Isolating The Living Space From Fungi and Gases In The Soil and Foundation

<u>Prepared for</u>:

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ISOLATING THE LIVING SPACE FROM FUNGI AND GASES IN THE SOIL AND FOUNDATION: A PILOT RETROFIT

Report to: Housing Technology Incentives Program, CMHC
from: Scanada Consultants Limited, Ottawa, 31 March 1990

(Final report 31 August 1990: IAQ test results received and incorporated)

Fig. 1 The Pilot Case

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INTRODUCTION

A portion of the outdoor air supply to a house may enter by way of the surrounding soil. That portion may increase (relatively) in houses built or retrofitted to be more nearly airtight. The "soil gases" entrained in that flow can be most undesirable. Thus a portion of what is thought to be safe "fresh air" may be anything but.

While the complete elimination of soil gas entry appears to be a practicable goal in new construction, it is not so readily achievable at reasonable cost in existing houses. Considerable efforts to restrict such entry may be justified, however, in existing houses where gas entry is linked to real problems: clearly excessive radon, for example, or methane, or simply the transfer of fungal spores into the indoor air from the soil or the foundation itself.

As briefly reviewed in the next section, there are now a few distinct approaches to keeping soil gases out of the indoor air, and these are more or less tailorable to existing houses. One Ottawa case was brought forward in 1988 in which fungal-related health problems appeared to be linked to the rubble stone foundations - and perhaps the soil outside - and seemed serious enough to call for considerable retrofit to restrict the entry of soil gases, gas-borne spores and surface spores into the indoor air.

In the project now reported, the original objective was to develop and demonstrate a practicable interior retrofit "system" that isolates the indoor air rather completely from both the foundation and the soil, thereby rendering the indoor air of this Ottawa case acceptably free of fungal spores. The further object was to consider how such an approach can apply to the more general case. As will be seen, the objective itself had to be tailored substantially to the circumstances.

BACKGROUND

Isolation of an existing house from the ground can be attempted in several ways:

i) Airtighten the basement envelope below grade, indoors, or line it with an air tight liner.

ii) Recognizing that airtightness can be very difficult to achieve or maintain, provide a space between such a liner and the basement envelope and vent the space to the outdoors, generally maintaining the space at a lower pressure than that of the indoor air.

iii) Use such a "vented interior jacket" only over the leakier areas - some or all of the basement walls, say - and seal or line the remainder of the basement as in i).

iv) Excavate outside the basement walls and install a liner and insulation/drainage layer to the perimeter drains; seal or line the floor from inside. (The owners had already chosen this approach, but agreed to delay implementation until a presumably lower cost interior approach has been tried in this project.)

v) Isolate the house proper from the basement, sealing off the first floor and air handling paths; if necessary, maintain the basement at a lower pressure than in the house proper.

On first viewing, it was thought that method iii), the "vented wall jacket", could best be applied to handle the Ottawa fungus case, and that was proposed (for trial purposes, pending the homeowner's pursuance of method iv). As will be seen, the first tests and first review of all circumstances led instead to the choice of method v) for trial purposes. A brief note on the basic methods ii) and iii) will serve to show their developmental track and general applicability and will help in explaining how the Ottawa case was redirected.

The "vented interior jacket" method

Today's materials and techniques make it practicable to form a nearly airtight membrane inboard of existing foundations; the provision of a vent-depressurized airspace between the membrane and the foundation can then make the whole work well in isolating indoor space from everything outside the membrane, if leaks from the airspace to the indoors and the outdoors are indeed minimal.

In February 1987 Dr. David Eyre of the Saskatchewan Research Council delivered a monograph on his depressurized buffer idea to Scanada, as a subcontractor on EMR's project "Avoiding moisture problems when retrofitting Canadian houses to conserve energy". Circulated then within EMR, Dr. Eyre's concept was next simplified by Scanada and proposed as an Unsolicited Proposal to Supply and Services Canada on 27 January 1988, still aimed directly at the retrofit of existing houses but with more emphasis on its ability to bar soil gases and radon, not just moisture. As a reviewer of the UP, CMHC suggested that the idea be brought forward to the Housing Technology Incentives Program as an immediately promising solution for the subject Ottawa fungus case, and perhaps as a test and demonstration of wider potentials.

THE HOUSE "AS FOUND": THE NEED TO REVISE THE ISOLATION METHOD

The job addressed here was to retrofit the subject house in Ottawa to free the air of fungal spores; the spores had been implicated by others as affecting the health of at least one householder. The house is a 1920's 2-1/2 storey frame/brick veneer construction with 195 sq. m. floor area and a rubblework basement about 80 sq. m. in plan (Figure 1, cover). The latter appeared to be the home of essentially all the fungus. Part of the second storey and all of the third is divided off as a second dwelling unit with its own interior stairway and exit at grade. The undivided basement underlies the whole, and the gas warm air heating system (converted from oil) serves both: the house envelope contains just one indoor air volume common to both dwelling units.

Prior to this project, an initial viewing had found that a) the fungus appeared to cover much of the south and west walls and some of the north wall of the basement; b) the fungus appeared to be somewhat within as well as on the surface of the these rubble walls; c) the walls appeared air-leaky to the soil, d) much of the wall area could be cleared for access, although extensive floor-to-ceiling shelving would have to be removed, a west wall oil tank would have to be removed or "contained" in the jacket (the tank is no longer used) and the furnace room on the north wall would have to be isolated. Further, the occupants at that time were willing, if not eager, to undertake such a disruptive process. Therefore the project was <u>initially</u> proposed to:

a) Characterize the house "as now" (spore counts, types, fungi locations, airtightness characteristics...)

b) Design & install the "vented wall jacket".

c) Characterize the house "as retrofitted", as above. (The spores themselves would, it was hoped, serve as a "tracer gas" to show the before-and-after status)

d) Monitor through the winter in two operational modes, again checking the spore counts and other indicators:

i) jacket mechanically exhaust-vented,

ii) jacket passively exhaust-vented.

The interval between the initial proposal and contracting stretched to several months (perhaps largely due to niggling questions about "ownership" of the vented jacket idea). There were considerable changes made in that period:

- The householder treated the fungus area surfaces with fungicide, sealed return air ducting to a degree, began continuous exhaust venting of the basement, and cut open the perimeter of the "fire ceiling" of the basement to allow inspection and sealing of the header zone.

- Noting considerable improvement (in all but the occasional seepage of water from outdoors), and appreciating the fact that the "interior jacket" approach should be considered as experimental in nature, the householder decided to accept the house owner's suggestion of proceeding with method v), i.e.: excavate and install an exterior liner/insulation-drainage layer around the basement walls. (This house is accessible outdoors around essentially all of its perimeter.) Understandably, the householder was no longer keen to rip down his shelving and so on to allow the jacket trial, although he remained open to helping demonstrate the concept of basement isolation as at least a temporary trial.

A further element was now added to support a change of plan: The first full tests of the house revealed:

- extremely little air leakage below grade through walls or floor (fan test with smoke pencil; four small wall leaks were close to grade and the air smelled of outdoors only, as if the paths were up through the rubble stone and not through the soil);

(Since interconnecting holes and paths were seen to extend into - and apparently through - the rubble stone, it follows that the clay soil itself is acting as an essentially airtight barrier. Recent tests for CMHC are showing that clays, silty clays and even damp silty sands may indeed act as air barriers, allowing very little "soil gas" entry.)

- a dry, airleaky house, readily amenable to maintenance of good air quality if the basement moisture and fungal growth were well controlled. Formaldehyde and other indicators were found to be at typical levels, i.e. very low. So, at least at this point, were the fungal spore counts.

- the first floor and heating ducting provided a remarkably free circuit between basement and upstairs. Tracer gas analysis, simultaneously in both zones, showed the basement tracer conveyed directly upstairs without even diffusing through the basement.

The test results are appended, Appendix 1.

The question not answered in this first testing was in regard to the extent of fungal growth within the rubble stone wall itself. In any case, the decision was made to alter the isolation design as follows.

REVISED APPROACH

Where rubble basements, or others such as brick or concrete block with porous, chambered walls, are damp or fungus-laden both superficially and within the walls, the essential problem may be to isolate the indoor air from the walls, not just from the soil. If the basement is cluttered with stored goods and fixed shelving (or if the household prefers to use it simply as an unheated cellar) then the solution may be to seal off the house from the basement at the first floor. That solution may fit a good number of houses; it fits the Ottawa fungus case well as a relatively non-disruptive trial solution.

The Ottawa case was especially amenable to this approach: with two households above the basement, a fire-resistant gypsum drywall ceiling had been installed across the underside of the first floor, as some jurisdictions call for. This had been done tokenly, but was completed under much of the return ducting, and some of the supply ducting, and was more or less ready for final bulkheading and sealing in several of such key areas. The fire ceiling had always been incomplete at the perimeter header, and had already been cut back more in that zone, by the householder, to allow inspection and attempts at header insulation and sealing. The (comprehensive sealing undertaken in this project serves to complete the important gas-seal integrity of this ceiling, which is important for fire safety performance. For full fire barrier purposes - which the ceiling never fulfilled - all sealed areas could be plastered or clad appropriately.)

Figure 1 is a photograph of the house. Figure 2 illustrates the barrier procedure followed in this case. CanAm Air Leakage Control undertook all the perimeter sealing and other gap filling/bulkheading to complete the ceiling plane as shown. The duct chase was also sealed off at the furnace room. All air leaks through the foundation above grade, and the few found just below, were also located by fan depressurization/smoke pencil and plugged with polyurethane. The householder sealed the stairway walls and weatherstripped the basement door.

