AARST National Radon Standards
Active Soil Depressurization
Radon Mitigation Standards (ASD RMS)
for Low Rise Residential Buildings

March, 2006

DRAFT FOR PUBLIC REVIEW

This document has been peer reviewed in workgroup forum and with balanced representation of stakeholder groups yet has NOT at this time been approved by the consortium procedures of AARST National Radon Standards.

Foreword

The 1988 Indoor Radon Abatement Act required the Environmental Protection Agency (EPA) to develop a voluntary program to provide information on proper installation procedures for radon mitigation systems and as a means to evaluate contractors who offer radon control services to homeowners. In December 1991, EPA published the "Interim Radon Mitigation Standards". The complete version of the Radon Mitigation Standards (RMS) was published in October of 1993. In April 1994 the RMS was revised (EPA 402-R-93-078, Revised April 1994).

Since that time, EPA's RMS document has been used as a basis for the creation of individual versions including for Pennsylvania, Illinois and the American Society for Testing and Materials (ASTM E2121). These documents and the input from the AARST Consortium stakeholders were used to develop and approve the present AARST Active Soil Depressurization Radon Mitigation Standards (ASD RMS) set forth in this document.

This Standard was approved on ____, ___ by the procedures outlined in the bylaws for AARST National Radon Standards that includes a balance of stakeholder representation and a public review that includes but is not limited to the AARST membership.

AARST National Radon Standards approved documents shall be reviewed for update and revision at least every five years.

AARST strives to provide accurate, complete, and useful information. AARST will make every effort to correct errors brought to its attention. However, neither AARST, nor any person contributing to the preparation of this document makes any warranty, express or implied, with respect to the usefulness or effectiveness of any information, method, or process disclosed in this material. Nor does AARST assume any liability for the use of, or for damages arising from the use of, any information, method, or process disclosed in this document. Mention of firms, trade names, commercial products or other documents in this document does not constitute endorsement or recommendation for their use. It is the sole responsibility of radon practitioners using this standard to stay current with changes to the standard and to comply with all local, state and federal codes and laws relating to their practice.

Table of Contents:

1.0 Purpose and Scope

1.1 Purposes

The purposes of the Active Soil Depressurization Radon Mitigation Standards (ASD RMS) are to:

a. provide minimum requirements and uniform standards that emphasis safety, system quality and effectiveness in the design and installation of mitigation systems in detached and attached residential buildings three stories or less in height.;

b. serve as a model set of requirements to be adopted in part or whole by state and/or local jurisdictions to fulfill objectives of their radon contractor certification or licensure programs; and

c. provide a means to evaluate ASD systems

1.2 The methods described in this standard are based on the techniques that have proven most effective in reducing radon levels in a wide range of residential buildings and soil conditions. Active soil depressurization systems include sub-slab depressurization, sub-membrane depressurization, block wall depressurization and crawl space depressurization.

1.3 Contractors

A “Contractor” is a person, persons or contracting firm regardless of its organizational structure who installs a radon reduction system.

1.4 Qualified Contractors

A “Qualified Contractor” is a Contractor who has demonstrated at least the minimum degree of appropriate technical knowledge and skills widely considered necessary to successfully lower radon concentrations. In addition:

1.4.1 A Qualified Contractor doing work in a non-certifying state has attended an entry-level radon mitigation course and also maintains current mitigation certification with a nationally recognized accrediting agency;

1.4.2 A Qualified Contractor doing work in any state that has a radon certification program maintains all required state certifications; and

1.4.3 Regardless of its structure, a contracting firm may be a Qualified Contractor if it employs at least one Qualified Contractor.

1.5 Preference for Qualified Contractors

Successfully lowering radon concentrations in a home requires significant technical knowledge and special skills. For purposes of consumer health and safety, it is highly recommended that Qualified Contractors design, install and inspect radon mitigation systems. However, where Qualified Contractors are unavailable, consumers may utilize Contractors with significant appropriate technical background and skills in the design, installation and inspection of radon mitigation systems. It is highly recommended that a Contractor who installs ASD radon mitigation systems become a Qualified Contractor and refer to these standards.

1.6 AARST recommends that any jurisdiction considering use of this document seek consensus through the AARST Nation Standards consortium process prior to adopting a modified version of this document. This provides the jurisdiction with a degree of expertise for such considerations while also providing an opportunity for the National Standards consortium to update this document when appropriate.

1.7 ASD systems have been found to be effective for minimizing entry of other soil based gases. A Contractor who uses ASD to vent soil gas other than radon should follow the appropriate requirements of this standard as well as state provided vapor intrusion control documents and/or other appropriate documents.

1.8 AARST recommends that any jurisdiction that is considering use of this document seek consensus through the AARST Nation Standards consortium process prior to adopting a modified version of this document. This provides the jurisdiction with a degree of expertise for such considerations while also providing an opportunity for the National Standards consortium to update this document when appropriate.

1.9 The terms “must” and “shall” indicate those provisions herein that are considered mandatory, while the terms “should”, “may”, or “recommended” indicate provisions considered helpful or good practice, but which are not mandatory.

2.0 Limitations

2.1 The ASD RMS is not intended to be used as a design manual, and compliance with its provisions will not guarantee reduction of indoor radon concentrations to any specific level. Design guidance is provided in the documents referenced in section 11.0. Those documents should be used as a minimum to assist with the selection of the most appropriate radon mitigation strategy.

2.2 The ASD RMS is limited to active soil depressurization systems. It does not address mitigation of airborne radon that results from radon in water or other mitigation methods such as sub-slab pressurization, building pressurization or changes to ventilation.

2.3 The ASD RMS shall not apply to radon mitigation systems installed prior to its effective date, except when a previously installed system is altered. "Altering" radon mitigation systems does not include activities such as replacing worn out equipment, while leaving the remainder of the system unchanged. Mitigation systems installed prior to the effective date of the ASD RMS should be in compliance with the requirements in force at the time of original installation (i.e. EPA Interim Radon Mitigation Standards, November 30, 1991 or the final EPA RMS of October 1993 that was revised in April of 1994). If a radon mitigation system does not comply with current standards, it shall be recommended to the client in writing that the non-compliance items be upgraded or altered to meet current standards. A written estimate of the cost for the proposed upgrading should also be provided.

3.0 General Practices

The following general practices are required for all contacts between Contractors and clients.

3.1 Any available results from radon tests shall be reviewed in developing an appropriate mitigation strategy. If the most recent radon tests were not performed in accordance with the EPA, State or AARST measurement protocols, the client shall be informed, and a retest shall be recommended.

3.2 Both written and verbal interpretations and recommendations regarding health risk associated with radon shall be provided in accordance with the latest version of the appropriate EPA documents or documents developed by the state in which the work is being done. EPA documents are listed in section 11.0.

3.3 The client shall be informed, prior to starting work, of the need to ventilate work areas during and after the use of sealants, caulks, or bonding chemicals containing volatile solvents. Ventilation shall be provided as recommended by the manufacturer of the material. Material Safety Data Sheets (MSDS) shall be made available to the client upon request

3.4 The client shall be informed of any observed adverse conditions that would likely be a health risk.

3.5 Clients should be provided the following written information prior to initiation of the work:

1. The Qualified Contractor's appropriate radon mitigation certification identification number;
2. A statement that describes the planned scope of the work;

3. A statement describing any known hazards associated with chemicals used in or as part of the installation;
4. A statement indicating compliance with and implementation of all relevant standards of certifying agencies having jurisdiction (e.g., code requirements);
5. A statement describing any system maintenance that the building owner would be required to perform;
6. The installation cost and an estimate of the annual system operating costs; and
7. The conditions of any warranty or guarantee.

