

มหาวิทยาลัยเชียงใหม่
Chiang Mai University

APPENDIX A

Indoor radon concentration in three seasons

House ID	Summer (Bq.m ⁻³)	Winter (Bq.m ⁻³)	Rainy (Bq.m ⁻³)
3	36.82002315	113.2150424	34.95683183
10	13.45486111	38.11667676	11.84778529
11	31.90104167	38.40042373	34.1356982
11/1	49.47916667	75.00378329	45.89969434
16	12.15277778	46.53450363	16.18806306
22	30.31994048	111.0081215	44.49203668
24	29.18002137	44.13841808	34.2710499
29	19.38657407	-	25.80705706
39	49.05007102	-	29.31287111
54	32.04571759	110.3460452	56.42361111
55	96.57118056	116.0525121	93.09735872
67	25.92329545	78.75554883	30.77651515
68	21.33969907	66.56875963	-
71	39.60503472	103.2523709	34.31165541
74	14.82928241	133.8865348	14.6631006
75	27.56076389	133.5502421	20.88025526
78	14.61226852	50.75918079	11.14395646
78/1	31.90104167	56.87550444	21.81869369
86	47.40918803	77.87278047	58.83287133
84/1	11.44255051	84.62538521	11.51719902
98	33.63715278	77.68361582	40.82207207
102	22.93113426	74.15254237	23.57826577
103	28.33581349	55.30576972	45.94996782

Indoor radon concentration in three seasons (continue).

House ID	Summer (Bq.m ⁻³)	Winter (Bq.m ⁻³)	Rainy (Bq.m ⁻³)
106	33.04811508	43.77728557	29.76190476
109	24.8119213	125.6368543	-
113	14.68460648	44.13841808	-
116	21.91840278	81.65607345	21.11486486
126/1	20.83333333	45.96700969	20.64564565
127	31.30918561	115.7372377	26.16963554
135	30.87515783	65.87658898	34.61558149
136	19.29450758	54.70011098	19.38728501
137	45.93460648	100.8562853	45.86617868
148	24.73958333	67.07033256	40.11824324
152	17.43344907	55.1730226	20.05912162
157	21.33969907	63.05488297	20.05912162
159/1	52.70337302	168.104318	45.14559202
165	20.5374053	42.90884786	22.07463145
172	35.77628968	88.21378128	22.47224903
182	15.0462963	118.1806144	13.72466216
No ID	75.89285714	192.4144006	64.09869691

Field data in winter season at 0.5-meter.

House ID	Indoor radon (Bq.m ⁻³)	soil-radon (kBq) (kBq.m ⁻³)	Permeability (m ²)	availability (Bq.m ⁻¹)	Thoron/Radon Ratio
11	38.40	25.06	7.32E-12	1.84E-07	0.121
11/1	75.004	19.40	4.72E-12	9.16E-08	0.376
78	50.76	24.32	1.58E-11	3.85E-07	0.287
10	38.12	25.65	6.03E-12	1.55E-07	0.879
103	55.31	34.21	6.98E-12	2.39E-07	0.325
148	67.07	42.76	3.04E-11	1.30E-06	0.403
165	42.91	61.99	6.63E-12	4.11E-07	0.222
68	66.57	85.64	2.47E-11	2.11E-06	0.285
109	125.64	44.99	1.13E-11	5.07E-07	0.094
127	115.74	31.01	1.43E-11	4.43E-07	0.304
159/1	168.10	29.28	4.14E-12	1.21E-07	0.174
84/1	84.63	56.25	2.06E-11	1.16E-06	0.250
3	113.22	19.69	1.09E-11	2.14E-07	0.313
182	118.18	30.38	1.30E-11	3.96E-07	0.244
22	111.01	19.71	8.20E-12	1.62E-07	0.363
102	74.15	75.72	6.00E-11	4.54E-06	0.161
106	43.78	72.88	9.14E-12	6.66E-07	0.295
113	44.14	31.95	1.68E-11	5.36E-07	0.189
116	81.66	69.58	1.60E-11	1.12E-06	0.296
126/1	45.97	70.22	3.43E-11	2.41E-06	0.246
135	65.88	54.23	3.42E-11	1.85E-06	0.103
152	55.17	85.94	2.06E-11	1.77E-06	0.276
157	63.06	88.98	7.40E-11	6.58E-06	0.207

Field data in winter season at 0.5-meter (continue).

House ID	Indoor radon (Bq.m ⁻³)	soil-radon (kBq) (kBq.m ⁻³)	Permeability (m ²)	availability (Bq.m ⁻¹)	Thoron/Radon Ratio
29	-	59.53	1.12E-11	6.65E-07	0.441
67	78.76	29.90	1.95E-11	5.84E-07	0.240
75	133.55	41.82	1.67E-11	7.00E-07	0.108
78/1	56.88	28.39	9.17E-12	2.60E-07	0.347
71	103.25	103.25	1.57E-11	1.62E-06	0.609
137	100.86	100.86	3.75E-11	3.78E-06	0.522
74	133.89	133.89	1.51E-11	2.02E-06	0.358
16	46.54	46.54	1.87E-11	8.72E-07	0.235
54	110.35	110.35	5.46E-12	6.02E-07	0.383
39	-	-	1.96E-11	-	0.324
No ID	192.41	192.41	6.71E-12	1.29E-06	0.405
55	116.05	116.05	8.48E-12	9.85E-07	0.250
98	77.68	77.68	4.29E-11	3.33E-06	0.181
172	88.21	88.21	6.07E-11	5.35E-06	0.173
86	77.87	77.87	1.53E-11	1.20E-06	0.312
136	54.70	54.70	1.05E-11	5.77E-07	0.111

Field data in winter season at 1.0-meter.

