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USACE / NAVFAC / AFCEC / NASA **UFGS-31 21 13 (November 2018)**

Preparing Activity: NAVFAC **Superseding**
UFGS-31 21 13 (August 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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SECTION 31 21 13

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11/18

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SECTION 31 21 13

RADON MITIGATION
11/18

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NOTE: This guide specification covers the requirements for constructing radon mitigation systems in new buildings, existing buildings and facilities, including constructing radon mitigation systems enclosures, when required.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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RADON MITIGATION FOR NEW CONSTRUCTION

NOTE: Consult the current EPA radon map and EPA documents for each state for additional information concerning radon zones.

For new construction in Zone 1 areas as defined on "EPA Map of Radon Zones", or when testing identifies radon concentrations equal to or greater than 4 pCi/L, passive radon mitigation systems should be incorporated into the original building design. The design should include provisions to permit installation of exhaust fans, if necessary, after testing the building under occupied conditions. Criteria for radon mitigation in new construction is specified in EPA 625-R-92-016, (1994, Third Printing

with Addenda) and the current version of "Radon Mitigation Standards for Schools and Large Buildings."

Materials (aggregate for capillary water barrier and poly(vinyl chloride) (PVC) pipe) currently in use for constructing new buildings, when properly arranged as indicated and specified in EPA 625-R-92-016, will provide a passive radon mitigation system. A separate specification section on radon mitigation for new construction seems unnecessary considering the materials are addressed in Division 02 and Division 15 sections and the installation will be shown on the drawings.

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NOTE: A simple, effective, efficient, and economical radon mitigation system is little more than a PVC vent pipe (one suction point) exhausted to the atmosphere without a fan (passive system). For large areas requiring mitigation, the system could include several vent pipes connected to a single outlet with an appropriately sized in-line fan (active system). Depending on the distances between suction points, several individual vent pipes with or without in-line fans may be more practical.

This guide specification provides criteria and material requirements for constructing radon mitigation systems, post mitigation testing and constructing gypsum wallboard enclosures to conceal the radon mitigation systems in occupied spaces.

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NOTE: The Designer should include unit price items to address post mitigation radon testing. Estimate the quantity and specify as unit price items in Section 00 21 13, INSTRUCTIONS TO BIDDERS or Section 01 20 00 Price and Payment Procedures per standard practice of the activity preparing the contract.

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NOTE: The work may involve a historic property. The designer must coordinate review of the proposed work with the appropriate cultural resources manager (CRM) and cultural resource laws and regulations, as part of the environmental review and permitting process. Consultation with stakeholders, including the state historic preservation office, may be required, and work involving historic properties will likely be required to confirm to the Secretary of the Interior's Standards for the Treatment of Historic Properties (usually at the REHABILITATION level). See https://www.nps.gov/tps/standards/four-treatments/treatment-

rehabilitation.htm
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PART 1 GENERAL

1.1 SUMMARY

****
NOTE: For work in the continental United States, Alaska and Hawaii select picoCuries per liter (pCi/L) as the unit of measure. For work elsewhere in the world Bequerels per cubic meter (Bq/cu m) may be the required unit of measurement. Consult with the Contracting Officer and use the unit of measure familiar to the prospective Contractors.
****

Provide all work necessary to reduce and maintain radon concentration levels below [148 Bequerels per cubic meter (Bq/cu m)][4.0 picoCuries per liter (pCi/L)] in various buildings specified herein. Perform mitigation system installation, and perform post-mitigation testing and monitoring for radon.

1.2 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

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.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

AMERICAN ASSOCIATION OF RADON SCIENTISTS AND TECHNOLOGISTS (AARST)

ANSI/AARST MALB	(2014) Protocol for Conducting Measurements of Radon and Radon Decay

	Products in Schools and Large Buildings
ANSI/AARST RMS-LB	(2018) Radon Mitigation Standards for Schools and Large Buildings

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301	(2016) Specifications for Structural Concrete

ASTM INTERNATIONAL (ASTM)

ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C475/C475M	(2017) Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board
ASTM C514	(2004; R 2020) Standard Specification for Nails for the Application of Gypsum Board
ASTM C645	(2014; E 2015) Nonstructural Steel Framing Members
ASTM C834	(2017) Standard Specification for Latex Sealants
ASTM C840	(2020) Standard Specification for Application and Finishing of Gypsum Board
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM C1002	(2018) 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
ASTM C1047	(2019) Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base
ASTM C1396/C1396M	(2017) Standard Specification for Gypsum Board
ASTM D2665	(2014) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM E2121	(2013) Standard Practice for Installing Radon Mitigation Systems in Existing Low-Rise Residential Buildings

