

**RADIOLOGICAL SURVEY REPORT
OF THE FORMER LUX CLOCK COMPANY
BUILDING, WATERBURY, CT**

**FOR
MOLL INDUSTRIES, INC.
WATERBURY, CT**

May, 1999

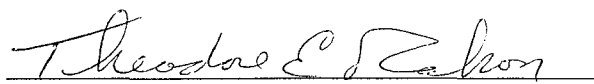
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1.0 INTRODUCTION

1.1 Site Description

The former Lux Clock Company building in Waterbury, Ct. is a 4-story, 160,000 sq.ft industrial building recently used for metal working by Moll Industries, Inc. The building is of brick construction and has a combination of concrete slab and aged wood plank flooring. A portion of the 3rd floor has been converted to a modern office area. Loading docks exist on both ends of the building. Several stair wells and freight elevators allow access to the 4 floors.

The Lux Clock Company had conducted a clock-making operation in the building during the 1920-40 era including some radium dial painting. Moll Industries, the present owner, has not used radioactive materials in their operation.

A radiation survey was conducted by the Connecticut DEP and the US Dept. of Energy on April 3, 1998 during which a few spots of elevated radioactivity were found.

1.2 Identity of Contaminants

The contaminant of interest is radium-226 used in radioluminous paint.

1.3 Objective

The objectives of the survey are to:

1. identify the location and extent of contamination
2. provide a decontamination cost estimate
3. perform limited tests for the presence of airborne radon and long-lived alpha radioactivity for health & safety purposes
4. confirm that the lower 3 floors are not contaminated and thus conclude that recently staged equipment there would also not be contaminated

1.4 Site Conditions At Time Of Survey

The survey was conducted on May 10 and 13, 1999. No manufacturing was being conducted at that time. A work crew was continuing to remove miscellaneous industrial equipment from the bottom two floors during the survey.

The Ct DEP had identified 3 spots of elevated radioactivity on the 4th floor as well as areas of slightly elevated gamma readings on the 3rd floor.

2.0 REGULATORY LIMITS

In the past, contamination limits for floors, walls and other fixtures for release to the general public have been given by USNRC Regulatory Guide 1.86:

Removable contamination:

20 dpm/100 sq.cm Ra-226

Total (fixed+removable) contamination:

100 dpm/100 sq.cm Ra-226 average over any 1 square meter area

300 dpm/100 sq.cm Ra-226 maximum on any 100 sq. cm area

However, new dose-based, or risk-based, site specific assessments are now required. Prospective doses estimated from residual contamination levels must be less than 15 mrem/yr. Compliance with the prospective dose limit must be estimated using computer codes input with residual contamination data, expected occupancy factors, estimated disturbance of residual contamination, resuspension factors, etc. Note that there is little direct correlation of meter readings with the 15 mrem.yr limit.

3.0 METHODOLOGY

3.1 Measurements

Measurements performed included:

- a. Gamma scans using a gamma scintillator: All 4 floors were scanned in an attempt to locate areas of gross contamination or bulk sources of radium. These scans were found to be insufficient to detect small specks of radium-bearing paint.
- b. Beta scans using 100 and 400 cm² gas proportional probes set for beta detection: The scan coverage included all windows sills, radiators and walls where paint may have been dripped as well as 100% of the floor area of the 4th floor and 10 to 50% of floor area of the 1st to 3rd floors. Floor areas uncovered after large pieces of equipment were recently removed also received 100% scans. The gas proportional beta scans proved to be very effective in locating small specks of radium-bearing paint.
- c. Direct alpha measurements: Locations exhibiting elevated beta levels were further investigated using a gas proportional probe set for alpha radiation detection.
- d. Wipe tests: 60 wipe tests of floors, walls and fixtures were collected and analyzed for gross beta and gross alpha radioactivity. Locations of wipe tests were subjectively chosen by the supervisor based on meter readings and on the supervisor's judgment as to the potential for contamination due to process locations, foot tracking, and other factors.

- e. 16 radon measurements were performed using passive diffusion charcoal canisters (4 canisters on each floor).
- f. 8 general area air samples were collected and analyzed for gross alpha/beta radioactivity (2 on each floor).