House ID	Indoor radon (Bq.m ⁻³)	soil-radon (kBq) (kBq.m ⁻³)	Permeability (m ²)	availability (Bq.m ⁻¹)	Thoron/Radon Ratio
11	38.40	-	7.32E-12	-	-
11/1	75.004	-	4.72E-12	-	-
78	50.76	57.28	1.45E-11	8.32E-07	0.166
10	38.12	57.98	5.46E-12	3.17E-07	0.289
103	55.31	26.32	5.09E-12	1.34E-07	0.228
148	67.07	88.97	3.71E-11	3.30E-06	0.275
165	42.91	82.45	1.04E-11	8.54E-07	0.133
68	66.57	141.57	4.88E-11	6.91E-06	0.105
109	125.64	-	1.13E-11	-	-
127	115.74	78.41	9.30E-12	7.29E-07	0.133
159/1	168.10	21.09	4.14E-12	8.74E-08	0.004
84/1	84.63	134.42	2.95E-11	3.96E-06	0.137
3	113.22	80.75	3.14E-11	2.53E-06	0.090
182	118.18	81.76	1.62E-11	1.33E-06	0.164
22	111.01	74.53	5.73E-12	4.27E-07	0.079
102	74.15	95.32	5.62E-11	5.35E-06	0.158
106	43.78	212.04	2.12E-11	4.49E-06	0.082
113	44.14	58.56	1.04E-11	6.07E-07	0.019
116	81.66	106.42	1.18E-11	1.26E-06	0.021
126/1	45.97	95.34	5.05E-11	4.82E-06	0.141
135	65.88	106.30	3.64E-11	3.87E-06	0.136
152	55.17	155.82	4.56E-11	7.11E-06	0.084
157	63.06	107.60	1.59E-10	1.71E-05	0.097

Field data in winter season at 1.0-meter (continue).

House ID	Indoor radon (Bq.m ⁻³)	soil-radon (kBq) (kBq.m ⁻³)	Permeability (m ²)	availability (Bq.m ⁻¹)	Thoron/Radon Ratio
24	44.14	147.20	2.70E-11	3.98E-06	0.102
29	0.00	156.97	3.76E-11	5.91E-06	0.133
67	78.76	-	1.95E-11	-	-
75	133.55	68.06	1.21E-11	8.21E-07	0.027
78/1	56.88	66.56	1.09E-11	7.26E-07	0.169
71	103.25	60.32	1.57E-11	9.45E-07	0.151
137	100.86	110.93	8.78E-11	9.74E-06	0.104
74	133.89	30.04	1.51E-11	4.52E-07	0.025
16	46.54	73.46	1.13E-11	8.30E-07	0.083
54	110.35	60.94	3.96E-12	2.42E-07	0.138
39	0.00	90.83	2.50E-11	2.27E-06	0.132
No ID	192.41	103.45	2.08E-11	2.15E-06	0.187
55	116.05	100.71	7.09E-12	7.14E-07	0.082
98	77.68	85.87	6.93E-11	5.95E-06	0.100
172	88.21	84.69	7.25E-11	6.14E-06	0.115
86	77.87	87.00	2.61E-11	2.27E-06	0.120
136	54.70	-	1.05E-11	-	-

Field data in summer season at 0.5-meter.

House ID	Indoor radon (Bq.m ⁻³)	soil-radon (kBq) (kBq.m ⁻³)	Permeability (m ²)	availability (Bq.m ⁻¹)	Thoron/Radon Ratio
11	31.90	34.36	1.63E-11	5.62E-07	0.293
11/1	49.48	74.43	2.85E-11	2.12E-06	0.167
78	14.61	51.23	1.74E-11	8.89E-07	0.186
10	13.46	82.68	3.56E-11	2.95E-06	0.257
103	28.34	100.63	2.92E-11	2.94E-06	0.252
148	24.74	111.01	5.20E-11	5.77E-06	0.172
165	20.54	201.02	4.67E-11	9.39E-06	0.039
68	21.34	57.79	8.16E-12	4.72E-07	0.258
109	24.81	56.40	3.59E-11	2.03E-06	0.224
127	31.31	24.90	9.58E-12	2.38E-07	0.412
159/1	52.70	34.01	1.57E-11	5.34E-07	0.283
84/1	11.44	50.24	6.68E-12	3.35E-07	0.262
3	36.82	30.96	2.37E-11	7.34E-07	0.417
182	15.05	27.02	1.34E-11	3.62E-07	0.273
22	30.32	10.74	5.26E-12	5.65E-08	0.284
102	22.93	167.22	4.65E-11	7.77E-06	0.075
106	33.05	175.37	6.06E-12	1.06E-06	0.087
113	14.69	14.30	1.25E-11	1.79E-07	0.209
116	21.92	65.72	3.48E-12	2.29E-07	0.161
126/1	20.83	113.57	4.59E-11	5.21E-06	0.152
135	30.88	42.57	2.83E-11	1.20E-06	0.232
152	17.43	159.34	5.29E-12	8.43E-07	0.086

Field data in summer season at 0.5-meter (continue).