COMPRESSED GAS ASSOCIATION (CGA)

CGA G-7	(2014) Compressed Air for Human Respiration; 6th Edition

GYPSUM ASSOCIATION (GA)

GA 216	(2010) Application and Finishing of Gypsum Panel Products

INTERNATIONAL CODE COUNCIL (ICC)

ICC IMC	(2018) International Mechanical Code

MASTER PAINTERS INSTITUTE (MPI)

MPI 50	(2015) Primer Sealer, Latex, Interior
MPI 114	(2012) Latex, Interior, Gloss (MPI GLoss Level 6)
MPI 139	(2016) Latex, Interior, High Performance Architectural, (MPI Gloss Level 3)
MPI 141	(2016) Latex, Interior, High Performance Architectural, Semi-Gloss (MPI Gloss Level 5)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2018) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code

NORTHEASTERN LUMBER MANUFACTURERS ASSOCIATION (NELMA)

NELMA Grading Rules	(2013) Standard Grading Rules for Northeastern Lumber

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1378	(1995) Thermoplastic Duct (PVC) Construction Manual, 2nd Edition

SOUTHERN PINE INSPECTION BUREAU (SPIB)

SPIB 1003	(2014) Standard Grading Rules for Southern Pine Lumber

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2014) Safety and Health Requirements Manual

U.S. DEPARTMENT OF THE NAVY (DON)

OPNAV M-5090.1	(2014) Environmental Readiness Manual

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 402-R-92-003	(1993) Protocols for Radon and Radon Decay Product Measurements in Homes
EPA 402-R-92-004	(1992) Indoor Radon and Radon Decay Product Measurement Device Protocols
EPA 402-R-92-014	(1993) Radon Measurement in Schools
EPA 402-R-93-078	(1993; R 1994) Radon Mitigation Standards
EPA 625-R-92-016	(1993; Am 1994) Radon Prevention in Design and Construction of Schools and Other Large Buildings
EPA 625-R-93-011	(1993) Radon Reduction Technique for Existing Detached Houses: Technical Guidance for Active Soil Depressurization Systems

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1096	(2017) Ionizing Radiation
29 CFR 1926.59	Hazard Communication
29 CFR 1926.103	Respiratory Protection
42 CFR 84	Approval of Respiratory Protective Devices

WEST COAST LUMBER INSPECTION BUREAU (WCLIB)

WCLIB 17	(2015) Standard Grading Rules

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA G-5	(2017) Western Lumber Grading Rules

1.3 DEFINITIONS

1.3.1 Active Soil Depressurization (ASD)

A family of radon mitigation systems involving mechanically-driven soil depressurization, including sub-slab depressurization (SSD), sub-membrane depressurization (SMD), block wall depressurization (BWD) and crawl space depressurization (CSD).

1.3.2 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.

1.3.3 Long Term Radon Detectors

****

NOTE: For work in the continental United States, Alaska and Hawaii select pCi/L as the unit of measure. For work elsewhere in the world Bq/cu m may be the required unit of measurement. Consult with the Contracting Officer and use the unit of measure familiar to the prospective Contractors.

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Alpha track, electret ion chamber, or approved equivalent. Devices capable of sensing and recording the presences of radon during a time period of 91 days to 12 months which when analyzed provide a numeric value, measured in [Bq/cu m][pCi/L], for radon concentrations during the time exposed.

1.3.4 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 0.25 Pa 1/1000 in water column

1.3.5 Pressure Field Extension (PFE)

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.

1.3.6 Qualified Mitigation Professional

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); and b) as required by statute, state licensure or certification program, where applicable."

1.3.7 Short Term Radon Detectors

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NOTE: For work in the continental United States, Alaska and Hawaii select pCi/L as the unit of measure. For work elsewhere in the world Bq/cu m may be the required unit of measurement. Consult with the Contracting Officer and use the unit of measure familiar to the prospective Contractors.

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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 [Bq/cu m][pCi/L], for radon concentrations during the time exposed.

