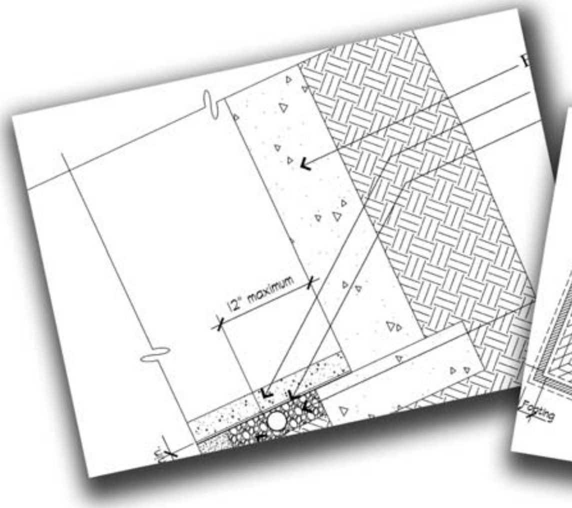

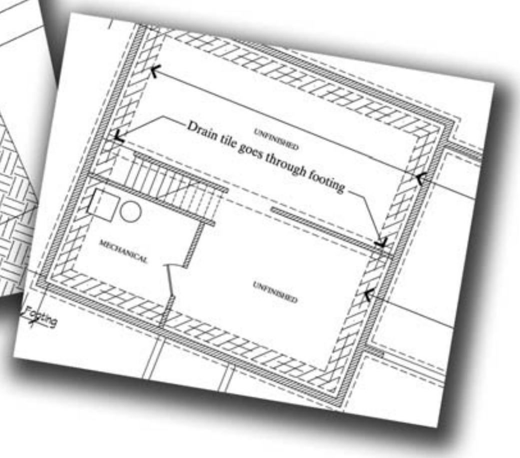

Member Guide

Alternate Method for the Gas Permeable Layer Required for Passive Radon Systems in the Minnesota Residential Energy Code

(Section AF103.2 Subfloor preparation)

Version 1.0 • July 2009

BUILDERS
ASSOCIATION OF MINNESOTA

Check the BAM website for updates to this guide and other resources: ***www.bamn.org/energycode***

Illustrations for this guide were generously donated by BAM Member,
Cundy Santine and Associates Architects

Original code language for the Minnesota Residential Energy Code
(Minnesota Rules Chapter 1322) may be downloaded from
www.bamn.org/energycode

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Introduction

Building and remodeling permits applied for on or after June 1, 2009 must comply with the new Residential Energy Code, Chapter 1322 of the Minnesota State Building Code. The Builders Association of Minnesota (BAM) has published this guide to help residential contractors submit a proposal to their local building official for an alternate method to complying with section AF103.2 of the new energy code. Contractors must specifically request and be granted permission from each local building code official in each municipality to use this method during the plan review phase of the permitting process, well before construction begins.

The Builders Association of Minnesota and our 14 local associations throughout Minnesota provided the resources to create this guide. BAM member Cundy Santine & Associates Architects created and donated the illustrations in this guide, and we are grateful for their support.

BAM is solely responsible for the content of this guide, not our project partners. This guide is intended to help contractors gain prior approval from local building officials to install an alternate method to section AF103.2 of the Minnesota Residential Energy Code.

Summary of the Alternate Method for AF103.2, #3

The following documentation presents an alternate system to meet the code intent of AF103.2 #3 of the Residential Energy Code, Chapter 1322 of the Minnesota State Building Code. The system uses a 4 inch sand base and an interior draintile that follows the perimeter of the foundation and is buried in a trench filled with clean aggregate sized at 1 – 1½ inches. The draintile loop can also be used as part of a water collection system. The draintile loop can also connect to the required radon vent pipe anywhere along the loop. Provisions are made for foundations that have interior foundation walls and foundations that exceed 2,000 and 4,000 square feet.

Alternate Method Code Language for AF103.2, #3

The Minnesota Residential Energy Code's radon provisions were based Appendix F of the 2006 International Residential Code. Both of these codes allow the use of a geotextile collection mat/soil gas collection mat with 4 inches of base sand as a gas-permeable layer to meet the requirements of AF103.2, #3. Given the technical reasons listed in this guide the following system is certainly an equivalent that has demonstrated the "capability to permit depressurization across the entire sub-floor area." The following alternate code language can be found in Appendix 1.