House ID	Indoor radon (Bq.m ⁻³)	soil-radon (kBq) (kBq.m ⁻³)	Permeability (m ²)	availability (Bq.m ⁻¹)	Thoron/Radon Ratio
157	21.34	120.93	1.52E-11	1.84E-06	0.165
24	29.18	194.02	1.28E-11	2.49E-06	0.137
29	19.39	46.99	1.99E-12	9.37E-08	0.342
67	25.92	25.77	4.58E-12	1.18E-07	0.009
75	27.56	36.87	2.68E-11	9.89E-07	0.169
78/1	31.90	19.46	1.45E-11	2.83E-07	0.416
71	39.61	53.53	2.28E-11	1.22E-06	0.252
137	45.94	125.72	2.85E-11	3.58E-06	0.191
74	14.83	32.84	3.70E-11	1.21E-06	0.258
16	12.15	24.95	2.07E-11	5.17E-07	0.104
54	32.05	26.71	6.56E-12	1.75E-07	0.320
39	49.05	56.74	3.16E-11	1.79E-06	0.260
None	75.89	73.69	9.44E-12	6.95E-07	0.284
55	96.57	30.40	1.13E-11	3.43E-07	0.294
98	33.64	120.69	4.84E-11	5.84E-06	0.092
172	35.78	119.18	6.48E-11	7.72E-06	0.085
86	47.41	89.80	8.72E-12	7.83E-07	0.161
136	19.30	32.57	3.96E-12	1.29E-07	0.096

Field data in summer season at 1.0-meter.

House ID	Indoor radon (Bq.m ⁻³)	soil-radon (kBq) (kBq.m ⁻³)	Permeability (m ²)	availability (Bq.m ⁻¹)	Thoron/Radon Ratio
11	31.90	38.76	1.63E-11	6.33E-07	0.331
11/1	49.48	34.77	1.75E-11	6.10E-07	0.075
78	14.61	48.38	1.58E-11	7.66E-07	0.133
10	13.46	99.71	4.30E-11	4.28E-06	0.185
103	28.34	54.40	1.85E-11	1.00E-06	0.243
148	24.74	134.14	7.04E-11	9.45E-06	0.070
165	20.54	215.16	5.96E-11	1.28E-05	0.079
68	21.34	136.86	2.29E-11	3.13E-06	0.076
109	24.81	62.73	3.23E-11	2.03E-06	0.087
127	31.31	105.14	1.40E-11	1.47E-06	0.069
159/1	52.70	34.22	1.57E-11	5.38E-07	0.108
84/1	11.44	171.68	1.07E-11	1.84E-06	0.076
3	36.82	54.43	3.05E-11	1.66E-06	0.224
182	15.05	70.44	2.01E-11	1.41E-06	0.163
22	30.32	65.43	9.50E-12	6.22E-07	0.098
102	22.93	184.35	8.91E-11	1.64E-05	0.098
106	33.05	242.99	2.09E-11	5.07E-06	0.101
113	14.69	-	1.25E-11	-	-
116	21.92	55.05	3.65E-12	2.01E-07	0.122
126/1	20.83	149.58	5.25E-11	7.86E-06	0.100
135	30.88	59.45	2.67E-11	1.59E-06	0.183

Field data in summer season at 1.0-meter (continue).

House ID	Indoor radon (Bq.m ⁻³)	soil-radon (kBq) (kBq.m ⁻³)	Permeability (m ²)	availability (Bq.m ⁻¹)	Thoron/Radon Ratio
152	17.43	267.45	4.45E-11	1.19E-05	0.069
157	21.34	137.61	1.63E-11	2.25E-06	0.081
24	29.18	41.09	9.53E-12	3.91E-07	0.115
29	19.39	220.79	4.56E-11	1.01E-05	0.081
67	25.92	-	4.58E-12	-	-
75	27.56	60.61	3.34E-11	2.02E-06	0.112
78/1	31.90	42.50	1.84E-11	7.82E-07	0.188
71	39.61	69.05	1.88E-11	1.30E-06	0.125
137	45.94	103.87	3.91E-11	4.06E-06	0.070
74	14.83	50.84	2.58E-11	1.31E-06	0.038
16	12.15	41.18	2.60E-11	1.07E-06	0.163
54	32.05	25.07	5.44E-12	1.36E-07	0.171
39	49.05	82.12	4.05E-11	3.33E-06	0.145
No ID	75.89	141.95	1.22E-11	1.73E-06	0.130
55	96.57	70.42	1.80E-11	1.27E-06	0.159
98	33.64	191.30	3.72E-11	7.12E-06	0.059
172	35.78	111.87	6.85E-11	7.66E-06	0.066
86	47.41	149.95	4.72E-11	7.07E-06	0.073
136	19.30	9.13	4.08E-12	3.72E-08	0.118

มหาวิทยาลัยเชียงใหม่
Chiang Mai University

APPENDIX B

CALIBRATION REPORT: RDA-200 + SCINTILLATION CELL # 1 (Chiang Mai University)

Specification of radon source (PYLON model RNC) employed for sensitivity and efficiency determination.