1.3.8 Suction Hole

Location at which vacuum is created for sub-slab communication testing.

1.3.9 Suction Point

Vertical standpipe penetrating into the soil gas environment containing radon and serving as the conduit to exhaust radon gas to the atmosphere.

1.3.10 Test Hole

Location at which pressure readings are taken during sub-slab communication testing. Readings are used to evaluate potential effectiveness of a sub-slab depressurization system.

1.4 SYSTEM DESCRIPTION AND REQUIREMENTS

1.4.1 Performance Requirements

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NOTE: For work in the continental United States, Alaska and Hawaii select pCi/L as the unit of measure. For work elsewhere in the world Bq/cu m may be the required unit of measurement. Consult with the Contracting Officer and use the unit of measure familiar to the prospective Contractors.

****

Radon mitigation systems must reduce and maintain radon concentration levels below [148 Bq/cu m][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,[ASTM E2121][OPNAV M-5090.1] EPA 402-R-93-078, EPA 402-R-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.

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the

District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. **Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.**

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force, and NASA projects, or choose the second bracketed item for Army projects.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Respirators; G[, [_____]]

Radon Mitigation Systems Components

Radon Mitigation Systems Enclosure Components

SD-06 Test Reports

Post Mitigation Testing; G[, [_____]]

SD-07 Certificates

Worker Protection Plan; G[, [_____]]

Medical Certification; G[, [_____]]

Worker Notification; G[, [_____]]

Respiratory Protection Program; G[, [_____]]

Contractor Qualifications; G[, [_____]]

Contractor Experience; G[, [_____]]

Testing Laboratory Certification; G[, [_____]]

Proof Of Current Calibration For Testing Devices; G[, [_____]]

Radon Mitigation System Inspection; G[, [_____]]

SD-08 Manufacturer's Instructions

Radon Mitigation Systems Components

Radon Mitigation Systems Enclosure Components

SD-10 Operation and Maintenance Data

Radon Mitigation Systems, Data Package 2; G[, [_____]]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Radon Detector Location Log; G[, [_____]]

Respirator Program Records; G[, [_____]]

1.6 RADON DETECTOR LOCATION LOG

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.

1.7 WORKER HEALTH AND SAFETY

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,[OPNAV M-5090.1,][EM 385-1-1,] and EPA 402-R-93-078.

1.7.1 Worker Protection Plan

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; suspected contaminants such as asbestos, lead paint, mold or other toxins that may exist; safety data sheets (SDS); ventilated work areas as required to reduce occupational radon exposure. Adhere to 29 CFR 1926.59 and provide the Contracting Officer with a copy of the SDS for all materials brought to the site.

1.7.2 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.

1.7.3 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.

1.7.4 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.

1.8 RESPIRATORY PROTECTION PROGRAM

Establish and implement a respirator program as required by 29 CFR 1910.1096, and 29 CFR 1926.103. Submit a written description of the program to the Contracting Officer. Submit a written program manual or operating procedure including methods of compliance with regulatory statutes.

1.8.1 Respirator Program Records

Submit records of the respirator program as required by 29 CFR 1926.103, and 29 CFR 1910.1096.

1.8.2 Respirator Fit Testing

Conduct a qualitative or quantitative fit test conforming to 29 CFR 1926.103 for each worker required to wear a respirator, and any authorized visitors who enter a regulated area where respirators are required to be worn. A respirator fit test must be performed prior to initially wearing a respirator and every 12 months thereafter. If physical changes develop that will affect the fit, a new fit test must be performed. Functional fit checks must be performed each time a respirator is put on and in accordance with the manufacturer's recommendation.

1.8.3 Respirator Selection and Use Requirements

Provide respirators, and ensure that they are used as required by 29 CFR 1910.1096, 29 CFR 1926.103 and in accordance with CGA G-7 and the manufacturer's recommendations. Respirators must be approved by the National Institute for Occupational Safety and Health NIOSH, under the provisions of 42 CFR 84, for use in environments containing radon. For air-purifying respirators, the particulate filter must be high-efficiency particulate air (HEPA)/(N-,R-,P-100). The initial respirator selection and the decisions regarding the upgrading or downgrading of respirator type must be made by the Contractor's Designated IH based on the measured or anticipated airborne radon concentrations to be encountered.