The following code language can be submitted to your local building official as an alternate method per AF103.2 Subfloor preparation, #3. To use this option pre-approval is required from your local building inspection department BEFORE CONSTRUCTION.

AF103.2 Subfloor preparation, alternate method using option #3.

A radon collection system must be installed under concrete floor slab areas and conditioned crawlspaces. A continuous loop of minimum 3 inch or 4 inch perforated pipe shall be laid in the sub-grade below the concrete slab. The pipe may be rigid or flexible but must be perforated. The loop of perforated pipe must be buried in a trench of gravel which is at least 1 foot (0.3 m) wide and a minimum of 4 inches (100 mm) deep. The trench gravel must be washed and measure at least 1 to 1½ inches (25 to 33 mm). The trench shall follow the interior perimeter of the foundation. In buildings where interior footings or other barriers separate the sub-grade area, the loop of pipe shall go through, not below, interior footings or barriers. The suction point shall be attached anywhere along the draintile loop to the vent stack. The suction point may be located in a sump basket provided a sump basket cover designed specifically to accommodate a radon pipe is used. The radon collection system described in this section may also be used as a sub-slab drainage system.

For slab areas up to 2,000 square feet (186 m2) a minimum of 3-inch diameter (102 mm) pipe shall be installed. For slabs over 2,000 square feet but less than 4,000 square feet a minimum 4-inch (102 mm) diameter pipe shall be installed. Slab areas over 4,000 square feet shall have a separate loop of 4 inch diameter pipe for every additional 2,000 square feet of slab area; a separate suction point must be used for each additional drain tile loop.

This code language was adapted from the following three sources:

1. Building Radon Out: A Step-by-Step Guide On How To Build Radon-Resistant Homes. U.S. Environmental Protection Agency: April 2001. EPA/402-K-01-002.

2. ASTM E 1465-07a: Standard Practice for Radon Control for the Design and Construction of New Low-Rise Residential Buildings. ASTM International: 2007
   a. This reference did not specify the type of base that could be used under the slab and around the gravel trench.

3. Ordinance No. 126, 2004 of the Council of the City of Fort Collins Amending Chapter 5, Article II, Division 2, of the City Code for the Purpose of Adopting the 2003 International Residential Code© (IRC), With Amendments, page 93 AF103.2, option 2. Downloaded from the City of Fort Collins Public Records Website: ***http://citydocs.fcgov.com***. To order an official copy, contact City Clerk's Office City Hall West 300 LaPorte Avenue Fort Collins, CO 80521
   a. Much of the Fort Collins amendment language came directly from the Building Radon Out document. However, the code language did not include specifications on a gravel bed for the drain tile loop and specifications for a sand base.

Background to Section AF103.2

The Minnesota Residential Energy Code requires all new residential construction to include a passive radon system. If the passive radon system does not adequately control radon to a level acceptable to a homeowner the system can be easily activated by installing a radon fan. The Energy Code requires the installation of a layer of gas-permeable material to "facilitate the installation of an active sub-slab depressurization system if needed." [AF103.1 on page 45 of the code]. Section AF103.2 states:

AF103.2 Subfloor preparation.
A layer of gas-permeable material shall be placed under all concrete slabs and other floor systems that directly contact the ground and are within the walls of the living spaces and conditioned crawl spaces of the building, to facilitate the installation of an active sub-slab depressurization system if needed. The gas-permeable layer shall consist of one of the following:

1. *A uniform layer of clean aggregate, a minimum of 4 inches (102 mm) thick. The aggregate shall consist of material that will pass through a 2-inch (51 mm) sieve and be retained by a 1/4-inch (6.4 mm) sieve.*

2. *A uniform layer of sand (native or fill), a minimum of 4 inches (102 mm) thick, overlain by a layer or strips of geotextile drainage matting designed to allow the lateral flow of soil gases.*

3. *Other materials, systems, or floor designs with demonstrated capability to permit depressurization across the entire sub-floor area.*

Source: Minnesota Residential Energy Code: Chapter 1322 Rules. Revisor's Office: 2009, page 45 of PDF version.

The current Residential Energy Code requires builders who want to use a 4" sand base with an interior draintile loop in a 1 foot gravel trench as a gas-permeable layer to use option number three in AF 103.2. This member guide uses U.S. EPA and ASTM documentation to make the case that the interior draintile sub-slab gas permeable layer has been demonstrated to out perform a geotextile drainage matting system. Thereby proving it is an equivalent method and can confidently be accepted as an alternate method by local building officials.

