LBL-10246
EEB-Vent 79-14
UC-37

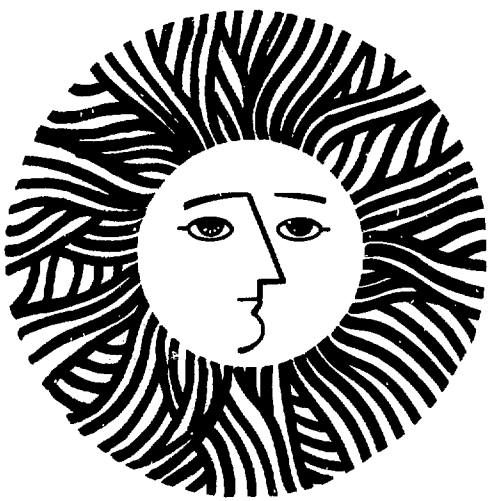
Lawrence Berkeley Laboratory
UNIVERSITY OF CALIFORNIA

ENERGY & ENVIRONMENT DIVISION

INSTRUCTIONS FOR OPERATING LBL PASSIVE ENVIRONMENTAL RADON MONITOR (PERM)

M. L. Boegel, W. W. Nazaroff, and J. G. Ingersoll

August 1979



Prepared for the U.S. Department of Energy under Contract W-7405-ENG-48

LBID-073
EEB-Vent 79-14

INSTRUCTIONS FOR OPERATING LBL PASSIVE ENVIRONMENTAL RADON MONITOR (PERM)

M.L. Boegel, W.W. Nazaro ,
and J.G. Ingersoll

Energy Efficient Buildings Program
Energy and Environment Division
Lawrence Berkeley Laboratory
University of California
Berkeley, CA 94720
August 15, 1979

The work described in this report was funded by the Office of Buildings and Community Systems, Assistant Secretary for Conservation and Solar Applications of the U.S. Department of Energy under contract No. W-7405-ENG-48.

INSTRUCTIONS FOR OPERATING LBL PASSIVE ENVIRONMENTAL RADON MONITOR (PERM)

CONTENTS: Each package should contain:

1 Instruction Booklet containing data sheets

1 PERM with desiccant cannister (see Fig. 1)

1 spare desiccant cannister in a plastic bag

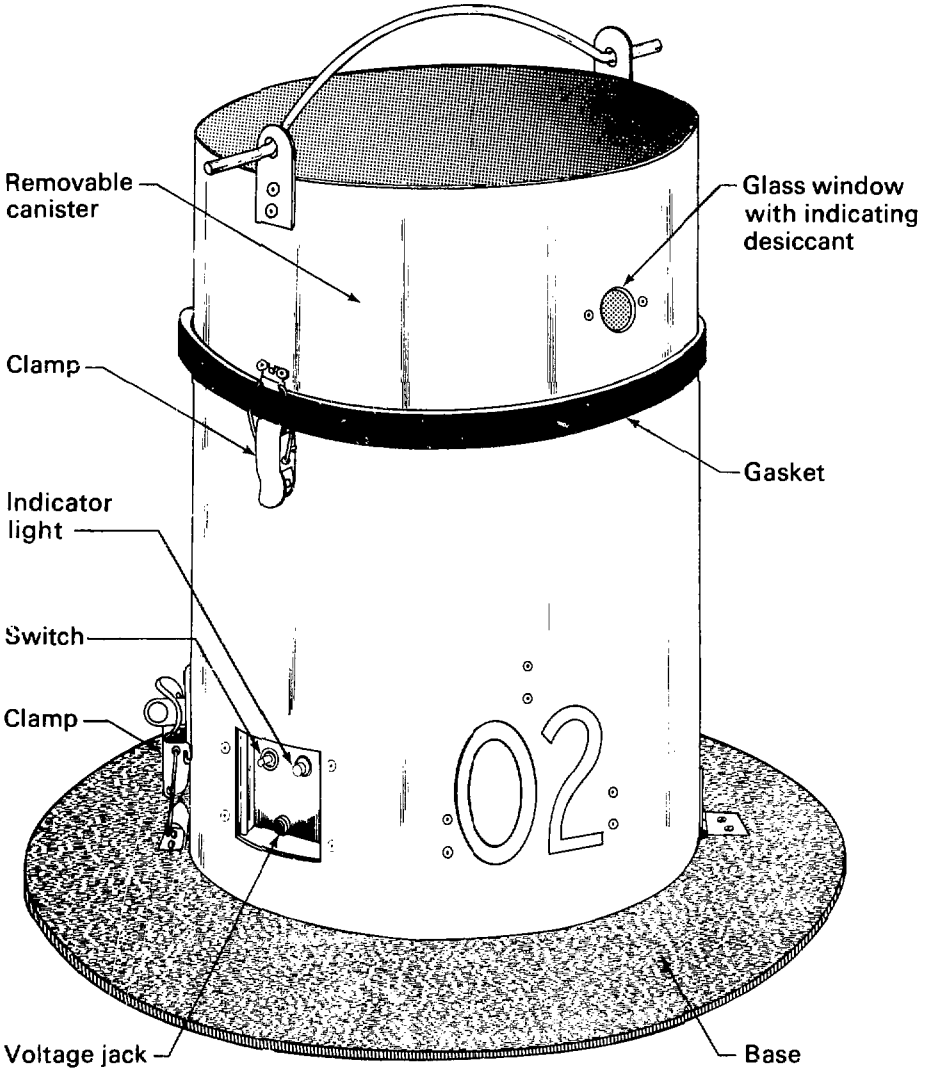
4 small brown boxes (see Fig. 2), each containing:

