054	May 1999
056	May 1999
057	February 2003
058	May 2001
060	September 1984 / revised February 1998
061	September 1984 / revised February 1998
072	September 1986 / revised July 1993
073	March 2002
081	January 1993 / revised September 2001
082	January 1993 / revised September 2001
083	December 1999 / revised March 2000
084	December 1999 / revised March 2000
085	December 1999 / revised March 2000
090	July 1995
171	May 1985
183	December 1987 / revised June 1999
184	December 1987 / revised June 1999
185	December 1987 / revised June 1999
186	December 1987 / revised June 1999
187	December 1987 / revised June 1999
199	November 1985
271	March 1998
290	March 1993 / revised February 1995
290a	March 1995
290b	March 1995
610	January 1990 / revised April 2001
611	January 1990 / revised March 2001
615	July 1993
618	July 1993
619	October 1999
620	June 1994
621	September 1997
622	September 1997
623	in preparation
624	March 2000

IRMM No.	Certification Date
625	March 2000
626	In preparation
627	in preparation
628	in preparation
629	in preparation
630a	in preparation
631	in preparation
632	November 2002
633	November 2002
634	September 1999
635	September 1998
637	March 2000 / revised June 2001
638	April 2000 / revised June 2001
639	May 2002
640	May 2002
641	February 2002
642	February 2002
643	in preparation
644	in preparation
645	in preparation
646	in preparation
647	November 2002
649	March 2001
650	in preparation
651	in preparation
652	in preparation
653	in preparation
654	in preparation
655	in preparation
656	in preparation
657	in preparation
658	in preparation
659	in preparation
1027a	December 1991
1027b	September 1992
1027c	June 1995 / revised November 1996
1027d	Withdrawn
1027e	November 1998
1027f	May 2002
1029a	January 1999
1030	in preparation
2000	November 1998
2010	November 1998
2020	in preparation
2030	December 1998

IRMM No.	Certification Date
2040	in preparation
2041	in preparation
2042	in preparation
2050	in preparation
2060	in preparation
2070	in preparation
2080	in preparation
2090	in preparation
3501	January 1999 / revised June 2001
3701	in preparation
EC-NRM-101	December 1982
EC-NRM-106	March 1984
EC-NRM-110	July 1983

EUROPEAN COMMISSION
DIRECTORATE GENERAL JRC
JOINT RESEARCH CENTRE
IRMM
Institute for Reference Materials and Measurements

TERMS AND CONDITIONS

Governing the Sales Contracts of the IRMM-JRC Geel

All sales contracts between the IRMM, hereinafter to be referred to as "the Seller" and its clients, hereinafter to be referred to as "the Buyer" shall be governed by and processed in accordance with the following terms and conditions. Acceptance of Seller's quotation by Buyer automatically implies acceptance by Buyer of Seller's Terms and Conditions.

1. Unless stated otherwise on the quotation, materials and services shall be furnished at prices and service fees fixed by the Seller, in effect on the date of shipment of materials or performance of the services. Where no specific prices are in effect, materials and services shall be furnished at prices and service fees calculated by the IRMM. The Seller's decision in these matters is final. Prices in catalogues issued by the Seller are subject to change without notice.

2. Subject to applicable regulations, Seller shall ship all materials covered by this order "Free Carrier Geel, Belgium" (FCA), normally by certified parcel post. Postage will be billed at cost and itemised on the invoice. Under this term it is understood that Seller shall have fulfilled his obligation to deliver when he has handed over the materials, cleared for export, into the charge of the carrier named by the Buyer or appointed by the Seller on behalf and at the expense of the Buyer.

3. Materials that, due to regulations or for any other practical reason, cannot be sent by certified parcel post shall be delivered "Ex Works Geel, Belgium", (EXW). Under this term the Seller fulfills his obligation to deliver when he has made the materials available at his premises. The Buyer bears all costs and risks of loss of or damage to the goods, involved in taking the materials from the Seller's premises to the desired destination.

4. If necessary, the Seller, at the Buyer's request, risk and expense, may provide assistance in obtaining any export licence or other official authorisation necessary for the exportation of the materials.

