

Radon Control Options
for
Design and Construction
of
New Low Rise Residential Buildings

**Summary of Standard Practice Under Consideration
based on a
Preliminary Version being prepared for Submission to ASTM Ballot
in
January 2005**

Presented by
Philip H. Anthes
of
Massachusetts Department of Public Health's Radon Program
at the
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Work-in-Progress

(Not an Approved Standard)

Radon Control Options for Design and Construction of New Low Rise Residential Buildings

Fourteenth National Radon Meeting P. H. Anthes Nov. 10, 2004

Terminology Changes

Fan Powered replaces **Active**

Radon Reduction replaces **Radon Mitigation**

Radon Control for New Construction (RCNC)
replaces

Radon Resistant New Construction (RRNC)

Applicable Everywhere

- **Applicable beyond “Zone 1” areas**
- **Architects and/or owners can specify practice as a construction specification**

Complete System

- **Before occupancy, builder**
 - **Builds-in system**
 - **Tests**
 - **Makes system operable (when necessary)**
 - **Retests (if operable)**
- **Can be fan powered or passive.**

Partial System

- **Before occupancy, builder**
 - Builds-in system
- **After occupancy, owner**
 - Tests
 - **Finishes** (when necessary)
 - **Retests** (if finished)
- **Can be fan powered or passive**

System Types

- **E 1465 (RCNC)**
 - Partial
 - Complete
 - Passive
 - Fan Powered
- **RRNC**
 - Passive
 - Active (fan powered)

Partial System

- The partial radon system's initial installation— includes every item that if installed later would require cutting into existing walls, floors and roofs.
- Major Advantage— reduced overall cost because on a national basis only 8% of new residential buildings will require an operable radon system.
 - Note: This percentage can vary widely from state to state and from one building development to another.]

Complete Passive System

- **Complete passive radon** system is **built-in** during construction and **tested**.
- **When initial test results are unacceptable the system is made operable before occupancy**
 - a) by removing the vent stack cap or
 - b) (when desired for greater radon reduction) by conversion to a fan powered system
 - c) with post-mitigation test and system repair if necessary
- **Major Advantages—**
 - The **lowest operating cost** when operated passively, with up to 50% radon reduction
 - Buyer is **assured of acceptable radon concentrations** before occupancy.

Complete Fan Powered System

- **Complete fan powered radon system is built-in during construction and tested.**
- **When initial test results are unacceptable the system is made operable before occupancy**
 - a) by removing the vent stack cap and
 - b) by turning-on the radon fan
 - c) with post-mitigation test and system repair if necessary
- **Major Advantages—**
 - The **greatest radon reduction, up to 99%.**
 - Buyer is **assured of acceptable radon concentrations before occupancy.**

Energy and Heat Loss

- Initially, **all** ASTM E 1465 radon **systems** **would have capped vent stack pipes.**
- If screening **test** result is **low**, **cap is not removed**
 - saving electric power** for fan powered systems because fan doesn't operate
 - saving fuel** because heat loss from vent stack is prevented

E 1465 Radon System Characteristics

- **Complete** or **Partial**
- **Fan Powered** or **Passive**
- **Operable** or **Not operable**
- **Vent Sack:**
 - **Cap-on** or **Cap-off**

Complete Radon System

- **100% Complete before Occupancy**
 - System Installed.
 - Tested per radon screening test protocol.
 - Made operable, if screening test is high.
 - Tested per post-mitigation test protocol (operable systems only.)
 - System repaired and/or upgraded, if post-mitigation test is high, then retested.
 - Label installed, describing installed system and how it should be maintained.
 - Third party post-mitigation test results provided.

Partial Radon System

- **Certain Parts Installed before occupancy:**
 - All foundation components
 - Complete capped vent stack terminating above roof
 - **Label**— notifying owner/occupant that:
 - Partial radon system is installed.
 - Partial system is not operable.
 - Builder was not required to test radon system.
 - Building should be tested for radon after occupancy, and if test results are high, completed and retested.
 - That certain completion options are available and compatible.

