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SIGMA-ALDRICH®

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INTRODUCTION

Public confidence in measurement results is important in many aspects of modern society, including consumer protection in food consumption, health-care, environmental protection, and fair trade. Certified Reference Materials (CRMs) are cornerstones of modern analytical quality assurance because they allow calibration of instruments, validation of methods, and quality control of methods and laboratories based on traceability and comparability of measurement results.

The Institute for Reference Materials and Measurements (IRMM) provides
IRMM certified reference materials, produced by the EC-JRC-IRMM
BCR® certified reference materials (BCR® is a registered trademark of the European Commission), for which production was supported by research funding of the European Commission, DG Research and
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These CRMs are produced according to specific Guidelines of the European Commission which take into account the relevant ISO Guides 34 and 35.

The ERM® reference materials have undergone an additional uncompromising peer evaluation by the ERM® partners:

Federal Institute for Materials Research and Testing (BAM), Germany
LGC Standards, United Kingdom
IRMM, JRC, European Commission

to guarantee highest quality and reliability.

Certificates

Certificates carry a certified value with its uncertainty which is traceable either to a SI unit or an internationally accepted reference. The intended use for each CRM is stated on the certificate.
CRMs are stored under controlled conditions which ensure their stability. Monitoring programmes have been set up to control CRM stability during the whole shelf-life. At present IRMM's Reference Materials Unit offers about 600 different CRMs. A complete list of these CRMs can be accessed directly via the IRMM homepage:

irmm.jrc.ec.europa.eu

Availability

As CRMs should become regularly used items in any measurement laboratory, IRMM's Reference Materials Unit continues its effort to supply CRMs in sufficient amount to cover market needs. However, in exceptional cases where only limited amounts are available, it reserves the right to restrict and/or refuse orders. The reference materials contained in this catalogue are made available world-wide through the IRMM's Reference Materials Unit and its authorised distributors.

If samples are purchased through **UNAUTHORISED COMPANIES,** the IRMM cannot be held responsible for the integrity of the materials (especially in case of potentially unstable materials) nor, for the accuracy and/or completeness of the accompanying information (certificates, reports, etc.).

1 MATERIALS RELATED TO ENVIRONMENTAL ANALYSIS

1.1 PURE MATERIALS AND SYNTHETIC MIXTURES

Cat. No.	Substance	Purity (g/g)
	Polycyclic aromatic compounds	
BCR046	BENZO[b]CHRYSENE	0.994 + 0.006
		- 0.008
BCR047	BENZO[b]FLUORANTHENE	0.997 4 ± 0.002 6
BCR048R	BENZO[k]FLUORANTHENE (unit size 10 mg)	0.997 + 0.003
		- 0.004
BCR049	BENZO[j]FLUORANTHENE	0.997 ± 0.003
		± 0.006
BCR050	BENZO[e]PYRENE	0.991 + 0.009
		- 0.010
BCR052	BENZO[ghi]PERYLENE	0.992 3 ± 0.002 1
BCR077R	1-METHYLCHRYSENE (unit size 10 mg)	0.991 ± 0.007
BCR078R	2-METHYLCHRYSENE (unit size 10 mg	0.993 ± 0.005
BCR079R	3-METHYLCHRYSENE (unit size 10 mg)	0.993 ± 0.005
BCR080R	4-METHYLCHRYSENE (unit size 10 mg)	0.994 ± 0.004
BCR081R	5-METHYLCHRYSENE (unit size 10 mg)	0.997 3 ± 0.001 3
BCR091	ANTHANTHRENE	0.996 ± 0.004
BCR092	10-AZABENZO[a]PYRENE	0.996 ± 0.006
BCR093R	1-METHYLBENZ[a]ANTHRACENE (unit size 10 mg)	0.996 ± 0.005
BCR094	DIBENZ[a,c]ANTHRACENE	0.996 ± 0.004
BCR095	DIBENZ[a,j]ANTHRACENE	0.997 8 ± 0.002 5
BCR096	DIBENZO[a,l]PYRENE	0.997 2 ± 0.002 5
BCR097	BENZO[a]FLUORANTHENE	0.996 ± 0.004
BCR133	DIBENZO[a,e]PYRENE	0.996 + 0.004
		- 0.005
BCR134	BENZO[c]PHENANTHRENE	0.996 8 ± 0.001 4
BCR136R	BENZO[b]NAPHTHO[2,3-d]THIOPHENE (unit size 10 mg)	0.994 ± 0.006
BCR137R	BENZO[b]NAPHTHO[1,2-d]THIOPHENE (unit size 10 mg)	0.996 6 ± 0.002 9
BCR138	DIBENZ[a,h]ANTHRACENE	0.990 ± 0.007
BCR139	BENZO[ghi]FLUORANTHENE	0.995 ± 0.004
BCR140	BENZO[c]CHRYSENE	0.996 + 0.004
		- 0.005
BCR153R	DIBENZ[a,h]ACRIDINE (unit size 10 mg)	0.999 2 ± 0.000 6
BCR154	DIBENZ[a,j]ACRIDINE	0.999 0 + 0.000 7
		- 0.001 0
BCR155	DIBENZ[a,c]ACRIDINE	0.999 1 + 0.000 7
		- 0.000 8
BCR156R	DIBENZ[c,h]ACRIDINE (unit size 10 mg)	0.993 6 ± 0.002 1
BCR157	BENZ[a]ACRIDINE	0.998 2 ± 0.001 8
BCR158	BENZ[c]ACRIDINE	0.998 7 + 0.001 3
		- 0.001 8
BCR159	DIBENZO[a,h]PYRENE	0.993 ± 0.007

Cat. No.	Substance	Purity (g/g)
BCR160R	FLUORANTHENE (unit size 10 mg)	0.996 + 0.004
		- 0.005
BCR168	PICENE (unit size 10 mg)	0.998 + 0.001 3
		- 0.004
BCR177R	PYRENE (unit size 10 mg)	0.998 0 ± 0.000 4

Availability: Amber vials containing about 100 mg of powdered material.

Cat. No.	Substance	Purity (g/g)
	Polycyclic aromatic compounds	
BCR152	DIBENZ[a,i]ACRIDINE	0.998 5 + 0.001 0
		- 0.000 8
BCR265	DIBENZO[a,e]FLUORANTHENE	0.998 5 + 0.001 6
		- 0.001 0
BCR266	7H-DIBENZO[c,g]CARBAZOLE	0.997 1 ± 0.001 6
BCR267	INDENO[1,2,3-cd]FLUORANTHENE	0.998 6 + 0.000 9
		- 0.000 8
BCR269	CHRYSENE	0.992 8 ± 0.002 8
BCR270	TRIPHENYLENE	0.998 4 + 0.001 0
		- 0.000 6
BCR271	BENZ[a]ANTHRACENE	0.998 4 ± 0.000 9
BCR272	CORONENE	0.998 9 + 0.000 6
		- 0.000 4

Availability: Amber vials containing about 20 mg of powdered material.

Cat. No.	Substance	Purity (g/g)
	Nitro-polycyclic aromatic hydrocarbons	
BCR305	1-NITROPYRENE	0.997 6 ± 0.000 7
BCR306	1-NITRONAPHTALENE	0.996 9 ± 0.001 0
BCR307	2-NITRONAPHTALENE	0.997 7 + 0.000 9
		- 0.001 1
BCR308	9-NITROANTHRACENE	0.997 5 ± 0.001 0
BCR309	6-NITROCHRYSENE	0.989 ± 0.004
BCR310	3-NITROFLUORANTHENE	0.996 8 ± 0.001 2
		- 0.002 1
BCR311	6-NITROBENZO[a]PYRENE	0.997 8 + 0.000 8
		- 0.001 0
BCR312	2-NITRO-7-METHOXYNAPHTHO[2.1-b]FURAN	0.998 4 ± 0.000 7

Availability: Amber vials containing about 10 mg of powdered material.

Cat. No.	Substance	Purity (g/g)
	Oxygenated polycyclic aromatic hydrocarbons	
BCR337	DIBENZO[b,d]FURAN	0.987 ± 0.007
BCR338	4H-CYCLOPENTA[def]PHENANTHREN-4-ONE	0.995 1 ± 0.003 0
BCR339	6H-BENZO[c,d]PYREN-6-ONE	0.988 ± 0.009
BCR340	BENZO[b]NAPHTHO[1,2-d]FURAN	0.997 ± 0.003
		- 0.005
BCR341	BENZO[b]NAPHTHO[2,1-d]FURAN	0.996 + 0.004
		- 0.005
BCR342	BENZO[a]FLUORENONE	0.997 9 + 0.002 1
		- 0.002 2

Availability: Amber vials containing about 10 mg of powdered material.

Cat. No.	Substance	Purity (g/g)
	Polychlorinated biphenyls	
	IUPAC No.	
BCR289	8 2,4′- DICHLOROBIPHENYL	0.996 3 + 0.005
		- 0.001 8
BCR290	20 2,3,3′- TRICHLOROBIPHENYL	0.998 5 ± 0.001 3
BCR291	28 2,4,4′- TRICHLOROBIPHENYL	0.997 9 ± 0.001 3
BCR293	52 2,2′,5,5′- TETRACHLOROBIPHENYL	0.995 9 ± 0.002 5
BCR296	138 2,2′,3,4,4′,5′- HEXACHLOROBIPHENYL	0.999 2 ± 0.000 7
BCR297	153 2,2′,4,4′,5,5′- HEXACHLOROBIPHENYL	0.999 4 + 0.000 9
		- 0.000 5
BCR298	180 2,2′,3,4,4′,5,5′- HEPTACHLOROBIPHENYL	0.995 7 ± 0.001 4

Availability: Amber vials containing about 25 mg of powdered material.

Cat. No. BCR365 - Polychlorinated biphenyls in iso-octane

IUPAC No.	Content in mg/kg	Concentration in g/m³ at 25 °C [1]
8	11.4 ± 0.4	(7.8 ± 0.2)
20	15.2 ± 0.9	(10.5 ± 0.7)
28	24.8 ± 1.1	(17.1 ± 0.8)
35	14.3 ± 0.8	(9.8 ± 0.5)
52	14.8 ± 0.6	(10.2 ± 0.4)
101	14.4 ± 0.6	(9.9 ± 0.4)
118	14.9 ± 0.8	(10.3 ± 0.6)
138	8.6 ± 0.6	(5.9 ± 0.5)
153	14.2 ± 0.6	(9.8 ± 0.4)
180	15.2 ± 0.6	(10.4 ± 0.3)

1) Not certified concentrations (g/m³) were calculated from the certified content assuming a density of iso-octane of 687.77 kg/m³ at 25 °C.

Availability: Unit consisting of a pair of dark glass ampoules, each containing 2 cm³ of 2,2,4-Trimethylpentane (iso-octane) sealed under nitrogen. The pair of ampoules is supplied in a metal can which is packed with absorbent material

Cat. No. BCR614 - Polychlorodibenzo-p-dioxins (PCDDs) and polychlorodibenzofurans (PCDFs)

Congener	Certified mass fraction [1]	Uncertainty [2]	Mass fraction expressed in concentration units [3]	Uncertainty expressed in concentration units [3]
	(µg/kg)		(µg/L)	
2,3,7,8-T_4CDD	0.137	0.004	0.098 3	0.002 9
1,2,3,7,8-P_5CDD	0.698	0.014	0.501	0.010
1,2,3,4,7,8-HCDD	0.688	0.021	0.494	0.015
1,2,3,6,7,8-HCDD	0.696	0.006	0.500	0.004
1,2,3,7,8,9-HCDD	0.705	0.008	0.506	0.006
1,2,3,4,6,7,8-HCDD	1.400	0.020	1.005	0.014
1,2,3,4,6,7,8,9-O8CDD	1.396	0.007	1.001	0.005
2,3,7,8-T_4CDF	0.139 7	0.001 1	0.100 2	0.000 8
1,2,3,7,8-P_5CDF	0.707	0.013	0.507	0.009
2,3,4,7,8-P_5CDF	0.698	0.005	0.501	0.004
1,2,3,4,7,8-HCDF	0.700	0.006	0.502	0.005
1,2,3,6,7,8-HCDF	0.698	0.005	0.501	0.004
1,2,3,7,8,9-HCDF	0.699	0.009	0.502	0.007
2,3,4,6,7,8-HCDF	0.694	0.007	0.498	0.005
1,2,3,4,6,7,8-HCDF	1.396	0.008	1.001	0.006
1,2,3,4,7,8,9-HCDF	1.394	0.030	1.001	0.022
1,2,3,4,6,7,8,9-O_8CDF	1.397	0.024	1.002	0.017

1) The certified mass fraction has been calculated from the purity of the individual PCDD/F compounds as assessed in a comprehensive study and the gravimetric preparation of the solution.
2) Uncertainties have been calculated by combining contributions from the purity study and the gravimetric preparation; details are given in the certification report.
3) Non-certified values.

Cat. No. BCR614

Congener	Certified mass fraction [1]	Uncertainty [2]	Mass fraction expressed in concentration units [3]	Uncertainty expressed in concentration units [3]
	(µg/kg)		(µg/L)	
^{13}C-2,3,7,8-T_4CDD	13.95	0.06	10.01	0.05
^{13}C-1,2,3,7,8-P_5CDD	13.9	0.4	10.00	0.23
^{13}C-1,2,3,4,7,8-HCDD	13.98	0.07	10.03	0.05
^{13}C-1,2,3,6,7,8-HCDD	13.94	0.24	10.00	0.17
^{13}C-1,2,3,7,8,9-HCDD	13.95	0.10	10.01	0.07
^{13}C-1,2,3,4,6,7,8-HCDD	27.9	0.6	20.0	0.4
^{13}C-1,2,3,4,6,7,8,9-O_8CDD	27.87	0.16	20.00	0.12
^{13}C-2,3,7,8-T_4CDF	13.96	0.09	10.02	0.07
^{13}C-1,2,3,7,8-P_5CDF	13.94	0.24	10.00	0.17
^{13}C-2,3,4,7,8-P_5CDF	13.95	0.06	10.01	0.05
^{13}C-1,2,3,4,7,8-HCDF	13.90	0.07	9.97	0.05
^{13}C-1,2,3,6,7,8-HCDF	13.93	0.10	10.00	0.08
^{13}C-1,2,3,7,8,9-HCDF	13.93	0.10	10.00	0.07
^{13}C-2,3,4,6,7,8-HCDF	13.93	0.09	10.00	0.06
^{13}C-1,2,3,4,6,7,8-HCDF	27.92	0.20	20.03	0.15
^{13}C-1,2,3,4,7,8,9-HCDF	27.87	0.24	20.00	0.17
^{13}C-1,2,3,4,6,7,8,9-O_8CDF	27.88	0.25	20.01	0.18
^{13}C-1,2,3,4-T_4CDD	13.94	0.08	10.00	0.06

Cat. No. BCR614S1

Congener	Certified mass fraction [1]	Uncertainty [2]	Mass fraction expressed in concentration units [3]	Uncertainty expressed in concentration units [3]
	(µg/kg)		(µg/L)	
2,3,7,8-T_4CDD	0.273	0.008	0.196	0.006
1,2,3,7,8-P_5CDD	1.394	0.027	1.000	0.020
1,2,3,4,7,8-HCDD	1.37	0.05	0.986	0.030
1,2,3,6,7,8-HCDD	1.391	0.010	0.998	0.007
1,2,3,7,8,9-HCDD	1.408	0.015	1.011	0.011
1,2,3,4,6,7,8-HCDD	2.80	0.04	2.006	0.028
1,2,3,4,6,7,8,9-O_8CDD	2.787	0.010	2.000	0.007
2,3,7,8-T_4CDF	0.279 0	0.002 1	0.200 2	0.001 5
1,2,3,7,8-P_5CDF	1.412	0.025	1.013	0.018
2,3,4,7,8-P_5CDF	1.395	0.008	1.001	0.006
1,2,3,4,7,8-HCDF	1.398	0.011	1.003	0.008
1,2,3,6,7,8-HCDF	1.393	0.009	1.000	0.006
1,2,3,7,8,9-HCDF	1.397	0.017	1.002	0.012
2,3,4,6,7,8-HCDF	1.387	0.012	0.995	0.009
1,2,3,4,6,7,8-HCDF	2.787	0.012	2.000	0.009
1,2,3,4,7,8,9-HCDF	2.78	0.06	2.00	0.05
1,2,3,4,6,7,8,9-O_8CDF	2.79	0.05	2.00	0.04
^{13}C-2,3,7,8-T_4CDD	13.95	0.06	10.01	0.05
^{13}C-1,2,3,7,8-P_5CDD	13.9	0.4	10.00	0.23
^{13}C-1,2,3,4,7,8-HCDD	13.98	0.07	10.03	0.05
^{13}C-1,2,3,6,7,8-HCDD	13.93	0.24	10.00	0.17
^{13}C-1,2,3,7,8,9-HCDD	13.94	0.10	10.01	0.07
^{13}C-1,2,3,4,6,7,8-HCDD	27.9	0.6	20.0	0.4
^{13}C-1,2,3,4,6,7,8,9-O_8CDD	27.86	0.16	19.99	0.11
^{13}C-2,3,7,8-T_4CDF	13.96	0.09	10.01	0.07
^{13}C-1,2,3,7,8-P_5CDF	13.93	0.24	10.00	0.17
^{13}C-2,3,4,7,8-P_5CDF	13.94	0.06	10.00	0.05
^{13}C-1,2,3,4,7,8-HCDF	13.89	0.07	9.97	0.05
^{13}C-1,2,3,6,7,8-HCDF	13.93	0.11	9.99	0.08
^{13}C-1,2,3,7,8,9-HCDF	13.92	0.10	9.99	0.07
^{13}C-2,3,4,6,7,8-HCDF	13.93	0.09	9.99	0.06
^{13}C-1,2,3,4,6,7,8-HCDF	27.90	0.20	20.02	0.14
^{13}C-1,2,3,4,7,8,9-HCDF	27.86	0.24	19.99	0.17
^{13}C-1,2,3,4,6,7,8,9-O_8CDF	27.87	0.25	20.00	0.18
^{13}C-1,2,3,4-T_4CDD	13.93	0.07	10.00	0.05

1) The certified mass fraction has been calculated from the purity of the individual PCDD/F compounds as assessed in a comprehensive study and the gravimetric preparation of the solution.
2) Uncertainties have been calculated by combining contributions from the purity study and the gravimetric preparation; details are given in the certification report.
3) Non-certified values.

Cat. No. BCR614S2

Congener	Certified mass fraction [1]	Uncertainty [2]	Mass fraction expressed in concentration units [3]	Uncertainty expressed in concentration units [3]
	(µg/kg)		(µg/L)	
2,3,7,8-T_4CDD	1.09	0.04	0.785	0.023
1,2,3,7,8-P_5CDD	5.57	0.11	4.00	0.08
1,2,3,4,7,8-HCDD	5.49	0.17	3.94	0.12
1,2,3,6,7,8-HCDD	5.56	0.04	3.992	0.027
1,2,3,7,8,9-HCDD	5.63	0.06	4.04	0.05
1,2,3,4,6,7,8-HCDD	11.18	0.16	8.02	0.11
1,2,3,4,6,7,8,9-O_8CDD	11.15	0.04	8.000	0.027
2,3,7,8-T_4CDF	1.116	0.008	0.801	0.006
1,2,3,7,8-P_5CDF	5.65	0.10	4.05	0.07
2,3,4,7,8-P_5CDF	5.58	0.03	4.004	0.022
1,2,3,4,7,8-HCDF	5.59	0.05	4.01	0.04
1,2,3,6,7,8-HCDF	5.57	0.04	3.999	0.024
1,2,3,7,8,9-HCDF	5.59	0.07	4.01	0.05
2,3,4,6,7,8-HCDF	5.55	0.05	3.98	0.04
1,2,3,4,6,7,8-HCDF	11.15	0.05	8.00	0.04
1,2,3,4,7,8,9-HCDF	11.14	0.24	7.99	0.17
1,2,3,4,6,7,8,9-O_8CDF	11.16	0.19	8.01	0.14
^{13}C-2,3,7,8-T_4CDD	13.95	0.06	10.01	0.05
^{13}C-1,2,3,7,8-P_5CDD	13.9	0.4	10.00	0.23
^{13}C-1,2,3,4,7,8-HCDD	13.98	0.07	10.03	0.05
^{13}C-1,2,3,6,7,8-HCDD	13.93	0.24	10.00	0.17
^{13}C-1,2,3,7,8,9-HCDD	13.94	0.10	10.01	0.07
^{13}C-1,2,3,4,6,7,8-HCDD	27.9	0.6	20.0	0.4
^{13}C-1,2,3,4,6,7,8,9-O_8CDD	27.86	0.16	19.99	0.11
^{13}C-2,3,7,8-T_4CDF	13.96	0.09	10.01	0.07
^{13}C-1,2,3,7,8-P_5CDF	13.93	0.24	10.00	0.17
^{13}C-2,3,4,7,8-P_5CDF	13.94	0.06	10.00	0.05
^{13}C-1,2,3,4,7,8-HCDF	13.89	0.07	9.97	0.05
^{13}C-1,2,3,6,7,8-HCDF	13.93	0.11	9.99	0.08
^{13}C-1,2,3,7,8,9-HCDF	13.93	0.10	9.99	0.07
^{13}C-2,3,4,6,7,8-HCDF	13.93	0.09	9.99	0.06
^{13}C-1,2,3,4,6,7,8-HCDF	27.90	0.20	20.02	0.15
^{13}C-1,2,3,4,7,8,9-HCDF	27.86	0.24	19.99	0.17
^{13}C-1,2,3,4,6,7,8,9-O_8CDF	27.87	0.25	20.00	0.18
^{13}C-1,2,3,4-T_4CDD	13.93	0.08	10.00	0.06

1) The certified mass fraction has been calculated from the purity of the individual PCDD/F compounds as assessed in a comprehensive study and the gravimetric preparation of the solution.
2) Uncertainties have been calculated by combining contributions from the purity study and the gravimetric preparation; details are given in the certification report.
3) Non-certified values.

Cat. No. BCR614S3

Congener	Certified mass fraction [1]	Uncertainty [2]	Mass fraction expressed in concentration units [3]	Uncertainty expressed in concentration units [3]
	(µg/kg)		(µg/L)	
2,3,7,8-T_4CDD	5.47	0.16	3.92	0.12
1,2,3,7,8-P_5CDD	27.9	0.6	20.0	0.4
1,2,3,4,7,8-HCDD	27.5	0.9	19.7	0.6
1,2,3,6,7,8-HCDD	27.81	0.19	19.96	0.14
1,2,3,7,8,9-HCDD	28.17	0.30	20.21	0.21
1,2,3,4,6,7,8-HCDD	55.9	0.8	40.1	0.6
1,2,3,4,6,7,8,9-O_8CDD	55.74	0.19	40.00	0.14
2,3,7,8-T_4CDF	5.58	0.04	4.003	0.029
1,2,3,7,8-P_5CDF	28.2	0.5	20.3	0.4
2,3,4,7,8-P_5CDF	27.90	0.16	20.02	0.11
1,2,3,4,7,8-HCDF	27.96	0.22	20.06	0.16
1,2,3,6,7,8-HCDF	27.87	0.17	20.00	0.12
1,2,3,7,8,9-HCDF	27.9	0.4	20.04	0.24
2,3,4,6,7,8-HCDF	27.73	0.23	19.90	0.17
1,2,3,4,6,7,8-HCDF	55.74	0.24	40.00	0.17
1,2,3,4,7,8,9-HCDF	55.7	1.2	40.0	0.9
1,2,3,4,6,7,8,9-O_8CDF	55.8	1.0	40.0	0.7
^{13}C-2,3,7,8-T_4CDD	13.95	0.06	10.01	0.05
^{13}C-1,2,3,7,8-P_5CDD	13.9	0.4	10.00	0.23
^{13}C-1,2,3,4,7,8-HCDD	13.98	0.07	10.03	0.05
^{13}C-1,2,3,6,7,8-HCDD	13.93	0.24	10.00	0.17
^{13}C-1,2,3,7,8,9-HCDD	13.95	0.10	10.01	0.07
^{13}C-1,2,3,4,6,7,8-HCDD	27.9	0.6	20.0	0.4
^{13}C-1,2,3,4,6,7,8,9-O_8CDD	27.87	0.16	20.00	0.11
^{13}C-2,3,7,8-T_4CDF	13.96	0.09	10.02	0.07
^{13}C-1,2,3,7,8-P_5CDF	13.93	0.24	10.00	0.17
^{13}C-2,3,4,7,8-P_5CDF	13.94	0.06	10.01	0.05
^{13}C-1,2,3,4,7,8-HCDF	13.90	0.07	9.97	0.05
^{13}C-1,2,3,6,7,8-HCDF	13.93	0.11	10.00	0.08
^{13}C-1,2,3,7,8,9-HCDF	13.93	0.10	10.00	0.07
^{13}C-2,3,4,6,7,8-HCDF	13.93	0.09	10.00	0.06
^{13}C-1,2,3,4,6,7,8-HCDF	27.91	0.20	20.03	0.14
^{13}C-1,2,3,4,7,8,9-HCDF	27.87	0.24	20.00	0.17
^{13}C-1,2,3,4,6,7,8,9-O_8CDF	27.88	0.25	20.00	0.18
^{13}C-1,2,3,4-T_4CDD	13.93	0.07	10.00	0.05

1) The certified mass fraction has been calculated from the purity of the individual PCDD/F compounds as assessed in a comprehensive study and the gravimetric preparation of the solution.
2) Uncertainties have been calculated by combining contributions from the purity study and the gravimetric preparation; details are given in the certification report.
3) Non-certified values.

Cat. No. BCR614S4

Congener	Certified mass fraction [1]	Uncertainty [2]	Mass fraction expressed in concentration units [3]	Uncertainty expressed in concentration units [3]
	(µg/kg)		(µg/L)	
2,3,7,8-T_4CDD	27.3	0.8	9.6	0.6
1,2,3,7,8-P_5CDD	139.3	2.7	100.0	2.0
1,2,3,4,7,8-HCDD	137	5	98.6	3.0
1,2,3,6,7,8-HCDD	139.1	1.0	99.8	0.7
1,2,3,7,8,9-HCDD	140.8	1.5	101.1	1.1
1,2,3,4,6,7,8-HCDD	280	4	200.6	2.8
1,2,3,4,6,7,8,9-O_8CDD	278.7	1.0	200.0	0.7
2,3,7,8-T_4CDF	27.89	0.21	20.02	0.15
1,2,3,7,8-P_5CDF	141.2	2.5	101.3	1.8
2,3,4,7,8-P_5CDF	139.5	0.8	100.1	0.6
1,2,3,4,7,8-HCDF	139.8	1.1	100.3	0.8
1,2,3,6,7,8-HCDF	139.3	0.9	100.0	0.6
1,2,3,7,8,9-HCDF	139.6	1.7	100.2	1.2
2,3,4,6,7,8-HCDF	138.7	1.2	99.5	0.9
1,2,3,4,6,7,8-HCDF	278.7	1.2	200.0	0.9
1,2,3,4,7,8,9-HCDF	278	6	200	5
1,2,3,4,6,7,8,9-O_8CDF	279	5	200	4
^{13}C-2,3,7,8-T_4CDD	13.95	0.06	10.01	0.05
^{13}C-1,2,3,7,8-P_5CDD	13.99	0.4	10.00	0.23
^{13}C-1,2,3,4,7,8-HCDD	13.98	0.07	10.03	0.05
^{13}C-1,2,3,67,8-HCDD	13.93	0.24	10.00	0.17
^{13}C-1,2,3,7,8,9-HCDD	13.94	0.10	10.01	0.07
^{13}C-1,2,3,4,6,7,8-HCDD	27.9	0.6	20.0	0.4
^{13}C-1,2,3,4,6,7,8,9-O_8CDD	27.86	0.16	19.99	0.11
^{13}C-2,3,7,8-T_4CDF	13.96	0.09	10.01	0.07
^{13}C-1,2,3,7,8-P_5CDF	13.93	0.24	10.00	0.17
^{13}C-2,3,4,7,8-P_5CDF	13.94	0.06	10.00	0.05
^{13}C-1,2,3,4,7,8-HCDF	13.89	0.07	9.97	0.05
^{13}C-1,2,3,6,7,8-HCDF	13.93	0.11	9.99	0.08
^{13}C-1,2,3,7,8,9-HCDF	13.92	0.10	9.99	0.07
^{13}C-2,3,4,6,7,8-HCDF	13.93	0.09	9.99	0.06
^{13}C-1,2,3,4,6,7,8-HCDF	27.90	0.20	20.02	0.15
^{13}C-1,2,3,4,7,8,9-HCDF	27.86	0.24	19.99	0.17
^{13}C-1,2,3,4,6,7,8,9-O_8CDF	27.87	0.25	20.00	0.18
^{13}C-1,2,3,4-T_4CDD	13.93	0.08	10.00	0.06

1) The certified mass fraction has been calculated from the purity of the individual PCDD/F compounds as assessed in a comprehensive study and the gravimetric preparation of the solution.
2) Uncertainties have been calculated by combining contributions from the purity study and the gravimetric preparation; details are given in the certification report.
3) Non-certified values.

Cat. No. BCR614S5

Congener	Certified mass fraction [1]	Uncertainty [2]	Mass fraction expressed in concentration units [3]	Uncertainty expressed in concentration units [3]
	(µg/kg)		(µg/L)	
2,3,7,8-T_4CDD	109	4	78.5	2.3
1,2,3,7,8-P_5CDD	557	11	400	8
1,2,3,4,7,8-HCDD	549	17	394	12
1,2,3,6,7,8-HCDD	556	4	399.1	2.7
1,2,3,7,8,9-HCDD	563	6	404	5
1,2,3,4,6,7,8-HCDD	1118	16	802	11
1,2,3,4,6,7,8,9-O_8CDD	1115	4	799.9	2.7
2,3,7,8-T_4CDF	1116	0.8	80.1	0.6
1,2,3,7,8-P_5CDF	565	0	405	7
2,3,4,7,8-P_5CDF	558	3	400.4	2.2
1,2,3,4,7,8-HCDF	559	5	401	4
1,2,3,6,7,8-HCDF	557	4	399.9	2.4
1,2,3,7,8,9-HCDF	559	7	401	5
2,3,4,6,7,8-HCDF	555	5	398	4
1,2,3,4,6,7,8-HCDF	1115	5	800	4
1,2,3,4,7,8,9-HCDF	1114	24	799	17
1,2,3,4,6,7,8,9-O_8CDF	1116	19	801	14
^{13}C-2,3,7,8-T_4CDD	13.95	0.06	10.01	0.05
^{13}C-1,2,3,7,8-P_5CDD	13.9	0.4	10.00	0.23
^{13}C-1,2,3,4,7,8-HCDD	13.98	0.7	10.03	0.05
^{13}C-1,2,3,6,7,8-HCDD	13.93	0.24	10.00	0.17
^{13}C-1,2,3,7,8,9-HCDD	13.95	0.10	10.01	0.07
^{13}C-1,2,3,4,6,7,8-HCDD	27.9	0.6	20.0	0.4
^{13}C-1,2,3,4,6,7,8,9-O_8CDD	27.86	0.16	19.99	0.11
^{13}C-2,3,7,8-T_4CDF	13.96	0.09	10.02	0.07
^{13}C-1,2,3,7,8-P_5CDF	13.93	0.24	10.00	0.17
^{13}C-2,3,4,7,8-P_5CDF	13.94	0.06	10.00	0.05
^{13}C-1,2,3,4,7,8-HCDF	13.89	0.07	9.97	0.05
^{13}C-1,2,3,6,7,8-HCDF	13.93	0.11	9.99	0.08
^{13}C-1,2,3,7,8,9-HCDF	13.93	0.10	9.99	0.07
^{13}C-2,3,4,6,7,8-HCDF	13.93	0.09	9.99	0.06
^{13}C-1,2,3,4,6,7,8-HCDF	27.90	0.20	20.02	0.15
^{13}C-1,2,3,4,7,8,9-HCDF	27.86	0.24	19.99	0.17
^{13}C-1,2,3,4,6,7,8,9-O_8CDF	27.87	0.25	20.00	0.18
^{13}C-1,2,3,4-T_4CDD	13.93	0.08	10.00	0.06

Cat. No. BCR614S6

Congener	Certified mass fraction [1]	Uncertainty [2]	Mass fraction expressed in concentration units [3]	Uncertainty expressed in concentration units [3]
	(µg/kg)		(µg/L)	
^{13}C-1,2,3,7,8-P_5CDF	139.3	2.3	100.0	1.7
^{13}C-1,2,3,7,8,9-HCDF	139.4	0.9	100.0	0.7
^{13}C-1,2,3,4,7,8,9-HCDF	278.7	2.4	200.0	1.7

1) The certified mass fraction has been calculated from the purity of the individual PCDD/F compounds as assessed in a comprehensive study and the gravimetric preparation of the solution.
2) Uncertainties have been calculated by combining contributions from the purity study and the gravimetric preparation; details are given in the certification report.
3) Non-certified values.

Cat. No. BCR614S7

Congener	Certified mass fraction [1]	Uncertainty [2]	Mass fraction expressed in concentration units [3]	Uncertainty expressed in concentration units [3]
	(µg/kg)		(µg/L)	
^{13}C-2,3,7,8-T_4CDD	139.5	0.6	100.1	0.4
^{13}C-1,2,3,7,8-P_5CDD	139	4	99.9	2.4
^{13}C-1,2,3,4,7,8-HCDD	139.8	0.7	100.3	0.5
^{13}C-1,2,3,6,7,8-HCDD	139.3	2.4	100.0	1.7
^{13}C-1,2,3,4,6,7,8-HCDD	279	6	200	4
^{13}C-1,2,3,4,6,7,8,9-O_8CDD	278.7	1.6	200.0	1.1
^{13}C-2,3,7,8-T_4CDF	139.5	0.9	100.1	0.6
^{13}C-2,3,4,7,8-P_5CDF	139.2	0.6	99.9	0.4
^{13}C-1,2,3,4,7,8-HCDF	138.9	0.6	99.7	0.5
^{13}C-1,2,3,6,7,8-HCDF	139.4	1.1	100.0	0.8
^{13}C-2,3,4,6,7,8-HCDF	139.4	0.8	100.0	0.6
^{13}C-1,2,3,4,6,7,8-HCDF	278.7	2.0	200.0	1.4
^{13}C-1,2,3,4,6,7,8,9-O_8CDF	278.7	2.5	200.0	1.8

Cat. No. BCR614S8

Congener	Certified mass fraction [1]	Uncertainty [2]	Mass fraction expressed in concentration units [3]	Uncertainty expressed in concentration units [3]
	(µg/kg)		(µg/L)	
^{13}C-1,2,3,7,8,9-HCDD	558	4	400.5	2.7
^{13}C-1,2,3,4-T_4CDD	557.4	2.7	400.0	2.0

1) The certified mass fraction has been calculated from the purity of the individual PCDD/F compounds as assessed in a comprehensive study and the gravimetric preparation of the solution.
2) Uncertainties have been calculated by combining contributions from the purity study and the gravimetric preparation; details are given in the certification report.
3) Non-certified values.

Availability: BCR614 Solutions S1-S7 contain about 1 mL solution and BCR614 Solution S8 about 0.5 mL. The solutions are available individually or as set. A set consists of 11 ampoules, one of S2, S4-S8 and two of S1 and S3. In addition, the set contains an additional solution S9, which is not certified. This solution is intended as complementary tool for QA/QC purposes.

Cat. No. ERMAC213

Substance	PAHs in Acetonitrile / Toluene (µg/g)
Benz[*a*]anthracene	3.09 ± 0.04
Chrysene	3.06 ± 0.05
5-methylchrysene	3.08 ± 0.07
Benzo[*b*]fluoranthene	3.05 ± 0.05
Benzo[*k*]fluoranthene	3.06 ± 0.08
Benzo[*j*]fluoranthene	3.05 ± 0.10
Dibenz[*a,h*]anthracene	2.76 ± 0.05

Substance	PAHs in Acetonitrile / Toluene (µg/g)
Benzo[*ghi*]perylene	3.07 ± 0.05
Dibenzo[*a,l*]pyrene	2.85 ± 0.10
Dibenzo[*a,e*]pyrene	2.97 ± 0.10
Benzo[*c*]fluorene	(2.13 ± 0.11)
Cyclopental[*cd*]pyrene	(2.96 ± 0.12)
Dibenzo[*a,i*]pyrene	(2.37 ± 0.15)

Values in brackets are not certified.
Availability: ERMAC213 consists of 2 mL toluene containing 15 PAHs in an ampoule.

1.2 MATRIX MATERIALS

1.2.1 CERTIFIED FOR THE TOTAL ELEMENT CONTENT

Substance	Cat. No. BCR142R Light sandy soil (mg/kg)	Cat. No. ERMCC141 Loam soil (mg/kg)	Cat. No. BCR143R Sewage sludge amended soil (mg/kg)
As		9.9 ± 1.5	
Cd	0.34 ± 0.04	0.35 ± 0.05	71.8 ± 1.2
Co	12.1 ± 0.7	8.5 ± 0.5	12.3 ± 0.3
Cr		86 ± 8	
Cu	69.7 ± 1.3	14.4 ± 1.4	130.6 ± 1.5
Hg	0.067 ± 0.011	0.083 ± 0.017	1.10 ± 0.07
Mn	970 ± 16	464 ± 18	904 ± 13
Ni	64.5 ± 2.5	26.4 ± 2.4	299 ± 5
Pb	40.2 ± 1.9	41 ± 4	179.7 ± 2.1
Zn	(101 ± 6)	57 ± 4	1055 ± 14
Aqua regia soluble[1)]			
As		7.5 ± 1.4	
Cd	0.249 ± 0.010	0.25 ± 0.04	72.0 ± 1.8
Co	(10.2 ± 0.6)	7.9 ± 0.9	(11.8 ± 1.0)
Cr		31 ± 4	426 ± 12
Cu	(69.8 ± 1.0)	12.4 ± 0.9	(128 ± 7)
Hg		0.080 ± 0.008	(1.10 ± 0.06)
Mn	(800 ± 50)	387 ± 17	858 ± 11
Ni	61.1 ± 1.5	21.9 ± 1.6	296 ± 4
Pb	25.7 ± 1.6	32.2 ± 1.4	174 ± 5
Zn	93.3 ± 2.7	50 ± 4	1063 ± 16

Values in brackets are not certified.
Availability: Glass bottles containing about 50 g of powdered material; ERMCC141 contains minimum 24 g.
1) Details of the analytical procedure to obtain the aqua regia soluble content of the elements are given in the certification report.

Substance	Cat. No. BCR667 Estuarine sediment (mg/kg)	Cat. No. ERMCC690 Calcareous soil (mg/kg)
Br	(99.7 ± 2.5)	
Cd	(0.67 ± 0.11)	
Ce	56.7 ± 2.5	49.1 ± 2.5
Co	(23.0 ± 1.3)	
Cr	(178 ± 16)	
Cs	(7.8 ± 0.7)	
Cu	(60 ± 9)	
Dy	4.01 ± 0.14	2.90 ± 0.28
Er	2.35 ± 0.15	
Eu	1.00 ± 0.05	
Fe	(44800 ± 1)	
Gd	4.41 ± 0.12	3.2 ± 0.4
Ho	0.80 ± 0.06	
La	27.8 ± 1.0	24.4 ± 1.7
Lu	0.325 ± 0.020	
Mn	(920 ± 40)	

Substance	Cat. No. BCR667 Estuarine sediment (mg/kg)	Cat. No. ERMCC690 Calcareous soil (mg/kg)
Nd	25.0 ± 1.4	19.1 ± 2.2
Ni	(128 ± 9)	
Pb	(31.9 ± 1.1)	
Pr	6.1 ± 0.5	
Sb	(0.96 ± 0.05)	
Sc	13.7 ± 0.7	7.9 ± 0.9
Se	(1.59 ± 0.08)	
Sm	4.66 ± 0.20	3.5 ± 0.4
Ta	(0.876 ± 0.017)	
Tb	0.682 ± 0.017	0.50 ± 0.07
Th	10.0 ± 0.5	7.6 ± 0.8
Tm	0.326 ± 0.025	0.232 ± 0.026
U	2.26 ± 0.15	1.90 ± 0.23
Yb	2.20 ± 0.09	1.57 ± 0.19
Zn	(175 ± 13)	

Values in brackets are not certified.
Availability: BCR667: Glass bottles containing about 40 g of powdered material.
ERMCC690: Glass bottles containing about 70 g of powdered material.
The report gives additional indicative values for As, Au, Co, Cr, Cs, Cu, Er, Eu, Fe, Hf, Ho, Lu, Ni, Pb, Pr, Sb, Ta, W, Y and Zn.

