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COMPLETION REPORT FOR RADON FLUX MONITORING OF THE WSSRAP DISPOSAL FACILITY

WELDON SPRING SITE REMEDIAL ACTION PROJECT
WELDON SPRING, MISSOURI

JANUARY 2001 **REV. 0**

U.S. Department of Energy
Oak Ridge Operations Office
Weldon Spring Site Remedial Action Project

Prepared by MK-Ferguson Company and Jacobs Engineering Group

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APPROVALS

Environmental Safety and Health Manager	01/11/01 Date
Project Quality Manager	1/12/2001 Date
Deputy Project Director	1/15/01 Date

CERTIFICATE STATEMENT

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. (See 18 U.S.C. 1001.)

Pamela Thompson

DOE Project Manager
Weldon Spring Site Remedial Action Project

18 Jan 01
Date

DOE/OR/21548-876

Weldon Spring Site Remedial Action Project

Completion Report for Radon Flux Monitoring of the WSSRAP Disposal Facility

Revision 0

January 2001

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U.S. DEPARTMENT OF ENERGY
Oak Ridge Operations office
Under Contract DE-AC05-86OR21548

ABSTRACT

This completion report summarizes the measurement of Radon-222 (radon) flux on the surface of the Weldon Spring Site Remedial Action Project (WSSRAP) disposal cell. Radon flux measurements are required to demonstrate compliance with 40CFR61 and 40CFR192. For purposes of this report, the surface of the cell is interpreted as the top of the radon barrier proper, which is the 1-ft thick compacted clay layer lying directly above the uppermost waste surface.

The entire disposal cell was monitored during Phase 2 of radon flux monitoring using the procedure described in 40CFR61, Appendix B, Method 115. The monitoring was initiated on October 10, 2000, and completed on October 11, 2000. All monitoring conditions of Method 115 were appropriately met. The monitoring was performed at 100 separate locations.

To avoid placement of radon monitors over the "deep dimple" of the cell, WSSRAP ID location Numbers 10 and 23 were relocated 28 ft southeast of their respective locations. The "deep dimple" is the portion of the cell reserved for waste from the demolition of the quarry water treatment plant. It currently contains up to 9.5 feet of clean soil, which is in place to promote temporary drainage during the winter and early spring. The clean soil is scheduled to be removed in late spring of 2001, and therefore is not representative of the existing radon barrier depth.

The Phase 2 monitoring results indicated an average radon flux of 0.55 pCi/m^2/sec (standard deviation of 2.64 pCi/m^2/sec). This average is well below the 20 pCi/m^2/sec radon flux standard considered applicable and/or relevant and appropriate in the *Record of Decision for Remedial Action at the Chemical Plant Area of the Weldon Spring Site* (Ref. 1). In addition, only three of the 100 individual measurements exceeded the background range (Ref. 3, Section 2.1.2).

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1. INTRODUCTION

1.1. Purpose

This completion report documents the results of the Radon-222 (radon) flux monitoring performed on the top of the radon barrier proper of the Weldon Spring Site Remedial Action Project (WSSRAP) disposal cell in August and October 2000. Radon flux monitoring is required to demonstrate compliance with applicable and/or relevant and appropriate requirements in the *Record of Decision for Remedial Action at the Chemical Plant Area of the Weldon Spring Site* (Ref. 1).

The "radon barrier proper" means the 1-ft thick compacted clay layer lying directly above the uppermost waste surface. The top of the radon barrier proper is considered to be the current surface of the cell for radon flux monitoring purposes. An additional 2 ft of soil will be placed to the same specifications during final cap construction. This thicker layer will be the final radon and biointrusion barrier.

1.2. Scope

This report addresses the radon flux monitoring, analysis, data quality assurance, and reporting requirements outlined in the *Radon Flux Monitoring Plan for the WSSRAP Disposal Facility* (Ref. 2).

1.3. WSSRAP Disposal Cell

The waste placement area of the WSSRAP disposal cell covers about 24 acres, and contains approximately 1.48 million cu yd of contaminated wastes. The footprint of the cell, including clean fill dikes, covers about 47 acres.

The waste materials placed in the disposal facility resulted from the remedial actions authorized in the *Record of Decision for Remedial Action at the Chemical Plant Area of the Weldon Spring Site* (Ref. 1). These wastes are contaminated with uranium and thorium series radionuclides (including isotopes of radium), and include contaminated soils and stabilized sludges, building rubble, bulk wastes from the quarry cleanup, contaminated process equipment and piping, and other waste products resulting from the chemical processing of uranium and thorium. The cell has been designed to effectively contain these wastes for a minimum of 200 years.

Radon flux emanation control measures include the radon/infiltration barrier, a 3-ft thick (upon completion) clay layer designed to reduce radon emissions to the atmosphere to below 20 pCi/m^2/sec. The clean fill dike sides also minimize radon emissions. To help ensure long-term effectiveness of the radon barrier and clean fill dikes, the entire cell will be covered with a

3.5-ft thick layer of riprap. This will protect the cell clay cover from erosion, and will restrict penetration of cover by plant roots and burrowing animals.

2. REQUIREMENTS FOR PERFORMING RADON FLUX MONITORING

The *Record of Decision for Remedial Action at the Chemical Plant Area of the Weldon Spring Site* (Ref. 1) states that Radon flux standards in 40CFR61 Subparts Q and T, and 40CFR192.32(b)(1)(ii) are applicable and/or relevant and appropriate. These standards require that the Radon-222 (radon) flux from the disposal cell will not exceed an average of 20 $pCi/m^2/sec$.

The primary method approved by the U.S. Environmental Protection Agency (EPA) for measuring radon flux is found in 40CFR61, Appendix B, Method 115. This method consists of deploying large-area activated charcoal collectors on the radon barrier proper for a 24-hour period, during which time the radon emanating from the surface is adsorbed on the activated charcoal. The collectors are then returned to the vendor laboratory where they are analyzed by gamma spectroscopy to determine the amount of radon adsorbed. This was the monitoring method used to determine average radon flux from the WSSRAP disposal cell.

3. RADON FLUX MONITORING RESULTS

Table 3-1 summarizes salient requirements from the *Radon Flux Monitoring Plan for the WSSRAP Disposal Facility* (Ref. 2), and how these requirements were implemented as part of the radon flux monitoring process. This table applies to both Phase 1 and Phase 2 monitoring.

Table 3-1 Radon Flux Monitoring Requirements

Requirement from *Radon Flux Monitoring Plan for the WSSRAP Disposal Facility* (Ref. 2)	Status
Sampling conducted in accordance with Procedure ES&H 4.6.5.	Requirement met.
Activated charcoal purged of water and radon prior to use.	Requirement met.
Activated charcoal loaded into collector; scrubber pad and retainer ring secured.	Requirement met.
Collector placed on radon barrier proper with 1 to 2 in. of soil packed around rim.	Requirement met.
Sample ID, date, time, and location recorded.	Requirement met.
Sample IDs numbered per Procedure ES&H 4.1.1.	Sample IDs modified, see Tables 3-2 & 3-3.
Collection period of 24 ±2 hours.	Requirement met.
Collectors packaged, labeled, and shipped to vendor within 24 hours of collection.	Requirement met.
All collectors pre- and post-weighed by the vendor for moisture correction.	Requirement met.
Sampling chain-of-custody maintained per Procedure ES&H 4.1.2.	Requirement met.
Shipped in accordance with Instruction ECDI-26.	Requirement met.
Phase 1 monitoring in February 2000 on two-thirds of radon barrier.	Phase 1 performed in August 2000.
Phase 2 monitoring in the latter half of 2000 on remaining one-third of radon barrier (modified to include the entire cell [Appendix B]).	Phase 2 included the entire radon barrier except for "deep dimple."
Sample locations surveyed and included in final report.	Requirement met.
Measurements not initiated within 24 hours of a significant rainfall.	Requirement met.
Measurements not initiated unless ambient temperature was above 35° F and surface was not frozen.	Requirement met.
Monitors placed minimum 10 ft from any barrier edge.	Requirement met.
Minimum 10 ft between monitoring locations.	Requirement met.
Vendor laboratory counted two charcoal standards 20 times to establish 95% upper and lower confidence limits.	Requirement met.
Field replicates collected at 5% of the sample locations.	Requirement met.
Vendor laboratory recounted 10% of the samples.	Requirement met.
Recount results identified as "duplicate" in vendor laboratory reports.	Requirement met.
Five percent of the samples analyzed were field blanks.	Requirement met.
At least 85% of all measurements yielded usable results.	Requirement met.
Precision of 10% for all duplicate samples above 1.0 $pCi/m^2/sec$.	Requirement met.
Measurements and calculations reviewed by Worker Protection Supervisor or designee.	Requirement met.

3.1. Phase 1 Monitoring

Phase 1 monitoring was conducted August 1-2, 2000, at 70 separate locations on top of the disposal cell. See Figure 3-1 for Phase 1 monitoring locations. These locations included about two-thirds of the radon barrier area (i.e., all radon barrier area available at that time). Phase 1 monitoring was conducted, as a contingency in the event full monitoring would be prohibited in the fall of 2000 due to weather constraints. Had that occurred, Phase 1 monitoring could have been supplemented with monitoring from the remaining 30 locations (total of 100 locations). This contingency plan proved to be unneeded.

The requirements of both EPA Method 115 (40CFR61, Appendix B) and the *Radon Flux Monitoring Plan for the WSSRAP Disposal Facility* (Ref. 2) were met during Phase 1 monitoring. The average measured radon flux on the disposal cell was 0.10 pCi/m^2/sec (standard deviation of 0.15 pCi/m^2/sec, maximum value was 1.255 pCi/m^2/sec). The average was well below the regulatory requirement of 20 pCi/m^2/sec (Ref. 1). The individual measurements compared favorably to background radon flux levels, which can range from 0.005 to 1.4 pCi/m^2/sec, with an average value of approximately 0.43 pCi/m^2/sec (Ref. 3, Section 2.1.2). In fact, none of the individual measurements exceeded this background range.

Table 3-2 displays the Phase 1 radon flux monitoring results.

Table 3-2 Phase 1 Radon Flux Monitoring Results

WSSRAP ID	Vendor ID	Results (pCi/m^2/sec)
4	28	0.0749
5	27	0.054
6	24	0.214
6	Duplicate 24	0.208
7	23	0.0436
8	22	0.0544
9	21	0.0679
14	25	0.0529
15	26	0.0585
16	32	0.0625
17	29	0.0487
18	31	0.1004
19	30	0.155
19	Duplicate 30	0.155
20	36	0.323
20	Duplicate 36	0.336
21	33	0.1476
22	34	0.0582
28	47	0.0498
29	46	0.1166
30	45	0.1425
31	44	1.255

Table 3-2 Phase 1 Radon Flux Monitoring Results (Continued)

WSSRAP ID	Vendor ID	Results (pCi/m²/sec)
31	Duplicate 44	1.219
32	43	0.102
33	42	0.114
34	41	0.089
35	35	0.0587
41	48	0.0304
42	49	0.148
42	Duplicate 49	0.151
43	50	0.186
43	Duplicate 50	0.188
39 (Field Replicate of 43)	51	0.0645
44	52	0.1423
45	53	0.1026
46	54	0.1133
47	55	0.0869
48	37	0.092
51	66	0.0647
52	65	0.1342
53	64	0.154
53	Duplicate 64	0.150
54	63	0.1056
55	62	0.0839
56	61	0.124
57	59	0.0822
58	58	0.0962
59	57	0.0688
60	56	0.1094
61	38	0.0597
40 (Field Replicate of 61)	39	0.0173
64	67	0.0386
65	68	0.0887
66	69	0.0842
67	70	0.1065
68	71	0.0679
69	72	0.0619
70	73	0.0546
71	74	0.0487
38 (Field Replicate of 71)	75	0.0309
72	76	0.0452
73	77	0.0324
74	78	0.0284
76	12	0.0565
75 (Field Replicate of 76)	13	0.0459
77	15	0.0319
78	5	0.0334
79	8	0.0253
80	6	0.0454
81	7	0.1054
82	1	0.0506
83	2	0.0381