Operable or Not operable

- **Two Operable Systems**
 - Complete Fan Powered System
 - Complete Passive System
- **Four Non-operable Systems**
(i.e. with vent stacks capped)
 - Complete Fan Powered System
 - Complete Passive System
 - Partial System with Fan Powered Pipe Route
 - Partial System With Passive Pipe Route

Vent Sack: Cap-on or Cap-off

- **Cap-on:**
 - Makes system non-operable.
 - **Permits valid radon screening test result**
 - used to determine if radon system is required.
 - also used as the “before” number in % reduction calculations.
 - Prevents heat loss from vent stack.
 - Keeps rain, snow and squirrels out of vent stack.
 - Expected condition in 92% of all installations nation wide.
- **Cap-off:**
 - Makes system operable.
 - **Permits valid post mitigation test result**
 - to determine that post-mitigation radon levels are acceptable.
 - to be used as the “after” number in % deduction calculations.

Sample: Radon System Label

Radon Reduction System

Radon system specification: ASTM E 1465

Type: Soil Depressurization – Fan Powered

Configuration: Complete

Status: Operable

Upgrade Option: Install higher capacity radon fan.

Description:

A complete fan powered soil depressurization radon reduction system is installed in this building. The system's radon fan should always be running.

System Monitoring:

Read the radon system monitor periodically. The radon system monitor displays vent stack suction pressure, which is an indicator of the radon system's performance. If the monitor's readings change so that they are outside the normal operating pressure range, which should be shown on the face of the monitor, call for radon system service.

The state radon contact can provide names and phone numbers of certified or licensed radon contractors.

Radon Testing:

Test the dwelling units in this building for radon soon after occupancy. During this and future radon tests in this building the vent stack should not be capped and the radon fan should be running.

At least once every two years, this dwelling unit should be retested for radon.

Also retest the dwelling units for radon whenever there has been a change of ownership, occupants, heating ventilating or air conditioning equipment, or when the building's structure has been changed by renovations like additions and finishing rooms in basements or attics, etc.

Radon Test Result Interpretation:

When radon test results are 4 pCi/L (150 Bq/m³) or more, promptly repair and retest the system.

When radon test results are 2 pCi/L (75 Bq/m³) or more but are less than 4 pCi/L (150 Bq/m³), for additional health benefits consider installing a higher capacity radon fan or otherwise modifying the radon system to obtain radon reduction below 2 pCi/L (75 Bq/m³).

Additional Radon Information:

Call your state radon contact for additional radon information, including the names and phone numbers of certified or licensed radon contractors. The state radon contact phone number is available from U.S. EPA Regional Offices.

E 1465 Label No.1

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Label: Description

Radon Reduction System

Radon system specification: ASTM E 1465

Type: Soil Depressurization – Fan Powered

Configuration: Complete

Status: Operable

Upgrade Option: Install higher capacity radon fan.

Description:

A complete fan powered soil depressurization radon reduction system is installed in this building. The system's radon fan should always be running.

Label: Operating Instructions

System Monitoring:

Read the radon system monitor periodically. The radon system monitor displays vent stack suction pressure, which is an indicator of the radon system's performance. If the monitor's **readings** change so that they are **outside the normal operating pressure range**, which should be shown on the face of the monitor, **call for radon system service**.

The state radon contact can provide names and phone numbers of certified or licensed radon contractors.

Label: Radon Testing

Radon Testing:

Test the dwelling units in this building for radon soon after occupancy. During this and future radon tests in this building the **vent stack should not be capped and the radon fan should be running.**

At least **once every two years**, this dwelling unit should be retested for radon.

Also retest the dwelling units for radon whenever there has been a **change of ownership, occupants, heating ventilating or air conditioning equipment, or when the building's structure has been changed by renovations** like additions and finishing rooms in basements or attics, etc.