Substance	Cat. No. BCR320R Channel sediment (mg/kg)
As	21.7 ± 2.0
Cd	2.64 ± 0.18
Co	9.7 ± 0.6
Cr	59 ± 4
Cu	46.3 ± 2.9
Fe	25700 ± 1300
Hg	0.85 ± 0.09
Mn	910 ± 50
Ni	27.1 ± 2.2

Substance	Cat. No. BCR320R Channel sediment (mg/kg)
Pb	85 ± 5
Sc	5.2 ± 0.4
Se	(0.96 ± 0.18)
Sn	(9.4 ± 1.7)
Th	5.3 ± 0.4
Tl	0.65 ± 0.08
U	1.56 ± 0.20
V	46.5 ± 2.8
Zn	318 ± 20

Values in brackets are not certified.

Substance	Cat. No. BCR145R Sewage sludge (mixed origin) (mg/kg)	Cat. No. BCR146R Sewage sludge (industrial origin) (mg/kg)	Cat. No. BCR597 Sewage sludge (mg/kg)
Cd	3.50 ± 0.15	18.8 ± 0.5	
Co	5.6 ± 0.4	7.39 ± 27	
Cr		196 ± 7	203 ± 6
Cu	696 ± 12	838 ± 16	
Hg	2.01 ± 0.22	8.6 ± 0.4	
Mn	156 ± 4	323 ± 7	
Ni	247 ± 7	70 ± 5	
Pb	286 ± 5	609 ± 14	
Zn	2122 ± 23	3060 ± 60	
Aqua regia soluble [1)]			
Cd	(3.43 ± 0.17)	18.4 ± 0.4	
Co	(5.3 ± 0.7)	6.5 ± 0.4	
Cr	307 ± 13	174 ± 7	
Cu	707 ± 9	831 ± 16	
Hg	(1.99 ± 0.08)	8.39 ± 0.25	
Mn	(145 ± 7)	298 ± 9	
Ni	251 ± 6	65.0 ± 3.0	
Pb	282 ± 9	583 ± 17	
Zn	2140 ± 50	3040 ± 60	

Values in brackets are not certified.
Availability: Glass bottles containing about 50 g of powdered material for BCR146R, 40 g for BCR145R and BCR597.
[1)] Details of the analytical procedure to obtain the aqua regia soluble content of the elements are given in the certification report.

Substance	Cat. No. ERMCC580 Estuarine sediment (mg/kg)
Total Hg	132 ± 3
CH_3Hg^+	0.075 ± 0.004

Availability: Glass bottles containing about 40 g powder.

Substance	Cat. No. BCR038 Fly ash from pulverised coal (mg/kg)
As	48.0 ± 2.3
Cd	4.6 ± 0.3
Co	53.8 ± 1.9
Cr	192 ± 10
Cu	176 ± 9
Fe	33.8×10^3 ± 0.7×10^3

Substance	Cat. No. BCR038 Fly ash from pulverised coal (mg/kg)
Hg	2.10 ± 0.15
Mn	479 ± 16
Na	3.74×10^3 ± 0.15×10^3
Pb	262 ± 11
Zn	581 ± 29

Availability: BCR038 in ampoules containing about 5 g.

Substance	Cat. No. BCR176R Fly ash (mg/kg)
As	54 ± 5
Cd	226 ± 19
Co	26.7 ± 1.6
Cr	810 ± 70
Cu	1050 ± 70
Fe	13100 ± 500
Hg	(1.60 ± 0.23)
Mn	(730 ± 50)

Substance	Cat. No. BCR176R Fly ash (mg/kg)
Ni	117 ± 6
Pb	5000 ± 500
Sb	850 ± 50
Se	18.3 ± 1.9
Tl	1.32 ± 0.21
V	(35 ± 6)
Zn	16800 ± 400

Values in brackets are not certified.
The report gives additional indicative values for Ag, Au, Ba, Br, Ce, Cs, Eu, Hf, La, Na, Rb, Sc, Ta, Th and W.
Availability: Amber glass bottles containing about 40 g of powdered material.

Substance	Cat. No. BCR723 Trace elements in road dust (µg/kg)
Pd	6.1 ± 1.9
Pt	81.3 ± 2.5
Rh	12.8 ± 1.3

Availability: Brown glass bottles with screw cap containing approximately 25 g of powder.

Substance	Cat. No. ERMCZ120 Elements in fine dust (PM_{10}-like) (mg/kg)
As	7.1 ± 0.7
Cd	0.90 ± 0.22

Substance	Cat. No. ERMCZ120 Elements in fine dust (PM_{10}-like) (mg/kg)
Pb	113 ± 17
Ni	58 ± 7

Availability: Vial containing approximately 0.5 g of fine dust.

Substance	Cat. No. BCR596 Trapa natans (Aquatic plant) (mg/kg)
Al	
Cd	
Cr	36.3 ± 1.7
Cu	

Availability: CRMs are provided in units of 25 g.

Substance	Cat. No. BCR129 Hay powder (g/kg)	Cat. No. BCR402 White clover (mg/kg)
As		0.093 ± 0.010
Ca	6.40 ± 0.10	
Co		0.178 ± 0.008
I	0.167×10^{-3} ± 0.024×10^{-3}	
K	33.8 ± 0.8	
Mg	1.45 ± 0.04	
Mo		6.93 ± 0.19
N	37.2 ± 0.5	

Substance	Cat. No. BCR129 Hay powder (g/kg)	Cat. No. BCR402 White clover (mg/kg)
P	2.36 ± 0.07	
S	3.16 ± 0.04	
Se		6.70 ± 0.25
Zn	32.1×10^{-3} ± 1.7×10^{-3}	
Kjeldahl-N	34.2 ± 0.4	

Availability: CRMs are provided in powder form in bottles containing approximately for BCR129 30 g, BCR402 25 g.
Note: BCR402 was produced from white clover grown on a ground specially rich in selenium. This explains the high content of this element.

Substance	Cat. No. ERMCD281 Rye grass (mg/kg)
As	0.042 ± 0.010
B	5.5 ± 0.5
Ca	(6.3 g/kg)
Cd	0.120 ± 0.007
Cr	24.8 ± 1.3
Cu	10.2 ± 0.5
Fe	(0.18 g/kg)
Hg	0.0164 ± 0.0022
K	(34 g/kg)
Mg	(1.6 g/kg)
Mn	82 ± 4

Substance	Cat. No. ERMCD281 Rye grass (mg/kg)
Mo	2.22 ± 0.12
Na	(4.0 g/kg)
Ni	15.2 ± 0.6
P	(2.8 g/kg)
Pb	1.67 ± 0.11
S	(3.4 g/kg)
Sb	0.042 ± 0.007
Se	0.023 ± 0.004
Si	(1.3 g/kg)
Sn	0.062 ± 0.011
Zn	30.5 ± 1.1

Values in brackets are not certified.
Availability: Amber glass vial containing approximately 10 g.

Substance	Cat. No. BCR414 Plankton (mg/kg)
As	6.82 ± 0.28
Cd	0.383 ± 0.014
Co	(1.43 ± 0.06)
Cr	23.8 ± 1.2
Cu	29.5 ± 1.3
Fe	(1.85 ± 0.19 g/kg)
Hg	0.276 ± 0.018
K	(7.55 ± 0.17)
Mn	299 ± 13

Substance	Cat. No. BCR414 Plankton (mg/kg)
Mo	(1.35 ± 0.20)
Ni	18.8 ± 0.8
Pb	3.97 ± 0.19
Sc	(0.54 ± 0.02)
Se	1.75 ± 0.10
Sr	(261 ± 25)
V	8.10 ± 0.18
Zn	111.6 ± 2.5

Values in brackets are not certified.
Availability: CRM is provided in powder form in bottles containing approximately 5 g.

Substance	Cat. No. BCR482 Lichen (mg/kg)
Al	1103 ± 24
As	0.85 ± 0.07
Cd	0.56 ± 0.02
Cr	4.12 ± 0.15
Cu	7.03 ± 0.19

Substance	Cat. No. BCR482 Lichen (mg/kg)
Hg	0.48 ± 0.02
Ni	2.47 ± 0.07
Pb	40.9 ± 1.4
Se	
Zn	100.6 ± 2.2

Substance	Cat. No. ERMCD200 Bladderwrack (Fucus vesiculosus) (mg/kg)
Al	
As	55 ± 4
Cd	0.95 ± 0.06
Cr	
Cu	1.71 ± 0.18

Substance	Cat. No. ERMCD200 Bladderwrack (Fucus vesiculosus) (mg/kg)
Hg	0.0186 ± 0.0016
Ni	
Pb	0.51 ± 0.06
Se	0.088 ± 0.010
Zn	25.3 ± 1.7

Availability: BCR482 is provided in powder form in bottles containing approximately 15 g.
ERMCD200 is provided in powder form in bottles containing approximately 5 g.

Substance	Cat. No. BCR670 Lemna minor (Aquatic plant) (duck weed) (µg/kg)
As	(1980 ± 190)
Cd	(75.5 ± 2.5)
Ce	990 ± 40
Cr	(2050 ± 100
Cs	(77 ± 10)
Cu	(1820 ± 300)
Dy	79 ± 7
Er	44.0 ± 2.8
Eu	23.2 ± 1.5
Gd	98 ± 8
Ho	15.8 ± 1.8
La	487 ± 20
Lu	6.3 ± 0.5

Substance	Cat. No. BCR670 Lemna minor (Aquatic plant) (duck weed) (µg/kg)
Mo	(560 ± 70)
Nd	473 ± 15
Pb	(2060 ± 120)
Pr	121 ± 6
Sc	191 ± 11
Sm	94 ± 7
Tb	14.0 ± 1.1
Th	159 ± 18
Tm	5.7 ± 0.7
U	82 ± 8
Y	460 ± 60
Yb	40 ± 4
Zn	(24000 ± 2100)

Values in brackets are not certified.
Availability: Glass bottles containing about 10 g of powdered material.

Substance	Cat. No. ERMCE278k Mussel tissue (mg/kg)
As	6.7 ± 0.4
Ag	(0.044 ± 0.016)
Cd	0.336 ± 0.025
Cr	0.73 ± 0.22
Cu	5.98 ± 0.27
Fe	161 ± 8
Hg	0.071 ± 0.007
I	1.4 ± 0.4

Substance	Cat. No. ERMCE278k Mussel tissue (mg/kg)
Mn	4.88 ± 0.24
Ni	0.69 ± 0.15
Pb	2.18 ± 0.18
Rb	2.46 ± 0.16
Se	1.62 ± 0.12
Sr	19.0 ± 1.2
Zn	71 ± 4

Values in brackets are not certified.
Availability: CRMs are provided in powder form in bottles containing approximately 8 g.

Substance	Cat. No. BCR668 Mussel tissue (µg/kg)
As	(7100 ± 500)
Cd	(275 ± 11)
Ce	89 ± 7
Cr	(370 ± 60)
Cs	(13.8 ± 1.5)
Dy	8.9 ± 0.6
Er	4.5 ± 0.5

Substance	Cat. No. BCR668 Mussel tissue (µg/kg)
Eu	2.79 ± 0.16
Gd	13.0 ± 0.6
Ho	(1.8 ± 0.6)
La	80 ± 6
Lu	0.389 ± 0.024
Mo	(1990 ± 150)
Nd	54 ± 4

Substance	Cat. No. BCR668 Mussel tissue (µg/kg)
Pr	12.3 ± 1.1
Sc	(8.5 ± 1.8)
Sm	11.2 ± 0.8
Tb	1.62 ± 0.12
Th	10.7 ± 1.2

Substance	Cat. No. BCR668 Mussel tissue (µg/kg)
Tm	0.48 ± 0.08
U	56 ± 5
Y	59 ± 5
Yb	(2.8 ± 0.5)
Zn	(70700 ± 400)

Values in brackets are not certified.
Availability: Glass bottles containing about 10 g of powdered material.

Substance	Cat. No. BCR463 Tuna fish (mg/kg)	Cat. No. ERMCE464 Tuna fish (mg/kg)
Total Hg	2.85 ± 0.16	5.24 ± 0.10

Substance	Cat. No. BCR463 Tuna fish (mg/kg)	Cat. No. ERMCE464 Tuna fish (mg/kg)
CH3Hg +	3.04 ± 0.16	5.50 ± 0.17

Availability: Glass bottles containing about 15 g.

Substance	Cat. No. BCR505 Trace elements in estuarine water (nmol/kg)	Cat. No. BCR579 Coastal sea-water (ng/kg)
Cd	0.80 ± 0.04	
Co	(0.99 ± 0.26)	
Cu	29.4 ± 1.5	
Fe	(19 ± 4)	

Substance	Cat. No. BCR505 Trace elements in estuarine water (nmol/kg)	Cat. No. BCR579 Coastal sea-water (ng/kg)
Hg		1.9 ± 0.5
Ni	24.1 ± 2.0	
Pb	(0.24 ± 0.14)	
Zn	172 ± 11	

Values in brackets are not certified.
Availability: BCR505 is provided in 1 L polyethylene bottles and BCR579 in 1 L glass bottles.

Substance	Cat. No. ERMCA408 Simulated rainwater (low contents) (mg/L)
Mass concentration:	
Ammonium	0.910 ± 0.028
Cl	1.96 ± 0.07
Fluoride	0.194 ± 0.008
Mg	0.145 ± 0.022
NO_3	2.01 ± 0.09

Substance	Cat. No. ERMCA408 Simulated rainwater (low contents) (mg/L)
Ortho-phosphate	1.00 ± 0.05
SO_4	1.46 ± 0.04
Electrochemical property:	
Conductivity (20 °C)	18.7 ± 1.8 µS/cm
pH (20 °C)	6.3 ± 0.6

Availability: ERMCA408 is provided in units of about 95 mL in flame-sealed ampoules.

Substance	Cat. No. BCR479 Freshwater (low contents)	Cat. No. BCR480 Freshwater (high contents)
Nitrate		885 ± 13µmol/kg
As amount of substance content	214 ± 4 µmol/kg	
As mass fraction	13.3 ± 0.3mg/kg	

Availability: Units of about 100 mL in white glass ampoules.

Substance	Cat. No. BCR611 Bromide in ground water based on IC-measurements (low contents) (µg/kg)	Cat. No. BCR612 Bromide in ground water based on IC-measurements (high contents) (µg/kg)
Br	93 ± 4	252 ± 10

Availability: Set of four brown glass ampoules of 25 mL.

Substance	Cat. No. BCR609 Ground water (low contents) (µg/kg)	Cat. No. BCR610 Ground water (high contents) (µg/kg)	Cat. No. ERMCA616 Ground water (high carbonate content) (mg/L)
			Mass concentration:
Al	47.7 ± 1.6	159 ± 4	
As	1.20 ± 0.12	10.8 ± 0.4	
Cd	0.164 ± 0.012	2.94 ± 0.08	
Cu	2.48 ± 0.09	45.7 ± 1.5	
Pb	1.63 ± 0.04	7.78 ± 0.13	
Ca			42.6 ± 1.4
Cl			44.6 ± 10.9
K			5.79 ± 0.15
Mg			10.1 ± 0.3
Mn			
Na			27.9 ± 0.8
NO_3			
Ortho-phosphate			2.24 ± 0.10
PO_4			
SO_4			
			Electrochemical property:
Conductivity (20 °C)			426 ± 5 µS/cm
pH (20 °C)			7.12 ± 0.18

Availability: BCR609 and BCR610 are provided in 500 mL PE bottles; ERMCA616 consists of about 95 mL natural groundwater in a flame-sealed ampoule.

Substance	Cat. No. ERMCA615 Groundwater
As	9.9 ± 0.7
Cd	0.106 ± 0.011
Fe	5.11 ± 0.26
Hg	0.037 ± 0.004

Substance	Cat. No. ERMCA615 Groundwater
Mn	107 ± 5
Ni	25.3 ± 1.1
Pb	7.1 ± 0.6

Availability: One unit consists of about 95 mL natural groundwater in a flame-sealed ampoule.

Substance	Cat. No. ERMCA713 Wastewater µg/L
As	10.8 ± 0.3
Cd	5.09 ± 0.20
Cr	20.9 ± 1.3
Cu	101 ± 7
Fe	445 ± 27

Substance	Cat. No. ERMCA713 Wastewater µg/L
Hg	1.84 ± 0.11
Mn	95 ± 4
Ni	50.3 ± 1.4
Pb	49.7 ± 1.7
Se	4.9 ± 1.1

Availability: ampoule containing approximately 100 mL of wastewater effluent acidified with HNO3 to about pH 2.

1.2.2 CERTIFIED FOR THE EXTRACTABLE ELEMENT CONTENT AND SPECIES

Values in brackets are not certified.

Substance	Cat. No. BCR483 Sewage sludge amended soil (mg/kg)	Cat. No. BCR484 Sewage sludge amended (terra rossa) soil (mg/kg)	Cat. No. BCR700 Organic-rich soil (mg/kg)
EDTA:Cd	24.3 ± 1.3	0.509 ± 0.030	65.2 ± 3.5

Substance	Cat. No. BCR483 Sewage sludge amended soil (mg/kg)	Cat. No. BCR484 Sewage sludge amended (terra rossa) soil (mg/kg)	Cat. No. BCR700 Organic-rich soil (mg/kg)
Cr	28.6 ± 2.6	88 ± 4	10.1 ± 0.9
Cu	215 ± 11	1.39 ± 0.11	89.4 ± 2.8
Ni	28.7 ± 1.7	47.9 ± 2.6	53.2 ± 2.8
Pb	229 ± 8	152 ± 7	103 ± 5
Zn	612 ± 20	0.48 ± 0.04	510 ± 17
Acetic acid: Cd	18.3 ± 0.6		67.5 ± 2.8
Cr	18.7 ± 1.0		19.0 ± 1.1
Cu	33.5 ± 1.6	33.9 ± 1.4	36.3 ± 1.6
Ni	25.8 ± 1.0	1.69 ± 0.16	99.0 ± 5.1
Pb	2.10 ± 0.25	1.17 ± 0.16	4.85 ± 0.38
Zn	620 ± 24	193 ± 7	719 ± 24
Calcium chloride extractable content			
Cd	(0.45 ± 0.05)	(< 0.08)	
Cr	(0.35 ± 0.09)	(< 0.09)	
Cu	(1.2 ± 0.4)	(0.67 ± 0.29)	
Ni	(1.4 ± 0.2)	(< 0.05)	
Pb	(< 0.06)	(< 0.06)	
Zn	(8.3 ± 0.7)	(0.31 ± 0.17)	
Sodium nitrate extractable content			
Cd	(0.08 ± 0.03)	(< 0.05)	
Cr	(0.30 ± 0.07)	(< 0.03)	
Cu	(0.89 ± 0.22)	(0.48 ± 0.15)	
Ni	(0.65 ± 0.07)	(0.023 ± 0.005)	
Pb	(< 0.03)	(< 0.06)	
Zn	(2.7 ± 0.8)	(0.09 ± 0.04)	
Ammonium nitrate extractable content			
Cd	(0.26 ± 0.05)	(0.003 ± 0.002)	
Cr	(0.27 ± 0.10)	(< 0.06)	
Cu	(1.2 ± 0.3)	(1.1 ± 0.4)	
Ni	(1.1 ± 0.3)	(0.033 ± 0.017)	
Pb	(0.020 ± 0.013)	(< 0.06)	
Zn	(6.5 ± 0.9)	(0.17 ± 0.05)	

Availability: BCR483 and BCR484 are provided in glass bottles containing about 70 g of powder.
BCR700 is provided in glass bottles containing about 40 g of powder.

Substance	Cat. No. BCR684 River sediment (mg/kg)
NaOH-extractable P	550 ± 21
HCl-extractable P	536 ± 28
Inorganic P	1113 ± 24

Substance	Cat. No. BCR684 River sediment (mg/kg)
Organic P	209 ± 9
Conc. HCl-extract. P	1373 ± 35

Availability: Glass bottles containing about 35 g of powdered material.

Substance	Cat. No. BCR701 Lake sediment (mg/kg)
	Extractable mass fraction based on dry mass
Step 1: Cd	7.3 ± 0.4
Cr	2.26 ± 0.16
Cu	49.3 ± 1.7
Ni	15.4 ± 0.9
Pb	3.18 ± 0.21
Zn	205 ± 6
Step 2: Cd	3.77 ± 0.28
Cr	45.7 ± 2.0
Cu	124 ± 3
Ni	26.6 ± 1.3
Pb	126 ± 3
Zn	114 ± 5

Substance	Cat. No. BCR701 Lake sediment (mg/kg)
Step 3: Cd	0.27 ± 0.06
Cr	143 ± 7
Cu	55 ± 4
Ni	15.3 ± 0.9
Pb	9.3 ± 2.0
Zn	46 ± 4
	Mass fraction based on dry mass
Cd	(0.13 ± 0.08)
Cr	(62.5 ± 7.4)
Cu	(38.5 ± 11.2)
Ni	(41.4 ± 4.0)
Pb	(11.0 ± 5.2)
Zn	(95 ± 13

Values in brackets are not certified.
Availability: Glass bottles containing about 20 g of powdered material.

Substance	Cat. No. BCR462 Coastal sediment (µg/kg)	Cat. No. BCR646 Freshwater sediment (µg/kg)
Tributyltin (TBT)	54 ± 15	480 ± 80
Dibutyltin (DBT)	68 ± 12	770 ± 90
Monobutyltin (MBT)		610 ± 120
Triphenyltin (TPhT)		29 ± 11
Diphenyltin (DPhT)		36 ± 8
Monophenyltin (MPhT)		69 ± 18

Availability: Glass bottle containing about 25 g of powder for BCR462 and 40 g of powder for BCR646.

Substance	Cat. No. ERMCC580 Estuarine sediment (mg/kg)
Total Hg	132 ± 3
CH_3Hg^+	0.075 ± 0.004

Availability: Glass bottles containing about 40 g powder.

Substance	Cat. No. BCR605 Urban dust (µg/kg)
Trimethyllead (TriML)	7.9 ± 1.2

Availability: Glass bottles containing about 15 g of powder.

Substance	Cat. No. BCR545 Welding dust loaded on a filter (g/kg)
Cr (VI)	40.2 ± 0.6
total leachable Cr	39.5 ± 1.3

Availability: Glass fibre filter loaded with welding dust containing about 100 µg Cr (VI).

Substance	Cat. No. ERMCE477 Mussel tissue (mg/kg)
Tributyltin (TBT)	2.20 ± 0.19
Dibutyltin (DBT)	1.54 ± 0.12
Monobutyltin (MBT)	1.50 ± 0.28

Availability: Glass bottle containing about 14 g of powder.

Substance	Cat. No. BCR463 Tuna fish (mg/kg)	Cat. No. ERMCE464 Tuna fish (mg/kg)
Total Hg	2.85 ± 0.16	5.24 ± 0.10
CH_3Hg^+	3.04 ± 0.16	5.50 ± 0.17

Availability: Glass bottles containing about 15 g powder.

Substance	Cat. No. BCR627 Tuna fish tissue	Cat. No. ERMBC211 Rice
Total As	4.8 ± 0.3 mg/kg	260 ± 13 µg/kg
Dimethylarsinic acid	2.0 ± 0.3 µmol/kg	119 ± 13 µg/kg
Sum of arsenite and arsenate		124 ± 11 µg/kg
Arsenobetaine	52 ± 3 µmol/kg	

Availability: BCR627: Glass bottles containing about 10 g powder
ERMBC211: Vial containing about 10 g of powder

1.2.3 CERTIFIED FOR ORGANIC POLLUTANTS

Substance	Cat. No. ERMCZ100 Fine dust (PM_{10}-like) (mg/kg)
Benz[a]anthracene	0.91 ± 0.07
Benzo[a]pyrene	0.72 ± 0.05
Benzo[b]fluoranthene	1.42 ± 0.14
Benzo[j]fluoranthene	0.75 ± 0.14
Benzo[k]fluoranthene	0.67 ± 0.06

Substance	Cat. No. ERMCZ100 Fine dust (PM_{10}-like) (mg/kg)
Dibenzo[a,h]anthracene	0.18 ± 0.04
Indeno[1,2,3-c,d]pyrene	1.07 ± 0.10
Sum of Benzo[b]fluoranthene, benzo[k]fluoranthene and benzo[j]fluoranthene	2.84 ± 0.21

Availability: Vial containing about 0.5 g of fine dust.

Substance	Cat. No. BCR524 Contaminated industrial soil (mg/kg)
Pyrene	173 ± 11
Benz[a]anthracene	22.5 ± 1.8
Benzo[a]pyrene	8.6 ± 0.5
Benzo[e]pyrene	10.6 ± 1.4
Benzo[b]fluoranthene	13.5 ± 1.6

Substance	Cat. No. BCR524 Contaminated industrial soil (mg/kg)
Benzo[k]fluoranthene	6.2 ± 0.6
Benzo[b]naphtho[2,1-d]-thiophene	3.8 ± 0.6
Indeno[1,2,3-cd]pyrene	5.1 ± 0.4
Pentachlorophenol	0.034 ± 0.005

Availability: Glass bottle containing about 40 g of powder.

Substance	Cat. No. BCR535 Freshwater harbour sediment (mg/kg)
Pyrene	2.52 ± 0.18
Benz[a]anthracene	1.54 ± 0.10
Benzo[a]pyrene	1.16 ± 0.10
Benzo[e]pyrene	1.86 ± 0.13

Substance	Cat. No. BCR535 Freshwater harbour sediment (mg/kg)
Benzo[b]fluoranthene	2.29 ± 0.15
Benzo[k]fluoranthene	1.09 ± 0.15
Indeno[1,2,3-cd]pyrene	1.56 ± 0.14

Availability: Glass bottle containing about 40 g of powder.

Polychlorinated biphenyls (IUPAC No.)	Cat. No. BCR481 Industrial soil (mg/kg)	Cat. No. BCR536 Freshwater harbour sediment (µg/kg)
28		44 ± 5
52		38 ± 4
101	37 ± 3	44 ± 4
105		3.5 ± 0.6
118	9.4 ± 0.7	28 ± 3
128	9.1 ± 0.8	5.4 ± 1.2
138		27 ± 4
149	97 ± 7	49 ± 4
153	137 ± 7	50 ± 4
156	7.0 ± 0.5	3.0 ± 0.4
163		17 ± 3
170	52 ± 4	13.4 ± 1.4
180	124 ± 6	22 ± 2

Availability: BCR481 is provided in brown glass bottles with a polyethylene insert containing approximately 25 g of soil. BCR536 is provided in a glass bottle containing about 40 g of powder.

Substance	Cat. No. BCR529 Industrial (sandy) soil
3,4-dichlorophenol	0.23 ± 0.04 mg/kg
2,4,5-trichlorophenol	1.51 ± 0.10 mg/kg
Pentachlorophenol	0.23 ± 0.04 mg/kg
2,3,7,8-TCDD(D48)	4.5 ± 0.6 µg/kg
1,2,3,7,8-PeCDD(D54)	0.44 ± 0.05 µg/kg
1,2,3,4,7,8-HxCDD(D66)	1.22 ± 0.21 µg/kg
1,2,3,6,7,8-HxCDD(D67)	5.4 ± 0.9 µg/kg
1,2,3,7,8,9-HxCDD(D70)	3.0 ± 0.4 µg/kg

Substance	Cat. No. BCR529 Industrial (sandy) soil
2,3,7,8-TCDF(F83)	0.078 ± 0.013 µg/kg
1,2,3,7,8-PeCDF(F94)	0.145 ± 0.028 µg/kg
2,3,4,7,8-PeCDF(F114)	0.36 ± 0.07 µg/kg
1,2,3,4,7,8-HxCDF(F118)	3.4 ± 0.5 µg/kg
1,2,3,6,7,8-HxCDF(F121)	1.09 ± 0.15 µg/kg
1,2,3,7,8,9-HxCDF(F124)	0.022 ± 0.010 µg/kg
2,3,4,6,7,8-HxCDF(F130)	0.37 ± 0.05 µg/kg

Availability: Amber glass bottles containing about 50 g of dried soil.

Substance	Cat. No. BCR677 Sewage sludge (ng/kg)
2,3,7,8-T_4CDD(D48)	1.51 ± 0.16
1,2,3,7,8-P_5CDD(D54)	4.1 ± 0.9
1,2,3,6,7,8-H_6CDD(D67)	235 ± 16
1,2,3,7,8,9-H_6CDD(D70)	79 ± 7
1,2,3,4,6,7,8-H_7CDD(D73)	3.5×10^3 ± 0.4×10^3
O_8CDD(D75)	12.7×10^3 ± 0.8×10^3
2,3,7,8-T_4CDF(F83)	45 ± 4
1,2,3,7,8-P_5CDF(F94)	24.8 ± 1.6

Substance	Cat. No. BCR677 Sewage sludge (ng/kg)
2,3,4,7,8-P_5CDF(F114)	16.9 ± 1.5
1,2,3,4,7,8-H_6CDF(F118)	14.5 ± 1.6
1,2,3,6,7,8-H_6CDF(F121)	6.1 ± 0.8
1,2,3,7,8,9-H_6CDF(F124)	0.84 ± 0.29
2,3,4,6,7,8-H_6CDF(F130)	5.6 ± 0.6
1,2,3,4,6,7,8-H_7CDF(F131)	62 ± 3
1,2,3,4,7,8,9-H_7CDF(F134)	6.3 ± 0.8
O_8CDF(F135)	177 ± 7

Availability: BCR677 consists of approximately 40 g of dried sewage sludge in amber glass bottles.

Substance	Cat. No. BCR490 Fly ash (µg/kg)
2,3,7,8-T_4CDD(D48)	0.169 ± 0.012
1,2,3,7,8-P_5CDD(D54)	0.67 ± 0.04
1,2,3,4,7,8-H_6CDD(D66)	0.95 ± 0.11
1,2,3,6,7,8-H_6CDD(D67)	4.8 ± 0.4
1,2,3,7,8,9-H_6CDD(D70)	2.84 ± 0.17
2,3,7,8-T_4CDF(F83)	0.90 ± 0.05

Substance	Cat. No. BCR490 Fly ash (µg/kg)
1,2,3,7,8-P_5CDF(F94)	1.71 ± 0.12
2,3,4,7,8-P_5CDF(F114)	1.85 ± 0.11
1,2,3,4,7,8-H_6CDF(F118)	2.37 ± 0.12
1,2,3,6,7,8-H_6CDF(F121)	2.64 ± 0.14
1,2,3,7,8,9-H_6CDF(F124)	0.34 ± 0.05
2,3,4,6,7,8-H_6CDF(F130)	2.47 ± 0.17

Availability: BCR490 consists of approximately 30 g of fly ash in amber glass bottles.

Substance	Cat. No. BCR615 Fly ash (low level) (ng/kg)
2,3,7,8-T_4CDD(D48)	27 ± 5
1,2,3,7,8-P_5CDD(D54)	92 ± 12
1,2,3,4,7,8-H_6CDD(D66)	74 ± 12
1,2,3,6,7,8-H_6CDD(D67)	103 ± 13
1,2,3,7,8,9-H_6CDD(D70)	108 ± 16
1,2,3,4,6,7,8-H_7CDD(D73)	0.87×10^3 ± 0.13×10^3
O_8CDD(D75)	1.75×10^3 ± 0.20×10^3
2,3,7,8-T_4CDF(F83)	86 ± 28
1,2,3,7,8-P_5CDF(F94)	176 ± 26

Substance	Cat. No. BCR615 Fly ash (low level) (ng/kg)
2,3,4,7,8-P_5CDF(F114)	125 ± 20
1,2,3,4,7,8-H_6CDF(F118)	203 ± 21
1,2,3,6,7,8-H_6CDF(F121)	204 ± 23
1,2,3,7,8,9-H_6CDF(F124)	13.3 ± 2.0
2,3,4,6,7,8-H_6CDF(F130)	130 ± 15
1,2,3,4,6,7,8-H_7CDF(F131)	0.75×10^3 ± 0.09×10^3
1,2,3,4,7,8,9-H_7CDF(F134)	61 ± 6
O_8CDF(F135)	0.29×10^3 ± 0.04×10^3

Availability: BCR615 consists of approximately 50 g of dried fly ash in amber glass bottles.

Substance	Cat. No. BCR683 Beech wood (mg/kg)
Benz[a]anthracene	6.5 ± 0.7
Benzo[a]pyrene	3.4 ± 0.4
Benzo[e]pyrene	9.3 ± 1.0

Substance	Cat. No. BCR683 Beech wood (mg/kg)
Benzo[b]fluoranthene	5.8 ± 0.6
Benzo[k]fluoranthene	2.58 ± 0.29
Pentachlorophenol	3.6 ± 0.5

Availability: Glass bottle containing about 60 g of powder.

Polychlorinated biphenyls (IUPAC No.)	Cat. No. BCR682 Mussel tissue (µg/kg)	Cat. No. BCR718 Canned fresh herring (µg/kg)	Cat. No. BCR719 Canned fresh chub (ng/kg)
28	0.30 ± 0.07	0.41 ± 0.04	
52	0.78 ± 0.09	1.00 ± 0.04	
77			196 ± 6
81			13.6 ± 0.4
101		2.12 ± 0.06	
105		0.63 ± 0.06	
118	2.6 ± 0.3	1.78 ± 0.07	
126			20.0 ± 0.8
128		0.62 ± 0.101	
138	4.6 ± 0.8	2.97 ± 0.11	
138 + 163			
149	5.7 ± 0.9	2.58 ± 0.11	
153	9.2 ± 0.8	4.62 ± 0.10	
156		0.19 ± 0.09	
169			1.80 ± 0.15
170	0.17 ± 0.05	0.350 ± 0.026	
180	0.77 ± 0.07	0.795 ± 0.027	

Availability: BCR682, BCR718 and BCR719 are provided in sealed tin cans containing approximately 70 g fresh mussel tissue.

Polychlorinated biphenyls (IUPAC No.)	Cat. No. BCR420 Waste mineral oil (low level) (mg/kg)	Cat. No. BCR449 Waste mineral oil (high level) (mg/kg)
28	0.61 ± 0.06	0.80 ± 0.07
52		31.4 ± 1.8
101	1.45 ± 0.18	57.2 ± 1.9
105		17.4 ± 1.0
118	1.69 ± 0.14	46.6 ± 2.4

Polychlorinated biphenyls (IUPAC No.)	Cat. No. BCR420 Waste mineral oil (low level) (mg/kg)	Cat. No. BCR449 Waste mineral oil (high level) (mg/kg)
128		12.5 ± 0.7
153	0.92 ± 0.06	39.0 ± 1.7
156		6.9 ± 0.5
170		6.6 ± 0.6
180	0.195 ± 0.017	10.4 ± 0.4

Availability: BCR420 is provided in units of about 7.5 g in glass ampoules and BCR449 in units of about 50 g in glass ampoules.

1.2.4 OTHERS

Parameter	Cat. No. IRMM4431 (EUROSOIL 1)	Cat. No. IRMM4432 (EUROSOIL 2)	Cat. No. IRMM4433 (EUROSOIL 3)
Kf of atrazine(1)	7.0 ± 1.5	2.7 ± 0.7	2.4 ± 0.7
1/n of atrazine(1)	0.91 ± 0.11	0.93 ± 0.12	0.91 ± 0.13
Kf of 2,4-D(1)	2.5 ± 1.0	0.99 ± 0.30	1.31 ± 0.28
1/n of 2,4-D(1)	0.9 ± 0.4	0.96 ± 0.15	0.93 ± 0.15
Kf of lindane(1)		48 ± 11	
1/n of lindane(1)		0.98 ± 0.15	
pH in water(2)	6.21 ± 0.30	8.1 ± 0.9	6.2 ± 0.4
pH in 0.01M CaCl2(2)	5.65 ± 0.24	7.5 ± 0.8	5.5 ± 0.4

Parameter	Cat. No. IRMM4434 (EUROSOIL 4)	Cat. No. IRMM4435 (EUROSOIL 5)	Cat. No. IRMM4437 (EUROSOIL 7)
Kf of atrazine(1)	0.7 ± 0.4	13 ± 6	4.8 ± 1.1
1/n of atrazine(1)	0.87 ± 0.22	0.9 ± 0.4	0.92 ± 0.15
Kf of 2,4-D(1)	0.39 ± 0.21	18 ± 7	8.2 ± 1.8
1/n of 2,4-D(1)	0.9 ± 0.4	0.9 ± 0.4	0.88 ± 0.15
Kf of lindane(1)	8.3 ± 2.2		
1/n of lindane(1)	0.96 ± 0.12		
pH in water(2)	7.5 ± 0.7	4.1 ± 1.5	5.1 ± 0.8
pH in 0.01M $CaCl_2$(2)	6.8 ± 0.6	3.1 ± 1.1	4.3 ± 0.7

(1) Determination according OECD Testguideline 106.
(2) Measurement based on ISO Standard 10390.
Uncertainty express as estimated expanded uncertainty as defined in the Guide to the Expression of Uncertainty in Measurement (GUM).
Availability: Brown glass bottles with 200 g of air-dried fine soil (< 2 mm).

2.0 MATERIALS RELATED TO THE ANALYSIS OF FOOD AND FEEDING STUFF

2.1 PURE MATERIALS AND SYNTHETIC MIXTURES

Cat. No. BCR123 Ethanol			
Parameter	Ethanol H	Ethanol M	Ethanol L
$(D/H)_I$	109.65×10^{-6} ± 0.20×10^{-6}	101.69×10^{-6} ± 0.17×10^{-6}	$90.30 \times 10–6$ ± 0.18×10^{-6}
$(D/H)_{II}$	119.76×10^{-6} ± 0.25×10^{-6}	130.94×10^{-6} ± 0.21×10^{-6}	$122.20 \times 10–6$ ± 0.4×10^{-6}
R	2.184 ± 0.005	2.575 ± 0.006	2.708 ± 0.009

Availability: Units of 3 sealed NMR tubes containing respectively H-, M-, and L-ethanols, to which the tetramethylurea internal standard and the C_6F_6 lock substance are added. 15 mm (BCR123B) O.D. NRM tubes can be supplied.

Parameter	Unit	Cat. No. BCR656 (96% ethanol)
(D/H)I by ^{2}H-NMR	ppm	102.84 ± 0.20
(D/H)II by ^{2}H-NMR	ppm	132.07 ± 0.30
R by ^{2}H-NMR		2.570 ± 0.005
$\delta^{13}C_{VPDB}$ by IRMS	‰	-26.91 ± 0.07
Alcoholic grade tD	w/w %	(94)

Value in brackets is not certified.
Availability: BCR656: Units of 25 mL of 96 % vol. neutral ethanol from wine in glass bottle.

Parameter	Unit	Cat. No. BCR657 (Sugar)	Cat. No. BCR658 (Synthetic wine)	Cat. No. BCR659 (Synthetic wine)	Cat. No. BCR660 (Ethanol in water)
$(D/H)_I$ by ^{2}H-NMR	ppm				102.90 ± 0.16
$(D/H)_{II}$ by ^{2}H-NMR	ppm				131.95 ± 0.23
R by ^{2}H-NMR					2.567 ± 0.005
$\delta^{13}C_{VPDB}$ by IRMS	‰	-10.76 ± 0.04			-26.72 ± 0.09
$\delta^{18}O_{VSMOW}$ of water from wine by IRMS	‰		-7.19 ± 0.04	-7.18 ± 0.02	
(D/H)w of water (IRMS)	ppm				148.68 ± 0.14
Alcoholic grade tD	w/w %				11.96 ± 0.06 [1)]

1) in v/v %
Availability:BCR657: Units of approx. 1 g of dry glucose in a sealed amber vial;
BCR658: Units of 25 mL of synthetic wine solution in glass bottle;
BCR659: Units of 25 mL of synthetic wine solution in glass bottle;
BCR660: Units of 450 mL of aqueous ethanol solution in glass bottle.

Tetramethylurea (Cat. No. STA003M)

Tetramethylurea (TMU) which is used as Internal Standard in routine SNIF-NMR analysis is available in 500 mL quantities. The D/H nominal value of tetramethylurea batches is determined by multiple calibration at 61.45/400 MHz, 61.4/400 MHz and 45.05/400 MHz for deuterium and given in an accompanying analytical report.

Substance	Cat. No. BCR423RM Aflatoxin M_1 in chloroform (µg/mL)
Aflatoxin M_1	(9.93)

Value in brackets is not certified.
Availability: Sealed ampoules containing about 2.5 mL.

Compound	Cat. No. BCR663 Saxitoxin in acetic acid
	Mass fraction (mg/kg)
Saxitoxin·2HCl	9.8 ± 1.2

Availability: BCR-663 is available in ampoules containing 1 mL.

Substance	Cat. No. ERMAC699 Zearalenone in acetonitrile
	Mass concentration (µg/mL)
ZON	9.95 ± 0.30

Availability: ERMAC699 is supplied in ampoules filled and sealed under nitrogen in amounts of 4 mL.

Substance	Cat. No. ERMAC057 Aflatoxin B1 in acetonitrile	
	Mass fraction (µg/g)	Mass concentration at 20 °C (µg/mL)
Aflatoxin B1	3.79 ± 0.11	(2.97 + 0.09)

Values in brackets are not certified.
Availability: ERMAC057 is supplied in amber glass ampoules filled with 4 mL.