3.2 Instrumentation

Instruments used follow:

Meter	Serial #	Probe	Serial #	Calibration Date
Ludlum Model 3	83924	44-2 NaI Scintillator	011111	1/21/99
Ludlum Model 12	83334	43-68 Gas Prop.	140512	1/13/99
Ludlum Model 2350	105641	239-1F Gas Prop.	148949	5/11/98
Gast Model V191 Air Pump	0392	N/A	N/A	5/6/99
Eberline-Gast Model V138 Air Pump	1804	N/A	N/A	5/6/99

Wipe tests were analyzed using a Wallac Model 1415 alpha-beta liquid scintillation counter at CoPhysics Corporation. Air samples were analyzed in a Canberra Model 1404F Gas Proportional Counter. Standards used are traceable to the National Institute of Standards and Technology.

Radon measurements were conducted with passive diffusion charcoal canisters supplied and analyzed by Radon Testing Corp. of America in Elmsford, NY.

4.0 RESULTS

Locations of samples collected are shown in Figure 1. Areas of elevated radioactivity are shown in Figure 2. A discussion of specific measurements performed follow:

4.1 Gamma Readings

All gamma readings on the 1st and 2nd floors were at normal background levels. Elevated gamma readings on the 3rd and 4th floors found by the Ct DEP were confirmed during this survey.

4.2 Beta Readings

All beta readings on the 1st and 2nd floors were at normal background levels - no radium contamination was found.

Approximately 50 spots of beta radioactivity were found on the 4th floor in the general area of the 3 spots identified by the Ct DEP survey. These spots ranged from 10,000 to 100,000 dpm gross beta and each were less than 100 sq.cm in floor area. Normally, such contamination from radium dial painting shops exists as small radium paint flecks. Readings indicated that the spots consisted of such paint flecks trapped in between floor boards. One spot was further investigated by removing a floor board. Measurements and observations under the board showed that the contamination was indeed in the vertical crack between boards and not under the board. All spots found exceeded Reg Guide 1.86 limits and should be remediated. The spots were identified on the floor with white paint.

On the 3rd floor, 3 spots of slightly elevated activity were found near elevated gamma readings found by the Ct DEP. These spots were barely above background and may have been shielded by overlaying dirt or wood. These spots should be remediated also.

4.3 Alpha Readings

Most of the beta hot spots on the 4th floor showed no alpha readings thus indicating that the radium paint flecks were lodged in the floor cracks and were covered by a layer of clean dirt. A few spots showed up to 5000 dpm alpha.

4.4 Wipe Tests

No significant removable alpha contamination was detected in any of the 60 wipe tests collected, including wipe tests of hot spots. A few wipes showed a small amount of beta radioactivity, just over background but well within guidelines. The results are shown in Appendix A.

4.5 Air Samples

All 8 air samples showed no significant airborne radioactivity. The results are shown in Appendix B.

4.6 Radon Measurements

All 16 radon measurements showed radon-222 levels less than or equal to 0.5 pCi/l, well within the 4 pCi/l EPA guideline for homes. The results are shown in Appendix C.

5.0 RECOMMENDATIONS

The spots of contamination found on the 4th floor as well as the suspected spots on the 3rd floor should be remediated. A shrouded router or circular saw coupled to a HEPA vacuum should be able to remove most of the residual radium-bearing paint from the floor cracks. Some floor boards may have to be lifted if the radium paint flecks had worked down under the boards.

Decontamination personnel should wear protective clothing and respiratory protection during any such potential dust-producing operation. The operation should be performed under a licensed or specifically-approved radiation safety plan.

A confirmatory survey should be conducted after remediation. The 2 designated remediation areas (shown in Figure 2) are the east side of the 4th floor and the mid to west side of the 3rd floor. Survey activities should include:

- ♦ beta scans of 100% of the designated floor area and horizontal surfaces such as window sills;
- ♦ 13 fixed alpha and beta measurements in each of the designated floor areas; and
- ♦ 9 measurements for removable alpha and beta radioactivity (wipe tests) in each of the designated floor areas

The exact number and locations of fixed and removable measurements should be determined by the methodology presented in MARSSIM (Multi-Agency Radiation Survey and Site Investigation Manual, NUREG-1575, EPA402-R-97-016).

The 1st and 2nd floors, the east and west portions of the 3rd floor, and the west side of the 4th floor can be considered unaffected based on readings conducted in this survey and the 1998 survey by the Ct DEP and the US DOE. Thus, no further measurements in these areas are necessary.

Because the radioactivity found was isolated within the floor boards and no loose surface contamination was found, it is reasonable to conclude that Moll Industries' metal working equipment would be free of radium contamination. The equipment was brought in to the building long after radium dial painting had ceased. The only items that would potentially be contaminated would be the tables and chairs used by the radium dial painters. No evidence of the presence of such items was found during the survey.