It can be seen that the junction line of the rubblework with the brick/header/subfloor/sole plate planes could not be reached by the urethane to known and full effect; basement air can migrate through the rubble, up into the first floor walls or into the gaps between the floorboards, and thence into the room air above. However, that would be the case with the jacket retrofit as well, unless its "buffer" space were depressurized - which is exactly the case with the floor plane seal: the basement should be exhaust-depressurized with respect to the upstairs air if complete isolation is desired. The general airtightening of the basement - not just the first floor - may make it practicable to vent-depressurize it with just the 75 cfm fan that the householder had already installed.

The furnace is enclosed in its own room, with a fire door and token fire resistance lining around much of the room. For various reasons the room was not made airtight, so the largest pathway from basement area to upstairs is still by way of the return air side of the furnace itself. The householder has installed a makeup air opening of 150 mm diameter to the outdoors.

RESULTS

Testing of the house and sealed floor plane is reported in Appendix 2:

- airtightness: floor barrier
  basement alone
- soil gas volatile organic compounds (VOC's)
- basement air voc's
- fungus in soil gas
  basement
  upstairs

As before, no contaminants were found at worrisome concentrations. (However, the validity of fungal test procedure is suspect, as noted in the appendix.)

Isolation of upstairs from cellar now seems relatively complete. The floor plane barrier, including furnace pathways, now has an ELA of about 421 cm^2. Most of this remaining opening is probably into the return side of the furnace. The floor plane alone probably had an ELA of 1500 cm^2 or more before sealing (but much of that would have been as freely open to the attic and outdoors as it was open to the house indoor space above).

The basement alone - excluding the furnace and the first floor - is now very tight, with an ELA of about 421 cm^2. The below-grade portion has always been essentially airtight due to the clay soil. Soil gases as such have probably never had much of a role in the indoor conditions of this house.

DISCUSSION AND CONCLUSIONS

The option of isolating the house proper from the basement is a practicable one, even with a warm air heating system. The furnace should perhaps be isolated in its own vented room, but, even without that, the completion of the floor barrier plane below all ducting (as here done), with some further attention to the return air side of the furnace/plenum itself, seems able to provide good separation of basement from upstairs. Where needed, slight depressurization of the basement can then ensure no air movement from it or the soil to the house above.

The floor seal job here used the remnant of a fire ceiling because it was there and should be made good in any case. In most houses, the procedure would be to install polyethylene film across the basement under all ducts, joists and beams, and seal it around posts and to the perimeter header. This would be an easier and cheaper job than what was done here. With rubble or concrete block walls, the perimeter would also have to be capped, probably with urethane foam much as done here. A typical basement of $100m^2$ might entail about $1500 to seal the floor plane/ducting completely, or about $2200 ($700 extra) if polyurethane were needed to cap the foundation and seal to the perimeter. Stored materials and wall built-ins do not interfere seriously with the job of separating basement from upstairs at the first floor plane.

Where the basement space must be used by occupants with allergies seriously affected by below-grade contaminants, the contaminants must be removed or isolated. If they are related to dampness, fungi or possibly soil gases, then a) the basement must be cleared out and effectively lined or b) the walls must be dug clear on the outside and insulated/drained/barriered and the floor made good.

Scanada Consultants Limited

Project: 58910	Appendix 2	By: REP / Date: 31 Aug 1990	Page 1 of 1
Job. No.: 58910	Job Title: HTIP ISOLATE FUNGUS CELLAR		

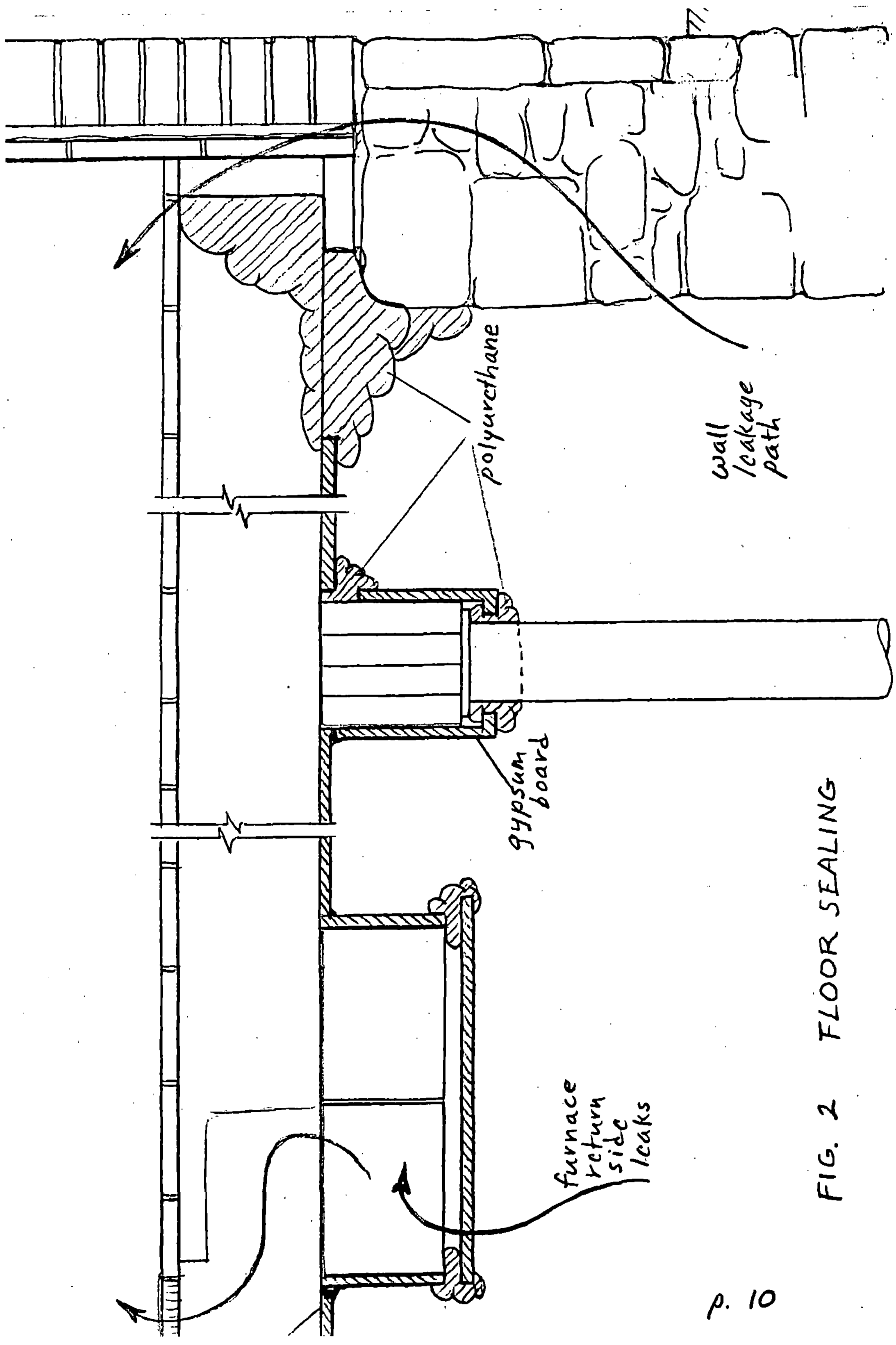

FIG. 2 FLOOR SEALING

APPENDIX 1 - THE HOUSE AS FOUND

- Airtightness Test
- Fungal Sampling
- Formaldehyde and Radon
- Tracer Gas Test
- Moisture Analysis
- Householder Survey

#20
Basement Door Closed*

FLUE SEALED

AIRTIGHTNESS TEST RESULTS
(AS PER CAN/CGSB - 149.10 - M86)

#20 CLOSED 8 MAR 89
Ext.Temp. =-12 C Wind Speed = 5 km/h
Envelope Area = 469 m^2 Volume = 685 m^3
Pressure With Fan Sealed - Start:-4 Pa Finish:-4 Pa

PRESS.(Pa) MEAS'D.	ADJ'D.	TI (C)	FLOW(L/S) MEAS'D.	ADJ'D.	FITTED	RELATIVE ERROR(%)
60.0	64.0	17.0	1100.00	1043.58	1020.98	2.17
55.0	59.0	17.0	1005.00	953.45	952.65	0.08
50.0	54.0	17.0	900.00	853.84	883.45	3.47
45.0	49.0	17.0	842.00	798.81	813.29	1.81
40.0	44.0	17.0	790.00	749.48	742.06	0.99
24.0	28.0	17.0	540.00	512.30	504.97	1.43
20.0	24.0	17.0	475.00	450.64	442.85	1.73
15.0	19.0	17.0	379.00	359.56	362.96	0.94

C = 29.5698 n = .851615

E.L.A. = 843.89 cm^2 N.L.A. = 1.799 cm^2/m^2

Q @ 10Pa = 210.12 L/S Q @ 50Pa = 827.40 L/S

Air Change per Hour @ 50Pa = 4.348

SXX= 1.914649E+12 SXY= 1.630544E+12

SYY= 1.396603E+12 SYX= 17.17897

Correlation Coefficient= .9971293

Relative Standard Error = 4.30%

* PFT's etc. run with basement door closed

FLUE SEALED

AIRTIGHTNESS TEST RESULTS
(AS PER CAN/CGSB - 149.10 - M86)

#20 OPEN* 8 MAR 89
Ext.Temp. =-12 C Wind Speed = 5 km/h
Envelope Area = 469 m^2 Volume = 685 m^3
Pressure With Fan Sealed - Start:-4 Pa Finish:-4 Pa