Existing Residential Radon Systems in Minnesota

There are thousands of active (fan operated) radon systems that have been installed in Minnesota homes to reduce unacceptably high radon levels. These systems were installed because homeowners tested their homes and found the radon levels unacceptable or real estate relocation companies or potential buyers required the homes to be tested. The U.S. Environmental Protection Agency has established 4.0 pCi/L as an "actionable level." They recommend to homeowners that if their home's radon level test result is above 4.0 pCi/L the homeowner should add an active radon system to reduce the level, preferably below 2.0 pCi/L.

WHAT DOES pCi/L MEAN?

Radon levels are measured in pCi/L which stands for picocuries per liter. See EPA's document A Citizen's Guide to Radon at ***http://www.epa.gov/radon/pdfs/citizensguide.pdf*** for an explanation of pCi/L levels and their risks.

When a radon mitigator is asked to reduce a dwelling's radon level below the EPA actionable standard of 4.0 pCi/L they install an active radon system. The majority of these active radon systems were installed as retrofits in existing houses (dwellings and dwelling units) by radon mitigators. If an existing dwelling has a sand base below the slab and an interior draintile loop is set in an aggregate trench, the most common radon mitigation system used ties the newly installed radon pipe somewhere into the existing draintile loop. A continuously exhausting fan is activated in the attic. A system monitoring device, which shows the homeowner whether or not the fan is running, is installed in the basement or in another location that can be easily accessed.

The Two-Thirds Reality of Radon Levels in Minnesota

The Minnesota Department of Health predicts that one-third of all existing homes have a radon level above 4.0 pCi/L. This estimate is based on testing results. The easiest way to meet the public policy goal of reducing home radon exposure for Minnesotans is to install an active radon system with a continuously exhausting fan in every new home. Unfortunately, there would be unintended negative consequences to this policy. First, two-thirds of the homes would have equipment running 24/7 that is not needed to protect the public's health. Second, the unnecessary operation of so many radon fans would have the adverse impact of wasting energy and causing unnecessary air pollution from the coal fired power plants that supply most of Minnesota's electricity. Third, Minnesota homeowners would be paying for equipment that is not needed to protect their health. The equivalent to installing an active radon system in every new dwelling would be to run a sump pump continuously in every new dwelling even if there were no standing water present in the interior draintile loop. Why waste energy to solve a problem that doesn't exist?

As a compromise the Minnesota Residential Energy Code requires all new construction to install a passive radon system. The passive system includes the installation of everything besides the active fan and a system monitoring device. Based on Minnesota Department of Health estimates, two-thirds of the new homes will never need this system due to low radon levels. However, the requirement to install a passive radon system gives one-third of the homeowners a low cost alternative to upgrading their passive system to an active one, if they so choose. The Minnesota Residential Energy Code does not require the home builder or the homeowner to test the passive radon system. The decision to test and mitigate post-construction is left up to the discretion of the homeowner.

Why not just test the site before the home is built and install systems in only those dwellings that will need them? This would be the best-case scenario for all homeowners and home builders. However, there is no such test available. Radon gas comes from naturally occurring decaying radium that is found in some Minnesota soils. The amount of radon that will enter a home also depends on the particular pressure dynamics of each individual dwelling. Those pressure dynamics are a function of; (1) the amount radon gas present in the soil, (2) on how well the foundation and slab are sealed against radon entry, (3) the pressure dynamics of the dwelling and (4) how the occupants live in and operate the home. Even in neighborhoods with known high radon concentrations there could be two homes across the street from each other where one home has a radon level below two and the other may have a radon level well above four. This unpredictably of a radon threat is why a passive system is now required in all new residential construction.

Since two-thirds of homeowners are likely paying for a radon system that will not reduce their family's radon exposure it is important to install the most cost-effective passive systems that can easily be converted to active systems. BAM's research indicates that the most cost-effective method to build a passive radon system includes a gas-permeable layer consisting of a 4 inch code-compliant sand base layer and an interior draintile system in a gravel filled trench measuring 1 foot wide and a minimal depth of 4-inches. This assessment is based on experience from Minnesota radon mitigators; the U.S. Environmental Protection Agency's document Building Radon Out: A Step-by-Step Guide On How To Build Radon-Resistant Homes and ASTM E 1465-07a: Standard Practice for Radon Control for the Design and Construction of New Low-Rise Residential Buildings. See the 'More Information' sidebar to download these technical documents. Note that there is a more current version of ASTM E 1465 available. The 2007a version is referred to here because EPA recommends it and a free download is available, see ***http://www.epa.gov/radon/pubs/index.html#index4***.