Table 3-2 Phase 1 Radon Flux Monitoring Results (Continued)

WSSRAP ID	Vendor ID	Results (pCi/m²/sec)
84	4	0.0536
85	3	0.0232
86	79	0.0475
87	16	0.0648
88	11	0.0683
89	10	0.0761
90	9	0.1062
91	17	0.0893
92	18	0.0423
96	14	0.157
96	Duplicate 14	0.148
97	19	0.095
95 (BLANK)	20	0.0085
94 (BLANK)	40	0.0444
93 (BLANK)	60	0.0361
98 (BLANK)	80	0.0108

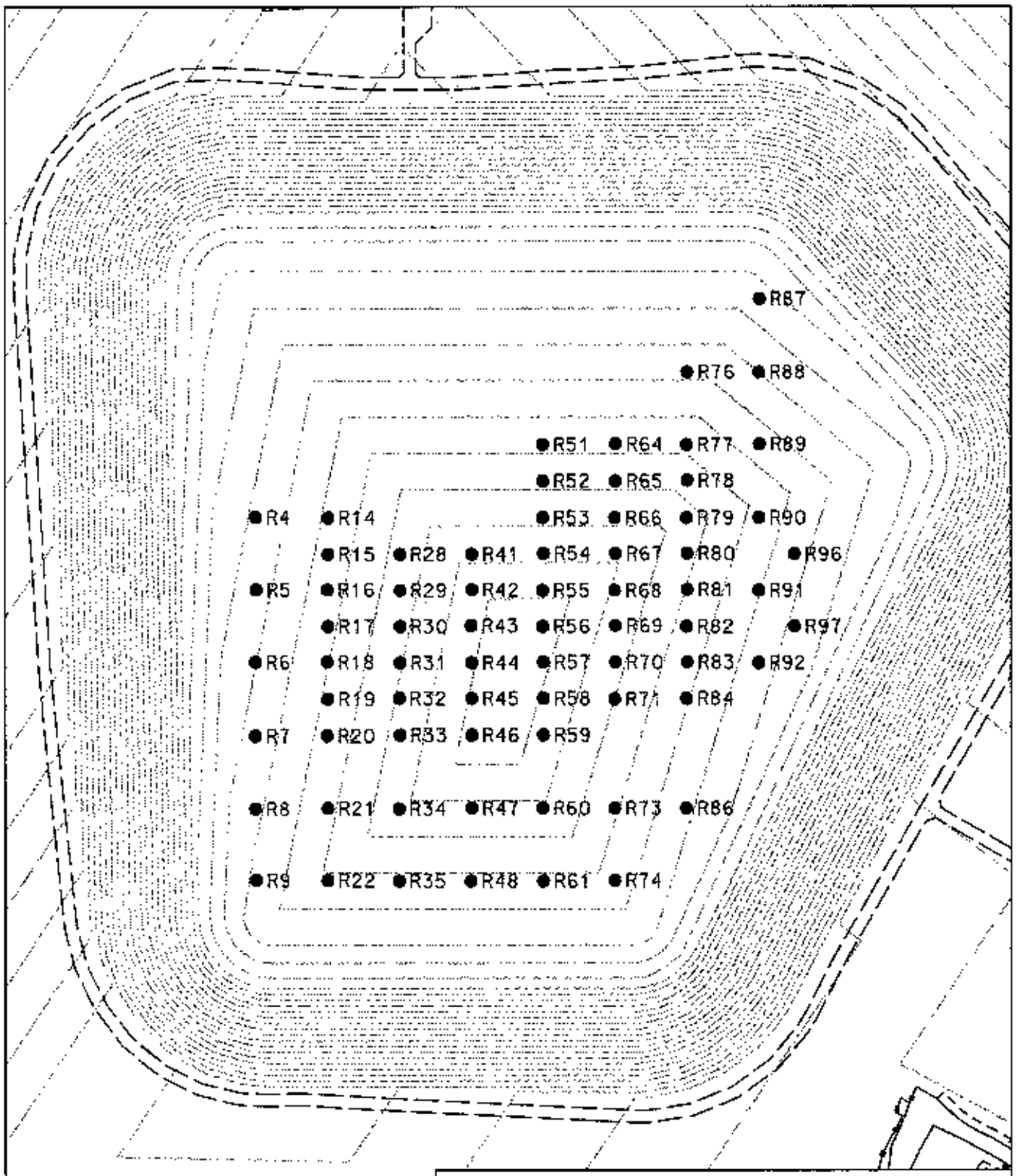
3.2. Phase 2 Monitoring

Phase 2 monitoring was conducted October 11-12, 2000, at 100 separate locations on top of the disposal cell. See Figure 3-2 for Phase 2 monitoring locations. These locations included all radon barrier area excepting the "deep dimple," the approximately 0.7 acre (at current grade) area reserved for the remaining contaminated waste. As of this writing, the dimple has at its deepest point approximately 9.5 ft of clean fill above the cell waste. Two monitoring locations, WSSRAP IDs 10 and 23, were to have been directly above the dimple. However they were repositioned 28-ft southeast to avoid possibility of biased low measurements.

Originally Phase 2 was only to have included the remaining one-third of the radon barrier area (i.e., that portion not included in Phase 1). However, due to favorable changes in construction sequencing, a 1-ft radon barrier surface was available over the entire cell by September 2000. This allowed for Phase 2 to be rescheduled as a one-time monitoring effort covering the entire radon barrier area (Appendix B).

The requirements of both EPA Method 115 (40CFR61 Appendix B) and the *Radon Flux Monitoring Plan for the WSSRAP Disposal Facility* (Ref. 2) were met during Phase 2 monitoring. The average measured radon flux on the disposal cell was 0.55 pCi/m²/sec (standard deviation of 2.64 pCi/m²/sec, maximum value was 26.4 pCi/m²/sec). The average is well below the regulatory requirement of 20 pCi/m²/sec (Ref. 1). Only three of the 100 individual measurements exceeded the background range of 0.005 to 1.4 pCi/m²/sec (Ref. 3, Section 2.1.2).

Additional monitoring was performed October 26-27, 2000 to confirm the 26.4 pCi/m²/sec maximum flux measurement. This included four additional measurements: one



● – MONITORING LOCATION

N

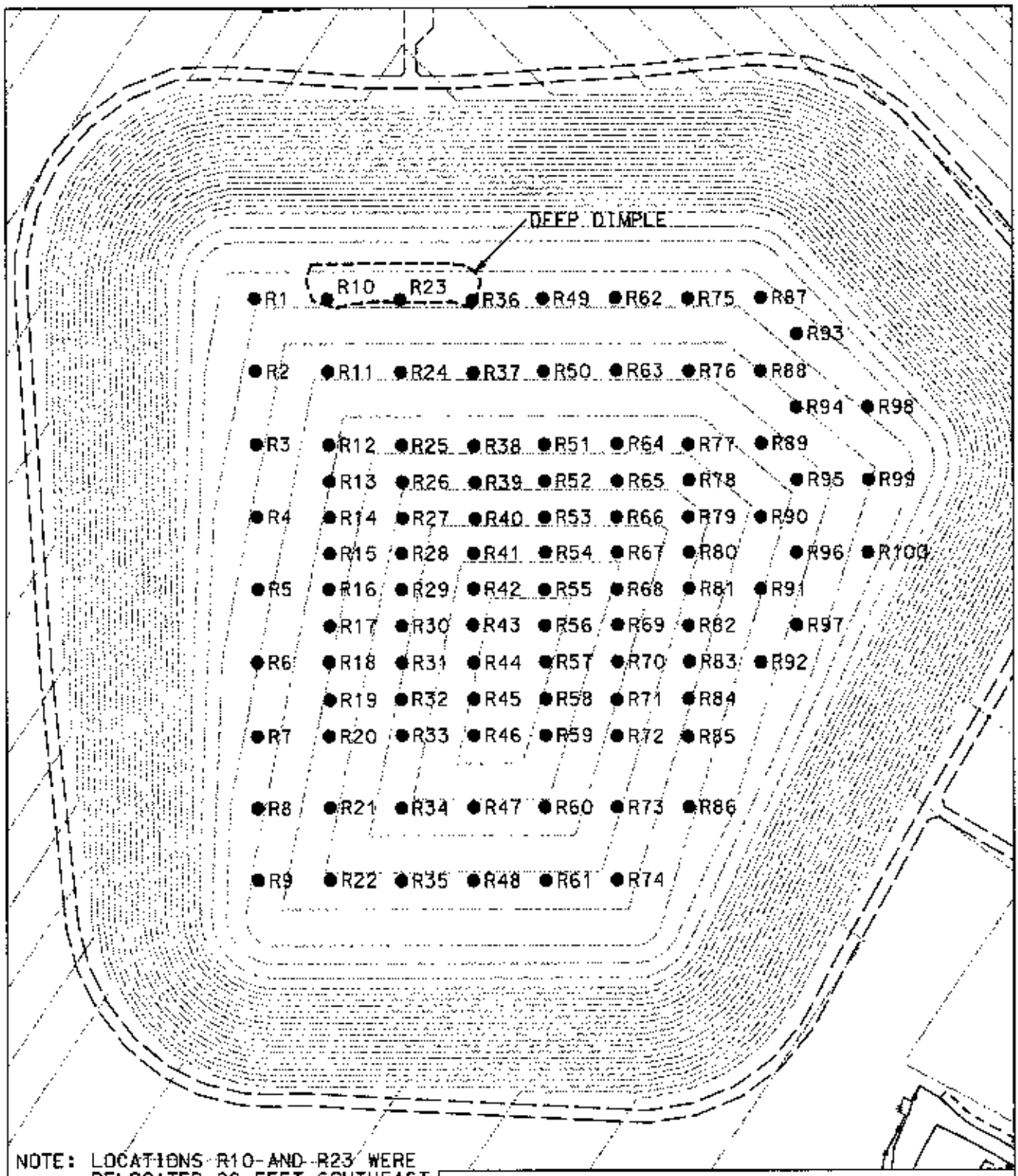
0 200 400

SCALE FEET

PHASE 1 RADON FLUX
MONITORING LOCATIONS

FIGURE 3-1

REPORT NO.: DOE/OR/21548-876		EXHIBIT NO.: A/DC/018/1200	
ORIGINATOR: DF	DRAWN BY: GLN	DATE: 12/18/00	



NOTE: LOCATIONS R10 AND R23 WERE RELOCATED 28 FEET SOUTHEAST TO AVOID THE "DEEP DIMPLE"

● – MONITORING LOCATION

N

0 200 400

SCALE FEET

PHASE 2 RADON FLUX MONITORING LOCATIONS

FIGURE 3-2

REPORT NO.: DOE/OR/21548-876		EXHIBIT NO.: A/DC/019/1200	
ORIGINATOR: DF	DRAWN BY: GLN	DATE: 12/6/00	

at the original location (WSSRAP ID 56), the others within 3 ft of this location. Additional monitoring results were 0.2795, 0.5629, 6.9934, and 13.2819 pCi/m^2/sec. This was interpreted as confirmation of the original result. These additional results were not included in the calculated average since they were not part of the monitoring plan. However, they would have changed the average only slightly (from 0.55 to 0.74 pCi/m^2/sec).

Table 3-3 displays the Phase 2 radon flux monitoring results.