PRESS.(Pa) MEAS'D.	PRESS.(Pa) ADJ'D.	TI (C)	FLOW(L/S) MEAS'D.	FLOW(L/S) ADJ'D.	FLOW(L/S) FITTED	RELATIVE ERROR(%)
60.0	64.0	16.6	1263.00	1199.05	1207.49	0.70
55.0	59.0	16.6	1177.00	1117.40	1132.24	1.33
50.0	54.0	16.5	1129.00	1072.02	1055.64	1.53
45.0	49.0	15.0	1034.00	984.37	977.54	0.69
40.0	44.0	15.0	947.00	901.54	897.76	0.42
35.0	39.0	14.9	861.00	819.81	816.05	0.46
30.0	34.0	14.9	775.00	737.93	732.12	0.79
25.0	29.0	14.9	670.00	637.95	645.56	1.19
18.0	22.0	16.8	553.00	524.82	518.84	1.14
15.0	19.0	16.8	470.00	446.05	462.03	3.58

C = 44.99058 n = .7910408

E.L.A. =1116.82 cm^2 N.L.A. = 2.381 cm^2/m^2

Q @ 10Pa = 278.08 L/S Q @ 50Pa = 993.29 L/S

Air Change per Hour @ 50Pa = 5.220

SXX= 5.602919E+12 SXY= 4.432138E+12

SYY= 3.51382E+12 SYX= 11.25465

Correlation Coefficient= .9988869

Relative Standard Error = 2.08%

* Basement door open to begin study of isolating basement by way of first floor

* Gas furnace (& water heater) flue sealed No makeup vent

Open 1117
Closed 844
273 floor diff. but basement involved

S291

ÉCO-RECHERCHES (CANADA) INC.
ECO-RESEARCH (CANADA) INC.

121 Boul. Hymus, Pointe Claire, Québec H9R 1E6 Téléphone: (514) 697-3273 Télex: 05-822554 Fax: 697-2090

June 14, 1989

Scanada Consultants Ltd.,
436 MacLaren Street,
Ottawa, Ontario
K2P OM8

Attention: Mr. R.E. Platts

Dear Mr. Platts:

Attached please find the completed report for the air samples taken for bacteria, yeasts and moulds at the Beauchamp house, McLeod Street, Ottawa on February 27, 1989.

We would like to draw your attention to the fact that one of the moulds (Aspergillus fumigatus) identified is known to be toxic to humans and a second (Alternaria alternata) has proved toxic in experiments.

We hope this is to your satisfaction. Please don't hesitate to contact us if you have any questions.

Yours very truly,

ECO-RESEARCH (CANADA) INC.

Pamela Wishart, B.Sc.

PW:rm
Encl.

(5891)

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Scanada Consultants Ltd.,
436 MacLaren Street,
Ottawa, Ontario
K2P OM8

June 14, 1989

Attention: Mr. R.E. Platts

CERTIFICAT D'ANALYSE
CERTIFICATE OF ANALYSIS

Laboratory No.: **290761**

Re: Sampling of bacteria, moulds and yeasts at the Beauchamp house, McLeod St., Ottawa on February 27, 1989.

Sampling Method: Biotest TCS Centrifugal Air Sampler

Results

Sample identification	Bacteria CFU/m^3 air)	Yeasts and moulds (CFU/m^3 air)
#1 2nd floor south Living room Fungus only	-	13
#2 3rd floor (corridor) Fungus only	-	6
#3 Basement north-west Fungus, bacteria	69	175
#4 Basement, south-west Fungus, bacteria	131	19
#5 Basement, 5th stairs (on the middle) Fungus, bacteria	138	6
#6 Bedroom Fungus, bacteria	38	0

S8910

Sample identification	Bacteria CFU/m^3 air)	Yeasts and moulds (CFU/m^3 air)
#7 Living room Fungus, bacteria	138	6
#8 Kitchen Fungus, bacteria	106	6

The mould samples found in the basement were sent for identification. The following moulds were found:

Name	Habitat	Toxicity
Phialophora fastigiata	Widely spread: Wood, wood pulp, soil and seeds.	-
Cladosporium cladosporioides	Cosmopolitan and very common; air, soil textiles, paint, grains cereals, decomposing vegetable matter, etc.	-
Broomella acuta	Soprophyte: plants and other substrates.	-
Alternaria alternata	Cosmopolitan Saprophyte common to numerous plants, soil, foodstuffs, textiles, etc.	Toxic in experimental trials.
Aspergillus fumigatus	Very common contaminant, frequently found on damp organic matter and composts which they cause rapid decomposition with the production of heat. They grow well at 45°C. Causes avian and human aspergilloses. Must be handled with care.	Produces several metabolities some of which are highly toxic: fumagillin, helvolic acid, gliotoxin, guionone derivatives, alkaloids similar to those from rye ergot.

58910

Unfortunately we are unable to state which moulds were found in which location in the basement, however, the moulds may well be found in many areas of the cellar now.

Pamela Wishart, B.Sc.

:rm

Ginette Dessureault,
Microbiologist

Also Walkinshaw test results - Letter April 4 to householder:

Basement 28% RH 17.5°C 175 CFU/m³ Alternaria including few penicillium

Bedroom 2nd Fl. 39% RH 19.2°C 38 non sp. isolates

"Samples were in the borderline of normal"

Bathroom 2nd Fl. 37% RH 20°C 125 P. sp. non spor. isolates

OTTAWA FUNGUS CASE

"As Found" cont'd

Formaldehyde - PF 1 (AQR) dosimeter, 1 week

Living room 0.015 ppm

Master B.R. 0.026

Radon - R.A.D. Surveymeter, 1 week

Not detectable... less than 0.001 WL

REP

TRACER GAS TEST

58910

NAHB-RESEARCH FOUNDATION

AIMS 05-01-1989

PROJECT: INDOOR IAQ START: 14:00 (02-25-1989) FILE: 110RI
HOUSE: ALLEN 0-20 STOP: 14:00 (03-04-1989) ANALYZED: 04-26-1989

************************************ RATES ************************************

OVERALL INFILTRATION RATE = -1.1 ± 107.3(m^3/h)
OVERALL AIR EXCHANGE RATE = -0.001 ± 0.111(1/h)

ZONE	ZONE LOCATION	SOURCE @25C (nL/m)	QTY	RATE @T (nL/h)	EXFILTRATION RATE (m^3/h)	SD	INFILTRATION RATE (m^3/h)	SD	ACH (/h)	SD
1	BASEMENT	35.0	2	2521	-444.0	212.0	219.9	53.7	1.279	0.318
2	LIV RM	24.4	2	2518	442.9	118.8	-221.0	149.1	-0.279	0.189

ZONE-ZONE	RATE	± SD (m^3/h)	ZONE-ZONE	RATE	± SD (m^3/h)
1 - 2	780.5	282.7	2 - 1	116.6	42.2

TOTAL FLOW IN OR OUT

ZONE	RATE	± SD (m^3/h)	ACH	± SD(/h)	ZONE	RATE	± SD (m^3/h)	ACH	± SD(/h)
1	336.5	91.4	1.957	0.540	2	559.6	152.0	0.706	0.195

************************************ ANALYSIS ************************************

ZONE	VOL m^3	SOURCE TYPE	AVG. TRACER CONC. (pL/L) ± SD PMCP	PMCH
1	172	PMCP	14.50 ± 1.45	3.02 ± 0.30
2	792	PMCH	20.22 ± 2.02	8.71 ± 0.87

	CATS#	CONCENTRATION (pL/L) PMCP	PMCH	PDCB	PDCH
1	2280	14.499	3.020	0.000	0.000
2	500	20.225	8.713	0.000	0.000

C.F.:	PDCB	PMCP	PMCH	PDCH	COEFFICIENTS FILE
	0.98	0.98	0.99	0.00	3WSCLLL1

************************************ NOTES ************************************

The standard deviation in the source strength has been set at 10 %.
The standard deviation in the volume measurement has been set at 5 %.
C11 IS LESS THAN C12
EXFILTRATION RATE FOR ZONE 1 IS NEGATIVE
INFILTRATION RATE FOR ZONE 2 IS NEGATIVE

Need do over, Tracer not well mixed (?)
More CAT tubes needed for 1st & 2nd Floor
Ideal case would be for 3-zone analysis

FOR MORE INFORMATION ON ANALYSIS, CALL MR. BEN-HUAT SONG, OF AIMS LABORATORY @ (301) 249-4000, state of Maryland.

MOISTURE ASSESSMENT

S8909 **MAPP VALIDATION : <u>FIELD OBSERVATIONS</u>**

Scanada File S8910

Case 20 (Ottawa) Homeowner Anon Tel. home S8909-#20

Address Ottawa Tel. office

Date/time/technologist 25 Feb 1989 REP 1400 hrs

CONDITIONS AND HOUSE PERFORMANCE

25 Feb. Outdoors: temp. -7?; apparent wind speed/direction 0-5 km/hr

Nearest sta. temp. -9 ; measured wind speed/direction

Indoors: (MARCH 8) Main floor temp. 21°C RH 23%

Basement temp. 13°C RH 30%

Upper floor temp. RH

Condensation on Indoor surface of double-glazed* windows: none

(on centreline, note height of condens. from bottom of glass, and presence of metal thermal bridge at that edge; note height up to which condens. is frozen. Ignore sunlit windows.)

a) Windows with all curtains/blinds open (for past 1 hr. min.):

window no.	1	2	3	4	5
location					

a) none or almost none
b) bottom area of glass
c) up to mid-height
d) all or almost all glass

none

b) Windows with heavy drapes or blinds closed (mark H) or sheer curtains pulled across (mark L, light) for at least past 2 hrs:

window no.	6	7	8	9	10
location					

a) none or almost none
b) bottom edge of glass
c) up to mid-height
d) all or almost all glass

---

* If single-glazed, mark SG.