MORE INFORMATION

The following documents can be downloaded for free from the US EPA's website at ***http://nepis.epa.gov/EPA/html/pubindex.htm***

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For Building Radon Out find EPA Document 402K01002

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For a one-time download of ASTM E 1465-07a find EPA Document 402K07010 at the above website or you can purchase this **standard at *http://www.astm.org/DATABASE.CART/HISTORICAL/E1465-07A.htm*.**

■

There is a more current version of ASTM E 1465 available.

■

The 2007a version is referred to here because EPA recommends it, see ***http://www.epa.gov/radon/pubs/index.html#index4***

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Radon levels are measured in pCi/L which stands for picocuries per liter. See EPA's document A Citizen's Guide to Radon at ***http://www.epa.gov/radon/pdfs/citizensguide.pdf*** for an explanation of pCi/L levels and their risks.

The Minnesota State Building Code requires a 4-inch thick base course consisting of clean graded sand, gravel, crushed stone, etc. be placed on concrete floors installed on the ground, below grade [IRC R506.2.2 Base]. An exception to R506.2.2 allows a builder to skip the base course if the slab is installed on well-drained or sand gravel mixture soils.

The building code has never required an interior draintile loop. Common practice in the residential construction industry, when an interior draintile loop is installed, is to dig a trench for the interior draintile loop and imbed the draintile into course aggregate. The draintile is drained by gravity to daylight or, more commonly, attached to a sump basket. A sump pump is connected if the draintile loop collects enough water to require mechanical drainage. The sump pump runs whenever the water level reaches a specified height.

The common building practice of installing an interior draintile loop in a gravel filled trench is accepted as a sub-slab preparation for new construction in Building Radon Out and ASTM E 1465-07a. Page 35 of Building Radon Out includes a Basement and Slab-On Grade Construction: Sub Slab Preparation section, which states:

> "If the house you are building has a slab-on-grade or basement foundation, the radon gas must be able to move laterally beneath the slab to the location where the vent pipe collects the gas. There are three basic methods for improving soil gas collection beneath slabs.
>
> **Gravel**
> This option is generally chosen in regions of the country where gravel is plentiful and economical or where gravel is required by the building code for water drainage. A continuous four-inch layer of ½ -inch to ¾ -inch clean (no fines) gravel placed beneath a slab provides a largely unrestricted path for radon to be collected. This size gravel provides a drainage layer and capillary break for moisture control.
>
> **Perforated Pipe Alternative**
> In some regions of the country, gravel is not a feasible option, either because native soils are sufficiently permeable and gravel is not required for water drainage, or because lack of local supply makes gravel very expensive. One alternative is to use the native fills beneath the slab and lay in a loop of perforated pipe to improve soil gas movement. This method is already employed in some homes with the use of a draintile loop. The loop of perforated pipe works well because the soil gases need only move to the loop rather than all the way across the slab as in the case of a single collection point.
>
> **Soil Gas Collection Mat Alternative**
> In some areas, the perforated pipe option may not be feasible if the labor needed to dig a trench for the pipe loop is too expensive, or if the sub-grade soils are compacted or frozen. The third option is to install interconnected strips of drainage mats (soil gas mats) on top of the sub-grade and beneath the slab. Drain mats consist of plastic material that resembles an egg crate. Wrapped around the "egg crate" is a geotextile filter fabric that allows for the passage of air but prevents the infiltration of wet concrete. The mat can be laid directly on top of the prepared sub-grade, which should be a uniform layer

of sand (native or fill) a minimum of four inches thick. The concrete can be poured directly over the soil gas collection mat."

Source, U.S. Environmental Protection Agency, Building Radon Out: A Step-by-Step Guide On How To Build Radon-Resistant Homes. EPA/402-K-01-002. April 2001. page 35.

EPA's document Building Radon Out clearly shows that an interior draintile system set in aggregate is preferred to the soil gas collection mat alternative. Therefore, it is logical to conclude that an interior draintile system or what EPA refers to as a Perforated Pipe Alternative meets the intent of AF102.3, #3 of the Minnesota Energy Code. Since the geotextile mat drainage system is already an approved method under AF102.3, #2 of the Minnesota Residential Energy Code; then EPA's perforated pipe alternative clearly has demonstrated the capability to permit depressurization across the entire sub-floor area.