Initial Date : 01-Oct-91	Today Date : 17-Jun-02	=	10.717808 yrs decayed	=	3912 days
Half-Life of Radium 226	1622 years		Decay constant of Radium =		1.171E-06 per day
Initial Source Activity	76.0 Bq	=	2054.0541 pCi	+/-	4%
Present Source Activity	75.652777 Bq	=	2044.6697 pCi	+/-	4%
Half-Life of Radon 222	91.8 hours	=	3.825 days	=	5508 minute
Dacey Constant of Radon	0.000125817 per minute	=	0.181176 per day		
Radon produced in	24 hours	=	12.536447 Bq	=	338.8261 pCi

Calibration of radon concentration transferred into the measuring system.

Start degassing the RNC :	17/06/02 8:30 dd/mm/yy hh:mm	volume of detector	160 ml.
T ₀	17/06/2002 8:40 dd/mm/yy hh:mm	volume of PYLON's RNC Source	66.3 ml.
T ₁	18/06/2002 8:43 dd/mm/yy hh:mm		
T ₀ - > T ₁	= 1443 minutes		
T ₀ is the time when finished degassing radon out of the RNC.		volume of AB-5's internal pump	154 ml.
T ₁ is the time when finished transferring of radon gas into the detector.			
Rn at T ₁	339.469807 pCi +/- 13.58	volume of tubing and connectors	216 ml.
RC at T ₁	569.293657 pCi/liter +/- 22.77		
Rn at T ₁	12.560383 Bq +/- 0.50	TOTAL VOLUME	596.3 ml.
RC at T ₁	21063.86529 Bq/m ³ +/- 842.55		

Note : Rn = Radon, RC = Radon concentration

Results of sensitivity and efficiency determination for the Lucas cell

H.V.	800 volts	DISC.	4.0	Remark :
Start count	18/06/02 12:13 dd/mm/yy hh:mm	Decayed time from T ₁ to start of counting	210 minutes	
Background (CPM)	1.60 +/- 0.63	18-Jun-02	INTERVAL LENGTH	5 minutes
Counts for interval	Avg. count (+/- error)	Avg. net count (+/- error)	Avg. net CPM (+/- error)	Sensitivity
1586	1591.67	1583.67	316.73	CPM/pCi/l (+/- error)
1518	16.29	16.55	3.31	CPM/Bq.m ⁻³ (+/- error)
1684		dpm = 2.22 x 3 x RC x V		Efficiency = (Avg. net CPM / RC) x (A x B)
1598		dpm = 606.639320		Efficiency = (Avg. net CPM / dpm) x (A x B)
1633		error = +/- 24.27		2.22 relates dpm to pCi
1540		A = 1.026774		3 is the number of alpha emitters
		B = 1.001889		RC is the radon gas concentration. (for Equilibrium)
				V is volume of the Lucas cell
				A is the correction factor for decay between T1 and the start of counting.
				B is the correction factor for decay from start of counting to middle of the intervals.

CALIBRATION REPORT : RDA-200 + SCINTILLATION CELL # 2-(Chiang Mai University)

Specification of radon source (PYLON model RNC) employed for sensitivity and efficiency determination.

Initial Date : 01-Oct-91	Today Date : 18-Jun-02	=	10.720548 yrs decayed	=	3913 days
Half-Life of Radium 226	1622 years		Decay constant of Radium	=	1.171E-06 per day
Initial Source Activity	76.0 Bq	=	2054.0541 pCi	+/-	4%
Present Source Activity	75.652689 Bq	=	2044.6673 pCi	+/-	4%
Half-Life of Radon 222	91.8 hours	≈	3.825 days	=	5508 minute
Dacey Constant of Radon	0.000125817 per minute	=	0.181176 per day		
Radon produced in	24 hours	=	12.536549 Bq	=	338.82566 pCi

Calibration of radon concentration transferred into the measuring system.

Start degassing the RNC :	18/06/02 8:55 Dd/mm/yy hh:mm	volume of detector	160 ml.
T ₀	18/06/2002 9:05 dd/mm/yy hh:mm	volume of PYLON's RNC Source	66.3 ml.
T ₁	19/06/2002 8:40 dd/mm/yy hh:mm		
T ₀ - > T ₁	= 1415 minutes		
T ₀ is the time when finished degassing radon out of the RNC.		volume of AB-5's internal pump	154 ml.
T ₁ is the time when finished transferring of radon gas into the detector.			
Rn at T ₁	339.451616 pCi +/- 13.34	volume of tubing and connectors	216 ml.
RC at T ₁	569.20110 pCi/liter +/- 22.37		
Rn at T ₁	12.33771 Bq +/- 0.49	TOTAL VOLUME	596.3 ml.
RC at T ₁	20690.440704 Bq/m ³ +/- 827.62		