Substance	Cat. No. ERMAC058 Aflatoxin B2 in acetonitrile	
	Mass fraction (µg/g)	Mass concentration at 20 °C (µg/mL)
Aflatoxin B2	3.80 ± 0.08	(2.98 + 0.06)

Values in brackets are not certified.
Availability: ERMAC058 is supplied in amber glass ampoules filled with 4 mL.

Substance	Cat. No. ERMAC059 Aflatoxin G1 in acetonitrile	
	Mass fraction (µg/g)	Mass concentration at 20 °C (µg/mL)
Aflatoxin G1	3.78 ± 0.13	(2.96 + 0.10)

Values in brackets are not certified.
Availability: ERMAC059 is supplied in amber glass ampoules filled with 4 mL.

Substance	Cat. No. ERMAC060 Aflatoxin G2 in acetonitrile	
	Mass fraction (µg/g)	Mass concentration at 20 °C (µg/mL)
Aflatoxin G2	3.80 ± 0.07	(2.98 + 0.06)

Values in brackets are not certified.
Availability: ERMAC060 is supplied in amber glass ampoules filled with 4 mL.

Substance	Cat. No. IRMM315 4-Deoxynivalenol in acetonitrile	
	Mass fraction (µg/g)	Mass concentration (µg/mL)
4-Deoxynivalenol	25.1 ± 1.2	(19.7 + 0.9)

Values in brackets are not certified.
Availability: IRMM315 is supplied in amber glass ampoules filled with 4 mL.

Substance	Cat. No. IRMM316 Nivalenol in acetonitrile	
	Mass fraction (µg/g)	Mass concentration (µg/mL)
Nivalenol	24.0 ± 1.1	(18.8 + 0.9)

Values in brackets are not certified.
Availability: IRMM316 is supplied in amber glass ampoules filled with 4 mL.

2.2 MATRIX MATERIALS

2.2.1 CERTIFIED FOR GMO CONTENT

The materials were prepared by quantitative mixing of non-genetically modified powder and genetically modified powder, produced from ground seed with the help of a dry-mixing technique, and are intended for the calibration of methods for the detection of genetically modified food.

CRMs for genetically modified Roundup Ready™ soya beans (Cat. No. ERMBF410k)

Six CRMs of dried soya bean powder with different mass fractions of genetically modified (Roundup Ready™) soya beans were produced by IRMM.

Cat. No.	Certified value Roundup Ready mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF410ak	< 0.7	-
ERMBF410bk	1.0	0.5
ERMBF410dk	10.0	1.0
ERMBF410gk	100	7

Availability: Vials containing about 1 g of soya bean powder.

CRMs for genetically modified Bt-176 maize (Cat. No. ERMBF411)

Six CRMs of dried maize powder with different mass fractions of genetically modified (Bt 176) maize were produced by IRMM.

Cat. No.	Certified value Bt-176 mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF411a	< 0.14	-
ERMBF411b	1.00	0.29
ERMBF411c	5.0	0.6
ERMBF411d	10.0	0.8
ERMBF411e	20.0	1.1
ERMBF411f	50.0	1.8

Availability: Vials containing about 1 g of maize powder.

CRMs for genetically modified Bt-11 maize (Cat. No. ERMBF412)

Six CRMs of dried maize powder with different mass fractions of genetically modified (Bt- 11) maize were produced by IRMM.

Cat. No.	Certified value Bt-11 mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF412a	< 0.12	-
ERMBF412b	0.98	0.29
ERMBF412c	4.9	0.6
ERMBF412d	9.8	0.9
ERMBF412e	19.6	1.3
ERMBF412f	48.9	2.1

Availability: Vials containing about 1 g of maize powder.

CRMs for genetically modified MON 810 maize (Cat. No. ERMBF413k)

Four CRMs of dried maize powder with different mass fractions of genetically modified (MON 810) maize were produced by IRMM.

Cat. No.	Certified value MON 810 mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF413ak	< 0.9	-
ERMBF413ck	4.9	1.0
ERMBF413ek *	19.8	1.5
ERMBF413gk	99	5

Availability: Vials containing about 1 g of maize powder.
* ERMBF413ek is also certified for the DNA copy number ratio.

Cat. No.	Certified value MON 810 DNA copy number ratio (%)	Uncertainty (%)
ERMBF413ek	0.77	0.08

Cat. No.	Certified value MON 810 DNA copy number ratio (%)	Uncertainty (%)
ERMBF413ek	0.77	0.08

Substance	Cat. No. ERMAD413 DNA fragments per plasmid
	Number
Fragment of *5′* plant-P35S junction DNA/plasmid	1 (negligible uncertainty)
Fragment of *hmg* DNA/plasmid	1 (negligible uncertainty)

Substance	Cat. No. ERMAD413 DNA fragments per plasmid
	Number ratio
Ratio between the number of *5' plant-P35S* junction and *hmg* fragments in the plasmid by duplex rt-PCR [(1)] and simplex rt-PCR [(2)]	(1.00 [1] ± 0.06) (1.04 [2] ± 0.06)

Values in brackets are not certified.
Availability: ERMAD413 is available in vials.

CRMs for genetically modified GA21 maize (Cat. No. ERMBF414)

Six CRMs of dried maize powder with different mass fractions of genetically modified (GA21) maize were produced by IRMM.

Cat. No.	Certified value GA21 mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF414a	< 0.8	-
ERMBF414b	1.0	0.8
ERMBF414c	4.9	1.0
ERMBF414d	9.9	1.1
ERMBF414e	17.2	1.2
ERMBF414f	42.9	1.7

Availability: Vials containing about 1 g of maize powder.

CRMs for genetically modified NK603 maize (Cat No. ERMBF415)

Six CRMs of dried maize powder with different mass fractions of genetically modified (NK603) maize were produced by IRMM.

Cat. No.	Certified value NK603 mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF415a	< 0.4	-
ERMBF415b	1.0	0.4
ERMBF415c	4.9	0.5
ERMBF415d	9.8	0.7
ERMBF415e *	19.6	0.9
ERMBF415f	49.1	1.3

Availability: Vials containing about 1 g of maize powder.
* ERMBF415e is also certified for the DNA copy number ratio.

Cat. No.	Certified value NK603 maize DNA copy number ratio (%)	Uncertainty (%)
ERMBF415e	0.95	0.11

Cat. No. ERMAD415	DNA fragments per plasmid
	Number
Fragment of 3' insertion-specific DNA / pIRMM-0086	1 (negligible uncertainty)
Fragment of *hmg* DNA / pIRMM-0086	1 (negligible uncertainty)

Availability: ERMAD415 is available in vials.

CRMs for genetically modified MON 863 maize (Cat. No. ERMBF416)

Four CRMs of dried maize powder with different mass fractions of genetically modified (MON 863) maize were produced by IRMM.

Cat. No.	Certified value MON 863 mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF416a	< 1.0	-
ERMBF416b	1.0	- 0.3 ; + 1.0

Cat. No.	Certified value MON 863 mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF416c	9.8	- 0.7 ; + 1.2
ERMBF416d	98.5	- 2.2 ; + 2.

Availability: Vials containing about 1 g of maize powder.

CRMs for genetically modified MON 863 x MON 810 maize (Cat. No. ERMBF417)

Four CRMs of dried maize powder with different mass fractions of genetically modified (MON 863 x MON 810) maize were produced by IRMM.

Cat. No.	Certified value MON 863 x MON 810 mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF417a	< 1.0	-
ERMBF417b	1.0	- 0.2 ; + 1.0
ERMBF417c	9.8	- 0.7 ; + 1.2
ERMBF417d	98.5	- 2.0 ; + 2.4

Availability: Vials containing about 1 g of maize powder.

CRMs for genetically modified 1507 maize (Cat. No. ERMBF418)

Four CRMs of dried maize powder with different mass fractions of genetically modified (1507) maize were produced by IRMM.

Cat. No.	Certified value 1507 maize mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF418a	< 0.5	-
ERMBF418b	1.0	- 0.2 ; + 0.6
ERMBF418c	9.9	- 0.6 ; + 0.8
ERMBF418d	98.6	- 1.7 ; + 2.0

Availability: Vials containing about 1 g of maize powder.

CRMs for genetically modified H7-1 sugar beet (Cat. No. ERMBF419)

Two CRMs of dried sugar beet powder with different mass fractions of genetically modified (H7-1) sugar beet were produced by IRMM.

Cat. No.	Certified value H7-1 sugar beet mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF419a	0	
ERMBF419b	1000	

Availability: Vials containing about 1 g of sugar beet powder.

CRMs for genetically modified 3272 maize (Cat. No. ERMBF420)

Three CRMs of dried maize powder with different mass fractions of genetically modified (3272) maize were produced by IRMM.

Cat. No.	Certified value 3272 maize mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF420a	< 1.3	-
ERMBF420b	9.8	1.2
ERMBF420c	98	8

Availability: Vials containing about 1 g of maize powder.

CRMs for genetically modified EH92-527-1 potato (Cat. No. ERMBF421)

Two CRMs of dried potato powder with different mass fractions of genetically modified (EH92-527-1) potato were produced by IRMM.

Cat. No.	Certified value 3272 maize mass fraction (g/kg)	Certified property Identity	Uncertainty
ERMBF421a	0	potato without the EH92-527-1 event	Not applicable
ERMBF421b	100	EH92-527-1 potato	

Availability: ERMBF421a: vials containing about 1 g of potato powder, ERMBF421b: vials containing about 0.5 g of potato powder.

CRMs for genetically modified 281-24-236 x 3006-210-23 cotton seed (Cat. No. ERMBF422)

Four CRMs of dried cotton seed powder with different mass fractions of genetically modified (281-24-236 x 3006-210-23) cotton seed were produced by IRMM.

Cat. No.	Certified value 281-24-236 x 3006-210-23 cotton seed mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF422a	< 0.5	-
ERMBF422b	> 979	-
ERMBF422c	10.0	1.7
ERMBF422d	100	16

Availability: Vials containing about 1 g of cotton seed powder.

CRMs for genetically modified MIR604 maize (Cat. No. ERMBF423)

Four CRMs of dried maize powder with different mass fractions of genetically modified (MIR604) maize were produced by IRMM.

Cat. No.	Certified value MIR604 maize mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF423a	< 0.9	-
ERMBF423b	1.0	- 0.3 ; + 1.0
ERMBF423c	9.8	- 0.9 ; + 1.3
ERMBF423d	98.5	16

Availability: Vials containing about 1 g of maize powder.

CRMs for genetically modified 59122 maize (Cat. No. ERMBF424)

Four CRMs of dried maize powder with different mass fractions of genetically modified (59122) maize were produced by IRMM.

Cat. No.	Certified value 59122 maize mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF424a	< 1.2	-
ERMBF424b	1.0	- 0.2 ; + 1.2
ERMBF424c	9.9	- 0.8 ; + 1.4
ERMBF424d	98.7	- 5.8 ; + 5.9

Availability: Vials containing about 1 g of maize powder.

CRMs for genetically modified 356043 soya seed (Cat. No. ERMBF425)

Four CRMs of dried soya seed powder with different mass fractions of genetically modified soya seed were produced by IRMM.

Cat. No.	Certified value 59122 maize mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF425a	< 0.5	-
ERMBF425b	1.0	0.4
ERMBF425c *	10.0	1.1
ERMBF425d	100	9

Availability: Vials containing about 1 g of soya seed powder.
* ERMBF425c is also certified for the DNA copy number ratio.

Cat. No.	Certified value 356043 soya DNA copy number ratio (%)	Uncertainty (%)
ERMBF425c	0.85	0.11

Cat. No. ERMAD425	DNA fragments per plasmid
Substance	Number
Fragment of *5'* insert-to-plant junction DNA / pIRMM-0073	1 (negligible uncertainty)
Fragment of *le1* DNA / pIRMM-0073	1 (negligible uncertainty)

Availability: ERMAD425 is available in vials.

CRMs for genetically modified 305423 soya seed (Cat. No. ERMBF426)

Four CRMs of dried soya seed powder with different mass fractions of genetically modified soya seed were produced by IRMM.

Cat. No.	Certified value 305423 soya seed mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF426a	< 0.8	-
ERMBF426b	5.0	0.8
ERMBF426c	10.0	1.0
ERMBF426d	100	7

Availability: Vials containing about 1 g of soya seed powder.

CRMs for genetically modified 98140 maize (Cat. No. ERMBF427)

Four CRMs of dried maize seed powder with different mass fractions of genetically modified (98140) maize were produced by IRMM.

Cat. No.	Certified value 305423 soya seed mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF427a	< 0.4	-
ERMBF427b	5.0	0.6
ERMBF427c *	20.0	0.8
ERMBF427d	100	4

Availability: Vials containing about 1 g of maize seed powder.
* ERMBF427c is also certified for the DNA copy number ratio.

Cat. No.	Certified value 98140 maize DNA copy number ratio (%)	Uncertainty (%)
ERMBF427c	1.75	0.13

Cat. No. ERMAD425	DNA fragments per plasmid
Substance	**Number**
Fragment of 5' insert-to-plant junction DNA / pIRMM-0090	1 (negligible uncertainty)
Fragment of *hmg* DNA / pIRMM-0090	1 (negligible uncertainty)

Availability: ERMAD427 is available in vials.

CRMs for genetically modified GHB119 cotton (Cat. No. ERMBF428)

Three CRMs of dried cotton seed powder with different mass fractions of genetically modified (GHB119) cotton were produced by IRMM.

Cat. No.	Certified value 305423 soya seed mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF428a	< 0.2	-
ERMBF428b	10	4
ERMBF428c	100	11

Availability: Vials containing about 1 g of cotton seed powder.

CRMs for genetically modified T304-40 cotton (Cat. No. ERMBF429)

Three CRMs of dried cotton seed powder with different mass fractions of genetically modified (T304-40) cotton were produced by IRMM.

Cat. No.	Certified value T304-40 cotton seed mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF429a	< 0.4	-
ERMBF429b	10	1.3
ERMBF429c	100	11

Availability: Vials containing about 1 g of cotton seed powder.

CRMs for genetically modified AM04-1020 potato (Cat. No. ERMBF430)

Five CRMs of dried potato powder with different mass fractions of genetically modified (AM04-1020) potato were produced by IRMM.

Cat. No.	Certified value AM04-1020 potato mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF430a	0	-
ERMBF430b	1000	-
ERMBF430c	10	1.4
ERMBF430d	40	5
ERMBF430e	100	12

Availability: Vials containing about 1 g of potato powder.

CRMs for genetically modified AV43-6-G7 potato (Cat. No. ERMBF431)

Five CRMs of dried potato powder with different mass fractions of genetically modified potato AV43-6-G7 were produced by IRMM.

Cat. No.	Certified value AV43-6-G7 potato mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF431a	0	-
ERMBF431b	1000	-
ERMBF431c	9.9	1.3
ERMBF431d	40	5
ERMBF431e	99	10

Availability: Vials containing about 1 g of potato powder

CRMs for genetically modified DAS-68416-4 soya seed (Cat. No. ERMBF432)

Four CRMs of dried soya seed powder with different mass fractions of genetically modified soya seed DAS-68416-4 were produced by IRMM.

Cat. No.	Certified value DAS-68416-4 soya seed mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF432a	< 0.3	-
ERMBF432b	5.0	0.6
ERMBF432c	10.0	1.7
ERMBF432d	100	13

Availability: Vials containing about 1 g of soya seed powder.

CRMs for genetically modified DAS-40278-9 maize (Cat. No. ERMBF433)

Four CRMs of dried maize powder with different mass fractions of genetically modified DAS-40278-9 maize were produced by IRMM.

Cat. No.	Certified value DAS-40278-9 maize mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF433a	< 0.3	-
ERMBF433b	5.0	0.6

Cat. No.	Certified value DAS-40278-9 maize mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF433c	10.0	0.9
ERMBF433d	100	8

Availability: Vials containing about 1 g of maize powder.

CRMs for genetically modified 73496 rapeseed (Cat. No. ERMBF434)

Five CRMs of dried rapeseed powder with different mass fractions of genetically modified rapeseed 73496 were produced by IRMM.

Cat. No.	Certified value 73496 rapeseed mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF434a	< 0.04	-
ERMBF434b	>988	-

Cat. No.	Certified value 73496 rapeseed mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF434c	1.00	0.15
ERMBF434d	10.0	1.4
ERMBF434e	100	12

Availability: Vials containing about 1 g of rapeseed powder.

CRMs for genetically modified PH05-026-0048 potato (Cat. No. ERMBF435)

Two CRMs for the detection of genetically modified PH05-026-0048 potato were produced by IRMM.

Cat. No.	Certified value PH05-026-0048 potato mass fraction (g/kg)
ERMBF435a	< 0.4

Cat. No.	Certified identity
ERMBF435b	Positive for event PH05-026-0048

Availability: Vials containing about 1 g of potato powder

CRMs for genetically modified DAS-44406-6 soya seed (Cat. No. ERMBF436)

Five CRMs of dried soya seed powder with different mass fractions of genetically modified soya seed DAS-44406-6 were produced by IRMM.

Cat. No.	Certified value DAS-44406-6 soya seed mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF436a	< 0.06	-
ERMBF436b	>986	-
ERMBF436c	1.00	0.14
ERMBF436d	10.0	1.0
ERMBF436e	100	9

Availability: Vials containing about 1 g of soya seed powder.

CRMs for genetically modified DAS-81419-2 soya seed (Cat. No. ERMBF437)

Five CRMs of dried soya seed powder with different mass fractions of genetically modified soya seed DAS-81419-2 were produced by IRMM.

Cat. No.	Certified value DAS-81419-2 soya seed mass fraction (g/kg)	Uncertainty (g/kg)
ERMBF437a	< 0.07	-
ERMBF437b	>986	-
ERMBF437c	0.99	0.12
ERMBF437d	9.9	1.5
ERMBF437e	100	9

Availability: Vials containing about 1 g of soya seed powder.

2.2.2 CERTIFIED FOR NATURAL TOXINS AND XENOBIOTICS

Substance	Cat. No. BCR459 Coconut oil (µg/kg)
Pyrene	< 0.9
Chrysene	< 0.6
Benzo[k]fluoranthene	< 0.2

Substance	Cat. No. BCR459 Coconut oil (µg/kg)
Benzo[a]pyrene	< 0.3
Benzo[ghi]perylene	< 0.2
Indeno[1,2,3-cd]pyrene	< 0.2

Availability: BCR459 is provided in ampoules containing approximately 45 g.

Polychlorinated biphenyls (IUPAC No.)	Cat. No. BCR450 Natural milk powder (µg/kg)	Cat. No. ERMBB444 Natural pork fat (blank) (µg/kg)	Cat. No. ERMBB445 Spiked pork fat (very low level) (µg/kg)	Cat. No. ERMBB446 Spiked pork fat (low level) (µg/kg)
28		< 2	14.8 ± 1.3	29.6 ± 2.1
52	1.16 ± 0.17	< 2	12.9 ± 0.9	25.5 ± 1.8
101		< 2	12.5 ± 1.2	30 ± 4
118	3.3 ± 0.4	< 2	12.7 ± 1.3	30.2 ± 2.7
138		< 2	14.6 ± 1.6	32 ± 4
153	19.0 ± 0.7	< 2	13.1 ± 1.1	30.8 ± 2.4
156	1.62 ± 0.20			
170	4.8 ± 0.6			
180	11.0 ± 0.7	< 2	12.6 ± 0.9	29.8 ± 2.5
sum (28, 52, 101, 118, 138, 153, 180)		< 14	93 ± 7	207 ± 11
*PDBE 47		(3.7)	(3.9)	(6.1)
γ-HCH (lindane)		(5.7)	(5.6)	(4.6)

* 2,2'4,4'-Tetrabromo-diphenylether
Values in brackets are not certified.
Availability: BCR450 in brown glass bottles of about 20 g. ERM-BB444 to 446 in glass ampoules of about 5 g.

Polychlorinated biphenyls (IUPAC No.)	Cat. No. BCR349 Cod liver oil (µg/kg)	Cat. No. ERMBB350 Fish oil (ng/g)
28	68 ± 8	21.3 ± 1.1
52	149 ± 21	37.4 ± 2.2
74	1.3	23.0 ± 1.9
95		(38 ± 47)
99	10	62 ± 6
101	372 ± 18	111 ± 5
105		25.8 ± 2.1
110		54.1 ± 2.8
118	460 ± 40	84 ± 4
138		137 ± 10
149		88 ± 9

Polychlorinated biphenyls (IUPAC No.)	Cat. No. BCR349 Cod liver oil (µg/kg)	Cat. No. ERMBB350 Fish oil (ng/g)
153	940 ± 40	220 ± 11
156		20.1 ± 1.3
163		(43 ± 73)
167		(17 ± 27)
177		25.8 ± 2.0
180	282 ± 23	67 ± 4
183		22.5 ± 1.8
187		67 ± 5
194		23.4 ± 1.5
196		41 ± 7

Values in brackets are not certified.
Availability: BCR349 and ERMBB350 are provided in sealed glass ampoules containing approximately 2 g fish oil.

Substance	Cat. No. BCR598 Cod liver oil (µg/kg)
HCB	55.7 ± 2.0
α-HCH	42 ± 3
β-HCH	16 ± 3
γ-HCH	23 ± 4
γ-Chlordane	6.9 ± 1.6
α-Chlordane	24.4 ± 1.8
Oxychlordane	11.0 ± 1.8

Substance	Cat. No. BCR598 Cod liver oil (µg/kg)
Transnonachlor	39 ± 4
Dieldrin	59 ± 4
p,p',-DDE	0.61×10^3 ± 0.04×10^3
o,p'-DDD	30 ± 4
p,p'-DDD	0.40×10^3 ± 0.03×10^3
p,p'-DDT	0.179×10^3 ± 0.018×10^3

Availability: BCR598 is provided in sealed glass ampoules containing approximately 5 g under dry argon.

Substance	Cat. No. ERMBB430 Pork fat (mg/kg)
HCB	0.193 ± 0.017
α-HCH	0.25 ± 0.04
β-HCH	0.109 ± 0.010
γ-HCH	(1.87 ± 0.31)
β-HEPO	0.213 ± 0.016

Substance	Cat. No. ERMBB430 Pork fat (mg/kg)
Dieldrin	(0.21 ± 0.05)
Endrin	(0.055 ± 0.016)
p,p',-DDT	0.48 ± 0.07
p,p',-DDD	0.222 ± 0.022
p,p'-DDE	0.38 ± 0.09

Values in brackets are not certified.
Availability: ERMBB430 is provided in sealed amber glass ampoules containing approximately 5 g of material bottled under argon.

Substance	Cat. No. BCR115 Animal feed (mg/kg)
HCB	0.019 4 ± 0.001 4
β-HCH	0.023 4 ± 0.002 6
γ-HCH	0.021 8 ± 0.002 0
Heptachlor	0.019 0 ± 0.001 5
γ-Chlordane	0.048 ± 0.006

Substance	Cat. No. BCR115 Animal feed (mg/kg)
α-Endosulfan	0.046 ± 0.004
Dieldrin	0.018 1 ± 0.002 3
Endrin	0.046 ± 0.006
o,p'-DDT	0.046 ± 0.005
p,p'-DDE	0.047 ± 0.004

Availability: BCR115 is provided in sealed hard glass ampoules containing approximately 30 g under dry N_2. The sample is a homogeneous animal feed obtained from commonly used ingredients and enriched with organochlorine pesticides.

Substance	Cat. No. BCR187 Milk powder (µg/kg)	Cat. No. BCR188 Milk powder (spiked) (µg/kg)
HCB	1.45 ± 0.21	37.4 ± 2.7
α-HCH	1.80 ± 0.14	
β-HCH		12.0 ± 1.2
γ-HCH	5.7 ± 0.8	45.4 ± 2.9
β-HEPO		32.0 ± 1.9

Substance	Cat. No. BCR187 Milk powder (µg/kg)	Cat. No. BCR188 Milk powder (spiked) (µg/kg)
p,p'-DDE	6.6 ± 0.6	51 ± 4
Dieldrin		36.1 ± 2.5
Endrin		6.2 ± 0.9
p,p'-DDT		69 ± 5

Availability: The samples are provided in sealed hard glass ampoules containing about 20 g (under Argon).

Substance	Cat. No. BCR607 Natural spray dried milk powdern (ng/kg)
2,3,7,8 - T_4CDD (D48)	0.25 ± 0.03
1,2,3,7,8 - P_5CD (D54)	0.79 ± 0.04
1,2,3,4,7,8 - H_6CDD (D66)	0.42 ± 0.07
1,2,3,6,7,8 - H_6CDD (D67)	0.98 ± 0.11
1,2,3,7,8,9 - H_6CDD (D70)	0.34 ± 0.05
2,3,7,8 - T_4CDF (F83)	0.05 ± 0.03

Substance	Cat. No. BCR607 Natural spray dried milk powdern (ng/kg)
1,2,3,7,8 - P_5CDF (F94)	0.054 ± 0.013
2,3,4,7,8 - P_5CDF (F114)	1.81 ± 0.13
1,2,3,4,7,8 - H_6CDF (F118)	0.94 ± 0.04
1,2,3,6,7,8 - H_6CDF (F121)	1.01 ± 0.09
2,3,4,6,7,8 - H_6CDF (F130)	1.07 ± 0.05

Availability: Amber glass bottles containing approximately 100 g.

Polychlorinated biphenyls (IUPAC No.)	Cat. No. ERMBC190 Rapeseed (colza)	Cat. No. ERMBC366 Rapeseed (colza)	Cat. No. ERMBC367 Rapeseed (colza)
	Certified values	Certified values	Certified values
Total glucosinolate content	23 ± 4µmmol/kg	11.9 ± 1.3µmmol/kg	99 ± 9µmmol/kg
Sulphur content	4.72 ± 0.22µg/kg	3.31 ± 0.17µg/kg	10.3 ± 0.5µg/kg

Availability: 20 g whole seed in an aluminium plastic laminated sachet sealed under nitrogen.

Substance	Cat. No. BCR262R Defatted peanut meal (blank)	Cat. No. BCR263R Defatted peanut meal (medium level)	Cat. No. BCR264 Defatted peanut meal (high level)	Cat. No. BCR375 Compound feed (very low level blank)	Cat. No. ERMBE375 Compound feed (very low level)	Cat. No. ERMBE376 Compound feed (high level)
	Mass fraction (µg/kg)					
Aflatoxin B1	< 3	17.1 ± 2.4	206 ± 13	< 1	2.6 ± 0.4	12.9 ± 1.8
Aflatoxin B2		3.0 ± 0.4			0.20 ± 0.04	0.68 ± 0.10
Aflatoxin G1		3.0 ± 0.5			0.40 ± 0.10	5.2 ± 0.8
Aflatoxin G2		(0.62 ± 0.21)			< 0.2	
Sum of aflatoxin B1, B2, G1 and G2		(23.7 ± 2.5)				

Values in brackets are not certified.

Availability: Sachets sealed under vacuum containing about 100 g (BCR263R) and about 150 g (BCR264) of finely ground defatted peanut meal. BCR262R is available in 280 mL amber glass bottles containing about 100 g of the peanut meal, additionally sealed in foil-laminate sachet. BCR375 is supplied in units of about 50 g of a finely ground compound feed, ERMBE375 and ERMBE376 consist of 2 bottles filled with about 75 g of compound feedingstuff each.

Cat. No.	Description	Aflatoxin M_1 (µg/kg)
ERMBD282	Whole milk powder (zero level)	< 0.02
ERMBD283	Whole milk powder (low level)	0.111 + 0.018
ERMBD284	Whole milk powder (high level)	0.44 ± 0.06

Availability: The materials are provided in units of 30 g in amber glass bottles filled and sealed under nitrogen.

Substance	Cat. No. BCR377 Maize Flour (very low level blank)	Cat. No. BCR396 Wheat Flour (very low level blank)
	Mass fraction (mg/kg)	Mass fraction (mg/kg)
DON	< 0.05	< 0.05

Availability: Sachets sealed under vacuum containing about 150 g of sealed finely ground flour.

Substance	Cat. No. BCR471 Wheat (blank)
	Mass fraction (µg/kg)
Ochratoxin A	< 0.6

Availability: Units of about 55 g in foil-laminate pouches sealed under vacuum.

Compound	Cat. No. BCR543 Mussel
	Mass fraction (mg/kg)
Saxitoxin·2HCl	< 0.07
Saxitoxin·2HCl (if enriched with BCR663)	0.48 ± 0.06
dc-saxitoxin	< 0.04

Availability: BCR543 is available in heat-sealed laminate sachets containing about 15 g of material each. BCR663 is available in ampoules containing 1 mL.

Substance	Cat. No. ERMBC716 Maize	Cat. No. ERMBC717 Maize
	Mass fraction (µg/kg)	
DON		673 ± 87
NIV		53 ± 10
ZON	< 5	83 ± 9

Availability: ERMBC716 and ERMBC717 are supplied in sachets containing at least 60 g.

2.2.3 CERTIFIED FOR THE TOTAL ELEMENT CONTENT

Substance	Cat. No. ERMBD150 Skimmed milk powder (g/kg)	Cat. No. ERMBD151 Skimmed milk powder (g/kg)
Ca	13.9 ± 0.8	13.9 ± 0.7
Cl	9.7 ± 2.0	9.8 ± 1.2
K	17.0 ± 0.7	17.0 ± 0.8
Mg	1.26 ± 0.10	1.26 ± 0.07
Na	4.18 ± 0.19	4.19 ± 0.23
	(mg/kg)	(mg/kg)
Cd	0.0114 ± 0.029	0.106 ± 0.013
Cu	1.08 ± 0.06	5.00 ± 0.23
Fe	4.6 ± 0.5	53 ± 4
Hg	0.060 ± 0.007	0.52 ± 0.04
I	1.73 ± 0.14	1.78 ± 0.17
Mn	0.289 ± 0.018	0.29 ± 0.03
Pb	0.019 ± 0.004	0.207 ± 0.014
Se	0.188 ± 0.014	0.19 ± 0.04
Zn	44.8 ± 2.0	44.9 ± 2.3

Availability: Glass bottles containing 20 g of skimmed milk powder.

Substance	Cat. No. ERMBB184 Bovine muscle (mg/kg)	Cat. No. ERMBB186 Pig kidney (mg/kg)	Cat. No. ERMBB422 Fish muscle (mg/kg)	Cat. No. BCR185R Bovine live (mg/kg)
As	0.0234 ± 0.0026	(0.008 ± 0.006)	12.7 ± 0.7	0.0330 ± 0.0029
Cd	0.0022 ± 0.0004	1.09 ± 0.05	0.0075 ± 0.0018	0.544 ± 0.017
Cu	2.31 ± 0.09	36.5 ± 1.8	1.67 ± 0.16	277 ± 5
Fe	75 ± 4	255 ± 13	9.4 ± 1.4	-
Hg	(0.0018 ± 0.0010)	(0.023 ± 0.011)	0.601 ± 0.030	-
I	-	-	1.4 ± 0.4	-
Mn	0.276 ± 0.013	7.26 ± 0.25	0.368 ± 0.028	11.07 ± 0.29
Pb	-	0.040 ± 0.005	-	0.172 ± 0.009
Se	0.45 ± 0.04	10.3 ± 0.9	1.33 ± 0.13	1.68 ± 0.14
Zn	146 ± 7	134 ± 5	16.0 ± 1.1	138.6 ± 2.1

Values in brackets are not certified.
Availability: BCR185R is provided in units of 15 g as lyophilised powders, in screw-capped glass bottles. ERMBB184 is provided in units of 7 g as lyophilised powder, in brown-glass vials. ERMBB186 and ERMBB422 are provided in units of 10 g as lyophilised powders, in brown-glass vials

Substance	Cat. No. BCR191 Brown bread
Cd µg/kg	28.4 ± 1.4
Cu µmg/kg	2.63 ± 0.07
Fe µmg/kg	40.7 ± 2.3

Substance	Cat. No. BCR191 Brown bread
Mn µmg/kg	20.3 ± 0.7
Pb µg/kg	187 ± 14
Zn µmg/kg	19.5 ± 0.5

Availability: BCR191 is provided in units of 25 g.

Substance	Cat. No. IRMM804 Rice flour (mg/kg)
As	0.049 ± 0.004
Cd	1.61 ± 0.07
Cu	2.74 ± 0.24

Substance	Cat. No. IRMM804 Rice flour (mg/kg)
Mn	34.2 ± 2.3
Pb	0.42 ± 0.07
Zn	23.1 ± 1.9

Availability: Amber glass bottles containing about 15 g of powdered material.

Substance	Cat. No. BCR273 Single cell protein (mg/g)	Cat. No. BCR274 Single cell protein (µg/g)
As		0.132 ± 0.014
Ca	11.97 ± 0.14	
Cd		0.030 ± 0.002
Co		0.039 ± 0.003
Cu		13.1 ± 0.4
Fe	0.156 ± 0.004	
K	2.22 ± 0.05	

Substance	Cat. No. BCR273 Single cell protein (mg/g)	Cat. No. BCR274 Single cell protein (µg/g)
Mn		51.9 ± 1.2
N	121.6 ± 0.8	
P	26.8 ± 0.4	
Pb		0.044 ± 0.010
Se		1.03 ± 0.05
Zn		42.7 ± 1.0

Availability: BCR273 and BCR274 are provided in units of 10 g as a dry powder in sealed glass ampoules.

Substance	Cat. No. BCR679 White cabbage
B mg/kg	(27.7 ± 1.9)
Ba mg/kg	(10.3 ± 0.6)
Ca mg/kg	(7768 ± 655)
Cd mg/kg	1.66 ± 0.07
Cr mg/kg	(0.6 ± 0.1)
Cu mg/kg	2.89 ± 0.12
Fe mg/kg	55.0 ± 2.5
Hg µg/kg	6.3 ± 1.4
Mg mg/kg	(1362 ± 127)

Substance	Cat. No. BCR679 White cabbage
Mn mg/kg	13.3 ± 0.5
Mo mg/kg	14.8 ± 0.5
Ni mg/kg	27.0 ± 0.8
P mg/kg	(3307 ± 241)
Sb µg/kg	20.6 ± 2.6
Sr mg/kg	11.8 ± 0.4
Tl µg/kg	3.0 ± 0.3
Zn mg/kg	79.7 ± 2.7

Values in brackets are not certified.
Availability: BCR679 is provided in units of 15 g.

Substance	Cat. No. ERMBC381 Rye Flour	Cat. No. ERMBC382 Wheat Flour	Cat. No. BCR383 Haricots Verts (Beans)	Cat. No. ERMBB384 Lyophilised pork muscle
Major components (g / 100 g)				
Glucose			(12.4)	
Fructose			(4.6)	
Sucrose			(1.0)	
N (Kjeldahl)	1.562 ± 0.014	1.851 ± 0.017	1.05 ± 0.04	14.2 ± 0.4
Fat	1.36 ± 0.16	1.39 ± 0.17		8.99 ± 0.20
Starch [1)]	72.2 ± 1.9	81.2 ± 1.7		
Starch & Sugars [2)]			(78.9)	
Dietary Fibre (Englyst)			(10.9)	
Dietary Fibre (AOAC 1985/1988) [3)]			11.9 ± 0.6	
Ash at 550 °C	1.08 ± 0.11	0.60 ± 0.10	2.39 ± 0.10	4.51 ± 0.19
Essential elements (g/kg)				
Ca	0.32 ± 0.04	0.210 ± 0.018	2.85 ± 0.23	0.164 ± 0.021
K	3.35 ± 0.11	1.88 ± 0.08	7.8 ± 0.4	
Mg	0.567 ± 0.013	0.247 ± 0.010	(0.9)	1.03 ± 0.04
Na			0.075 ± 0.007	1.86 ± 0.15
P	2.01 ± 0.07	1.19 ± 0.07	(1.8)	8.7 ± 0.5

Values in brackets are not certified.
Availability: ERMBC381 and ERMBC382: 100 ml amber vial containing 37 g flour; ERMBB384: 2 vials of 9 g lyophilised material;
BCR383: 100 g of powdered material in food grade laminated plastic/aluminium sachets sealed under nitrogen.
[1)]Mass fraction of polysaccharide in dry matter
[2)]Mass fraction of monosaccharides in dry matter
[3)]Prosky L. et al., J Assoc Off Anal Chem (1985) 68: 677-679, (1988) 71: 1017-1023

2.2.4 CERTIFIED FOR PROXIMATES AND CONVENTIONAL PROPERTIES

Substance	Cat. No. BCR162R Soya-maize oil blend
Methyl ester of	Mass fraction fatty acid methyl ester / Total fatty acid methyl ester (g/100 g)
16:0n-hexadecanoic acid	10.74 ± 0.16
18:0n-octadecanoic acid	2.82 ± 0.04
18:1n-octadecenoic acids	(26.5)
18:2n-octadecadienoic acids	(54.68)

Substance	Cat. No. BCR162R Soya-maize oil blend
18:3n-octadecatrienoic acids	(3.80)
9c-18:1 n-octadecenoic acid	25.4 ± 0.4
9c,12c-18:2n-octadecadienoic acid	54.13 ± 0.25
9c,12c,15c-18:3n-octadecatrienoic acid	3.35 ± 0.05

Values in brackets are not certified.
Availability: Each unit contains approximately 5.5 g soya-maize oil blend in 10 mL amber ampoule.

Substance	Cat. No. BCR163 Beef-pork fat oil blend
Methyl ester of	Mass fraction fatty acid methyl ester / Total fatty acid methyl ester 1) (g/100 g)
14:0n-tetradecanoic acids	2.29 ± 0.04
16:0n-hexadecanoic acids	25.96 ± 0.30
16:1 n-hexadecenoic acids	2.58 ± 0.16
18:0n-octadecanoic acids	18.29 ± 0.17
18:1n-octadecenoic acids	38.3 ± 0.4

Substance	Cat. No. BCR163 Beef-pork fat oil blend
Methyl ester of	Mass fraction fatty acid methyl ester / Total fatty acid methyl ester 1) (g/100 g)
18:2n-octadecadienoic acids	7.05 ± 0.17
18:3n-octadecatrienoic acids	0.86 ± 0.14
Sterols	Mass fraction (mg/100 g) in fat
Cholesterol	134 ± 5

Availability: In units of 2 × 5 mL in dark glass ampoules sealed under nitrogen.
1) Includes any geometric (i.e. cis/trans) and positional isomers, expressed as mass fraction of total fatty acid (methyl esters) derived from triglycerides.
2) These components are included in the Certified Value for this group of fatty acids.
The report gives additional indicative values: Fatty Acids and "Total" Sterol Mass Fraction.

Component	Cat. No. BCR633 Tracers in anhydrous butter fat (mg/kg)
β-Apo-8'-carotenic acid ethyl ester	26.5 ± 1.4
β-Sitosterol	530 ± 29

Component	Cat. No. BCR633 Tracers in anhydrous butter fat (mg/kg)
Stigmasterol	147 ± 11
n-Heptanoic acid triglyceride	1.06 * 103 ± 0.04 * 103

Availability: BCR 633 is supplied in units of about 5 g each in amber glass ampoules, which were filled under inert gas conditions (nitrogen).

Component	Cat. No. IRMM801 Cocoa Butter (%)
1,3-dipalmitoyl-2-oleyl-glycerol	18.14 ± 0.26
1-palmitoyl-2-oleoyl-3-stearoyl-glycerol	44.68 ± 0.30
1,2-dioleoyl-3-palmitoyl-glycerol	2.26 ± 0.16
1,3-distearoyl-2-oleoyl-glycerol	31.63 ± 0.29
1,2-dioleoyl-3-stearoyl-glycerol	3.29 ± 0.17

Availability: IRMM801 is supplied in units of 5 g in brown amber glass ampoules sealed under argon/helium.

Component	Cat. No. BCR519 Anhydrous butter fat (%)
Cholesterol	0.30 ± 0.03
C24	0.05 ± 0.02
C26	0.25 ± 0.03
C28	0.59 ± 0.04
C30	1.15 ± 0.05
C32	2.43 ± 0.12
C34	5.64 ± 0.18

Component	Cat. No. BCR519 Anhydrous butter fat (%)
C36	10.47 ± 0.19
C38	12.53 ± 0.22
C40	10.03 ± 0.16
C42	6.69 ± 0.10
C44	6.11 ± 0.08
C46	6.86 ± 0.08
C48	8.69 ± 0.15

Component	Cat. No. BCR519 Anhydrous butter fat (%)
C50	11.40 ± 0.24
C52	10.96 ± 0.25

Component	Cat. No. BCR519 Anhydrous butter fat (%)
C54	5.89 ± 0.13

Availability: The material consists of anhydrous butter fat and is supplied in units of two glass ampoules sealed under nitrogen, each containing approximately 5 mL fat. At normal ambient temperature BCR519 is solid.