Label: Test Result Interpretation

When radon test results are 4 pCi/L (150 Bq/m³) or more, promptly repair and retest the system.

When radon test results are 2 pCi/L (75 Bq/m³) or more but are less than 4 pCi/L (150 Bq/m³), for additional health benefits consider installing a higher capacity radon fan or otherwise modifying the radon system to obtain radon reduction below 2 pCi/L (75 Bq/m³).

Label: Additional Information

Additional Radon Information:

Call your state radon contact for additional radon information, including the names and phone numbers of certified or licensed radon contractors. The state radon contact phone number is available from U.S. EPA Regional Offices.

E 1465 is about Radiation Protection

“1.4 Radon in air testing is used to assure the effectiveness of these soil depressurization radon systems. **The US national goal** for indoor radon concentration, established by the US Congress in the 1988 Indoor Radon Abatement Act, is to **reduce indoor radon as close to the levels of outside air as is practicable**. The radon concentration in outside air is about 0.4 picocuries per litre (pCi/l) (15 Becquerels per cubic metre (Bq/m³)); the U.S.’s average radon concentration in indoor air is 1.3 pCi/L (50 Bq/m³). **The goal of this practice is to make available new residential buildings with indoor radon concentrations below 2.0 pCi/L (75 Bq/m³) in occupiable spaces**. This practice attempts to pursue the ALARA goal, used in the radiation protection disciplines, that recommends that **radiation exposure should be reduced to levels which are “as low as reasonably achievable.”**”

Part of a **Passive** System Label

Radon Test Result Interpretation:

When radon test results are **6 pCi/L (225 Bq/m³) or more**, promptly finish this partially installed system as a **complete fan powered system**. After the operable fan powered installation is finished relabel the operable system and retest.

When radon test results are **4 pCi/L (150 Bq/m³) or more but are less than 6 pCi/L (225 Bq/m³)**, a) either promptly finish this partially installed system as a **complete passive system**, and then relabel the system and retest or b) for greater health benefit and radon reduction promptly finish this system as a **complete fan powered system**, and then relabel the operable system and retest.

When radon test results are **2 pCi/L (75 Bq/m³) or more but are less than 4 pCi/L (150 Bq/m³)**, a) either finish this partially installed system as a complete passive system, relabel the system and retest, or b) for greater health benefit and radon reduction, **consider converting** this system **to a complete fan powered system**, and then relabeling the system and retesting.

Comprehensive Set of Construction Methods

- **Foundation Types**
 - Slab-on-Grade Foundations
 - Full and Partial Basement Foundations
 - Crawlspace Foundations
 - Combination Foundations
- **Ground Covers**
 - Poured Concrete Floor and Thin Slabs
 - Sealed Polyethylene Membranes in Crawlspaces

Construction Methods (cont)

- **Foundation Walls**
 - Solid Foundation Walls
 - Hollow Foundation Walls
 - Barriers at Top of Wall
 - Barriers at Ledges and Above and Below Openings for Windows and Doors
 - Foundations without Walls
 - Mobile Homes
 - Post-Tensioned Slab Foundations
 - Manufactured Homes
 - Damp-Proofing
 - Sealing Walls Below Grade

Construction Methods (cont)

- **Gas-Permeable Layer**
 - Sub-Slab Gas-Permeable Layers
 - Sub-Membrane Gas-Permeable Layers
 - Not All Gas-Permeable Layers are Equal
- **Soil-Gas Collectors**
 - Type 1- Buried **Length of Perforated Pipe**
 - Type 2- Buried **Loop of Perforated Pipe**
 - Type 3- Buried **Loop of Perforated Pipe in a Trench**
 - Type 4- Proprietary **Mat Strips** on Soil
 - Type 5- **Loop of Perforated Pipe on Soil** under Membrane

Construction Methods (cont)