3.6 When delays in the installation of a permanent radon control system are unavoidable, and a temporary system is installed, the client shall be informed about the temporary nature of the system and a signed acknowledgment of this fact should be obtained. A label that is readable from at least three feet shall be placed on the system. The label shall include a statement that the system is temporary and that it will be replaced with a permanent system within 30 days. The label shall also include the date of the temporary installation, the estimated completion date and the Contractor's name, phone number, and applicable certification number and certifying agency. The 30 day limit on use of a temporary mitigation system may be extended in cases where a major renovation or change in building use necessitates a delay in the installation of a permanent mitigation system.

3.7 Local Authorities and Building Codes

3.7.1 All components of ASD shall be in compliance with the applicable mechanical, electrical, building, plumbing, energy and fire prevention codes, standards, and regulations of the local jurisdiction. Where nationally published codes are more stringent than required by local jurisdiction, it is recommended to observe the most recent versions of nationally published codes. For localities having no relevant code requirements, the most recent version of nationally published codes shall be observed to assure appropriate design and safety of occupants. Some relevant examples of nationally published codes are provided in Appendix B.

3.7.2 The ASD RMS does not contain all code or other requirements of the jurisdictions where the radon mitigation system is being installed.

3.7.3 Although the provisions of the ASD RMS have been carefully reviewed for potential conflicts with other regulatory requirements, adherence to the ASD RMS does not guarantee compliance with the applicable codes or regulations of any Federal, state, or local agency with jurisdiction.

3.7.4 Where discrepancies exist between provisions of the ASD RMS and local or state codes that prevent compliance with the ASD RMS, the local or state codes shall take precedence. The deviation should be reported in writing to the appropriate certifying agency within 30 days if compliance with local codes necessitates a deviation from the ASD RMS. Other deviations from ASD RMS's mandatory requirements undertaken by the Qualified Contractor or Contractor that are not a code requirement shall be reported in writing to the homeowner and to the appropriate certifying agency within 30 days. A copy of this report shall be included in the final homeowner system documentation. Reasons for the deviation should be included in the report.

3.7.5 All licenses and permits required by local ordinances shall be obtained.

4.0 Building Investigation

4.1 A thorough visual inspection of the building shall be conducted by a Qualified Contractor prior to initiating any radon mitigation work. The inspection is intended to identify any specific building characteristics and

configurations (e.g., significant slab openings, crawlspaces, adjoining slabs or heating ventilation and air conditioning HVAC systems that may cause depressurization) that may affect the design, installation, and effectiveness of a radon mitigation system. As part of this inspection, clients should be asked to provide any available information on the building (e.g., construction specifications or photos, sump pump operation, etc.) that might be of value in determining the radon mitigation strategy. It is recommended that a visual inspection or diagnostics be performed where appropriate prior to submission of the bid proposal to the client.

4.2 Diagnostic procedures should be performed when necessary to enable appropriate and effective system design. Such procedures could include: characterizing or measuring building pressures, performing diagnostic radon measurements and/or performing sub-slab pressure field extension tests.

4.3 As part of the building investigation, a floor-plan sketch should be developed (if not already in existence and readily available) that includes an illustration of the building foundation including slab-on-grade, basement and crawlspace areas. The sketch should include the location of suspected interior foundation footers, drain fixtures and the HVAC systems. It should be annotated to include suspected or confirmed significant radon entry points, results of any diagnostic testing, and the anticipated layout of the radon mitigation system suction holes, ASD fan and piping.

5.0 Systems Design

5.1 Radon reduction without creation of other hazards is of primary importance in ASD system design. Other appropriate system design features should be considered such as system durability, objectionable noise or aesthetics, ease of service and long-term operating cost (power consumption and conditioned air loss).

5.2 All ASD systems shall be designed and installed as permanent, integral additions to the building.

5.3 All ASD systems shall be designed and installed to avoid the creation of any health or safety hazards.

5.4 The mitigation system shall be designed and installed to avoid compromising the function of any mechanical systems, ground water control systems and shall also avoid obstructing doorways or windows and accessibility to switches, controls, electrical junction boxes or equipment requiring maintenance.

5.5 No positively pressurized portion of the ASD system shall be installed in or pass through the conditioned space of the building.

5.6 The preferred mitigation approach for crawl spaces shall be sub-slab depressurization (SSD) if the crawl space has a concrete floor or sub-membrane depressurization (SMD) if the crawl space does not have a concrete floor. Crawl space depressurization (CSD) or crawl space isolation (CSI) are alternative methods that may be used if the crawl space cannot be accessed or has insufficient height to work in.

Crawlspace depressurization (CSD) shall not be used as a radon control system when combustion appliances are installed within the crawlspace, or where adequate isolation cannot be created between the crawlspace and surrounding spaces containing one or more combustion appliances. CSD shall also not be used if such depressurization will likely cause damage to building components or adversely impact the operation of any combustion appliance.

6.0 Systems Installation

6.1 Suction Pits

6.1.1 To increase pressure field extension of the subslab communication zone, a minimum of 1/3 of a cubic foot (i.e. approx. half of a 5 gallon bucket) of void space should either exist or be excavated (unless prohibited by bedrock) from the area immediately below the slab penetration point of the SSD system piping.

6.2 ASD Piping

6.2.1 All portions of the ASD piping shall be installed so that any rainwater or condensation within the pipes drains downward into the ground beneath the slab or soil-gas retarder membrane.

6.2.2 The minimum inside diameter of ASD piping from the suction point(s) to the exhaust point should be equivalent to the cross sectional area of a three inch pipe or as determined by appropriate diagnostics.

If system effectiveness requires high airflow (e.g. greater than 80 to 100 cfm net), the minimum inside diameter of ASD piping from the suction point(s) to the exhaust point should be equivalent to the cross sectional area of a four inch pipe or as determined by appropriate diagnostics.

6.2.3 All piping and fittings moving air except the intake and exhaust locations shall be made air and water tight. ASD Plastic (PVC or ABS) piping and fittings shall be either permanently sealed with adhesives as specified by the manufacturer of the pipe or fittings, or joined with rubber couplings as defined in section 12.29.

6.2.4 Pipe materials

6.2.4.1 All ASD plastic pipe fittings shall be of the same material as the plastic piping they are joined to.

6.2.4.2 The pipe cleaner and cement used for joining together plastic pipes and fittings shall be compatible with the pipe and fitting material, and shall be used as recommended by the manufacturer.

6.2.4.3 All ASD plastic piping except piping routed below concrete slabs or under soil gas retarder membranes shall have a minimum pipe wall thickness of Schedule 20 PVC, ABS or equivalent piping material. Schedule 40 piping or piping of equivalent strength should be used in internal and external locations subject to significant weathering or physical damage. ASD piping routed beneath a concrete slab or a soil-gas retarder membrane may be corrugated or rigid perforated drain piping.

6.2.5 Securing Pipe

6.2.5.1 ASD piping shall be fastened in a workmanlike manner to the structure of the building with hangers, strapping, or other supports that will adequately and durably secure the vent material. Existing plumbing pipes, ducts, or mechanical equipment shall not be used to support or secure ASD piping.

6.2.5.2 Supports for ASD piping shall be installed at least every 6 feet on horizontal runs and at least every 10 feet on vertical runs.

6.2.5.3 ASD piping shall be supported or secured in a permanent manner that prevents their downward movement to the bottom of a suction pit, sump pit or the soil beneath a soil-gas retarder membrane.

6.2.6 Pipe Clearance Requirements

6.2.6.1 ASD piping shall not block any necessary access to any areas requiring maintenance or inspection such as mechanical equipment or a crawl space unless the piping is designed for easy removal and airtight replacement. Rubber couplings shall be used where the piping may need to be removed for access to equipment. See rubber coupling definition at 12.30

6.2.7 Protection Of Pipe From The Elements

6.2.7.1 Attic and external ASD piping runs should be protected to avoid the risk of piping freeze-up and excessive condensation on exterior pipe surfaces if the piping is installed in areas where it is likely that significant freeze-up inside the piping could take place or significant external condensation could damage adjacent building materials.