Figure 1 - Sample Locations

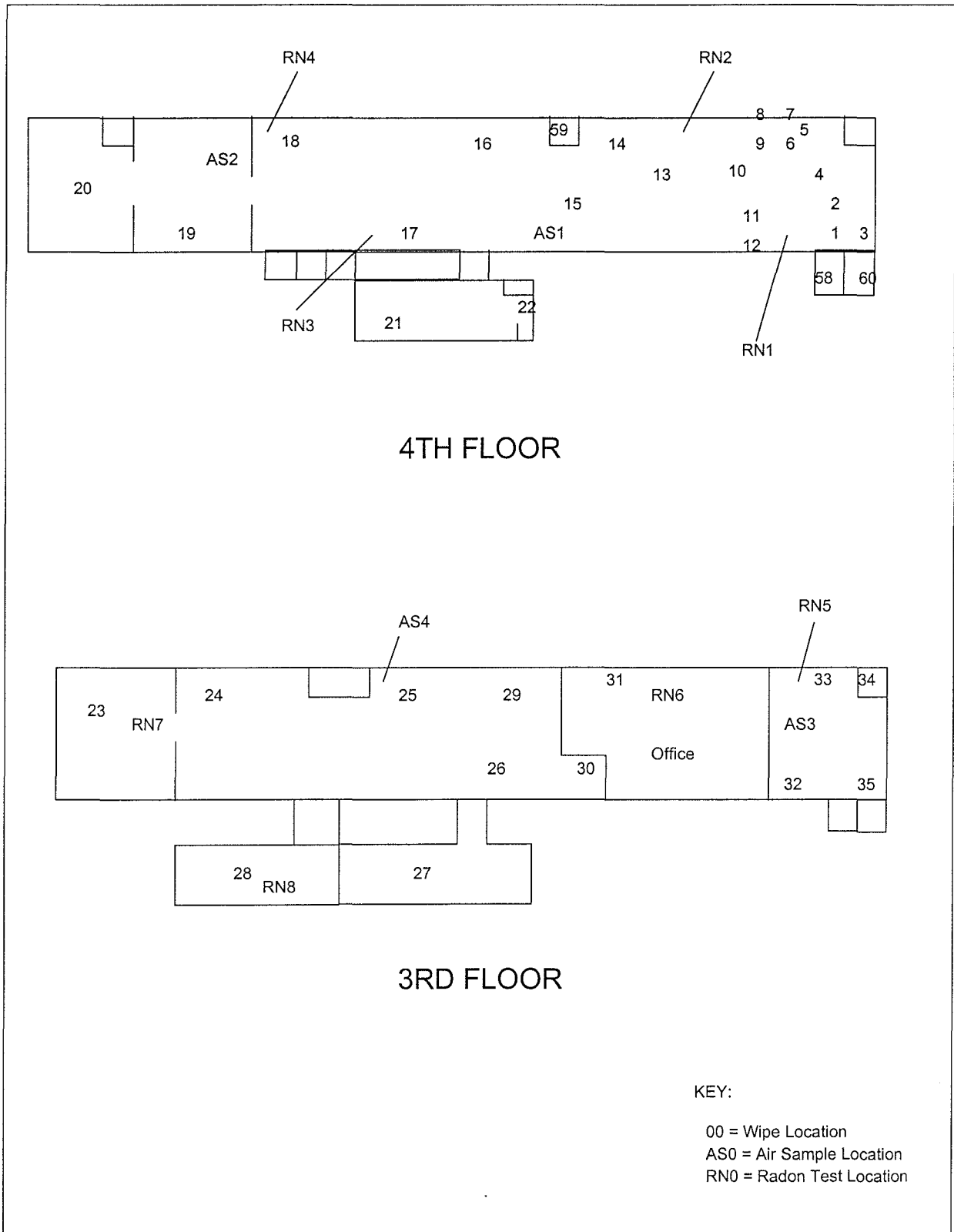


Figure 1a - Sample Locations (continued)

