
USACE / NAVFAC / AFCEC / NASA UFGS-31 21 13 (August 2011)

Preparing Activity: NAVFAC Superseding
UFGS-31 21 13 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMLR dated October 2013

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SECTION 31 21 13

RADON MITIGATION 08/11

NOTE: This guide specification covers the requirements for diagnostic testing for radon and designing and constructing radon mitigation systems in 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 items(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).

RADON MITIGATION FOR NEW CONSTRUCTION

NOTE: EPA has published "EPA Map of Radon Zones". Consult the map, EPA document EPA-402-R-93-071, "EPA Map of Radon Zones" 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", 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)
"Radon Prevention in Design and Construction of
Schools and Other 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.

NOTE: In most cases the work for this project will
be performed by small business Contractors with
little or no sophisticated drawing resources.
Therefore, the design requirements are very minimal
with respect to the production of drawings.

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 diagnostic testing,
designing and constructing radon mitigation systems,
post mitigation testing and constructing gypsum
wallboard enclosures to conceal the radon mitigation
systems in occupied spaces.

DRAWING INFORMATION REQUIRED

NOTE: Prepare A4 (297 by 210 mm) 8 1/2 by 11 inch
scaled drawings for each building and include at the
end of this section. Depending on the building
size, several drawings may be needed to show the
entire building in legible scaled size.

A blank drawing with sample title block is included
at the end of this guide specification. Include the
information for identifying the project and radon
mitigation system designer and leave blank.

For each building requiring radon mitigation provide
the following information:

1. Building footprint including interior walls and partitions. Identify interior load bearing walls and fire rated walls. Locate and identify underslab utilities.
2. Overall building dimensions. Approximate building height and floor to floor or ceiling heights (could be addressed in General Notes).
3. Room/space numbers or names.
4. Approximate location of radon readings taken during site investigation and presented in this section on Attachment A. See Criteria Note in paragraph entitled "Existing Conditions".
5. Identify suspected or confirmed entry points of radon into the buildings such as exterior wall separations from floor slab, large cracks in floor slabs, floor drains, and exposed earth in crawl spaces.
6. Identify and locate hazardous materials such as lead based paint, vinyl asbestos flooring, transite or cement asbestos siding, if any.
7. In addition to the drawings, provide a general description for each building under paragraph entitled "Building Descriptions" below. See paragraph entitled "Building Descriptions" and associated Criteria Note for additional information.

NOTE: In order to estimate the total contract time required to complete all work for the project, the following time frames, which are defined, specified and permitted in this guide specification, should be considered:

1. Diagnostic Testing - (*) days.
2. Design of radon mitigation systems and enclosures - (*) days.
3. Government review/approval of design - 30 days.
4. Construction of radon mitigation systems and enclosures - (*) days.
5. Establish equilibrium - 1 to 15 days after start-up of the radon mitigation system. (Contractor decision).
6. Short term detector testing - 2 to 90 days after installation. (Contractor decision).
7. Short term detector test results - will usually be available approximately 30 days after detectors

are sent to laboratory.

8. Long term detector testing - 8 to 12 months after installation. (Contractor or Government decision).

9. Long term detector test results - will usually be available approximately 30 days after detectors are sent to laboratory.

Note:

* Depends on the number and size of buildings requiring radon mitigation.

PART 1 GENERAL

1.1 SUMMARY

NOTE: On Attachment A, identify the buildings, provide radon concentration level readings and identify the detector type used to record these readings and include at the end of this section.

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 EFD/EFA 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 pre-mitigation diagnostic testing and analysis, provide mitigation system design and installation, and perform post-mitigation testing and monitoring for radon. Building floor plans and radon readings (identified on Attachment A) are provided at the end of this section.