	Cat. No. BCR632 Butter fat	
Compound	Cat. No. BCR632A pure butter fat (g/100 g)	Cat. No. BCR632B Adulterated butter fat (g/100 g)
C24	0.07 ± 0.04	0.08 ± 0.04
Cholesterol	0.289 ± 0.012	0.278 ± 0.011
C26	0.33 ± 0.06	0.34 ± 0.06
C28	0.74 ± 0.07	0.75 ± 0.06
C30	1.37 ± 0.08	1.46 ± 0.07
C32	2.83 ± 0.14	3.30 ± 0.12
C34	6.09 ± 0.29	6.57 ± 0.25
C36	10.7 ± 0.5	11.1 ± 0.4
C38	12.5 ± 0.4	12.7 ± 0.4

	Cat. No. BCR632 Butter fat	
Compound	Cat. No. BCR632A pure butter fat (g/100 g)	Cat. No. BCR632B Adulterated butter fat (g/100 g)
C40	10.05 ± 0.19	10.07 ± 0.17
C42	7.07 ± 0.13	7.10 ± 0.10
C44	6.68 ± 0.12	6.57 ± 0.12
C46	7.36 ± 0.17	7.12 ± 0.17
C48	8.74 ± 0.21	8.42 ± 0.19
C50	10.74 ± 0.24	10.28 ± 0.19
C52	9.8 ± 0.4	9.36 ± 0.28
C54	4.7 ± 0.5	4.5 ± 0.4

Availability: BCR632 is available as a set of BCR632A and BCR632B: 2 amber glass ampoules each with approximately 5 mL.

	Cat. No. BCR121 Wholemeal flour	Cat. No. BCR122 Margarine	Cat. No. BCR431 Brussels sprouts	Cat. No. BCR485 Mixed vegetables	Cat. No. BCR487 Pig's liver	Cat. No. ERMBD600 Whole milk powder
	(mg/kg)					
A (all-*trans*-retinol)						3.8 ± 0.6
A (all-*trans*-retinol and 13-*cis*-retinol)						4.1 ± 0.8
B_1 (thiamin)	4.63 ± 0.39			3.07 ± 0.34	8.6 ± 1.1	4.5 ± 0.6
B_2 (riboflavin)					106.8 ± 5.6	16.7 ± 1.4
B_6 (total pyridoxine)	4.10 ± 1.02			4.8 ± 0.8	19.3 ± 2.9	
B_{12} (cyanocobalamin)					1.12 ± 0.09	0.32 ± 0.07
C (total ascorbate)			4830 ± 240			74 ± 11
D_3 (cholecalciferol)		0.125 ± 0.007				
E (tocopherol)		241 ± 12				86 ± 15
Folate (total)	0.50 ± 0.07			3.15 ± 0.28	13.3 ± 1.3	
Niacin			43 ± 3			
Trans-α-carotene				10.5 ± 0.6		
Trans-β-carotene				23.7 ± 1.5		
Total-α-carotene				9.8 ± 0.7		
Total-β-carotene				25.6 ± 1.2		
Lutein				12.5 ± 0.8		
Lutein + zeaxanthin 5-methyltetrahydro-folic acid (5-MTHF)				22.3 ± 1.3 (2.14 + 0.42)		

Values in brackets are not certified;

Availability: BCR121: about 50 g unit size.
BCR122: can filled with about 200 g.
BCR431: about 20 g lyophilised and powdered material in food grade plastic/aluminium laminated sachets under nitrogen.
BCR485: about 25 g unit size.
BCR487: about 15 g unit size.
ERMBD600: sachet with about 100 g.

Cat. No.	Description	Amylose mass fraction (g/100 g)
BCR465	Rice flour (low level)	15.40 ± 0.30
BCR466	Rice flour (medium level)	23.1 ± 0.5
BCR467	Rice flour (high level)	27.7 ± 0.8

Availability: 10 g of ground rice flour in vacuum sealed laminated polyester/aluminium/polyethylene sachets.

Substance	Cat. No. BCR644 Artificial foodstuff	Cat. No. BCR645 Artificial foodstuff
Mass fraction on dry mass basis (g / 100 g)		
Fructose	16.2 ± 1.1	
Sucrose	10.81 ± 0.25	26.2 ± 0.8
Lactose	15.85 ± 0.29	27.8 ± 0.6
Starch / glucose	35.1 ± 1.2	25.2 ± 0.9

Availability: BCR-644 and BCR-645 are supplied in units of approximately 50 g in 125 mL amber glass bottles.

	Cat. No. BCR651 Beer (% ethanol v/v)	Cat. No. BCR652 Beer (% ethanol v/v)	Cat. No. BCR653 Wine (% ethanol v/v)
Ethanol	0.505 ± 0.006	0.051 ± 0.002	0.539 ± 0.007

Availability: Amber glass ampoule, flushed with nitrogen, containing 10 mL of sample.

Substance	Cat. No. ERMBC381 Rye Flour	Cat. No. ERMBC382 Wheat Flour	Cat. No. BCR383 Haricots Verts (Beans)	Cat. No. ERMBB384 Lyophilised pork muscle
Major components (g / 100 g)				
Glucose			(12.4)	
Fructose			(4.6)	
Sucrose			(1.0)	
N (Kjeldahl)	1.562 ± 0.014	1.851 ± 0.017	1.05 ± 0.04	14.2 ± 0.4
Fat	1.36 ± 0.16	1.39 ± 0.17		8.99 ± 0.20
Starch [1)]	72.2 ± 1.9	81.2 ± 1.7		
Starch & Sugars [2)]			(78.9)	
Dietary Fibre (Englyst)			(10.9)	
Dietary Fibre (AOAC 1985/1988) [3)]			11.9 ± 0.6	
Ash at 550 °C	1.08 ± 0.11	0.60 ± 0.10	2.39 ± 0.10	4.51 ± 0.19
Essential elements (g/kg)				
Ca	0.32 ± 0.04	0.210 ± 0.018	2.85 ± 0.23	0.164 ± 0.021
K	3.35 ± 0.11	1.88 ± 0.08	7.8 ± 0.4	
Mg	0.567 ± 0.013	0.247 ± 0.010	(0.9)	1.03 ± 0.04
Na			0.075 ± 0.007	1.86 ± 0.15
P	2.01 ± 0.07	1.19 ± 0.07	(1.8)	8.7 ± 0.5

Values in brackets are not certified.
Availability: ERMBC381 and ERMBC382: 100 ml amber vial containing 37 g flour; ERMBB384: 2 vials of 9 g lyophilised material;
BCR383: 100 g of powdered material in food grade laminated plastic/aluminium sachets sealed under nitrogen.
[1)]Mass fraction of polysaccharide in dry matter
[2)]Mass fraction of monosaccharides in dry matter
[3)]Prosky L. et al., J Assoc Off Anal Chem (1985) 68: 677-679, (1988) 71: 1017-1023

Substance	Cat. No. BCR380R Whole milk powder (g/100 g)	Cat. No. BCR685 Skim milk powder (g/100 g)
Mass fraction		
Crude protein	28.66 ± 0.28	38.2 ± 0.4
(Kjeldahl-N x 6.38)	26.95 ± 0.16	0.96 ± 0.12
Fat	37.1 ± 1.0	
Lactose (anhydrous)	6.00 ± 0.13	
Ash		

Availability: BCR380R is supplied in units of about 100 g, BCR685 in units of about 50 g, in amber glass bottles.

Quantity	Cat. No. BCR446 Low oil content rapeseed	Cat. No. BCR447 Medium oil content rapeseed
	Mass fraction (g/100 g)	
'As is' Oil	39.49 ± 0.15	41.99 ± 0.15
Moisture and volatiles	7.01 ± 0.07	7.42 ± 0.07
'Dry basis' Oil	42.48 ± 0.15	45.36 ± 0.15

Availability: About 150 g of rapeseed in a specially laminated bag containing an oxygen absorber and sealed under dry argon.

Substance	Cat. No. BCR708 Dairy feed	Cat. No. BCR709 Pig feed	
Mass fraction			
Crude protein	240 ± 12	199 ± 5	g/kg
Crude oils and fats	65 ± 8	51 ± 14	g/kg
Crude fibre	93 ± 14	56 ± 12	g/kg
Crude ash	50.0 ± 3.0	42 ± 4	g/kg

Substance	Cat. No. BCR708 Dairy feed	Cat. No. BCR709 Pig feed	
Ca	4.8 ± 0.5	1.05 ± 0.16	g/kg
Cu	37 ± 4	173 ± 25	mg/kg
Mg	1.47 ± 0.22	1.89 ± 0.30	g/kg
P	4.7 ± 0.4	5.4 ± 0.7	g/kg

Availability: 100 mL amber glass bottle containing about 40 g of material.

Substance	Cat. No. ERMBC514 Haricot beans (g/kg)	Cat. No. ERMBC515 Carrot (g/kg)	Cat. No. ERMBC516 Apple (g/kg)	Cat. No. ERMBC517 Full fat soya flour (g/kg)	Cat. No. ERMBD518 Bran breakfast cereal (g/kg)
Dietary Fibres					
Methods used:					
AOAC 1990	256 ± 5	311 ± 6	164 ± 4	126 ± 5	302 ± 8
Englyst (by gas chromatography)	198 ± 10	271 ± 6	137 ± 5	119 ± 7	241 ± 8
Uppsala	237 ± 15	298 ± 11	162 ± 8	128 ± 9	276 ± 18
AOAC 1992 MES-TRIS	259 ± 15	295 ± 4	149 ± 10	124 ± 21	305 ± 6
Englyst (by colorimetry)	201 ± 6	252 ± 12	134 ± 5	123 ± 8	250 ± 11

Availability: ERMBC514 to BC517 and ERMBD518 are supplied in units of approximately 25 g in food grade glass bottles sealed under vacuum.

	Cat. No. BCR537 Plastic film A (mg/dm^2)	Cat. No. BCR538 Plastic film B (mg/dm^2)	Cat. No. BCR539 Plastic film C (mg/dm^2)
Overall migration by total immersion in olive oil 10 days at 40 °C	8.3 ± 1.0		
Overall migration by single sided cell in olive oil 10 days at 40 °C		5.7 ± 0.7	
Overall migration by pouch in olive oil 10 days at 40 °C			6.1 ± 1.0

Availability: PET/foil/PE heat sealed pouches containing double thickness sheets of additive free linear low density polyethylene of (33 x 22.5) cm for BCR537, (125 x 22.5) cm for BCR538 and (45 x 25) cm for BCR539.

Parameters (determined according to ISO and ICC standards)	Cat. No. BCR563 Common wheat flour
Protein contentg/100 g dry matter basis	11.71 ± 0.13
Ash content dry matter basis	0.562 ± 0.008
Falling number / s	319 ± 15
Zeleny sedimentation 4 volume / mL	44 ± 1
CHOPIN ALVEOGRAPH	
P/mmH_2O*	80.8 ± 2.1
L/mm**	109 ± 7.2
P/L	0.8 ± 0.1
W/(10–^{4} Joules)***	289.9 ± 10.4
BRABENDER FARINOGRAPH	
Maximum consistency / BU (Brabender Units)	499 ± 5
Development time / min.	1.7 ± 0.3
Stability / min.	2.5 ± 0.4

Parameters (determined according to ISO and ICC standards)	Cat. No. BCR563 Common wheat flour
Degree of softening / BU (Brabender Units)	87 ± 9
BRABENDER EXTENSOGRAPH	
Maximum resistance / EU (Brabender Extensograph Units)	446 ± 39
Resistance at 50 mm / EU (Brabender Extensograph Units)	261 ± 30
Energy / (cm^2)	119 ± 14
Extensibility / mm	202 ± 9
MOISTURE MASS FRACTION [g/100 g]	13.95 ± 0.04

Availability: BCR563 is provided in vacuum sealed laminated foil envelopes in units of approximately 360 g.
*P:Mean curve height of Alveograph.
**L:Mean curve length.
***W:Area under Alveograph curve.

2.2.5 CERTIFIED FOR MICROBIOLOGICAL PROPERTIES

Cat. No. IRMM311: Genomic DNA (gDNA) of Bacillus licheniformis DSM 5749 in agarose inserts for Pulsed Field Gel Electrophoresis (PFGE)

*Sfi*I digested DNA fragments in the size interval 50 kb – 90 kb	Fragment length (kb)
Band no1	89.6 ± 4.7
2	80.9 ± 2.5
3	75.3 ± 2.7
4	72.2 ± 3.5
5	66.9 ± 1.9

*Sfi*I digested DNA fragments in the size interval 50 kb – 90 kb	Fragment length (kb)
6	64.6 ± 2.9
7	60.3 ± 1.3
8	56.5 ± 1.3
9	53.9 ± 1.3
10	50.6 ± 1.3

Availability: Each vial contains one agarose insert of undigested genomic DNA of Bacillus licheniformis DSM 5749 for PFGE.

Cat. No. IRMM312: Genomic DNA (gDNA) of Bacillus subtilis DSM 5750 in agarose inserts for Pulsed Field Gel Electrophoresis (PFGE)

***Sfi*I digested DNA fragments in the size interval 50 kb – 90 kb**	**Fragment length (kb)**
Band no1	89.2 ± 0.9
2	81.4 ± 0.8
3	77.7 ± 0.6
4	62.5 ± 1.8
5	59.5 ± 2.1

***Sfi*I digested DNA fragments in the size interval 50 kb – 90 kb**	**Fragment length (kb)**
6	44.0 ± 2.4
7	29.2 ± 2.0
8	23.6 ± 1.3
9	18.6 ± 1.3

Availability: Each vial contains one agarose insert of undigested genomic DNA of Bacillus subtilis DSM 5750 for PFGE.

Cat. No. IRMM313: Genomic DNA (gDNA) of Campylobacter coli (CNET068) and Campylobacter jejuni (CNET112) in agarose inserts for Pulsed Field Gel Electrophoresis (PFGE)

***Sma*I digested DNA fragments**	**DNA fragment sizes (kb)**
Fragment no 2	458.8 ± 2.0
3	351.7 ± 2.4
4	303.0 ± 2.3

***Sma*I digested DNA fragments**	**DNA fragment sizes (kb)**
5	263.2 ± 1.9
6	188.2 ± 1.2
7	173.2 ± 1.3

*Sma*I digested DNA fragments	DNA fragment sizes (kb)
8	131.1 ± 1.5
9	114.4 ± 1.2
10	95.5 ± 1.4
11	81.2 ± 1.7
12	

*Sma*I digested DNA fragments	DNA fragment sizes (kb)
13	54.9 ± 2.2
14	40.7 ± 1.6
15	(25.4 ± 1.3)
16	(17.6 ± 0.3)
	(10.9 ± 0.4)

Values in brackets are not certified.
Availability: Each vial contains one agarose plug for PFGE with undigested genomic DNA of *Campylobacter coli* CNET068 and *Campylobacter jejuni* CNET112 embedded.

Cat. No. IRMM351: Escherichia coli 0157 in material spheres

	Number of colony forming unit (cfu)
cfu per material sphere on nutrient agar	4 ± 2
cfu per material sphere on enterohemolysin agar	4 ± 2

Availability: Each vial contains one material sphere of Escherichia coli 0157 (NCTC 12900).

Cat. No. IRMM447: Genomic DNA (gDNA) of Listeria monocytogenes (strain 4B, NCTC 11994) with certified identity

	Indicative value (µg)
Mass of genomic DNA *Listeria monocytogenes* per vial	(1.1 ± 0.7)

Values in brackets are not certified.
Availability: Vial containing approximately 1.1 µg genomic DNA in lyophilised form and closed under argon atmosphere.

Cat. No. IRMM448: Genomic DNA (gDNA) of Campylobacter Jejuni (NCTC 11351) with certified identity

Property	
Identity	Confirmed by ceuE gene
Mass of genomic DNA per vial (ng)	(71 ± 39)

Values in brackets are not certified.
Availability: Vial containing approximately 71 ng genomic DNA in lyophilised form and closed under argon atmosphere.

Cat. No. IRMM449: Genomic DNA (gDNA) of Escherichia coli O157 (strain EDL 933) with certified identity

	Indicative value (µg)
Mass of genomic DNA Escherichia coli per vial	(1.3 ± 0.7)

Values in brackets are not certified.
Availability: Vial containing approximately 1.3 µg genomic DNA in lyophilised form and closed under argon atmosphere.

2.2.6 CERTIFIED FOR VETERINARY DRUGS

Cat. No.	Description	Substance	Hormones in lyophilised bovine urine		
BCR386[1]	Bovine urine	Diethylstilboestrol(DES)	< 0.1		
BCR387[1]	Bovine urine	Dienoestrol(DE)	< 0.1		
BCR388[1]	Bovine urine	Hexoestrol(HEX)	< 0.1		
BCR390RM [1]	Bovine urine	Dienoestrol(DE)	(34)		
BCR391[1]	Bovine urine	Hexoestrol(HEX)	13.3 ± 3.1		
			Content	Relevant below the certified value	Relevant above the certified value
BCR502[2]	Bovine urine	Clenbuterol	< 0.1		
		Salbutamol	< 0.2		

Cat. No.	Description	Substance	Hormones in lyophilised bovine urine		
BCR503[2]	Bovine urine	Clenbuterol	2.5	0.4	0.4
		Salbutamol	2.3	0.6	0.9
BCR504[2]	Bovine urine	Clenbuterol	6.0	0.5	0.7
		Salbutamol	5.6	1.1	1.9

Availability: [1] Vial containing approximately 0.36 g lyophilised bovine urine corresponding to 5.20 g of fresh bovine urine.
[2] Vial containing approximately 0.31 g lyophilised bovine urine corresponding to 5.18 g of fresh bovine urine.

Cat. No.	Description	Substance	Hormones in lyophilised bovine urine Mass concentration in reconstituted sample (µg/kg)
ERMBB386[1]	Bovine urine	Diethylstilboestrol(DES)	< 0.6
		Dienoestrol(DE)	< 0.6
		Hexoestrol(HEX)	< 0.4
ERMBB389[2]	Bovine urine	Diethylstilboestrol(DES)	1.1 ± 0.5
		Dienoestrol(DE)	5.5 ± 1.4
		Hexoestrol(HEX)	6.1 ± 0.9

Availability: [1] Vial containing approximately 0.36 g lyophilised bovine urine corresponding to 5.20 g of fresh bovine urine.
[2] Vial containing approximately 0.31 g lyophilised bovine urine corresponding to 5.18 g of fresh bovine urine.

Cat. No.	Description	Substance	Mass fraction in reconstituted sample (µg/kg)*
BCR648649	Bovine liver	Clenbuterol	< 0.5
	Bovine liver	Clenbuterol	1.2 ± 0.3
BCR474	Bovine liver	17 α-trenbolone	< 0.5
BCR475	Bovine liver	17 α-trenbolone	7.6 ± 2.2
BCR411	Bovine muscle	Diethylstilboestrol	> 0.5
BCR412	Bovine muscle	Diethylstilboestrol	< 0.1
BCR673	Bovine eye	Clenbuterol	< 0.5
BCR674	Bovine eye	Clenbuterol	9.4 ± 1.1

Availability: BCR648 and -649 are provided in units of 10 g lyophilised bovine liver in vials sealed under argon. BCR474 and -475 are sold as set and provided in brown glass vials in units of 2.8 g lyophilised liver corresponding to 10 g fresh liver. BCR411 and -412 are provided brown glass vials as lyophilised bovine muscle in units equivalent to about 5 g of fresh bovine tissue.
BCR673 and BCR674 are provided in brown glass vials containing about 0.1 g of material.

	Cat. No. BCR444 Porcine muscle (blank)(µg/kg)	Cat. No. ERMBB130 Pork muscle (µg/kg)
Chloramphenicol	< 0.2	0.230 ± 0.021

Availability: BCR444 is provided in brown glass vials, ERMBB130 in an amber glass bottle, each containing about 7 g of lyophilised pork muscle tissue.

Cat. No.	Description	Substance	Mass fraction in reconstituted sample (mg/kg)
BCR695	Pig liver	Chlortetracycline	< 0.004
BCR696	Pig liver	Chlortetracycline	0.58 ± 0.11
BCR697	Pig muscle	Chlortetracycline	< 0.006
BCR706	Pig kidney	Chlortetracycline	< 0.005
BCR707	Pig kidney	Chlortetracycline	1.30 ± 0.20

Availability: These CRMs are provided in sealed glass vials containing lyophilised tissue equivalent to 5 g of fresh tissue.

Substance	Cat. No. BCR725 Salmon tissue (µg/kg)
Flumequine	1170 ± 210
Oxolinic acid	600 ± 100

Availability: BCR725 is provided in amber glass vials containing 2.2 g of lyophilised salmon tissue material.

	Cat. No. ERMBB124 Pork muscle
Nitroimidazoles in the reconstituted material	Mass fraction (µg/kg)
Ronidazole (RNZ)	2.09 ± 0.25
Metronidazole (MNZ)	1.93 ± 0.15
2-hydroxymethyl-1-methyl-5-nitroimidazole (HMMNI)	0.69 ± 0.09
Hydroxymetronidazole (MNZOH)	6.2 ± 0.9
Hydroxyipronidazole (IPZOH)	1.67 ± 0.12
Dimetridazole (DMZ)	< 0.25

Availability: ERMBB124 is provided in amber glass bottles containing 10 g of lyophilised pork muscle tissue.

2.2.7 CERTIFIED FOR IDENTITY

(Cat. No. BCR599) Ewes'/Goats' Curd

BCR599 consists of a set of two freeze dried curd materials made from a mixture of ewes' and goats' milk, intended to detect adulteration by cows' milk in cheeses made from ewes' milk, goats' milk and mixtures thereof, according to the reference method described in Commission Regulation (EC) No. 1081/96. The 0 % material is not adulterated, the 1 % material is adulterated milk 1 % of cows' milk.

Availability: BCR599 is available as a set of two brown glass vials containing each about 15 g of lyophilised curd powder under Argon atmosphere.

(Cat. No. IRMMAD482) Calibration kit for ruminant detection by PCR

The calibration kit for ruminant detection by PCR is not a certified reference material because the copy number concentration values have only been determined in a single laboratory and the material have not yet been tested for long term stability. Consequently, the DNA copy number concentrations are provided as indicative values and not as certified values.

The materials are intended for the determination of a cut-off value to discriminate positive samples (containing the ruminant target sequence) from negative samples by quantitative PCR. As any reference material (RM), the materials can also be used for control charts or precision studies.

	Copy number concentration of the plasmid
	Indicative value [cp/µL]
IRMM AD482a	128
IRMM AD482b	32
IRMM AD482c	8

Availability: IRMMAD482 consists of a kit of three different vials containing plasmid solutions bearing a ruminant DNA target with indicative copy number concentrations of 128 cp/µL, 32 cp/µL and 8 cp/µL. The vials contain at least 1 mL of plasmid solution with Tris-EDTA buffer and maize genomic DNA at a concentration of 12 ng/µL.

2.2.8 OTHERS

Substance	Cat. No. ERMBD273 Toasted bread
	Mass fraction (ng/g)
Acrylamide	425 ± 29

Availability: ERMBD273 is available in a brown glass vial containing about 30 g of toasted bread powder.

3 MATERIALS RELATED TO CLINICAL CHEMISTRY

3.1 PURE STANDARDS AND SYNTHETIC MATERIALS

Cat. No.	Description	Purity (%)
BCR546	Formaldehyde 2,4-dinitrophenylhydrazone	> 99.3

Cat. No.	Description	Purity (%)
BCR547	Acetaldehyde 2,4-dinitrophenylhydrazone	98.3 ± 0.5

Cat. No.	Description	Purity (%)
BCR548	Acrolein 2,4-dinitrophenylhydrazone	> 97.9
BCR549	Acetone 2,4-dinitrophenylhydrazone	> 99.6

Cat. No.	Description	Purity (%)
BCR550	Glutaraldehyde 2,4-dinitrophenylhydrazone	> 98.1

Availability: Approximately 10 mg of crystals in glass vials.

Compounds	Cat. No. BCR551 Acetonitrile solution	Cat. No. BCR552 Acetonitrile solution
	Mass concentration (µg/mL)	(blank) (µg/mL)
Formaldehyde 2,4-Dinitrophenylhydrazone	2.94 ± 0.05	< 0.08
Acetaldehyde 2,4-dinitrophenylhydrazone	4.89 ± 0.07	< 0.05
Acrolein 2,4-dinitrophenylhydrazone	0.483 ± 0.011	< 0.04
Acetone 2,4-dinitrophenylhydrazone	4.96 ± 0.07	< 0.05

Availability: Set BCR5512 consists of 4 samples of BCR551 and 1 sample of BCR552.

Compounds	Cat. No. BCR553 Glass fibre filters Spiked mass per filter (expressed as µg formaldehyde)	Cat. No. BCR554 Glass fibre filters Mass per filter (blank) (expressed as µg formaldehyde)
Formaldehyde 2,4-dinitrophenylhydrazone on glass fibre filters	4.96 ± 0.06	< 0.1

Availability: Set BCR5534 consists of 2 samples of BCR553 and 1 sample of BCR554.

Substance	Cat. No. BCR555 Chlorinated hydrocarbons on Tenax (ng)
Dichloromethane	320 ± 40
1,1,1-Trichloroethane	370 ± 40
Trichloroethylene	390 ± 40

Substance	Cat. No. BCR555 Chlorinated hydrocarbons on Tenax (ng)
Perchloroethylene	327 ± 17
Toluene	57 ± 7

Availability: Stainless steel tube of 9.0 cm length and 0.25 inches outer diameter containing a single section of 250 mg TENAX GR, charged with 4 chlorinated hydrocarbons and toluene at the levels shown above.

Cat. No.	Description	Latex spheres Parameters of the calibration line
BCR165	Nominal 2 µm latex (0.02 % solids)	2.223 ± 0.013
BCR166	Nominal 4.8 µm latex (0.2 % solids)	4.821 ± 0.019
BCR167	Nominal 9.6 µm latex (1.4 % solids)	9.475 ± 0.018

Availability: Vials containing 2 mL of an aqueous suspension of latex spheres.

Cat. No.	Thyroxine (T_4)	3,3′,5-triiodothyronine (T_3)
IRMM468	98.6 ± 0.7	(0.51 ± 0.17)
IRMM469	(1.50 ± 0.12)	97.1 ± 0.7

Values in brackets are not certified.
Availability: The material consists of an off-white crystalline powder in an amber glass vial sealed under N_2 atmosphere. Each vial contains about 100 mg of the powder.

3.2 MATRIX MATERIALS

3.2.1 CERTIFIED FOR THE HORMONE CONTENT

Cat. No. ERMDA451- Cortisol reference panel of fresh frozen human sera

Serum No.	Certified value nmol/L	Uncertainty nmol/L
1	361	14
2	432	17
3	288	11
4	152	6
5	329	13

Serum No.	Certified value nmol/L	Uncertainty nmol/L
6	278	11
7	515	20
8	163	7
9	287	11
10	230	9

Serum No.	Certified value nmol/L	Uncertainty nmol/L
11	334	13
12	261	10
13	430	17
14	626	24
15	246	10
16	211	8
17	366	14
18	146	6
19	166	7
20	83	4
21	89	4
22	180	7

Serum No.	Certified value nmol/L	Uncertainty nmol/L
23	387	15
24	384	15
25	315	12
26	215	9
27	497	19
28	299	12
29	265	11
30	114	5
31	764	29
32	623	24
33	264	10
34	390	15

Availability: As panel of 34 x 1 mL serum in screw capped cryo-vials.

	Cortisol in human serum (concentration in the reconstituted material [1])	
Cat. No.	**(µg/L)**	**(nmol/L)**
ERMDA192	98.8 ± 2.0	273 ± 6
ERMDA193	277 ± 5	763 ± 14

Availability: In units of lyophilised material of a 1.25 mL portion of serum kept under nitrogen in sealed glass ampoules.
[1]The sample is to be reconstituted with (1.25 ± 0.01) mL of distilled water.

	Progesterone in human serum (concentration in the reconstituted material [1])	
Cat. No.	**(µg/L)**	**(nmol/L)**
BCR348R	8.5 ± 0.4	26.9 ± 1.2
ERMDA347	3.19 ± 0.07	10.13 ± 0.21

Availability: In units of lyophilised material of a 1 mL portion of serum kept under nitrogen in sealed glass ampoules.
[1]The sample is to be reconstituted with (1.0 ± 0.01) mL of distilled water.

Cat. No.	17β-Estradiol in human serum (concentration in the reconstituted material) Amount-of-substance concentration (nmol/L)
BCR576 [1]	0.114 ± 0.005
BCR577 [2]	0.689 ± 0.032
BCR578 [2]	1.34 ± 0.07

Availability: BCR576, -577, -578 are lyophilised material of a 5 mL (BCR576) or 1 mL (BCR577 and BCR578) portion of serum kept under nitrogen in sealed glass ampoules.
[1]The sample is to be reconstituted with (5.00 ± 0.05) mL of distilled water.
[2]The sample is to be reconstituted with (1.00 ± 0.01) mL of distilled water.

3.2.2 CERTIFIED FOR THE TOTAL ELEMENT CONTENT AND OTHER PROPERTIES

Cat. No.	Description	Substance	Metal concentrations in the reconstituted material [1] (µg/L)	
ERMCE196	Lyophilised bovine blood	Pb Cd [2]	772 ± 11	12.33 ± 0.20
BCR634	Lyophilised human blood	Pb Cd	46 ± 5	1.4 ± 0.4
BCR635	Lyophilised human blood	Pb Cd	210 ± 24	6.6 ± 0.6
BCR636	Lyophilised human blood	Pb Cd	$0.52 \cdot 10^3$ ± $0.05 \cdot 10^3$	11.6 ± 0.6

Availability: In units of lyophilised material equivalent to about 5.75 mL of bovine blood with additives kept under nitrogen in rubber stoppered vials. BCR634, BCR635 and BCR636 are available in lyophilised form in brown glass vials, containing approximately 0.6 g dry matter equivalent to 3.0 mL of fresh whole blood.
[1]The sample is to be reconstituted with (5.00 ± 0.01) mL water.
[2]Recertified by IRMM.

Cat. No.	Description	Substance	Element concentration in the reconstituted material [1] (mmol/L)
BCR304	Lyophilised human serum	Ca	2.201 ± 0.019
		Li	0.985 ± 0.029
		Mg	1.85 ± 0.03

Availability: In units of lyophilised material equivalent to about 5.3 mL of human serum kept under vacuum in rubber stoppered vials.
[1]The sample is to be reconstituted with (5.00 ± 0.01) mL bi-distilled water.

Cat. No.	Description	Substance	Metal concentrations (µg/L)
BCR637	Human serum	Al	12.5 ± 3.081 ± 7
		Se	1110 ± 220
		Zn	
BCR638	Human serum	Al	55 ± 7
		Se	104 ± 7
		Zn	1430 ± 210
BCR638	Human serum	Al	194 ± 14
		Se	133 ± 12
		Zn	2360 ± 140

Availability: Supplied in frozen form in white plastic vials containing approximately 4.5 mL serum.

Substance	ERMDB001 Human hair (mg/kg)
As	0.044 ± 0.006
Cd	0.125 ± 0.007
Cu	33 ± 4
Hg	0.365 ± 0.028

Substance	ERMDB001 Human hair (mg/kg)
Pb	2.14 ± 0.20
Se	3.24 ± 0.24
Zn	209 ± 12

Availability: Supplied in amber glass bottle, provided in aluminium sachet, and contains a minimum amount of 3.5 g of a human hair homogeneous powder

3.2.3 CERTIFIED FOR PROTEIN CONTENT

Cat. No.	Description	Mass concentration in the reconstituted material [1](g/L)
BCR393	Lyophilised Apo A I from human serum	1.06 ± 0.05

Availability: In units of lyophilised material equivalent to about 1.5 mL of Apolipoprotein solution in sealed glass ampoules under nitrogen.
[1]The sample must be reconstituted with 1.0 mL of phosphate buffer.

Cat. No.	Description	Mass concentration in the reconstituted material [1](g/L)
BCR457	Human Thyroglobulin (Tg)	0.324 ± 0.018

Availability: In units of lyophilised material in sealed glass ampoules under nitrogen.
[1]The sample must be reconstituted with 1.0 mL of distilled water.

Cat. No.	Description	Protein mass per ampoule [1] (µg)
BCR486	Purified alphafoetoprotein (AFP)	100 ± 9

Availability: BCR486 is provided in sealed glass ampoules. Each sample is in lyophilised form and it contains purified AFP without additives. The protein mass per ampoule is equivalent to (100 ± 9) µg when the material is reconstituted with 1.0 mL phosphate buffer according to the specified procedure.
[1]Carbohydrate mass of the molecule is not included.

Cat. No.	Description	Protein mass/ampoule
BCR613	Prostate specific antigen in the reconstituted material	71 ± 7µg

Availability: Lyophilised PSA in sealed glass ampoules kept under argon gas.

Cat. No.	Description	HbA_{1c}/Hb_T in reconstituted material (%)
BCR405RM	Glycated haemoglobin (HbA_{1c}) in human haemolysate	(6.29 ± 0.18)

Value in brackets is not certified.
Availability: Sealed glass ampoules of lyophilised material equivalent to about 0.5 mL of a solution of haemolysate of human erythrocytes kept under carbonmonoxide.
[1)]Sample to be reconstituted with 1 mL of deionised water and diluted with appropriate haemolyzing reagent, taking into account that the total haemoglobin (Fe_4) concentration is about 0.23 mmol/L (15 g/L).

Cat. No. ERMDA470kIFCC Human Serum Proteins	
Description	Mass concentration [1)] (g/L)
α_2 macroglobulin (A2M)	1.43 ± 0.06
α_1 acid glycoprotein (AAG)	0.617 ± 0.013
α_1 antitrypsin (AAT)	1.12 ± 0.03
Albumin (ALB)	37.2 ± 1.2
Complement 3c (C3c)	1.00 ± 0.04
Complement 4 (C4)	0.162 ± 0.007

Cat. No. ERMDA470kIFCC Human Serum Proteins	
Description	Mass concentration [1)] (g/L)
Haptoglobin (HPT)	0.889 ± 0.021
Immunoglobulin A (IgA)	1.80 ± 0.05
Immunoglobulin G (IgG)	9.17 ± 0.18
Immunoglobulin M (IgM)	0.723 ± 0.027
Transferrin (TRF)	2.36 ± 0.08
Transthyretin (TTR)	0.220 ± 0.018

Availability: Glass bottle containing lyophilised materials equivalent to about 1 mL of serum with additives kept under nitrogen.
[1)]Sample to be reconstituted with (1.00 ± 0.01) g water.

Cat. No.	Description	Mass concentration (mg/L)
ERMDA471IFCC	Cystatin C	5.48 ± 0.15

Availability: Glass vial containing lyophilised human serum spiked with cystatin C.

Cat. No.	Description	Mass concentration (mg/L)
ERMDA474IFCC	C-reactive protein (CRP)	41.2 ± 2.5

Availability: Glass ampoule containing at least 1 mL processed human serum spiked with CRP.

Cat. No.	Description	Absorbance at 540 nm and 10.00 mm pathlength	Mass concentration (mg/L)	Substance concentration (µmol/L)
BCR522	Haemiglobincyanide (HiCN) in bovine blood lysate	0.5457 ± 0.0009	800.3 ± 1.3	49.61 ± 0.08

Availability: Bovine blood lysate in sealed brown glass ampoules (10 mL) equivalent to about 800.3 mg/L of haemiglobincyanide.

Cat. No.	Description	Amount-of-substance concentration of creatinine (µmol/L)
BCR573	Creatinine in human serum	68.7 ± 1.4
BCR574	Creatinine in human serum	105.0 ± 1.3
BCR575	Creatinine in human serum	404.1 ± 7.1

Availability: BCR573, -574, -575 are the lyophilised form of approximately 1 mL portion of serum, with no additives. The mass of the lyophilised material contained in the ampoule is about 0.09 g.

Cat. No. BCR573i - Set of creatinine interfering substances

Availability: Consists of three vials with lyophilised solutions
- 0.025 mg calcium dobesilate / 1.2 mg cefoxitin;
- 0.044 mg sodium pyruvate;
- 0.108 mg bilirubin ditaurate.

Cat. No.	Description	Amount-of-substance fraction (mmol/mol)	
IRMMIFCC467	Haemoglobin isolated from whole blood	HbA0/(HbA1c + HbA0)	> 976

Availability: Provided in vials containing approximately 39 mg a deep frozen buffered solution.

3.2.4 CERTIFIED FOR CATALYTIC ACTIVITY

	Description	Catalytic concentration in reconstituted material Certified value	
		U/L	µkat/L
BCR410	Prostatic acid phosphatase highly purified, from human prostate [2)]	28.0 ± 0.7	0.466 ± 0.012
BCR647	Human adenosine deaminase (ADA1), from human erythrocytes [2)]		2.55 ± 0.09
BCR693	Human pancreatic lipase from pancreatic juice [4)]		28.9 ± 1.2
BCR694	Human pancreatic lipase (recombinant) [4)]		17.4 ± 1.0
ERMAD452	γ-Glutamyltransferase partially purified, from pig kidney [3)]	114.1 ± 2.4	1.90 ± 0.04
ERMAD454	Alanine aminotransferase partially purified, from pig heart [3)]	186 ± 4	3.09 ± 0.07
ERMAD455	Creatine kinase CK-MB from human heart [3)]	101 ± 4	1.68 ± 0.07
IRMMIFCC456	Human pancreatic α-Amylase [3)]		9.1 ± 0.3
ERMAD457IFCC	Aspartate Transaminase (AST)	104.6 ± 2.7	1.74 ± 0.05

Availability: Sealed glass ampoules of lyophilised material equivalent to about 1 mL of a solution of enzyme stabilized by incorporation in serum albumin matrix of human (BCR410) or bovine (ERMAD452, ERMAD454 and ERMAD457IFCC) origin kept under dry nitrogen. BCR647 has been stabilised by incorporation in a matrix of 50 mmol/L Tris/HCl buffer 9pH=7.4) and human serum albumin (30 g/L). ERMAD455 and IRMM IFCC456 are provided in sealed ampoules or vials filled with dry nitrogen. Samples are in lyophilised form and equivalent to about 1 mL of a solution of purified enzyme. BCR693 and BCR694 are provided in ampoules of lyophilised material equivalent to about 1 mL of stabilised enzyme.

[1)]According to IFCC recommended method at 30 °C.
[2)]According to method specified in report.
[3)]According to IFCC recommended method at 37 °C.
[4)]According to method described in certification report at 37 °C.

3.2.5 CERTIFIED FOR DNA SEQUENCE

SET OF PLASMID SOLUTIONS		
	Number of specific DNA fragments per plasmid	
	Certified value	Uncertainty
BCR-ABL b3a2 transcript	1	negligible
BCR transcript	1	negligible
GUSB transcript	1	negligible
	Copy number concentration of the plasmid	
	Certified value [cp/µL]	Uncertainty [cp/µL]
ERMAD623a	1.08×10^{6}	0.13×10^{6}
ERMAD623b	1.08×10^{5}	0.11×10^{5}
ERMAD623c	1.03×10^{4}	0.10×10^{4}
ERMAD623d	1.02×10^{3}	0.09×10^{3}
ERMAD623e	1.04×10^{2}	0.10×10^{2}
ERMAD623f	10.0	1.5

Availability: ERMAD623 is a set of six plasmid solutions (a-f). Each of six vials contains approximately 600 µL of plasmid solution.

3.2.6 OTHERS

Cat. No.	Description	Parameters of the calibration line
ERMAD149	Lyophilised rabbit thromboplastin	Slope 1.257 ± 0.013 Intercept – 0.242 ± 0.019

Availability: ERMAD149 in sealed glass ampoules containing the lyophilised form of a 0.5 mL aliquot of the extract of rabbit brain tissue, without calcium ion added.

	Cat. No. BCR665 Asbestos fibres in lung tissue (Number of fibres of more than 1 µm in length in million per g dry tissue)	Cat. No. BCR666 Asbestos fibres in lung tissue (Number of fibres of more than 1 µm in length in million per g dry tissue)
Amosite + crocidolite	49 ± 16	2.3 ± 0.9
Anthophyllite	1.8 ± 0.9	5.1 ± 1.5

Availability: Sealed vials with 100 mg of lung tissue.

	Cat. No. IRMM435 Pharmaceutical glass containers Alkali leaching and release
Volume of titration solution 0.01 mol/L HCl per 50 mL of leachate	0.38 ± 0.04mL
Sodium release per volume of leachate	1.41 ± 0.14mg/L
Release of Na_2O per volume of leachate	1.91 ± 0.19mg/L

Availability: Each unit of IRMM435 consists of 20 vials of 18.9 mL brimful capacity, made of a semi-durable type of glass, which screw caps.

4 MATERIALS CERTIFIED FOR PHYSICAL PROPERTIES

4.1CERTIFIED FOR THERMAL PROPERTIES

Cat. No. IRMM440 (A-D) - Resin bonded glass fibre board

The certified thermal conductivity between – 10 °C and + 50 °C is given by

λ [W/(m.K)] = 0.029 394 9 + 0.000 106 0 x T [°C] + 2.047 x 10^{-7} x T^2 [(°C)^2]

This equation is valid for a sample of the reference material within the density range [64 kg/m^3 - 78 kg/m^3].