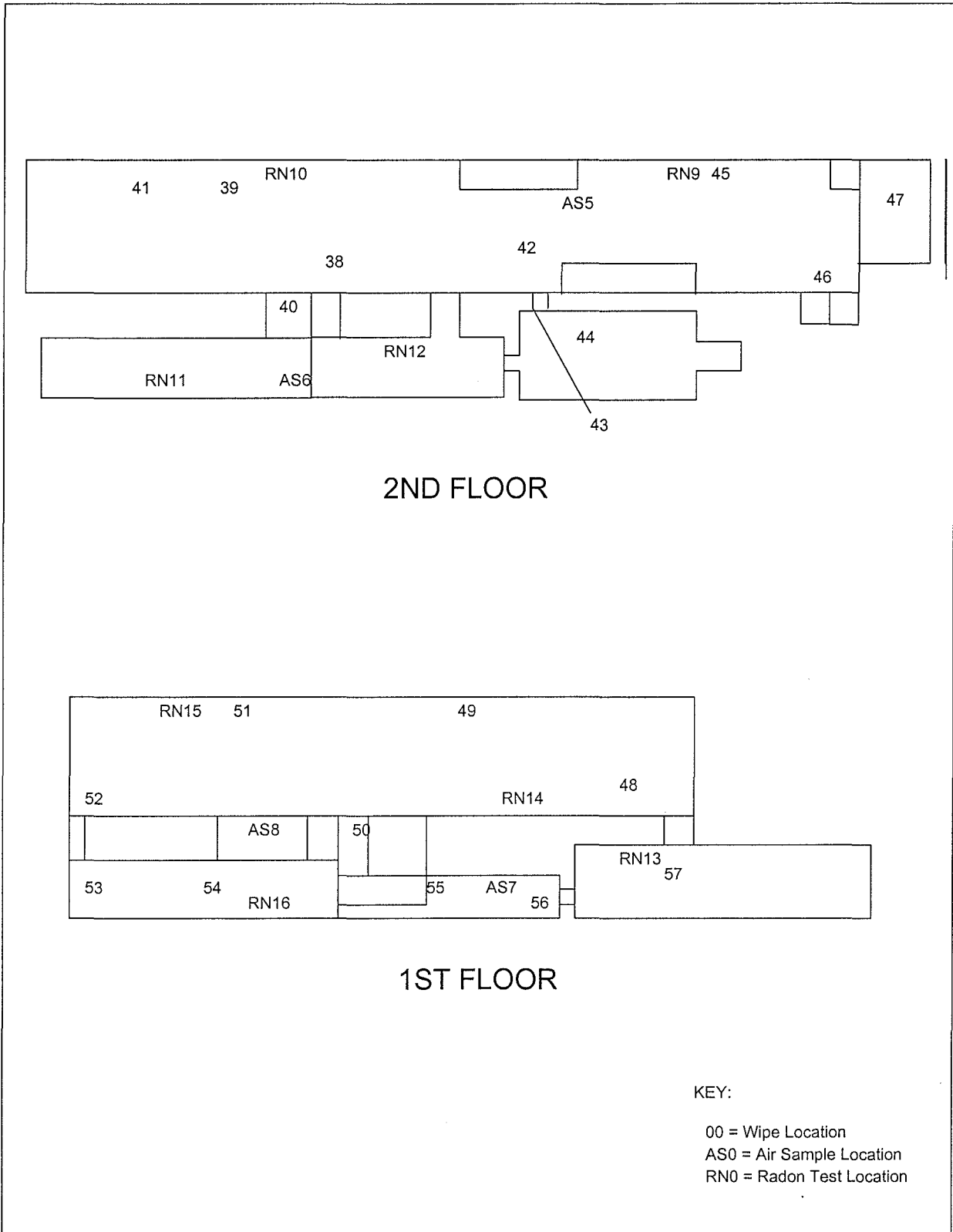