- **Pipe Connections to Soil-Gas Collectors**
 - Method 1: Vertical Suction Point Pipe Directly Over Soil-Gas Collector Pipe
 - Method 2: Vertical Suction Point Pipe Offset from Soil-Gas Collector Pipe
 - Method 3: Horizontal Suction Point Pipe Beside Soil Gas Collector Pipe
 - Method 4: Suction Points Connected by a Manifold under a Slab or Membrane
 - Method 5: Vertical Suction Point Pipe Directly Over Sub Membrane Gas-Collector Pipe
 - Method 6: Vertical Suction Point Pipe Directly Over Gas-Collector Mat

Construction Methods (cont)

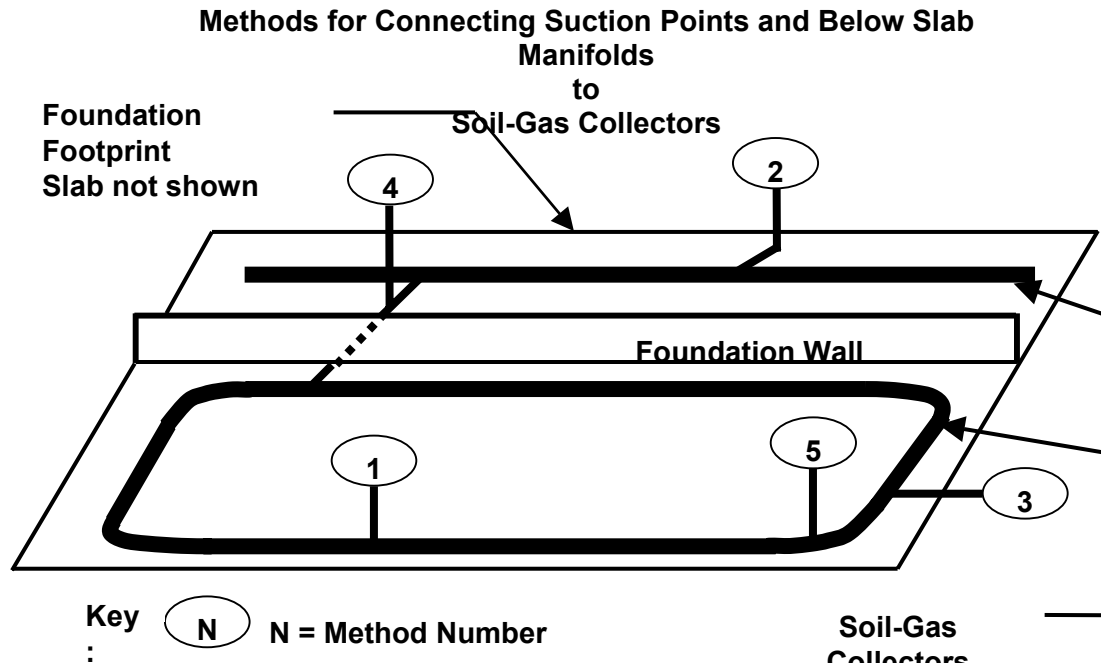


Figure 1: Methods for Connecting to Soil-Gas Collectors

Construction Methods (cont)

- **Sealing Gas-Permeable Layer**
 - Sealing **Top**
 - Sealing **Sides**
 - Sealing **Bottom**
 - Sealing at **Penetrations**
 - Ducts
 - Pipes

Construction Methods (cont)

- **Radon System Piping**
 - **Physical Requirements of Pipe**
 - **Pipe Wall Thickness**
 - **Above Ground Pipe**
 - **Below Ground Pipe**
 - **Pipe Size**
 - Above Ground Pipe Size
 - Below Ground Pipe Size
 - **Connection to Gas-Permeable Layer**
 - **Discharge from Vent Stack Pipes**
 - **Pipe Route**
 - **Fan Powered (Active) System Pipe Route**
 - **Passive System Pipe Route**
 - **Partial Radon System Pipe Route**
 - Pipe Route vs. Goals for Radon Reduction System
 - **Radon System Piping Drainage**
 - **Radon System Fan Mounting Space and Piping Accessibility**
 - Accessibility for Fan Installation
 - Accessibility for Radon System Monitor
 - **Radon System Piping Supports**
 - **Pipe Insulation**