The uncertainty of the certified thermal conductivity is * 0.000 28 W/(m.K) at the 95 % confidence level over the range [- 10 °C / + 50 °C].

Availability: Boards which can be cut to: (300 x 300 x 35) mm, (500 x 500 x 35) mm, (600 x 600 x 35) mm, (1000 x 1000 x 35) mm.

Cat. No. BCR724 (A-E) - Glass-ceramic

The certified thermal diffusivity between 298 K and 1025 K is given by α [m^2/s . 10^{-6}] = 4.406 – 1.351 . 10^{-2} . T + 2.133 . 10^{-5} . T^2 – 1.541 . 10^{-8} . T^3 + 4.147 . 10^{-12} . T^4

The uncertainty of the certified thermal diffusivity is + 6.1 [%] at the 95 % confidence level over the range from 298 K to 1025 K.

The certified thermal conductivity between 298 K and 1025 K is given by λ [W/(m . K)] = 2.332 + 515.1 / T

The uncertainty of the certified thermal conductivity is + 6.5 [%] at the 95 % confidence level over the range from 298 K to 1025 K.

Availability: Glass-ceramic cylinders in different shapes (BCR724A: diameter = 13.0 mm, height > 18 mm; BCR724B: diameter = 13.9 mm, height > 21 mm; BCR724C: diameter = 25.9 mm, height > 22 mm; BCR724D: diameter = 26.9 mm, height > 22 mm; BCR724E: diameter = 50.7 mm, height > 25 mm).

Substance	Cat. No. ERMEF411 Hard coal	Cat. No. ERMEF412 Brown coal	Cat. No. ERMEF413 Furnace coke
Gross calorific value (GCV) (MJ/kg)	29.0 ± 0.4	26.02 ± 0.22	29.5 ± 0.4
Net calorific value (NCV) (MJ/kg)	28.0 ± 0.4	24.98 ± 0.25	29.4 ± 0.5
Volatile matter (g/100 g)	38.1 ± 1.0	50.1 ± 0.7	
Ash (g/100 g)	8.3 ± 0.7	4.11 ± 0.23	
C (g/100 g)	71.4 ± 1.0	66.2 ± 0.7	87.8 ± 1.9
Ca (g/kg)		9.8 ± 0.4	2.92 ± 0.22
Cd (mg/kg)		(0.012 ± 0.004)	
Cl (mg/kg)	99 ± 19		(350 ± 130)
Co (mg/kg)	(3.5 ± 0.8)		
Cu (mg/kg)		(0.68 ± 0.22)	
H (g/100 g)	4.80 ± 0.14	4.88 ± 0.15	
Hg (mg/kg)	(0.079 ± 0.015)	0.071 ± 0.011	

Substance	Cat. No. ERMEF411 Hard coal	Cat. No. ERMEF412 Brown coal	Cat. No. ERMEF413 Furnace coke
K (mg/kg)		229 ± 18	
Mg (g/kg)		(3.73 ± 0.16)	(0.00123 ± 0.00019)
Mn (mg/kg)		48.6 ± 1.9	
N (g/100 g)	1.43 ± 0.10	0.74 ± 0.06	1.10 ± 0.07
Na (g/kg)		2.20 ± 0.12	0.64 ± 0.07
Pb (mg/kg)		(0.25 ± 0.05)	(8.41 ± 1.6)
S (g/100 g)	0.598 ± 0.017	0.360 ± 0.023	0.58 ± 0.12
Sb (mg/kg)	(1.5 ± 0.4)	(0.024 ± 0.004)	
Se (mg/kg)	5.1 ± 1.0	0.96 ± 0.14	1.33 ± 0.26
Tl (mg/kg)	(0.24 ± 0.07)		
V (mg/kg)	(22 ± 7)	0.57 ± 0.04	
Zn (mg/kg)	(13 ± 4)	(0.99 ± 0.18)	16.0 ± 2.5

Values in brackets are not certified.
Availability: ERMEF411, ERMEF412 and ERMEF413 are available in units of about 50 g in aluminium-laminated sachets.

4.2 CERTIFIED FOR MECHANICAL PROPERTIES

Cat. No. BCR116 - Shear testing of powders

The flow of powders or granulated materials under the force of gravity affects the design and operation of silos used for their bulk storage. The European Federation of Chemical Engineering (EFCE) therefore developed a test method, based on the Jenike Shear Cell, to determine the shear strength of powders under different compaction and loading conditions. The complexity of this method is such that errors due to poor technique can easily arise. A reference material has therefore been produced with which laboratories can verify both their equipment and experimental technique.

Essentially the EFCE method consists of using a known load to compact a powder sample into a cylindrical Jenike Cell composed of two metal rings one upon the other. Having reached critical compaction of the powder, the steady state force necessary to displace the upper ring horizontally with respect to the lower one is determined with the compaction load still applied. Having established steady state shear the normal load on the powder is then reduced and the horizontal force necessary to continue to shear the powder is determined. It is this variation of the shear force as a function of the reduced normal load for a given compaction load which characterizes the powder.

The reference material consists of 3 kg of limestone powder packed in a polyethylene jar. It is accompanied by a certificate giving shear stress as a function of normal applied stress for four different powder compaction stresses.

Cat. No. BCR425 - Creep

Creep is the progressive deformation of a material under load. Metallic materials are usually tested at elevated temperatures for periods of 1 000 to 100 000 hours by surrounding them with a suitable constant temperature furnace. The need to operate under such conditions gives rise to problems of alignment, strain measurement, temperature measurement etc. which can result in considerable differences in results between laboratories.
BCR425 was therefore developed to allow laboratories to validate their creep testing rigs and procedures as a whole within a reasonable time (500 to 600 hours) using a material whose properties are sensitive to test conditions.

The test piece is delivered in the form of a bar of 14 mm diameter and 500 mm length which must be machined by the laboratory to the required shape and size.

At a test temperature of 600 °C, using an applied stress of 160 MPa the certified properties are as follows:

Creep rate at 400 hours of	(72 ± 5)10^{-6} h^{-1}
Time to a creep strain of 2 %	(278 ± 16)h
Time to a creep strain of 4 %	(557 ± 30)h

Cat. No. BCR661B - Nimonic 75 for ambient temperature tensile properties

Property	Certified value
0.2 % proof stress $R_{p0.2}$	(300 ± 8) MPa
0.5 % proof stress $R_{p0.5}$	(318 ± 7) MPa

Property	Certified value
Ultimate tensile strength R_m	(750 ± 14) MPa
Elongation to fracture A	(40.9 ± 0.9) %

Property	Certified value
Reduction in area Z	(60 ± 4) %

Availability: BCR661B can be supplied in 3 bars of 150 mm long and diameter 14 m or as 1 bar of 500 m long, sufficient for the manufacture of three test-pieces.

Cat No. BCR692 - Scratch testing

Failure event	Critical load	
	Certified value (N)	Uncertainty (N)
Forward chevron cracks at the borders of the scratch track. (Lc_1 shall be taken at the closest end of the event to the scratch track start).	(Lc_1) 13.6	1.8
Forward chevron cracks at the borders of the scratch track, with local interfacial spallation or with gross interfacial spallation. (Lc_2 shall be taken at the failure event that occurs first and at the closest end of the event to the scratch track start).	(Lc_2) 17.0	2.1
Gross interfacial shell-shaped spallation. (Lc_3 shall be taken at the first point where the substrate can be seen at the centre of the track in a crescent that goes completely through the track).	(Lc_3) 28	2.9

Availability: The reference samples are (30x30x5) mm steel coupons coated with a diamond-like carbon coating (DLC) applied by plasma-assisted chemical vapour deposition. The coupons are distributed in a reusable plastic box containing desiccant.

4.3 CERTIFIED FOR MORPHOLOGICAL PROPERTIES

Particle size distributions				
Cat. No.	**Form of Quartz**	**Certified Property**	**Size Range (µm)**	**Unit Size (g)**
BCR066	Powder	Stokes' diameter	0.35-3.50	10
BCR067	Powder	Stokes' diameter	2.40-32.00	10
BCR068	Sand	Volume diameter	160.0-630.0	100
BCR069	Powder	Stokes' diameter	14.0-90.0	10
BCR070	Powder	Stokes' diameter	1.20-20.00	10

Particle size distributions				
Cat. No.	**Form of Quartz**	**Certified Property**	**Size Range (µm)**	**Unit Size (g)**
BCR130	Powder	Volume diameter	50-220	50
BCR131	Powder	Volume diameter	480-1800	200
BCR132	Gravel	Volume diameter	1400-5000	700

Cat. No.	Form of Quartz	Specific Surface Area ($m^2 \cdot g^{-1}$)	Unit Size (g)
BCR169	Alpha alumina	0.104 ± 0.012	60
BCR170	Alpha alumina	1.05 ± 0.05	60
BCR171	Alumina	2.95 ± 0.13	50
BCR172	Quartz	2.56 ± 0.10	10
BCR173	Titanium dioxide	8.23 ± 0.21	46
BCR175	Tungsten	0.18 ± 0.04	200

Cat. No. BCR301RM Mullite ($3Al_2O_3 \cdot 2SiO_2$)

High crystallinity.
Vitreous phase 0.03 g/g. No other phase detected.

Impurities in g/kg:	
Fe_2O3< 2	Na_2O< 1
CaO< 1.2	K_2O< 0.5
MgO< 0.5	TiO_2< 0.5

Cat. No. BCR301RM Mullite		
Reflection	Lattice spacing (nm)	Relative intensity
[110]	0.538 2	0.50
[210]	0.339 0	1
[220]	0.269 5	0.40

Cat. No. BCR301RM Mullite		
Reflection	Lattice spacing (nm)	Relative intensity
[121]	0.220 6	0.59
[331]	0.152 4	0.36

Cat. No. BCR302 - Microcrystalline cellulose (Water content at 10 water activities)

The water content of the material when in equilibrium with the atmosphere above each saturated salt solution specified in the table was determined at 25 °C by the method recommended by COST 90.
BCR302 is specifically intended to check the correct application of the COST procedure for determination of water sorption isotherms of foods.

Nominal water activity a_w at 25 °C	Certified equilibrium water content mass fraction g/kg)	Specified saturated salt aqueous solution
0.1105	21.3 ± 1.1	1 Lithium Chloride
0.2245	32.4 ± 1.3	2 Potassium Acetate
0.3300	41.5 ± 0.9	3 Magnesium Chloride
0.4276	51.6 ± 0.9	4 Potassium Carbonate
0.5286	59.7 ± 1.4	5 Magnesium Nitrate
0.5770	64.7 ± 1.5	6 Sodium Bromide
0.7083	82.5 ± 1.7	7 Strontium Chloride
0.7528	88.9 ± 2.4	8 Sodium Chloride
0.8426	110 ± 4	9 Potassium Chloride
0.9019	133 ± 5	10 Barium Chloride

Availability: 20 g in sealed sachets.

Cat. No.	Description	Micropore volume (cm^3 / g^1)	Median micropore width (nm)
BCR704	Faujasite type zeolite	0.205 ± 0.006	0.668 ± 0.019
BCR705	Linde type A zeolite	0.181 ± 0.006	0.592 ± 0.020

Availability: Glass bottle containing 10 g of pellets.

Cat. No. BCR261T - Reference material for depth profiling by ion beam sputtering

In order to achieve the accuracy required when measuring compositional depth profiles using ion beam sputtering in association with Auger Electron Spectroscopy, a reference material of accurately known thickness on a stable substrate is required. BCR261T is a tantalum pentoxide on tantalum foil reference material existing in two nominal thicknesses of 30 and 100 nm.

	Nominal thickness (nm)	Certified values	
Cat. No.		10^{21} oxygen atoms/m^2	oxide thickness ratio
BCR261T	(30)	1.72 ± 0.07	0.321 ± 0.013
	(100)	5.40 ± 0.12	

Values in brackets are not certified.
Availability: Four rectangular foils of 5 x 10 mm of each oxide thickness.

Cat. No. ERMFD100 - Colloidal Silica in water	Equivalent spherical diameter	
	Certified value (nm)	Uncertainty (nm)
Intensity-weighted harmonic mean diameter (DLS)	19.0	0.6
Intensity-based modal Stokes diameter (CLS)	20.1	1.3
Number-based modal diameter (TEM/SEM)	19.4	1.3
Intensity-weighted mean diameter (SAXS)	21.8	0.7
Equivalent spherical diametr, volume-weighted mean (SAXS)	(20.4)	(1.6)
Zeta Potential	(- 43.0 mV)	(22 mV)

Values in brackets are not certified.
Availability: ERMFD100 is available in 10 mL pre-scored amber glass ampoules containing approximately 9 mL of suspension.

Cat. No. ERMFD304 - Colloidal Silica in aqueous solution	Equivalent spherical diameter	
	Certified value (nm)	Uncertainty (nm)
Scattering intensity-weighted harmonic mean diameter (DLS)	42.1	0.6
Extinction intensity-based modal Stokes (CLS)	33.0	3.0
Number-based modal diameter (TEM/SEM)	(27.8)	(1.5)

Values in brackets are not certified.
Availability: ERMFD304 is available in 10 mL pre-scored amber glass ampoules containing approximately 9 mL of suspension.

Cat. No. ERMFD102 - Mixture of Silica Nanoparticles in aqueous solution	Equivalent spherical diameter			
	Size class A		Size class B	
	Certified value (nm)	Uncertainty (nm)	Certified value (nm)	Uncertainty (nm)
Scattering intensity-weighted arithmetic mean hydromatic diameter (DLS)	17.8	1.5	88.5	2.2
Extinction intensity-weighted modal Stokes'diameter (CLS)	23.9	2.0	88	7
Number-weighted modal area-equivalent diameter (TEM and SEM)	18.2	1.6	84.0	2.1
Number-weighted median area-equivalent diameter (TEM and SEM)	18.3	1.7	83.3	2.3
Number-weighted mean hydrodynamic diameter (PTA)	-	-	(82)	(4)
Number-weighted modal maximum particle height (ATM)	(16.9)	(1.8)	(80)	(6)

Values in brackets are not certified. More indicative & information values are given on the certificate
Availability: ERMFD102 is available in 10 mL pre-scored amber glass ampoules containing approximately 9 mL of suspension.

5 MATERIALS RELATED TO INDUSTRIAL APPLICATIONS

5.1 CERTIFIED FOR COMPOSITION

Certified Parameter	Cat. No. IRMM441 n-Heptane (g/kg)	Cat. No. IRMM442 Isooctane (g/kg)
Isooctane, purity by difference		999.85 ± 0.05
n-Heptane, purity by difference	999.85 ± 0.05	
Impurities		
Total organics (other than isooctane)		0.11 ± 0.04
Total organics (other than n-Heptane)	0.12 ± 0.05	
Isooctane	0.07 ± 0.02	
n-Heptane		0.02 ± 0.02
Water	0.03 ± 0.02	0.04 ± 0.02

Availability: IRMM441 and -442 are supplied in ampoules of 100 mL.

Cat. No. ERMEF001 - Biodiesel certified for selected parameters specified in EN 14214	Unit	Certified values
Ester content	% (m/m)	98.9 ± 1.7
Linolenic acid methyl ester content	% (m/m)	8.82 ± 0.16
Monoglyceride content	% (m/m)	0.65 ± 0.04
Diglyceride content	% (m/m)	0.136 ± 0.015
Triglyceride content	% (m/m)	<0.1
Total glycerol content	% (m/m)	0.187 ± 0.009
Water content	% (m/m)	0.0205 ± 0.0024
Density (at 15 °C)	kg/m³	883.20 ± 0.04

Cat. No. ERMEF001 - Biodiesel certified for selected parameters specified in EN 14214	Unit	Certified values
Viscosity (at 40 °C)	mm^2/s	4.465 ± 0.005
Oxidation stability (at 110 °C)	h	9.8 ± 0.5
Acid value	mg KOH/g	0.184 ± 0.015
Iodine value	g iodine/100 g	112 ± 4
Flash point	°C	181 ± 14

Availability: Vials containing about 27 mL of biodiesel.

Cat. No.	Description	Substance	Certified values
BCR032	Moroccan Phosphate rock	CaO	518 ± 4 g/kg
		P_2O_5	329.8 ± 1.7 g/kg
		CO_2	51.0 ± 0.8 g/kg
		F	40.4 ± 0.6 g/kg
		SiO_2	20.9 ± 1.2 g/kg
		SO_3	18.4 ± 0.8 g/kg
		Al_2O_3	5.5 ± 0.6 g/kg
		MgO	4.0 ± 0.1 g/kg
		Fe_2O_3	2.3 ± 0.1 g/kg
		As	(9.5 ± 0.5 mg/kg)
		B	(22.6 ± 2.2 mg/kg)

Cat. No.	Description	Substance	Certified values
BCR032	Moroccan Phosphate rock	Cd	(20.8 ± 0.7 mg/kg)
		Cr	(257 ± 16 mg/kg)
		Co	(0.59 ± 0.06 mg/kg)
		Cu	(33.7 ± 1.4 mg/kg)
		Hg	(0.055 ± 0.011 mg/kg)
		Mn	(18.8 ± 1.3 mg/kg)
		Ni	(34.6 ± 1.9 mg/kg)
		Ti	(171 ± 10 mg/kg)
		V	(153 ± 7 mg/kg)
		Zn	(253 ± 6 mg/kg)

Values in brackets are not certified. Availability: Units of about 100 g in the form of fine powder.

Cat. No.	Description	Substance	Certified values (g/kg)
BCR010	Tin Ore	Sn	765.9 ± 1.2

Availability: This CRM is contained in brown glass bottles. The approximate quantity per unit is 225 g.

Cat. No.	Description	Substance	Certified values (g/kg)
BCR033	Super-phosphate	P_2O_5	193.4 ± 1.2
		SO_4	428.0 ± 4.1
		CaO	314.8 ± 3.1
		SiO_2	29.2 ± 1.2
		F	16.5 ± 0.5
		Al_2O_3	11.0 ± 0.8
		Fe_2O_3	4.0 ± 0.2
		MgO	2.1 ± 0.2
BCR113	Potassium Chloride	K	502.5 ± 1.1
		Cl	478.0 ± 0.9
		Na	15.3 ± 0.2
		Ca	1.03 ± 0.04
		Mg	0.24 ± 0.01
		water soluble K	501.3 ± 0.7
BCR114	Potassium Sulphate	K	418.0 ± 0.9
		SO_4	533 ± 2
		Cl	18.5 ± 0.1
		Na	11.0 ± 0.1

Cat. No.	Description	Substance	Certified values (g/kg)
		Ca	9.4 ± 0.2
BCR114		Mg	0.74 ± 0.01
		water soluble K	417.6 ± 0.8
BCR178	Calcium Ammonium Nitrate	NH4 – N	130.44 ± 0.32
		NO_3 - N	130.15 ± 0.57
		total - N	260.19 ± 0.54
		Ca	88.82 ± 0.27
BCR179	Urea	total – N	465.4 ± 0.8
		Uric – n	460.9 ± 0.9
		Biuret	10.37 ± 0.11

Availability: Units of about 100 g in the form of fine powder.

Substance	Cat. No. BCR126A Lead crystal glass (g/kg)
SiO_2	57.80 ± 0.11
PbO	23.98 ± 0.06
K2O	9.99 ± 0.07
Al_2O_3	0.126 ± 0.013
Fe_2O_3	0.005 5 ± 0.001 2
Sb_2O_3	0.291 ± 0.012
BaO	1.053 ± 0.030
CaO	1.033 ± 0.030

Substance	Cat. No. BCR126A Lead crystal glass (g/kg)
MgO	0.512 ± 0.013
ZnO	1.01 ± 0.04
Na_2O	3.57 ± 0.07
Li_2O	0.494 ± 0.016
Density at 20 °C	2.990 5 ± 0.001 6 g/cm³
Refractive index $n_D^{20\,°C}$ at 589.3 nm	1.559 67± 0.000 22

Availability: In the form of square plates (100 × 100 mm) and 10 mm thickness.

5.2 CERTIFIED FOR TRACE ELEMENT CONTENT

Cat. No.	Material	Certified value	Form	Unit
IRMM521	Ni	< 0.1 mg Co kg^{-1}	B:0.5 mm wire R:0.1 mm foil	100 cm^2 (1.8 g) 75 cm^2 (6.7 g)
IRMM522	Cu	< 0.05 mg Co kg^{-1} 0.95 ± 0.04 mg Ag kg^{-1}	A: 0.1 mm foil B: 1.0 mm foil C: 0.5 mm wire D: 1.0 mm wire	100 cm^2 (8.9 g) 20 cm^2 (17.8 g) 1 m (1.8 g) 1 m (7.0 g)
IRMM523	Al	< 0.1 mg Na kg^{-1}	A: 0.1 mm foil B: 1.0 mm foil C: 1.0 mm wire	100 cm^2 (2.7 g) 20 cm^2 (5.4 g) 1 m (2.1 g)
IRMM524	Fe	< 0.05 mg Co kg^{-1} < 0.1 mg Mn kg^{-1}	A: 0.1 mm foil B: 0.5 mm wire	100 cm^2 (7.9 g) 1 m (1.6 g)
IRMM525	Nb	19.6 ± 1.8 mg Ta kg^{-1}	A: 0.02 mm foil B: 0.1 mm foil C: 0.5 mm wire	20 cm^2 (0.3 g) 20 cm^2 (1.7 g) 1 m (1.7 g)
IRMM526	Nb	0.30 ± 0.09 mg Ta kg^{-1}	A: 0.02 mm foil B: 0.1 mm foil C: 0.5 mm wire	20 cm^2 (0.3 g) 20 cm^2 (1.7 g) 1 m (1.7 g)
IRMM529	Rh	< 5 g Pt kg^{-1} 26.0 ± 0.6 g Ir kg^{-1}	0.05 mm foil	20 cm^2 (1.2 g)
IRMM531	Ti	< 0.1 mg Sc kg^{-1}	A: 0.1 mm foil B: 0.5 mm foil C: 0.5 mm wire	100 cm^2 (4.5 g) 20 cm^2 (4.5 g) 1 m (1 g)
IRMM527R	Al – 0.1% Co	1.001 ± 0.024 g Co kg^{-1}	A: 0.1 mm foil B: 0.5 mm wire C: 1.0 mm wire	100 cm^2 (2.7 g) 1 m (0.5 g) 1 m (2.1 g)

Cat. No.	Material	Certified value	Form	Unit
IRMM528R	Al – 1.0% Co	10.02 ± 0.23 g Co kg^{-1}	A: 0.1 mm foil C: 1.0 mm wire	100 cm^2 (2.7 g) 1 m (2.1 g)
IRMM530R	Al – 0.1% Au	1.003 ± 0.012 g Au kg^{-1}	A: 0.1 mm foil C: 1.0 mm wire	100 cm^2 (2.7 g) 1 m (2.1 g)
IRMM532	Al – 0.01% Co	0.100 0 ± 0.0025 g Co kg^{-1}	A: 0.1 mm foil B: 0.5 mm wire C: 1.0 mm wire	100 cm^2 (2.7 g) 1 m (0.5 g) 1 m (2.1 g)
IRMM533	Al – 0.1% Ag	0.996 ± 0.017 g Ag kg^{-1}	A: 0.1 mm foil B: 0.5 mm wire C: 1.0 mm wire	100 cm^2 (2.7 g) 1 m (0.5 g) 1 m (2.1 g)
IRMM534	Al – 2.0% Sc	19.95 ± 0.20 g Sc kg^{-1}	A: 0.1 mm foil B: 0.5 mm wire C: 1.0 mm wire	100 cm^2 (2.7 g) 1 m (0.5 g) 1 m (2.1 g)

Cat. No.	Description	Substance	Certified value (mg/kg)	Form, dimensions [1] and availability
BCR017A	Copper	P	6.85 ± 0.2	A:∅42 mm,h30 mm
BCR017B		S	10.4 ± 0.6	B:chips (bottle with 50 g)
BCR022A	Copper (electrolytic tough pitch)	O	138 ± 7	∅26 mm,h9 mm
BCR022B	Copper (electrolytic tough pitch)	O	138 ± 7	∅9 mm,h50 mm
BCR054R	Copper (low oxygen)	O	0.47 ± 0.07	∅7 mm,h50 mm
BCR058	Copper (continuous cast)	O	390 ± 12	∅7 mm,h50 mm
BCR024B	Titanium	N	117 ± 13	B:25 cubes of 0.4 g
BCR024C		O	608+23	C:25 cubes of 0.2 g
BCR059A	Titanium alloy Ti6Al4V	O	1750 ± 70	A:∅26 mm,h9 mm
BCR059B		N	172 ± 27	B:25 cubes of 0.2 g
BCR318	Titanium	H	12.2 ± 0.6	∅7 mm,h1 mm
				(bottle with approx. 100 discs)
BCR275	Zirconium alloy Zircaloy-4	O	1670 ± 50	∅13 mm,h1 mm
		N	39.0 ± 1.7	(bottle with 10 discs)
		C	113 ± 4	
BCR276	Zirconium alloy Zircaloy-4	O	1540 ± 80	∅4.5 mm,h2 mm
		N	41 ± 9	(bottle with approx. 100 discs)
		C	108 ± 101	
BCR102	Tungsten carbide powder	O	185 ± 4	Bottles containing 2 - 3 g powder, sealed under argon in an aluminium container

1)∅ = diameter, h = height

Substance	Cat. No. BCR286 Electrolytically refined lead (mg/kg)	Cat. No. BCR287 Thermally refined lead (mg/kg)	Cat. No. BCR288 Lead with added impurities (mg/kg)
Ag		15.20 ± 0.21	
As			55.7 ± 1.6
Bi	21.5 ± 0.5	67.3 ± 1.1	215.8 ± 2.4
Cd		0.356 ± 0.024	33.3 ± 0.9
Cu		0.98 ± 0.05	19.3 ± 0.4
Sb	0.099 ± 0.021	0.040 ± 0.015	
Se			< 0.2
Te			32.8 ± 1.3
Tl	2.47 ± 0.07	0.73 ± 0.04	2.26 ± 0.08

Substance	Cat. No. BCR286 Electrolytically refined lead (mg/kg)	Cat. No. BCR287 Thermally refined lead (mg/kg)	Cat. No. BCR288 Lead with added impurities (mg/kg)
Zn	< 0.1	< 0.1	8.2 ± 0.4

Availability: CRMs are available as follows: BCR286A and -287A: blocks of 60 × 60 × 12 mm, BCR286B, -287B and -288B: chips in bottles containing about 160 g.

Substance	Cat. No. BCR321	Cat. No. ERMEB322	Cat. No. ERMEB323	Cat. No. ERMEB324	Cat. No. ERMEB325	Cat. No. BCR326	Cat. No. BCR327
	Unalloyed zinc (mg/kg)						
Al	< 0.7						
Cd	(0.23 ± 0.03)	15.08 ± 0.30	6.51 ± 0.21	48.6 ± 1.1	94.7 ± 2.5	203.0 ± 2.0	301.4 ± 2.3
Cu	(0.97 ± 0.05)	5.89 ± 0.15	18.9 ± 0.4	9.87 ± 0.18	47.5 ± 2.0	104.8 ± 2.7	(0.56 ± 0.11)
Fe	(2.22 ± 0.14)	19.1 ± 0.8	11.3 ± 0.7	58.5 ± 1.6	56.1 ± 3.3	264.8 ± 2.1	144.0 ± 1.3
In	< 0.2						
Pb	4.85 ± 0.20	15.0 ± 0.5	48.6 ± 0.9	26.1 ± 0.5	142 ± 9	307.0 ± 1.6	409.4 ± 2.3
Sn	< 0.5	5.6 ± 0.6	18.7 ± 0.7	9.8 ± 0.5	46.1 ± 2.0		
Tl	0.78 ± 0.10	5.28 ± 0.30	10.8 ± 0.5	19.9 ± 0.5	36.8 ± 1.2		

Values in brackets are not certified.
Availability: Discs of 80 mm diameter and 20 mm thickness (BCR321, -326, -327) and 60 mm diameter, 30 mm thickness, respectively (ERMEB322, EB323, EB324 and EB325).

Substance	Cat. No. BCR351	Cat. No. BCR352	Cat. No. BCR353	Cat. No. BCR354	Cat. No. BCR355
	ZnAl4 (mg/kg)				
Al	[43.55 ± 0.11] × 10^3	[41.50 ± 0.10] × 10^3	[39.5 ± 0.4] × 10^3	[37.27 ± 0.16] × 10^3	[34.43 ± 0.13] × 10^3
Cd	(0.21 ± 0.03)	2.88 ± 0.12	10.44 ± 0.16	29.7 ± 0.4	58.1 ± 0.4
Cu	12.13 ± 0.15	31.26 ± 0.29	100.0 ± 0.8	312.3 ± 2.5	1035 ± 6
In	< 0.2	3.02 ± 0.28	2.55 ± 0.23	9.8 ± 0.9	24.6 ± 1.4
Mg	131.0 ± 0.9	283.0 ± 1.8	452.5 ± 2.4	602 ± 5	786 ± 6
Ni	(1.9 ± 0.6)	6.74 ± 0.16		83.1 ± 2.9	268 ± 8
Pb	4.50 ± 0.20	(6.4 ± 1.6)	24.4 ± 1.3	30.8 ± 1.2	56.9 ± 1.9
Sn	< 1	3.0 ± 0.7	5.6 ± 0.6	14.1 ± 1.1	29.1 ± 2.0
Tl	0.74 ± 0.06	3.2 ± 0.4	3.95 ± 0.22	11.01 ± 0.20	23.25 ± 0.28

Values in brackets ( ) are not certified.
Availability: Discs of 80 mm diameter and 20 mm thickness.

	Cat. No. BCR356	Cat. No. BCR357	Cat. No. BCR359	Cat. No. BCR360	Cat. No. BCR361
	ZnAl4Cu1 (mg/kg)				
Al	[44.34 ± 0.11]×10^3	[42.27 ± 0.11]×10^3	[37.11 ± 0.11]×10^3	[34.27 ± 0.12]×10^3	[40.68 ± 0.19]×10^3
Cd	0.73 ± 0.09	2.83 ± 0.10	29.8 ± 0.4	59.5 ± 0.6	(0.80 ± 0.17)
Cu	[3.944 ± 0.022]×10^3	[5.849 ± 0.021]×10^3	[9.89 ± 0.04]×10^3	[12.34 ± 0.05]×10^3	[7.98 ± 0.04]×10^3
Fe	31.5 ± 0.6	25.7 ± 1.2	119.7 ± 1.1		10.34 ± 0.26
In	<0.2	3.30 ± 0.14	15.5 ± 0.6	29.8 ± 0.6	(<0.2)
Mg	132.3 ± 1.8	273 ± 4	557 ± 5	705 ± 5	
Ni	3.43 ± 0.19	9.82 ± 0.25	92.6 ± 0.6	267 ± 8	
Pb	9.87 ± 0.23	13.8 ± 0.6	36.2 ± 0.8	73.9 ± 1.4	5.31 ± 0.20
Sn	(0.32 ± 0.16)	3.51 ± 0.14	16.93 ± 0.22	33.0 ± 0.8	46.3 ± 0.9
Tl	0.79 ± 0.05	2.76 ± 0.05	13.34 ± 0.24	25.9 ± 0.7	37.4 ± 0.5

Values in brackets ( ) are not certified. Availability: Discs of 80 mm diameter and 20 mm thickness.

Substance	Cat. No. BCR089 TiAl6V4	Cat. No. BCR090 Titanium with added impurities
	(mg/kg)	
Al	59700 ± 400	28.2 ± 1.4
C	38 ± 10	501 ± 14
B		533 ± 11
Co		513 ± 9
Cr	122 ± 6	563 ± 16
Cu	10.3 ± 1.2	314 ± 10
Fe	515 ± 16	488 ± 11
H	31 ± 5	(492 ± 26)
Hf	0.126 ± 0.011	667 ± 7
Mn	4.2 ± 0.6	(710 ± 50)
Mo	15.2 ± 1.8	

Substance	Cat. No. BCR089 TiAl6V4	Cat. No. BCR090 Titanium with added impurities
	(mg/kg)	
N	212 ± 33	(500+40)
Nb		(436+13)
Ni	106 ± 7	
O	1660 ± 60	
Sb	1.94 ± 0.12	
Sn	10.4 ± 1.7	
Ta	0.30 ± 0.09	
V	39760 ± 290	
W	1.6 ± 0.4	
Zr	2.8 ± 0.6	

Values in brackets are not certified.
Availability: BCR089: Cylinder of 40 mm ⌀ and 20 mm height. BCR090A: Cylinder of 40 mm ⌀ and 20 mm height. BCR090B: Cubes of about 0.2 g in bottles containing approximately 25 g.

Cat. No.	Substance	Quaternary bronze	Brass	Arsenic-Copper	Lead-bronze	Tin-bronze
		(g/kg)				
BCR691	As	1.94 ± 0.10	0.99 ± 0.10	46.0 ± 2.7	2.85 ± 0.22	1.94 ± 0.20
	Pb	79 ± 7	3.9 ± 0.4	1.75 ± 0.14	92 ± 17	2.04 ± 0.18
	Sn	71.6 ± 2.1	20.6 ± 0.7	2.02 ± 0.29	101 ± 8	70 ± 6
	Zn	60.2 ± 2.2	148 ± 5	0.55 ± 0.05	1.48 ± 0.24	1.57 ± 0.25

Availability: Set of five discs (one of each composition) of 35 mm ⌀ and 2 mm thickness, packed in a box.

Cat. No.	Description	Certified S content (g/kg)
BCR331	Steam Coal	4.99 ± 0.10
BCR332	High Volatile Industrial Coal	9.61 ± 0.17
BCR333	Coking Steam Coal	13.44 ± 0.26

Cat. No.	Description	Certified S content (g/kg)
BCR334	Anthracite	16.09 ± 0.19
BCR335	Flame Coal	50.8 ± 0.6
BCR336	High Volatile Steam Coal	32.90 ± 0.26

Availability: These CRMs are available in units of about 20 g in ampoules with argon atmosphere.

Substance	Cat. No. BCR460 Total Fluorine in coal powder (mg/kg)
Cl	(59 ± 18)
F	225 ± 6

Values in brackets are not certified.
Availability: BCR460 in glass bottles containing about 40 g.

Substance	Cat. No. BCR461 Total Fluorine in clay (mg/kg)
F	568 ± 60

Availability: The samples are provided in units of 30 g in glass bottles.

Cat. No.	Description	Certified S content (g/kg)
ERMEF672	Gasoil	0.203 ± 0.006
ERMEF671	Gasoil	0.452 ± 0.009
ERMEF104	Gasoil	1.019 ± 0.019
BCR105	Gasoil	3.63 ± 0.10

Cat. No.	Description	Certified S content (g/kg)
BCR106	Gasoil	5.02 ± 0.08
BCR107	Gasoil	10.40 ± 0.15
ERMEF211	Petrol	0.048 8 ± 0.001 7

Availability: The materials are available in dark glass ampoules sealed under nitrogen. ERMEF104, -671 and –672 contain 8 mL, BCR105, 106 and -107 contain 25 g. ERMEF211 is available in clear borosilicate glass ampoules and contains 19 mL.

Cat. No.	Description	Solvent Yellow 124 (SY124) content (mg/kg)
ERMEF317	Gasoil	0.141 ± 0.018
ERMEF318	Gasoil	7.0 ± 0.4

Availability: The materials are available in dark glass ampoules sealed under nitrogen, containing 20 mL.

Certified Parameter	Cat. No. IRMM441 n-Heptane (%)	Cat. No. IRMM442 Isooctane(%)
n-Heptane, purity by difference	99.985 ± 0.005	
Isooctane, purity by difference		99.985 ± 0.005
Impurities		
Total organics (other than isooctane)		0.011 ± 0.004
Total organics (other than n-Heptane)	0.012 ± 0.005	
Isooctane	0.007 ± 0.002	
n-Heptane		0.002 ± 0.002
Water	0.003 ± 0.002	0.004 ± 0.002
Lead	< 0.5 µg/L	< 1 µg/L

Availability: IRMM441 and -442 are supplied in ampoules of 100 mL.

Cat. No.	Description	Substance	Certified values (g/kg)
BCR109	Zinc ore (blende)	Pb	7.38 ± 0.03
		Fe	145.1 ± 0.6
		Cu	9.46 ± 0.08
		Cd	4.61 ± 0.09

Cat. No.	Description	Substance	Certified values (g/kg)
BCR109	Zinc ore (blende)	Mg	0.20 ± 0.01
		F	0.081 ± 0.004
		Hg	0.00 96 ± 0.000 12

Availability: This RM is contained in brown glass bottles. The approximate quantity per unit is 200 g for BCR109.

Cat. No.	Description	Substance	Certified values (g/kg)
BCR032	Moroccan Phosphate rock	CaO	517.6 ± 3.2
		P_2O_5	329.8 ± 1.7
		CO_2	51.0 ± 0.8
		F	40.4 ± 0.6
		SiO_2	20.9 ± 1.2
		SO_3	18.4 ± 0.8
		Al_2O_3	5.5 ± 0.6
		MgO	4.0 ± 0.1
		Fe_2O_3	2.3 ± 0.1
		As	$9.5 \times 10^{-3} \pm 0.5 \times 10^{-3}$
		B	$22.6 \times 10^{-3} \pm 2.2 \times 10^{-3}$

Cat. No.	Description	Substance	Certified values (g/kg)
BCR032	Moroccan Phosphate rock	Cd	$20.8 \times 10^{-3} \pm 0.7 \times 10^{-3}$
		Cr	$257 \times 10^{-3} \pm 16 \times 10^{-3}$
		Co	$0.59 \times 10^{-3} \pm 0.06 \times 10^{-3}$
		Cu	$33.7 \times 10^{-3} \pm 1.4 \times 10^{-3}$
		Hg	$55 \times 10^{-6} \pm 11 \times 10^{-6}$
		Mn	$18.8 \times 1^{0-3} \pm 1.3 \times 10^{-3}$
		Ni	$34.6 \times 10^{-3} \pm 1.9 \times 10^{-3}$
		Ti	$171 \times 10^{-3} \pm 10 \times 10^{-3}$
		V	$153 \times 10^{-3} \pm 7 \times 10^{-3}$
		Zn	$253 \times 10^{-3} \pm 6 \times 10^{-3}$

Availability: Units of about 100 g in the form of fine powder.

Substance	Cat. No. BCR664 Glass (mg/kg)
As	5.9 ± 0.4
Ba	29.1 ± 0.7
Cd	5.7 ± 0.4
Cl	68 ± 8
Co	2.77 ± 0.21

Substance	Cat. No. BCR664 Glass (mg/kg)
Cr	2.65 ± 0.13
Pb	53.1 ± 2.6
Sb	24.3 ± 1.0
Se	8.6 ± 0.5

Availability: Glass plate of (50 x 50 x 7) mm.

Cat. No.	Material	Uranium mass fraction (mg/kg)
IRMM540R	Uranium-doped oxide glass	15.0 ± 0.9
IRMM541	Uranium-doped oxide glass	49.4 ± 2.7

Availability: Glass disc of 15 mm diameter and 2 mm thickness, polished on both sides.

Substance	Cat. No. ERMEC590 Polyethylene (LDPE) g/kg	Cat. No. ERMEC591 Polypropylene (PP) g/kg
Br 2,4,4'-TriBDE (BDE-28)	2.13 ± 0.09	2.08 ± 0.07 0.0025 ± 0.0004
2,2',4,4'-TetraBDE (BDE-47)	0.23 ± 0.04	0.245 ± 0.023
2,2',3,4,4'-PentaBDE (BDE-99)	0.302 ± 0.030	0.32 ± 0.04
2,2',4,4',6-PentaBDE (BDE-100)	0.063 ± 0.005	0.066 ± 0.007
2,2',4,4',5,5'-HexaBDE (BDE-153)	0.047 ± 0.006	0.044 ± 0.006
2,2',4,4',5,6'-HexaBDE (BDE-154)	0.0257 ± 0.0026	0.026 ± 0.004
2,2',3,4,4',5,6'-HeptaBDE (BDE-183)	0.132 ± 0.012	0.087 ± 0.008
2,2',3,3',4,4',6,6'-OctaBDE + 2,2',3, 4,4',5,6,6'- OctaBDE (BDE-197+204)	0.076 ± 0.010	0.052 ± 0.009
DecaBDE (BDE-209)	0.65 ± 0.10	0.78 ± 0.09
DecaBB (BB-209)	0.63 ± 0.10	0.74 ± 0.08
Sb	(0.756 ± 0.025)	(0.713 ± 0.022)

Values in brackets are not certified.
Availability: Brown glass bottle with 20 g granulate.

Substance	Cat. No. ERMEC680k Polyethylene (low level) mg/kg
As	4.1 ± 0.5
Br	96 ± 4
Cd	19.6 ± 1.4
Cl	102.2 ± 3.0
Cr	20.2 ± 1.1
Hg	4.64 ± 0.20

Substance	Cat. No. ERMEC680k Polyethylene (low level) mg/kg
Pb	13.6 ± 0.5
S	76 ± 4
Sb	10.1 ± 1.6
Sn	(15.3 ± 2.8)
Zn	(137 ± 20)

Values in brackets are not certified.
Availability: Brown glass bottle with 100 g granulate.