1 rubber stopper assembly mounted in a large black plastic vial. Thermoluminescent Dosimeter (TLD) chip is mounted on the small face of the rubber stopper (see Fig. 3); DO NOT TOUCH CHIP.

1 small black plastic vial containing a reference TLD chip. DO NOT OPEN VIAL.

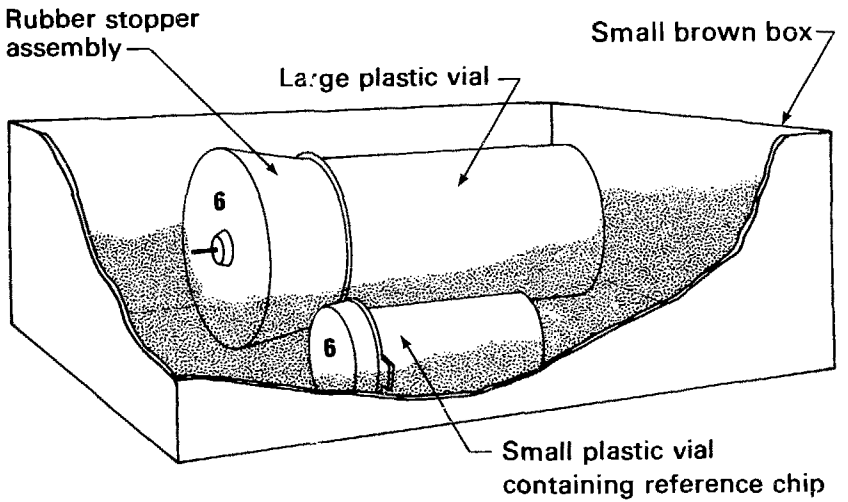
1 data card (see Fig. 4)

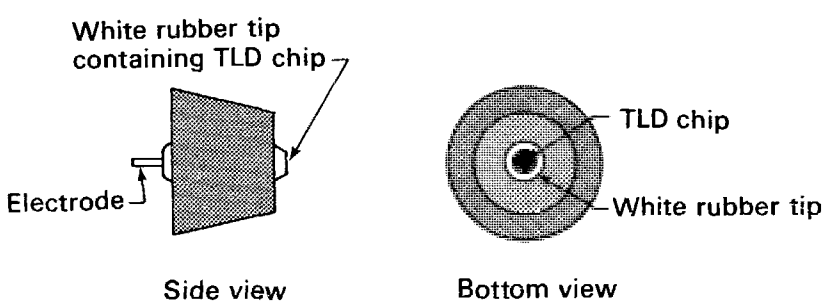
6 mailing labels



XBL 798-2628

Figure 1. Passive Environmental Radon Monitor (PERM), exterior view.