5. It will be the Buyer's responsibility to designate an experienced carrier as an intermediate consignee for the shipment. This carrier will collect the materials from the Sellers facilities in Geel, Belgium. Shipping carriers and modes of shipment must fully comply with international transportation regulations in effect at the time of shipment.

6. Responsibility for loss of or damage to materials sold under this order shall pass to the Buyer when such materials have been handed over into the charge of the carrier named by the Buyer or appointed by the Seller on behalf and at the expense of the Buyer.

7. Buyer shall advise Seller of having taken delivery by means of the Confirmation of Delivery form, a specimen of which is attached as Annex I. This form is to be returned to Seller by mail or fax within six weeks after delivery. In the event that the form is not returned, Seller shall have the right to assume that Buyer has taken delivery.

8. Upon receipt of the Confirmation of Delivery form from Buyer, Seller shall establish the invoice concerned and forward it to the Buyer. Payment shall be made by bank transfer in EURO promptly within 30 days from the date of this invoice. The Buyer shall remit sums due to the Seller's bank account as stated on the invoice.

9. In case of non-payment the Buyer shall pay interest at the rate of 12 percent per annum on all amounts not paid within 30 days from date of invoice as well as all of the IRMM's legal and ancilliary costs, necessary to obtain full settlement of its invoices.

10. Seller reserves the right to limit quantities and frequency of orders.

11. Seller shall not be liable for any particular, indirect, incidental or consequential damage, including but not limited to, injury or damage caused to persons or property, or loss of any kind whatsoever, resulting from packaging, labelling, transportation, delay in filling the order or in delivery, or otherwise.

12. Failing any amicable arrangement, the courts of Turnhout, Belgium shall have sole jurisdiction.

* * *

END-USE UNDERTAKING

These details must be prepared on the end-users notepaper as an original signed document. The document will be presented to Belgian Authorities as part of the export licence application

1a. Full name of end user / consignee :

Position held in the organisation below :

Address of End-user/consignee		**Address where goods are to be used**	
Institute/ Company		Institute/ Company	
Adress		Adress	
Town		Town	
Post Code		Post Code	
Nature of end-users business			

1b. Has ordered from the European Commission JRC IRMM, Retieseweg, 2440 Geel Belgium

2. The following item[s]

a. Description;	
b. Quantity-.	
End-Users order ref.	

3. The item[s] ordered will be used for the following purpose(s):.

Undertaking

4. The goods described above are for our own use, at the address given above, and will not be re-exported or sold for export.
5. The goods will not be used for military purposes
6. The goods will not be used for purpose connected with chemical biological or nuclear weapons or missiles capable of delivering such weapons, nor will they be resold if we know or suspect that they are intended or likely to be used for such a purpose.
7. Further, neither these goods nor a replica of them will be used in any nuclear explosive activity or unsafeguarded nuclear fuel cycle activity

Name [block capitals]		Signature:		Date:	

Notes

For the IRMM to obtain the necessary export approval, the End User must supply an **End-Use Undertaking**. The End-Use undertaking must be:

- An ORIGINAL document, not a copy
- Be prepared on the end-users / consignee's headed notepaper,
- Signed and dated by the end-user / consignee
- Contain the appropriate wording
- Include a description of the goods
- Include the quantities to be exported

Facsimile or photocopies of the End-use Undertaking. are not accepted. To avoid delays please complete all the required sections, in English if possible.

"Nuclear explosive activity" includes research on or development, design, manufacture, construction, testing or maintenance of any nuclear explosive device or components or subsystems of such a device.
"Unsafeguarded nuclear fuel-cycle activity" includes research on or development, design, manufacture, construction, operation or maintenance of

i. any reactor, critical facility, conversion plant or fabrication plant, reprocessing plant, plant for the separation of isotopes of source or special fissionable material, or separate storage installation, where there is an obligation to accept International Atomic Energy Agency (IAEA) safeguards at the relevant facility or installation, existing or future, when it contains any source or special fissionable material which is not being met,

or

ii. any heavy water production plant, where there is an obligation to accept IAEA safeguards on any nuclear material produced by or used in connection with any heavy water production therefrom which is not being met: and also includes any. such activity where there is no such obligation.