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 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 (AMCA)

AMCA 210 (2007) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 301 (2010; Errata 2011) Specifications for Structural Concrete

ASTM INTERNATIONAL (ASTM)

ASTM B209 (2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

ASTM B209M (2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)

ASTM C1002 (2007) 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 (2010a) Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base

ASTM C1396/C1396M (2013) Standard Specification for Gypsum Board

ASTM C475/C475M (2012) Joint Compound and Joint Tape for Finishing Gypsum Board

ASTM C514 (2004; E 2009; R 2009) Standard Specification for Nails for the Application of Gypsum Board

ASTM C645 (2013) Nonstructural Steel Framing Members

ASTM C834 (2010) Latex Sealants

ASTM C840 (2011) Application and Finishing of Gypsum Board

ASTM C920 (2011) Standard Specification for Elastomeric Joint Sealants

ASTM D2665 (2012) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings

GYPSUM ASSOCIATION (GA)

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

INTERNATIONAL CODE COUNCIL (ICC)

ICC IMC (2012) International Mechanical Code

ICC UMC (1997; Errata 2 & 3 1997) Uniform Mechanical Code

MASTER PAINTERS INSTITUTE (MPI)

MPI 114 (Oct 2009) Interior Latex, Gloss, MPI Gloss Level 6

MPI 139 (Oct 2009) Interior High Performance Latex, MPI Gloss Level 3

MPI 141 (Oct 2009) Interior High Performance Latex MPI Gloss Level 5

MPI 50 (Oct 2009) Interior Latex Primer Sealer

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1 (2011; Errata 2012) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2014) 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 (2002) Standard Grading Rules for Southern Pine Lumber

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

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-93-003	(1993) Protocols for Radon and Radon Decay Product Measurements in Homes
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

WEST COAST LUMBER INSPECTION BUREAU (WCLIB)

WCLIB 17	(2004) Standard Grading Rules
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WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA G-5	(2011) Western Lumber Grading Rules
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1.3 DEFINITIONS

1.3.1 Design

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.

Documents which include design drawings, design narrative (basis of design and calculations) and product data prepared and assembled by or under the direct supervision of a United States Environmental Protection Agency (USEPA) Radon Contractor Proficiency (RCP) listed mitigation contractor [and State listed mitigation contractor] and proposed by the Contractor to meet the contract requirements. [Listing in the State of [_____] is required.]

1.3.2 Design Drawings

Documentation showing in graphic and quantitative form the extent, design, arrangement, location, relationships, and dimensions of the construction to be provided by the Contractor.

1.3.3 Designer

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.

USEPA RCP listed mitigation contractor [and State listed mitigation contractor] associated with the Contractor who is responsible for the design and has the qualifications and experience specified. [Listing in the State of [_____] is required.]

1.3.4 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.

1.3.5 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 EFD/EFA and use the unit of measure familiar to the prospective Contractors.

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.

1.3.6 Short 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 EFD/EFA and use the unit of measure familiar to the prospective Contractors.

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.

1.3.7 Suction Hole

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

1.3.8 Suction Point

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

1.3.9 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

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 EFD/EFA and use the unit of measure familiar to the prospective Contractors.

Radon mitigation systems shall reduce and maintain radon concentration levels below [148 Bq/cu m] [4.0 pCi/L] in various buildings specified herein. Test, design and construct radon mitigation systems in accordance with EPA 402-R-93-078, EPA 402-R-93-003, EPA 402-R-92-004 and as specified herein. Additional guidance for testing, designing and constructing radon mitigation systems is contained in EPA 625-R-92-016 and EPA 625-R-93-011.

1.4.2 Criteria for Pricing Diagnostic Testing and Suction Points

NOTE: In order to achieve uniform pricing for diagnostic testing and the number of suction points to be constructed, complete Attachment B and include at the end of this section. See Criteria Note accompanying Attachment B for additional information.

For purposes of uniformly pricing diagnostic testing and the number of suction points to be constructed, base prices on the minimum requirements specified in Attachment B, located at the end of this section. Test locations, suction point locations, pipe sizes, number of fans and discharge points to the building exterior, routing of the radon mitigation systems piping, provision of associated enclosures, and all other work necessary to achieve the desired results specified are the Contractor's responsibility and shall be based on the requirements and restrictions, if any, specified herein.