Cat. No. VDA0014 - Cd in polyethylene

A set of four certified reference materials for Cd in polyethylene (40.9 mg/kg, 75.9 mg/kg, 197.9 mg/kg and 407 mg/kg) has been certified by IRMM on behalf of VDA (Verband der Automobilindustrie e.V., Frankfurt). Information can be obtained from IRMM, Geel (B).

5.3 OTHERS

Cat. No. IRMM471 - Cementite Grains in Carburised Pure Iron

	Certified value (g/kg)
Carbon mass fraction in cementite grains	66.9 ± 2.7

Availability: 4-5 mm long rod with 5 mm diameter.

6 MATERIALS RELATED TO ISOTOPIC MEASUREMENTS

6.1 CERTIFIED FOR ISOTOPE ABUNDANCE RATIO (AMOUNT RATIO)

Cat. No. BCR123 Ethanol			
Parameter	Ethanol H	Ethanol M	Ethanol L
(D/H)I	$109.65 \times 10^{-6} \pm 0.20 \times 10^{-6}$	$101.69 \times 10^{-6} \pm 0.17 \times 10^{-6}$	$90.30 \times 10^{-6} \pm 0.18 \times 10^{-6}$
(D/H)II	$119.76 \times 10^{-6} \pm 0.25 \times 10^{-6}$	$130.94 \times 10^{-6} \pm 0.21 \times 10^{-6}$	$122.20 \times 10^{-6} \pm 0.4 \times 10–6$

Cat. No. BCR123 Ethanol			
Parameter	**Ethanol H**	**Ethanol M**	**Ethanol L**
R	2.184 ± 0.005	2.575 ± 0.006	2.708 ± 0.009

Availability: Units of 3 sealed NMR tubes containing respectively H-, M-, and L-ethanols, to which the tetramethylurea internal standard and the C_6F_6 lock substance are added. 15 mm (BCR123B) O.D. NRM tubes can be supplied.

Parameter	**Unit**	**Cat. No. BCR656 (96% ethanol)**	**Cat. No. BCR657 (Sugar)**	**Cat. No. BCR658 (Synthetic wine)**	**Cat. No. BCR659 (Synthetic wine)**	**Cat. No. BCR660 (Ethanol in water)**
(D/H)I by ^{2}H-NMR	ppm	102.84 ± 0.20				102.90 ± 0.16
(D/H)II by ^{2}H-NMR	ppm	132.07 ± 0.30				131.95 ± 0.23
R by ^{2}H-NMR		2.570 ± 0.005				2.567 ± 0.005
$\delta^{13}C_{VPDB}$ by IRMS	‰	-26.91 ± 0.07	-10.76 ± 0.04			-26.72 ± 0.09
$\delta^{18}O_{VSMOW}$ of water from wine by IRMS	‰			-7.19 ± 0.04	-7.18 ± 0.02	
$(D/H)_w$ of water (IRMS)	ppm					148.68 ± 0.14
Alcoholic grade t_D	w/w %	(94)				11.96 ± 0.06 [1)]

1) in v/v %
Value in brackets is not certified.
Availability: BCR656: Units of 25 mL of 96 % vol. neutral ethanol from wine in glass bottle;
BCR657: Units of approx. 1 g of dry glucose in a sealed amber vial;
BCR658: Units of 25 mL of synthetic wine solution in glass bottle;
BCR659: Units of 25 mL of synthetic wine solution in glass bottle;
BCR660: Units of 450 mL of aqueous ethanol solution in glass bottle.

Code	**Description**	**Amount ratios**	**Unit size**
		n(^{41}Ca)/n(^{40}Ca)	
ERMAE701/1		$1.011\,4(68) \cdot 10^{-6}$	
ERMAE701/2		$1.023\,5(69) \cdot 10^{-7}$	
ERMAE701/3		$1.018\,1(69) \cdot 10^{-8}$	
ERMAE701/4	0.6 M HNO_3	$1.047\,9(71) \cdot 10^{-9}$	
ERMAE701/5	solution	$1.052\,0(71) \cdot 10^{-10}$	25 mL
ERMAE701/6		$1.091\,3(74) \cdot 10^{-11}$	
ERMAE701/7		$1.054\,9(72) \cdot 10^{-12}$	
ERMAE701/8		$1.052\,4(71) \cdot 10^{-13}$	

Code	**Description**	Isotope amount fraction (·100)						Amount ratios			Unit size
IRMM009	**0.2 M HNO_3** solution	**^{24}Mg**	**^{25}Mg**	**^{26}Mg**				***n*(^{25}Mg)/*n*(^{24}Mg)**	***n*(^{26}Mg)/*n*(^{24}Mg)**		**4 mL**
		78.992(25)	10.003(9)	11.005(19)				0.126 63(13)	0.139 32(26)		
IRMM010		**^{190}Pt**	**^{192}Pt**	**^{194}Pt**	**^{195}Pt**	**^{196}Pt**	**^{198}Pt**	***n*(^{190}Pt)/*n*(^{195}Pt)**	***n*(^{192}Pt)/*n*(^{195}Pt)**	***n*(^{194}Pt)/*n*(^{195}Pt)**	**30 mg (wire)**
	Pt	0.011 7(11)	0.782(17)	32.86(27)	33.78(16)	25.21(23)	7.356(82)	0.000 347(34)	0.023 15(48)	0.973(11)	
	metal							***n*(^{196}Pt)/*n*(^{195}Pt)**	***n*(^{198}Pt)/*n*(^{195}Pt)**		
								0.746 4(82)	0.217 8(24)		
IRMM011	**H_3BO_3** solution	**^{10}B**	**^{11}B**					***n*(^{10}B)/*n*(^{11}B)**			**1 g**
		19.824(20)	80.176(20)					0.247 26(32)			
IRMM012	**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)**	**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)	

IRMM016	Li_2CO_3 solution	**^{6}Li**	**^{7}Li**					***n*(^{6}Li)/*n*(^{7}Li)**			**1 g**
		7.588 9(75)	92.411 1(75)					0.082 121(87)			
IRMM017	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(76)	0.033 488 9(82)		
IRMM018a	SiO_2 solid	**^{28}Si**	**^{29}Si**	**^{30}Si**				***n*(^{29}Si)/*n*(^{28}Si)**	***n*(^{30}Si)/*n*(^{28}Si)**		**5 g**
		92.220 36(49)	4.687 30(36)	3.092 34(37)				0.050 827 2(40)	0.033 532 0(42)		

6.2 CERTIFIED FOR ISOTOPE AMOUNT CONTENT

Cat. No.	Description	Isotope amount content	Isotope enrichment	Unit size
IRMM610	HNO_3 aqueous solution	3.683 11 (88) µmol ^{10}B·g^{-1}	*n*(^{10}B)/*n*(^{11}B)=18.80 (2)	5 mL
IRMM611	HNO_3 aqueous solution	4.025 (40) µmol ^{11}B·g^{-1}	*n*(^{10}B)/*n*(^{11}B)=0.247 26 (32)	5 mL
IRMM615	0.5 M HCl solution	3.850 (14) µmol ^{6}Li·g^{-1}	*n*(^{6}Li)/*n*(^{7}Li)=21.897 (44)	5 mL
IRMM618	0.5 M HNO_3 solution	112.13 (17) µmol ^{87}Rb·kg^{-1}	*n*(^{85}Rb)/*n*(^{87}Rb)=0.20 498 (24)	5 mL
IRMM619	0.5 M HNO_3 solution	85.00 (24) µmol ^{85}Rb·kg^{-1}	*n*(^{85}Rb)/*n*(^{87}Rb)=2.593 0 (20)	5 mL
IRMM620	4.5 M HCl solution	173.35 (16) µmol ^{57}Fe·kg^{-1}	*n*(^{54}Fe)/*n*(^{57}Fe)=< 0.0001 *n*(^{56}Fe)/*n*(^{57}Fe)= 0.025 39 (31) *n*(^{58}Fe)/*n*(^{57}Fe)=0.025 16 (18)	5 mL
IRMM621	1 M HNO_3 solution	97.35 (15) µmol ^{111}Cd·kg^{-1}	*n*(^{106}Cd)/*n*(^{111}Cd)= <0.000 05 *n*(^{108}Cd)/*n*(^{111}Cd)= <0.000 05 *n*(^{110}Cd)/*n*(^{111}Cd)=0.004 44 (42) *n*(^{112}Cd)/*n*(^{111}Cd)=0.021 74 (10) *n*(^{113}Cd)/*n*(^{111}Cd)=0.005 818 (56) *n*(^{114}Cd)/*n*(^{111}Cd)=0.010 875 (88) *n*(^{116}Cd)/*n*(^{111}Cd)=0.001 629 (44)	4 mL
IRMM622	1 M HCl solution	9.739 (18) µmol ^{111}Cd·kg^{-1}	*n*(^{106}Cd)/*n*(^{111}Cd)= <0.000 05 *n*(^{108}Cd)/*n*(^{111}Cd)= <0.000 05 *n*(^{110}Cd)/*n*(^{111}Cd)=0.004 44 (42) *n*(^{112}Cd)/*n*(^{111}Cd)=0.021 74 (10) *n*(^{113}Cd)/*n*(^{111}Cd)=0.005 818 (56) *n*(^{114}Cd)/*n*(^{111}Cd)=0.010 875 (88) *n*(^{116}Cd)/*n*(^{111}Cd)=0.001 629 (44)	4 mL
IRMM624	1 M HCl solution	174.84 (42) µmol ^{50}Cr·kg^{-1}	*n*(^{52}Cr)/*n*(^{50}Cr)=0.066 41 (50) *n*(^{53}Cr)/*n*(^{50}Cr)=0.000 323 (64) *n*(^{54}Cr)/*n*(^{50}Cr)=0.000 11 (11)	5 mL
IRMM625	1 M HNO_3 solution	144.233 (90) µmol ^{52}Cr·kg^{-1}	*n*(^{50}Cr)/*n*(^{52}Cr)=0.051 85 (20) *n*(^{53}Cr)/*n*(^{52}Cr)=0.113 33 (38) *n*(^{54}Cr)/*n*(^{52}Cr)=0.028 35 (34)	5 mL
IRMM632	1 M HNO_3 solution	0.096 84 (41) µmol ^{65}Cu·g^{-1}	*n*(^{63}Cu)/*n*(^{65}Cu)=0.002 892 1 (92)	5 mL
ERMAE633	1 M HNO_3 solution	5.998 (36) µmol ^{63}Cu·g^{-1}	*n*(^{65}Cu)/*n*(^{63}Cu)=0.445 63 (42)	4 - 5 mL
IRMM634	1.8 M HCl solution	163.61 (38) µmol ^{56}Fe·kg^{-1}	*n*(^{54}Fe)/*n*(^{56}Fe)=0.063 70 (27) *n*(^{57}Fe)/*n*(^{56}Fe)=0.023 096 (72) *n*(^{58}Fe)/*n*(^{56}Fe)=0.003 071 (29)	5 mL
ERMAE637	0.2 M HNO_3 solution	0.791 37(30) µmol ^{24}Mg·g^{-1}	*n*(^{26}Mg)/*n*(^{24}Mg)=0.139 68 (32) *n*(^{25}Mg)/*n*(^{24}Mg)=0.126 86 (18)	5 mL
ERMAE638	0.1 M HNO_3 solution	0.857 4 (34) µmol ^{26}Mg·g^{-1}	*n*(^{24}Mg)/*n*(^{26}Mg)=0.003 104 (26) *n*(^{25}Mg)/*n*(^{26}Mg)=0.001 084 (^{11})	5 mL
ERMAE639	0.5 M HCl solution	11.891 (50) µmol ^{202}Hg·g^{-1}	*n*(^{196}Hg)/*n*(^{202}Hg)=0.004 972 (46) *n*(^{198}Hg)/*n*(^{202}Hg)=0.330 6 (21) *n*(^{199}Hg)/*n*(^{202}Hg)=0.561 9 (28) *n*(^{200}Hg)/*n*(^{202}Hg)=0.770 5 (28) *n*(^{201}Hg)/*n*(^{202}Hg)=0.441 26 (88) *n*(^{204}Hg)/*n*(^{202}Hg)=0.230 27 (75)	5 mL

Cat. No.	Description	Isotope amount content	Isotope enrichment	Unit size
ERMAE640	0.5 M HCl solution	14.71 (11) nmol $^{202}Hg \cdot g^{-1}$	$n(^{196}Hg)/n(^{202}Hg)=0.000\ 018\ 09\ (38)$ $n(^{198}Hg)/n(^{202}Hg)=0.000\ 623\ (11)$ $n(^{199}Hg)/n(^{202}Hg)=0.001\ 603\ (16)$ $n(^{200}Hg)/n(^{202}Hg)=0.005\ 499\ (34)$ $n(^{201}Hg)/n(^{202}Hg)=0.013\ 351\ (52)$ $n(^{204}Hg)/n(^{202}Hg)=0.002\ 595\ (21)$	5 mL
ERMAE641	Cl in water	18.959 (15) µmol $^{35}Cl \cdot g^{-1}$	$n(^{37}Cl)/n(^{35}Cl)=0.319\ 77\ (83)$	4 - 5 mL
ERMAE642	Cl in water	4.375 (26) µmol $^{37}Cl \cdot g^{-1}$	$n(^{35}Cl)/n(^{37}Cl)=0.019\ 14\ (48)$	4 - 5 mL
IRMM643	2.8 M HNO_3 solution	334.33 (84) µmol $^{32}S \cdot kg^{-1}$	$n(^{33}S)/n(^{32}S)=0.007\ 877\ 6\ (58)$ $n(^{34}S)/n(^{32}S)=0.044\ 149\ 3\ (78)$ $n(^{36}S)/n(^{32}S)=0.000\ 153\ 40\ (94)$	5 mL
IRMM644	3.2 M HNO_3 solution	326.28 (80) µmol $^{32}S \cdot kg^{-1}$	$n(^{33}S)/n(^{32}S)=0.007\ 969\ 8\ (70)$ $n(^{34}S)/n(^{32}S)=0.045\ 162\ 2\ (82)$ $n(^{36}S)/n(^{32}S)=0.000\ 170\ 0\ (58)$	5 mL
IRMM645	2.8 M HNO_3 solution	371.96 (57) µmol $^{32}S \cdot kg^{-1}$	$n(^{33}S)/n(^{32}S)=0.007\ 747\ 6\ (38)$ $n(^{34}S)/n(^{32}S)=0.042\ 747\ 3\ (62)$ $n(^{36}S)/n(^{32}S)=0.000\ 145\ 1\ (42)$	5 mL
IRMM646	2.8 M HNO_3 solution	4586 (27) µmol $^{34}S \cdot kg^{-1}$	$n(^{32}S)/n(^{34}S)=0.038\ 314\ 9\ (31)$ $n(^{33}S)/n(^{34}S)=0.000\ 470\ 88\ (15)$ $n(^{36}S)/n(^{34}S)=0.000\ 018\ 1\ (37)$	5 mL
ERMAE647	1 M HNO_3 solution	134.974 (73) µmol $^{63}Cu \cdot g^{-1}$	$n(^{65}Cu)/n(^{63}Cu)=0.445\ 60\ (74)$	4 mL
ERMAE649	1 M HNO_3 solution	0.836 88 (27) µmol $^{205}Tl \cdot g^{-1}$	$n(^{203}Tl)/n(^{205}Tl)=0.418\ 91\ (18)$	4 - 5 mL
IRMM651	0.5 M HNO_3 solution	0.077 506 (30) µmol $^{64}Zn \cdot g^{-1}$	$n(^{66}Zn)/n(^{64}Zn)=0.557\ 17\ (30)$ $n(^{67}Zn)/n(^{64}Zn)=0.080\ 702\ (34)$ $n(^{68}Zn)/n(^{64}Zn)=0.366\ 27\ (12)$ $n(^{70}Zn)/n(^{64}Zn)=0.011\ 981\ (22)$	5 mL
IRMM652	0.5 M HNO_3 solution	0.156 000 (50) µmol $^{64}Zn \cdot g^{-1}$	$n(^{66}Zn)/n(^{64}Zn)=0.004\ 107\ 3\ (59)$ $n(^{67}Zn)/n(^{64}Zn)=0.000\ 499\ 87\ (96)$ $n(^{68}Zn)/n(^{64}Zn)=0.002\ 029\ 5\ (23)$ $n(^{70}Zn)/n(^{64}Zn)=0.000\ 052\ 76\ (34)$	5 mL
IRMM653	0.5 M HNO_3 solution	0.138 014 (60) µmol $^{67}Zn \cdot g^{-1}$	$n(^{64}Zn)/n(^{67}Zn)=0.013\ 191\ 5\ (81)$ $n(^{66}Zn)/n(^{67}Zn)=0.024\ 551\ 6\ (70)$ $n(^{68}Zn)/n(^{67}Zn)=0.051\ 086\ (36)$ $n(^{70}Zn)/n(^{67}Zn)=0.000\ 527\ 8\ (18)$	5 mL
IRMM654	0.5 M HNO_3 solution	0.146 098 (48) µmol $^{68}Zn \cdot g^{-1}$	$n(^{64}Zn)/n(^{68}Zn)=0.00.\ 489\ 4\ (38)$ $n(^{66}Zn)/n(^{68}Zn)=0.003\ 186\ 8\ (46)$ $n(^{68}Zn)/n(^{68}Zn)=0.001\ 411\ 3\ (17)$ $n(^{70}Zn)/n(^{68}Zn)=0.000\ 194\ 98\ (78)$	5 mL
IRMM3702	0.5 M HNO_3 solution	1.512 (30) µmol $^{64}Zn \cdot g^{-1}$	$n(^{66}Zn)/n(^{64}Zn)=0.563\ 97\ (30)$ $n(^{67}Zn)/n(^{64}Zn)= 0.082\ 166\ (35)$ $n(^{68}Zn)/n(^{64}Zn)= 0.375\ 19\ (16)$ $n(^{70}Zn)/n(^{64}Zn)= 0.012\ 418\ (23)$	3 mL

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BCR267	INDENO[1,2,3-cd]FLUORANTHENE (purity)	6
BCR269	CHRYSENE (purity)	6
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BCR272	CORONENE (purity)	6
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BCR636	HUMAN BLOOD (Pb, Cd)	51
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IRMM526	Nb	61
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IRMM532	Al-0.01 % Co	62
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IRMM804	RICE FLOUR	40
STA003m	TETRAMETHYLUREA	28
VDA 0014	POLYETHYLENE (40, 75, 200, 400 mg/kg Cd)	66

ALPHABETICAL LIST

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γ-GLUTAMYLTRANSFERASE (catalytic concentration)	ERMAD452IFCC	54
10-AZABENZO[a]PYRENE (purity)	BCR092	5
1-METHYLBENZ[a]ANTHRACENE (purity)	BCR093R	5
1-METHYLCHRYSENE (purity)	BCR077R	5
1-NITRONAPHTALENE (purity)	BCR306	6
1-NITROPYRENE (purity)	BCR305	6
2,2',3,4,4',5,5'-HEPTACHLOROBIPHENYL (IUPAC No. 180) (purity)	BCR298	7
2,2',3,4,4',5'-HEXACHLOROBIPHENYL (IUPAC No. 138) (purity)	BCR296	7
2,2',4,4',5,5'-HEXACHLOROBIPHENYL (IUPAC No. 153) (purity)	BCR297	7
2,2',5,5'-TETRACHLOROBIPHENYL (IUPAC No. 52) (purity)	BCR293	7
2,3,3'-TRICHLOROBIPHENYL (IUPAC No. 20) (purity)	BCR290	7
2,4,4'-TRICHLOROBIPHENYL (IUPAC No. 28) (purity)	BCR291	7
2,4'-DICHLOROBIPHENYL (IUPAC No. 8) (purity)	BCR289	7
2,4-DINITROPHENYLHYDRAZONES in ACETONITRILE	BCR551	50
2,4-DINITROPHENYLHYDRAZONES in ACETONITRILE (blank)	BCR552	50
2-METHYLCHRYSENE (purity)	BCR078R	5
2-NITRO-7-METHOXYNAPHTHO[2,1-b]FURAN (purity)	BCR312	6
2-NITRONAPHTALENE (purity)	BCR307	6
3 REFERENCE ETHANOLS (H, M, L) (for SNIF-NMR)	BCR123A, B	27, 66
3,3',5 TRIIODOTHYRONINE (T3)	IRMM469	50
3-METHYLCHRYSENE (purity)	BCR079R	5
3-NITROFLUORANTHENE (purity)	BCR310	6
4-DEOXYNIVALENOL in acetonitrile	IRMM315	29
4H-CYCLOPENTA[def]PHENANTHREN-4-ONE (purity)	BCR338	7
4-METHYLCHRYSENE (purity)	BCR080R	5
5-METHYLCHRYSENE (purity)	BCR081R	5
6-NITROBENZO[a]PYRENE (purity)	BCR311	6
6-NITROCHRYSENE (purity)	BCR309	6
7H-DIBENZO (c.g) CARBAZOLE (purity)	BCR266	6
9-NITROANTHRACENE (purity)	BCR308	6
ACETALDEHYDE-2,4-DINITROPHENYLHYDRAZONE (purity)	BCR547	49
ACETONE-2,4-DINITROPHENYLHYDRAZONE (purity)	BCR549	50
ACROLEIN-2,4-DINITROPHENYLHYDRAZONE (purity)	BCR548	50
AFLATOXIN B1 IN ACETONITRILE	ERMAC057	28
AFLATOXIN B2 IN ACETONITRILE	ERMAC058	29
AFLATOXIN G1 IN ACETONITRILE	ERMAC059	29
AFLATOXIN G2 IN ACETONITRILE	ERMAC060	29
AFLATOXIN M1 STANDARD SOLUTION	BCR423RM	28
Al	IRMM523	61
Al-0.01 % Co	IRMM532	62
Al-0.1 % Ag	IRMM533	62
Al-0.1 % Au	IRMM530R	62
Al-2.0 % Sc	IRMM534	62

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ALPHA ALUMINA (0.10 m^2/g) (nitrogen BET specific surface area)	BCR169	57
ALPHA ALUMINA (1.05 m^2/g) (nitrogen BET specific surface area)	BCR170	57
ALPHA-AMYLASE (catalytic concentration)	IRMMIFCC456	54
ALUMINA (2.95 m^2/g) (nitrogen BET specific surface area)	BCR171	57
ANHYDROUS BUTTER FAT (tracers)	BCR633	42
ANHYDROUS BUTTER FAT (triglycerides)	BCR519	42-43
ANIMAL FEED (Organochlorine pesticides)	BCR115	38
ANTHANTHRENE (purity)	BCR091	5
ANTHRACITE (S)	BCR334	64
APPLE (dietary fibre)	ERMBC516	45
AQUATIC PLANT (Cr)	BCR596	17
ARTIFICIAL FOODSTUFF (major nutrients)	BCR644	44
ARTIFICIAL FOODSTUFF (major nutrients)	BCR645	44
ASPARTATE TRANSAMINASE (AST)	ERMAD457IFCC	54
BCR-ABL pDNA CALIBRANT	ERMAD623	54
BEECH WOOD	BCR683	26
BEEF-PORK FAT BLEND (fatty acid profile)	BCR163	42
BEER (EtOH, low level)	BCR651	44
BEER (EtOH, very low level)	BCR652	44
BENZ[a]ACRIDINE (purity)	BCR157	5
BENZ[a]ANTHRACENE (purity)	BCR271	6
BENZ[c]ACRIDINE (purity)	BCR158	5
BENZO[a]FLUORANTHENE (purity)	BCR097	5
BENZO[a]FLUORENONE (purity)	BCR342	7
BENZO[b]CHRYSENE (purity)	BCR046	5
BENZO[b]FLUORANTHENE (purity)	BCR047	5
BENZO[b]NAPHTHO (1,2-d) FURAN (purity)	BCR340	7
BENZO[b]NAPHTHO (2,1-d) FURAN (purity)	BCR341	7
BENZO[b]NAPHTHO[1,2-d]THIOPHENE (purity)	BCR137R	5
BENZO[b]NAPHTHO[2,3-d]THIOPHENE (purity)	BCR136R	5
BENZO[c,d]PYREN-6-ONE (purity)	BCR339	7
BENZO[c]CHRYSENE (purity)	BCR140	5
BENZO[c]PHENANTHRENE (purity)	BCR134	5
BENZO[e]PYRENE (purity)	BCR050	5
BENZO[ghI]FLUORANTHENE (purity)	BCR139	5
BENZO[ghI]PERYLENE (purity)	BCR052	5
BENZO[j]FLUORANTHENE (purity)	BCR049	5
BENZO[k]FLUORANTHENE (purity)	BCR048R	5
BIODIESEL	ERMEF001	59-60
BLADDERWRACK (Fucus vesiculosus) (trace elements)	ERMCD200	19
BORIC ACID, isotopic, solid	IRMM011	67
BORON (natural) spike, aqueous solution	IRMM611	68
BORON-10 spike, aqueous solution	IRMM610	68

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BOVINE BLOOD (Pb, Cd)	ERMCE196	51
BOVINE BLOOD LYSATE (haemiglobincyanide)	BCR522	53
BOVINE EYE (CLENBUTEROL BLANK)	BCR673	48
BOVINE EYE (CLENBUTEROL POSITIVE)	BCR674	48
BOVINE LIVER (CLENBUTEROL BLANK)	BCR648	48
BOVINE LIVER (CLENBUTEROL POSITIVE)	BCR649	48
BOVINE LIVER (trace elements)	BCR185R	40
BOVINE LIVER (trenbolone blank and positive)	BCR4745	48
BOVINE MUSCLE (diethylstilboestrol blank)	BCR412	48
BOVINE MUSCLE (diethylstilboestrol positive)	BCR411	48
BOVINE MUSCLE (trace elements)	ERMBB184	47
BOVINE URINE (diethylstilboestrol, dienoestrol and hexoestrol)	ERMBB389	48
BOVINE URINE (diethylstilboestrol, dienoestrol and hexoestrol) (blank)	ERMBB386	48
BOVINE URINE (clenbuterol and salbutamol)	BCR502	47
BOVINE URINE (clenbuterol and salbutamol)	BCR503	47
BOVINE URINE (clenbuterol and salbutamol)	BCR504	47
BOVINE URINE (dienoestrol blank)	BCR387	47
BOVINE URINE (dienoestrol positive)	BCR390RM	47
BOVINE URINE (diethylstilboestrol blank)	BCR386	47
BOVINE URINE (hexoestrol blank)	BCR388	47
BOVINE URINE (hexoestrol positive)	BCR391	47
BRAN BREAKFAST CEREAL (dietary fibre)	ERMBD518	45
BROWN BREAD (trace elements)	BCR191	40
BROWN COAL	ERMEF412	55
BRUSSELS SPROUT (vitamins)	BCR431	43
BUTTER FAT	BCR632	43
CADMIUM-111 spike, nitrate solution	IRMM621	68
CADMIUM-111 spike, nitrate solution	IRMM622	68
CALCAREOUS SOIL	ERMCC690	15-16
CALCIUM AMMONIUM NITRATE FERTILIZER (composition)	BCR178	61
CALCIUM-41 isotopic, nitrate solution (set of 8 units)	ERMAE701	67
Calibration kit for ruminant detection by PCR	IRMMAD482	49
CARROT (dietary fibre)	ERMBC515	45
CEMENTITE GRAINS IN CARBURISED PURE IRON	IRMM471	66
CHANNEL SEDIMENT (trace elements)	BCR320R	16
CHLORIDE (natural) spike, chloride solution	ERMAE641	69
CHLORIDE-37 spike, chloride solution	ERMAE642	69
CHLORINATED HYDROCARBONS ON TENAX	BCR555	50
CHROMIUM (natural) spike, chloride solution	IRMM625	68
CHROMIUM, isotopic, chloride solution	IRMM012	67
CHROMIUM-50 spike, chloride solution	IRMM624	68
CHRYSENE (purity)	BCR269	6
CHUB (PCBs)	BCR719	26
CLAY (F)	BCR461	64

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COAL (F)	BCR460	64
COASTAL SEAWATER (Hg)	BCR579	20
COASTAL SEDIMENT (butyltins)	BCR462	23
COCOA BUTTER	IRMM801	42
COCONUT OIL (PAH blank)	BCR459	36
COD LIVER OIL (Organochlorine pesticides)	BCR598	37
COD LIVER OIL (PCBs)	BCR349	37
COKING STEAM COAL (S)	BCR333	64
COLLOIDAL SILICA	ERMFD100	58-59
COLLOIDAL SILICA	ERMFD304	59
COLLOIDAL SILICA IN AQUEOUS SOLUTION	ERMFD102	59
COMMON WHEAT FLOUR (properties)	BCR563	46
COMPOUND FEED (aflatoxin B1 blank)	BCR375	39
COMPOUND FEEDINGSTUFF (high level)	ERMBE376	39
COMPOUND FEEDINGSTUFF (very low level)	ERMBE375	39
CONTINUOUS CAST COPPER (O)	BCR058	62
COPPER (natural) spike, nitrate solution	ERMAE633	68
COPPER (O)	BCR054R	62
COPPER (S, P)	BCR017A, B	62
COPPER ALLOYS	BCR691	64
COPPER-63, nitrate solution	ERMAE647	69
COPPER-65 spike, nitrate solution	IRMM632	68
CORONENE (purity)	BCR272	6
CORTISOL REFERENCE SERUM PANEL	ERMDA451	50-51
CREATINE KINASE (CK-MB iso-enzyme) (catalytic concentration)	ERMAD455	54
CREATININE (interfering substances)	BCR573i	54
Cu	IRMM522	61
DAIRY FEED (nutritional properties)	BCR708	45
DEFATTED PEANUT MEAL (aflatoxin B1, blank)	BCR262R	39
DEFATTED PEANUT MEAL (aflatoxin B1, high level)	BCR264	39
DEFATTED PEANUT MEAL (aflatoxin B1, medium level)	BCR263R	39
DIBENZ[a,c]ACRIDINE (mylas)	BCR155	5
DIBENZ[a,h]ACRIDINE (purity)	BCR153R	5
DIBENZ[a,l]ACRIDINE (mylas)	BCR152	6
DIBENZ[a,j]ACRIDINE (purity)	BCR154	5
DIBENZ[a.c]ANTHRACENE (purity)	BCR094	5
DIBENZ[a.j]ANTHRACENE (purity)	BCR095	5
DIBENZ[c,h]ACRIDINE (purity)	BCR156R	5
DIBENZO[a,e]FLUORANTHENE (mylas)	BCR265	6
DIBENZO[a,h]PYRENE (mylas)	BCR159	5
DIBENZO[a.e]PYRENE (mylas)	BCR133	5
DIBENZO[a.h]ANTHRACENE (purity)	BCR138	5
DIBENZO[a.l]PYRENE (mylas)	BCR096	5
DIBENZO[b,d]FURAN (mylas)	BCR337	7

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ELECTROLYTICALLY REFINED LEAD (trace elements)	BCR286A, B	62
ESCHERICHIA COLI 0157 (NCTC 12900)	IRMM351	47
ESTUARINE SEDIMENT	BCR667	15-16
ESTUARINE SEDIMENT (Hg, methylmercury)	ERMCC580	16, 23
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EUROSOIL (adsorption coefficients and Ph)	IRMM4431	27
EUROSOIL (adsorption coefficients and Ph)	IRMM4432	27
EUROSOIL (adsorption coefficients and Ph)	IRMM4433	27
EUROSOIL (adsorption coefficients and Ph)	IRMM4434	27
EUROSOIL (adsorption coefficients and Ph)	IRMM4435	27
EUROSOIL (adsorption coefficients and Ph)	IRMM4437	27
EWES'/GOATS' CURD (for adulteration with cows' milk) 0 and 1 % cows' milk	BCR599	49
FAUJASITE TYPE ZEOLITE (mircopore volume and width)	BCR704	58
Fe	IRMM524	61
FINE DUST (PM_{10}-like) (elements)	ERMCZ120	17
FINE DUST (PM_{10}-like) (PAHs)	ERMCZ100	24
FISH MUSCLE (trace elements)	ERMBB422	40
FISH OIL	ERMBB350	37
FLAME COAL (S)	BCR335	64
FLUORANTHENE (purity)	BCR160R	6
FLY ASH (LOW LEVEL) (PCDDs and PCDFs)	BCR615	26
FLY ASH (PCDDs and PCDFs)	BCR490	25
FLY ASH (trace elements)	BCR176R	17
FLY ASH FROM PULVERISED COAL (trace elements)	BCR038	17
FORMALDEHYDE-2,4-DINITROPHENYLHYDRAZONE (purity)	BCR546	49
FORMALDEHYDE-2,4-DINITROPHENYLHYDRAZONE on filter	BCR553	50
FORMALDEHYDE-2,4-DINITROPHENYLHYDRAZONE on filter (blank)	BCR554	50
FRESH WATER (nitrate, high level)	BCR480	20
FRESH WATER (nitrate, low level)	BCR479	20
FRESHWATER HARBOUR SEDIMENT (PAHs)	BCR535	24
FRESHWATER HARBOUR SEDIMENT (PCBs)	BCR536	25
FRESHWATER SEDIMENT (butyltin and phenyltin compounds)	BCR646	23
FULL FAT SOYA (dietary fibre)	ERMBC517	45
FURNACE COKE	ERMEF413	55
GAS OIL (0.0203 % S)	ERMEF672	64
GAS OIL (0.0452 % S)	ERMEF671	64
GAS OIL (0.1019 % S)	ERMEF104	64
GAS OIL (0.363 % S)	BCR105	64
GAS OIL (0.502 % S)	BCR106	64
GAS OIL (1.040 % S)	BCR107	64
GAS OIL (Solvent Yellow 124)	ERMEF317	65
GAS OIL (Solvent Yellow 124)	ERMEF318	55
GENETICALLE MODIFIED AM04-1020 POTATO	ERMBF430	35

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GENETICALLE MODIFIED DAS-44406-6 SOYA	ERMBF436	36
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GENETICALLY MODIFIED 281-24-236 X 3006-210-23 COTTON SEED	ERMBF422	33
GENETICALLY MODIFIED 3272 MAIZE	ERMBF420	32
GENETICALLY MODIFIED 59122 MAIZE	ERMBF424	33
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GENETICALLY MODIFIED EH92-527-1 POTATO	ERMBF421	32
GENETICALLY MODIFIED GA21 MAIZE	ERMBF414	31
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GENETICALLY MODIFIED H7-1 SUGAR BEET	ERMBF419	32
GENETICALLY MODIFIED MIR604 MAIZE	ERMBF423	33
GENETICALLY MODIFIED MON 810 MAIZE	ERMBF413k	30
GENETICALLY MODIFIED MON 863 MAIZE	ERMBF416	31-32
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GENETICALLY MODIFIED NK603 MAIZE	ERMBF415	31
GENETICALLY MODIFIED PH05-026-0048 POTATO	ERMBF435	36
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GENETICALLY MODIFIED SOYA 305423	ERMBF426	34
GENETICALLY MODIFIED SOYA 356043	ERMBF425	33
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Genomic DNA of Bacillus licheniformis DSM 5749	IRMM311	46
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Genomic DNA of Campylobacter coli (CNET068) and Campylobacter jejuni (CNET112)	IRMM313	46-47
Genomic DNA of Campylobacter jejuni	IRMM448	47
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Genomic DNA of Listeria monocytogenes	IRMM447	47
GLASS (trace elements)	BCR664	65
GLASS-CERAMIC	BCR724A-E	55
GLUTARALDEHYDE-2,4-DINITROPHENYLHYDRAZONE (purity)	BCR550	50
GROUND WATER	ERMCA615	21
GROUND WATER	ERMCA616	21
GROUND WATER (Br, high level)	BCR611	20
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GROUND WATER (trace elements, high level)	BCR610	21
GROUND WATER (trace elements, low level)	BCR609	21
HAEMOGLOBIN HbA0	IRMMIFCC467	54
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HARICOTS BEANS (dietary fibre)	ERMBC514	45
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HUMAN ADENOSINE DEAMINASE (ADA 1)	BCR647	54
HUMAN APOLIPOPROTEIN A I (mass concentration)	BCR393	52
HUMAN BLOOD (Pb, Cd)	BCR634	51
HUMAN BLOOD (Pb, Cd)	BCR635	51
HUMAN BLOOD (Pb, Cd)	BCR636	51
HUMAN HAEMOLYSATE (glycated haemoglobin (HbAlc)	BCR405RM	53
HUMAN HAIR (trace elements)	ERMDB001	52
HUMAN PANCREATIC LIPASE (from pancreatic juice)	BCR693	54
HUMAN PANCREATIC LIPASE (recombinant)	BCR694	54
HUMAN PROSTATIC ACID PHOSPHATASE (catalytic concentration)	BCR410	54
HUMAN SERUM (17ß-ESTRADIOL, high level)	BCR578	51
HUMAN SERUM (17ß-ESTRADIOL, low level)	BCR576	51
HUMAN SERUM (17ß-ESTRADIOL, medium level)	BCR577	51
HUMAN SERUM (Al, Se, Zn)	BCR637	52
HUMAN SERUM (Al, Se, Zn)	BCR638	52
HUMAN SERUM (Ca, Mg, Li)	BCR304	52
HUMAN SERUM (cortisol spiked)	ERMDA193	51
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HUMAN SERUM (CRP)	ERMDA474IFCC	53
HUMAN SERUM (cystatin C)	ERMDA471IFCC	53
HUMAN SERUM (high creatinine)	BCR575	53
HUMAN SERUM (high progesterone)	BCR348R	51
HUMAN SERUM (low creatinine)	BCR573	53
HUMAN SERUM (medium creatinine)	BCR574	53
HUMAN SERUM (progesterone)	ERMDA347	51
HUMAN SERUM (proteins)	ERMDA470kIFCC	53
HUMAN THYROGLOBULIN (Tg) (mass concentration)	BCR457	52
INDENO[1,2,3-cd]FLUORANTHENE (purity)	BCR267	6
INDUSTRIAL SANDY SOIL (PCDDs, PCDFs)	BCR529	25
INDUSTRIAL SOIL (PAHs)	BCR524	24
INDUSTRIAL SOIL (PCBs)	BCR481	25
IRON (natural) spike, chloride solution	IRMM634	68
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ISOOCTANE (purity)	IRMM442	59, 65
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LAKE SEDIMENT (trace elements)	BCR701	23
LATEX SPHERES (particle diameter 2 microns)	BCR165	50
LATEX SPHERES (particle diameter 4.8 microns)	BCR166	50
LATEX SPHERES (particle diameter 9.6 microns)	BCR167	50
LEAD GLASS (composition/refractive index)	BCR126A	61
LEAD WITH ADDED IMPURITIES (trace elements)	BCR288B	62
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LICHEN (trace elements)	BCR482	18
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LIMESTONE POWDERS (for shear testing)	BCR116	56
LINDE TYPE A ZEOLITE (mircopore volume and width)	BCR705	58
LITHIUM CARBONATE, isotopic, solid	IRMM016	68
LITHIUM-6 spike, chloride solution	IRMM615	68
LOAM SOIL	ERMCC141	15
LOW VOLATILE STEAM COAL (S)	BCR331	64
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LUNG TISSUE (asbestos fibres)	BCR666	55
MAGNESIUM (natural) spike, nitrate solution	ERMAE637	68
MAGNESIUM-26 spike, nitrate solution	ERMAE638	68
MAIZE	ERMBC716	39
MAIZE	ERMBC717	39
MAIZE FLOUR (deoxynivalenol blank)	BCR377	39
MARGARINE (vitamins)	BCR122	43
MERCURY (natural) spike, chloride solution	ERMAE639	68
MERCURY-202 spike, chloride solution	ERMAE640	69
Mg, isotopic, nitrate solution	IRMM009	67
MICROCRYSTALLINE CELLULOSE (water content above saturated solutions)	BCR302	58
MILK POWDER (PCDDs, PCDFs)	BCR607	38
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MOROCCAN PHOSPHATE ROCK (trace elements)	BCR032	60
MULLITE (lattice spacing, other parameters)	BCR301RM	57-58
MUSSEL (dc-saxitoxin)	BCR543	39
MUSSEL TISSUE	BCR668	19-20
MUSSEL TISSUE	BCR682	26
MUSSEL TISSUE (butyltins)	ERMCE477	24
MUSSEL TISSUE (elements)	ERMCE278k	19
NATURAL MILK POWDER (PCBs)	BCR450	37
NATURAL MILK POWDER (pesticides)	BCR187	38
NATURAL PORK FAT (blank)	ERMBB444	37
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Nb	IRMM526	61
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NIMONIC 75 FOR TENSILE PROPERTIES	BCR661B	56-57
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ORGANIC-RICH SOIL (extractable elements)	BCR700	21
OXIDE GLASS (15 ppm U)	IRMM540R	66
OXIDE GLASS (50 ppm U)	IRMM541	66
PAHs IN ACETONITRILE / TOLUENE	ERMAC213	14
PCB STANDARD SOLUTION	BCR365	7
PETROL	ERMEF211	64
PHARMACEUTICAL GLASS	IRMM435	55
PICENE (purity)	BCR168	6
PIG FEED (nutritional properties)	BCR709	45
PIG KIDNEY (CTC free)	BCR706	48
PIG KIDNEY (CTC incurred)	BCR707	48
PIG KIDNEY (trace elements)	ERMBB186	40
PIG LIVER (CTC free)	BCR695	48
PIG LIVER (CTC incurred)	BCR696	48
PIG LIVER (vitamins)	BCR487	43
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PLANKTON (trace elements)	BCR414	18
PLASMID DNA FRAGMENTS OF 356043 SOYBEAN	ERMAD425	33
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PLASMID DNA FRAGMENTS OF MON 810 MAIZE	ERMAD413	30-31
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PLASTIC FILM (OVERALL MIGRATION IN OLIVE OIL (film A)	BCR537	45
PLASTIC FILM (OVERALL MIGRATION IN OLIVE OIL (film B)	BCR538	45
PLASTIC FILM (OVERALL MIGRATION IN OLIVE OIL (film C)	BCR539	45
PLATINUM, isotopic, metal	IRMM010	67
POLYCHLORODIBENZO-P-DIOXINS (PCDD) AND POLYCHLORODIBENZOFURANS (PCDFS)	BCR614	8-14
POLYETHYLENE (40, 75, 200, 400 mg/kg Cd)	VDA 001-004	66
POLYETHYLENE (LDPE)	ERMEC590	66
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POLYPROPYLENE (PP)	ERMEC591	66
PORCINE MUSCLE (chloramphenicol blank)	BCR444	48
PORK FAT (pesticides)	ERMBB430	38
PORK MUSCLE	ERMBB124	49
PORK MUSCLE	ERMBB130	48
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QUARTZ (particle size 160 – 630 microns)	BCR068	57
QUARTZ (particle size 2.40 – 32.00 microns)	BCR067	57
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RAPESEED (colza) (S, total glucosinolate, high level)	ERMBC367	38
RAPESEED (colza) (S, total glucosinolate, low level)	ERMBC366	38
RAPESEED (colza) (S, total glucosinolate, medium level)	ERMBC190	38
RAPESEED (oil, moisture, volatiles)	BCR446	45
RAPESEED (oil, moisture, volatiles)	BCR447	45
RESIN-BONDED FIBRE BOARD (thermal conductivity)	IRMM440	55
Rh	IRMM529	61
RICE (As species)	ERMBC211	24
RICE FLOUR	IRMM804	40
RICE FLOUR (mylase, low level)	BCR465	44
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RICE FLOUR (mylase, high level)	BCR467	44
RIVER SEDIMENT (extractable phosphorous)	BCR684	22
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RUBIDIUM (natural) spike, nitrate solution	IRMM619	68
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SEWAGE SLUDGE (mixed origin) (trace elements)	BCR145R	16
SEWAGE SLUDGE (PCDDs and PCDFs)	BCR677	25
SEWAGE SLUDGE AMENDED (terra rossa) SOIL (trace elements)	BCR484	21
SEWAGE SLUDGE AMENDED SOIL (trace elements)	BCR143R	15
SEWAGE SLUDGE AMENDED SOIL (trace elements)	BCR483	21
SILICON DIOXIDE, isotopic, solid	IRMM018a	68
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SKIM MILK POWDER	BCR685	45
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SPIKED PORK FAT (very low level)	ERMBB445	37
SULPHUR-32 spike, nitrate solution	IRMM643	69
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SULPHUR-32 spike, nitrate solution	IRMM645	69
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SUPERPHOSPHATE (various parameters)	BCR033	60
TANTALUM PENTOXIDE ON TANTALUM FOIL	BCR261T	58
TETRAMETHYLUREA	STA003m	28
THALLIUM (natural) spike, nitrate solution	ERMAE649	69
THERMALLY REFINED LEAD (trace elements)	BCR287A, B	62
THROMBOPLASTIN RABBIT (prothrombin time)	ERMAD149	55
THYROXINE (T4)	IRMM468	50
Ti	IRMM531	61
Ti 6AL 4V ALLOY (O)	BCR059A, B	62
TiAl6V4 (Al, V)	BCR089	64
TIN ORE CONCENTRATE (Sn)	BCR010	60
TITANIA (8.23 m^2/g) (nitrogen BET specific surface area)	BCR173	57
TITANIUM (H)	BCR318	62
TITANIUM (impurities)	BCR090A, B	64
TITANIUM (O, N)	BCR024B, C	62
TOASTED BREAD	ERMBD273	49
TRACE ELEMENTS IN WHITE CABBAGE	BCR679	48
TRIPHENYLENE (purity)	BCR270	6
TUNA FISH (total and methylmercury)	ERMCE464	20
TUNA FISH (total and methylmercury)	BCR463	20
TUNA FISH TISSUE (As species)	BCR627	21
TUNGSTEN (0.18 m^2/g) (nitrogen BET specific surface area)	BCR175	57
TUNGSTEN CARBIDE POWDER (O)	BCR102	62
UNALLOYED ZINC (disc) (trace elements)	BCR326	63
UNALLOYED ZINC (disc) (trace elements)	BCR327	63
UNALLOYED ZINC (trace elements)	ERMEB322	63
UNALLOYED ZINC (trace elements)	ERMEB323	63
UNALLOYED ZINC (trace elements)	ERMEB324	63
UNALLOYED ZINC (trace elements)	ERMEB325	63
UNALLOYED ZINC (trace elements)	BCR321	63
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UREA FERTILIZER (composition)	BCR179	61
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WHEAT FLOUR (deoxynivalenol blank)	BCR396	39
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WHOLE MILK POWDER (aflatoxin M1, high level)	ERMBD284	39
WHOLE MILK POWDER (aflatoxin M1, low level)	ERMBD283	39
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WHOLE MILK POWDER (major nutrients)	BCR380R	45
WHOLE MILK POWDER (vitamins)	ERMBD600	43
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ZINC-64 spike, nitrate solution	IRMM3702	69
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ZINC-67 spike, nitrate solution	IRMM653	69
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ZIRCALOY (C, N, O)	BCR276	62
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ZnAl4 (trace elements)	BCR352	63
ZnAl4 (trace elements)	BCR353	63
ZnAl4 (trace elements)	BCR354	63
ZnAl4 (trace elements)	BCR355	63
ZnAl4Cu1 (trace elements)	BCR356	63
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Application Note 1