6.2.8 Discharge Pipe

6.2.8.1 The vent stack shall discharge outside the structure and the exhaust point should be designed and installed to minimize significant airflow blockages from ice accumulation in areas where it is likely to take place.

6.2.8.2 To reduce the potential for re-entrainment of radon into the living spaces of a building, and to prevent direct exposure of individuals outside of buildings to high levels of radon, the discharge from ASD piping shall meet all the following requirements. The discharge from ASD piping shall be:

(1) 12 inches or more above the surface of the roof for ASD piping that penetrates the roof or above the roof plane for ASD piping attached to the side of a building.

(2) at least two feet above windows, doors or other openings into conditioned or otherwise occupiable spaces of the structure if the openings are less than 10 feet from the discharge location.

(3) ten feet or more from any opening into the conditioned or otherwise occupiable spaces of an adjacent building.

(4) ten feet or more above ground level.

The determination of the required distance (ten feet) from the point of discharge to openings in the structure shall be the shortest measurement between the two points. Measurements shall be made around intervening obstacles.

6.3 Sealing Requirements

6.3.1 Sealing openings in the slab, foundation, or crawl space membrane is an important component of ASD systems in order to enhance pressure field extension, minimize conditioned air being removed from the building, reduce any depressurization of the building by the ASD system, and allow usage of a more efficient, quieter ASD fan. Openings or cracks that may compromise the pressure field extension and/or the performance of the ASD and are determined to be inaccessible or beyond the ability of the Contractor to seal shall be disclosed to the client and included in the documentation.

6.3.1.1 When sealing cracks in slabs and other small openings of the slab and foundation walls, caulks and sealants designed for such application shall be used. Urethane sealants (or equivalent) are recommended because of their adhesion and durability.

6.3.1.2 Large exposed openings in slabs and foundation walls shall be sealed with durable materials such as non-shrink mortar, sheet metal or other comparable materials appropriate for such application.

6.3.2 Openings around ASD piping penetrations of the slab or the foundation walls, shall be cleaned, pre-filled as needed with backer rod or comparable material, and sealed in a permanent, air-tight manner using an appropriate caulk, mortar or other sealant material. Accessible openings into the soil around other utility penetrations of the slab or walls, shall be sealed as needed.

6.3.3 Sump pits or other large accessible openings in the slab that permit entry of soil-gas or that would allow conditioned air to be drawn into an ASD system shall be covered and sealed to the extent possible without compromising the water control capability of the sump.

6.3.3.1 When installing ASD systems that use sump pits as the suction point, if sump pumps are needed, submersible sump pumps shall be installed.

6.3.3.2 If ASD piping is installed in the cover of a sump pit, the system shall include a mechanism such as rubber couplings to facilitate removal of the sump pit cover for sump pump maintenance.

6.3.3.3 If any sump pump is replaced in a sump that permits entry of soil gas a submersible sump pump should be used.

6.3.3.4 To permit easy removal for sump pump servicing, the cover shall be sealed using silicone or other non-permanent type caulking materials or an airtight gasket**.**

6.3.3.5 Covers for sump pits or other large slab openings shall be made of durable plastic or other rot resistant rigid material, designed to permit airtight sealing and to support the weight of an adult standing on the cover. Penetrations of sump covers to accommodate electrical wiring, water ejection pipes, or ASD piping shall be designed to permit air-tight sealing around penetrations, using silicone or other non-permanent caulk, or grommet openings. Sump pit covers should incorporate a viewport or allow visual access to permit observations of conditions in the sump pit.

6.3.3.6 When a sump pit is the only system in a basement for relief of excess surface water and a cover for the sump is made airtight, design features shall be implemented that retain a water relief system such as installing a radon resistant drain in the sump cover, if the cover is flush with the slab or lower, or installing a radon resistant drain in the concrete floor if water can migrate below the slab from the drain to the sump pit.

6.3.4 Any accessible openings, perimeter channel drains, interior foundation drainage boards, or cracks that exist where the slab meets the foundation wall (floor-wall joint) and are open to the sub-slab soil shall be sealed with urethane caulk or equivalent material. When the opening or channel is greater than 1/2 inch in width, a closed cell foam backer rod or other filler material shall be inserted in the channel before application of the sealant. This sealing technique shall be done in a manner that retains the drainage below the sealant. The channel drain can be left unsealed under specific locations that have had water leakage down the foundation wall, as long as these openings do not compromise the overall radon mitigation system performance.

Other cracks in the slabs, expansion or control joints, accessible slab openings under bathtubs or showers, or any other accessible opening that may compromise the pressure field extension and/or the performance of the ASD shall likewise be sealed.

6.3.5 If an ASD suction system is installed into a basement de-watering system, exposed openings into the drainage system that can be sealed without compromising the water drainage feature shall be sealed. Any exposed open cores of a block wall foundation that are adjacent to the de-pressurized de-watering system should be closed and sealed as prescribed in section 6.3.6.

6.3.6 Where Block Wall Depressurization (BWD) is used to mitigate radon, openings in the tops of such walls and all accessible openings or cracks in the interior and exterior surfaces of the walls shall be closed and sealed with polyurethane or equivalent caulks, or other permanent fillers or sealants.

6.3.7 Any seams in soil-gas-retarder membranes used for sub-membrane depressurization (SMD) systems shall be lapped at least 12 inches and sealed with a compatible sealant. The membrane shall to the extent practical be sealed at its edges to the foundation walls.

The opening around penetrations of a soil gas retarder for ASD piping and other utility pipes shall be as small as practical and sealed using a gasket fitting or pipe clamp or tape that has long lasting adhesion and or an appropriate sealant.

6.3.7.1 Membranes installed in crawlspaces as soil-gas retarders shall be a minimum thickness of 6 mil polyethylene, 3 mil cross-laminated or equivalent flexible material. Heavier gauge sheeting should be used when crawlspaces are used for storage, or frequent entry is required for maintenance of utilities.

6.3.7.2 Any wood installed as part of a radon mitigation system that directly contacts masonry or soil, shall be resistant to decay and insect attacks or otherwise protected.

6.3.8 When crawl space isolation is combined with ASD mitigation, openings to livable areas surrounding the crawl space shall be closed and sealed. Access doors between the basement and the isolated crawl space shall be fitted with airtight gaskets and a means of positive closure, but shall not be permanently sealed.

6.3.9 When crawlspace depressurization (CSD) is used, any accessible openings between the crawl space and the areas surrounding the crawl space shall be sealed to the extent practicable. Sealing of openings around hydronic heat or steam pipe penetrations shall be done using non-combustible materials.

6.4 Drain Installation Requirements

6.4.1 A radon resistant drain (definition 12.27) should be installed in any drain that discharges directly into the soil beneath the slab or through solid pipe to a dry well or has other exposure to the soil.

6.4.2 Openings in the slab that exist for mechanical system water drainage that are likely to allow blower driven soil air entry (e.g. drains open to HVAC ducting under negative pressure) into a home shall be modified to minimize this airflow into the home and still retain the water drainage capability. Examples of this modification include: Rerouting the drain line into a condensate pump or a radon resistant drain or including a trap in the drain that provides a minimum of 6 inches of standing water.

6.4.3 When a radon mitigation system is designed to draw soil gas from a perimeter drain tile loop (internal or external) that discharges water through a drain line to daylight, a one-way flow valve or water trap or other control device should be installed to prevent outside air from entering the ASD system while allowing water to flow out of the system.

6.4.4 When there are indications that water is likely to collect on the surface of a sub-membrane depressurization system (SMD), a radon resistant drain should be installed at the lowest location that is likely to collect water. The homeowner should be informed about this condition.

