

SECTION 31 21 13 RADON MITIGATION

PART 1 GENERAL

1.01 SUMMARY

- A. Provide all work necessary to reduce and maintain radon concentration levels below 4.0 picoCuries per liter (pCi/L) in Facility 10 and Facility 12. Perform mitigation system installation, and perform post-mitigation testing and monitoring for radon.

1.02 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
 - 1. Air Movement and Control Association International, Inc. (AMCA): 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 - 2. American Association of Radon Scientists and Technologists (AARST):
 - a. ANSI/AARST MALB (2014), Protocol for Conducting Measurements of Radon and Radon Decay Products in Schools and Large Buildings.
 - b. ANSI/AARST RMS-LB (2018), Radon Mitigation Standards for Schools and Large Buildings.
 - 3. American Concrete Institute (ACI): 301, Specifications for Structural Concrete.
 - 4. ASTM International (ASTM):
 - a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - b. C475/C475M, Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
 - c. C514, Standard Specification for Nails for the Application of Gypsum Board.
 - d. C645, Nonstructural Steel Framing Members.
 - e. C834, Standard Specification for Latex Sealants.
 - f. C840, Standard Specification for Application and Finishing of Gypsum Board.
 - g. C920, Standard Specification for Elastomeric Joint Sealants.
 - h. C1002, Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
 - i. C1047, Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.

- j. C1396/C1396M, Standard Specification for Gypsum Board.
- k. D2665, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
- l. E2121, Standard Practice for Installing Radon Mitigation Systems in Existing Low-Rise Residential Buildings.
- 5. Compressed Gas Association (CGA): CGA G-7, Compressed Air for Human Respiration; 6th Edition.
- 6. Gypsum Association (GA): 216, Application and Finishing of Gypsum Panel Products.
- 7. International Code Council (ICC): IM, International Mechanical Code.
- 8. Master Painters Institute (MPI):
 - a. 50, Primer Sealer, Latex, Interior.
 - b. 114, Latex, Interior, Gloss (MPI Glass Level 6).
 - c. 139, Latex, Interior, High Performance Architectural, (MPI Glass Level 3).
 - d. 141, Latex, Interior, High Performance Architectural, Semi-Gloss (MPI Gloss Level 5).
- 9. National Electrical Manufacturers Association (NEMA): MG 1, Motors and Generators.
- 10. National Fire Protection Association (NFPA): 70, ERTA 7 2023; TIA 23-15, National Electrical Code.
- 11. Northeastern Lumber Manufacturers Association (NELMA): Grading Rules, Standard Grading Rules for Northeastern Lumber.
- 12. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): 1378, Thermoplastic Duct (PVC) Construction Manual, 2nd Edition.
- 13. Southern Pine Inspection Bureau (SPIB): 1003, Standard Grading Rules for Southern Pine Lumber.
- 14. U.S. Environmental Protection Agency (EPA):
 - a. 402-R-92-003, Protocols for Radon and Radon Decay Product Measurements in Homes.
 - b. 402-R-92-004, Indoor Radon and Radon Decay Product Measurement Device Protocols.
 - c. 402-R-92-014, Radon Measurement in Schools.
 - d. 402-R-93-078, Radon Mitigation Standards.
 - e. 625-R-92-016, Radon Prevention in Design and Construction of Schools and Other Large Buildings.
 - f. 625-R-93-011, Radon Reduction Technique for Existing Detached Houses: Technical Guidance for Active Soil Depressurization Systems.
- 15. U.S. National Archives And Records Administration (NARA):
 - a. 29 CFR 1910.1096, Ionizing Radiation.
 - b. 29 CFR 1926.59, Hazard Communication.
 - c. 29 CFR 1926.103, Respiratory Protection.
 - d. 42 CFR 84, Approval of Respiratory Protective Devices.

16. Lumber Inspection Bureau (WCLIB).
17. Standard Grading Rules.
17. Western Wood Products Association (WWPA): G-5, Western Lumber Grading Rules.