NOTE: The number of suction points for each building specified in Attachment B are the recommended number based on existing information and are provided for pricing purposes only. The actual number of suction points required may be more or less depending on the results of the site investigations, effectiveness of sub-slab communication, diagnostic testing, and post mitigation testing and monitoring. If the final number of suction points differs from those specified, the Government will issue a modification pursuant to Contract Clause "FAR 52.243-4, Changes."

1.5 SUBMITTALS

NOTE: Review Submittal Description (SD) definitions

in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated 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 submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation 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.

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

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

NOTE: The design documentation will be submitted by the Contractor as construction submittals in the format described elsewhere in this section.

Revise Section 01 33 00 SUBMITTAL PROCEDURES paragraph entitled "Scheduling", subparagraph b. After the first sentence, include the following as an additional unnumbered subparagraph:

"Submittals for design of the radon mitigation systems and enclosures, specified in Section 31 21 13 RADON MITIGATION will require 30 working days for Government review and approval."

Radon mitigation systems[; G][; G, [____]]

Radon mitigation systems enclosures[; G][; G, [____]]

SD-03 Product Data

Radon mitigation systems components

Radon mitigation systems enclosure components

Radon diagnostic testing devices[; G][; G, [_____]]

SD-05 Design Data

Radon mitigation systems design narrative[; G][; G, [_____]]

SD-06 Test Reports

Pre-mitigation testing[; G][; G, [_____]]

Post mitigation testing[; G][; G, [_____]]

SD-07 Certificates

Contractor qualifications[; G][; G, [_____]]

Contractor experience[; G][; G, [_____]]

Worker protection plan[; G][; 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][; G, [_____]]

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

SD-11 Closeout Submittals

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

Testing laboratory certification[; G][; G, [_____]]

Proof of current calibration for testing devices[; G][; G, [_____]]

1.6 DESIGN REQUIREMENTS

NOTE: The design documentation will be submitted by
the Contractor as construction submittals in the
format described below.

Prepare designs in accordance with the requirements of EPA 402-R-93-078 except that when the contract specification requirements are more stringent, the contract specification shall take precedence. The

Contractor shall:

- a. Prepare design drawings and assemble and provide product data for construction of multiple radon mitigation systems;
- b. Prepare design narrative supporting the design shown;
- c. Coordinate all elements of the design to ensure there are no conflicts;
- d. For each building, present information 100 percent complete in a single submission and in sufficient detail to permit a complete review by the Government. The Government's review is to check the design for conformance with the requirements contained in the contract documents. Design approval shall not be construed as a waiver from performing requirements contained in the contract which may have been omitted from the Contractor prepared design documents.
- e. Provide [six] [_____] copies of the complete design documents.

1.6.1 Design Drawing Requirements

Prepare, organize, and present drawings in the format considered standard industry practice for radon mitigation work and as described herein. Provide drawings complete, accurate and explicit enough to show compliance with the contract requirements and to permit construction. Drawings illustrating systems proposed to meet the requirements of the contract specification shall reflect proper detailing for each system to assure appropriate use, proper fit, compatibility of components and coordination with the design narrative and the contract specification. Coordinate drawings to ensure there are no conflicts between design disciplines and between drawings and the contract specification. Title block shall be the same as that used in the project drawings provided in the project specification. Each Contractor prepared drawing shall bear the certification number and signature of the RCP listed individual responsible for the work portrayed on that drawing and proposed to meet the contract requirements.

1.6.1.1 Radon Mitigation Systems (Format and Content)

On copies of the building floor plans, locate and identify each diagnostic test performed using alpha numeric designations. Prepare a separate drawing for each type of diagnostic test performed in each building. Provide grab sample (GS) data on Attachment C. Provide sub-slab communication (SSC) test data on Attachment D. Provide short term detector (STD) data on copies of the "Device Placement Log" contained in EPA 402-R-92-014.