ASTM E 1465-07a: Standard Practice for Radon Control for the Design and Construction of New Low-Rise Residential Buildings also concurs that an interior draintile in a gravel trench is a more effective method of sub-slab depressurization than geotextile material over sand. In this ASTM standard Table 2: Gas-Permeable Layer (GPL) Type Comparison describes Type 3 a Trench Filled with Large Aggregate, on page 9. A trench is made around the perimeter of the foundation. The trench includes a perforated 4" pipe loop and is filled with clean crushed stone from 1 to 1½ inches. The trench measures at least 4" deep and must be least 1 foot wide. The standard does not have any restrictions on what type of base course must be used outside of the gravel filled trench. To confirm this, see Table 2, at Description "soil coverage" under the column labeled Type 3. Here is the description of the perforated pipe in a trench option for a gas-permeable layer for the ASTM standard:

"6.4.2.3 Type 3- Buried Loop of Perforated Pipe in a Trench-shall be a loop of 4 in. (100 mm) perforated pipe buried in a 4 in. (100 mm) deep gas-permeable layer of crushed stone 1 to 1½-in. (25 to 38-mm). The crushed stone shall be contained in a trench which is about 1 ft (0.3 m) wide. The pipe and trench shall follow the interior perimeter of the foundation. The ends of the pipe shall be joined in a tee assembly to which the suction point shall be attached. The tee assembly shall be located so that the suction point pipe penetrates the slab in an unobtrusive place and so that the vent stack can be attached. See Table: 4. Table 5, and Table 6 and Fig. 1 for additional specifications."

Source: ASTM E 1465-07a: Standard Practice for Radon Control for the Design and Construction of New Low-Rise Residential Buildings. ASTM International: 2007. Page 11, section 6.4.2.3.

- Table 5 of ASTM E 1465-07a: Methods for Connecting to the Soil-Gas Collector (SGC) Comparing Characteristics of Connection Methods (see Note 1 in Table 5)
  - o Explains how to connect the draintile to the radon pipe, page 11.
- Table 6 of ASTM E 1465-07a: Quantity of Pipe Parts Required for Connecting Suction Point Pipe to the Soil-Gas Collector
  - o Explains the parts needed to connect suction point pipe to the soil gas collector (draintile), page 12.
- Figure 1 of ASTM E 1465-07a: Foundation Footing (Foundation Walls Not Shown) Soil-Gas Collectors, Connecting Sub-Slab Manifold, and Suction Point Pipe Have Been Installed
  - o Shows how to connect the draintile system through an interior foundation footing.

Fortunately, ASTM E1465-07a also allows the 4 inch perforated pipe in the aggregate filled trench to also be used as a ground water control facility [draintile loop connected to a sump basket] see Table 4: Soil Gas Collectors, Type 3, Note 1, page 10.

ASTM E 1465-07a: Standard Practice for Radon Control for the Design and Construction of New Low-Rise Residential Buildings also concurs with the EPA's Building Radon Out document that an interior draintile in a gravel trench is a more effective method of sub-slab depressurization than geotextile material over sand as explained below:

In ASTM E 1465-07a Table 2: Gas-Permeable Layer (GPL) Types Comparison, Type 4 uses a proprietary geotextile mat over 4" of sand without any aggregate. Table 3: Gas-Permeable Layer Comparison: Crushed Stone and Gas-Permeable Mat Typical Installations compares the methods Type 1: 4 inches of clean crushed stone to Type 4: geotextile mats placed per manufacture's recommendations, installed 1 foot inside the building's interior perimeter plus three strips of geotextile material running parallel to the short side of the foundation footprint. The comparison shows that 4" of clean crushed stone (Type 1 Gas Permeable Layer from Table 2) has significantly more area of coverage, 2700 square feet versus and a larger volume of permeable layer compared to 474 square feet for the Typical Proprietary Mat Strips (Type Gas Permeable Layer from Table 2). This is of course because the crushed rock covers the entire 2,700 square feet of the foundation and the geotextile strips only cover a portion of the perimeter. The volume of the large crushed aggregate layer equals the width of the gas permeable layer times the length of the gas permeable layer times the height of the gas permeable layer (V=W*L*H see layer volume in Table 2, page 9). The volume of the proprietary mat strips equals the perimeter of the slab times the width of the gas permeable layer times the height of the gas permeable layer (V=P*W*H see layer volume in Table 2, page 9).