Comparison of a measurement result with the certified value

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The comparison of a measurement result on a certified reference material with the certified value is explained. The method compares the difference between the certified and measured values with its uncertainty, i.e. the combined uncertainty of certified and measured value. Guidance on how to determine the standard uncertainties of certified values as well as standard uncertainties of measurement results is given.

INTRODUCTION

One of the most frequent applications of certified reference materials is validation of measurement procedures. To achieve this, measurements on certified reference materials are performed and the results are compared with the certified values. This comparison is often described in a qualitative manner such as measurement results “agree”, “agree well” or even “agree perfectly” with the certified values. However, a structured and quantitative approach exists that allows making a statement on the evidence of any bias.
This approach takes into account the certified value, the measurement result and their respective uncertainties. These uncertainties are subsequently combined and the expanded uncertainty is compared to the difference. This note will explain the procedure of the uncertainty estimation and the comparison of results with a certified value.

BASIC PRINCIPLES

After the measurement of a CRM the absolute difference between the mean measured value and the certified value can be calculated as

$$\Delta_m = |c_m - c_{CRM}|$$

Δ_m ..... absolute difference between mean measured value and certified value
c_m ..... mean measured value
c_{CRM} ..... certified value

Each measurement has an uncertainty u_m as described in the ISO Guide to the Expression of Uncertainty in Measurement (GUM) [1] and the Eurachem/CITAC Guide “Quantifying Uncertainty in Analytical Measurement” [2]. This means, any measurement result is only known within the limits of this uncertainty. Similarly, the certified value of a CRM is only known with a specified uncertainty u_{CRM} stated on the certificate. Uncertainties are usually expressed as standard deviations, but only the variances (the squared standard deviations) are additive. The uncertainty of Δ_m is u_Δ, that is calculated from the uncertainty of the certified value and the uncertainty of the measurement result according to

$$u_\Delta = \sqrt{u_m^2 + u_{CRM}^2}$$

u_Δ ..... combined uncertainty of result and certified value (= uncertainty of Δ_m)
u_m ..... uncertainty of the measurement result
u_{CRM} ..... uncertainty of the certified value

The expanded uncertainty U_Δ, corresponding to a confidence level of approximately 95 %, is obtained by multiplication of u_Δ by a coverage factor (k), usually equal to 2.

$$U_\Delta = 2 \cdot u_\Delta$$

U_Δ ..... expanded uncertainty of difference between result and certified value

To evaluate method performance, Δ_m is compared with U_Δ: If $\Delta_m \le U_\Delta$ then there is no significant difference between the measurement result and the certified value.

DETERMINATION OF THE INDIVIDUAL UNCERTAINTIES

Uncertainty of the certified value

The expanded uncertainties U_{CRM} of each certified value are given on the certificate. Each ERM®-certificate also contains in a footnote an explanation of the derivation of the uncertainty (see Figs. 1 and 2). In most cases, the coverage factor is explicitly stated, (an example can be seen in Fig. 1). The standard uncertainty, u_{CRM}, of the certified value is obtained by dividing the stated expanded uncertainty by the coverage factor.
In some cases, the uncertainty is the 95 % confidence interval of the mean of laboratory means (for an example see Fig. 2). In this case, the t-factor for a 95 % confidence level

with n-1 degrees of freedom (n being the number of laboratories) needs to be determined from statistical tables. [Alternatively, the factor can be derived in MS Excel® using the function tinv(0.05, n-1)]. The standard uncertainty of the certified value u_{CRM} is then obtained by dividing the stated expanded uncertainty by the t- factor.

Uncertainty of the measured value

According to ISO/IEC 17025 [3], measurement uncertainties must be known for each measurement. In the absence of full uncertainty budgets, several approximations exist (ranked in decreasing usefulness) to estimate measurement uncertainties:

1) The within-laboratory reproducibility standard deviation (intermediate precision) as determined from e.g. quality control charts can be used as (rough) estimation of u_m.
2) A reproducibility standard deviation from other sources (e.g. the certification reports available on www.erm-crm.org or an interlaboratory comparison) can be used after it has been proven that the laboratory's performance is equivalent to the performance of the participants in the study in question.
3) The standard deviation of the measurements can be used as very rough estimation. This estimation is typically underestimating the real uncertainty.

ERM®- BB445

PORK FAT		
Chlorobiphenyl [1] Ballschmiter No. (Congener name)	Mass fraction	
	Certified value [2] [µg/kg]	Uncertainty [3] [µg/kg]
28 (2,4,4'-Trichlorobiphenyl)	14.8	1.3
52 (2,2',5,5'-Tetrachlorobiphenyl)	12.9	0.9

[1] As obtained by quantification using GC methods.
[2] Unweighted mean value of the means of 8 accepted sets of data, each set being obtained in a different laboratory a with a different method of determination. The certified value and its uncertainty are traceable to the International Syst units (SI).
[3] Estimated expanded uncertainty U with a coverage factor k = 2, corresponding to a level of confidence of about 95 defined in the Guide to the Expression of Uncertainty in Measurement (GUM), ISO, 1995. Uncertainty contributions a

Figure 1: Certificate with expanded uncertainty. The standard uncertainty of the certified value (u_{CRM}) is obtained by dividing the expanded uncertainty by the coverage factor (in this case: 2; marked in red)

ERM®- CC580

ESTUARINE SEDIMENT		
Parameter	Mass fraction (based on dry mass)	
	Certified value [1]	Uncertainty [2]
Total Hg	132 mg / kg	3 mg / kg
CH_3Hg^+	75 µg / kg	4 µg / kg

1) Unweighted mean value of the means of 11 to 13 accepted sets of data, each set being obtained in a different laboratory and / or with a different method of determination. Certified value is based on dry mass. The certified values are traceable to SI.

2) The certified uncertainty is the half-width of the 95 % confidence interval of the mean defined in the k-factors were chosen according to the t-distribution depending of the number of accepted sets of results and were 2.179 for total Hg and 2.228 for MeHg.

Figure 2: Certificate with a confidence interval. The standard uncertainty of the certified value (u_{CRM}) is obtained by dividing the expanded uncertainty (in this case: 4 for CH_3Hg) by the coverage factor (in this case: 2.228; marked in red)

EXAMPLE ERM-BB445 (PCBs IN PORK FAT)

PCB 52: certified value = (12.9 ± 0.9) µg/kg. Footnote 2 of the certificate states that a coverage factor of k = 2 was applied. u_{CRM} is therefore 0.9/2 µg/kg= 0.45 µg/kg.
The laboratory measurements gave an average of (14.3 ± 1.8) µg/kg (single standard deviation of 6 measurements spread over three weeks). The standard deviation is divided by the square root of the number of measurements, as the average of the results is compared with the certified value. u_m is therefore estimated as 1.8/√6 µg/kg = 0.74 µg/kg.

$$\Delta_m = |c_m - c_{MRC}| = |14.3 - 12.9|\ \mu g/kg = 1.4\ \mu g/kg$$

$$u_\Delta = \sqrt{u_m^2 + u_{CRM}^2} = \sqrt{0.74^2 + 0.45^2}\ \mu g/kg = 0.87\ \mu g/kg$$

The expanded uncertainty U_Δ is $2 \cdot u_\Delta$ = 1.7 µg/kg. This is larger than the difference Δ_m between the certified and the measured value. The measured mean value is therefore not significantly different from the certified value.

1 International Standards Organisation (1993) Guide to the expression of uncertainty in measurement. ISO, Geneva. ISBN 92-67-10188-9
2 Ellison SLR, Roesslein M, Williams A (eds) (2000) EURACHEM/CITAC Guide: Quantifying uncertainty in analytical measurement, 2nd edn. EURACHEM. ISBN 0-948926-15-5. Available via http:// www.eurachem.com
3 International Standards Organisation (1999) ISO/IEC 17025: General Requirements for the competence of calibration and testing laboratories. ISO, Geneva

Application Note 2a

European Reference Materials

February 2011

Using Reference Materials for Calibration. Background

As the first in a series dedicated to calibration, this note explains principles for the use of reference materials in analytical calibration, that is, calibration for the purpose of determining the response behaviour of analytical instruments. Issues addressed include the estimation and use of calibration uncertainty, and requirements on reference materials for calibration. ERM® are perfectly suited for this purpose, because they fulfil the stated requirements.

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INTRODUCTION

One of the basic requirements of ISO/IEC 17025 is that all equipment having a significant effect on the accuracy or validity of measurement results provided by a laboratory shall be calibrated before being put into service. To this end, laboratories, especially accredited ones, must have an established calibration programme which ensures that measurements are traceable [1] to the International System of Units (SI) or to other agreed references.

The term "calibration" is currently defined in reference [1] as the

> "operation that, under specified conditions, in a first step, establishes a relation between the **quantity values** with measurement uncertainties provided by **measurement standards** and corresponding **indications** with associated **measurement uncertainties** and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication".

For a chemist in an analytical laboratory this general definition means that calibration determines the relationship between measured instrumental response and amount of the substance to be determined (the analyte) using appropriate calibration materials, and also the calculation used to obtain the result from a new observation. Establishing this relationship is key to establishing traceability to SI units or other appropriate references.

ANALYTICAL CALIBRATION: FOCUS ON INSTRUMENTAL RESPONSE

Analytical instruments are typically calibrated using one or more calibration materials containing known amounts of the analyte. Most often these are synthetic materials such as calibration solutions, prepared from pure substances, but for special analytical techniques (e.g. direct analysis of solid samples by SS-AAS or XRF) matrix materials are used for calibration.

PRINCIPLES OF CALIBRATION: SINGLE-POINT CALIBRATION

1) Calibration

The basic principles of calibration can be illustrated by the simplest case: single-point calibration. This is used when the instrumental response (such as the peak area in a chromatogram) is, perhaps after baseline correction, strictly proportional to the amount of analyte. Then calibration may be carried out at a single level, by replicate analyses of a single calibration material. From the calibration data ($\bar{y}_{cal}$ is the mean value of response; x_{cal} is the reference value of analyte amount) the response factor is determined according to

$$F = \frac{\bar{y}_{cal}}{x_{cal}} \quad (1)$$

The response factor is then used to convert instrumental response data y_{samp} obtained on other samples into analyte amounts x_{samp} according to

$$x_{samp} = \frac{y_{samp}}{F} \quad (2)$$

Equations (1) and (2) illustrate the two steps in calibration; establishing a relationship between reference value x_{cal} and response y, and then using this to derive a calculation to predict values x_{samp} from new measured values y_{samp}.

2) Calibration uncertainty

Like any other measurement result the result of a calibration – whether calculated using a factor or a function summarising the calibration data – has an associated uncertainty. This uncertainty has to be included in the uncertainty budget of any result obtained using the calibrated equipment [2,3]. In the case of single-level calibration the uncertainties directly associated with calibration may be expressed as follows:

$$\frac{u_{cal}(x_{samp})}{x_{samp}} = \sqrt{\left(\frac{s(y_{samp})}{y_{samp}}\right)^2 + \left(\frac{s(\bar{y}_{cal})}{\bar{y}_{cal}}\right)^2 + \left(\frac{u(x_{cal})}{x_{cal}}\right)^2} \quad (3)$$

In this expression, all the terms are in the form of relative standard uncertainties. $u_{cal}(x_{samp})$ is the uncertainty in x_{samp} arising from calibration. The different terms on the right represent, respectively:

- the uncertainty arising from variation in the response obtained on a sample,
- the uncertainty arising from variation in the response from calibration material,
- the uncertainty associated with the reference value used in calibration.

All of these uncertainty contributions are combined as a root sum of squares.

Note: There are usually other sources of uncertainty in a complete measurement. These can often be combined with the calibration uncertainty by simple extension of equation (3). Details can be found in references [2] and [3].

The structure of the uncertainty budget described here can be used for other calibration designs, by combining the following contributions to the standard uncertainty of the result:

- the variability of measurements for the given sample, expressed as a standard deviation;
- the variability of measurements on calibration materials, expressed as a standard deviation;
- the standard uncertainty of the reference values attributed to the calibration materials.

The standard uncertainty reported to the customers additionally requires the analyst to consider the standard uncertainty associated with other effects not covered by the calibration.

MATRIX EFFECTS

The sample matrix can bias the analyte signal through spectral and non-spectral interference effects. Non-spectral interferences or matrix effects as they are often known, are characterized by changes in signal intensity that are matrix-induced and not related to spectral overlap. Matrix effects can lead to signal suppression, as well as signal enhancements. An important issue is that matrix effects often depend on the absolute matrix concentration not on the relative concentration of matrix to analyte. Matrix effects can be reduced by simply diluting the sample (if permitted by analyte concentration) or corrected for by certain calibration strategies such as internal standardisation, standard addition, matrix-matched calibration or isotope dilution mass spectrometry. More details on matrix effects and calibration strategies compensating for that can be found in the following literature [4,5].

REQUIREMENTS FOR CALIBRATION MATERIALS

Calibration materials have to be sufficiently homogeneous and stable so as to ensure that the assigned property values (including uncertainty) are valid for any portion of the calibration sample taken and utilised according to the supplier´s specification. In addition, technical requirements for calibration materials are case-dependent and cannot be summarised in a single application note. The only generic requirements that can be addressed here concern the information provided for a calibration material:

- For each reference value (analyte concentration) x_{ref} the standard uncertainty $u(x_{ref})$ has to be specified, either directly or by way of specifying an expanded uncertainty $U(x_{ref})$ with the associated coverage factor k. In addition a statement of traceability is required (Application Note 3 “Using Reference Materials to Establish Traceability“).
- For matrix materials, the matrix needs to be specified in sufficient detail to enable comparison with sample matrices where analyte-matrix interferences may occur.

EXAMPLES

Examples are explained in Application Note 2b “Using Reference Materials for Calibration. Examples”.

[1] International Vocabulary of Metrology — Basic and General Concepts and Associated Terms, 3rd edition (VIM 3) available from http://www.bipm.org or as ISO/IEC Guide 99-12:2007
[2] Hässelbarth W, Guide to the Evaluation of Measurement Uncertainty for Quantitative Test Results, Eurolab Technical Report No. 1/2006, www.eurolab.org
[3] Ellison SLR, Williams A, Roesslein M (Eds),: Quantifying Uncertainty in Analytical Measurement 2nd Ed. (2000). Eurachem/CITAC Guide, available at www.eurachem.org.
[4] Thompson M, Ellison SLR, Analytical Methods Committee Report: A review of interference effects and their correction in chemical analysis with special reference to uncertainty, Accred Qual Assur (2005) 10:82–97
[5] Vogl J, *Calibration strategies and quality assurance,* in Nelms S (ed.) “ICP Mass Spectrometry”, Blackwell Publishing Ltd. (2005) 147-181

Application Note 2b

European Reference Materials

February 2011

Using Reference Materials for Calibration. Examples - Determination of Kavain by HPLC-UV

ERM®-AC020a, kavain, is a CRM with a certified purity of 99.8 ± 0.2 mass %. The intended use of this material is for the calibration of methods for the determination of kavain in herbal products, foodstuffs and other relevant matrices. This example shows how ERM®-AC020a can be used as a calibrant to determine the amount of kavain in a solution of unknown concentration, and estimates the uncertainty of the calibration.

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CALIBRATION DATA

Five calibration standards from a certified reference material (CRM) of well-defined purity and uncertainty (ERM®-AC020a kavain) plus a blank were prepared. Standards were prepared in 1 % formic acid in acetonitrile. Chrysin was used as internal standard (IS) with a fixed mass fraction for all calibration standards and samples. The calibration standards were approximately equally spaced across the intended calibration range.

The peak height ratios (compared to the chrysin internal standard) were plotted against the corresponding kavain mass fractions and the regression parameters for the calibration line were calculated. The regression line and the regression parameters can be obtained, when plotting the data in Microsoft Excel® and using the tool “regression”.

Table 1: Observed calibration data

Calibration standard	Kavain mass fraction in µg/g	Observed peak height relative to IS
	x_{cal}	y_{cal}
1	0.0000	0.00000
2	20.000	0.53576
3	40.000	1.06537
4	60.000	1.58447
5	80.000	2.11463
6	100.00	2.65250

With this plot (Fig. 1) the regression line can be obtained in the following form:

$$y = a \cdot x + b \qquad (1)$$

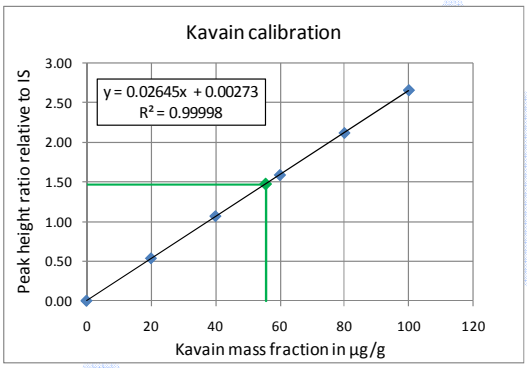

Fig. 1: Plot of the calibration data (blue) together with the regression line (black) and the results obtained for the unknown sample (green)

For the kavain calibration the parameters a and b are as follows:

Slope a: 0.02645 g/µg
Intercept b: 0.00273

Inspection of the calibration line gave no reason to suspect non-linearity, and inspection of the residuals showed no obvious trend. The calibration achieved the required correlation coefficient of at least 0.999.

The prepared solution of an unknown sample was analysed and a peak height ratio of 1.47200 was obtained. Applying the regression equation from above and introducing the peak height ratio as $\bar{y}_{samp}$ = 1.47200 a kavain mass fraction of x_{samp} = 55.5490 µg/g can be calculated.

CALIBRATION UNCERTAINTY

To calculate the uncertainty contribution for the kavain mass fraction in the sample deriving from the calibration, we start with the following equation (equation 3 in Application Note 2a):

$$\frac{u_{cal}(x_{samp})}{x_{samp}} = \sqrt{\left(\frac{s(y_{samp})}{y_{samp}}\right)^2 + \left(\frac{s(\bar{y}_{cal})}{\bar{y}_{cal}}\right)^2 + \left(\frac{u(x_{cal})}{x_{cal}}\right)^2} \qquad (2)$$

To estimate the uncertainty associated with random variation in the observations in the calibration and in the observation of the peak height for the unknown sample, the prediction interval $s_{x_{samp}}$ for predicted values of x is used.

This is calculated from the following equation:

$$s_{x_{samp}} = \frac{s(r)}{a}\sqrt{\frac{1}{N} + \frac{1}{n} + \frac{(\bar{y}_{samp} - \bar{y}_{cal})^2}{a^2 \sum_{i=1}^{n}(x_i - \bar{x}_{cal})^2}} \qquad (3)$$

N is the number of observations used to obtain the value $\bar{y}_{samp}$

$\bar{y}_{samp}$ is the arithmetic mean of peak height ratios determined for the unknown sample

$\bar{y}_{cal}$ is the arithmetic mean of the observed peak height ratios y_{cal} of the calibration standards in Table 1

$\bar{x}_{cal}$ is the arithmetic mean of the kavain mass fractions in the calibration standards in Table 1

x_i is the kavain mass fraction in the calibration standard i

n is the number of (x, y) pairs used in the regression

a is the estimated slope of the regression line.

The terms $s(y_{samp})$ and $s(\bar{y}_{cal})$ can be identified in equation (3) and therefore equation (2) can be modified as follows:

$$\frac{u_{cal}(x_{samp})}{x_{samp}} = \sqrt{\left(\frac{s_{x_{samp}}}{x_{samp}}\right)^2 + \left(\frac{u(x_{cal})}{x_{cal}}\right)^2} \quad (4)$$

The residual standard deviation $s(r)$ in equation (3) is given by

$$s(r) = \sqrt{\sum_{i=1}^{n} r_i^2 \Big/ (n-2)} \quad (5)$$

where the residuals r_i are the differences between observed and predicted value for the peak height. The predicted values can be obtained by inserting the kavain mass fractions of the calibration standards x_{cal} (Table 1) in the equation (1) of the regression line and calculate y_{cal}. These predicted values y_{cal} and the corresponding residuals are given in the Table 2.

Table 2: Predicted values for the peak height ratios and resulting residuals

Observation	Predicted y_{cal}	Residuals r_i
1	0.00273	-0.00273
2	0.53182	0.00394
3	1.06091	0.00446
4	1.59000	-0.00553
5	2.11909	-0.00446
6	2.64819	0.00431

With the residuals r_i from the table above $s(r)$ can be calculated as follows:

$$s(r) = \sqrt{\frac{0.000112}{(6-2)}} = 0.00529$$

This result is being inserted together with the other required data in equation (3):

$$s_{x_{samp}} = \frac{0.00529}{0.02645}\sqrt{\frac{1}{1}+\frac{1}{6}+\frac{(1.47200-1.32546)^2}{0.02645^2 \times 7000}} = 0.21643\ \mu g/g$$

This gives the uncertainty associated with variability in observations in the calibration and in the observation of the peak height for the unknown sample. Dividing by the calculated mass fraction in the sample we can express this as a relative standard uncertainty as follows:

(0.21643 µg/g) / (55.5490 µg/g) = 0.00390.

The term $u(x_{cal})$ has uncertainty contributions from the CRM used to prepare the calibration standards and the preparation of these standards; here only dilution occurs:

$$\frac{u(x_{cal})}{x_{cal}} = \sqrt{\left(\frac{u_{CRM}}{x_{CRM}}\right)^2 + \left(\frac{u(x_{dil})}{x_{dil}}\right)^2} \quad (6)$$

u_{CRM} is obtained from the calibration material certificate. The CRM has a certified value of 99.8 mass % kavain with a value for the standard uncertainty, u_{CRM}, of 0.075 mass % or expressed as a relative standard uncertainty (and an expanded uncertainty, U_{CRM}, of 0.2 mass %, calculated by $U_{CRM}=k \cdot u_{CRM}$ with a coverage factor $k = 2.45$):

(0.075 %) / (99.8 %) = 0.00075.

For the preparation of the calibration standards, we assume that the relative standard uncertainty associated with volumetric operations in preparing the calibration solutions is 0.001. Combining all the terms as relative standard uncertainties, gives the relative calibration uncertainty:

$$\frac{u_{cal}}{55.5490} = \sqrt{0.00390^2 + 0.00075^2 + 0.00100^2} = 0.00410$$

Converting this relative uncertainty to the units in which the result is expressed gives the calibration uncertainty u_{cal} as:

55.5490 µg/g x 0.00410 = 0.22775 µg/g

Uncertainties and uncertainty contributions are usually rounded to a maximum of two significant digits. Subsequently the quantity value, here the kavain mass fraction in the sample, is rounded so that the total number of digits agrees with the uncertainty.

This results in a kavain mass fraction x_{samp} with the uncertainty contribution for the calibration u_{cal}:

x_{samp} = 55.55 µg/g

u_{cal} = 0.23 µg/g

Finally, note that this estimates the uncertainty associated with calibration. It does not include the (usually much larger) uncertainties associated with extraction efficiency, test sample preparation, matrix effects, test material inhomogeneity or operator effects. However, it is useful in deciding whether the calibration procedure is suitable for its intended use.

NOTE

In addition to calibration using pure substances, it is also possible to use matrix calibrants. Often this is preferred for non-destructive testing, solid sampling techniques or when strong matrix effects occur. Examples are the quantification of toxic metals in plastic by XRF or the quantification of sulfur in fuel applying the combustion-UV-fluorescence technique.

Suitable CRMs for toxic metals in plastic are ERM®-EC680k and ERM®-EC681k; suitable CRM for sulfur in fuel are ERM®-EF211, ERM®-EF212a and ERM®-EF213.

Application Note 3

European Reference Materials

Using Reference Materials to Establish Traceability.

August 2006

Traceability of measurements enables results to be compared across space and time and is a requirement of ISO/IEC 17025. This note describes the steps that need to be applied to chemical measurement methods to ensure traceability of the results. Reference materials are essential to achieving traceability of measurement results. The ERM® range of certified reference materials are produced by three of Europe's top metrology institutions. ERM® reference materials have stated traceabilities and provide a means of ensuring reliability and comparability of the results of chemical analysis.

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INTRODUCTION

All chemical measurement results depend upon and are ultimately traceable to the values of measurement standards of various types, such as those for mass, volume and the amount of a particular chemical species. If results obtained by different laboratories are to be comparable, it is essential that all results are based on reliable measurement standards whose values are linked to a stated reference. If there are differences in the quality of the measurement standards used in different laboratories, discrepancies will inevitably arise when different laboratories analyse the same sample. It is a requirement of standards such as ISO/IEC 17025 [1] that test results should be traceable, preferably to national or international standards.

DEFINITION

"*Traceability is a property of the result of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties*" [2].

TRACEABLE MEASUREMENTS

The value of the result for an unknown quantity obtained from a comparison with the value of a calibration standard (where the uncertainty of the result is the uncertainty of this comparison plus the uncertainty of the standard) is traceable to the value of the calibration standard provided the method used for the comparison is *valid* and its *uncertainty* is known.

Application to chemical measurements

Method development establishes an optimised procedure which can be used to compare a sample and standard. Validation shows that, in terms of its performance, this procedure is fit for the purpose in hand and has the appropriate uncertainty.

Calibration establishes the relationships between the values provided by the measurement system with the values of the reference standards.

Traceability or control has to be established for each parameter specified in the procedure. Traceability is established through the use of measurement standards (e.g. certified reference materials) which are appropriate for each parameter. These certified reference materials are selected on the basis of fitness for purpose.

Establishing Traceable Results

The following steps are necessary to establish traceable results [3]:

1) Specify the measurand and acceptable uncertainty.
2) Choose a suitable method of estimating the value, *i.e*. a measurement procedure with associated calculation (equation) and measurement conditions.
3) Demonstrate (validation) that the calculation and measurement conditions include all the 'influence quantities' that significantly affect the result.
4) Identify relative importance of each influence quantity. A methodology to help analysts categorise the degree of control to be applied to realising a particular experimental value has been developed [4].
5) Choose and apply appropriate certified reference materials and standards.
6) Estimate the uncertainty of the result.

Figures 1 and 2 show how calibration using a common reference material provides traceability between laboratories and allows a meaningful comparison of results.

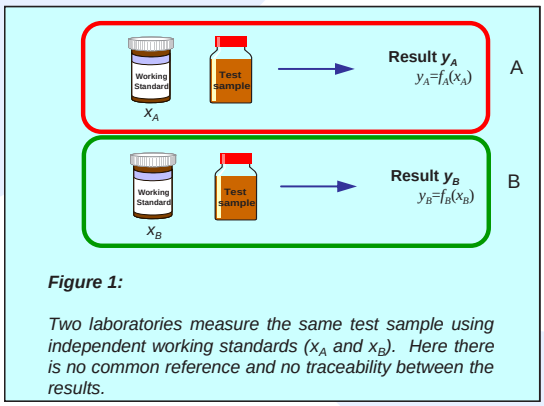

Figure 1:

Two laboratories measure the same test sample using independent working standards (x_A and x_B). Here there is no common reference and no traceability between the results.

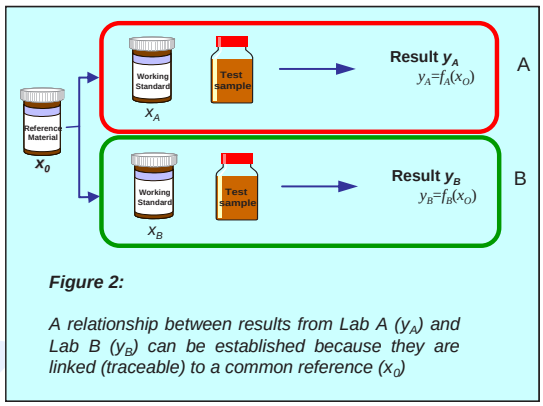

Figure 2:

A relationship between results from Lab A (y_A) and Lab B (y_B) can be established because they are linked (traceable) to a common reference (x_0)

A STRATEGY FOR ESTABLISHING TRACEABILITY

To achieve traceability

- The method must be properly validated and applied within its stated scope. If not, erroneous results may still be produced, even if all measurements and standards are traceable.
- The method must be carried out using the ***appropriate stated references.***

Key steps to select the appropriate stated references

- Write down and understand the equation used to calculate the analytical result.
- Identify any 'reagents' or equipment with specified values.
- Identify the fixed conditions used in the method.
- Obtain appropriate 'stated references'.

What are 'appropriate stated references'?

- Any 'reference point' that an analyst uses to obtain or realise a particular quantity or value in practice.
- Physical calibrations are well established, *e.g.* calibrated weight; reference thermometer; volumetric glassware; stopwatch.
- Chemical calibrations can be established in the same way using pure or matrix certified reference materials (calibrants) and well-characterised pure materials.

What is appropriate?

- The analyst must decide, based on:
  - The degree of control that is required in obtaining or realising a particular value in practice.
  - The extent to which the quantity affects the result.
  - The uncertainty of each stated reference must be appropriate.

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1 International Standards Organisation (2005) ISO/IEC 17025: General Requirements for the competence of testing and calibration laboratories. ISO, Geneva

2 International Vocabulary of Basic and General Terms in Metrology. ISO, Geneva, 1993, 2nd edition. ISBN 92-67-01075-1

3 Eurachem/CITAC 2003, Traceability in Chemical Measurement. A Guide to achieving comparable results in chemical measurements (www.eurachem.ul.pt)

4 Meeting the Traceability Requirements of ISO/IEC 17025. An Analyst's Guide. 3rd Edition. V Barwick and S Wood (Editors), LGC Limited, September 2005. ISBN 0-948926-23-6

Application Note 4

Use of Certified Reference Materials for the quantification of GMO in food and feed

September 2006

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This application note provides guidance on the correct use of IRMM's Reference Materials certified for their GM (genetically modified) mass fraction of a specific GM event.
The details given below refer particularly to the use of the CRMs ERM-BF410, ERM-BF411, ERM-BF412, ERM-BF413, ERM-BF414, ERM-BF415, ERM-BF416, ERM-BF417, ERM-BF418 and ERM-BF423.

INTRODUCTION

Legislation (EC) No 1830/2003 demands the labelling of food and feed products consisting of or containing more than 0.9 % genetically modified organisms (GMOs), provided the GMO has been placed on the European market in accordance with Community legislation. Therefore, quantification of GM in such products has to be performed in a reliable manner. Appropriate Certified Reference Materials (CRMs) are indispensable quality assurance tools for this.

GMO CRM CHARACTERISTICS

The certified values of the CRMs listed above are based on the masses of dried genetically modified seed powder and dried non-genetically modified seed powder used in the gravimetric preparation. The masses are corrected for their water content and the purity estimates. The GM mass fraction is calculated as:

$$\frac{\text{corrected mass}_{GM\ powder}}{\text{corrected mass}_{GM\ powder} + \text{corrected mass}_{non\text{-}GM\ powder}}$$

Each GMO CRM is certified for a mass fraction of a specific genetic modification event (as stated on the certificate). Consequently, the CRM can only be used to quantify the event indicated on the certificate and the corresponding blank material can only be used to prove the absence of this event below the threshold given on the certificate.

ERM®- BF418c

DRIED MAIZE POWDER		
	Mass Fraction	
	Certified value [1] [g / kg]	Uncertainty [2] [g / kg]
1507 maize	9.9	-0.6 ; +0.8

1) The certified value is based on the mass fraction of dried non-genetically modified powder and dried genetically modified powder mixed and corrected for the water content. The certified value is traceable to the SI.

2) The certified uncertainty is the expanded uncertainty estimated in accordance with the Guide to the Expression of Uncertainty in Measurement (GUM) with a coverage factor $k = 2$, corresponding to a level of confidence of about 95 %.

Figure 1: Part of the certificate of GM CRM ERM-BF418c.

Recently released GMO CRMs of IRMM have been certified with an asymmetric uncertainty range. If such a CRM is used for bias control (see ERM Application Note 1), the 'plus uncertainty' has to be used in the case that the average measurement result exceeds the certified value and the 'minus uncertainty' has to be used in the case that the average measurement result is lower than the certified value.

USING REAL-TIME PCR

Real-time Polymerase Chain Reaction (rt-PCR) is commonly used to quantify GM fractions in food and feed samples. This DNA-based quantification technique measures the ratio between transgenic deoxyribonucleic acid (DNA), i.e. derived from the genetic modification, and endogenous DNA, which is specific for the biological species.
Because of the differing genetic composition of different parts of the seeds of monocotyledons (e.g. maize endosperm, seed coat and embryo), the value of the DNA ratio in the reference material may be not the same as the value of the certified powder mass fraction. Hence, the ratio of extractable transgenic DNA / extracted endogenous DNA is not necessarily equal to the ratio GM maize mass / total maize mass, even if both DNA species have comparable extraction yields.
During the preparation of GMO CRMs, special care was taken to ensure that the GM and non-GMO powders are similar with respect to their particle size distribution. This is particularly important regarding the amount of extractable DNA in both powders. Different DNA extraction efficiencies of the GM and non-GM powder would influence the GM concentration value measured by rt-PCR. Therefore, only extraction methods which were validated to fulfil this requirement should be used.
During certification the GM mass fraction of the CRM is verified using an event-specific rt-PCR method. However, one has to be careful to draw quantitative conclusions from measurements of unknown samples, as the DNA-based GM quantification may vary with the particular variety tested. If not available elsewhere, it is advisable to investigate the impact of different varieties on the rt-PCR results during an in-house validation [1].

Real-time PCR detection methods submitted and validated under the provision of Regulation (EC) No 1829/2003 are accessible for the public via the homepage of the Community Reference Laboratory for GM Food and Feed (http://gmo-crl.jrc.it/detectionmethods.htm).

EXPRESSING RESULTS IN RELATIVE DNA COPY NUMBERS

In Europe the most often used methodology for GMO quantification is rt-PCR, therefore a recent Commission Recommendation (2004/787/EC) proposes to express measurement results on GM samples in DNA copy numbers. If one is using GMO CRMs certified for their GM mass fraction for the calibration of measurements and expresses the final result in relative copy numbers, one should be aware that the maize CRMs have been produced using GMO maize being heterozygous for the transgene. Information about the zygosity of the seed materials used for the production of the CRMs can be found in the corresponding certification report. Furthermore one has to take into account that the relative GM copy numbers for maize are influenced by the way the GMO hybrid variety was produced and by the endoreduplication status of the seeds, which increases the impact of genomic distribution present in the endosperm tissue. Considering the extreme cases the relative GM copy numbers can either be 33 % (transgenic event originating from the father used to cross the heterozygous seed) or 66 % (transgenic event originating from the mother plant used to cross the heterozygous seed) under the assumption that endoreduplication is so intense that the impact of the endosperm is close to 100 %. All other cases (less impact of endoreduplication and bigger impact of the embryo tissue) will lead to values between 33 and 66 %, based on the assumption that in comparison to these effects the impact of the seed coat can be neglected.
An example for the transformation of a measurement result and its uncertainty obtained in g/kg into relative copy numbers is given below.