XBL798-2626

Figure 2. (top) Rubber stopper assembly and reference chip vial packaged in small brown mailing box.

Figure 3. (bottom) Detail of rubber stopper assembly.

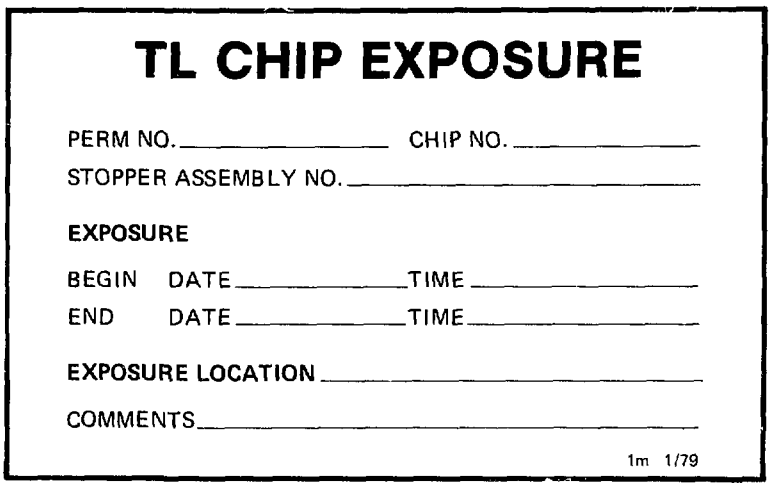


Figure 4. PERM data card.

IMPORTANT GUIDELINES: Observe the following at all times:

- DO NOT OPEN VIAL
- DO NOT TOUCH CHIPS. If a chip is dislodged or touched, return chip and rubber stopper assembly in its small brown box to LBL.
- DO NOT expose chips to fluorescent light or direct sunlight. Avoid excessive exposure to indirect or incandescent light.
- Keep rubber stopper and plastic vial in close proximity before, during and after exposure. Note how they are packaged and paired (Fig. 2.). The small brown box, rubber stopper assembly and small plastic vial in each set all bear the same identifying number.
- CAUTION: HIGH VOLTAGE. Electrode connector and external banana plug are -900 V with the PERM body and funnel as reference. There is a current limiter in the battery circuit, but 900 V will provide a shock.* DO NOT DEPRESS SAFETY BUTTON when working with an open PERM.
- PERM should not be exposed to high relative humidities. (Keep it out of the bathroom).
- Keep spare desiccant cannister in plastic bag to maintain dessicant charge.
- Keep PERM out of the reach of small children who might injure themselves or damage the instrument.

*DO NOT insert anything other than a banana jack into the external banana plug. (The banana plug is provided for use with a voltmeter to measure electrode voltage.) A safety switch button is connected to the PERM circuit so that electrode voltage will be disconnected when the PERM is open (Fig. 5).