Table 3 of the standard does not compare how well the trench filled with large aggregate would compare to the 4 inches of large aggregate and the typical proprietary mat strips. However, it is easy to see why the trench system would outperform the proprietary mat strips. The Layer Volume uses the exact same formula for the trench filled with aggregate and the mat strips V=P*W*H. The foundation perimeter is the same for both systems. The width of the gas-permeable layer is the same for both systems. However the trench is at least 4 inches deep and the mat is 1 inch or less depending on the manufacturer's system.

Even without this comparison, ASTM E 1465-07a clearly allows a gravel filled trench with an interior draintile as a gas-permeable layer for a passive radon system. EPA's document Building Radon Out clearly prefers an aggregate trench with an interior draintile loop over the performance of a soil gas collection mat alternative. There are thousands of properly functioning active radon systems connected to trenched interior draintile systems in Minnesota that confirm these technical findings.

Without a doubt, a base of 4 inches of clean crushed rock will outperform either the trench system with interior draintile or the soil gas collection mat system in passive radon systems. A sand base is not impermeable to radon gas; it is less permeable compared to crushed rock. If sand were impermeable to radon gas then an easy radon mitigation strategy would be to add a layer of sand, add a layer of polyethylene with a 12 inch lap and seal foundation/slab penetrations and cracks.

The reality is that, according to Minnesota Department of Health estimates, one-third of all newly built homes in Minnesota will have an unacceptably high level of radon and two-thirds will not. According to ASTM E 1465-07a a passive radon system can usually only decrease the radon level by up to 50 percent while a fan operated active radon system can reduce indoor radon concentrations up to 99%, see sections 1.1.2 and 1.1.1 on page 1. This is because according to ASTM E 1465-07a section 5.2 on page 4, "passive radon systems depressurizes the gas-permeable layer intermittently; the fan powered [active] system depressurizes the gas-permeable layer continuously." Passive systems may not reduce radon levels to acceptable standards even if they are installed according to above code practices such as running the radon pipe straight, without any elbows or turns. Homeowners who test and find unacceptably high radon levels from their passive systems can easily and cost-effectively install a radon fan to activate their systems.

Installing 4 inches of large aggregate under slabs substantially increases the cost of a new home. Aggregate is also more difficult to work with, especially when rigid insulation is added under the slab as a best practice or as a manufacturer's requirement for installing an in-slab heating system. In a worst-case scenario, two-thirds of Minnesota homeowners in newly built homes will not achieve any benefit from a passive radon system. The remaining third of homeowners may receive a radon reduction from their passive system. In a best case scenario, two-thirds of Minnesota homeowners in newly built homes will have the lowest installation costs possible and may receive a minor radon reduction from the passively installed system.

Activating a passive radon system with an aggregate filled trench and an interior draintile system has been proven as an effective method for thousands of homes in Minnesota. There are very few, if any, homes built with geotextile drainage mat systems. Why not allow an alternate method to AF103.2 that is proven to work by EPA and ASTM technical documentation and proven, practical application?

If you or your local building official has questions about this alternate method please submit them to the Frequently Asked Question portion of ***http://www.bamn.org/energycode*** . Thank you to all local building officials for considering this alternative method.

Appendix 1

The following code language may be submitted to a local building official as an alternate method to section AF103.2 Subfloor preparation, number 3 of the Minnesota Residential Energy Code. This alternate code language must be submitted to the local building inspection department before construction and prior approval must be obtained before this method is installed. Background information supporting this alternate method for AF103.2 can be found in the text of this document, the BAM Member Guide: Alternate Method for the Gas Permeable Layer Required for Passive Radon Systems in the Minnesota Residential Energy Code (Section AF103.2 Subfloor Preparation). This document is available for download at http://www.bamn.org/energycode

AF103.2 Subfloor preparation, alternate method using option #3.