Note : Rn = Radon, RC = Radon concentration

Results of sensitivity and efficiency determination for the Lucas cell

H.V.	800 volts	DISC.	4.0	Remark :
Start count	19/06/02 12:10 dd/mm/yy hh:mm	Decayed time from T ₁ to start of counting	210 minutes	
Background (CPM)	2.60 +/- 0.36	19-Jun-02	INTERVAL LENGTH	5 minutes
Counts for interval	Avg. count (+/- error)	Avg. net count (+/- error)	Avg. net CPM (+/- error)	Sensitivity CPM/pCi/l (+/- error) CPM/Bq.m ⁻³ (+/- error)
1496	1484.50	1471.50	294.30	0.541398 0.022149 0.014632 0.000606
1411	15.73	15.76	3.15	0.508069 0.021039
1527		dpm = 2.22 x 3 x RC x V		Sensitivity = (Avg. net CPM / RC) x (A x B)
1502		dpm = 595.884692		Efficiency = (Avg. net CPM / dpm) x (A x B)
1486		error = +/- 23.84		2.22 relates dpm to pCi 3 is the number of alpha emitters
1485		A = 1.026774		RC is the radon gas concentration. (for Equilibrium)
		B = 1.0001889		V is volume of the Lucas cell

A is the correction factor for decay between T1 and the start of counting.
B is the correction factor for decay from start of counting to middle of the intervals.

CALIBRATION REPORT : RDA-200 + SCINTILLATION CELL # 3 (Chiang Mai University)

Specification of radon source (PYLON model RNC) employed for sensitivity and efficiency determination.

Initial Date : 01-Oct-91	Today Date : 19-Jun-02	=	10.723288 yrs decayed	=	3914 days
Half-Life of Radium 226	1622 years		Decay constant of Radium =		1.171E-06 per day
Initial Source Activity	76.0 Bq	=	2054.0541 pCi	+/-	4%
Present Source Activity	75.652600 Bq	=	2044.6649 pCi	+/-	4%
Half-Life of Radon 222	91.8 hours	=	3.825 days	=	5508 minute
Dacey Constant of Radon	0.000125817 per minute	=	0.181176 per day		
Radon produced in	24 hours	=	12.536535 Bq	=	338.825263 pCi

Calibration of radon concentration transferred into the measuring system.

Start degassing the RNC :	19/06/02 8:50 dd/mm/yy hh:mm	volume of detector	160 ml.
T_0	19/06/2002 9:00 dd/mm/yy hh:mm	volume of PYLON's RNC Source	66.3 ml.
T_1	20/06/2002 8:18 dd/mm/yy hh:mm		
$T_0 - > T_1$	= 1398 minutes		
T_0 is the time when finished degassing radon out of the RNC.		volume of AB-5's internal pump	154 ml.
T_1 is the time when finished transferring of radon gas into the detector.		volume of tubing and connectors	216 ml.
Rn at T_1	329.787213 pCi +/- 13.19	TOTAL VOLUME	596.3 ml.
RC at T_1	553.055866 pCi/liter +/- 22.12		
Rn at T_1	12.202127 Bq +/- 0.49		
RC at T_1	20463.067033 Bq/m ³ +/- 818.52		

Note : Rn = Radon, RC = Radon concentration

Results of sensitivity and efficiency determination for the Lucas cell

H.V.	800 volts	DISC.	4.0	Remark :			
Start count	20/06/02 11:48 dd/mm/yy hh:mm	Decayed time from T_1 to start of counting	210 minutes				
Background (CPM)	0.30 +/- 0.12	20-Jun-02	INTERVAL LENGTH	5 minutes			
Counts for interval	Avg. count (+/- error)	Avg. net count (+/- error)	Avg. net CPM (+/- error)	Sensitivity		Efficiency	
				CPM/pCi/l (+/- error)	CPM/Bq.m ⁻³ (+/- error)	cpm/dpm (+/- error)	
1498	1456.50	1455.00	291.00	0.541275	0.022414	0.014629	0.000606
1416	15.58	15.58	3.12			0.507954	0.021034
1400		dpm = 2.22 x 3 x RC x V		Sensitivity = (Avg. net CPM / RC) x (A x B)			
1471		dpm = 589.336331		Efficiency = (Avg. net CPM / dpm) x (A x B)			
1504		error = +/- 23.57		2.22 relates dpm to pCi			
1450		A = 1.026774		RC is the radon gas concentration. (for Equilibrium)			
		B = 1.0001889		3 is the number of alpha emitters			
				V is volume of the Lucas cell			
				A is the correction factor for decay between T1 and the start of counting.			
				B is the correction factor for decay from start of counting to middle of the intervals.			

CALIBRATION REPORT : RDA-200 + OPEN SCINTILLATION CELL # 1 (Chiang Mai University)

Specification of radon source (PYLON model RNC) employed for sensitivity and efficiency determination.