1.8.3.1 Respirators

Provide personnel with respiratory protection as indicated in 29 CFR 1926.103. Breathing air must comply with CGA G-7.

1.9 QUALITY ASSURANCE

****

NOTE: Some states require only State listed mitigation contractors to perform radon mitigation work in their State. Determine the requirements for the State in which the work will be performed, and include the bracketed text if such is the case,

otherwise delete.
****

1.9.1 Contractor Qualifications and Experience

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.

1.9.1.1 Contractor Qualifications

The person responsible for diagnostic testing, construction and on-site supervision, as required by the specifications, must have successfully completed the requirements of and maintaining a current certification issued by either the National Radon Proficiency Program (NRPP) or the National Radon Safety Board (NRSB)as a qualified mitigation professional. Alternatively, in a State with legislation requiring mandatory credentialing for this work, compliance with the State legislation is acceptable. Evidence showing successful completion of the requirements of the NRPP or the NRSB must include copy of current certification document and documentation issued by the State.[Listing in the State of [_____] is required.]

1.9.1.2 Contractor Experience

Submit written evidence demonstrating that the Contractor has successfully designed and installed at least [two] [_____] radon mitigation systems of the same or similar to the type required herein. The Contractor must have [3][5][_____] years of experience installing radon mitigation systems. Experience proof must include but not be limited to:

a. The contract name and number, completion dates of the project and the total cost of the project;

b. The names, telephone numbers and fax number of the facility or installation for whom the radon mitigation system design, construction and testing were performed;

c. The name, telephone number and fax number of a supervisory level point of contact at each facility or installation who has knowledge of the Contractor's performance.

1.9.1.3 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). The qualified mitigation professional must have [3][5][_____] years of experience installing radon mitigation systems.

1.9.2 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.[Listing in the State of [_____] is required.]

1.9.3 Diagnostic Testing Equipment

Submit proof of current calibration for testing devices used in performing diagnostic testing.

1.9.4 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, or the State equivalent, where applicable.

1.9.5 Preconstruction Conference

****

NOTE: Specify additional or modified requirements to be addressed in the preconstruction safety conference within the bracket if different from that described. Confer with the appropriate Construction Office and Safety and Occupational Health Office representatives to make this determination. For Army projects refer to EP 415-1-260, Chapter 9, Resident Engineers Management Guide. If this conference is addressed in another specification section, reference the appropriate section.

****

Conduct a safety preconstruction conference to discuss the details of the Worker Protection Plan, Accident Prevention Plan (APP) including the AHAs required in specification section 01 35 26 GOVERNMENTAL 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. [_____]

1.10 DELIVERY, STORAGE AND HANDLING

1.10.1 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.

1.10.2 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.

1.11 PROJECT CONDITIONS

1.11.1 Building Descriptions

****

NOTE: Provide a general description for each building and address conditions which may affect the work or the cost of accomplishing the work. For each building, address the following as appropriate for the areas in which work is to be accomplished:

1. Type of construction for the exterior walls, interior walls and partitions and the floor in contact with or above soil containing radon gas. Indicate thickness of concrete slab and aggregate beneath the concrete slab.

2. Number of floors.

3. Type of roof, flat or pitched. If pitched roof, overhang size. Type of roof covering.

4. Do rooms/spaces have suspended ceilings? This could be shown on the drawings if not consistent throughout the building.

5. Will the building and individual rooms or spaces be occupied or unoccupied during construction? Will access to the building or individual room or spaces be restricted in any way which would delay the start of work each day?

6. Restrictions with respect to penetrations to the building exterior, such as no roof penetrations, if any.

7. Restrictions on penetrating the concrete floor slab with respect to what may be embedded in the concrete slab (i.e. rebar spacing, electrical grounding grid embedded in the concrete slab).

8. Restrictions with respect to routing vent pipe on the building interior or exterior, if any. Vents may not be desired on the exterior of a particular side of the building.

The sample paragraph below may be used as a starting point for each building description.

****

[Building No. [_____] is a three story, brick faced (CMU backed), slab-on grade structure with a partial basement on the southeast corner of the building. Concrete slab is approximately [_____] mm inches thick and the aggregate beneath the concrete slab is approximately [_____] mm inches thick. Interior partitions are gypsum wallboard on metal studs except where indicated otherwise on the drawings. The roof is flat and covered with single ply rubber membrane. Except for the basement, mechanical rooms and closets, all rooms have suspended acoustical ceilings located

approximately 450 mm 18 inches below the structural floor or roof above. The building will[not] be occupied during the contract period.[Roof penetrations are not permitted and the south elevation must remain unchanged as a result of the work.][Penetrations to the building exterior must be through the roof only. All elevations must remain unchanged as a result of the work.]