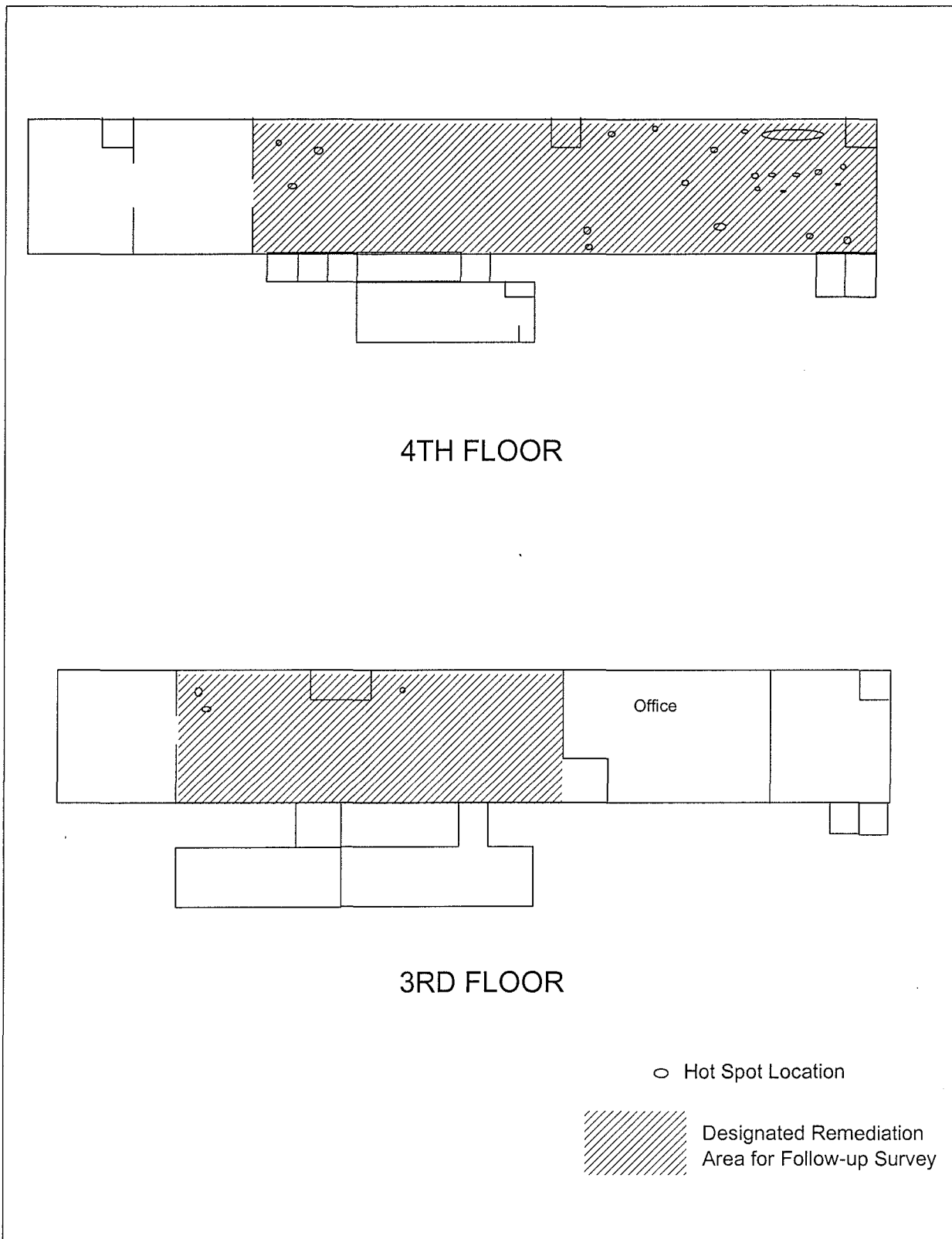