1.03 DEFINITIONS

- A. Active Soil Depressurization (ASD): A family of radon mitigation systems involving mechanically-driven soil depressurization, including subslab depressurization (SSD), submembrane depressurization (SMD), block wall depressurization (BWD) and crawl space depressurization (CSD).
- B. Contract Documents: Documents furnished to prospective bidders/proposers containing information and specifying criteria and project requirements for diagnostic testing, design, construction and monitoring of multiple radon mitigation systems. The documents include this specification and the drawings listed in and accompanying this specification.
- C. Pressure Differential Gauge: A tool used to measure the PFE created by an ASD system. Calibrate the gauge in accordance with national standards and the manufacturer's recommendations. The gauge must be capable of readings to 1/1000 in water column.
- D. Pressure Field Extension (PFE): The distance that a pressure change, created by drawing soil-gas through a suction point, extends outward in a subslab gas permeable layer, under a membrane, behind a solid wall or in a hollow wall.
- E. Qualified Mitigation Professional:
 1. Regardless of team composition, a "Qualified Mitigation Professional" for the purposes of this document is defined as: An individual that has demonstrated a minimum degree of appropriate technical knowledge and skills specific to radon mitigation of schools and large buildings:
 - a. As established in certification requirements of the National Radon Proficiency Program (NRPP) or the National Radon Safety Board (NRSB).
 - b. As required by statute, state licensure or certification program, where applicable.
- F. Radon Detectors: Charcoal, electret ion chamber, or approved equivalent. Devices capable of sensing and recording the presences of radon during a time period of 48 hours to 90 days which when analyzed provide a numeric value, measured in pCi/L, for radon concentrations during the time exposed.
- G. Suction Hole: Location at which vacuum is created for subslab communication testing.

- H. Suction Point: Vertical standpipe penetrating into the soil gas environment containing radon and serving as the conduit to exhaust radon gas to the atmosphere.
- I. Test Hole: Location at which pressure readings are taken during subslab communication testing. Readings are used to evaluate potential effectiveness of a subslab depressurization system.

1.04 SYSTEM DESCRIPTION AND REQUIREMENTS

- A. Performance Requirements: Radon mitigation systems must reduce and maintain radon concentration levels below 4.0 pCi/L in various buildings specified herein. Test and construct radon mitigation systems in accordance with ANSI/AARST RMS-LB, ANSI/AARST MALB, EPA 402-R-93-078, EPA 402R-92-003, EPA 402-R-92-004, and as specified herein. Additional guidance for testing and constructing radon mitigation systems is contained in EPA 625-R-92-016 and EPA 625-R-93-011.

1.05 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 23, Submittal Procedures:
 - 1. Product Data:
 - a. Radon Mitigation Systems Components.
 - b. Radon Mitigation Systems Enclosure Components Test Reports.
 - 2. Post Mitigation Testing; Certificates:
 - a. Worker Protection Plan.
 - b. Medical Certification.
 - c. Worker Notification.
 - d. Contractor Qualifications.
 - e. Testing Laboratory Certification.
 - f. Proof Of Current Calibration For Testing Devices; Radon Mitigation System Inspection.
 - 3. Manufacturer's Instructions:
 - a. Radon Mitigation Systems Components.
 - b. Radon Mitigation Systems Enclosure Components Operation and Maintenance Data.
 - c. Radon Mitigation Systems, Data Package 2.
 - 4. Closeout Submittals:
 - a. Radon Detector Location Log.
 - b. Respirator Program Records.

1.06 RADON DETECTOR LOCATION LOG

- A. Prepare and provide to the Contracting Officer a Radon Detector Location Log for each building detailing the identity and location of each short term

and long term radon detector. Prepare the log using copies of the "Device Placement Log" contained in EPA 402-R-92-014, and provide the appropriate information as line items. In addition to the log, on a copy of the building floor plans, locate and identify each short term and long term detector.