]PART 2 PRODUCTS

2.1 RADON MITIGATION SYSTEMS

2.1.1 System Performance

****

NOTE: For work in the continental United States, Alaska and Hawaii select pCi/L as the unit of measure. For work elsewhere in the world Bq/cu m may be the required unit of measurement. Consult with the Contracting Officer and use the unit of measure familiar to the prospective Contractors.

****

Radon mitigation systems must reduce and maintain radon concentration levels below [148 Bq/cu m][4.0 pCi/L] after activation of the mitigation systems.

2.1.1.1 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.

2.1.1.2 System Outlet Location

****

NOTE: In climates where condensation is subject to freezing and ice build-up at the discharge point above the roof line, include the bracketed text, otherwise delete.

****

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.[Rain caps are not permitted.] Maintain water tight seal through all penetrations to the building exterior.

2.1.1.3 System Failure Warning Monitor

Provide a means to detect and announce each radon mitigation system failure. System failure is defined as:

a. System blockage: foreign debris.

b. Mechanical failure: fan or other mechanical failure.

c. System leakage: pipe breakage or crack.

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.

2.1.1.4 Air Cleaners

Do not use air cleaners as a radon reduction method.

2.1.1.5 Ventilation Devices

Do not use devices that solely increase ventilation as a radon reduction method.

2.1.1.6 Back Drafting

Do not allow radon mitigation systems to cause back drafting of building chimneys.

2.1.2 Radon Mitigation Systems Components

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 1, 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.

f. Crawl space soil-gas retarder membrane must be minimum [40][60] mils thick.

****
NOTE: Include mock downspouts and fittings only when round PVC piping is not acceptable for aesthetic reasons.
****

[g. Mock Downspouts and Fittings: Aluminum, ASTM B209M ASTM B209, minimum 0.81 mm 0.032 inch thick, color to match existing. Seal seams and joints. Use downspout only on the building exterior above the fan with appropriate round to downspout shape PVC adapter.

]2.2 RADON MITIGATION SYSTEMS ENCLOSURES

****
NOTE: Select the first bracketed paragraph for

enclosure materials and construction when the project involves only radon mitigation work. Select the second bracketed paragraph when the project also involves building renovations which require project specification sections addressing the work listed in the second bracketed paragraph.
****

****
NOTE: When selecting the MPI painting/coating designations, determine whether an eggshell, semi-gloss or gloss finish is desired.
****

[Radon mitigation systems enclosure components, materials, fabrication, construction and installation must conform to the following industry standards:

a. Concrete: ACI 301.

b. Wood Studs and Furring: WWPA G-5, WCLIB 17, SPIB 1003 or NELMA Grading Rules Standard Light Framing, air dried or kiln dried lumber.

c. Metal Studs and Furring: ASTM C645, but not lighter than 25 gage.

d. Gypsum Wallboard Work: ASTM C1396/C1396M, ASTM C475/C475M, ASTM C514, ASTM C1002, ASTM C1047, ASTM C840 and GA 216. Wallboard must be minimum [12][15] mm [1/2][5/8] inch thick.

e. Sealants: ASTM C834.

f. Painting/Coating: MPI 50 and [[MPI 139] [MPI 141][MPI 114]], provide primer, intermediate and top coat. Match existing coating material. Match the adjacent surfaces color.

g. 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.

][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

3.1 RADON MITIGATION SYSTEMS INSTALLATION

3.1.1 Furnishings

****
NOTE: Choose one of the following options. In most projects, the Government will remove furniture and equipment before the Contractor begins work. In

this case the first paragraph should be used.
****

[Furniture [,(_____)] and equipment will be removed from the area of work by the Government before radon mitigation work begins.

][Furniture [,(_____)] and equipment will remain in the building. Cover and seal furnishings with 0.15 mm 6-mil plastic sheet or remove from the work area and store in a location on site approved by the Contracting Officer.

]3.1.2 Installation

a. 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.

b. 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. Insure that all penetrations to the building exterior are weathertight.

c. 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.

d. Coordinate all work with the Contracting Officer.