Figure 2 - Approximate Locations of Elevated Beta Readings



Appendix A - Wipe Test Results

RADIOANALYTICAL RESULTS

Client: Moll Industries / ERM
 Date Collected: 5/10/98
 Date Analyzed: 5/12/99

Type: Wipe Tests (Swabs)
 Counting Time: 5 min.
 Method: Alpha/Beta LSC

Sample	Gross Alpha (dpm ± 1s)	Gross Beta (dpm ± 1s)	Floor	Description
1	3.6 ± 2.7	20.2 ± 7.1	4	Hot Spot
2	1.5 ± 1.9	24.8 ± 7.5	4	Hot Spot
3	1.5 ± 1.9	15.4 ± 6.5	4	Entry Floor
4	-0.6 ± 0.4	9.1 ± 5.6	4	General Floor
5	1.5 ± 1.9	32.1 ± 8.3	4	Hot Spot
6	1.5 ± 1.9	15.4 ± 6.5	4	Hot Spot
7	1.5 ± 1.9	15.4 ± 6.4	4	Window Sill
8	2.5 ± 2.2	1.7 ± 4.4	4	Window Sill
9	2.5 ± 2.3	9.1 ± 5.6	4	Hot Spot
10	0.4 ± 1.4	8.0 ± 5.5	4	Hot Spot (under board)
11	0.4 ± 1.3	-0.4 ± 4.0	4	Hot Spot
12	1.5 ± 1.9	1.7 ± 4.4	4	Window Sill
13	0.4 ± 1.3	3.8 ± 4.8	4	General Floor
14	1.5 ± 1.9	3.8 ± 4.8	4	General Floor
15	3.6 ± 2.7	5.9 ± 5.2	4	General Floor
16	2.6 ± 2.4	7.0 ± 5.5	4	General Floor
17	1.5 ± 2.0	8.0 ± 5.6	4	General Floor
18	5.7 ± 3.3	33.2 ± 8.5	4	General Floor
19	0.4 ± 1.3	14.3 ± 6.3	4	General Floor
20	2.5 ± 2.3	8.1 ± 5.5	4	General Floor
21	0.4 ± 1.3	0.7 ± 4.3	4	General Floor
22	2.5 ± 2.3	10.1 ± 5.8	4	General Floor
23	-0.6 ± 0.4	11.1 ± 5.9	3	General Floor
24	0.4 ± 1.3	11.1 ± 5.9	3	General Floor
25	-0.6 ± 0.4	14.3 ± 6.3	3	General Floor
26	0.4 ± 1.4	-0.4 ± 4.1	3	General Floor
27	2.5 ± 2.3	8.0 ± 5.5	3	General Floor
28	0.4 ± 1.4	9.1 ± 5.7	3	General Floor
29	0.4 ± 1.4	-0.4 ± 4.1	3	General Floor
30	1.5 ± 1.9	5.9 ± 5.1	3	Office-Warehouse Door - Floor
31	3.6 ± 2.7	11.1 ± 5.9	3	Front Entrance Floor
32	1.5 ± 1.9	22.8 ± 7.4	3	General Floor
33	1.5 ± 1.9	16.5 ± 6.6	3	General Floor
34	4.7 ± 3.0	9.1 ± 5.7	3	Elevator floor
35	0.4 ± 1.4	13.3 ± 6.4	3	Entry Floor
36	4.7 ± 3.0	14.3 ± 6.4	4	Rest Room Floor - Women
37	4.6 ± 3.0	-0.7 ± 4.1	4	Rest Room Floor - Men
38	-0.6 ± 0.4	4.8 ± 5.0	2	General Floor
39	2.6 ± 2.4	12.2 ± 6.1	2	General Floor
40	-0.6 ± 0.4	0.7 ± 4.2	2	Elevator floor

Sample	Gross Alpha (dpm \pm 1s)	Gross Beta (dpm \pm 1s)	Floor	Description
41	1.5 \pm 1.9	4.8 \pm 5.0	2	General Floor - Cafeteria
42	0.4 \pm 1.4	5.9 \pm 5.2	2	General Floor
43	1.5 \pm 1.9	3.8 \pm 4.8	2	Elevator floor
44	-0.6 \pm 0.4	7.0 \pm 5.3	2	General Floor
45	0.4 \pm 1.3	7.0 \pm 5.3	2	General Floor
46	2.5 \pm 2.3	8.1 \pm 5.5	2	General Floor
47	1.5 \pm 1.9	0.7 \pm 4.3	2	General Floor
48	-0.6 \pm 0.4	1.7 \pm 4.5	1	General Floor
49	-0.6 \pm 0.5	2.7 \pm 4.7	1	General Floor
50	0.4 \pm 1.4	4.8 \pm 5.0	1	Stairwell Floor
51	-0.6 \pm 0.4	5.9 \pm 5.2	1	General Floor
52	-0.6 \pm 0.4	-1.4 \pm 3.9	1	General Floor
53	1.5 \pm 1.9	2.7 \pm 4.6	1	General Floor & Drain
54	-0.6 \pm 0.4	-1.4 \pm 3.8	1	General Floor
55	-0.6 \pm 0.4	-3.7 \pm 3.3	1	General Floor
56	1.5 \pm 1.9	2.7 \pm 4.6	1	General Floor
57	0.4 \pm 1.3	1.7 \pm 4.4	1	General Floor
58	0.4 \pm 1.3	0.7 \pm 4.2	4	Rest Room Floor
59	2.6 \pm 2.3	1.7 \pm 4.5	4	Stair Landing - Top
60	0.4 \pm 1.3	-3.5 \pm 3.3	4	Stair Landing - Mid
MDA's:	2.0	7.8	Minimum Detectable Activity	

Uncertainties are 1-sigma counting, quench correction, and energy region separation errors.

Standards are traceable to the National Institute of Standards and Technology.