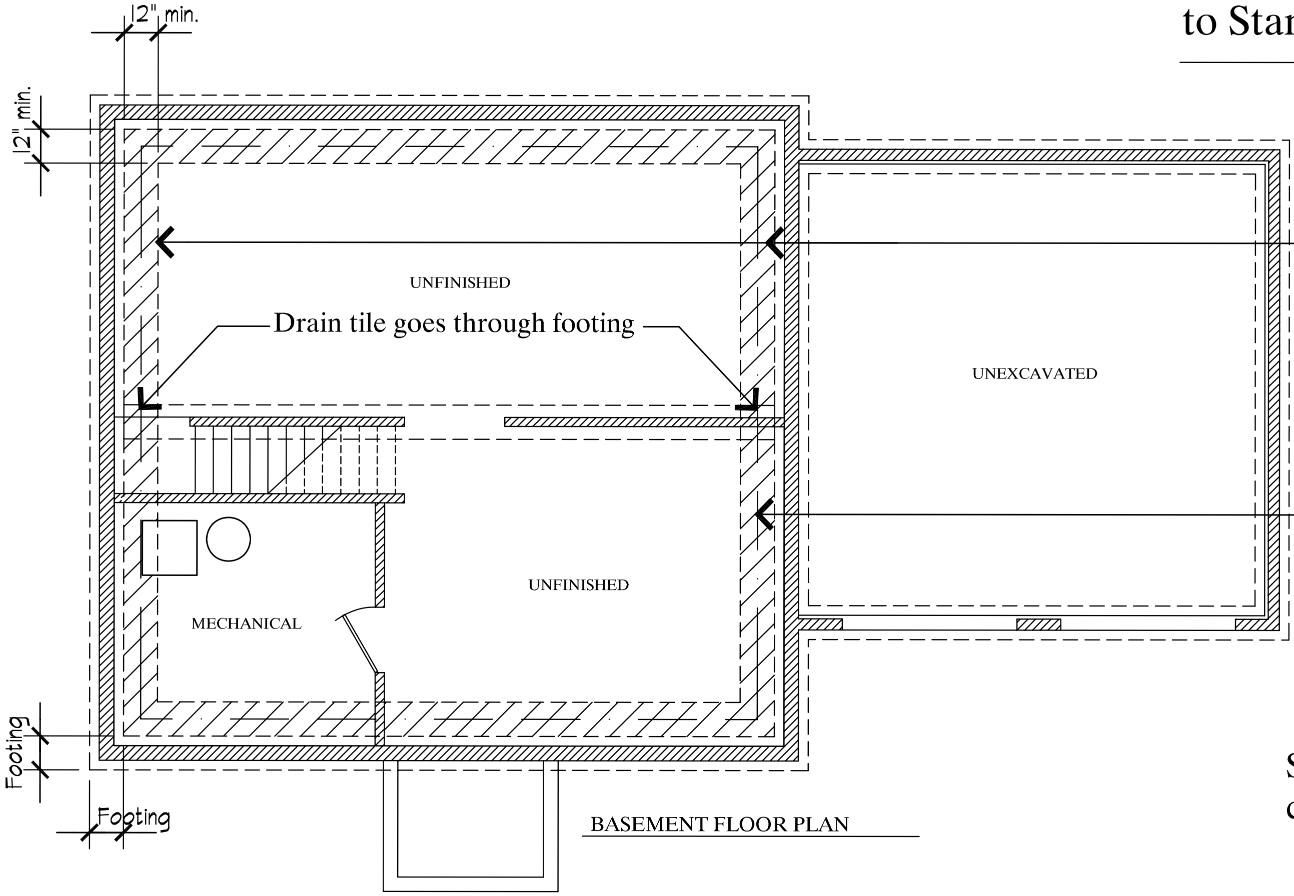
A radon collection system must be installed under concrete floor slab areas and conditioned crawlspaces. A continuous loop of minimum 3 inch or 4 inch perforated pipe shall be laid in the sub-grade below the concrete slab. The pipe may be rigid or flexible but must be perforated. The loop of perforated pipe must be buried in a trench of gravel which is at least 1 foot (0.3 m) wide and a minimum of 4 inches (100 mm) deep. The trench gravel must be washed and measure at least 1 to 1½ inches (25 to 33 mm). The trench shall follow the interior perimeter of the foundation. In buildings where interior footings or other barriers separate the sub-grade area, the loop of pipe shall go through, not below, interior footings or barriers. The suction point shall be attached anywhere along the draintile loop to the vent stack. The suction point may be located in a sump basket provided a sump basket cover designed specifically to accommodate a radon pipe is used. The radon collection system described in this section may also be used as a sub-slab drainage system.

For slab areas up to 2,000 square feet (186 m2) a minimum of 3-inch diameter (102 mm) pipe shall be installed. For slabs over 2,000 square feet but less than 4,000 square feet a minimum 4-inch (102 mm) diameter pipe shall be installed. Slab areas over 4,000 square feet shall have a separate loop of 4 inch diameter pipe for every additional 2,000 square feet of slab area; a separate suction point must be used for each additional drain tile loop.