Initial Date : 01-Oct-91	Today Date : 20-Jun-02	=	10.726027 yrs decayed	=	3915 days
Half-Life of Radium 226	1622 years	=	Decay constant of Radium =	1.171E-06	per day
Initial Source Activity	76.0 Bq	=	2054.0541 pCi	+/-	4%
Present Source Activity	75.652512 Bq	=	2044.6625 pCi	+/-	4%
Half-Life of Radon 222	91.8 hours	=	3.825 days	=	5508 minute
Dacey Constant of Radon	0.000125817 per minute	=	0.181176 per day		
Radon produced in	24 hours	=	12.536520 Bq	=	338.824867 pCi

Calibration of radon concentration transferred into the measuring system.

Start degassing the RNC :	20/06/02 8:15 dd/mm/yy hh:mm	volume of detector	160 ml.
T ₀	20/06/2002 8:30 dd/mm/yy hh:mm	volume of PYLON's RNC Source	66.3 ml.
T ₁	21/06/2002 8:23 dd/mm/yy hh:mm		
T ₀ - > T ₁	= 1433 minutes		
T ₀ is the time when finished degassing radon out of the RNC.		volume of AB-5's internal pump	154 ml.
T ₁ is the time when finished transferring of radon gas into the detector.		volume of tubing and connectors	216 ml.
Rn at T ₁	337.321841 pCi +/- 13.49	TOTAL VOLUME	596.3 ml.
RC at T ₁	565.691500 pCi/liter +/- 22.63		
Rn at T ₁	12.480908 Bq +/- 0.50		
RC at T ₁	20930.585499 Bq/m ³ +/- 837.22		

Note : Rn = Radon, RC = Radon concentration

Results of sensitivity and efficiency determination for the Lucas cell

H.V.	800 volts	DISC.	4.0	Remark :
Start count	21/06/02 8:23 dd/mm/yy hh:mm	Decayed time from T ₁ to start of counting	0 minutes	
Background (CPM)	0.5 +/- 0.16	21-Jun-02	INTERVAL LENGTH	1 minutes
Counts for interval	Avg. count (+/- error)	Avg. net count (+/- error)	Avg. net CPM (+/- error)	Sensitivity
144	157.67	157.17	157.17	CPM/pCi/l (+/- error)
162	7.25	7.24	7.24	CPM/Bq.m ⁻³ (+/- error)
167				cpm/dpm (+/- error)
				Sensitivity = (Avg. net CPM / RC) x (A x B)
				Efficiency = (Avg. net CPM / dpm) x (A x B)
				2.22 relates dpm to pCi
				3 is the number of alpha emitters
				RC is the radon gas concentration. (for Equilibrium)
				V is volume of the Lucas cell
				A is the correction factor for decay between T1 and the start of counting.
				B is the correction factor for decay from start of counting to middle of the intervals.

CALIBRATION REPORT : RDA-200 + OPEN SCINTILLATION CELL # 2 (Chiang Mai University)

Specification of radon source (PYLON model RNC) employed for sensitivity and efficiency determination.

Initial Date : 01-Oct-91	Today Date : 21-Jun-02	=	10.739726 yrs decayed	=	3916 days
Half-Life of Radium 226	1622 years	=	Decay constant of Radium =	=	1.171E-06 per day
Initial Source Activity	76.0 Bq	=	2054.0541 pCi +/-	=	4%
Present Source Activity	75.652423 Bq	=	2044.6601 pCi +/-	=	4%
Half-Life of Radon 222	91.8 hours	=	3.825 days	=	5508 minute
Dacey Constant of Radon	0.000125817 per minute	=	0.181176 per day	=	
Radon produced in	24 hours	=	12.536505 Bq	=	338.824470 pCi

Calibration of radon concentration transferred into the measuring system.

Start degassing the RNC :	21/06/02 8:30 dd/mm/yy hh:mm	volume of detector	160 ml.
T ₀	21/06/2002 8:40 dd/mm/yy hh:mm	volume of PYLON's RNC Source	66.3 ml.
T ₁	22/06/2002 8:38 dd/mm/yy hh:mm		
T ₀ - > T ₁	= 1438 minutes		
T ₀ is the time when finished degassing radon out of the RNC.		volume of AB-5's internal pump	154 ml.
T ₁ is the time when finished transferring of radon gas into the detector.		volume of tubing and connectors	216 ml.
Rn at T ₁	338.395170 pCi +/- 13.54	TOTAL VOLUME	596.3 ml.
RC at T ₁	567.491481 pCi/liter +/- 22.70		
Rn at T ₁	12.520621 Bq +/- 0.50		
RC at T ₁	20997.184782 Bq/m ³ +/- 839.89		

Note : Rn = Radon, RC = Radon concentration

Results of sensitivity and efficiency determination for the Lucas cell

H.V.	800 volts	DISC.	4.0	Remark :					
Start count	26/06/02 8:29 dd/mm/yy hh:mm	Decayed time from T ₁ to start of counting	0 minutes						
Background (CPM)	1.35 +/- 0.26	22-Jun-02	INTERVAL LENGTH	1 minutes					
Counts for interval	Avg. count (+/- error)	Avg. net count (+/- error)	Avg. net CPM (+/- error)	Sensitivity		Efficiency			
				CPM/pCi/l (+/- error)	CPM/Bq.m ³ (+/- error)	cpm/dpm (+/- error)			
129	162.67	161.32	161.32	0.284316	0.017222	0.007684	0.000465	0.800440	0.048484
171	7.36	7.34	7.34	Sensitivity = (Avg. net CPM / RC) x (A x B)		Efficiency = (Avg. net CPM / dpm) x (A x B)			
188		dpm = 2.22 x RC x V		2.22 relates dpm to pCi		3 is the number of alpha emitters			
		dpm = 201.572974		RC is the radon gas concentration. (for Equilibrium)		V is volume of the Lucas cell			
		error = +/- 8.06		A is the correction factor for decay between T1 and the start of counting.					
		A = 1.000000		B is the correction factor for decay from start of counting to middle of the intervals.					
		B = 1.000189							