Radioactive Materials License: NYS 2691-3949

Appendix B - Air Sample Results

CoPhysics Corporation
 1242 Route 208
 Monroe, NY 10950
 Tel: 914-783-4402 Fax: 914-783-7191
 www.cophysics.com

RADIOANALYTICAL RESULTS

Client: Moll Industries / ERM
 Date Analyzed: 5/19/99

Type: Air Samples

Sample	Floor	Gross Alpha (dpm ± 1 sig)	Gross Beta (dpm ± 1 sig)	lpm	Date	Start	End	liters	Air Concentration	
									Gross Alpha (uCi/ml)	Gross Beta (uCi/ml)
AS1	4	-2 ± 1	3 ± 2	19.0	5/10/99	10:20	14:55	5225	< 1.0E-13	< 3.3E-13
AS2	4	-1 ± 1	0 ± 2	3.9	5/10/99	10:44	15:05	1018	< 5.2E-13	< 1.7E-12
AS3	3	-1 ± 1	0 ± 2	19.0	5/10/99	15:00	18:05	3515	< 1.5E-13	< 4.9E-13
AS4	3	2 ± 2	2 ± 2	3.9	5/10/99	15:12	18:05	675	< 7.9E-13	< 2.6E-12
AS5	2	1 ± 2	4 ± 2	3.9	5/13/99	9:38	13:36	928	< 5.7E-13	< 1.9E-12
AS6	2	0 ± 2	2 ± 2	19.0	5/13/99	9:40	13:44	4636	< 1.1E-13	< 3.8E-13
AS7	1	0 ± 2	5 ± 2	3.9	5/13/99	13:39	17:35	920	< 5.8E-13	< 1.9E-12
AS8	1	-1 ± 1	0 ± 2	19.0	5/13/99	13:43	17:38	4465	< 1.2E-13	< 3.9E-13
MDA's		1.2	3.9	Minimum Detectable Activity						

Method: Gas Proportional Counting using a Canberra Model 2404F Alpha/Beta Counting System (Serial # 790347)

Uncertainties are 1-sigma counting errors.

Alpha standard radionuclide: Pu-239

Beta standard radionuclide: Sr/Y-90

Standards are traceable to the National Institute of Standards and Technology.

Radioactive Materials License: NYS 2691-3949

Appendix C - Radon Test Results

Site Radon Inspection Report

Date: May 17, 1999

Mr. Ted Rahon
COPHYSIC CORP.
1242 Route 208
Monroe, NY 10950

-----> Client:
Test Location: Moll Inc.

Individual Canister Results:

RN
14 Radon Level : 0.4 pCi/L Location : 1ST FLOOR
Canister ID # : 3290007 Test Start : 05/10/99 @ 10:30
Canister Type : PASS-DIF-4 Test Stop : 05/13/99 @ 12:00

RN
16 Radon Level : 0.2 pCi/L Location : 1ST FLOOR
Canister ID # : 3290196 Test Start : 05/10/99 @ 11:45
Canister Type : PASS-DIF-4 Test Stop : 05/13/99 @ 12:00

RN
13 Radon Level : 0.5 pCi/L Location : 1ST FLOOR
Canister ID # : 3290197 Test Start : 05/10/99 @ 11:30
Canister Type : PASS-DIF-4 Test Stop : 05/13/99 @ 12:00

RN
15 Radon Level : 0.4 pCi/L Location : 1ST FLOOR
Canister ID # : 3290382 Test Start : 05/10/99 @ 12:30
Canister Type : PASS-DIF-4 Test Stop : 05/13/99 @ 12:00

RN
9 Radon Level : 0.4 pCi/L Location : 2ND FLOOR
Canister ID # : 3290004 Test Start : 05/10/99 @ 10:30
Canister Type : PASS-DIF-4 Test Stop : 05/13/99 @ 10:45



RN
10

Radon Level : 0.2 pCi/L Location : 2ND FLOOR
 Canister ID # : 3290093 Test Start : 05/10/99 @ 11:30
 Canister Type : PASS-DIF-4 Test Stop : 05/13/99 @ 10:45

RN
12

Radon Level : 0.2 pCi/L Location : 2ND FLOOR
 Canister ID # : 3290186 Test Start : 05/10/99 @ 11:30
 Canister Type : PASS-DIF-4 Test Stop : 05/13/99 @ 10:45

RN
5

Radon Level : 0.5 pCi/L Location : ^{3RD}~~2ND~~ FLOOR
 Canister ID # : 3290223 Test Start : 05/10/99 @ 10:30
 Canister Type : PASS-DIF-4 Test Stop : 05/13/99 @ 12:00