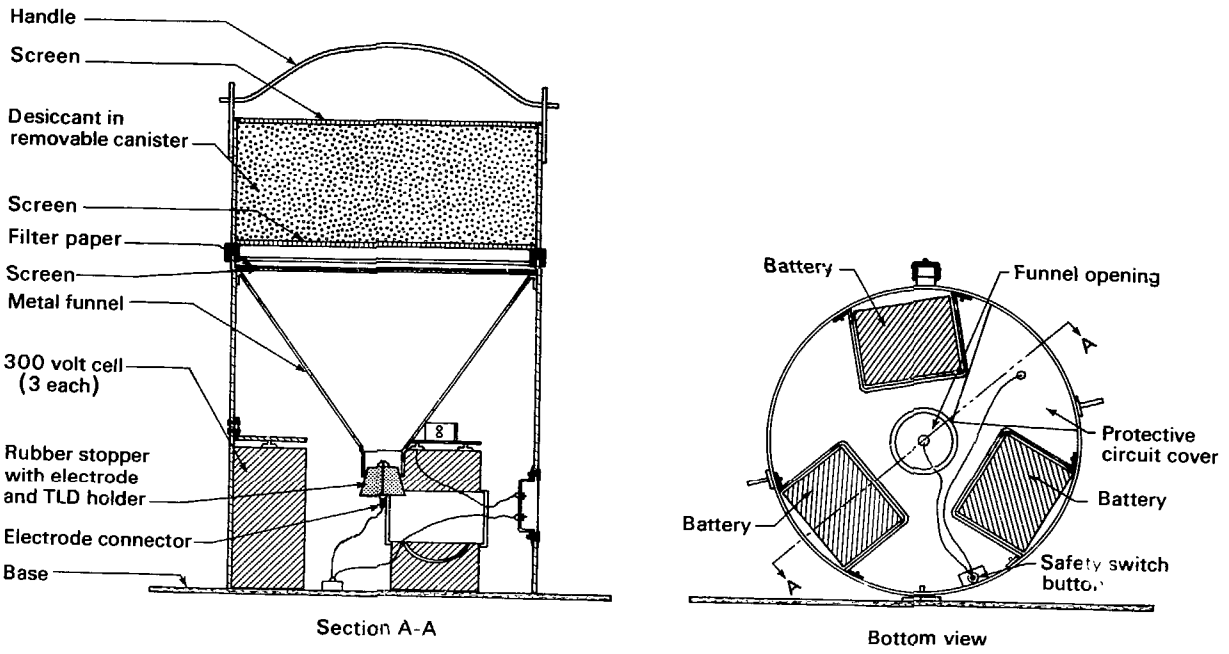


Figure 5. Schematic Drawing of Passive Radon Monitor

THE RADON MONITORING PROJECT:

OBJECTIVE:

The Passive Environmental Radon Monitor (PERM) is used in a Lawrence Berkeley Laboratory (LBL) project to assess the impact of energy conservation in buildings, especially reduced ventilation, on indoor air quality. A reduction in ventilation air could lead to increased concentrations of a variety of indoor contaminants. Radon is of particular concern because:

1. There are various sources of indoor radon, including concrete, other building materials, soil beneath foundations, and in some cases, water;

2. Substantial documentation shows elevated radon concentrations indoors; and

3. There is compelling evidence that very high exposures to radon (much higher than the general public would receive indoors) are the cause of disproportionate lung cancer rates in uranium miners.

The PERM program will enable LBL to measure indoor radon levels in a wide sampling of residential buildings.

PERMS:

The principle of operation of the PERMs is described as follows:

"The instrument operates on the principle, used in previous monitors, of electrostatic collection of ^{218}Po ions in a sensitive volume into which radon diffuses from ambient air through a porous barrier. The sensitive volume consists of a metal funnel with a filter paper sealed to the large opening and a rubber stopper, containing an electrode, inserted in the narrow opening. Application of a negative potential to the electrode attracts the positively charged ^{218}Po atoms that form within the funnel by the decay of radon. The cumulative alpha activity that collects on the electrode is detected continuously with a lithium fluoride thermoluminescent detector (1/8" x 1/8" x .015") which is mounted on the electrode tip. The thin LiF is very sensitive to alpha radiation and relatively insensitive to beta and gamma radiation. After a suitable period of exposure, usually one or two weeks, the lithium fluoride chip is removed and read in a TLD analyzer. The cumulative alpha activity is directly proportional to time-integrated radon concentration."*

*Andreas C. George, "A Passive Environmental Radon Monitor," in Radon Workshop, February 1977, HASL No. 325.