6.5 ASD Fan Installation Requirements

6.5.1 ASD fans should originate from a manufacturer that lists ASD (radon mitigation) as one of the fans intended uses. ASD fans shall be designed or otherwise sealed to reduce the potential for leakage of water or soil gas from the fan housing.

6.5.2 ASD fans shall be sized to provide the pressure difference and air-flow characteristics necessary to achieve the radon reduction goals established for the specific mitigation project. Guidelines for sizing ASD fans and piping can be found in the reference documents in section 11.0.

6.5.3 ASD fans shall only be installed in attics with adequate ventilation, on the exteriors of the buildings or in garages that are not beneath conditioned or otherwise occupiable spaces. ASD fans shall not be installed below ground, nor in the conditioned (heated/cooled) or otherwise occupiable space of a building, nor in any basement, crawlspace, or other interior location directly beneath the conditioned or otherwise occupiable space of a building.

6.5.4 ASD fans shall be installed in a configuration that avoids condensation buildup in the fan housing. ASD fans shall be installed on vertical runs of ASD piping or in accordance with the manufacturers installation specifications.

6.5.5 ASD fans mounted on the exterior of buildings shall be rated for outdoor use or installed in a weather proof protective housing.

6.5.7 ASD fans shall be mounted and secured in a manner that minimizes transfer of vibration to the structural framing of the building.

6.5.8 To facilitate maintenance and future replacement, ASD fans shall be connected to the ASD piping using removable rubber couplings or other easily removable connectors that can be tightly secured to the fan and the piping and are air and water tight.

6.6 Electrical Requirements

6.6.1 All radon mitigation ASD fans shall have a means of disconnect. The disconnect shall be within eyesight of the fan unless the remote switch has a lock-out feature. The disconnect can be a switch or a plug.

6.6.2 Wiring shall not be located in or chased through the mitigation piping.

6.6.3 It is recommended that all external wiring be in conduit.

7.0 Monitors and Labeling

7.1 All ASD systems shall include a mechanism to directly indicate the fan is operating. The mechanism shall be simple to interpret and be located where it is easily seen or heard by building occupants and protected from damage or destruction.

7.1.1 ASD fan monitors, such as manometer type pressure gauges, or electrical amperage gauges shall be clearly marked to indicate the pressure or amperage readings that existed when the system was initially activated. The mechanism shall have a durable label describing how to interpret the monitor and what to do if the monitor indicates the fan performance has degraded or is not operating.

7.1.2 Pressure activated electrical ASD fan monitors (whether visual or audible) shall be on non-switched circuits and designed to reset automatically when power is restored after service or power supply failure. Battery operated monitoring devices shall not be used unless they are equipped with a low power warning feature.

7.2 The circuit breaker(s) protecting the ASD fan circuit, should be labeled with the following or similar wording, **“**Radon” or "Radon Fan".

7.3 The fan disconnect shall have a label with the following or similar wording, “Radon Fan Switch - Leave On”.

7.4 A system description label made of durable material, shall be placed on the ASD system, the electric service entrance panel, or other prominent location. This label shall be legible from a distance of at least three feet and include the following information: "Radon Reduction System," the Contractor name, phone number, and applicable certification id, date of installation, and an advisory that the building should be tested for radon at least every two years or as required or recommended by state or certifying agencies. In addition, all exposed or visible interior ASD piping shall be identified with at least one label on each floor level and one label on each mitigation suction pipe. The label shall read, "Radon Reduction System" or “Radon System” or other equivalent wording.

7.5 Sump pits shall be identified with a durable label that reads “Radon Reduction System” or equivalent wording.

7.6 All crawl spaces that have been modified for radon reduction other than SSD of a crawl space concrete floor shall have a durable label placed at each entrance into the crawl space that states the following or similar wording : “Radon Reduction System”. The Contractor may elect to have addition information about the system.

8.0 Post-Mitigation Evaluation

8.1 Contractors shall conduct a follow-up inspection of any radon mitigation systems they install to verify conformance with the requirements of the ASD RMS.

8.2 A Qualified Contractor shall personally conduct within 30 days of system completion a follow-up inspection of all radon mitigation systems that were changed from the original design. In addition, at least twenty percent (20%) of all installations that were not changed from the initial design shall be inspected within 30 days of system completion by a Qualified Contractor.

8.3 Any items found to not be in compliance with any ASD RMS requirements shall be changed to be in compliance.

8.4 The suction in the system piping shall be measured and recorded after installation of an ASD mitigation system. It is recommended that a pressure field extension evaluation also be made with closed building conditions at the most distant point from each penetration using either smoke or a micro-manometer.

8.5 Clients shall be advised of any observed significant flue gas spillage that has taken place. If observed, the ASD fan wiring should be disconnected until the condition has been evaluated and corrected if the flue gas spillage condition persists. The client shall be advised to contact an HVAC contractor or other qualified person to evaluate and correct any significant flue gas spillage condition as well as to verify proper appliance installation and performance.

Two possible methods for attempting to evaluate flue gas spillage are to perform a back draft test while the ASD system is operating or by installing passive or active spillage detectors and instructing the homeowner how to interpret their use. Backdraft testing procedures are covered in the references listed in 11.16, 11.17, and 11.18, or simplified back draft procedures are contained in Appendix A. Note that seasonal and varying weather conditions should be considered when seeking to evaluate the potential for flue gas spillage.

Any statement to the client regarding a backdraft test should also include a statement that a simple back draft test was performed and other weather or house conditions could produce significantly different results. In addition, the client should be given sources of addition information such as those specified in section 11.22 and 11.23

8.6 To provide an initial measure of system effectiveness, a short-term measurement shall be conducted using a radon gas measurement device in accordance with AARST National Radon Standard Protocols for Radon Measurements in Homes and any state requirements. Radon decay product testing is not endorsed to make mitigation decisions based on Appendix F, from the AARST National Radon Standard Protocols for Radon Measurements in Homes.

This test should be conducted no sooner than 24 hours nor later than 30 days following completion and activation of the ASD system(s). The test shall be made in the same location as the pre-mitigation test location or the lowest livable area. A post mitigation test shall also be made in the lowest livable area above any crawl space that was remediated using CSD or Crawl space isolation. It is recommended that additional measurements be made in the lowest livable area above each other unique structural area.

8.7 The initial post mitigation test may be conducted by the Contractor who installed the mitigation, if qualified to do such testing, by the client, or by a third party testing firm. If this test is conducted by the Contractor, and the

test results are accepted by the client as satisfactory evidence of system effectiveness, further post-mitigation testing is not required. However, to avoid the appearance of a conflict of interest, the Contractor shall recommend to the client that a post mitigation test be conducted by an independent tester certified by the state or certified by a nationally recognized certifying agency if the state has no radon certification program, or the Contractor can recommend that the client perform the test using a radon test kit approved by the state or approved by a nationally recognized certifying agency if the state does not have an approved list. A copy of the report of any post-mitigation testing conducted by the client or by an independent testing firm shall be requested.

8.8 The client shall be advised to retest the building at least every two years or whenever the building undergoes significant alteration or as required or recommended by the state or certifying agency.

9.0 System Documentation

9.1 Records of all radon mitigation work performed should be kept for at least 3 years or for the period of any warranty or guarantee, whichever is longer. These records should include:

1. The Building Investigation Summary and floor plan sketch.
2. Pre- and post-mitigation radon test data.
3. Pre- and post-mitigation diagnostic test data.
4. Copies of contracts and warranties.
5. A narrative or pictorial description of mitigation system(s) installed.

9.2 Other records or bookkeeping required by local, state, or Federal statutes and regulations shall be maintained for the period(s) prescribed by those requirements.

9.3 Health and safety records, including Mitigation Installer radon exposure logs, should be maintained for a minimum of 20 years.