Householder's observations of windows through monitoring period:

Disregarding sunlit windows, kitchen, bathroom, and basement, and windows where drapes, curtains or blinds are closed through the day, the condensation pattern in daytime on the indoor surface of double glazed* windows is:

	a) none or almost none (check ___)	b) bottom area of glass	c) up to mid-hgt	d) all or almost all glass
1) On cold mornings	✓			
2) Through cold days	✓			
3) through most days	✓			

Householder's recollection from midwinter periods generally

In this year's midwinter weeks ✓ and/or those of the last few years (specify) ✓ ________________________, the window condensation has been about the same ✓ or somewhat worse _______ or somewhat less _______ than the pattern recorded above for this monitoring period.

Within those years, occupancy changes or house renofits occurred as follows, with approximate dates noted and also when condensation pattern changed: ____

____

____

____

Other visual observations (generally with the householder, at beginning or end of monitoring period):
Interior surface condensation or telltale mould, dustmarking, water stains on ceiling or below windows _________.

Describe: none

____

____

____

____

* If single-glazed, mark SG.

Gross leaks into envelope: from basement into exterior walls - several

Where possible, check in attic around chimney ________, plumbing stack ________ vent pipes ______, gas vents _______; closet tops _____ and dropped ceilings _______, exhaust ducts _______, balloon frame wall tops ______, and attic hatches ______, or doors _____; and describe any gross leaks ie. those where 4 or more fingers could be poked freely through the ceiling plane, or of equivalent area. (Reasonably fitted hatches and electrical fixtures are not gross leaks.)

Check around exterior walls at under-sink pipe penetrations _________, bathtubs against exterior walls (looking from underneath where possible) ✓, openings from the basement area into the exterior walls ✓; and around recessed medicine cabinets ________, radiator housings _______, exhaust fan housing _______; and warm air ducts in walls _______ or where floor registers or boots intrude under interior finish _____; and describe any gross leaks, ie. where at least one finger could be poked into the exterior cavity, or of equivalent area.

✓ ducts/pipes/wiring - main entry

Envelope moisture observations/measurements not accessible

Attic: Visible frost, ice, wetness, mould on sheathing and rafters or truss chords: Describe, including notes on frost thickness and density if accessible, and extent (coverage area) of moisture or telltales:

If accessible, probe and record moisture meter readings on wettest area of sheathing ________
and rafters/chords ________.
Also read close-by dry-looking surfaces of each ________

Record attic temperature at time of meter rdg. ________

Exterior walls and header (band joist) area, where accessible:

From outside: Moisture probe bottom edge of sheathing every four meters or so, and record all, noting location around perimeter wherever rdg. exceeds 15 in cold weather. Identify type of sheathing. ____________________

____

____

____

____

Moisture probe underside of window sills, inside drip kerf if any, at corners and in centre. Record all, noting location wherever rdg. exceeds 15 in cold weather ____________________

____

____

____

____

From interior: Moisture probe interior surface of exterior sheathing wherever accessible through electrical cover plates (those that can be removed without marring interior paint or finish.) Record all readings, and record locations of any exceeding 15. ____________________

____

____

____

HOUSE CHARACTERISTICS AND HOUSEHOLD DATA

(All data on house dimensions, volume, surface area must be recorded separately with the ELA report, following the CGSB test protocol and satisfying the A.G. Wilson outline of 13 Dec 88.)

1. Gathering basic data needed to categorize airleakiness visually (part of basis of "MAPP Pass")

(1) Year built ______; group: pre 1920 ✓; 1921-45 ______; 1946-1960 ______; 1961 to 1970 ______; post 1970 ______;

(2) Bldg. type: 1 storey ___ 1.5 ___ 2 ___ 2.5 ✓; raised basement ______; split level ______.

(3) Construction category:

a) Balloon frame ___✓___ or other pre 1945 inc. solid masonry ______. (Note no. of stories inc. 3 or 3.5 for this pre '45 group ________) Note stucco classes are separate,below.

b) Platform frame, board subfloor general ______.

c) Platform frame, 1.5 storey, plywood subfloor ______.

d) Pre 1945 fully stuccoed ______.

e) Platform frame plywood subfloor general ______.

f) Post 1945 fully stuccoed (incl. over foundation).____ Note other degrees of stucco and cladding tightness are covered below.

(Disregard any ELA test experience in filling in 4 to 15)

(4) Tight cladding: House is predominantly covered with:

a) Wood clapboard heavily painted/repainted, laps and ends thereby sealed; caulked to window trim, corners etc.__________

NO b) Panel type siding (plywood, hardboard) with joints battened; caulked to window trim, corners etc. ______.

c) Stucco not included in category 3d) or 3f); not covering full house and/or not applied over foundation/sill area______. (It still comprises a tight cladding but not extremely tight as in 3f)

d) Re-siding applications over existing siding where rigid insulation and/or "house wrap" has been applied and caulked to all openings, covers ... and across sill to foundation ______

e) Other apparently tight cladding ______ Describe ______
____

5) Unknown cladding, possibly tight: Re-siding applications over older painted clapboard, panel or stucco cladding.

6) Loose cladding (airleaky): brick veneer ___✓___ proprietary lop siding over building paper ______, other ________________ .

7) Tight windows: For a house of this age, the windows appear unusually tight because:

a) Generally painted shut, heavily painted or caulked trim; the operable windows can not be hand rattled ... seem unusually tight ______.

b) Windows unusually well weatherstripped, trim caulked ______.

c) Aluminum self-storing storms, well sealed to window easing or trim ______.

d) Tight new windows, well installed and sealed to casing or trim inside and/or outside ______

8) Windows seem just normally tight for house of this age ✓.

9) Windows seem abnormally loose, airleaky, more so than age of house would suggest. ______

10) Entry doors seem unusually tight ______ or about normal ✓ or unusually loose, airleaky ______ for house of this age.

11) Basement seems unusually tight ______ (eg. cast concrete incl. floor, unusually crack-free, or extensive interior finishing for house of this age); or about normal ______ or unusually air-leaky ✓. Foundation construction and floor drain are covered in part 2,17.) Rubblework foundation

12) House has been commercially airtightened: all interior, and sill area ______.

13) Attic has been fully as accessible in upper attic insulated with cellulose fibre at least 100 mm thick ✓ or with mineral wool where poly v.b. and general sealing was done over old insulation. ______.

14) Walls have been fully insulated with cellulose fibre part.

15) House is far from compact: unusually irregular or extended or winged shape ______ and/or overhanging floors ______ and/or rooms over garage or carport ______ offer generous perimeter and surface areas; abnormally high surface/volume ratio. ______

2. Gathering Basic data needed to follow MAPP in detail

Some or most of the following may be needed for a given case:

A. Information that May Be Needed to Assess Moisture Generation

(1) Number of occupants 1 2 3 4 (5) 6 7 8

(2) Number normally home only at night 1 2 3 4 (5) 6 7 8

(3) Clothes dryer yes[✓] no[ ]
(4) -vented outdoors in heating season (HS) yes[✓] no[ ] ✓?

(5) Hanging laundry to dry indoors in HS
-the odd piece or two, now and then [ ]
-a little of the washing, regularly [✓]
-most or all of the washing, regularly [ ]

(6) Kitchen fan* (disregard charcoal or other recirculating types) yes[ ] no[✓]

(7) -used in HS when cooking, boiling water or dishwashing N/A
almost always[ ]
whenever needed to clear windows or odours[ ]
rather seldom[ ]

(8) Bathroom fan(s)* in bathroom(s) where most bathing/showering is done yes[ ] no[✓]

(9) -used in HS when bathing/showering almost always[ ] N/A
whenever needed to clear windows[ ]
sometimes[ ]

[* Check to see that fans do not exhaust into the attic.]

(10) Humidifiers none[ ] portable[ ] on warm air[✓] drum type

(11) -used during HS almost always[✓]
sometimes[ ]
seldom[ ]

(12) -if on warm air furnace...setting in midwinter, %RH[40]

(13) Dehumidifiers none[ ] basement, summer-fall [ ]

(14) -if other usage and/or placement, identify... [ ]

(15) Hobbies or activities likely to give off moisture freely, and not specially vented? Identify*...

[* Examples include indoor greenhouse or hydroponic gardens, large aquariums, whirlpool baths, hairdressing salons... Not included are most arrays of house plants; or saunas, photography labs or other facilities or activities that add little moisture to the air, or only now and then.]