CALIBRATION REPORT: RDA-200 + OPEN SCINTILLATION CELL # 4 (Chiang Mai University)

Specification of radon source (PYLON model RNC) employed for sensitivity and efficiency determination.

Initial Date : 01-Oct-91	Today Date : 23-Jun-02	=	10.734247 yrs decayed	=	3918 days
Half-Life of Radium 226	1622 years		Decay constant of Radium =		1.171E-06 per day
Initial Source Activity	76.0 Bq	=	2054.0541 pCi	+/-	4%
Present Source Activity	75.652246 Bq	=	2044.6553 pCi	+/-	4%
Half-Life of Radon 222	91.8 hours	=	3.825 days	=	5508 minute
Dacey Constant of Radon	0.000125817 per minute	=	0.181176 per day		
Radon produced in	24 hours	=	12.536476 Bq	=	338.823677 pCi

Calibration of radon concentration transferred into the measuring system.

Start degassing the RNC :	23/06/02 7:45 dd/mm/yy hh:mm	volume of detector	160 ml.
T_0	23/06/2002 7:55 dd/mm/yy hh:mm	volume of PYLON's RNC Source	66.3 ml.
T_1	24/06/2002 8:18 dd/mm/yy hh:mm		
$T_0 - T_1$	= 1463 minutes		
T_0 is the time when finished degassing radon out of the RNC.		volume of AB-5's internal pump	154 ml.
T_1 is the time when finished transferring of radon gas into the detector.			
Rn at T_1	343.752861 pCi +/- 13.75	volume of tubing and connectors	216 ml.
RC at T_1	576.476373 pCi/liter +/- 23.06		
Rn at T_1	12.718856 Bq +/- 0.51	TOTAL VOLUME	596.3 ml.
RC at T_1	21329.625811 Bq/m ³ +/- 853.19		

Note : Rn = Radon, RC = Radon concentration

Results of sensitivity and efficiency determination for the Lucas cell

H.V.	800 volts	DISC.	4.0	Remark :
Start count	24/06/02 8:18 dd/mm/yy hh:mm	Decayed time from T_1 to start of counting	0 minutes	
Background (CPM)	1.20 +/- 0.24	24-Jun-02	INTERVAL LENGTH	1 minutes
Counts for interval	Avg. count (+/- error)	Avg. net count (+/- error)	Avg. net CPM (+/- error)	Sensitivity CPM/pCi/l (+/- error) CPM/Bq.m ³ (+/- error) Efficiency cpm/dpm (+/- error)
167	170.00	168.80	168.80	0.292869 0.017515 0.007915 0.000473 0.824518 0.049312
182	7.53	7.51	7.51	
161		dpm = 2.22 x RC x V		Sensitivity = (Avg. net CPM / RC) x (A x B)
		dpm = 204.764408		Efficiency = (Avg. net CPM / dpm) x (A x B)
		error = +/- 8.19		2.22 relates dpm to pCi 3 is the number of alpha emitters
	A = 1.000000			RC is the radon gas concentration. (for Equilibrium)
	B = 1.000189			V is volume of the Lucas cell
				A is the correction factor for decay between T1 and the start of counting.
				B is the correction factor for decay from start of counting to middle of the intervals.

CALIBRATION REPORT : RDA-200 + OPEN SCINTILLATION CELL # 5 (Chiang Mai University)

Specification of radon source (PYLON model RNC) employed for sensitivity and efficiency determination.

Initial Date : 01-Oct-91	Today Date : 24-Jun-02	=	10.736986 yrs decayed	=	3919 days
Half-Life of Radium 226	1622 years	=	Decay constant of Radium =	=	1.171E-06 per day
Initial Source Activity	76.0 Bq	=	2054.0541 pCi	+/-	4%
Present Source Activity	75.652069 Bq	=	2044.6529 pCi	+/-	4%
Half-Life of Radon 222	91.8 hours	=	3.825 days	=	5508 minute
Dacey Constant of Radon	0.000125817 per minute	=	0.181176 per day		
Radon produced in	24 hours	=	12.536461 Bq	=	338.823280 pCi

Calibration of radon concentration transferred into the measuring system.