9.4 Upon completion of the mitigation project, the clients shall be provided with an information package that includes:

1. Any building permits required by local codes.
2. A final ASD system layout with system components labeled on a floor plan.
3. Pre-and post-mitigation radon test data if available.
4. Copies of contracts and warranties.
5. A description of the installed ASD system and its basic operating principles.
6. A description of any deviations from the ASD RMS or State requirements.
7. A description of the proper operating procedures of any installed mechanical equipment or electrical systems, including manufacturer's operation and maintenance instructions and warranties.
8. A list of appropriate actions for clients to take if the system failure warning device indicates system degradation or failure.
9. A recommendation to re-test at least every two years
10. The name, telephone number, and certification Identification number of the Contractor or the Qualified Contractor.
11. The phone number of the state radon office.

This information package shall be labeled "Radon Mitigation Information" or similar wording and shall be securely attached to the ASD system in a visible location.

10.0 Mitigation Installer Health and Safety

Although this section contains specific safety recommendations, it cannot address all of the safety concerns associated with ASD installations. The user has responsibility for establishing appropriate safety practices.

10.1 OSHA, state and local standards or regulations relating to Mitigation Installer safety and occupational radon exposure shall be complied with. Applicable standards and regulations can be found in OSHA and NIOSH publications listed in document references 11.19, 11.20 and 11.21.

10.2 In addition to the OSHA and NIOSH standards, the following requirements that are specifically or uniquely applicable for the safety and protection of radon Mitigation Installers shall be met:

10.2.1 All Mitigation Installers shall be advised of the hazards of exposure to radon and the need to apply protective measures when working in areas of elevated radon concentrations.

10.2.2 Each Mitigation Installers WLM or pCi/l/day exposure to radon or radon decay products at each work site shall be recorded and maintained. WLM calculations shall be based on one of the following methods:

1. The highest pre-mitigation indoor radon measurement divided by 200 or the highest radon decay product measurement at the worksite, times the Mitigation Installer's exposure hours, divided by 170.

2. Actual measurement of radon at the worksite divided by 200 or the radon decay product measurement, times the Mitigation Installer's exposure hours, divided by 170.

3. An alpha track or comparable device consistently worn at the job site as a radon dosimeter by a Mitigation Installer in which all exposure to the radon detector is assumed to be the Mitigation Installer's exposure. The radon measurement is divided by 200, multiplied times the total hours the detector was open, divided by 170. The radon dosimeter shall be stored in a low radon environment during non-working hours.

PCi/L/day calculations shall be based on one of the following methods:

1. The highest pre-mitigation indoor radon measurement at the worksite, times the Mitigation Installer's exposure hours, divided by 24.

2. Actual measurement of radon at the worksite times the Mitigation Installer's exposure hours, divided by 24.

3. An alpha track or comparable device consistently worn at the job site as a dosimeter by a Mitigation Installer in which all exposure to the alpha track is assumed to be the Mitigation Installer's exposure. The alpha track measurement multiplied by the number of days the detector was open. The alpha track shall be stored in a low radon environment during non-working hours.

.

10.2.3 Consistent with OSHA Permissible Exposure Limits, Mitigation Installer's exposure shall be limited to less than 5700 pCi/L/days or 4 working level months (WLM) over any 12 month period (An equilibrium ratio of 50 percent shall be used to convert radon levels to radon decay product levels.) Practices shall be arranged to keep Mitigation Installer's WLM or pCi/L/day exposure as low as reasonably achievable (ALARA).

10.2.4 A Mitigation Installer protection plan shall be maintained. Where applicable, the Mitigation Installer protection plan shall be approved by any state or local regulating agencies that require such a plan.

The plan shall be available to all Mitigation Installers and be reviewed with each Mitigation Installer at least once a year. Confirmation of a Mitigation Installer knowledge of the Mitigation Installer protection plan should be recorded with the Mitigation Installer's signature and date.

Review of the Mitigation Installer protection plan should as a minimum include safe use of all job site equipment including safe practices when using ladders or scaffolding, safe procedures for crawl space work, avoidance of jobsite hazards and discussion of hanta-virus symptoms.

10.2.4.1 Appropriate safety equipment shall be available on the job site such as hard hats, eye protection, hearing protection, steel-toe boots and protective gloves during cutting, drilling, grinding, coring or other activities.

10.2.4.2 Work areas shall be ventilated when practical to reduce the Mitigation Installer's exposure to radon, radon decay products, dust, or other airborne pollutants.

10.2.4.3 In any planned work area where it is suspected that friable asbestos may exist and be disturbed, work shall not be conducted until a properly certified asbestos inspector determines that such work will be undertaken in a manner which complies with applicable asbestos regulations.

10.2.4.4 Each Mitigation Installer shall be provided with the applicable Material Safety Data Sheets (MSDS) for all hazardous materials used and be apprised of the safety procedures required for each.

11.0 Reference Documents

The following documents are sources of additional radon mitigation information and are recommended reading for all persons involved in radon ASD mitigation installations.

11.1 "ASTM E 2121-01" Standard Practice for Installing Radon Mitigation Systems in Existing Low-Rise Residential Buildings"

11.2 EPA "Radon Mitigation Standards," EPA 402-R-93-078, October 1993, revised April 1994.

11.3 EPA Training Manual, "Reducing Radon In Structures," (Third Edition), January 1993.

11.4 "Radon Reduction Techniques for Detached Houses, Technical Guidance (Second Edition)" EPA/625/5-87/019, January 1988.

11.5 "Radon Reduction Techniques for Existing Detached Houses, Technical Guidance (Third Edition) for Active Soil Depressurization Systems," EPA/625/R-93-011, October, 1993.

11.6 EPA "Handbook, Sub-Slab Depressurization for Low Permeability Fill Material," EPA/625/6-91/029, July 1991

11.7 "Application of Radon Reduction Methods," EPA/625/5-88/024, August 1988.

11.8 "Indoor Radon and Radon Decay Product Measurement Device Protocols," EPA 402-R-92-004, July, 1992.

11.9 "Protocols for Radon and Radon Decay Product Measurements in Homes," EPA 402-R-92-003, June, 1993

11.10 "A Citizen's Guide To Radon" EPA 402-K02-006, revised May 2004.

11.11 "Consumer's Guide to Radon Reduction," EPA, 402-K03-002, revised February 2003.

11.12 "Home Buyers and Sellers Guide to Radon," EPA 402–K- 00–008, July 2000,

11.13 "Build Radon Out: A step by step Guide on How to Build Radon Resistant Homes. EPA 402-K-01-002, April 2001

11.14 "Model Standards and Techniques for Control of Radon in New Residential Buildings", EPA 402-R-94-009, March 1994

11.15 "ASHRAE Standard 62-1989," Appendix B, Positive Combustion Air Supply.

11.16 "ASTM E 1998 ”Guide for Assessing Depressurization-Induced Backdrafting and Spillage from Vented Combustion Appliances”

11.17 "National Gas Code," Appendix H (p.2223.1-98), 1988, Recomended Procedure for Safety Inspection of an Existing Appliance Installation.

11.18 “The Spillage Test” Method to Determine the Potential for Pressure-Induced Spillage from Vented, Fuel-Fired, Space Heating Appliances, Water Heaters and Fireplaces. Canadian General Standards Board. CAN/CGSB-51.71-95, April 1995.

11.19 OSHA "Safety and Health Regulations for Construction, Ionizing Radiation," 29 CFR 1926.53

11.20 OSHA "Occupational Safety and Health Regulations, Ionizing Radiation," 29 CFR 1910.96

11.21 NIOSH "Guide to Industrial Respiratory Protection," DHHS (NIOSH) Publication No. 87-116, September, 1987

11.22 EPA website, Indoor Air Quality, “Preventing Problems with Combustion Equipment”, http://www.epa.gov/iaq/homes/hip-combustion.html

11.23 Consumer Product Safety Commission, Carbon Monoxide Questions and Answers, CPSC Document #466, http://www.cpsc.gov/cpscpub/pubs/466.html

11.24 “Protocols for Radon Measurements in Homes” (MAH September 2005). AARST National Radon Standards Consortium

12.0 Description of Terms

Terms not defined herein have their ordinary meaning within the context of their use. Ordinary meaning is defined in "Webster's Ninth New Collegiate Dictionary."