Construction Methods (cont)

- **Radon System Electrical Requirements**
 - Electrical Junction Box for Radon Fan to be Installed under the Roof
 - Electrical Junction Box for Radon Fan to be Installed above the Roof
 - Electrical Junction Box for Electrically Operated Radon System Monitor
 - Circuit Lists
 - Disconnecting Means
 - Electrical Code
- **Radon Labels**
 - Pipe Labels
 - Fan Powered Radon System Label
 - Membrane Inspection Label
 - Radon System Labels
 - Radon System Label No.1 (Complete fan powered operable system)
 - Radon System Label No.2 (Complete fan powered non-operable system)
 - Radon System Label No.3 (Complete passive operable system)
 - Radon System Label No.4 (Complete passive non-operable system)
 - Radon System Label No.5 (Partial fan powered pipe route non-operable system)
 - Radon System Label No.6 (Partial passive pipe route non-operable system)

Testing New Construction Radon

- **Radon Tests**
 - **Radon Test Correctness**
 - **Vent Stack Cap and Testing**
 - **Independent Radon Tests**
 - **Heat Loss Prevention after Radon Testing**
 - **Radon Testing**
 - **Builder's Required Radon Testing for Complete Radon Systems**
 - **Owner's Advised Radon Testing for Partial Radon Systems**

Interpreting Test Results

- **Action Required for Complete Fan Powered Systems**
 - When **Screening Tests** Equal or **Exceed 4 pCi/L** (150 Bq/m³)
 - When **Post Mitigation Tests** Equal or **Exceed 4 pCi/L** (150 Bq/m³)
 - When Screening or Post Mitigation Tests Equal or **Exceed 2 pCi/L** (75 Bq/m³) but are Less than 4 pCi/L (150 Bq/m³)
- **Action Required for Complete Passive Systems**
 - When **Screening Tests** Equal or **Exceed 6 pCi/L** (225 Bq/m³)
 - When **Screening Tests** Equal or **Exceed 4 pCi/L** (150 Bq/m³) but are Less than 6 pCi/L (225 Bq/m³)
 - When **Post Mitigation Tests** Equal or **Exceed 4 pCi/L** (150 Bq/m³)
 - When Screening or Post Mitigation Tests Equal or **Exceed 2 pCi/L** (75 Bq/m³) but are Less than 4 pCi/L (150 Bq/m³)
- **Action Required for Partial Systems with Fan Powered Pipe Route**
 - When **Screening Tests** Equal or **Exceed 4 pCi/L** (150 Bq/m³)
 - When **Post Mitigation Tests** Equal or **Exceed 4 pCi/L** (150 Bq/m³)
 - When Screening or Post Mitigation Tests Equal or **Exceed 2 pCi/L** (75 Bq/m³) but are Less than 4 pCi/L (150 Bq/m³)
- **Action Required for Partial Systems with a Passive Pipe Route**
 - When **Screening Tests** Equal or **Exceed 6 pCi/L** (225 Bq/m³)
 - When **Screening Tests** Equal or **Exceed 4 pCi/L** (150 Bq/m³) but are Less than 6 pCi/L (225 Bq/m³)
 - When **Post Mitigation Tests** Equal or **Exceed 4 pCi/L** (150 Bq/m³)
 - When Screening or Post Mitigation Tests Equal or **Exceed 2 pCi/L** (75 Bq/m³) but are Less than 4 pCi/L (150 Bq/m³)
- **Acceptable Radon Test Results**

Presentation

Ends!

Questions?