(16) Foundation type — mostly basement[✓] mostly crawlspace[ ] mixed[ ] slab-on-grade[ ]

(17) Foundation wall — concrete[ ] conc. block[ ] stone, brick...[✓]

(18) Dirt floor — none[ ] about quarter of floor* [✓] about half of floor[ ] most or all of floor[ ]

[* "floor" meaning whole plan area of house on ground]

(19) Dirt floor appears in winter to be — dry[ ] damp[✓] wet[ ]

(20) Ground cover (polyethylene [ ] or other[ ]) yes[ ] no[✓]

(21) Water pools on ground cover, fall-winter — yes[ ] no[✓]

(22) Water floods over considerable area of basement floor (any material or finish) in fall-winter — never or rarely[ ] some years[✓] often[ ]

(23) Floor drain — yes[✓] no[ ]

(24) -usually open to storm/drain tile in HS — yes[ ] no[✓]

(25) Water seepage through considerable area of foundation walls (liquid water) in HS — yes[✓] no[ ]

(26) Areas of efflorescence, mould and/or dampness on foundation walls in HS — essentially none[ ]

75 cfm fan
Basement vented to help control mold + IAQ

a few small spots[ ]
many spots and/or some large areas[✓]

(27) Temperature of basement area in HS (or most of area...)
well below 15 C [✓]
around 15 C [ ]
well above 15 C [ ]

(28) Plan area of house on ground
[66.4 m^2]
[ft^2]

B. Information Relating to Midwinter Air Change Rate (climatic data are built in to the MAPPs for the various locations)

(29) Airleakiness: ELA, standard fan depress. m^2[.112]

(30) House height: the height above grade (disregarding unheated attic...) is about:
one storey[ ]
or between one and two stories, eg., raised basement, or bungalow on sloped grade[ ]
two or more storeys[✓]

(31) House exposure:* First, the general "terrain" around much of the site can best be described as:
1. ocean or large lake [ ]
2. flat terrain, few if any obstructions to winds [ ]
3. rural, low bldgs. & scattered trees [ ]
4. urban, industrial or forest area [✓]
5. centre of large city with high-rise bldgs. [ ]

[* adapted from the LBL studies - Lawrence Berkeley Laboratories]

(32) House exposure: Second, the close-in "shielding" or shelter (within 2 or 3 house heights from the house) can best be described as
1. none: no close-by shelter [ ]
2. a few scattered obstructions [ ]
3. some obstructions [ ]
4. obstructions practically all around [✓]
5. large obstructions all around house...[ ]

(33) House has an active flue(s) (i.e. venting the main combustion heating device. *Do not count flue from airtight wood stove or condensing or other high efficiency furnace, or from fireplace with damper normally closed*) yes[✓] no[ ]

(34) House has passive flue(s) (incl. fireplace if used often or if damper left open through HS; or any flue normally open from indoors to outdoors) yes[ ] no[✓]

C. Recollections Indicating Indoor RH, Midwinter, House "As Is"

The householder's recollection of midwinter window condensation fits most closely to which one, or possibly two, of the following descriptions? (Disregard kitchen and bathroom windows and those where heavy curtains, blinds or drapes are drawn at night. Consider only condensation on the indoor surface of double glazing.)

(a) Almost all the glass is covered "always"..."most days"...Water often runs down on and over sill...The condens. persists into early *spring or even later* [ ]

(b) Almost all the glass is covered "often"... "every cold day"... water sometimes runs down on to sill [ ]

(c) Almost all the glass is covered only "on coldest mornings"..."on windy, cold days"...And/or bottom area of glass is covered "often"..."most mornings" [ ]

(d) Little condensation in midwinter...bottom area of glass on cold mornings [ ]

(e) "Almost none"..."bottom edge of glass only on cold mornings" [✓]

Filename: ____________

Date: ____________

	assumption made	action taken
exposure class:	4	
height class:	2 (2.5)	
ELA @10 pa:	.112 m² flue sealed + combustion air duct sealed	
adjustments for flues:	1	
number of occupants:	5	
dryer vented:	yes	
kitchen - bathrm. fan:	no	
hobbies - cooking:	—	
below grade moisture:	yes but very cool (12-13°C) + fan-vented + combustion air duct	

AGW:

How much basement moisture?

It would seem to qualify for at least

10 kg/100 m²/day = 66/100 × 10 = 6.6 kg/day

Apparently about 4 kg/day used for MAPP diagram. yes

no - very cool (S!)

AIRTIGHTNESS TEST RESULTS
(AS PER CAN/CGSB - 149.10 - M86)

#20 OPEN* Scanada (Ottawa) 8 MAR 89
Ext.Temp. =-12 C Wind Speed = 5 km/h
Envelope Area = 469 m^2 Volume = 685 m^3
Pressure With Fan Sealed - Start:-4 Pa Finish:-4 Pa

PRESS.(Pa) MEAS'D.	PRESS.(Pa) ADJ'D.	TI (C)	FLOW(L/S) MEAS'D.	FLOW(L/S) ADJ'D.	FLOW(L/S) FITTED	RELATIVE ERROR(%)
60.0	64.0	16.6	1263.00	1199.05	1207.49	0.70
55.0	59.0	16.6	1177.00	1117.40	1132.24	1.33
50.0	54.0	16.5	1129.00	1072.02	1055.64	1.53
45.0	49.0	15.0	1034.00	984.37	977.54	0.69
40.0	44.0	15.0	947.00	901.54	897.76	0.42
35.0	39.0	14.9	861.00	819.81	816.05	0.46
30.0	34.0	14.9	775.00	737.93	732.12	0.79
25.0	29.0	14.9	670.00	637.95	645.56	1.19
18.0	22.0	16.8	553.00	524.82	518.84	1.14
15.0	19.0	16.8	470.00	446.05	462.03	3.58