1.07 WORKER HEALTH AND SAFETY

- A. Comply with OSHA, state and local standards or regulations relating to worker safety and occupational radon exposure. Prepare a worker protection plan in accordance with 29 CFR 1910.1096, and EPA 402-R-93-078.
 - 1. Worker Protection Plan:
 - a. The worker protection plan must address, at a minimum occupational radon exposure, safe use of all Job Site equipment including safe practices when using ladders or scaffolding; safe procedures for crawl space work and avoidance of Job Site hazards; discussion of hantavirus symptoms; fire and life safety issues; confined space access; handling caustic solvents and bonding chemicals; appropriate use of personal protective equipment; respiratory protection program; safety data sheets (SDS); ventilated work areas as required to reduce occupational radon exposure.
 - b. Adhere to 29 CFR 1926.59 and provide a copy of the SDS for all materials brought to the Site.
 - 2. Worker Exposure Records: Maintain records of worker exposure to radon sufficient to verify that workers are exposed to less than four working level months (WLM) in any 12-month period.
 - 3. Medical Certification: Provide a written certification for each worker and supervisor, signed by a licensed physician indicating that the worker and supervisor has met or exceeded all of the medical prerequisites listed herein and in 29 CFR 1910.1096 and 29 CFR 1926.103 as prescribed by law. Submit certificates prior to the start of work.
 - 4. Worker Notification: Train workers exposed to radon about the hazards of exposure to radon and the need to apply protective measures when working in areas with elevated radon concentrations. Training must comply with 29 CFR 1910.1096. Submit a notification signed by each worker acknowledging they have been properly trained regarding the hazards of radon exposure.

1.08 QUALITY ASSURANCE

- A. Contractor Qualifications and Experience:
 - 1. Within 15 days after award, submit written evidence or data demonstrating that the Contractor and one or more subcontractors

employed by the Contractor possess the qualifications and experience specified below:

- a. Qualified Mitigation Professional: A Qualified Mitigation Professional must be physically present or ensure a responsible person is present during onsite activities and immediately available to direct, instruct and oversee activities of other individuals, mitigation installers and other professionals engaged in installation activities for the mitigation system(s).
- B. Testing Laboratory: Submit testing laboratory certification as proof that the testing laboratory performing radon detector analysis has successfully completed the requirements of the National Radon Safety Board (NRSB) or the National Radon Proficiency Program, (NRPP) and is qualified and authorized to perform such analysis. Alternatively, in a State with legislation requiring mandatory credentialing for this work, compliance with the State legislation is acceptable.
- C. Diagnostic Testing Equipment: Submit proof of current calibration for testing devices used in performing diagnostic testing.
- D. On-Site Supervision: No work at the Site will be permitted without the presence of a person possessing the qualifications specified elsewhere in this section, namely certification issued by either the National Radon Proficiency Program, (NRPP) or the National Radon Safety Board (NRSB) as a qualified mitigation professional.
- E. Preconstruction Conference: Conduct a safety preconstruction conference to discuss the details of the Worker Protection Plan, Accident Prevention Plan (APP) including the AHAs required in Section 01 35 23, Safety Requirements. The safety preconstruction conference must include the Contractor and their Qualified Mitigation Professional, Designated IH and Project Supervisor and the Contracting Officer. Deficiencies in the APP will be discussed. Onsite work must not begin until the APP has been accepted.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Delivery of Products: Deliver materials to the site in an undamaged condition. Deliver proprietary items in manufacture's original unopened and undamaged containers of packages with manufacture's name and brand and other pertinent data such as specification number, type, and class, date of manufacture. Schedule deliveries of materials to coincide with scheduled installation.
- B. Storage and Handling: Carefully store materials off the ground to provide proper ventilation, drainage and protection against weather and dampness. Protect materials from marring, staining, rust, damage and overload and from contaminants such as grease, oil and dirt. Store materials at

temperatures recommended by the manufacturer. Handle material to avoid damage such as chipping and breaking. Replace damaged material.