TLD CHIPS:

The thermoluminescent dosimeter (TLD) chips used in the PERM are made of lithium fluoride, the most common thermoluminescent material. When the chip is exposed in the PERM to ionizing radiation from the radioactive decay products of radon, electron hole pairs are generated. Some of the hole pairs enter metastable states above the ground state. The metastable states have potential energy wells deeper than room temperature thermal energy, so the electron hole pairs do not recombine until additional heat energy is supplied. Upon returning to the ground state, a photon is emitted. The chip is analyzed at LBL using a TLD reader. This instrument heats the chip at a specified cycle, and counts the photons that are subsequently emitted with a photomultiplier tube and counting electronics. The reading is proportional to the integrated radon concentration during exposure.

Because the TLD chips are somewhat sensitive to background gamma radiation, a reference chip in a small black plastic vial is paired with the chip in each rubber stopper assembly. The reference chip will be exposed to the same amount of background radiation as the chip in the rubber stopper assembly and its background reading can be subtracted from that of the stopper assembly chip so that a true value of the radon exposure is obtained.

SAMPLING PROCEDURE:

1. Check battery potential by depressing the switch on the side of the PERM (Fig. 1). If the red light goes on, the voltage is O.K. If not, the batteries should be replaced. See section on Problems and contact LBL.

2. Check the desiccant charge by looking into the circular window on the cannister (Fig. 1). The desiccant is blue if charged and pink if exhausted. Under normal conditions, the charge should last two weeks. If the desiccant is pink, replace the cannister with the spare unit or recharge the desiccant. You can remove the cannister by opening the two latches on the side of the PERM and lifting the cannister up by its handle. You may return the cannister to LBL for a new one or recharge the desiccant by baking the cannister in a regular kitchen oven for several hours at 150°C (300°F).

3. Open the PERM by unhooking the latch at the base next to the light switch. When the PERM is opened, the safety switch button is released and the electrode voltage disconnected. DO NOT DEPRESS BUTTON while working with the open PERM.

4. Open one of the small brown boxes included with the PERM (Fig. 2). Remove the rubber stopper assembly from its large plastic vial and visually check the rubber stopper assembly to make sure the chip is in place (Fig. 3). (The chip should be tucked into the white rubber tip. The chip looks like a 1/8" square of translucent paper.)

5. Place rubber stopper--chip first--in the funnel inside the PERM (Fig. 5). Press the rubber stopper into the funnel firmly, with a twisting motion.

6. Locate the electrode connection inside the PERM. The connector fits snugly over the electrode protruding from the rubber stopper. Attach the connector by pushing it gently over the electrode until it is secure.

7. Place the small vial containing a reference chip on base of PERM as indicated by the diagram on the inner side of the PERM base.

8. Close PERM--remember to reattach the latch on the base.

9. Locate the PERM in a place where the air is somewhat typical, e.g., the bedroom, den or living room, unless a specific location has been requested by LBL.

10. Log all information on data sheets provided in this binder, and on the card in the small brown box. Fill out the Housing Structure Survey questionnaire supplied separately with this binder (a sample questionnaire is given on page 14 of this binder).

11. The normal sampling period is one week, unless otherwise specified by LBL.

12. At the end of one week (or other specified time period), remove the rubber stopper assembly and small plastic vial. Log the date and the time as indicated on the data sheet and card. Place the exposed rubber stopper assembly in its large plastic vial and pack it with the small plastic vial, the data card and the Housing Structure Survey questionnaire in the small brown box. Seal the box and mail to LBL using labels supplied. If another measurement period is required, repeat procedure starting with step 1, using a new rubber stopper assembly package.

13. Happy Radon Hunting!

SHIPPING NOTES:

Unless instructed otherwise, user should mail exposed rubber stopper assembly and exposed vial back to LBL weekly. The chips will be read out at LBL and an unexposed package will be returned to the user. When mailing exposed materials, include enough packing material to prevent jostling. Remember that the rubber stopper assembly and small plastic vial should be kept in close proximity before, during and after exposure.