Table 3-3 Phase 2 Radon Flux Monitoring Results

WSSRAP ID	Vendor ID	Results (pCi/m^2/sec)
1	1	0.0372
2	2	0.0735
3	3	0.0459
4	4	0.1935
5	5	0.0755
6	6	0.236
7	7	0.166
7	Duplicate 7	0.1563
8	8	0.2411
9	9	0.2046
10	10	0.0413
11	11	0.0567
12	12	0.0685
12	Duplicate 12	0.0642
13	13	0.0436
14	14	0.0838
15	15	0.0926
16	16	0.2168
17	17	0.1828
18	18	0.1397
19	19	2.3315
20	20	0.4214
21	21	0.1777
22	22	0.4731
22	Duplicate 22	0.461
23	23	0.1717
24	24	0.0415
24 (Field Replicate)	102	0.0784
25	25	0.0894
26	26	0.0392
27	27	0.1012
28	28	0.0817
29	29	0.2303
30	30	0.224
31	31	0.2733
32	32	0.3855
32	Duplicate 32	0.393
33	33	0.3783

Table 3-3 Phase 2 Radon Flux Monitoring Results (Continued)

WSSRAP ID	Vendor ID	Results (pCi/m^2/sec)
33	Duplicate 33	0.3804
34	34	0.1497
35	35	0.195
36	36	0.1374
37	37	0.0327
38	38	0.1262
39	39	0.4449
40	40	0.3056
41	41	0.3334
42	42	0.2139
43	43	0.374
44	44	0.3728
45	45	0.4498
45	Duplicate 45	0.4502
46	46	0.5179
47	47	0.1933
48	48	0.1624
48	48	0.1615
49	49	0.0382
49	Duplicate 49	0.041
50	50	0.2025
51	51	0.2315
51	Duplicate 51	0.2367
52	52	0.3228
53	53	0.3677
54	54	0.3498
55	55	0.3045
56	56	26.4375
56	Duplicate 56	26.7311
57	57	0.4832
58	58	0.1472
59	59	0.1846
60	60	0.2558
60 (Field Replicate)	101	0.2113
61	61	0.232
62	62	0.1884
63	63	0.3674
64	64	0.3915
65	65	0.4606
66	66	0.3075
67	67	0.3528
68	68	0.188
68 (Field Replicate)	103	0.1404
69	69	0.1766
70	70	0.0836
71	71	0.1965
72	72	0.1146
73	73	0.298
74	74	0.1288
75	75	0.1512

Table 3-3 Phase 2 Radon Flux Monitoring Results (Continued)

WSSRAP ID	Vendor ID	Results (pCi/m²/sec)
76	76	0.4694
77	77	0.3124
78	78	0.313
79	79	0.1455
80	80	0.3915
80	Duplicate 80	0.3771
81	81	0.5443
81	Duplicate 81	0.5698
82	82	0.1529
83	83	0.1802
84	84	0.2158
85	85	0.2005
86	86	0.156
87	87	0.3006
88	88	0.5571
88 (Field Replicate)	104	0.4732
89	89	0.3870
90	90	0.3003
91	91	0.2061
92	92	2.4447
93	93	0.3629
94	94	0.3404
95	95	0.4462
96	96	0.4113
97	97	0.4968
98	98	0.6069
99	99	0.5239
99 (Field Replicate)	105	0.2751
100	100	0.5132
BLANK	106	< 0.0088
BLANK	107	< 0.0088
BLANK	108	< 0.0088
BLANK	109	< 0.0088
BLANK	110	< 0.0088

3.3. Barometric Pressure Considerations

To further address the effect of barometric pressure on radon flux, a sensitivity analysis was performed during June 2000 on top of the radon barrier. Radon gas concentrations were monitored using two side-by-side NITON RAD 7 radon detectors in accordance with requirements of WSSRAP Procedure ES&H 4.6.10, *Operation of the NITON RAD 7 Radon Detector*. Barometric pressure was monitored at the WSSRAP meteorological station. Plots of resultant measured radon concentrations and barometric pressures are presented in Appendix A. Results show that radon peak duration was short, most lasting only 3 hours or less. Otherwise the results were inconclusive, as sometimes radon levels increased with decreasing barometric

pressure, and sometimes they decreased. Also, radon concentrations sometimes increased with increasing barometric pressure.

As stated in the National Council on Radiation Protection and Measurements (NCRP) Report No. 103 (Ref. 3) the influence of barometric pressure changes on radon flux is not significant over the long term. Although sudden drops in barometric pressure can increase the radon emanation rate by 10 times or more, the episodes are brief and the barometric pressure differences between the soil air and atmosphere eventually equilibrate or the soil radon production rate will not sustain the flux increase. Conversely, a sudden increase in barometric pressure will reduce the emanation rate, although the effect is less dramatic (Ref. 3, Section 2.1.2).

3.4. Quality Control

Quality control requirements in the *Radon Flux Monitoring Plan for the WSSRAP Disposal Facility* (Ref. 2) included the following:

- Vendor laboratory will establish 95% upper and lower confidence limits using two charcoal standards counted 20 times.
- Collect field replicates at 5% of the sample locations.
- Vendor laboratory recount of 10% of the samples to document reproducibility.
- Include 5% of the samples as field blanks.
- At least 85% of all measurements must yield usable results.
- Precision of 10% for all duplicate samples above 1.0 pCi/m^2/s.

All quality control requirements were met in both Phase 1 and Phase 2 monitoring. There were 60 monitoring locations in Phase 1 monitoring, and 100 monitoring locations in Phase 2 monitoring. Field replicates were collected at four locations (7%) during Phase 1 monitoring, and at five locations (5%) during Phase 2 monitoring. The vendor laboratory performed eight duplicate recounts (13%) during Phase 1 monitoring, and 11 duplicate recounts (11%) during Phase 2 monitoring. The maximum relative percent difference between the duplicate recounts was 7.1%, which occurred during Phase 2 monitoring for WSSRAP ID 49. Four field blanks (7%) were collected during Phase 1 monitoring, and five field blanks (5%) were collected during Phase 2 monitoring. There were 58 measurements (97%) yielding usable results in Phase 1 monitoring, and 100 measurements (100%) yielding usable results in Phase 2 monitoring. The maximum percent precision for duplicate samples above 1.0 pCi/m^2/sec was 3% in Phase 1 monitoring, and 1% in Phase 2 monitoring.

3.5. Conclusion

Radon flux monitoring was conducted over the entire radon barrier proper October 10-11, 2000, in accordance with applicable requirements of 40CFR61 and the *Radon Flux Monitoring Plan for the WSSRAP Disposal Facility* (Ref. 2). The average measured radon flux was 0.55 pCi/m^2/sec, which is well below the 40CFR61, Subparts Q and T, flux standard of 20 pCi/m^2/sec. This average as well as the vast majority of individual measurements, was within the background range of radon flux (Ref. 3, Section 2.1.2). Barometric pressure effects on radon flux were not significant over the long term (Ref. 3, Section 2.1.2).

4. REFERENCES

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2. MK-Ferguson Company and Jacobs Engineering Group. *Radon Flux Monitoring Plan for the WSSRAP Disposal Facility*. Rev. 1. DOE/OR/21548-813. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, MO. December 1999.

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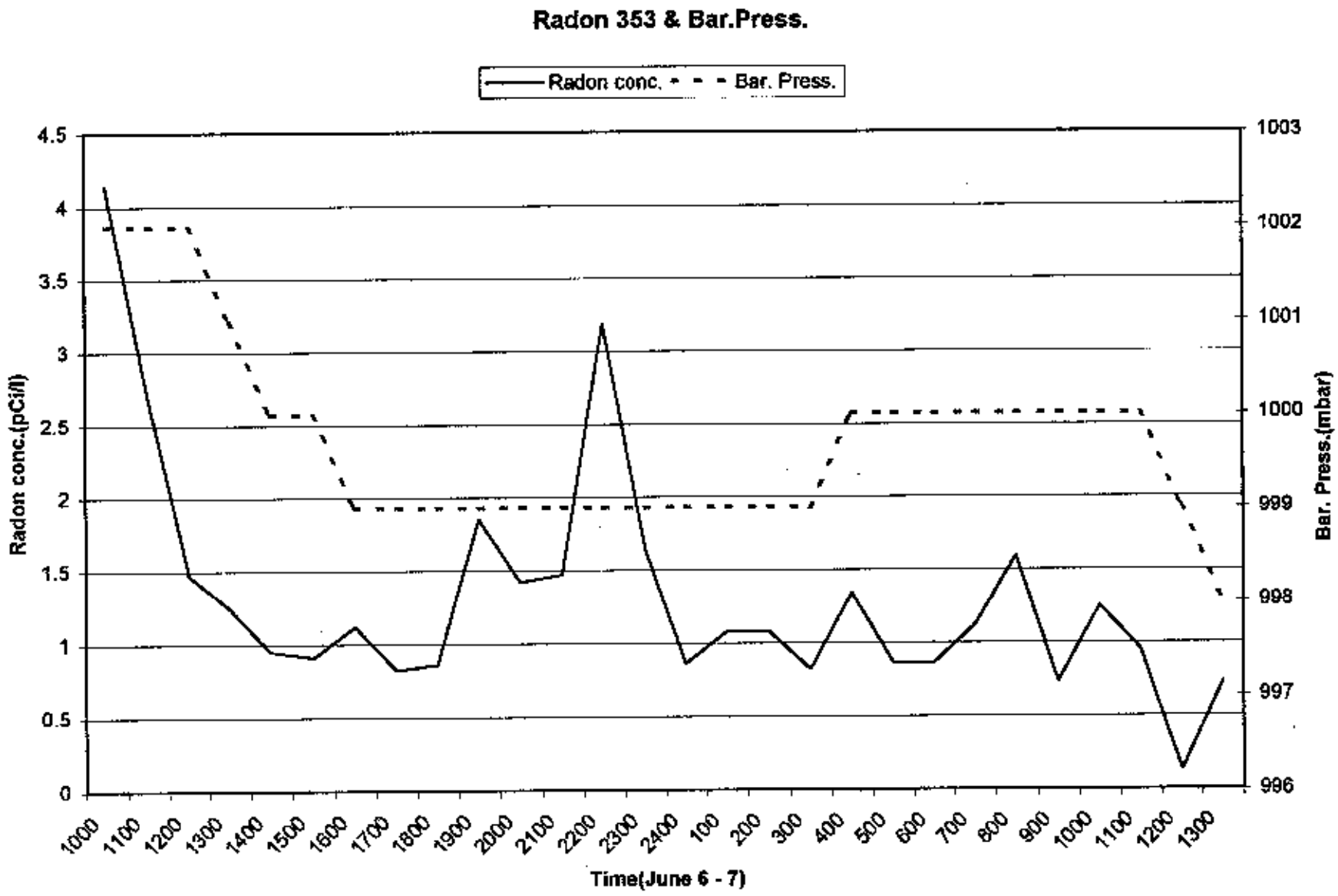
APPENDIX A
Results of Radon vs. Barometric Pressure Sensitivity Study