RN
6

Radon Level : 0.3 pCi/L Location : 3RD FLOOR
 Canister ID # : 3290189 Test Start : 05/10/99 @ 10:30
 Canister Type : PASS-DIF-4 Test Stop : 05/13/99 @ 12:00

RN
8

Radon Level : 0.2 pCi/L Location : 3RD FLOOR
 Canister ID # : 3290200 Test Start : 05/10/99 @ 10:45
 Canister Type : PASS-DIF-4 Test Stop : 05/13/99 @ 12:00

RN
11

Radon Level : 0.1 pCi/L Location : ^{2ND}~~3RD~~ FLOOR
 Canister ID # : 3290386 Test Start : 05/10/99 @ 10:30
 Canister Type : PASS-DIF-4 Test Stop : 05/13/99 @ 10:45



RN
7 Radon Level : 0.1 pCi/L Location : 3RD FLOOR
Canister ID # : 3290391 Test Start : 05/10/99 @ 10:30
Canister Type : PASS-DIF-4 Test Stop : 05/13/99 @ 12:00

RN
3 Radon Level : 0.3 pCi/L Location : ~~OTHER~~ *4TH FLOOR*
Canister ID # : 3276001 Test Start : 05/10/99 @ 10:30
Canister Type : PASS-DIF-4 Test Stop : 05/13/99 @ 11:00

RN
1 Radon Level : 0.4 pCi/L Location : ~~OTHER~~ *4TH FLOOR*
Canister ID # : 3276275 Test Start : 05/10/99 @ 10:30
Canister Type : PASS-DIF-4 Test Stop : 05/13/99 @ 11:30

RN
2 Radon Level : 0.5 pCi/L Location : ~~OTHER~~ *4TH FLOOR*
Canister ID # : 3276280 Test Start : 05/10/99 @ 10:30
Canister Type : PASS-DIF-4 Test Stop : 05/13/99 @ 11:00

RN
4 Radon Level : 0.2 pCi/L Location : 4TH FLOOR
Canister ID # : 3290192 Test Start : 05/10/99 @ 10:30
Canister Type : PASS-DIF-4 Test Stop : 05/13/99 @ 11:00

The reported results indicate that radon levels in your home are below the United States Environmental Protection Agency (EPA) action level of 4.0 picoCuries per liter of air (pCi/L). Since radon levels can vary significantly from season to season it is advisable to conduct at least one short-term test during the winter heating season, if you have not done so already. The EPA recommends retesting if your living patterns change and you begin occupying a lower level of your home, such as a basement.

General radon information may be obtained by consulting the EPA booklet: A Citizen's Guide To Radon (EPA Document #402-K92-001, 2nd Ed., May 1992). To request a copy, please contact your state health department. New York State residents may contact the health department at 800-458-1158, ext. 451.



New Dose Model Selection Assessment

Group	Area of Evaluation	Raw	Raw	Weighting	Weighted	Weighted	Comments
		Score	Score				
		RD5	MIDAS	Factor	RD5 SCORE	MIDAS SCORE	
Chem / RES	Ease of Use	9	6	5	45	30	Midas complexity requires coninued familiarization
EP / RES	Meets NRC Requirements	8	10	5	40	50	RD5 does not come with skin dose calculations
IT	Meets IT Standards	7	7	3	21	21	Midas is not proven in VB/Windows environment
RES	Basis / QA Documentation	9	10	4	36	40	Midas claims they are App b compliant
EP	Graphical Output Quality	5	9	3	15	27	Midas busy, RD5 has not proven isopleths
RES	Radiological Capabilities	7	9	3	21	27	Unlimited nuclides, many dose componenets
ENV	Meteorological Capabilities	5	7	3	15	21	RD5 requires 15 min averaged data
RES	Comparison with RASCAL	7	8	3	21	24	
EP	User Satisfaction	9	4	4	36	16	Midas users dissatisfied with company responsiveness and product comitment
Chem/RES	Addresses Optional Capabilities	3	7	3	9	21	Midas has more of the optional items built in
RES	Addresses Ingestion Pathway	0	6	2	0	12	RD5 does not address ingestion, midas preicts footpring and calcs field samples
RDAC	Confidence in vender ability to deliver	5	8	4	20	32	Fort Calhoun had problems with getting Midas on-line, VB work not done yet, RD5 graphics not done yet.
	Overall Assessment				279	321	