PROBLEMS:

If any problems or questions arise, please call (collect) one of the following persons at Lawrence Berkeley Laboratory:

Mary Boegel
John Ingersoll
Buck Koonce

Lawrence Berkeley Laboratory
Ventilation Program
1 Cyclotron Road, Bldg. 90/rm.3038
Berkeley, California 94720

Commercial Phone: (415) 486-6591
FTS: 451-6591

PERM DATA LOG

PERM NO._____

LOG SHEET NO._____

EXPOSURE BEGIN: DATE_____ TIME_____

END: DATE_____ TIME_____

STOPPER ASSEMBLY NO._____

LOCATION NAME OF BUILDING_____

CITY_____ STATE_____

PERM LOCATION_____

COMMENTS _____

_____

EXPOSURE BEGIN: DATE_____ TIME_____

END: DATE_____ TIME_____

STOPPER ASSEMBLY NO._____

LOCATION NAME OF BUILDING_____

CITY_____ STATE_____

PERM LOCATION_____

COMMENTS _____

_____

EXPOSURE BEGIN: DATE_____ TIME_____

END: DATE_____ TIME_____

STOPPER ASSEMBLY NO._____

LOCATION NAME OF BUILDING_____

CITY_____ STATE_____

PERM LOCATION _____

COMMENTS _____

_____

EXPOSURE BEGIN: DATE_____ TIME_____

END: DATE_____ TIME_____

STOPPER ASSEMBLY NO._____

LOCATION NAME OF BUILDING_____

CITY_____ STATE_____

PERM LOCATION_____

COMMENTS _____

_____

PERM DATA LOG

PERM NO.________

LOG SHEET NO.________

EXPOSURE	BEGIN: DATE________ TIME________	
	END: DATE________ TIME________	
	STOPPER ASSEMBLY NO.________	
LOCATION	NAME OF BUILDING________	
	CITY________	STATE________
	PERM LOCATION________	
COMMENTS	________	
EXPOSURE	BEGIN: DATE________ TIME________	
	END: DATE________ TIME________	
	STOPPER ASSEMBLY NO.________	
LOCATION	NAME OF BUILDING________	
	CITY________	STATE________
	PERM LOCATION________	
COMMENTS	________	
EXPOSURE	BEGIN: DATE________ TIME________	
	END: DATE________ TIME________	
	STOPPER ASSEMBLY NO.________	
LOCATION	NAME OF BUILDING________	
	CITY________	STATE________
	PERM LOCATION________	
COMMENTS	________	
EXPOSURE	BEGIN: DATE________ TIME________	
	END: DATE________ TIME________	
	STOPPER ASSEMBLY NO.________	
LOCATION	NAME OF BUILDING________	
	CITY________	STATE________
	PERM LOCATION________	
COMMENTS	________	

PERM DATA LOG

PERM NO.______

LOG SHEET NO.______

EXPOSURE	BEGIN: DATE ______ TIME ______	
	END: DATE ______ TIME ______	
	STOPPER ASSEMBLY NO. ______	
LOCATION	NAME OF BUILDING ______	
	CITY ______	STATE ______
	PERM LOCATION ______	
COMMENTS	______	
	______	
EXPOSURE	BEGIN: DATE ______ TIME ______	
	END: DATE ______ TIME ______	
	STOPPER ASSEMBLY NO. ______	
LOCATION	NAME OF BUILDING ______	
	CITY ______	STATE ______
	PERM LOCATION ______	
COMMENTS	______	
	______	
EXPOSURE	BEGIN: DATE ______ TIME ______	
	END: DATE ______ TIME ______	
	STOPPER ASSEMBLY NO. ______	
LOCATION	NAME OF BUILDING ______	
	CITY ______	STATE ______
	PERM LOCATION ______	
COMMENTS	______	
	______	
EXPOSURE	BEGIN: DATE ______ TIME ______	
	END: DATE ______ TIME ______	
	STOPPER ASSEMBLY NO. ______	
LOCATION	NAME OF BUILDING ______	
	CITY ______	STATE ______
	PERM LOCATION ______	
COMMENTS	______	
	______	