Radon 353 & Bar.Press.
Radon conc.
Bar. Press.
Radon conc.(pCi/l)
Bar. Press.(mbar)
Time(June 6 - 7)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
1003
1002
1001
1000
999
998
997
996
1000
1100
1200
1300
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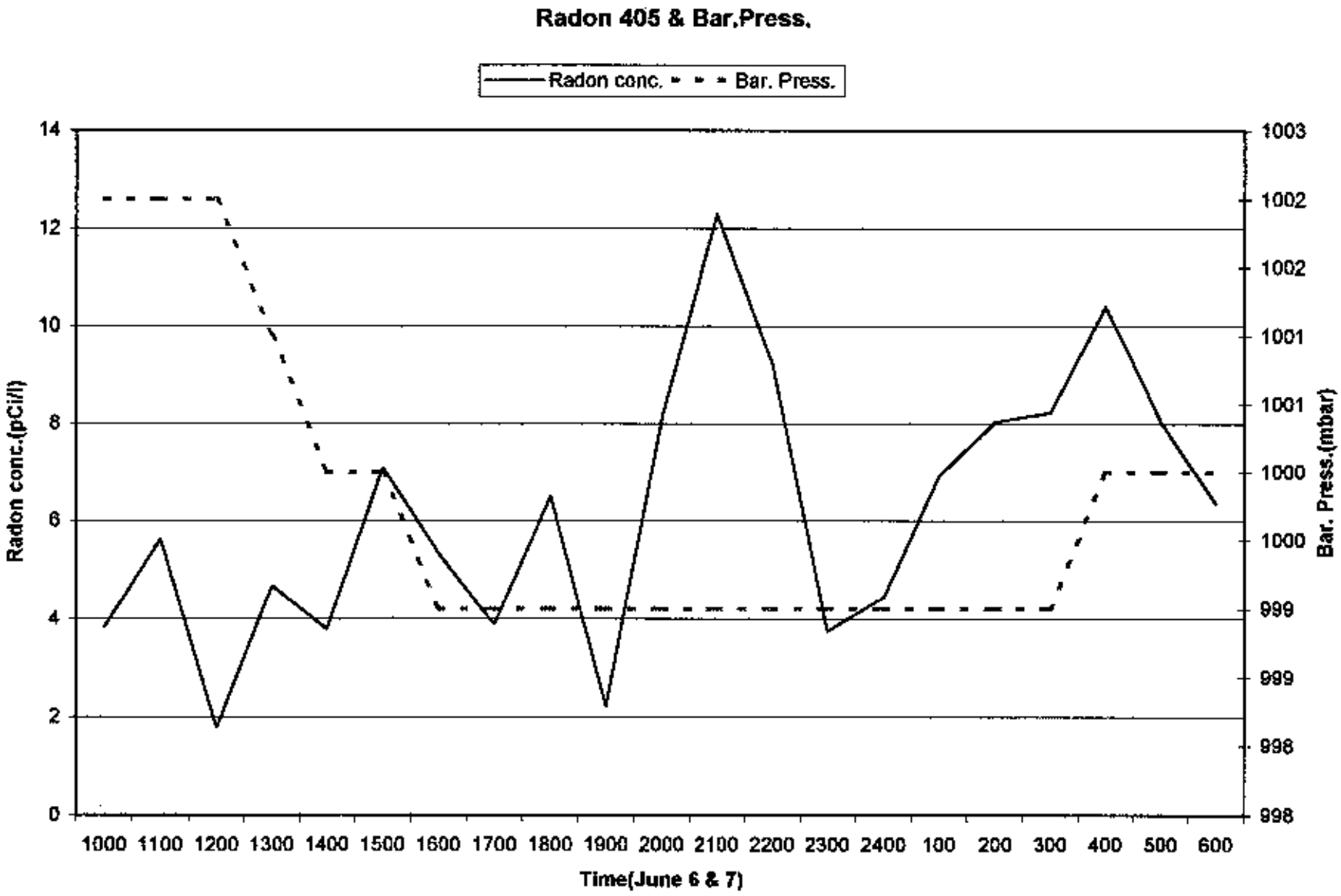
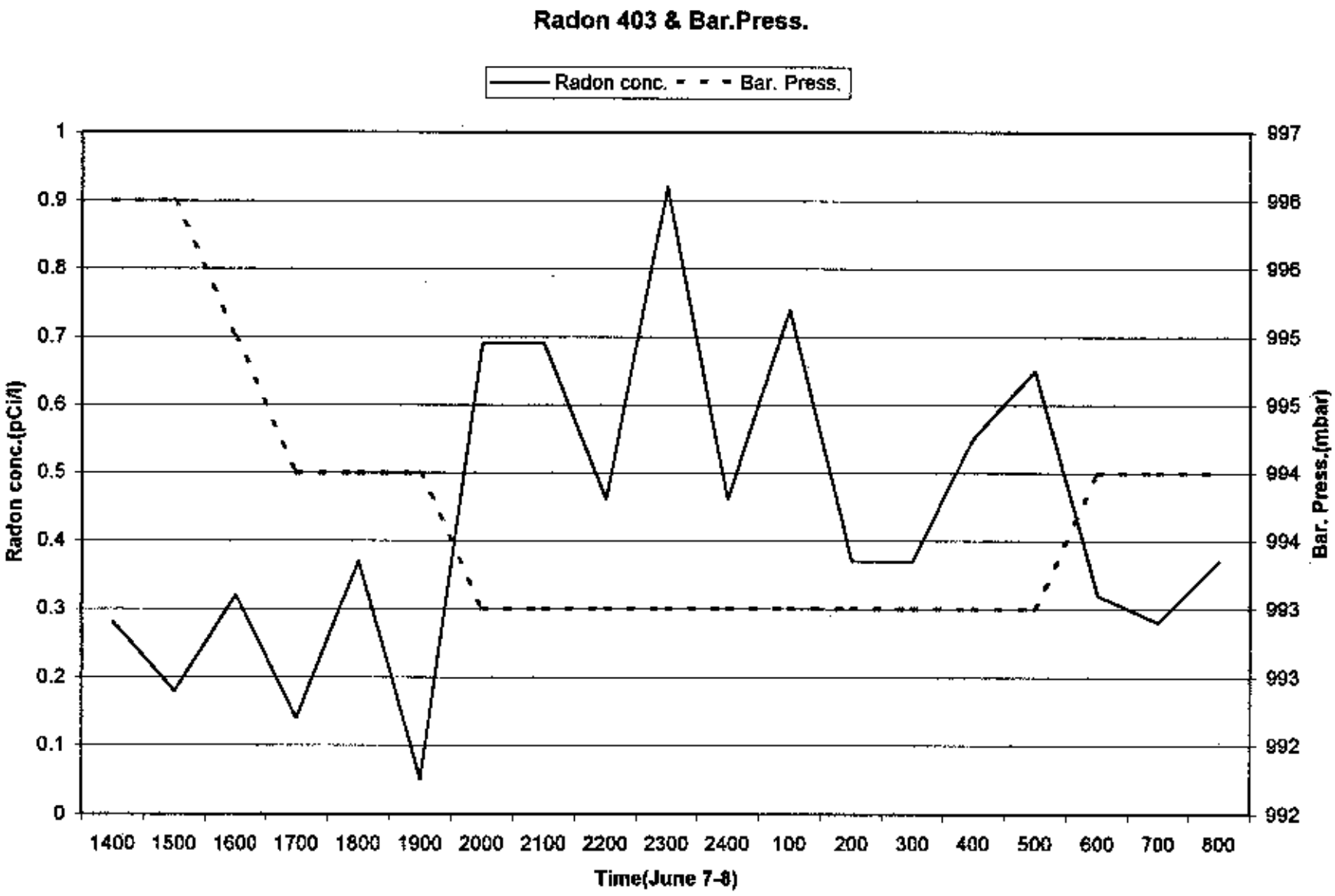
1200
1300


Radon 405 & Bar.Press.
Radon conc.
Bar. Press.
Radon conc.(pCi/l)
Bar. Press.(mbar)
Time(June 6 & 7)
0
2
4
6
8
10
12
14
998
998
999
999
1000
1000
1001
1001
1002
1002
1003
1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000 2100 2200 2300 2400 100 200 300 400 500 600