C = 44.99058 n = .7910408

E.L.A. =1116.82 cm^2 ** N.L.A. = 2.381 cm^2/m^2

Q @ 10Pa = 278.08 L/S Q @ 50Pa = 993.29 L/S

Air Change per Hour @ 50Pa = 5.220

SXX= 5.602919E+12 SXY= 4.432138E+12

SYY= 3.51382E+12 SYX= 11.25465

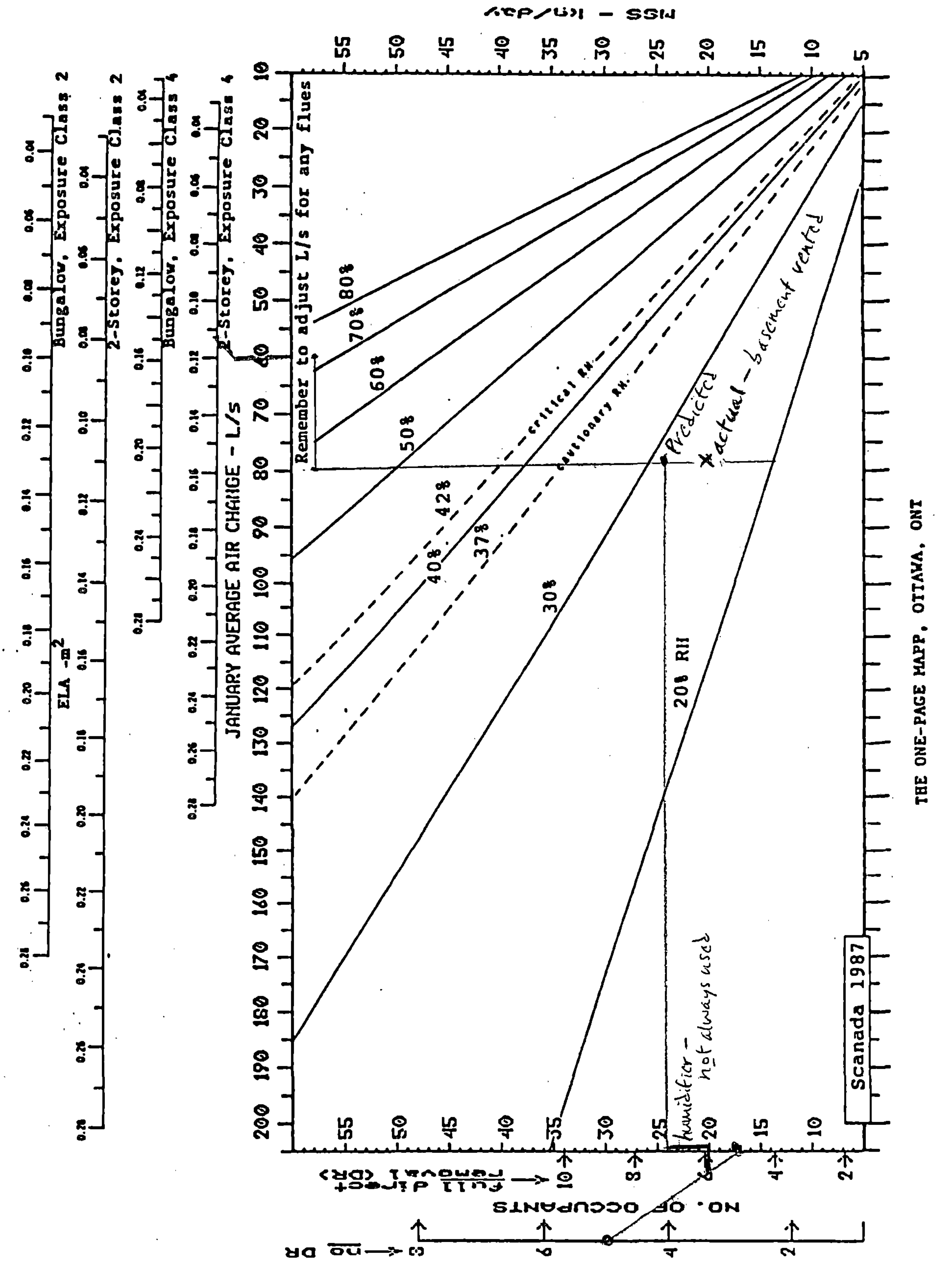
Correlation Coefficient= .9988869

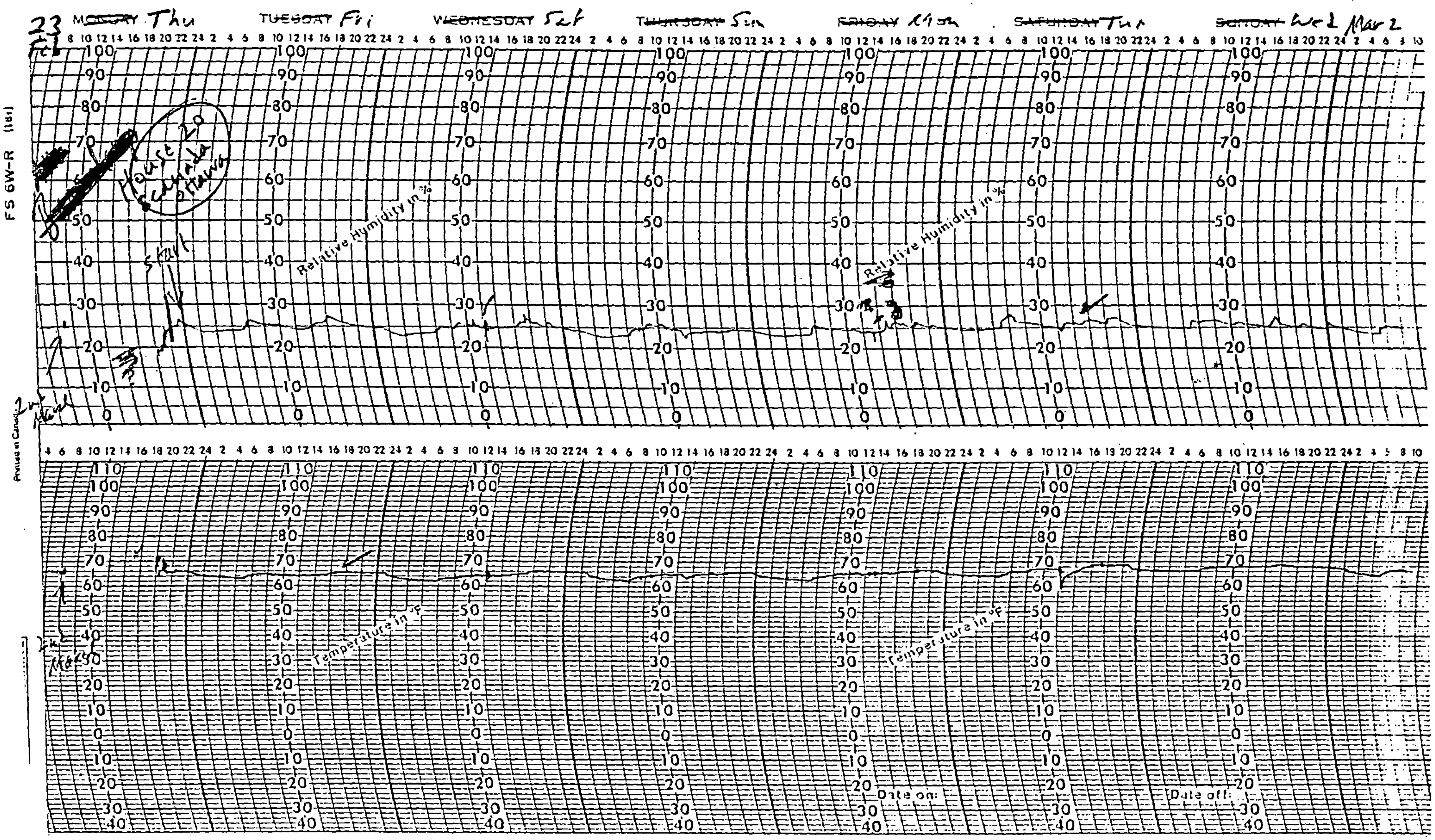
Relative Standard Error = 2.08%

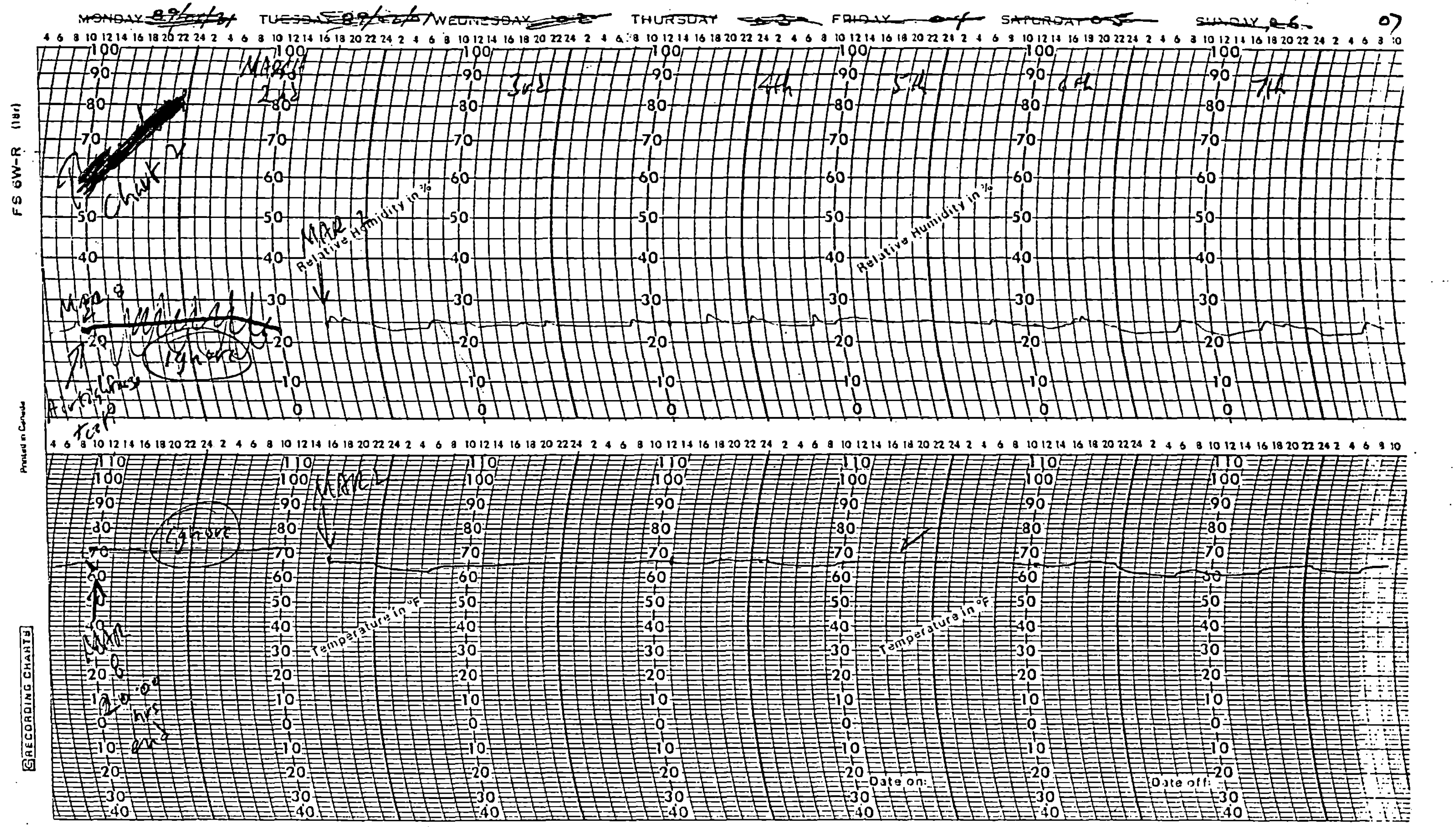
* Basement door open

** Gas furnace + water heater, flue sealed. Combustion air sealed + basement fan sealed

3. Inland Medium: One-Page MAPP




23 Feb
Thu
Fri
Sat
Sun
Mon
Tue
Wed Mar 2
House 20 Canada Ottawa
Relative Humidity in %
Temperature in °F
Date on:
Date off:
FS 6W-R (181)
Printed in Canada


MONDAY
TUESDAY
WEDNESDAY
THURSDAY
FRIDAY
SATURDAY
SUNDAY
Relative Humidity in %
Temperature in °F
Date on:
Date off:
FS 6W-R (18r)
Printed in Canada
RECORDING CHARTS

THE HOMEOWNER SURVEY

(EMR form)

House 0-20

58910

Contents

Note: The person being interviewed has been identified throughout this questionnaire as the Occupant. Another person who shares the responsibilities of the household is identified as the Spouse.

FOR OFFICE USE

Occupant Information

Anon - Scanada File 58909 - #20

600. Occupant Name: Anon. (Surname) L (Initial) 600 ______

Mailing Address:

601. Street: ______ 601 ______

602. City: Ottawa 602 ______

603. Postal Code: ______ 603 ______

Telephone numbers of occupant & spouse:

Home: ______ ______

Work: ______ ______

Work: ______ (Area Code) ______ (Number)

Homeowner (If different from the occupant)

Name: ______

Address: ______

______

Phone: ______

This case has been taken on for study on basement mould + means of isolation

[signature]

FOR OFFICE USE

~~604. What type of house is this?~~

~~1 - R-2000 Demo 2 - R-2000 ID or repeat 3 - Comparative~~ ~~604 ____~~

605. Date the house was occupied: 1985 (MM DD YY) 605 ____

606. Is this the original occupant?

1 - Yes 2 - No 606 2

607. Number of occupants over 18 years of age? 3 607 3

608. Number of occupants under 18 years of age? 2 608 2

609. How many occupants over 18 years of age remain home during the major portion of the working day? 0 609 0

610. How many occupants under 18 years of age remain home during the major portion of the working day? 0 610 0

611. Is the occupant the:

1 - owner (2 - renter) 3 - owner/builder 611 2

612. What is the approximate age of the occupant?

1 - 18-30 (2 - 31-45) 3 - 46-60 4 - over 60 612 2

613. What is the approximate age of the spouse?

-1 N/A 1 - 18-30 (2 - 31-45) 3 - 46-60 4 - over 60 613 2

614. to 615. What are the primary occupations of the occupant and the spouse?