Start degassing the RNC :	24/06/02 8:25	dd/mm/yy hh:mm	volume of detector	160 ml.
T_0	24/06/2002 8:35	dd/mm/yy hh:mm	volume of PYLON's RNC Source	66.3 ml.
T_1	25/06/2002 8:08	dd/mm/yy hh:mm		
$T_0 - > T_1$	= 1413	minutes		
T_0 is the time when finished degassing radon out of the RNC.			volume of AB-5's internal pump	154 ml.
T_1 is the time when finished transferring of radon gas into the detector.			volume of tubing and connectors	216 ml.
Rn at T_1	333.018623	PCI +/- 13.32	TOTAL VOLUME	596.3 ml.
RC at T_1	558.474967	pCi/liter +/- 22.34		
Rn at T_1	12.321689	Bq +/- 0.49		
RC at T_1	20663.573784	Bq/m ³ +/- 826.54		

Note : Rn = Radon, RC = Radon concentration

Results of sensitivity and efficiency determination for the Lucas cell

H.V.	800	volts	DISC.	4.0	Remark :
Start count	25/06/02 8:08	dd/mm/yy hh:mm	Decayed time from T_1 to start of counting	0	minutes
Background (CPM)	0.60	+/-	0.17	25-Jun-02	INTERVAL LENGTH 1 minutes
Counts for interval	Avg. count (+/- error)	Avg. net count (+/- error)	Avg. net CPM (+/- error)	Sensitivity	
151	149.67	149.07	149.07	CPM/pCi/l (+/- error)	CPM/Bq.m ⁻³ (+/- error)
163	7.06	7.05	7.05	0.266968 0.016538	0.007215 0.000447
135				Efficiency	
		dpm = 2.22 x RC x V		cpm/dpm (+/- error)	
		dpm = 197.370308		0.751598 0.046560	
		error = +/- 7.93		Sensitivity = (Avg. net CPM / RC) x (A x B)	
		A = 1.000000		Efficiency = (Avg. net CPM / dpm) x (A x B)	
		B = 1.000189		2.22 relates dpm to pCi	
				3 is the number of alpha emitters	
				RC is the radon gas concentration. (for Equilibrium)	
				V is volume of the Lucas cell	
				A is the correction factor for decay between T1 and the start of counting.	
				B is the correction factor for decay from start of counting to middle of the intervals.	

CALIBRATION REPORT : RDA-200 + OPENED SCINTILLATION CELL # 6 (Chiang Mai University)

Specification of radon source (PYLON model RNC) employed for sensitivity and efficiency determination.

Initial Date : 01-Oct-91	Today Date : 25-Jun-02	=	10.739726 yrs decayed	=	3920 days
Half-Life of Radium 226	1622 years		Decay constant of Radium =		1.171E-06 per day
Initial Source Activity	76.0 Bq	=	2054.0541 pCi	+/-	4%
Present Source Activity	75.652069 Bq	=	2044.6505 pCi	+/-	4%
Half-Life of Radon 222	91.8 hours	=	3.825 days	=	5508 minute
Dacey Constant of Radon	0.000125817 per minute	=	0.181176 per day		
Radon produced in	24 hours	=	12.536447 Bq	=	338.822884 pCi

Calibration of radon concentration transferred into the measuring system.

Start degassing the RNC :	25/06/02 8:15 dd/mm/yy hh:mm	volume of detector	160 ml.
T_0	25/06/2002 8:25 dd/mm/yy hh:mm	volume of PYLON's RNC Source	66.3 ml.
T_1	26/06/2002 8:29 dd/mm/yy hh:mm		
$T_0 - > T_1$	= 1444 minutes		
T_0 is the time when finished degassing radon out of the RNC.		volume of AB-5's internal pump	154 ml.
T_1 is the time when finished transferring of radon gas into the detector.			
Rn at T_1	339.68116 pCi +/- 13.59	volume of tubing and connectors	216 ml.
RC at T_1	569.64809 pCi/liter +/- 22.79		
Rn at T_1	12.56820 Bq +/- 0.50	TOTAL VOLUME	596.3 ml.
RC at T_1	21076.97933 Bq/m ³ +/- 843.08		

Note : Rn = Radon, RC = Radon concentration

Results of sensitivity and efficiency determination for the Lucas cell

H.V.	800 volts	DISC.	4.0	Remark :			
Start count	26/06/02 8:29 dd/mm/yy hh:mm	Decayed time from T_1 to start of counting	0 minutes				
Background (CPM)	1.05 +/- 0.23	26-Jun-02	INTERVAL LENGTH	1 minutes			
Counts for interval	Avg. count (+/- error)	Avg. net count (+/- error)	Avg. net CPM (+/- error)	Sensitivity		Efficiency	
				CPM/pCi/l (+/- error)	CPM/Bq.m ⁻³ (+/- error)	cpm/dpm (+/- error)	
141	150.67	149.62	149.62	0.262697	0.016258	0.007100	0.0004
150	7.09	7.07	7.07			0.739575	0.04577
161		dpm = 2.22 x RC x V		Sensitivity = (Avg. net CPM / RC) x (A x B)			
		dpm = 202.33900		Efficiency = (Avg. net CPM / dpm) x (A x B)			
		error = +/- 8.09		2.22 relates dpm to pCi			
		A = 1.000000		RC is the radon gas concentration. (for Equilibrium)			
		B = 1.000189		V is volume of the Lucas cell			
				A is the correction factor for decay between T1 and the start of counting.			
				B is the correction factor for decay from start of counting to middle of the intervals.			

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