Radon 403 & Bar.Press.
Radon conc.
Bar. Press.
Radon conc.(pCi/l)
Bar. Press.(mbar)
Time(June 7-8)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
997
996
996
995
995
994
994
993
993
992
992
1400
1500
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700
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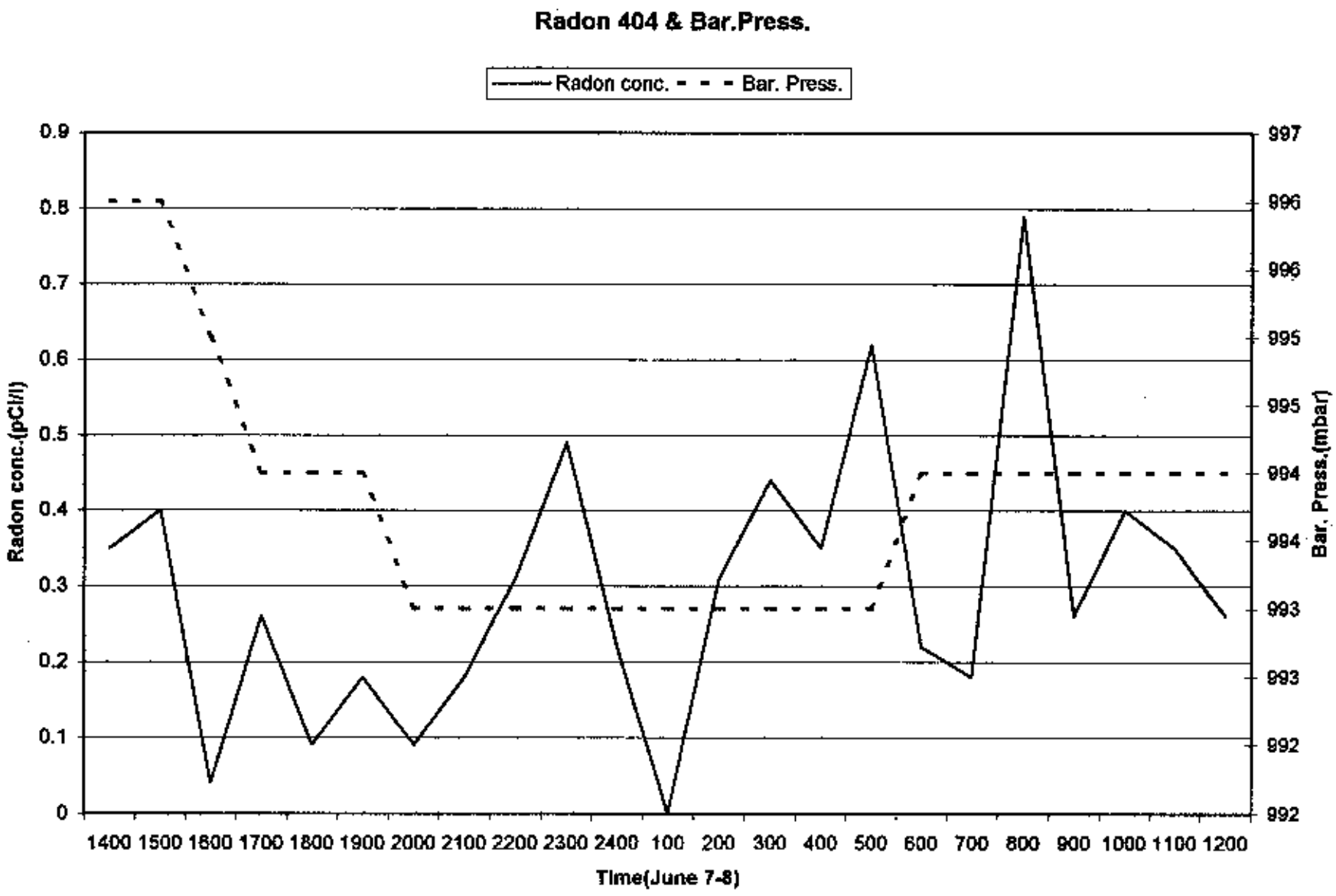
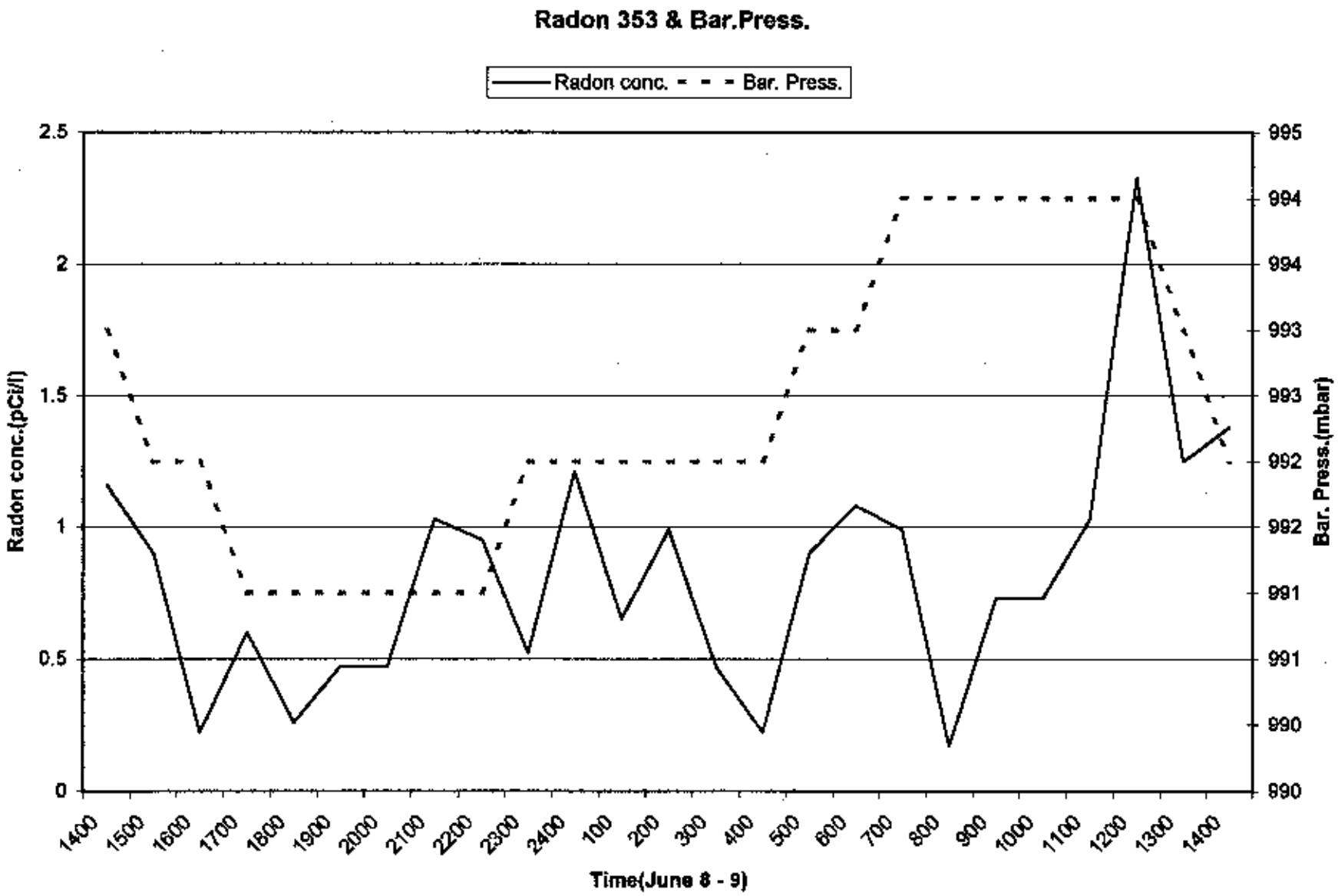
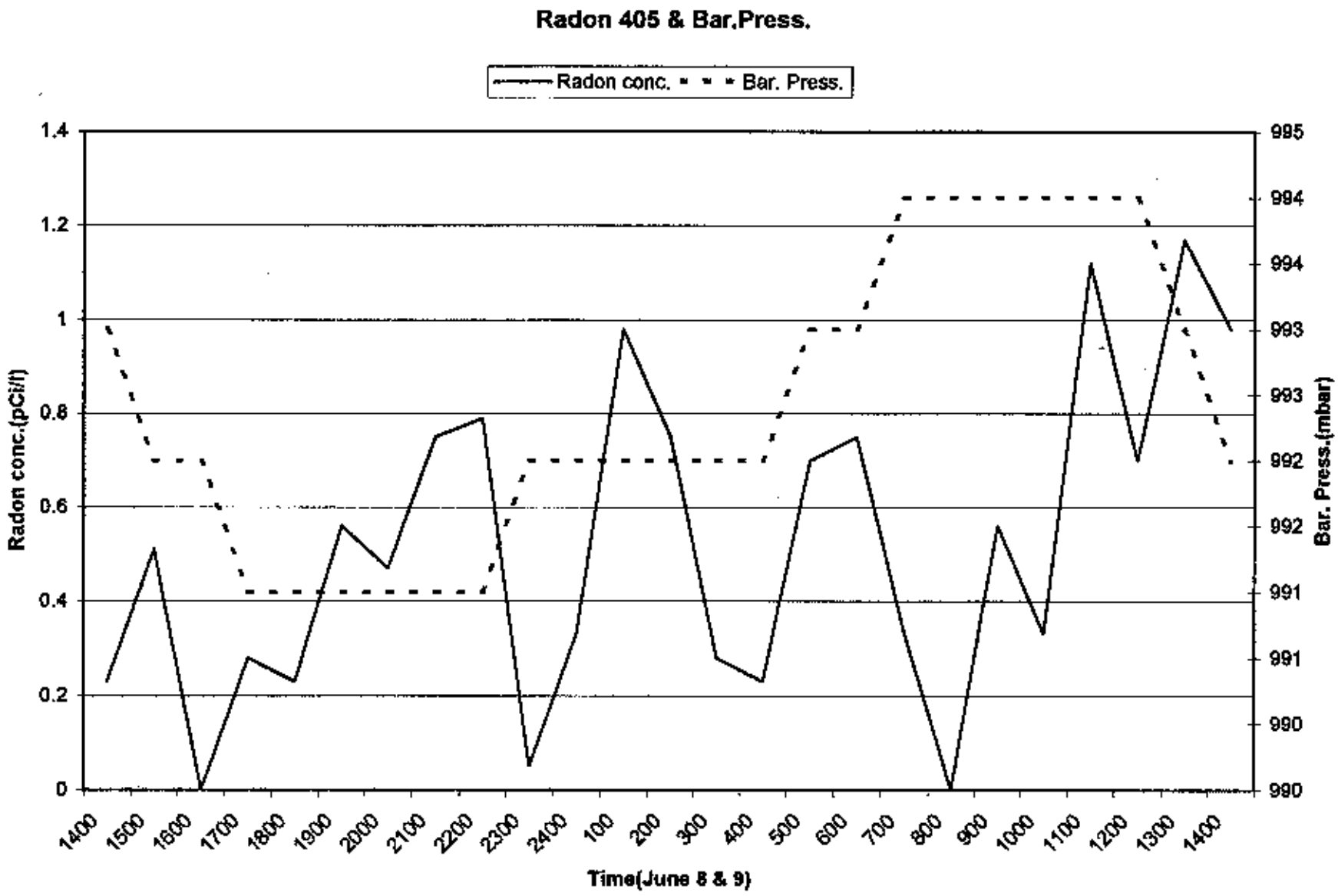

Radon 404 & Bar.Press.
Radon conc.
Bar. Press.
Radon conc.(pCi/l)
Bar. Press.(mbar)
Time(June 7-8)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
997
996
996
995
995
994
994
993
993
992
992
1400 1500 1600 1700 1800 1900 2000 2100 2200 2300 2400 100 200 300 400 500 600 700 800 900 1000 1100 1200


Radon 353 & Bar.Press.
Radon conc.
Bar. Press.
Radon conc.(pCi/l)
Bar. Press.(mbar)
Time(June 8 - 9)
2.5
2
1.5
1
0.5
0
995
994
994
993
993
992
992
991
991
990
990
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400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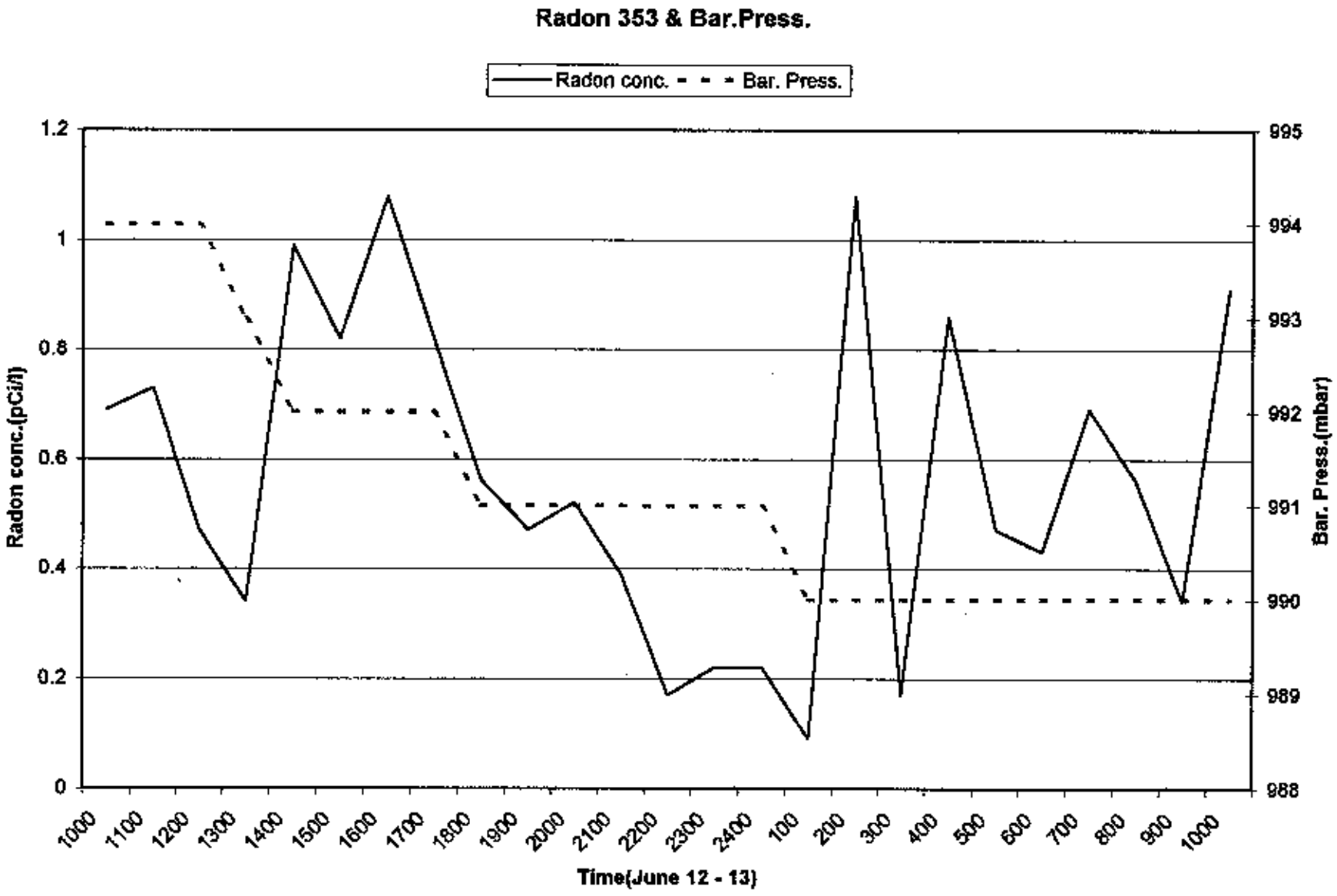
Radon conc.
Bar. Press.
Radon conc.(pCi/l)
Bar. Press.(mbar)
Time(June 8 & 9)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
995
994
994
993
993
992
992
991
991
990
990
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400