On copies of the building floor plans, show suction point(s) and routing of the radon mitigation system(s) piping to the building exterior. Indicate pipe size, length of piping in the network, number and nature of flow obstructions, such as fittings, and fan characteristics for each system. Supplement the floor plan information with additional drawings keyed to each floor plan location showing riser diagrams, utility connections and routing, component installations, elevations, sections and details of the radon mitigation system(s). Also, provide construction and installation details such as supporting systems, attachment methods and surface penetration and sealing methods.

Drawings shall not be smaller than A4 (297 by 210 mm) 8 1/2 by 11 inches.

Government will furnish [five] [_____] copies of the project specification.

1.6.1.2 Radon Mitigation Systems Enclosures (Format and Content)

Prepare drawings not smaller than A4 (297 by 210 mm) 8 1/2 by 11 inches portraying the proposed method for enclosing each radon mitigation system in occupied spaces. All spaces shall 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.

Drawings shall indicate methods and materials to be used in constructing the enclosures and accesses for all operating components. Drawings showing typical enclosures and installations are acceptable (i.e. corner installation, mid-wall installation, etc.).

1.6.2 Design Narrative

1.6.2.1 Format

The design narrative shall include a cover page indicating the project title, location, construction contract number and preparer, a table of contents and tabbed or colored page separations for quick reference. Submit design narrative prepared on A4 (297 by 210 mm) 8 1/2 by 11 inch white paper. The design narrative shall be bound in one volume.

1.6.2.2 Content

The design narrative shall include a basis of design and calculations. Specific requirements relative to the technical content to be provided are specified in this specification section. The design narrative shall be a presentation of facts to demonstrate that the project requirements are fully understood and that the design is based on sound engineering. The design narrative shall include and address the following:

- a. Executive summary.
- b. Scope of work.
- c. Building description.
- d. Diagnostic testing performed and results of the testing (include Attachments C and D and the Device Placement Logs for the short term detectors).
- e. Diagnostic test devices and equipment used.
- f. Locations where readings were recorded (include floor plans).
- g. Suspected or confirmed entry points of radon into the buildings (narrative or show on floor plans).
- h. Potential problems which may be caused by active (fan-powered) radon mitigation systems, if any.
- i. Conclusions and recommendations.

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 EFD/EFA and use the unit of measure familiar to the prospective Contractors.

- j. Radon mitigation method chosen to reduce radon concentrations levels below [148 Bq/cu m] [4.0 pCi/L] and reasons for choosing the method.
- k. Data and calculations to verify negative pressure exists throughout the soil gas environment containing radon sufficient to exhaust the soil gas to the atmosphere under all weather and building operating conditions.
- l. Statement of compliance with applicable laws, ordinances, criteria, rules, and regulations of Federal, State, regional and local authorities regarding radon mitigation.
- m. Appendices (to include design drawings, forms and logs, laboratory analysis sheets, etc.).

1.6.3 Design Review and Approval

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 EFD/EFA and use the unit of measure familiar to the prospective Contractors.

The design will be reviewed and approved by the Government prior to start of construction. The Government's review is to check the design for conformance with the contract requirements. Design approval does not relieve the Contractor of the responsibility of meeting the requirements of the contract and providing radon mitigation systems which, while active, reduce and maintain radon concentration levels below [148 Bq/cu m] [4.0 pCi/L]. The design of the radon mitigation systems and enclosures shall be approved prior to submission of construction submittals for the materials to be used in the construction of the systems and enclosures.

Contract completion time includes 30 days for review and approval of the design. Partial or incomplete design submissions will not be reviewed and will be immediately returned to the Contractor for completion and resubmission. Design submissions found to be not in compliance with the contract requirements will be returned to the Contractor for correction and resubmission. The Contractor shall make such modifications as may be necessary to bring the design into compliance at no change in contract price and schedule. Under either of these circumstances, the Government will have a 30-day review period adjusted to commence upon receipt of the revised design documents with no increase in the total contract completion time provided.

1.7 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.

1.8 WORKER HEALTH AND SAFETY

Provide in accordance with EPA 402-R-93-078. Prepare a worker protection plan in accordance with EPA 402-R-93-078.