EXAMPLE

By using for calibration CRMs certified for their GM mass fraction, a maize sample was found to contain 65 ± 20 g/kg of maize event 1507. The expanded measurement uncertainty of 20 g/kg was calculated using a coverage factor of 2 and a measurement uncertainty of the quantification method of 15 %, estimated during in-house validation. In order to transform the result obtained for the GM mass fraction into a copy number ratio, the result in g/kg needs to be transformed into percent by dividing by 10. It has to be taken into consideration that the maize GMO CRMs used for calibration have been produced from heterozygous maize seeds, the results need to be divided by 2:

$$\frac{\bar{x}}{10 \times 2} = \frac{65}{20} = 3.3$$

for $\bar{x}$ = average of the GM content found in g/kg

Note, that in cases where a different DNA extractability has been observed for the non-GMO and GMO base materials used to produce the CRMs, a correction factor needs to be applied. Information about the DNA extractability can be found in the certification report. Using CTAB a ratio of 0.7 ± 0.3 was found for the DNA extractability of the GMO powder divided by the non-GMO powder. Hence, the true GM content of the sample under investigation is overestimated in terms of copy numbers and needs to be corrected:

$$3.3 * f = 3.3 * 0.7 = 2.3$$

for f = correction factor related to the different DNA extractability of the GMO and non-GMO powder used as CRM

The effect of endoreduplication and the breeding of the heterozygous maize event need to be considered in the uncertainty of the measurement results. The uncertainty needs to cover the range of 33 % (66 % minus 33%) and the value measured might differ with 16.5 %. For the estimation of the copy number ratio the DNA extracted from the maize sample under investigation needs to be quantified and the number of maize genomes estimated. For this estimation the DNA concentration is divided by the genome size of maize. Consequently, the uncertainty related to the DNA quantification and the uncertainty related to the genome size estimation need to be considered in the uncertainty calculation. According to literature maize genome sizes are known to vary up to 36 % [2]. During in-house validation the reproducibility of the quantification method was established to be 22 %. Consequently, the expanded combined uncertainty for the result expressed in copy number ratios (U_{cc}) can be calculated as:

$$U_{cc} = k\sqrt{u_m^2 + u_{gs}^2 + u_{Dq}^2 + u_e^2}$$

$$U_{cc} = 2\sqrt{15^2 + \left(\frac{18}{\sqrt{3}}\right)^2 + 22^2 + \left(\frac{16.5}{\sqrt{3}}\right)^2}\ \% = 60\%$$

for k = coverage factor
u_m = uncertainty contribution related to the copy number quantification method
u_{gs} = uncertainty contribution related to the genome size estimation
u_{Dq} = uncertainty contribution related to the DNA quantification
u_e = uncertainty contribution related to the breeding and endoreduplication

Expressed in copy numbers the maize sample contains 2.3 ± 1.4 transgenic sequences of event 1507 per 100 endogenous sequence. Compared to the result expressed in 1507 mass fractions of 65 ± 20 g/kg the relative expanded uncertainty increased from 30 to 60 %.

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[1] IUPAC Technical Report (2002): Harmonized Guidelines for Single-Laboratory Validation of Methods of Analysis
[2] Poggio et al., Annals of Botany 85 (1998),107-115.

Application Note 5

Use of Certified Reference Materials for the quantification of GMO in DNA copy number ratio

November 2007

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This application note provides guidance on the correct use of European Reference Materials certified for their GM (genetically modified) copy number fraction of a specific GM event. The details given below refer particularly to the use of the CRMs ERM-BF413d and ERM-AD413 and the upcoming CRMs certified for copy number ratio.

INTRODUCTION

The JRC-IRMM has recently developed two new types of GMO Certified Reference Materials (CRMs) which permit the correct implementation of the Recommendation (EC) 787/2004 [1] using a metrologically traceable system. This note gives instructions on how the new CRMs should be applied.

CHARACTERISTICS OF THE NEW GMO CRMs

A. New GMO matrix CRMs

The certified values are based on two different measurement units. Besides a certified value for the mass fraction of a specific genetic modification event (see application note 4) the new CRM is certified for the DNA copy number ratio. This parameter, expressed in %, is calculated according to:

$$\text{DNA copy number ratio [\%]} = \frac{\text{GM DNA copy number [cp]}}{\text{Target taxon-specific DNA copy number [cp]}} \times 100$$

The certification is based on QRT-PCR (quantitative real-time PCR) measurements. These measurements are calibrated by using a dedicated plasmid DNA calibrant that is certified to contain one copy of both the GM and the taxon-specific target sequence per plasmid (see part B).

Therefore, the GM maize DNA copy number ratio is directly related to the GM event analysed. Moreover, in the example below, the CRM ERM-BF413d should only be used in conjunction with the plasmid calibrant ERM-AD413 and the event-specific MON 810 detection method [2]. The certified MON 810 DNA copy number ratio (0.57 %) is different from the certified mass fraction (10.0 g/kg or 1.0 %) as the certified MON 810 copy number ratio takes into account the zygosity, ploidy and endoreduplication status of the seeds used to produce this material.

The matrix CRM is intended for the quality control of analytical procedures including the DNA extraction and purification as well as the PCR measurement steps for a particular GM event.

B. New GMO plasmid CRMs

The certified calibrants contain a defined DNA fragment specific for a genetic modification as well as a defined DNA fragment specific for the taxon analysed. That plasmid contains a 170 base pair (bp) fragment of the MON 810 *5' plant-P35S* junction and a 351 bp fragment of the maize endogenous high mobility group gene (*hmg*).
The certified values are the number of cloned GM and the number of taxon-specific DNA fragment per plasmid respectively. The number ratio between those two DNA fragments is provided as an indicative value obtained by duplex and simplex real-time PCR.

USE OF THE GMO PLASMID CALIBRANT

The calibrant has to be used in conjunction with a defined QRT-PCR method [1].
Each calibrant is delivered on dry-ice in a closed plastic tube and should be kept at -20 °C until use. The contents should be first thawed, then mixed and finally opened and diluted under a laminar flow to reduce the risk of contamination. Each tube contains approximately 2 x 10^6 copies (cp) of plasmid per µL and the recommended starting volume for the dilution series is 50 µL. The dilution protocol stated on the certificate should be followed. The dilution buffer is not provided.
The dilution series should always be prepared fresh and any excess discarded in closed tubes. The dilution series is used to prepare two calibration curves (CCs) (one CC for the transgene and one CC for the taxon-specific gene) each having 5 points, each point measured in triplicate in the PCR reaction (see example). One tube provides enough calibrant to prepare 10 CCs for both targets which means that a total number of 100 to 250 samples can be quantified with one tube. The recommended sample intake for QRT-PCR is 5 µL of template DNA per PCR well.
Measured fluorescence threshold values (Ct values) must be plotted against the theoretical number of copies of both fragments to generate two CCs. These CCs are used for the

quantification of the GM target relative to the taxon-specific target in an unknown sample. The results can then be calculated as the ratio of both targets and expressed in percentage according to the Recommendation (EC) 787/2004. An internal quality control (QC) PCR can be made by calculating the average ratio of measured Ct values for the taxon-specific and transgenic targets for the calibration points corresponding to 2000 cp/µL. That ratio should be in agreement with 1.04 % (expanded uncertainty 0.06 %) for a simplex PCR as indicated in the certification report (see also ERM Application Note 1).

EXAMPLE

Genomic DNA extracted from an unknown sample and from ERM-BF413d used as QC material are analysed by QRT-PCR using ERM-AD413 as calibrant. Ct values are obtained for the ERM-AD413 calibrant after amplification of the *hmg* and MON 810 fragments (**Table 1**). Average Ct values for the unknown sample, 32.76 and 25.44 are obtained for the amplification of MON 810 and *hmg* fragments, respectively. For the QC material, average Ct values of 31.22 and 22.20 are obtained for the MON 810 and *hmg* fragments, respectively.

Total number of cp of the MON 810 fragment	Ct values measured			average
	replicate 1	replicate 2	replicate 3	Ct
50000	25.30	25.19	25.15	25.21
10000	27.57	27.62	27.66	27.62
1000	31.19	30.89	31.14	31.07
100	33.99	35.12	34.80	34.64
25	35.79	35.67	36.37	35.95
NTC	45.00	45.00	45.00	45.00
Total number of cp of the *hmg* fragment				
500000	20.76	20.67	20.63	20.69
100000	22.92	23.00	23.04	22.99
10000	26.39	26.36	26.33	26.36
5000	27.31	27.29	27.37	27.32
1000	29.38	29.19	29.57	29.38
NTC	45.00	45.00	45.00	45.00

***Table 1**: Example of experimental Ct values obtained using the ERM-AD413 as calibrant. NTC[1] = no template control.*

The slopes and Y-intercepts of the two calibration curves must be determined to calculate the MON 810 content in both samples assuming a straight line as the best-fit model function. The built-in modules of Microsoft®Excel or any other available calibration/determination software can be used to calculate the slopes and Y-intercepts.

The slopes (*b*) of both linear regression lines can be calculated using the formula: $b = \frac{\sum\left(\log(x) - \log(\bar{x})\right)\left(y - \bar{y}\right)}{\sum\left(\log(x) - \log(\bar{x})\right)^2}$ where, x represents the number of copies of the fragment amplified and y represents the corresponding Ct value. The slopes of the calibration curves of the *hmg* and the MON 810 fragments given in **Table 1** are respectively -3.25 and -3.32. The Y-intercepts (a) of the regression lines are calculated using the formula: $a = \bar{y} - b\bar{x}$ when log (*x*) =0. In our example, the *a*-values for the *hmg* and MON 810 regression lines are 39.26 and 40.93, respectively. Those values represent the theoretical *Ct* values corresponding to 1 *cp* of both fragments. The slope serves to calculate the PCR efficiency (ε) with the formula: $\varepsilon = (10^{-1/b} - 1)*100$. In our example, the PCR efficiencies were equal to 99.7 % and 103.1 % for the amplification of the MON 810 and *hmg* fragments, respectively. The number of MON 810 copies (*cp*) present in the unknown sample is calculated as: $cp_{MON810} = 10^{\left(\frac{Ct_{MON810} - a_{MON810}}{b_{MON810}}\right)}$, where Ct_{MON810}, a_{MON810} and b_{MON810} are the *Ct* values, the Y-intercept and the slope obtained for MON 810 amplification. The same calculation is done to determine the number of copies of the *hmg* fragment with the formula: $cp_{hmg} = 10^{\left(\frac{Ct_{hmg} - a_{hmg}}{b_{hmg}}\right)}$. In our example, the estimated average copy numbers of MON810 and *hmg* fragments present in the unknown sample is 289 and 17878 cp, respectively. The MON 810 content of the unknown sample expressed in percentage is therefore equal to: $\frac{289\ \ cp_{MON810}}{17878\ \ cp_{hmg}} * 100 = 1.62\ \ \%$. The same calculation is made for the QC material containing: $\frac{841\ \ cp_{MON810}}{177513\ \ cp_{hmg}} * 100 = 0.47\ \ \%$ of MON 810. Taking into account the uncertainty associated with the ERM-BF413d and the uncertainty of the measurement (see ERM Application Note 1), it can be verified if the measured value agrees with the certified values of ERM-BF413d. In the example given above the ratio of the average *Ct* values of 1.05 obtained for 10000 cp (5 µL of ERM-AD413 at 2000 cp/µL) is in agreement with the indicative value of 1.04 ± 0.06 reported on the ERM-AD413 certificate, meaning that this GM quantification was under control.

[1] European Commission Recommendation (EC) N° 787/2004 of 4.10.2004 on technical guidance for sampling and detection of genetically modified organisms and material produced from genetically modified organisms as or in products in the context of Regulation (EC) No 1830/2003. Off. J. Eur. Union L 348 (2004) 18-26

[2] ISO 21570:2005 Foodstuffs - Methods of analysis for the detection of genetically modified organisms and derived products - Quantitative nucleic based methods. Annex D2 Event-specific method for the relative quantitation of maize line MON 810 DNA using real-time PCR. 93-99.

[1] Cross-contamination or unspecific amplification should be suspected if the Ct values for the NTC differs form the number of PCR cycles performed.

Application Note 6

Use of ERM certificates and materials

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This application note describes some practical aspects associated with handling and use of certified reference materials (CRMs) in laboratories. The various values provided on a certificate, re-use of materials, applying a moisture correction and interpretation of the traceability statement are also explained.

INTRODUCTION

Understanding the information contained in reference material certificates and correct use of these materials are necessary get the maximum benefit from them. This application note explains the basic terms used on ERM certificates, and gives guidance on the practical handling of materials.

TERMS ON THE CERTIFICATE

Types of assigned values

Three categories of values are assigned for ERM-branded reference materials:

Certified values fulfil the highest standards for reliability. They are traceable to stated references and are accompanied by a GUM (ISO Guide 98 "Guide to the expression of uncertainty in measurement") compatible expanded uncertainty statement valid for the entire shelf life of the ERM-CRM.

Indicative values are not certified due to either a larger uncertainty than required for the intended use or insufficient variety of methods used in the characterisation. The information is therefore unsuitable for certification at the accuracy required for certified values.

Additional material information are values created during the certification exercise, which are usually the result of one method only and indicate the order of magnitude rather than an accurate value.

In summary, certified values are those values the certifying body is confident in assigning with the highest accuracy, while indicative values display higher uncertainties and/or lack a full traceability statement. This hierarchy in reliability is shown by the fact that only certified values are on the first page of the certificate. It follows that certified values are more assured than indicative values which in turn are more assured than additional material information.

Metrological traceability statement

Certified and indicative values come with a traceability statement. These statements unambiguously identify the measurand as well as the traceability of the values assigned to this measurand (see also the ERM policy on traceability on www.erm-crm.org). This information is given in one or two footnotes on the certified or indicative values and measurands (see Figures 1 and 2). The following alternatives exist:

Measurands can be structurally defined ("rational") like for total cadmium or ochratoxin A, or procedurally defined (empirical"), such as for dietary fibre, extractable cadmium or impact toughness, which are defined via specific measurement protocols.

For structurally defined measurands, ERM principles are stricter than those of ISO Guide 34 and 35 and require availability of results obtained from at least two completely independent methods or confirmation of results by primary methods of measurement by an independent method to demonstrate the absence of any method bias of assigned values.

Values assigned to the measurands can be traceable to the International System of Units (SI) or to an artefact (empirical scales). In the former case, all input factors are calibrated with standards whose values are traceable to the SI, whereas in the latter cases arbitrary standards have been used for at least one step in the calibration (e.g. World Health Organisation primary reference preparation in clinical chemistry, Vienna Standard Mean Ocean Water (VSMOV) for chemical shift).

ERM®- AD452/IFCC

GAMMA-GLUTAMYLTRANSFERASE

	Certified value[1]	Uncertainty [2]
Catalytic concentration in reconstituted material	114.1 U/L 1.90 µkat/L	2.4 U/L 0.04 µkat/L

1) This value is the unweighted mean of 12 sets of results, idependently obtained from 12 laboratories. It is traceable to the IFCC primary reference method at 37 °C. The material must be reconstituted according to the specified procedure (see below). Values were converted from U/L into µkat/L by multiplication with 0.01667.

Figure 1: Traceability statement of ERM-AD452/IFCC. The measurand is procedurally defined and proper calibration of all input factors is assumed.

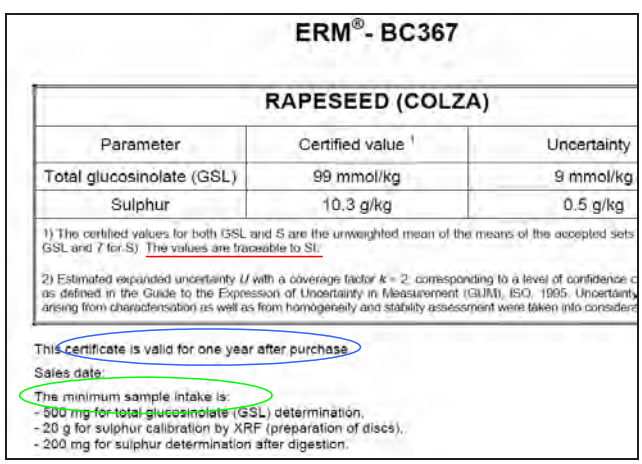
In earlier ERM certificates, this information was combined into one footnote (Figure 1). Since the adoption of the common ERM policy on traceability, this information is given in two footnotes, one connected to identity of the measurand itself, the other specifying the traceability of the values assigned to it.

Minimum sample intake

Every material is intrinsically heterogeneous. The minimum amount of material that is representative of the whole unit (bottle, vial etc.) is defined as minimum sample intake (Figure 2). The certified value and its uncertainty cannot be guaranteed for subsamples smaller than the minimum sample intake.

Expiry date

Producers of reference materials guarantee the integrity of the material and the validity of the certificate for a specified time (known as the shelf life), provided the material is unopened and stored under the recommended storage conditions. This does not automatically mean that the user has to discard the unused sample once the shelf life has expired, but the producer cannot guarantee stability any longer. Users can continue to use a material under their own responsibility, if they have additional evidence of stability (e.g. no changes in quality control charts, comparison with other materials), however the material certificate will not be valid.



ERM®- BC367

RAPESEED (COLZA)

Parameter	Certified value [1]	Uncertainty
Total glucosinolate (GSL)	99 mmol/kg	9 mmol/kg
Sulphur	10.3 g/kg	0.5 g/kg

1) The certified values for both GSL and S are the unweighted mean of the means of the accepted sets GSL and 7 for S). The values are traceable to SI.

2) Estimated expanded uncertainty *U* with a coverage factor *k* = 2, corresponding to a level of confidence c as defined in the Guide to the Expression of Uncertainty in Measurement (GUM), ISO, 1995. Uncertainty arising from characterisation as well as from homogeneity and stability assessment were taken into considera

This certificate is valid for one year after purchase.

Sales date:

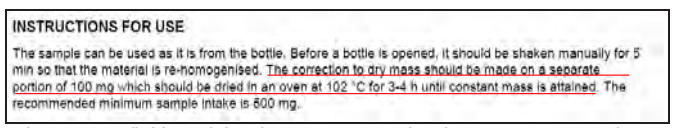
The minimum sample intake is:
- 500 mg for total glucosinolate (GSL) determination,
- 20 g for sulphur calibration by XRF (preparation of discs),
- 200 mg for sulphur determination after digestion.

Figure 2: The shelf life and minimum sample intake are marked in blue and green, respectively.

The shelf life may be extended by the producer if additional information on the stability becomes available. This, however, refers only to newly purchased samples and not to samples distributed before the extension of the original shelf life.

Instructions for use

The instructions for use give a detailed description for each material. These descriptions can refer to dry mass correction (Figure 3), reconstitution procedure, use of values, storage of the material *etc*. If these instructions are not followed, the assigned values are not valid.



INSTRUCTIONS FOR USE

The sample can be used as it is from the bottle. Before a bottle is opened, it should be shaken manually for 5 min so that the material is re-homogenised. The correction to dry mass should be made on a separate portion of 100 mg which should be dried in an oven at 102 °C for 3-4 h until constant mass is attained. The recommended minimum sample intake is 800 mg.

Figure 3: Definition of the dry mass correction for ERM-CE477. Please note the different recommended sample intakes for dry mass correction and certified measurands (in this case butyltins), reflecting different degrees of homogeneity for moisture and butyltins.

HANDLING ISSUES

Measurement method to be used

The measurement method must determine the same measurand as described in the certificate. This means that for procedurally defined measurands, the method specified on the certificate must be used. For structurally defined measurands, any method determining this measurand can be used and should give unbiased results.

All instruments must be properly calibrated to ensure that measurement results are traceable to the same reference as the certified value. For results traceable to an artefact, a standard whose value is traceable to the same artefact must be used.

Use of opened bottles

For opened units, alteration or even degradation of the material can happen which could not be accounted for during the certification process. Therefore, CRM producers cannot guarantee the assigned values of opened units. It is up to the user's judgement whether or not this material can be further used and which storage conditions or treatment are necessary. As a general guideline, materials should be stored cool, dry, in the dark and closed. Further information is often available in the certification report, which is freely available on www.erm-crm.org. In any case, materials from opened containers should be used as soon as possible after opening to minimise change.

Moisture correction

Many certified values are stated as content per dry mass of sample. As results from different methods (e.g. drying oven, Karl Fischer titration, vacuum drying oven) may differ significantly, the procedure for moisture correction must be clearly stated on the certificate (Figure 3) and this method must be used. Using different conditions can significantly alter the material (Figure 4) and the results obtained. Determination of the dry mass must be performed on a separate subsample.

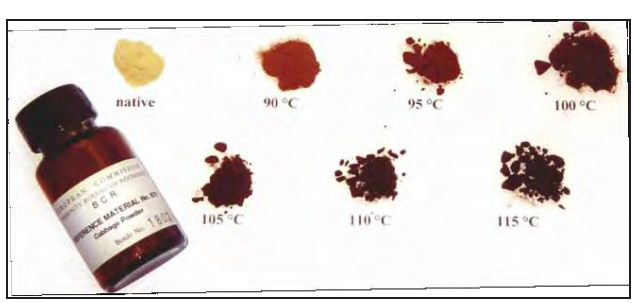


Figure 4: Effect of different drying conditions on a cabbage reference material. Specified drying condition on the certificate : 16 h at 70 °C

APPLICATION NOTE IRMM-351

1. Presence / absence test

For application in presence/absence tests, analyse at least two vials of the CRM. Plate and incubate material spheres as explained on the certificate under instructions for use. Count colony forming units (cfu) per plate and evaluate results based on individual cfu values per analysed vial. The test has been passed if, for each material sphere, the result is within the 95% confidence interval specified for the CRM (4 ± 2). The test failed if the obtained cfu values are not within these limits.

2. Method validation

If this CRM is used for method validation or testing of media, a similar approach as for certification of the batch should be applied. This requires the measurement of an appropriate number of CRM vials, minimum 15 in agreement with the number of CRM vials analysed during the characterisation study (section 5.2 of the certification report). Conclusions should be based upon patterns (histograms) of the results obtained in the laboratory and during certification rather than on mean cfu values. The histogram obtained in the laboratory is compared with the hypergeometric distribution obtained for the homogeneity and batch characterisation data (fig.1) and a chi square value is calculated. The success of the validation is assessed from this chi square value with respect to critical limits. If the lab falls short of the critical value, it failed in method validation. A detailed explanation on the statistics can be found in the certification report.

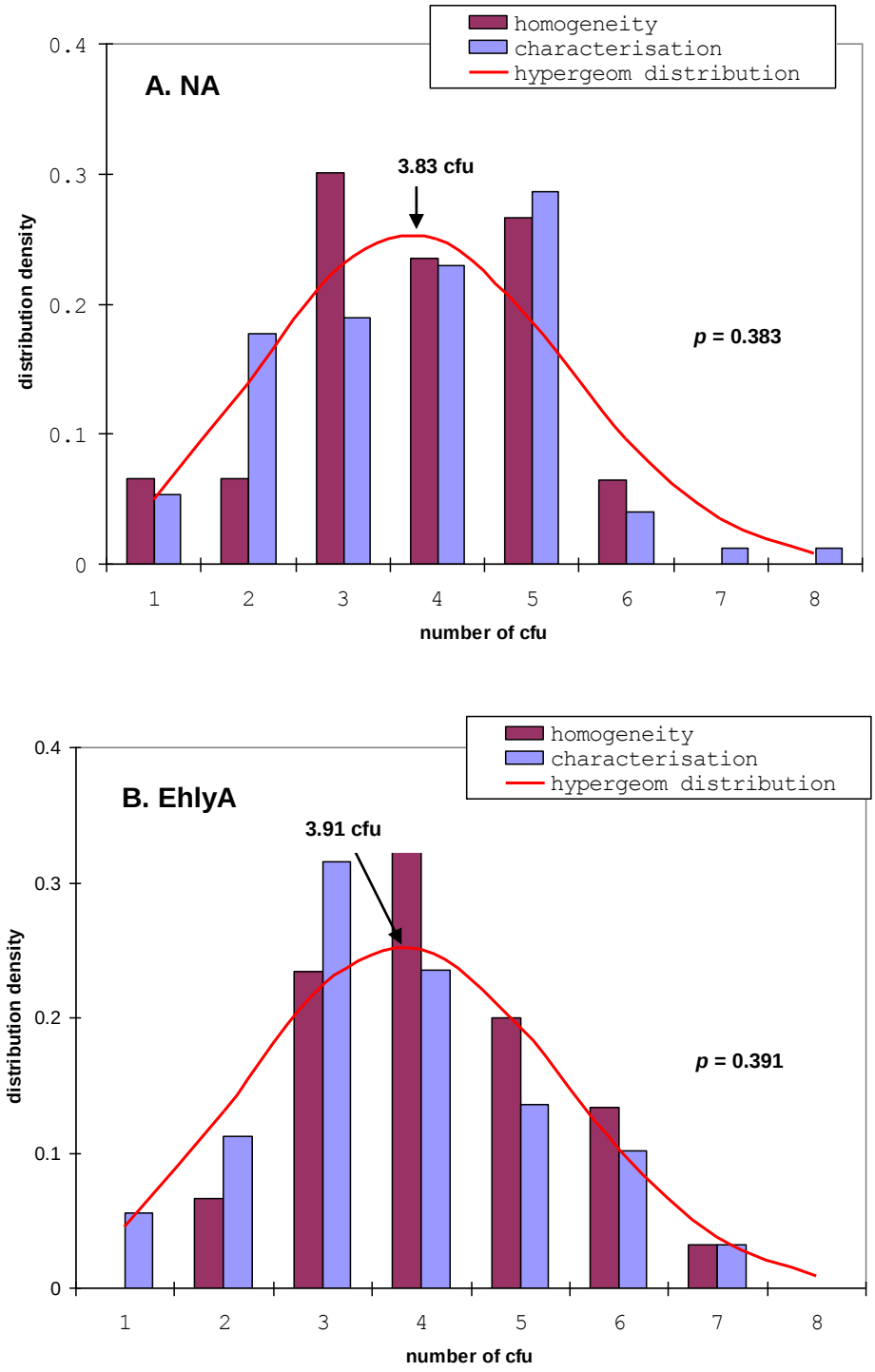


Fig. 1: Representation of observed (histograms) and expected (hypergeometric distribution) cfu values obtained for homogeneity and batch characterisation by colony counting on NA and EhlyA. Mean cfu values are indicated by arrows.

APPLICATION NOTE IRMM-352

1. Presence / absence test

For application in presence/absence tests, analyse at least two vials of the CRM. Plate and incubate material spheres as explained on the certificate under instructions for use. Count colony forming units (cfu) per plate and evaluate results based on individual cfu values per analysed vial. The test has been passed if, for each material sphere, the result is within the 95% confidence interval specified for the CRM (5 $\pm$ 2 on nutrient agar and 4 $\pm$ 2 on XLD agar). The test failed if the obtained cfu values are not within these limits.

2. Method validation

If this CRM is used for method validation or testing of media, a similar approach as for certification of the batch should be applied. This requires the measurement of an appropriate number of CRM vials, minimum 15 in agreement with the number of CRM vials analysed during the characterisation study (section 5.2 of the certification report). Conclusions should be based upon patterns (histograms) of the results obtained in the laboratory and during certification rather than on mean cfu values. The histogram obtained in the laboratory is compared with the hypergeometric distribution obtained for the homogeneity and batch characterisation data (fig.1) and a chi square value is calculated. The success of the validation is assessed from this chi square value with respect to critical limits. If the lab falls short of the critical value, it failed in method validation. A detailed explanation on the statistics can be found in the certification report.

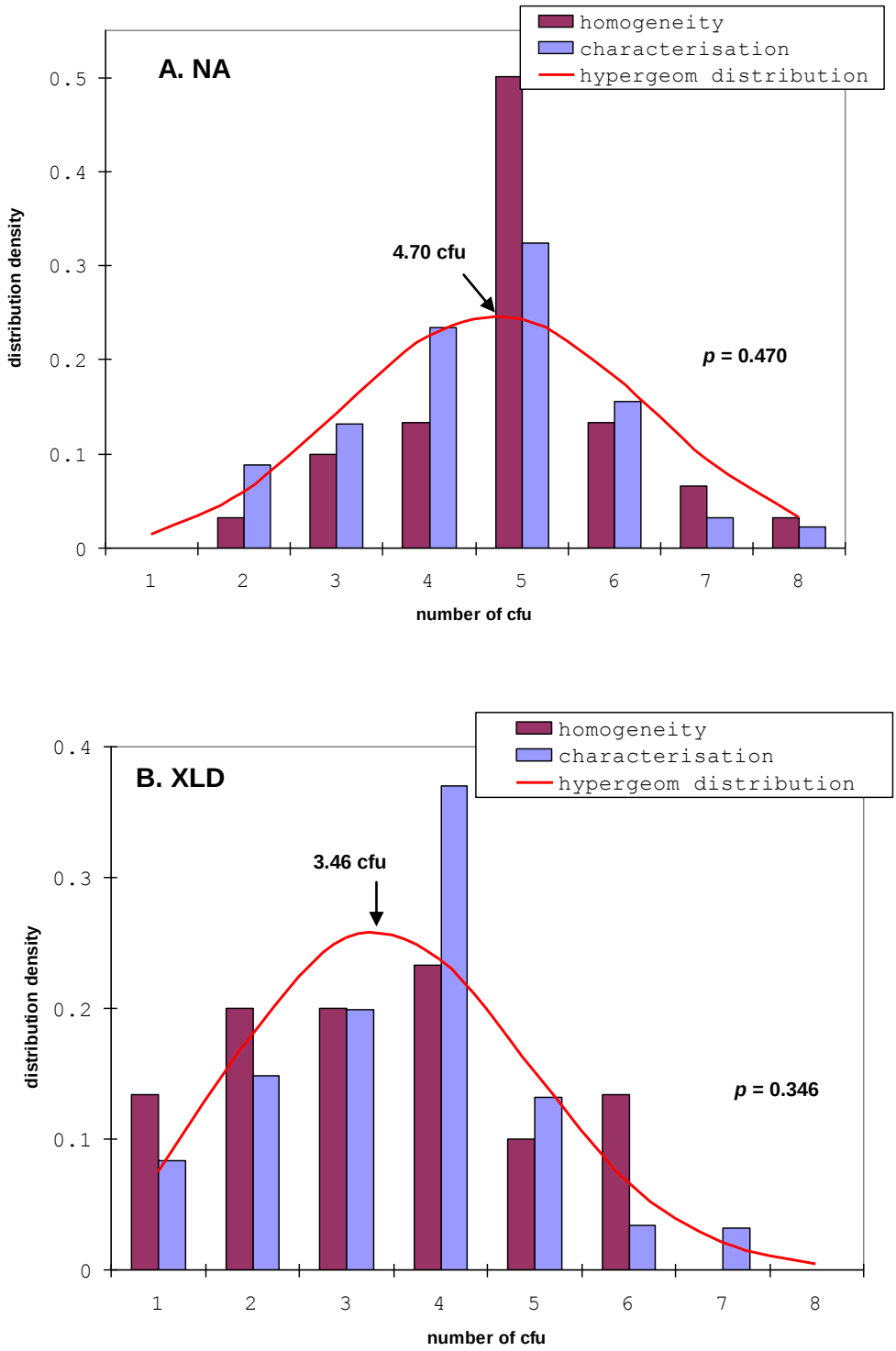


Fig. 1: Representation of observed (histograms) and expected (hypergeometric distribution) cfu values obtained for homogeneity and batch characterisation by colony counting on NA and XLD. Mean cfu values are indicated by arrows.

Application Note

ERM®-AD623

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Use of ERM-AD623 for the Quantification of *BCR-ABL1* transcripts

The certified reference material (CRM) ERM-AD623 [1] is intended to be used for the calibration of quantitative real time polymerase chain reaction (qPCR) assays measuring the BCR-ABL1 b3a2 transcript levels in cDNA samples from leukaemia patients.

INTRODUCTION

The fusion gene *BCR-ABL1* results from a genetic translocation joining two genes (c-abl oncogene 1 [*ABL1*] and breakpoint cluster gene [*BCR*]) and is the primary cause of chronic myeloid leukaemia (CML). Breakpoints can occur at different positions within the genes and the two major transcripts are called b2a2 and b3a2 (joining exon 13 and exon 14 of *BCR* respectively with exon 2 of *ABL1*).

BCR-ABL encodes a constitutively active tyrosine kinase which is targeted by the standard therapy for CML with tyrosine kinase inhibitors. Regular monitoring of *BCR-ABL1* transcript levels in the peripheral blood from patients is essential to evaluate treatment efficacy [2]. A multistep measurement procedure consisting of RNA extraction, reverse transcription and qPCR, as shown in Figure 1, is used to quantify *BCR-ABL* transcript levels in blood samples.

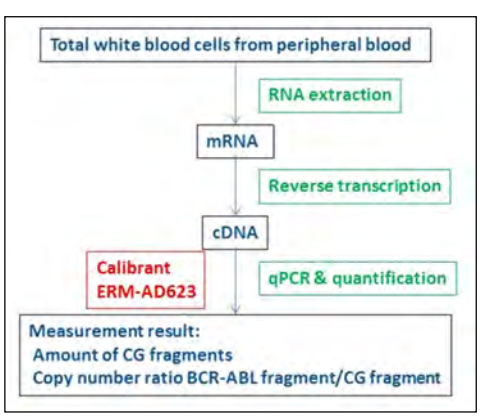

Figure 1: Multistep measurement procedure to quantify BCR-ABL transcripts levels in blood samples. CG: control gene, qPCR: quantitative real time PCR

INTENDED USE OF ERM-AD623

ERM-AD623 is intended for the calibration of qPCR assays quantifying the *BCR-ABL1* b3a2 transcript in relation to the transcript of 1 of 3 control genes (CG): *ABL1, BCR*, or glucuronidase beta (*GUSB*). Several qPCR assays with different probe/primer sets or PCR instruments can be used (as listed in Annex H of the certification report [1]). The suitability of ERM-AD623 for the quantification of the *BCR-ABL1* b2a2 transcript would have to be verified by the laboratory.

ERM-AD623 can be used directly in the routine analysis of cDNA samples or indirectly for calibrating in-house plasmid standards.

Limitations

ERM-AD623 cannot be used to control the earlier steps of the measurement procedure, i.e. RNA extraction and reverse transcription.

Conversion of the measured copy number ratio *BCR-ABL1* transcripts/CG transcripts to the international scale (IS) requires the use of established conversion factors processes or an additional matrix reference material with a certified value traceable to the World Health Organization (WHO) International Genetic Reference Panel for the Quantification of BCR-ABL translocation [3, 4].

PRACTICAL USE OF ERM-AD623

Design of calibration curves

Two calibration curves, one for the *BCR-ABL* fragment and one for the CG fragment, should be included in each qPCR experiment to compensate for between-day variations or variability due to other sources like different reagent batches and different instruments. It is recommended that each of the six ERM-AD623 plasmid solutions is measured in triplicate.

The calibration curves are obtained by plotting the quantification cycle (C_q) value (also called C_t value) measured for each ERM-AD623 plasmid solution against the $\log_{10}$ of the amount of fragment copies added to the qPCR reaction (Figure 2).

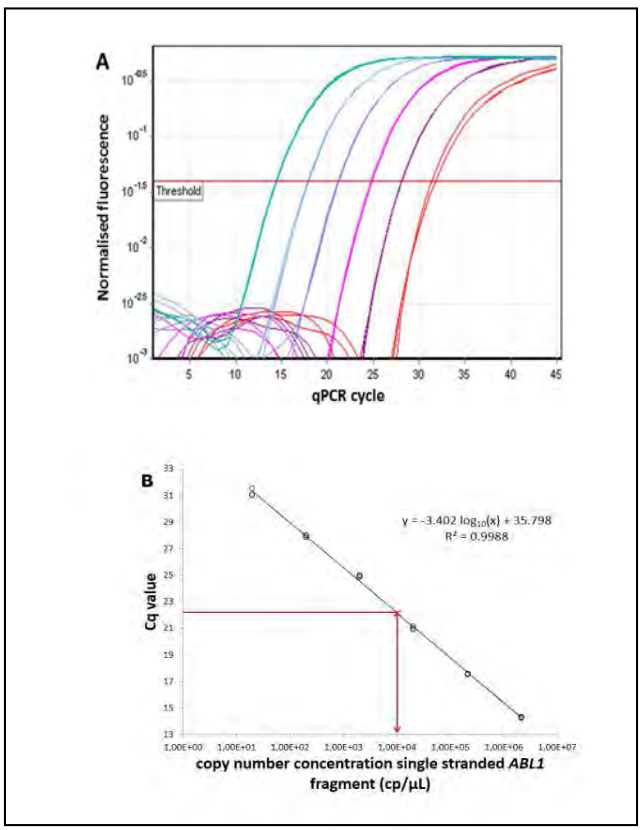

Figure 2: Example of an amplification plot and a calibration curve for the ABL1 target obtained with the six ERM-AD623 plasmid solutions.

The certified copy number concentrations of the ERM-AD623 plasmid solutions refer to copy numbers of the double stranded plasmid and these values must be multiplied by 2 when measuring single stranded cDNA samples.

In addition, the difference in slope between the calibration curve from the *BCR-ABL1* fragment and the calibration curve from the CG fragment should be taken in account when evaluating the quality of a qPCR experiment. Small slope differences may have a large effect on the calculated copy number ratio *BCR-ABL1* transcript/CG transcript due to the logarithmic scale of the calibration curves.

Calculating results for unknown samples

Number of *BCR-ABL1* and CG transcripts

The number of *BCR-ABL1* and CG transcripts in an unknown sample are calculated from the measured Cq values by using the equation of the calibration curves. The number of CG transcripts in a cDNA sample gives an indication of the quality of the RNA extraction and the reverse transcription step. In case of undetectable *BCR-ABL1* transcript levels, the number of CG transcripts can be used to determine the level of molecular response as described in the European LeukemiaNet recommendations [2].

Copy number ratio

The copy number ratio *BCR-ABL1* fragment/CG fragment is calculated as:

$$\frac{\text{number of BCR-ABL1 transcripts}}{\text{number of CG transcripts}} \cdot 100\ \%$$

Uncertainties

The uncertainty associated with the certified copy number concentrations of the ERM-AD623 plasmid solutions must be taken into account when reporting the number of CG transcripts in a cDNA sample.

As the sequences of the *BCR-ABL* and the CG transcript are on one plasmid, the contribution of ERM-AD623 to the uncertainty associated with the measured copy number ratio *BCR-ABL* transcript/CG transcript is negligible.

qPCR assay validation and trend evaluation

The validation process of in-house developed qPCR assays should confirm that the PCR efficiencies obtained with ERM-AD623 are equal to those of the cDNA samples [6]. In addition, assays should be optimised to yield similar intercept values for the calibration curves of the *BCR-ABL* and the CG fragment [5].

Run-to-run variability and trends in results over time can be evaluated as the Cq values obtained for each ERM-AD623 plasmid solution should remain stable providing the same threshold for the fluorescence signal is used.

HANDLING OF THE MATERIAL

The six ERM-AD623 plasmid solutions should be stored at -20 °C until use. To prepare the solutions for use, the content of the vials should be thawed completely and mixed gently by inverting the vials several times. Once thawed, the solutions can be stored for a maximum of 4 weeks at 4 °C or placed back at -20 °C. However, the solutions should not pass more than 10 freeze/thaw cycles.

The certified values of the plasmid solutions and their associated uncertainty are only valid when the minimum sample intake specified on the certificate of 5 µL is respected. ERM-AD623 cannot be used for a reliable quantification of the BCR-ABL transcript with lower sample intakes as no certified values are available.

Recommendations on the quality criteria for qPCR measurements have been published [5] and are summarized in Table 1.

REFERENCES

[1] Deprez *et al*. 2012. ISBN 978-92-79-23343
[2] Baccarani *et al*. 2013. Blood 122; 872-884
[3] Brandford *et al.* 2008. Blood 122; 3330-3338
[4] White *et al*. 2010. Blood 116; e111-e117
[5] Foroni *et al.* 2011. British Journal of Haematology 153; 179-190
[6] Branford *et al*. 2006. Leukemia 20; 1925-1930

Table 1: Recommended quality criteria for qPCR measurement results [5]

Type of sample	Criteria	Acceptable values/results
All (calibrants and cDNA samples)	Variability of Cq values within replicates = highest value - lowest value	< 0.5 if average Cq value ≤ 30 < 1.0 if average Cq value > 30 and ≤ 33 < 1.5 if average Cq value > 33 and < 37
Calibrants	Slope of the calibration curve	Between -3.20 and -3.60
Calibrants	Coefficient of determination of linear regression (R^2) of the calibration curve	> 0.980
cDNA samples	Amount of CG transcripts per qPCR reaction	≥ 10 000 *ABL1* fragments or ≥ 24 000 *GUSB* fragments