Radon 353 & Bar.Press.
Radon conc.
Bar. Press.
Radon conc.(pCi/l)
Bar. Press.(mbar)
Time(June 12 - 13)
1.2
1
0.8
0.6
0.4
0.2
0
995
994
993
992
991
990
989
988
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
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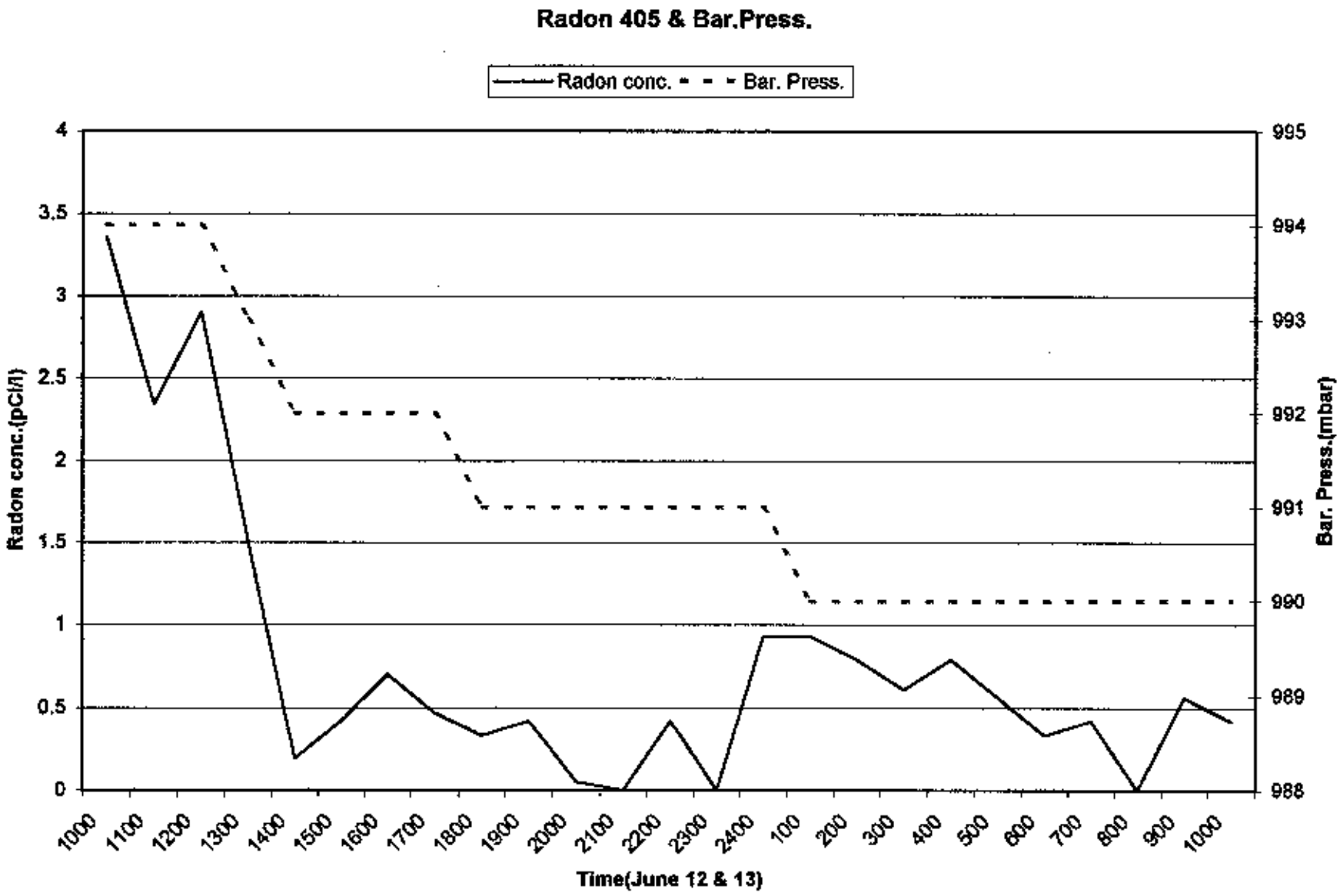
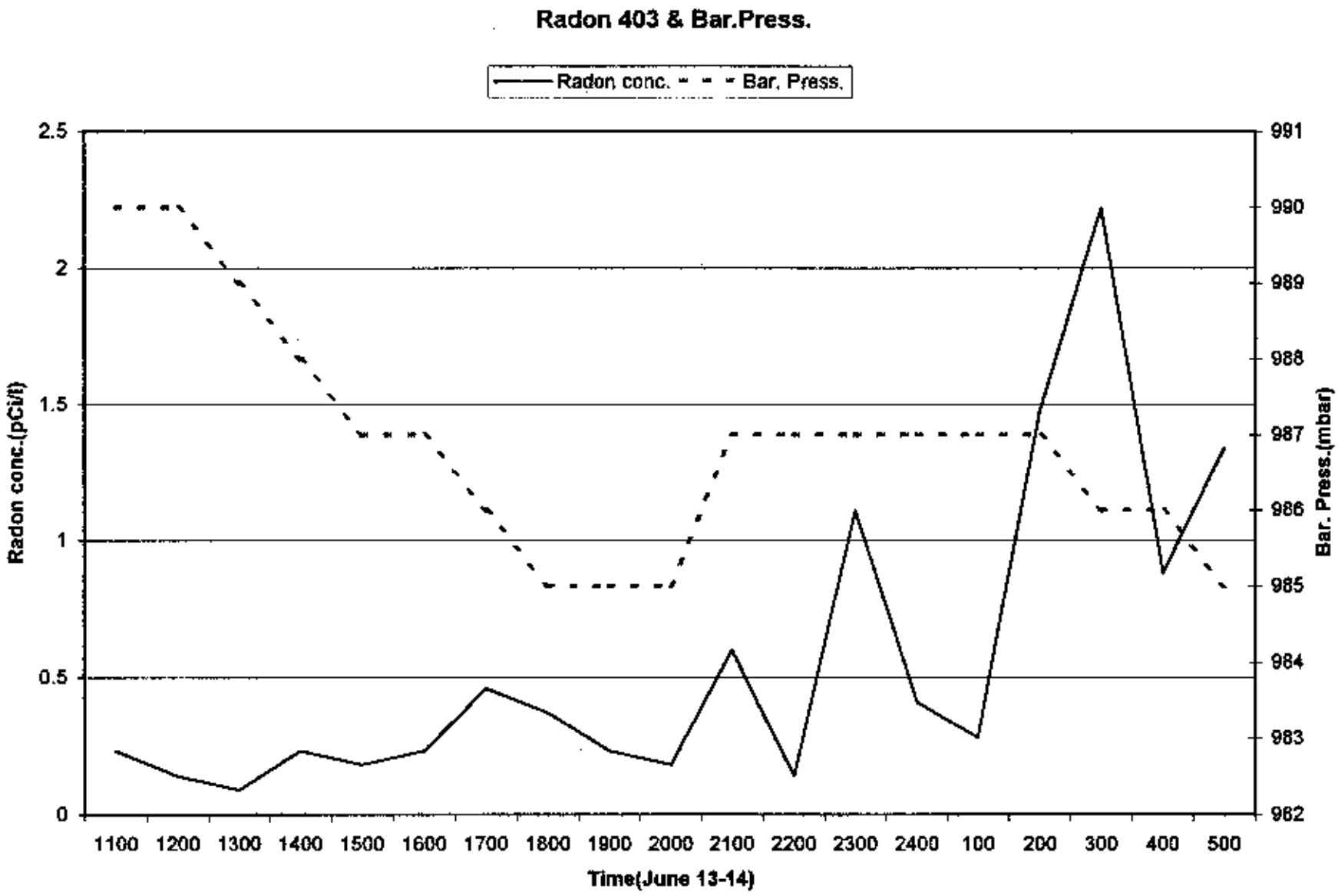
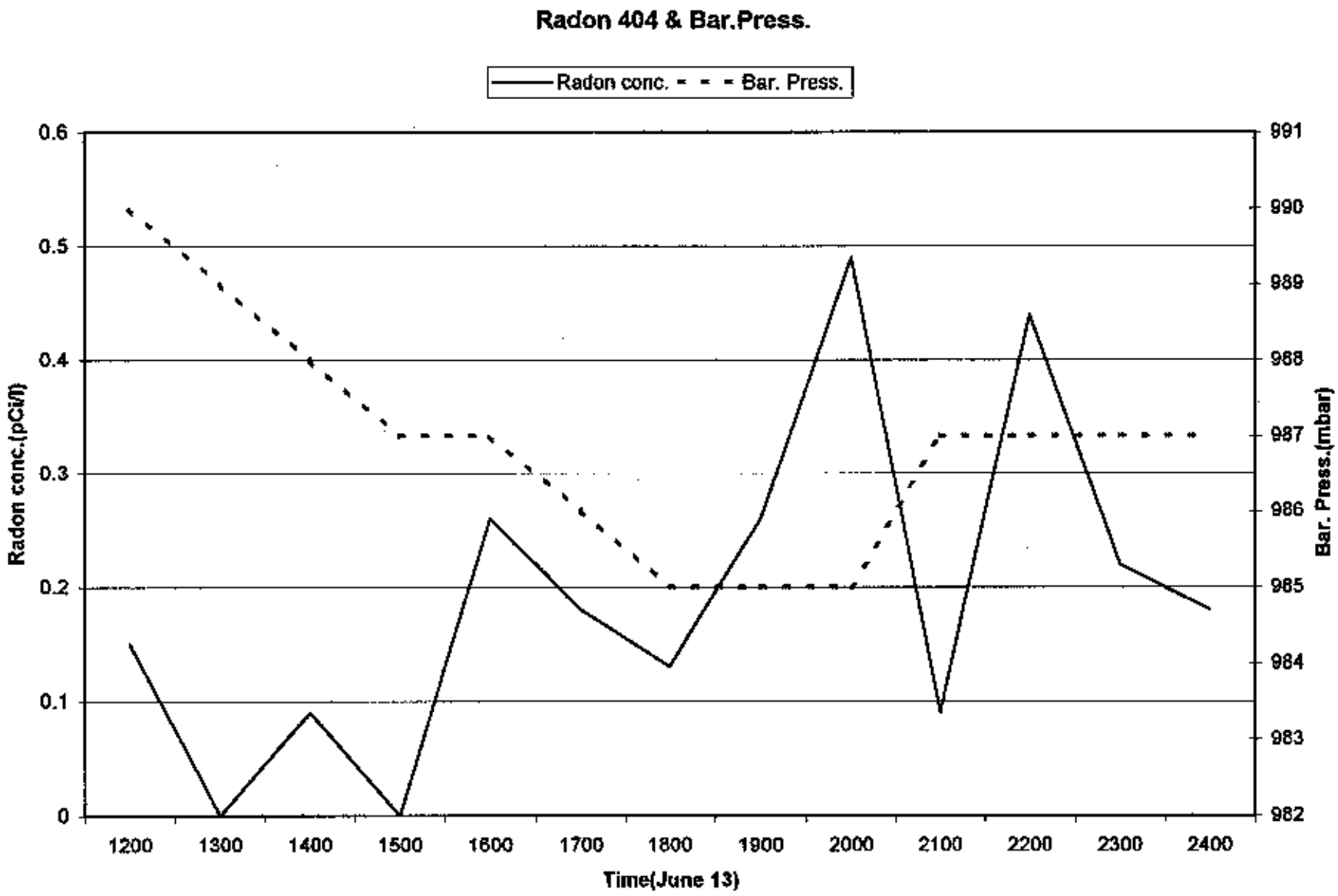
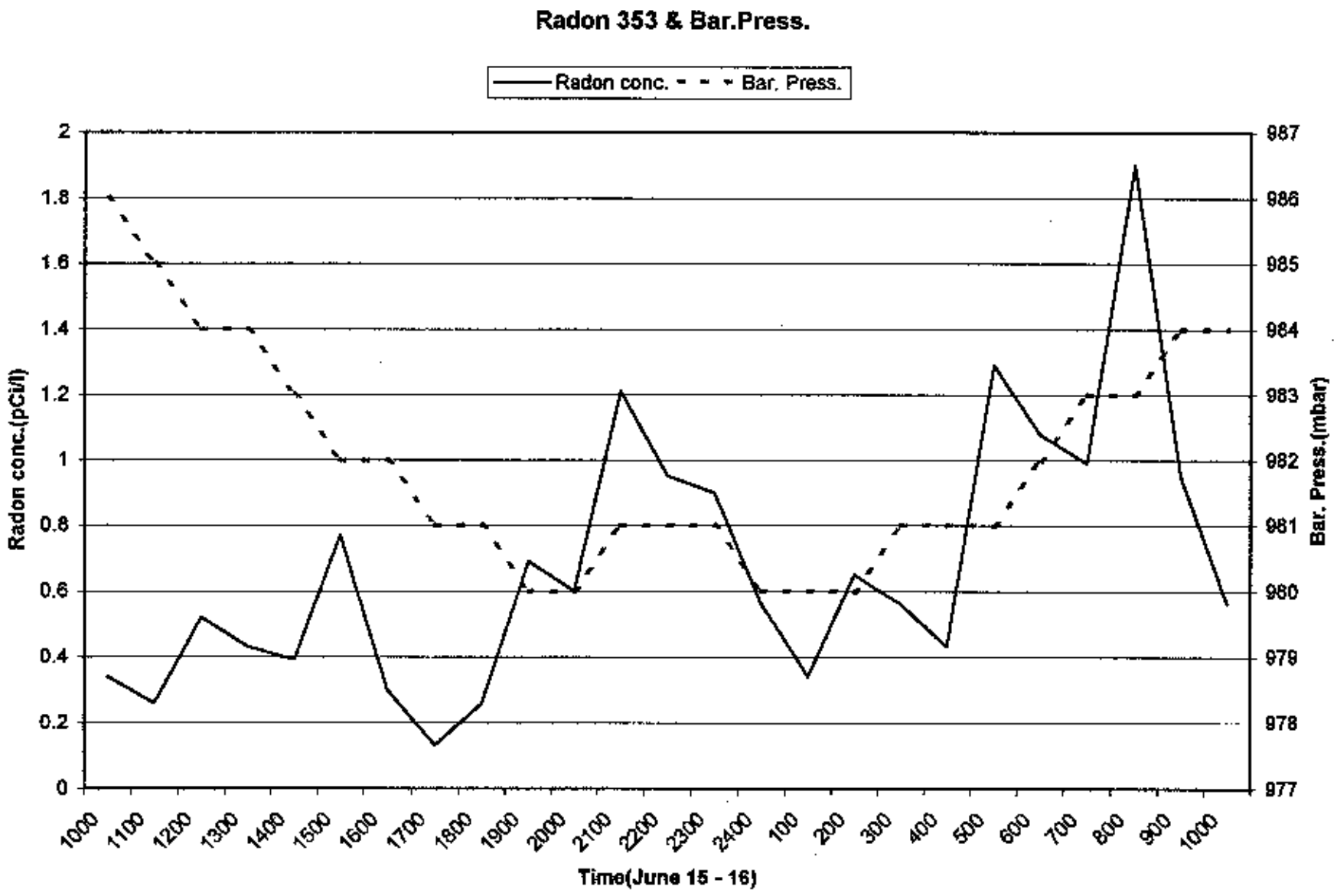
500
600
700
800
900
1000