3.1.3 Supervision

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

3.1.4 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 [15] [_____] meters [50] [_____] feet of each fan installation. Base bids on providing [15] [_____] meters [50] [_____] feet of wire and conduit or surface metal raceway for each fan.

3.1.5 Mechanical Work

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

3.1.6 System Identification

****
NOTE: For NAVFAC projects include the bracketed text, otherwise delete.

****

Label all components of the radon mitigation systems including, but not limited to, piping (every 3 meters 10 feet), enclosures, fans, electrical conduit (every 3 meters 10 feet) and circuit breakers. Labels must read:

Radon Reduction System. Do Not Turn Off.
Public Works Office Phone [_____]

[or as specified by the Contracting Officer.

]3.2 RADON MITIGATION SYSTEM ENCLOSURES INSTALLATION

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. Install enclosures plumb, level and parallel to existing walls, partitions and ceilings as appropriate, and secure in place in a rigid and substantial manner.

3.3 POST MITIGATION FUNCTIONAL EVALUATION/INSPECTION

3.3.1 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.

3.3.1.1 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 0.25 Pa 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).

3.3.2 Non-ASD Systems

Measurements of airflow volume, pressure and other system parameters that are applicable to the method chosen must be recorded after installation.

3.4 FIELD QUALITY CONTROL

3.4.1 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.

3.4.2 Post Mitigation Testing and Monitoring

Perform post mitigation radon testing in the buildings as specified in

ANSI/AARST RMS-LB, EPA 402-R-93-078 and herein.

3.4.2.1 Short Term

****

NOTE: For work in the continental United States, Alaska and Hawaii select pCi/L as the unit of measure. For work elsewhere in the world Bq/cu m may be the required unit of measurement. Consult with the Contracting Officer and use the unit of measure familiar to the prospective Contractors.

****

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 activation of the 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 186 square meters 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 [148 Bq/cu m][4.0 pCi/L] require system redesign and installation modifications as necessary to achieve radon test results below [148 Bq/cu m][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 [148 Bq/cu m][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).

3.4.2.2 Long Term

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NOTE: For work in the continental United States, Alaska and Hawaii select pCi/L as the unit of measure. For work elsewhere in the world Bq/cu m may be the required unit of measurement. Use the unit of measure familiar to the prospective Contractors.

****

After acceptance of the radon mitigation systems, provide for long term testing (8 to 12 months), see below.

a. Perform all testing in accordance with ANSI/AARST MALB, ANSI/AARST RMS-LB and all local, state and Federal requirements. Provide long term radon detectors (alpha track, electret ion chamber or approved equivalent) at the rate of one detector per 186 square meters 2,000 square feet but not less than one detector per enclosed space, except for closets. Locate and identify each detector on copies of the building floor plans and in the Radon Detector Location Log. After installing the detectors, furnish the completed detector documentation and mailers to the Contracting Officer.

****

NOTE: Depending upon the resources available at the activity or facility, select the appropriate paragraph for collecting the long term detectors.

****

[b. At the end of the testing period, collect the detectors, request return of the detector documentation and mailers from the Contracting Officer and send the detectors to the testing laboratory for analysis. 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 in the Radon Detector Location Log.

][c. At the end of the testing period, the Contracting Officer will collect and send the detectors to the testing laboratory for analysis. Radon test results must be sent from the testing laboratory directly to the Contracting Officer with one copy to the Contractor.

] d. Radon test results above [148 Bq/cu m][4.0 pCi/L] require system redesign and installation modifications as necessary to achieve radon test results below [148 Bq/cu m][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 the short term and long term test procedures specified herein until test results below [148 Bq/cu m][4.0 pCi/L] are achieved.

e. Payment for work required because long term testing results in readings above [148 Bq/cu m][4.0 pCi/L] will be made from the funds identified in the "Schedule of Prices" for the work required under this paragraph and defined under the paragraph POST MITIGATION TESTING - SCHEDULE OF PRICES DATA included herein. Payment of these funds will be made only after the Contracting Officer has received the radon testing results from the testing laboratory and the readings for the long term testing are below [148 Bq/cu m][4.0 pCi/L].

f. Final system modifications (as-built systems installations) must be reflected in the Contractor's design documents (drawings and design narrative).

-- End of Section --