Lawrence Berkeley Laboratory
Energy and Environment Division
Ventilation Group

HOUSING STRUCTURE SURVEY

Family Name _____ LBL Code _____

Address _____

Telephone _____ Date _____

GENERAL STRUCTURE CHARACTERISTICS

House Type: ☐ detached ☐ attached ☐ apartment ☐ other (specify) _____

Size: Ground Level Area (include attached garage) _____ ft^2 Total Volume _____ ft^2 Age: _____

Structure Materials: ☐ wood ☐ concrete block ☐ poured concrete ☐ other (specify) _____

External Cladding: ☐ wood ☐ stucco ☐ brick ☐ metal ☐ vinyl ☐ concrete ☐ other (specify) _____

Number of floors above substructure: ☐ one ☐ two ☐ three ☐ split ☐ other (specify) _____

Attic: ☐ yes ☐ no Use: ☐ storage ☐ residence ☐ other (specify) _____

Vents: ☐ yes ☐ no Windows: ☐ yes ☐ no

Garage: ☐ detached ☐ attached—one wall borders living space ☐ attached—two walls border living space

Door to living space: ☐ yes ☐ no Area: _____ ft^2

INTERIOR SURFACE MATERIALS

Walls: _____ plaster board, _____ wood, _____ plaster, _____ brick, _____ other (specify) _____

Floors: _____ wood, _____ linoleum, _____ carpet, _____ other (specify) _____

Ceilings: _____ wood, _____ plaster board, _____ plaster, _____ other (specify) _____

ENERGY USE ASPECTS

Heating System: ☐ central forced air ☐ hot water/steam ☐ baseboard ☐ wall/space heater ☐ other (specify) _____

Energy: ☐ gas ☐ oil ☐ electric ☐ solar ☐ other (specify) _____

Heat Exchanger: ☐ central ☐ window _____ flow rate

Fire Places: _____ number in house _____ number with dampers _____ number with glass doors

Air Conditioning: ☐ central ☐ windows ☐ heat pump

Infiltration Characteristics: ☐ apparently tight ☐ apparently leaky ☐ uncertain

Weather Stripping: ☐ doors ☐ windows

Exhaust Fans: ☐ *kitchen* ☐ *bathroom* ☐ *other (specify)* _____

Flue Vents: ☐ oven ☐ furnace ☐ other (specify) _____

SUBSTRUCTURE (Complete more than one section, if applicable.)

Basement: floor area _____ ft^2 depth below ground _____ ft. height above ground _____ ft.

Floor Material ☐ open ground ☐ concrete, thickness _____ in. (if known) ☐ other (specify) _____

Floor Finish: ☐ sealant ☐ paint ☐ linoleum ☐ carpet ☐ other (specify) _____

Wall Material: ☐ concrete block ☐ poured concrete ☐ stone ☐ wood ☐ other (specify) _____

Wall Finish: ☐ sealant ☐ paint ☐ plasterboard ☐ other (specify) _____

Doors: ☐ to exterior ☐ to living space ☐ windows _____ ft^2 (total window area)

Drainage: ☐ sump ☐ drain ☐ none ☐ other (specify) _____

Use: ☐ recreation ☐ storage ☐ residence ☐ other (specify): _____

Crawl Space: area _____ ft^2 depth below ground _____ ft. height above ground _____ ft.;

Floor Material: ☐ open ground ☐ concrete, thickness _____ in. (if known) ☐ other (specify) _____

Floor Finish: ☐ sealant ☐ paint ☐ none ☐ other (specify) _____

Wall Material: ☐ concrete block ☐ poured concrete, thickness _____ in. (if known) ☐ stone ☐ wood ☐ other (specify) _____

Vents: ☐ yes ☐ no Door (or other opening): ☐ to exterior ☐ to living space

Slab: area _____ ft^2 thickness _____ in. (if known)

Finish: ☐ paint ☐ linoleum ☐ carpet ☐ wood ☐ other (specify) _____

Other Substructure Type: Describe. _____