12.1 Active Soil Depressurization (ASD): A family of radon mitigation systems involving mechanically-driven soil depressurization, including sub-slab depressurization (SSD), drain tile depressurization (DTD), block wall depressurization (BWD), crawl space depressurization (CSD) and sub-membrane depressurization (SMD).

12.2 ASD Fan: A particular type of fan capable of creating negative pressure in the sub-slab soil, under a membrane, in a block wall or in a crawl space. The fan needs to be air and water tight. The fan should be listed by the manufacturer as suitable for radon ASD applications.

12.3 Backer Rod: A semi rigid closed cell foam material resembling a rope of various diameters. Used to fill around pipes, large cracks, etc. to assist in making a sealed penetration

12.4 Block Wall Depressurization: A radon mitigation technique that depressurizes the void space within a block wall foundation by drawing air from inside the wall and venting it to the outside.

12.5 Certified: A rating applied by some states or jurisdictions to individuals or companies that are qualified and authorized to provide radon testing or mitigation services within the area of their jurisdiction.

12.6 Client: The person, persons, or company that contracts with a Contractor to install a radon reduction system in a building.

12.7 Combination Foundations: Buildings constructed with more than one foundation type, e.g., basement/crawlspace or basement/slab-on-grade.

12.8 Communication Test: A diagnostic test to evaluate the potential effectiveness of a sub-slab or block wall depressurization system by using a shop vacuum or other fan or vacuum device to draw air from the space below a slab or from the cavities inside a block wall and then measuring the change in pressure at various small test holes

through the slab or the block wall using a micro-manometer or heatless smoke. Also called a pressure-field extension test.

12.9 Contractor: Any person, persons or contracting firm regardless of organizational structure who installs a radon reduction system.

12.10 Crawl Space: An open area beneath part or all of the livable space of a dwelling that typically has either a concrete slab or dirt floor. The dirt floor may sometimes be covered with gravel or a membrane. The crawl space can have an open height of a few inches to several feet. The crawl space can be storage space but is not living space, and may or may not be ventilated to the outside.

12.11 Crawlspace Depressurization (CSD): An ASD radon mitigation technique designed to achieve lower air pressure in the crawlspace than in the rooms bordering and above the crawlspace. An ASD fan draws air from the crawl space and exhausts that air as specified in section 6.2.8.2. Crawlspace depressurization is intended to mitigate rooms bordering and above the crawlspace but not the crawlspace itself.

12.12 Depressurization: A negative pressure induced in one area relative to another.

12.13 Diagnostic Tests: Procedures used to identify or characterize conditions under, beside and within buildings that may contribute to radon entry or elevated radon levels or that may provide information regarding the performance of a mitigation system.

12.14 Drain Tile Depressurization (DTD): A type of active soil depressurization radon mitigation system where the suction point piping attaches to a drain tile or is located in gas-permeable material near the drain tile. The drain tile or perimeter drain may be inside or outside the footings of the building.

12.15 Drain Tile Loop: A continuous length of drain tile or perforated pipe extending around all or part of the internal or external perimeter of a basement or crawlspace footing.

12.16 Flue gas spillage: A condition where the normal movement of combustion products up a flue (due to the buoyancy of the hot flue gases), is reversed, so that the combustion products enter the building. Flue gas spillage of combustion appliances (such as fireplaces and furnaces) can occur when depressurization in the house overwhelms the buoyant force of the hot gases. Flue gas spillage can also be caused by a blockage in the chimney or flue termination.

12.17 Mil: - 1mil=1/1000 of an inch.

12.18 Mitigation installer: An owner, employee or sub-contractor of the Contractor who installs or directly supervises the Contractor radon ASD mitigation systems. The Contractor has responsible control for the implementation of the requirements of the ASD RMS by the Mitigation Installers. Contractor is defined in section 12.9.

12.19 Mitigation System: Any system or steps designed to reduce radon concentrations in the indoor air of a building.

12.20 Natural Draft Combustion Appliance: Any fuel burning appliance that relies on natural convective flow to exhaust combustion products through a flue to the outside air.

12.21 Perimeter Channel Drain: A means for collecting water around the perimeter of a basement by means of a large gap or channel between the concrete floor and the foundation wall. Collected water may flow to aggregate beneath the channel drain or to a sump where it can be drained or pumped away. Sometimes referred to as a canal drain, floating slab or french drain.

12.22 pCi/L: The abbreviation for pico curies per liter which is a unit of measure for the amount of radioactivity in a liter of air. The prefix "pico" means a multiplication factor of 1 trillionth. A Curie is a commonly used measurement of radioactivity. There are 2.2 disintegrations per minute of radioactive material in 1 pico-curie.

12.23 Pressure Field Extension: The distance that a pressure change, created by drawing soil-gas through a suction point extends outward in a sub-slab gas permeable layer, under a membrane, behind a solid wall, or in a hollow wall.

12.24 Qualified Contractor: Qualified Contractors (defined in section 1.5) are those who have attended an entry-level radon mitigation course and maintain current mitigation certification with a nationally recognized accrediting agency in non-certifying states and maintain all required radon certifications while doing work in a state with a radon certification program.

12.25 Radon: A naturally occurring, chemically inert, radioactive element (Rn-222) which exists as a gas and is measured in pico curies per liter (pCi/L) or in Becquerel's per cubic meter (Bq/m^3)

12.26 Radon Decay Products: The four short-lived radioactive elements (Po-218, Pb-214, Bi-214, Po-214) which exist as solids and immediately follow Rn-222 in the decay chain. They are measured in working levels (WL).

12.27 Radon Resistant Drain: A floor drain that has a check valve that minimizes air flow if the drain trap dries up or a trapped drain that has an automatic supply of priming water.

12.28 Re-Entrainment: The unintended re-entry into a building of radon that is being exhausted by a radon mitigation system.

12.29 Rubber coupling: Coupling made of rubber like material that has a stainless steel mechanical band on each end to secure either two pipes or a pipe and a fan so that the connection is water and air tight but is removable.

12.30 Soil Gas: The gas mixture present in soil, which may contain radon.

12.31 Soil-Gas Retarder: A continuous membrane or other comparable material laid over gravel or dirt floor areas that is used to retard the flow of soil gases into a building. See section 6.3.7.1 for minimum membrane thickness.

12.32 Stack Effect: The overall upward movement of air inside a building that results from heated air rising and escaping through openings in the building envelope, thus causing indoor air pressure in the lower portions of a building to be lower than the pressure in the soil beneath or surrounding the building foundation.

12.33 Sub-Membrane Depressurization (SMD): A radon mitigation technique designed to achieve lower air pressure in the space under a soil gas retarder membrane than above it by use of an ASD fan drawing air from beneath the membrane.

12.34 Sub-Slab Depressurization (SSD): A radon mitigation technique designed to achieve lower air pressure under a floor slab than above it. An ASD fan is installed in the radon system piping that draws air from below the floor slab.

12.35 Sump pit depressurization (SPD): A radon mitigation technique where the radon piping is routed into the sump pit that has a sealed cover.

12.36 Working Level (WL): A unit of measurement defining the concentration of radon decay products in the air.

12.37 Working Level Month (WLM): A unit of exposure used to express the accumulated human exposure to radon decay products. It is calculated by multiplying the average working level to which a person has been exposed by the number of hours exposed and dividing the product by 170.