PART 2 PRODUCTS

2.01 RADON MITIGATION SYSTEMS

- A. System Performance: Radon mitigation systems must reduce and maintain radon concentration levels below 4.0 pCi/L after activation of the mitigation systems.
 - 1. System Piping: Route radon mitigation systems piping so as not to interfere with the daily operations and functions of the building occupants. Keep visibility of the systems to a minimum. Enclose each radon mitigation system in occupied spaces, however, all operating components must be accessible for maintenance and repair. All spaces must be considered to be occupied spaces except for mechanical and electrical rooms, warehouses, storerooms, janitor closets, crawl spaces, and attic spaces. Enclosures are not required for portions of systems installed above suspended acoustical ceilings.
 - 2. System Outlet Location: Mitigation system discharge points must be as specified in ANSI/AARST RMS-LB and EPA 402-R-93-078. Prevent foreign objects from entering the outlet. Maintain watertight seal through all penetrations to the building exterior.
 - 3. System Failure Warning Monitor:
 - a. Provide a means to detect and announce each radon mitigation system failure. System failure is defined as:
 - b. System Blockage: Foreign debris.
 - c. Mechanical Failure: Fan or other mechanical failure.
 - d. System Leakage: Pipe breakage or crack.
 - e. Provide an audio or visual annunciator device to indicate system failure and locate the annunciator device in an occupied space. Conform to the requirements of ANSI/AARST RMS-LB and EPA 402-R-93-078.
 - 4. Air Cleaners: Do not use air cleaners as a radon reduction method.
 - 5. Ventilation Devices: Do not use devices that solely increase ventilation as a radon reduction method.
 - 6. Back Drafting: Do not allow radon mitigation systems to cause back drafting of building chimneys.
- B. Radon Mitigation Systems Components:
 - 1. Mechanical and electrical materials, fabrication, construction and installation must conform to the following industry standards:
 - a. Poly(vinyl chloride) (PVC) Piping: ASTM D2665, Schedule 40.
 - b. In-line Tubular Centrifugal Fans: AMCA 210 and UL listed.

- c. Electrical Work: NFPA 70, NEMA MG , ANSI/AARST RMS-LB and EPA 402-R-93-078, No. 12 AWG minimum wire size, solid copper installed in EMT or surface metal raceway.
- d. Mechanical Work: ICC IMC, SMACNA 1378, ANSI/AARST RMS-LB and EPA 402-R-93-078.
- e. Sealants: ASTM C920, polyurethane, Type S, Grade P for horizontal application, Grade NS for vertical application, Class 25, Use T.

2.02 RADON MITIGATION SYSTEMS ENCLOSURES

- A. Radon mitigation systems enclosure components, materials, fabrication, construction and installation must conform to the following industry standards:
 - 1. Concrete: ACI 301.
 - 2. Wood Studs and Furring: WWPA G-5, WCLIB 17, SPIB 1003 or NELMA Grading Rules Standard Light Framing, air dried or kiln dried lumber.
 - 3. Metal Studs and Furring: ASTM C645, but not lighter than 25 gauge.
 - 4. Gypsum Wallboard Work: ASTM C1396/C1396M, ASTM C475/C475M, ASTM C514, ASTM C1002, ASTM C1047, ASTM C840 and Gauge 216. Wallboard must be minimum 1/2 inch thick.
 - 5. Sealants: ASTM C834.
 - 6. Painting/Coating: MPI 50 and MPI 139, provide primer, intermediate and top coat. Match existing coating material. Match the adjacent surfaces color.
 - 7. Hardware: Be of the type and size necessary for the project requirements. Sizes, types, and spacing of fasteners for manufactured building materials must be as recommended by the product manufacturer. Hardware exposed to the weather or embedded in or in contact with preservative treated wood, exterior masonry, or concrete walls or slabs must be zinc coated.
 - 8. Radon mitigation systems enclosure components, materials, fabrication, construction and installation for concrete, wood studs and furring, metal studs and furring, gypsum wallboard, sealants and painting must conform to the requirements specified in the respective specification sections addressing this work contained in the project specification.

PART 3 EXECUTION

3.01 RADON MITIGATION SYSTEMS INSTALLATION

A. Installation:

1. Provide radon mitigation systems as indicated in the approved design drawings, as specified in ANSI/AARST RMS-LB, EPA 402-R-93-078 and as required by the specifications and standards referenced herein for the respective materials using workmen skilled in the trades involved. Install piping plumb and parallel to existing walls, partitions and ceilings as appropriate, slope horizontal runs to drain, and secure in place in a rigid and substantial manner.
2. Seal new and existing floor slab penetrations in accordance with EPA 402-R-93-078 and as specified herein. Prevent entry of soil gas into the building and exhausting of conditioned air via the radon mitigation system. Seal cracks and openings around floor slab penetrations with polyurethane sealant. Provide backer rod or comparable filler material as required. Ensure that all penetrations to the building exterior are weathertight.
3. Lay work out in advance. Exercise care where cutting, channeling, chasing or drilling floors, walls, partitions, ceilings or other surfaces as necessary for proper installation, support or anchorage. Patch and repair damage to buildings, piping and equipment using workmen skilled in the trades involved.
4. Coordinate all work with the Contracting Officer.