If local building officials have questions about this method have them contact BAM at 651-646-7959 x166 or karenl@bamn.org

Illustration #1

Passive Radon System Connected to Standard Drain Tile System



Underslab Drain Tile System: Trench to be 4" minimum depth, and 12" minimum width, gravel fill - 1" to 1 ½" aggregate size.

3" or 4" drain tile loop

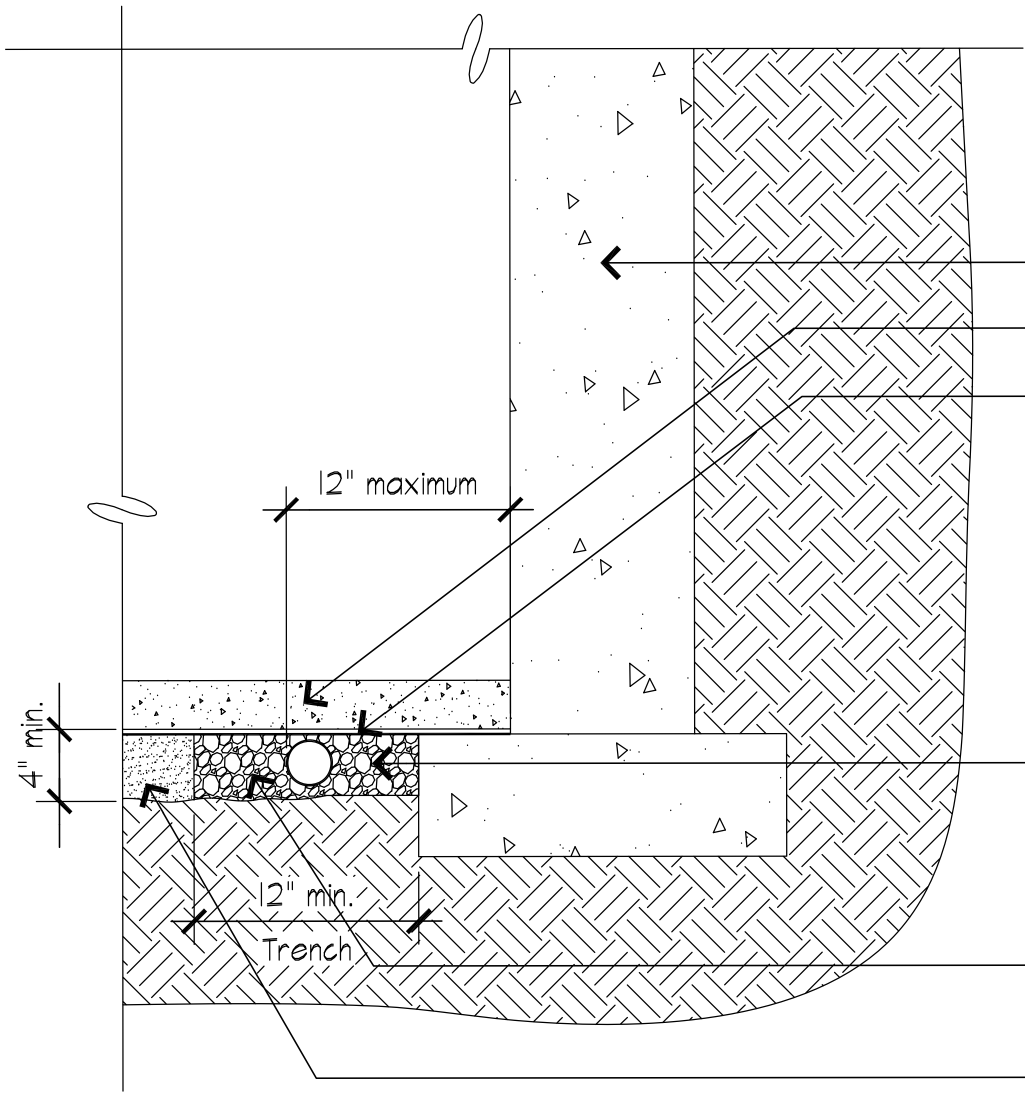
See Appendix 1 for specific code requirements.

THIS ILLUSTRATION DOES NOT REFLECT ALL THE REFERENCES TO THE ACTUAL CODE LANGUAGE.

FOR PRECISE REQUIREMENTS AND OPTIONS OF SPECIFIC CODE SECTIONS CHECK THE ORIGINAL CODE LANGUAGE AT www.bam.org/energycode

Illustration #2

Passive Radon System Connected to Standard Drain Tile System



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