Appendix A - Procedures for Checking Flue Gas Spillage

This appendix is informative and is not part of this standard. Various procedures for checking a natural draft combustion appliance for the possibility of flue gas spillage have been published and several are noted in the references listed in 11.16, 11.17, and 11.18.

The following checklist was derived from EPA RMS and from Pennsylvania DEP RMS checklist for evaluating the potential for flue gas spillage of natural draft combustion appliances.

1. Close all external windows and doors, and the door between the basement and the first floor.
2. Close fireplace and wood stove dampers unless those appliances are operating.
3. Turn on all exhaust and any forced air distribution fans.
4. Turn ON all combustion appliances EXCEPT any combustion appliance that feeds into the same chimney as the natural draft appliances being tested. (NOTE: It is not recommended to build fires in solid fuel devices like fireplaces and wood stoves solely for the purpose of this test.)
5. Turn OFF the combustion appliance to be tested and wait at least 5 minutes before beginning test.
6. To begin a test for actual spillage of flue gases, turn ON the appliance being tested.
7. Check for flue gas spillage near the vent hood after the appliance has been running for five minutes. Chemical smoke, or a carbon monoxide or carbon dioxide tester can be used to indicate spillage.
8. Repeat steps (4) through (7) for each natural draft combustion appliance being tested for flue gas spillage.

Seasonal and extreme weather conditions should be considered when evaluating pressure differentials and the potential for flue gas spillage. In order to better quantify spillage occurrences at a later date, a flue spillage indicator or CO monitor could be located in the same area as the combustion appliance.

Appendix B – Codes relevant to ASD Radon Mitigation

NOTE:

Appendix B has not been completed.
This informational (editorial) section will be completed before publication.

The final version will either have the actual code language or the code language summarized with references to the actual code documents and paragraphs. The most recent code versions are being considered.

The information below is only an initial compendium of text that might be applicable from several code documents. Wider outreach is underway to assure relevant and applicable text is provided. Your contributions for code references are welcome.

Some particularly relevant building (International Residential Code - IRC), electrical (National Electrical Code - NEC) and fire codes (National Fire Protection Association - NFPA) are shown in this Appendix since code compliance is required by this document. Note: The ASD RMS and the following list does not contain all code requirements of the jurisdictions where the system is being installed.

IRC2003 pg.94 - R502.8.1 Sawn Lumber: Notches in solid lumber joists, rafters and beams shall not exceed one sixth of the depth of the member, shall not be longer than one third of the depth of the member and shall not be located in the middle one third of the span. Notches at the ends of the member shall not exceed one-fourth the depth of the member. The tension side of members 4 inches or greater in nominal thickness shall not be notched except at the ends of the members. The diameter of holes bored or cut into members shall not exceed one-third the depth of the member. Holes shall not be closer than 2 inches to the top or bottom of the member, or to any other hole located in the member. Where the member is also notched, the hole shall not be closer than 2 inches to the notch.

IRC2003 pg.249 - R807.1 Attic access: In buildings with combustible ceiling or roof construction, an attic access opening shall be provided to attic areas that exceed 30 square feet and have a vertical height of 30 inches or greater.

The rough-framed opening shall not be less than 22 inches by 30 inches and shall be located in a hallway or other readily accessible location. A 30-inch minimum unobstructed headroom in the attic space shall be provided at some point above the access opening. See Section M1305.1.3 for access requirements where mechanical equipment is located in attics.

IRC2003 pg.347 - G2409.4.6 (308.4.4) Clearance for servicing equipment. Front clearance shall be sufficient for servicing the burner, and the furnace or boiler.

IRC2003 pg.392 – P2605.1 General. Support for piping shall be provided in accordance with the following:

1. Piping shall be supported so as to ensure alignment and prevent sagging, and to allow movement associated with the expansion and contraction of the piping system.

2. Piping in the ground shall be laid on a firm bed for its entire length, except where support is otherwise provided.
3. Hangers and anchors shall be sufficient strength to maintain their proportional share of the weight of pipe and contents and of sufficient width to prevent distortion of the pipe. Hangers and strapping shall be approved material that will not promote galvanic action. Ridgid support sway bracing shall be provided at changes in direction greater than 45 degrees for pipe sizes 4 inches and larger
4. Piping shall be supported at distances not to exceed those indicated in Table P2605.1

Piping Material	Maximum Horizontal spacing in (feet)	Maximum Vertical spacing
ABS pipe	4	10
PVC	4	10
Copper	10	10

IRC2003 pg.440 - E3305.2 Working clearances for energized equipment and panelboards. Except as otherwise specified in Chapters 33 through 42, the dimensions of the working space in the direction of access to panelboards and live parts likely to require examination, adjustment, servicing or maintenance while energized shall not be less than 36 inches in depth. Distances shall be measured from the energized parts where such parts are exposed or from the energized parts where such parts are exposed or from the enclosure front or opening where such parts are enclosed. In addition to the 36-inch dimension, the work space shall not be less than 30 inches wide in front of the electrical equipment and not less than the width of the equipment. The work space shall be clear and shall extend from the floor or platform to a height of 6.5 feet. In all cases, the work space shall allow at least a 90 degree opening of equipment doors or hinged panels. Equipment associated with the electrical installation located above and below the electrical equipment shall be permitted to extend not more than 6 inches beyond the front of the electrical equipment.

IRC2003 pg 440 – E3305.3 Clearances over panelboards. A dedicated space directly over a panelboard that extends from the panelboard to the structural ceiling or to a height of 6 feet above the panelboard, whichever is lower, and has a width and depth equal to the equipment shall be dedicated and kept clear of equipment unrelated to the electrical equipment. Piping, ducts or equipment unrelated to the electrical equipment shall not be installed in such dedicated space.

IRC2003 pg 458 - E3603.3 Laundry circuit. A minimum of one 20-ampere-rated branch circuit shall be provided for receptacles located in the laundry area and shall serve only receptacle outlets in the laundry area.

IRC2003 pg 458 - E3603.4 Bathroom branch circuits. A minimum of one 20-ampere-rated branch circuit shall be provided to supply the bathroom receptacle outlet(s). Such circuits shall have no other outlets.

IRC2003 pg.462 - E3605.5.3 & NEC2005 - 21.19(A)(2) Small conductors. Except as specifically permitted by Section E3605.5.4, the rating of overcurrent protection devices shall not exceed the ratings shown in Table E3605.5.3 for the conductors specified therein.

IRC2003 pg.462 - Table 3605.5.3
Over-current protection rating

Maximum overcurrent protection rating	Copper (AWG) size	Aluminum (AWG) size
15 amps	14 gauge	12 gauge
20 amps	12 gauge	10 gauge
30 amps	10 gauge	8 gauge

IRC2003 pg.465 – E3701.2 Allowable wiring methods. The allowable wiring methods for electrical installations shall be those listed in Table E3701.2. Single conductors shall be used only where part of one of the recognized wiring methods listed in Table E3701.2

IRC2003 pg.465 - Table 3701.2
Allowable wiring methods

Allowable wiring method	Designated abbreviation
Electrical metallic tubing	EMT
Electrical non-metallic tubing	ENT
Flexible metal conduit	FMC
Liquidtight flexible conduit	LFC
Nonmetallic sheathed cable	NM
Ridgid non-metallic conduit	RNC
Ridgid metallic conduit	RMC
Underground feeder cable	UF

IRC2003 pg.465 - E3702.1 Installation and support requirements. Wiring methods shall be installed and supported in accordance with Table E3702.1

[note: NA = Not Applicable, A = Applicable]