Radon 405 & Bar.Press.
Radon conc.
Bar. Press.
Radon conc.(pCi/l)
Bar. Press.(mbar)
4
3.5
3
2.5
2
1.5
1
0.5
0
995
994
993
992
991
990
989
988
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
100
200
300
400
500
600
700
800
900
1000
Time(June 12 & 13)


Radon 403 & Bar.Press.
Radon conc.
Bar. Press.
Radon conc.(pCi/l)
Bar. Press.(mbar)
2.5
2
1.5
1
0.5
0
991
990
989
988
987
986
985
984
983
982
1100 1200 1300 1400 1500 1600 1700 1800 1900 2000 2100 2200 2300 2400 100 200 300 400 500
Time(June 13-14)


Radon 404 & Bar.Press.
Radon conc.
Bar. Press.
Radon conc.(pCi/l)
Bar. Press.(mbar)
Time(June 13)
0.6
0.5
0.4
0.3
0.2
0.1
0
991
990
989
988
987
986
985
984
983
982
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400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Radon conc.
Bar. Press.
Radon conc.(pCi/l)
Bar. Press.(mbar)
Time(June 15 - 16)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
987
986
985
984
983
982
981
980
979
978
977
1000
1100
1200
1300
1400
1500
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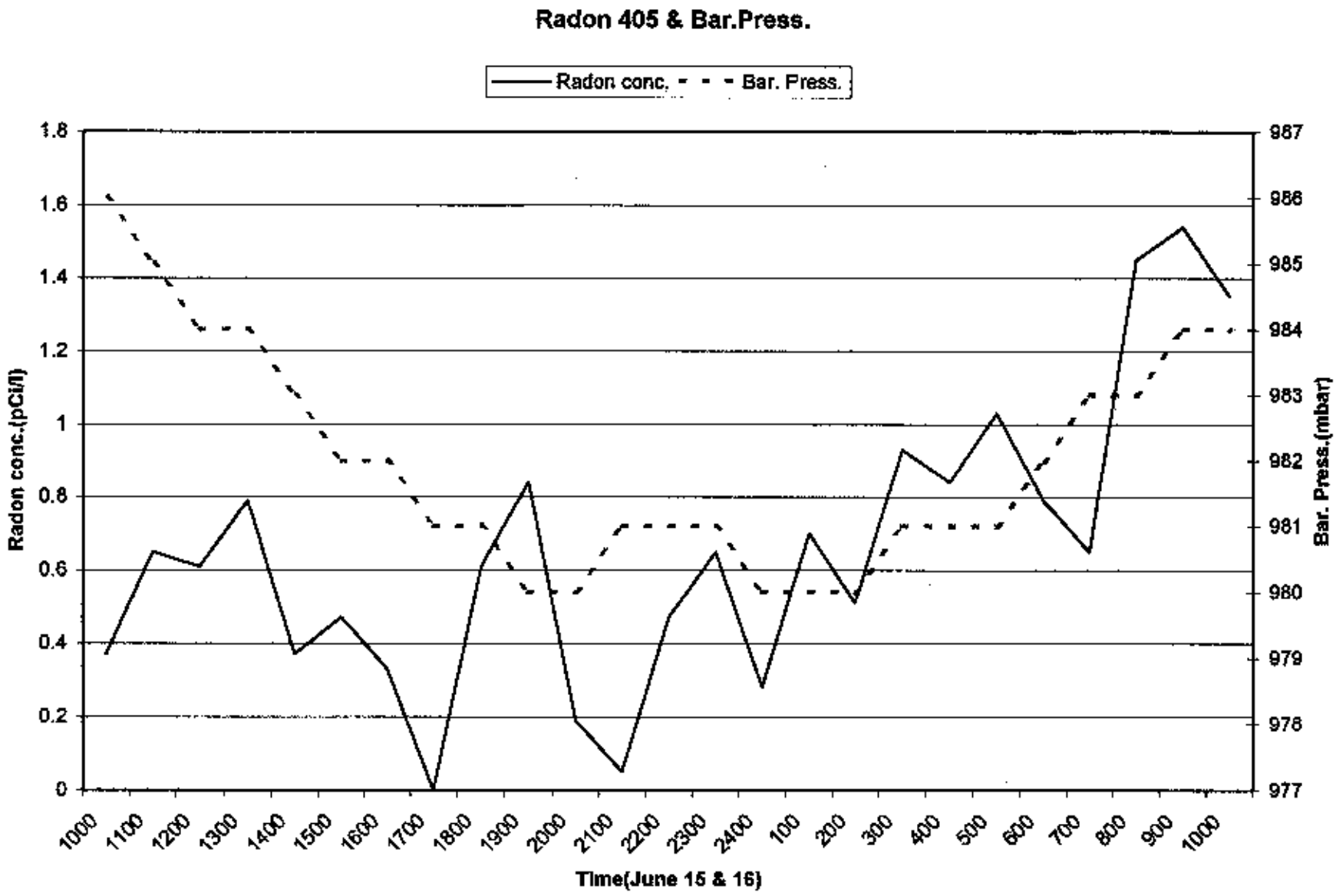
500
600
700
800
900
1000


Radon 405 & Bar.Press.
Radon conc.
Bar. Press.
Radon conc.(pCi/l)
Bar. Press.(mbar)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
987
986
985
984
983
982
981
980
979
978
977
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1100
1200
1300
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1500
1600
1700
1800
1900
2000
2100
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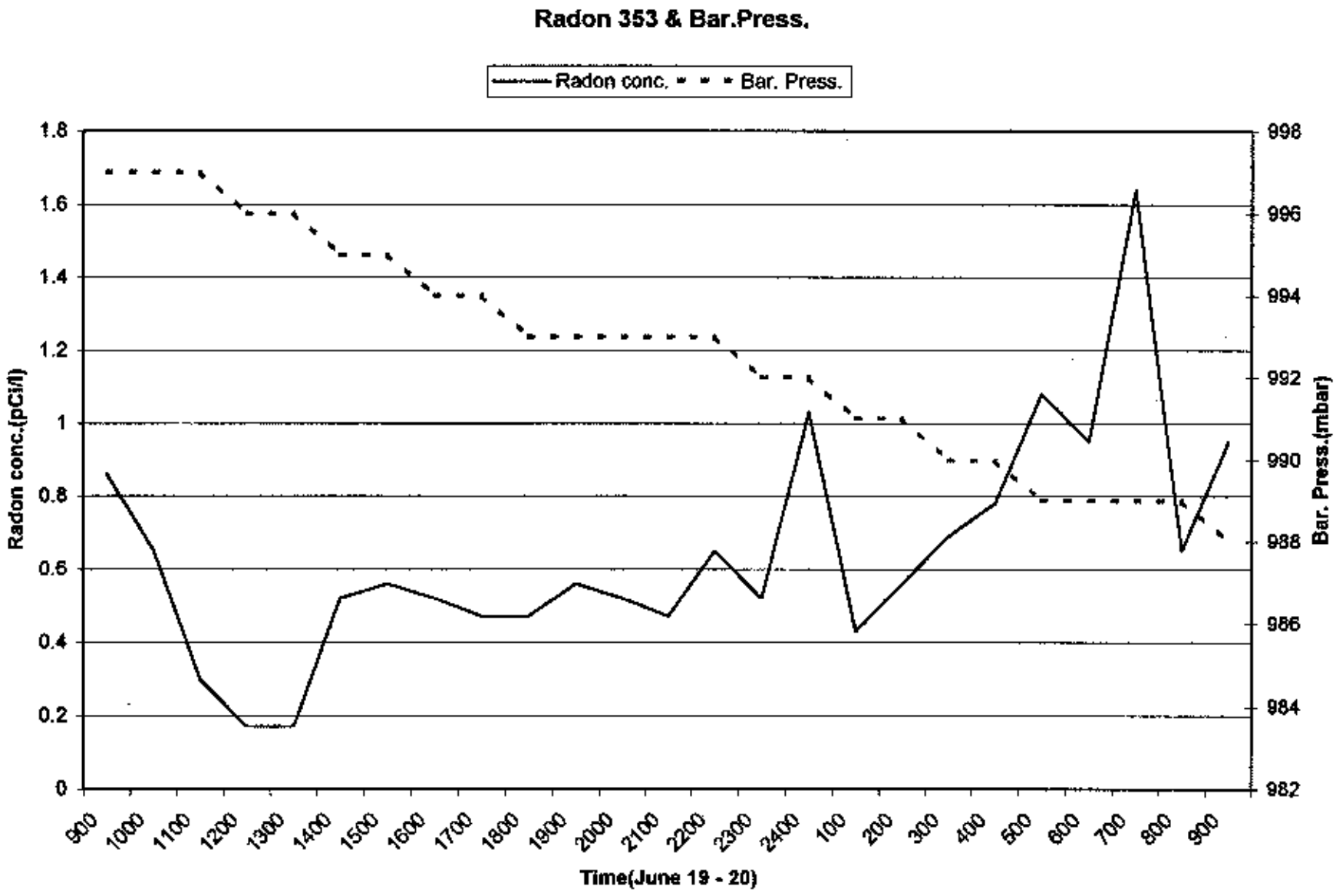
2300
2400
100
200
300
400
500
600
700
800
900
1000
Time(June 15 & 16)