B. Supervision: Installation of the radon mitigation systems must be supervised by a qualified mitigation professional.

C. Electrical Work: NFPA 70, ANSI/AARST RMS-LB and EPA 402-R-93-078, No. 12 AWG minimum wire size, solid copper installed in EMT or surface metal raceway. A source of electric power should be available within 50 feet of each fan installation. Base bids on providing 50 feet of wire and conduit or surface metal raceway for each fan.

D. Mechanical Work: ICC IMC, SMACNA 1378, ANSI/AARST RMS-LB, and EPA 402-R-93-078.

E. System Identification: Label all components of the radon mitigation systems including, but not limited to, piping (every 10 feet), enclosures, fans, electrical conduit (every 10 feet) and circuit breakers.

3.02 RADON MITIGATION SYSTEM ENCLOSURES INSTALLATION

- A. Provide enclosures as indicated in the approved design drawings and as required by the specifications and standards referenced herein for the respective materials using workmen skilled in the trades involved.
- B. Install enclosures plumb, level and parallel to existing walls, partitions and ceilings as appropriate, and secure in place in a rigid and substantial manner.

3.03 POST MITIGATION FUNCTIONAL EVALUATION/INSPECTION

- A. ASD Systems: In conjunction with activating an ASD system, the suction in system piping must be measured and recorded along with at least one PFE measurement that is conducted under closed-building or normal operating conditions. It is recommended that both measurements be made under conditions that reflect normal building operation when significantly occupied and include consideration for worst-case conditions.
 - 1. PFE Measurement: Obtain PFE measurements at more than one point distant from each suction point(s) to verify intended design using a differential pressure gauge capable of reading to 1/1000 in water column. Record PFE test location and close in a nonpermanent fashion to facilitate any future needs (e.g. diagnosing a system when radon tests do not indicate success in achieving mitigation goals).
- B. Non-ASD Systems: Measurements of airflow volume, pressure and other system parameters that are applicable to the method chosen must be recorded after installation.

3.04 FIELD QUALITY CONTROL

- A. Radon Mitigation System Inspection: Inspect and approve in writing by a qualified mitigation professional each radon mitigation system. Verify compliance with the design, ANSI/AARST MALB, ANSI/AARST RMS-LB and the presence of fire stops. Provide the Radon Mitigation System inspection to the Contracting Officer. Deficiencies identified in the inspection report must be corrected by the Contractor at no additional cost to the Government.
- B. Post Installation Testing and Monitoring:
 - 1. Perform post installation radon testing in Facility 10 and Facility 12 as specified in ANSI/AARST RMS-LB, EPA 402-R-93-078 and herein.
 - 2. Test each radon mitigation system as described below:
 - a. Test each radon mitigation system for effectiveness no sooner than 24 hours nor later than 15 days after installation of the passive radon mitigation system. Perform all testing in accordance with ANSI/AARST MALB, ANSI/AARST RMS-LB and all

local, state, and Federal requirements. Provide short term radon detectors (charcoal, electret ion chamber or approved equivalent) at the rate of one detector per 2,000 square feet but not less than one detector per enclosed space, except for closets. On copies of the building floor plans, locate and identify each short term detector and provide short term detector data on copies of the "Device Placement Log" contained in EPA 402-R-92-014.

- b. At the end of the testing period, collect the detectors and send the detectors to the testing laboratory for analysis. Provide radon test results of the effectiveness of the mitigation systems not later than 30 days after collecting the detectors. Radon test results must be sent from the testing laboratory directly to the Contracting Officer with one copy to the Contractor. Complete the line item information on the "Device Placement Log."
- c. Radon test results above 4.0 pCi/L require system activation and installation modifications as necessary to achieve radon test results below 4.0 pCi/L. Submit design modifications to the Government for review and approval. After approval of the design modifications, provide installation modifications to the radon mitigation system and retest for effectiveness. Repeat this short term test procedure until test results below 4.0 pCi/L are achieved.
- d. System modifications (as-built systems installations) must be reflected in the Contractor's design documents (drawings and design narrative).

END OF SECTION