614. Occupant 10 615. Spouse 15

-1 - N/A
10 - Professional
11 - Manager/Admin.
12 - Technical
13 - Sales
14 - Clerical
15 - Trades
16 - Homemaker
17 - Student
18 - Retired
99 - Other ____________

614 10
615 15

616. What was the occupants previous residence?

1 - an apartment 2 - a row home
3 - a semi-detached home 4 - a detached home 616 1

617. Did the occupants own or rent their previous residence?

-1 - N/A 1 - owned 2 - rented 617 2

FOR OFFICE USE

618. to 620. If the occupant rented their previous residence, how did they pay for the following utilities?

-1 - N/A 1 - paid directly
2 - included in rent 98 - don't know

618. Space Heating ______ 618 98

619. Water Heating ______ 619 98

620. Lights and Appliances ______ 620 98

621. Was this house built as a custom home for the present homeowner?

1 - Yes 2 - No 98 - don't know 621 2

Note: A custom home is a home that the homeowner ordered built and had input to the basic design and/or construction techniques.

622. to 623. What does the occupant feel will happen to energy prices in the future?

1 - increase 2 - remain constant 3 - decrease 98 - don't know

622. over the next 5 years ______ 622 ______

623. over the next 10 years ______ 623 ______

IF THE OCCUPANT RENTS THE RESIDENCE GO TO QUESTION 663.

Homeowner Information

625. For how many years do the occupants expect to own their home?

1 - 5 years or less 2 - 6 to 10 years
3 - 11 to 15 years 4 - more than 15 years
98 - don't know 625 ______

626. What was the purchase price of the home, excluding the price of the land? ______ 626 ______

627. Was the homeowner aware of the R-2000 Program before they purchased their home?

1 - Yes 2 - No 627 ______

628. If the homeowner decided to purchase another home, would they consider the purchase of an R-2000 home?

1 - Yes 2 - No 98 - don't know 628 ______

If the home occupant answered NO to question 628, place the reason in the comment section below.

______

______

FOR OFFICE USE

681. to 685. List the features inside the home which contribute to increased energy consumption.

97 - none
21 - well pump
22 - sump pump
23 - sauna
24 - workshop
25 - indoor pool
26 - whirlpools
27 - energy intensive hobbies
28 - garbage compactor/shredder
29 - central vacuum
30 - open windows/doors
99 - Other ________________

681 ____
682 ____
683 ____
684 ____
685 24

687. to 691. List the features outside the home which contribute to increased energy consumption.

97 - none
32 - outdoor pool
33 - electric gardening tools
34 - yard lighting
35 - separate workshop
36 - heated walk/driveway
99 - Other ________________

687 97
688 ____
689 ____
690 ____
691 ____

692. Does the occupant use a block heater?

1 - Yes 2 - No

692 2

695. If the occupant uses a vehicle block heater, calculate the total hours per year the block heater is used. Otherwise, enter -1 for Not Applicable.

______ hrs/day X ______ No. of vehicles X ______ days/yr = ______ total hrs/yr

695 ____

696. Since the home has been occupied, are there areas attached to the home which were not previously heated, and are now heated?

97 - none
3 - addition
99 - Other ________________
21 - garage
54 - sunspace

696 97

FOR OFFICE USE

Air Quality Information

700. Does the occupant have any concerns regarding the air quality in the home?
1 - Yes 2 - No 700 1

IF THE ANSWER TO QUESTION 700 WAS YES, COMPLETE QUESTIONS 701 TO 724, OTHERWISE GO TO QUESTION 725.

701. to 724. Identify any air quality concern(s) by indicating whether or not the following occurs during the summer and/or winter. Do not prompt the occupant.

1 - minor problem 3 - severe problem
2 - moderate problem 97 - no problem

	Summer	Winter	Office use
Moisture/humidity (701-712)			
window panes, sills and trim	701 ____	702 ____	701 ____ 702 ____
mildew in room ceiling corners	703 ____	704 ____	703 ____ 704 ____
sensory perception of moisture	705 ____	706 ____	705 ____ 706 ____
warped or swollen doors	707 ____	708 ____	707 ____ 708 ____
damp basement floors or walls	709 ____	710 ____	709 3 710 2
other: fungus	711 ____	712 ____	711 ____ 712 1-2 ?
Comments: ____			
Odours (713-718)			
in the kitchen	713 ____	714 ____	713 ____ 714 ____
in the bathroom	715 ____	716 ____	715 ____ 716 ____
other: ____	717 ____	718 ____	717 ____ 718 ____
Comments: ____			
Dry Static Air (719-724)			
sensory perception (eg. dry throat)	719 ____	720 ____	719 ____ 720 ____
static electricity	721 ____	722 ____	721 ____ 722 ____
other: ____	723 ____	724 ____	723 ____ 724 ____
Comments: ____			

FOR OFFICE USE

725. Approximately how many cigarettes are smoked in the home per day? ____________ 725 none

726. Are any pipes or cigars smoked in the home?

1 - Yes 2 - No 726 2

727. Approximately how many plants are in the home? _____ 727 minimal

728. Approximately how many of these are spider plants? ___ 728 none

Note: spider plants have the ability to absorb certain amounts of formaldehyde from the air. wow!

729. to 732. List the occupant's hobbies that could effect the air quality in the home?

97 - none
41 - pottery/crafts
42 - wood working
43 - mechanical work
44 - oil painting
45 - beer/wine making
46 - furniture refinishing
99 - other (specify) __________

729 42
730 ______
731 ______
732 ______

735. to 740. Prior to moving into the home, were any members of the family sensitive to the following problems? Indicate these below.

(Enter 1 - Yes or 2 - No)

	Adults	Children
Allergies	735 1	736 ______
Asthma	737 ______	738 ______
Other: ____________	739 ______	740 ______

735 1
736 ______
737 ______
738 ______
739 ______
740 ______

741. What is the source for water used in this house?

1 - municipal water
2 - homeowner spring or surface well
3 - homeowner well deeper than 25 feet
99 - other

741 1

742. Where does the clothes dryer vent?

-1- N/A
1 - indoors
2 - outdoors
3 - indoors in winter/outdoors in summer
4- directly to the HRV

742 2

FOR OFFICE USE

745. to 752. How often does the occupant operate the following equipment?

-1 - N/A
1 - continuously
2 - intermittantly
3 - never used

745. humidifier in winter ______ 745 1

746. dehumidifier in summer ______ 746 ______

747. electronic air cleaning equipment ______ 747 ______

748. HRV in the summer ______ 748 ______

749. HRV in the winter ______ 749 ______

750. furnace blower - in winter ______ 750 2

751. furnace blower - in summer ______ 751 ______

752. air conditioning ______ 752 ______

753. to 754. Has a manual been provided for the operation and maintenance of the ventilation and heating system(s)?

-1 - N/A 1 - Yes 2 - No

753. ventilation system ______ 753 2

754. heating system ______ 754 ______

755. to 760. Is the occupant aware of the need to perform the following mechanical system maintenance?

-1 - N/A 1 - Yes 2 - No

755. clean the HRV filters ______ 755 ______

756. clean the HRV core ______ N/A 756 ______

757. check the HRV intake hood ______ 757 ______

758. adjust the humidistat setting ______ 758 1

759. change the furnace filter ______ 759 1

760. clean the electronic air cleaner ______ N/A 760 ______

Note: If the occupant answers no to any of the above questions, impress upon the homeowner the importance of regular equipment maintenance in terms of air quality, equipment longevity and energy savings. Ask them to refer to the appropriate manuals regarding operation and maintenance.

31 MAY 89

APPENDIX 2

THE HOUSE AS RETROFITTED

- Airtightness test indicating the tightness of the first floor/heating system

- Soil gas tests

- Basement air tests

- Fungus sampling: in soil gases and in basement and house air

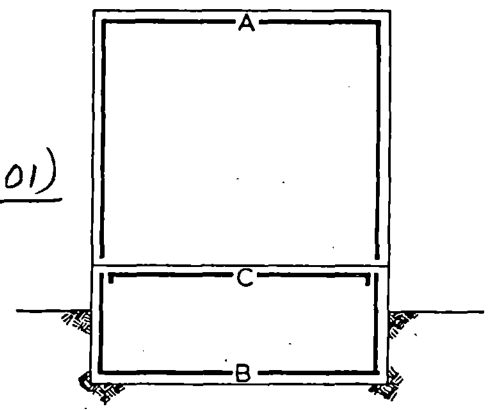
Scanada Consultants Limited

Project: FLOOR LEAKAGE CHARACTERIZATION	By: K. RUEST	Page 1 of 1
Job. No.: 58910	Job Title: OTTAWA FUNGUS BASEMENT	Date: MARCH 28/90

	TEST	ELA	
TEST 1	$A_2 + B_2$	$= 1577.01\ cm^2$	(basement door open)
TEST 2	$A_2 + C_2$	$= 1397.12\ cm^2$	(basement door closed)
TEST 3	$B_2 + C_2$	$= 825.23\ cm^2$	(depress. basement to outdoors) (kitchen door open)

–Makeup duct open–

$$C_2 = \frac{\underbrace{(A_2+C_2)}_{\text{TEST 1}} + \underbrace{(B_2+C_2)}_{\text{TEST 2}} - \underbrace{(A_2+B_2)}_{\text{TEST 3}}}{2}$$



$$C_2 = \frac{(1397.12)+(825.23)-(1577.01)}{2}$$

$$C_2 = \frac{645.34}{2}$$

$$C_2 = \underline{\underline{322.67\ cm^2}}$$ — FLOOR LEAKAGE "ELA"

Check:

	$825.23\ cm^2$	— BASEMENT & FLOOR "ELA"
	$-\ 322.67\ cm^2$	— FLOOR LEAKAGE "ELA"
B_2	$502.56\ cm^2$	— BASEMENT LEAKAGE EXCLUDING FLOOR "ELA"
	$1397.12\ cm^2$	— FLOOR & ABOVE "ELA"
	$-\ 322.67\ cm^2$	— FLOOR LEAKAGE "ELA"
A_2	$1074.55\ cm^2$	— HOUSE LEAKAGE ABOVE BASEMENT "ELA"

$\therefore$

1074.55	A_2
+ 502.56	B_2
1577.11	(A_2+B_2)

Note: the subscript 2, as in A_2, refers to the post-tightened period. A was not tightened.