Radon 353 & Bar.Press.
Radon conc.
Bar. Press.
Radon conc.(pCi/l)
Bar. Press.(mbar)
Time(June 19 - 20)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
998
996
994
992
990
988
986
984
982
900
1000
1100
1200
1300
1400
1500
1600
1700
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400
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600
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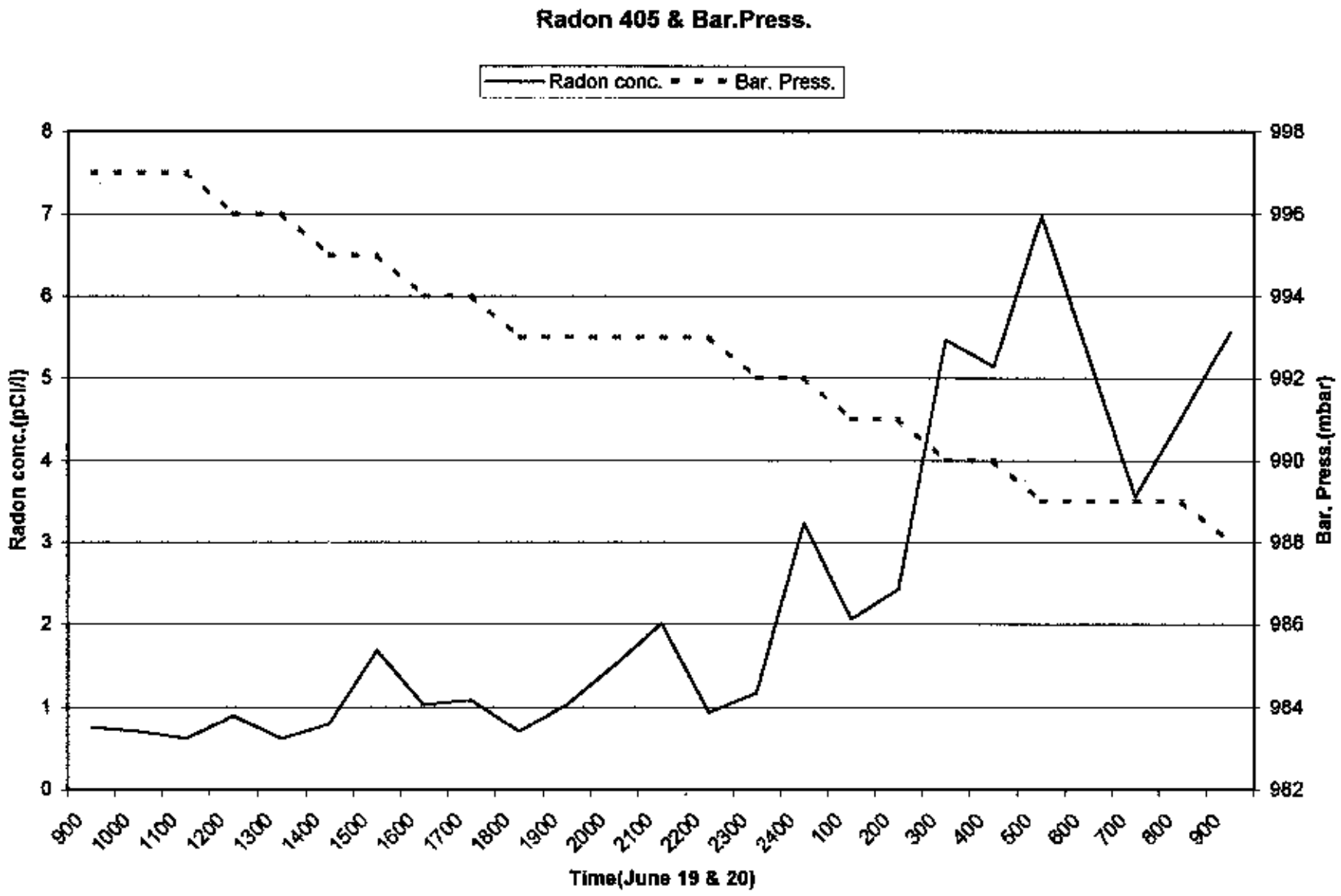
Radon 405 & Bar.Press.
Radon conc.
Bar. Press.
Radon conc.(pCi/l)
Bar. Press.(mbar)
Time(June 19 & 20)
0
1
2
3
4
5
6
7
8
982
984
986
988
990
992
994
996
998
900
1000
1100
1200
1300
1400
1500
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1700
1800
1900
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2100
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2300
2400
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900

APPENDIX B

Supplemental Change to Radon Flux Monitoring Plan
for the WSSRAP Disposal Facility, Rev. 1, December 1999

86945

APR 27 2000

Mr. Daniel Wall
Project Manager
Superfund Division
U.S. Environmental Protection Agency
Region VII
901 North 5th Street
Kansas City, Kansas 66101

Dear Mr. Wall:

SUPPLEMENTAL CHANGES TO RADON FLUX MONITORING PLAN FOR THE WSSRAP DISPOSAL FACILITY, REV. 1, DECEMBER 1999

This letter serves as a summary of supplemental changes to the subject plan. It addresses comments made by Garianne Howard of the EPA Office of Radiation and Indoor Air during the April 5, 2000, conference call between yourself and Ms. Howard of EPA, Tom Pauling of the U.S. Department of Energy, and Elizabeth Algutifan of the WSSRAP Project Management Contractor (PMC). Comments on the plan were also provided by the Missouri Department of Natural Resources (MDNR) (reference February 3, 2000 letter from Larry Erickson of MDNR to Tom Pauling of DOE) and are addressed here. The following paragraphs detail the substantive changes to the plan based on EPA's and MDNR's comments.

Section 3.2 of the plan called for the radon flux monitoring to be conducted in two phases due to the need to coordinate with scheduled construction activities. As the result of changes in construction sequencing, a 1-foot radon barrier surface will now be available over the entire disposal cell by late September 2000. The monitoring has therefore been rescheduled as a one-time effort, estimated to be complete by the end of October 2000. In contrast to a two-phased approach, the single phased approach will meet the stipulation of 40 CFR 61, Appendix B, Method 115 that after disposal is concluded, the pile will be considered as consisting of only one region. Keep in mind that if the samples taken on the 1-foot barrier do not meet the flux standard, we will resample (probably in phases) on the 3-foot barrier during 2001. If that occurs, we will revise and reissue an amended sampling plan.

86945 _ 2

MDNR's concern with the ability of the contract laboratory to count all 105 charcoal samples within a 5-day period was discussed with Mr. Shawn Price, Radon Program Manager for Air Chek. Mr. Price stated that his facility uses 16 high-efficiency, sodium iodide well detectors to perform the gamma spectrometry analysis. Each sample is counted for 5 to 10 minutes with an instrument background count conducted after every sixth sample count. Mr. Price has assured us that all the samples can be counted within one day after receipt.

Please call Tom Pauling at (636) 926-7051 if you have any questions.

Sincerely,

ORIGINAL SIGNED BY
STEPHEN H. MCCRACKEN

Stephen H. McCracken
Project Manager
Weldon Spring Site
Remedial Action Project

cc: Robert Dye, EPA Region VII
Gustavo Vazquez, EH-41
Larry Erickson, MDNR (2 copies)
Mary Picel, ANL
Dave Hixson, PMC
Melissa Lutz, PMC

CONCURRENCE/ REVIEWED BY:
RTG SYMBOL: EM-95
INITIALS/SIG.: TPauling
DATE: 4/ 27 /2000
CONCURRENCE:
RTG SYMBOL: EM-95
INITIALS/SIG.: SMcCracken
DATE: 4/ /2000
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INITIALS/SIG.
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RTG SYMBOL
INITIALS/SIG.
DATE

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In its comments, the MDNR expressed concern that the non-homogeneous makeup of the wastes within the disposal cell might necessitate a greater number of sampling locations than the 100 currently planned. MDNR therefore requested that the WSSRAP conduct an error analysis to statistically determine the proper number of sampling locations. As Ms. Howard stated during the recent conference call, per the NESHAP, the disposal cell is considered to consist of only one region after disposal is complete, independent of the degree of homogeneity of the wastes within. In addition, the intent of the monitoring is to obtain

an *average* radon flux rate over the surface of the entire pile to compare to the 20 pCi/m^2-s standard. We thus maintain that, in accordance with Appendix B, Method 115, 100 measurements will be adequate to properly determine the average radon flux rate from the radon barrier surface.

Further technical clarifications to the plan requested by the MDNR included the dependence of radon flux on atmospheric conditions (i.e., barometric pressure and temperature) and moisture content. To address the effect of barometric pressure on radon flux, a field sensitivity analysis will be conducted this spring. Results of the analysis will be documented and discussed in the emission test report to be submitted after completion of the radon flux monitoring task.

The laboratory chosen by the WSSRAP to analyze the charcoal samples used to determine radon flux is Air Chek, Inc. The effects of moisture uptake by the charcoal samples are addressed in Air Chek's standard operating procedure (SOP) "Measurements of Indoor Ambient Radon Concentrations and Soil Flux Measurements Using Activated Charcoal Adsorber Detectors." The SOP requires that the charcoal samples be pre-weighed to 225 grams and re-weighed following field deployment. The SOP specifies that results for samples which have increased in weight by more than 20% be flagged as questionable, as they are only estimates of the true values. As a rule of thumb, the SOP notes that for a 96-hour field exposure, typical moisture gain of a sampler ranges from 2% to 5% of the total charcoal weight. The WSSRAP radon flux monitoring effort will be conducted over a 24-hour period, and the samples will be shipped to the laboratory in sealed bags by overnight service. The laboratory will count them upon receipt the next day. Careful adherence to these steps should keep moisture uptake to a minimum and result in valid measurements.

The MDNR further requested a clarification of the criterion that 85% of all measurements must yield valid results. Based on the contract laboratory's SOP, invalid results could occur for the following reasons:

- Samplers returned to the laboratory more than 192 hours (8 days) after the end of the deployment period.
- Samplers with no sampling start and end dates/times provided.
- Samplers that have increased by weight more than 20% over their beginning weight.
- Samplers exposed to extreme temperatures (greater than 90° F or less than 30° F as noted on the field sheet).
- Charcoal samples that are improperly sealed by the client before shipment to the laboratory.

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MK-Ferguson Company
Weldon Spring Site Remedial Action Project

TRANSMITTAL OF CONTRACT DELIVERABLE

Date: **January 16, 2001** Transmittal No.: **CD-0253-00**

Title of Document: **Completion Report For Radon Flux Monitoring Of The WSSRAP Disposal Facility**

Doc. Num.: **876** Rev. No.: **0** Date of Document: **January 2001**

Purpose of Transmittal: Request for Department of Energy acceptance of contract deliverable.

In compliance with the Project Management Contract, MK-Ferguson Company hereby delivers the attached document to the U.S. Department of Energy, Weldon Spring Site Office. The document has been reviewed and approved by Project Management Contractor management.

The document will be considered accepted unless we receive written notification to the contrary within 30 days of the date of this transmittal.

Number of copies transmitted: **13**

Douglas E. Steffen
Project Director

IMP: Form Contract Deliverable