Installation requirements	EMT RMC	ENT	FMC LFC	NM UF	RNC
Where run parallel with the framing member, the wiring shall be 1.25 inches from the edge of a framing member such as a joist, rafter or stud or shall be physically protected.	NA	A	A	A	NA
Bored holes in studs and vertical framing members for wiring shall be located 1.25 inches from the edge or shall be protected with a minimum 0.0625-inch steel plate or sleeve or other physical protection.	NA	A	A	A	NA
Bored holes in joists, rafters, beams and other horizontal framing members shallbe 2 inches from the edge of the structural framing member.	A	A	A	A	A
Securely fastened bushings or grommets shall be provided to protect wiring run through openings in metal framing members.	NA	A	NA	A	NA
The maximum number of 90-degree bends shall not exceed four between junction boxes.	A	A	A	NA	A
Bushings shall be provided where entering a box, fitting or enclosure unless the box or fitting is designed to afford equivalent protection.	A	A	A	NA	A
Maximum allowable on center support spacing for wiring method in feet.	10	3[b]	4.5[b]	4.5[i]	3[d]
Maximum support distance in inches from box or other termination.	36	36	12[bg]	12[hi]	36

b. Supports not required in accessible ceiling spaces between light fixtures where lengths do not exceed 6 feet
d. Five feet for trade sizes greater than 1 inch
g. Thirty-six inches where flexibility is necessary
h. Within 8 inches of boxes without cable clamps
i. Flat cables shall not be stapled on edge

Note: The following codes are summarized and not the actual code language.

IRC2003 pg.465 - E3702.2.1 Across structural members. Where run across the top ….

Wiring in attics run across the top of the attic floor joists or across rafters that are within 7 feet of the floor joists shall be protected by guard strips at least as high as the cable if the attic access has permanent stairs or ladders. Attics without permanent stairs or ladders shall provide similar protection within 6 feet of the nearest edge of the attic entrance. Wiring run parallel to rafters or joist do not require such protection.

Electrical cables used where exposed to direct rays of the sun shall be of a type listed for sunlight resistance.
[IRC2003 - E3702.3.3 pg.465]

Wiring that is likely to be exposed to physical damage shall be protected by one of the following: electrical metallic tubing, schedule 80 PVC rigid conduit, pipe, guard strips, conduit or other approved means.
[IRC2003 - E3702.3.2 pg.465]

Electrical cables run at angles to joists in unfinished basements shall be routed through bored holes in the joist or on running boards.
[IRC2003 - E3702.4 pg.465]

Nonmetallic sheathed cable installed parallel with framing members shall be 1.25 inches from the edge of the framing member.
[IRC2003 – Table E3702.1 pg.467]

Conduit SHALL terminate in NEC approved junction boxes using approved conduit connectors.
[IRC2003 - E3805.1 pg.474]

In damp or wet locations, boxes, conduit bodies and fittings shall be placed or equipped so as to prevent moisture from entering or accumulating within the box, conduit body or fitting. Boxes, conduit bodies and fittings installed in wet locations shall be listed for use in wet locations.
[IRC2003 - E3805.11 pg.485]

Conductors entering boxes, conduit bodies or fittings shall be protected from abrasion.
[IRC2003 - E3806.1 pg.487]

All switches shall be installed so as not to be more than six feet seven inches above the floor or working platform.
[IRC2003 - E3901.6 pg.493]

When a chosen design requires creation of an attic port, a switched or pull chain light in the attic shall be installed. [NEC2005 – 210.70c]

Where installation of an ASD system requires pipes or electrical lines or conduits to penetrate a firewall or other fire resistance rated wall, ceiling, or floor, penetrations shall be protected in accordance with applicable building, mechanical, fire, and electrical codes.
[NEC2005 – 300.21]

Wiring shall not be located in or chased through any ductwork.
[NEC2005 - 300.22]

Liquid tight non-metalic conduit shall not be longer than six feet.
[NEC2005 - 356.12(3)]

Exterior mounted ASD fans shall use wiring, conduit and connectors approved by UL for continuous exterior use. Plug and cord shall be properly rated for electrical capacity and weather. Plugs or outlets used for exterior mounted fans shall have a UL approved exterior continuous duty rating.
[NEC2005 - 4068 (B2A)]

ASD fans or disconnect switches shall not be installed within ten feet of an on-site filled propane or natural gas tank unless rated for such location.
[LP Gas Code 3.3.6 & 6.3.9 & 6.3.10]

Still Checking for code requirement

6.6.3.2 Any plugged cord used to supply power to an ASD fan shall be no more than 6 feet in length. No plugged cord may penetrate a wall or be concealed within a wall.

6.7.6 Where installation of an ASD system requires pipes or electrical lines or conduits to penetrate a firewall or other fire resistance rated wall, ceiling, or floor, penetrations shall be protected in accordance with applicable building, mechanical, fire, and electrical codes.

NEC2005 Sect. 400.8 Uses Not Permitted.

Unless specifically permitted in 400.7, flexible cords and cables shall not be used for the following:

1) As a substitute for the fixed wiring of a structure
2) Where run through holes in walls, structural ceilings, suspended ceilings, dropped ceilings, or floors
3) Where run through doorways, windows, or similar openings
4) Where attached to building surfaces

Exception: Flexible cord or cable shall be permitted to be to attached building surfaces in accordance with the provisions of 3.6.8.8.

5) Where concealed by walls, floors, or ceilings or located above suspended or dropped ceilings

6) Where installed in raceways, except as otherwise permitted.

NEC2005 Sect. 358.8 Branches and Busways

(B) Cord and Cable Assemblies. Suitable cord and cable assemblies approved for extra-hard use or hard usage and listed bus drop cable shall be permitted as branches from busways for the connection of portable equipment or the connection of stationary equipment to facilitate their interchange in accordance with 400.7 and 400.8 and the following conditions:

(1) The cord or cable shall be attached to the building by an approved means.

(2) The length of the cord or cable from the busway plug-in device to a suitable tension take-up support device shall not exceed 1.8 m (6 ft.).

Note: Appendix B is still in the process of being completed.

DRAFT FOR PUBLIC REVIEW
Statement regarding document status and creation

This document has been peer reviewed in workgroup forum and with balanced representation of stakeholder groups yet has NOT at this time been approved by the consortium procedures of AARST National Radon Standards.

Original Standards Action (05-02):

Review and Revise Interim standard previously adopted Radon Mitigation Standards (RMS). (EPA 402-R-93-078, October 1993, Revised April 1994.)
Document Purpose: Minimum Standard

Analyze strengths and weaknesses of existing documents of similar subject matter, including those prepared by EPA, States, researchers and industry training facilitators in order to compose a comprehensive document with appendices, indexes and/or references that appropriately addresses variations in protocols necessary for specific situations caused by region, geology or climate.

The committee shall assess the appropriateness of the document title with respect for concerns that the other mitigation documents will be forthcoming that relate to situations other than ASD for homes.

Significant deliberation within the committee has been undertaken to achieve improvements and stronger consensus. This document version has been approved for public review distribution as it enters its final stage of completion. While not all delegates below voted, distribution was approved by a majority vote of the consortium delegates.

AUTHORIZED CONSORTIUM VOTING DELEGATES (for this subcommittee)

CHAIR – Bill Brodhead

EDUCATORS	Jack Hughes (No alternate at this time)
REGULATED STATES	Matt Shields (No alternate at this time)
NON- REGULATED STATES	Conrad Weiffenbach (Bill Bell alternate)
PROFICIENCY PROGRAM	Shawn Price (Angel C. Price alternate)
PROFICIENCY PROGRAM	Bill Bell (Nancy Bredhoff alternate)
HOME INSPECTORS (ASHI)	Bruce Thomas (Bill Levy alternate)
MEASUREMENT PROFESSIONALS	Gary Hodgden (Elean Robson alternate)
MITIGATION PROFESSIONALS	Dave Grammer (Dave Hill alternate)
EPA (non-voting)	Gene Fisher (Phil Jalbert alternate)
Manufacturer	Carolyn Allen (No alternate at this time)