AIRTIGHTNESS TEST RESULTS
(AS PER CAN/CGSB - 149.10 - M86)

A2+B2, WHOLE HOUSE.. FEB.23, 1990
Ext.Temp. =-3.4 C Wind Speed = 15 km/h
Envelope Area = NOT AVAILABLE Volume = ~~1 m^3~~
Pressure With Fan Sealed - Start: 0 Pa Finish: 0 Pa

PRESS.(Pa)		TI	FLOW(L/S)			RELATIVE
MEAS'D.	ADJ'D.	(C)	MEAS'D.	ADJ'D.	FITTED	ERROR(%)
60.0	60.0	17.0	1397.00	1346.99	1394.94	3.56
55.0	55.0	17.0	1369.00	1320.00	1311.66	0.63
50.0	50.0	17.6	1282.00	1234.83	1226.13	0.71
45.0	45.0	17.2	1196.00	1152.79	1138.05	1.28
40.0	40.0	17.4	1091.00	1051.22	1047.06	0.40
35.0	35.0	17.2	1005.00	968.69	952.67	1.65
30.0	30.0	17.4	933.00	898.98	854.23	4.98
25.0	25.0	17.9	766.00	737.44	750.85	1.82
20.0	20.0	16.7	651.00	628.02	641.20	2.10
15.0	15.0	17.3	519.00	500.16	523.11	4.59
10.0	10.0	17.7	386.00	371.74	392.66	5.63

C = 77.00329 n = .7075028

E.L.A. =1577.01 cm^2 N.L.A. =NOT AVAILABLE

Q @ 10Pa = 392.66 L/S Q @ 50Pa =1226.13 L/S

[redacted]

SXX= 1.533813E+13 SXY= 1.085177E+13

SYY= 7.742752E+12 SYX= 26.1352

Correlation Coefficient= .9957876

Relative Standard Error = 3.21%

AIRTIGHTNESS TEST RESULTS
(AS PER CAN/CGSB - 149.10 - M86)

A2+C2, FLOOR & ABOVE — FEB.23, 1990

Ext.Temp. =-3.4 C — Wind Speed = 15 km/h

Envelope Area = NOT AVAILABLE — ~~Volume = 1 m^3~~

Pressure With Fan Sealed - Start: 0 Pa Finish: 0 Pa

PRESS.(Pa) MEAS'D.	PRESS.(Pa) ADJ'D.	TI (C)	FLOW(L/S) MEAS'D.	FLOW(L/S) ADJ'D.	FLOW(L/S) FITTED	RELATIVE ERROR(%)
60.0	60.0	13.6	1244.00	1206.56	1231.13	2.04
55.0	55.0	16.0	1187.00	1146.49	1157.84	0.99
50.0	50.0	16.3	1139.00	1099.56	1082.56	1.55
45.0	45.0	16.6	1034.00	997.68	1005.02	0.74
40.0	40.0	16.7	957.00	923.22	924.89	0.18
35.0	35.0	16.6	919.00	886.72	841.75	5.07
30.0	30.0	16.7	813.00	784.30	755.03	3.73
25.0	25.0	16.5	708.00	683.25	663.91	2.83
25.0	25.0	15.7	661.00	638.77	663.91	3.94
20.0	20.0	15.9	550.00	531.32	567.22	6.76
15.0	15.0	16.0	452.00	436.57	463.04	6.06

C = 68.55388 — n = .7053793

E.L.A. =1397.12 cm^2 — N.L.A. =NOT AVAILABLE

Q @ 10Pa = 347.87 L/S — Q @ 50Pa =1082.56 L/S

~~Air Change per Hour @ 50Pa = [illegible]~~

SXX= 8.677981E+12 — SXY= 6.121268E+12

SYY= 4.377914E+12 — SYX= 27.90397

Correlation Coefficient= .9931124

Relative Standard Error = 4.06%

AIRTIGHTNESS TEST RESULTS
(AS PER CAN/CGSB - 149.10 - M86)

B2+C2, FLOOR & BELOW FEB.23, 1990
Ext.Temp. =-3.4 C Wind Speed = 15 km/h
Envelope Area = NOT AVAILABLE ~~Volume = 1 m^3~~
Pressure With Fan Sealed - Start: 0 Pa Finish: 0 Pa

PRESS.(Pa) MEAS'D.	PRESS.(Pa) ADJ'D.	TI (C)	FLOW(L/S) MEAS'D.	FLOW(L/S) ADJ'D.	FLOW(L/S) FITTED	RELATIVE ERROR(%)
60.0	60.0	11.0	775.00	755.11	780.72	3.39
55.0	55.0	10.9	746.00	726.98	731.71	0.65
50.0	50.0	10.0	718.00	700.80	681.56	2.75
45.0	45.0	10.7	670.00	653.15	630.10	3.53
40.0	40.0	10.8	622.00	606.25	577.17	4.80
35.0	35.0	12.4	505.00	490.83	522.51	6.45
30.0	30.0	11.6	461.00	448.69	465.82	3.82
25.0	25.0	11.3	409.00	398.29	406.66	2.10
20.0	20.0	11.0	348.00	339.07	344.37	1.56
15.0	15.0	11.0	296.00	288.40	277.94	3.63

C = 36.96043 n = .745019

E.L.A. = 825.23 cm^2 N.L.A. =NOT AVAILABLE

Q @ 10Pa = 205.47 L/S Q @ 50Pa = 681.56 L/S

Air Change per Hour @ 50Pa ~~= 2453.604~~

SXX= 1.119946E+12 SXY= 8.343813E+11

SYY= 6.34011E+11 SYX= 22.05046

Correlation Coefficient= .9901878

Relative Standard Error = 5.56%

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SF6 AIR CHANGE RATE 1.40 AC/Hr
(Bag method)

RCS BIO-TEST (FUNGUS & MOULD RESULTS) *

	FUNGAL & MOULD	
BASEMENT (SOUTH-WEST CORNER)	1 (MOULD)	6CFU (MOULD)/m^3 of air
LIVING ROOM	0	0CFU/m^3 of air
MASTER BEDROOM	0	0CFU/m^3 of air
BASEMENT (NORTH-WEST CORNER)	0	0CFU/m^3 of air
WALL HOLE SAMPLING	0	0CFU/m^3 of air
DRAIN SAMPLING	0	0CFU/m^3 of air

FLUORISIL SAMPLING **

SAMPLING SITE	WEIGHT OF DEPOSIT µg.	CONCENTRATION mg/m^3	GAS
WALL SAMPLING near grade level	2	0.222	DICAMBA
	0.047	0.005	2,4,5 TP
	0.058	0.006	2,4 D
DRAIN SAMPLING	2	0.222	DICAMBA
	0.058	0.006	2,4,5 TP
	0.047	0.005	2,4 D
BASEMENT AIR	(NO SAMPLE LEFT FOR ANALYSIS SINCE SAMPLING BAG DEFLATED IN LAB)		

** Fluorisil intended to pick up herbicides. Being re-analysed. RJ

RADON SAMPLING

	pCi/L	mWL
BASEMENT	0.6	3
WALL	0.03	0.15
DRAIN	30.42	152.1
(CANADIAN LEVEL	20.00	100
EPA LEVEL	4.00	20)

* Fungus Sampling and lab procedure not validated – value is suspect RJ

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TENAX SAMPLING

SUBSTANCES IDENTIFIED ($\mu g/m^3$)

SUBSTANCE	LOCATION: WALL nr. grade *	LOCATION: DRAIN
ETHYLENE GLYCOL	T	–
O-XYLENE	T	T
m-XYLENE	T	4.0
p-XYLENE	T	T
STYRENE	2.7	T
DICHLOROMETHANE		–
TOLUENE		3.75
1,3,5-DIMETHYLBENZENE		T
DICHLOROBENZENE		T

T = TRACE QUANTITIES $< 1\ \mu g/m^3$

– = NONE DETECTED

TEMPERATURE AND RH IN BASEMENT

TEMPERATURE 12.7 °C

RELATIVE HUMIDITY 46.4 %

SOIL GASES PASSIVE RATE OF ENTRY

WALL HOLE 1.2 L/HR. (near grade, in rubblestone)

DRAIN 0.0 L/HR.

STATIC PRESSURE READINGS

* wall sample: hole in rubblestone wall is just ½ m below grade. Gas probably includes indoor and outdoor air as well as soil gas in this case.