1.9 QUALITY ASSURANCE

1.9.1 Contractor Qualifications and Experience

Within 15 days after award, submit written evidence or data demonstrating that the Contractor and/or 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, design, construction and on-site supervision, as required by the specifications, shall have successfully completed the requirements of and shall be maintaining a current listing in the USEPA RCP Program. 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 USEPA National RCP Program shall include copy of current, valid USEPA RCP photo identification card or equivalent documentation issued by the State.

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. Experience proof shall 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/or 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.

1.9.2 Testing Laboratory

Submit testing laboratory certification as proof that the testing laboratory performing radon detector analysis has successfully completed the requirements of the USEPA Radon Measurement Proficiency (RMP) Program 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.

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 USEPA RCP listing or the State equivalent, where applicable .

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 Project Drawings

Building floor plans are provided at the end of this section.

1.11.2 Existing Conditions

NOTE: For each building, provide radon concentration level readings on Attachment A and include at the end of this section. Also, identify the detector type used to record these readings.

Assign an identification number (Reading ID No.) to each reading. Show the approximate location of each reading on the floor plans using the Reading ID No.

Identify suspected or confirmed radon entry points into the buildings, where appropriate.

The buildings were tested for radon. The test dates, radon levels recorded and detector type used are indicated on Attachment A, located at the end of this section. The approximate locations of the readings are shown on the project drawings. [Drawings also show suspected [and confirmed] radon entry points into the buildings.]

1.11.3 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 shall remain

unchanged as a result of the work.] [Penetrations to the building exterior shall be through the roof only. All elevations shall remain unchanged as a result of the work.]]

1.12 POST MITIGATION TESTING - SCHEDULE OF PRICES DATA

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 EFD/EFA and use the unit of measure
familiar to the prospective Contractors.

In addition to the requirements specified in Section entitled "Price and Payment Procedures", the following applies:

In accordance with Contract Clause "FAR 52.232-5, Payments Under Fixed - Price Construction Contracts," include in the "Schedule of Prices" a line item for the work required under paragraph entitled "Long Term." This line item shall be a minimum of 10 percent of the contract price. 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].

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 EFD/EFA and use the unit of measure
familiar to the prospective Contractors.

Radon mitigation systems shall 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 shall be accessible for maintenance and repair. All spaces shall 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 shall be as specified in 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 EPA 402-R-93-078.

2.1.1.4 Air Cleaners

Air cleaners shall NOT be used as a radon reduction method.

2.1.1.5 Ventilation Devices

Devices which reduce radon solely by increasing ventilation to the occupied space shall NOT be used.

2.1.1.6 Back Drafting

Radon mitigation system shall NOT cause back drafting of building chimneys.

2.1.2 Radon Mitigation Systems Components

Mechanical and electrical materials, fabrication, construction and installation shall 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 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, ICC UMC, SMACNA 1378 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 shall 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 shall conform to the following industry standards:

- a. Concrete: ACI 301.
- b. Wood Studs and Furring: WHPA 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 shall 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. Coating material shall match existing. Color shall match the adjacent surfaces.
- g. Hardware: Shall be of the type and size necessary for the project requirements. Sizes, types and spacing of fasteners for manufactured building materials shall 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 shall 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 shall conform to the requirements specified in the respective specification sections addressing this work contained in the project specification.]

PART 3 EXECUTION

3.1 RADON TESTING

Perform radon testing in accordance with EPA 402-R-93-003 and EPA 402-R-92-004. The Contractor shall arrange that all laboratory test results are sent from the testing laboratory directly to the Contracting Officer with one copy to the Contractor.

3.1.1 Pre-Mitigation Testing

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 EFD/EFA and use the unit of measure familiar to the prospective Contractors.

Within [30] [_____] days after award, test buildings to determine the relative radon concentration levels in these buildings. Perform diagnostic testing prior to design of the radon mitigation systems using radon diagnostic testing devices approved by the Contracting Officer.

Test basements, areas of buildings where the underside of the floor comes in direct contact with the soil as well as areas that can pull ground floor air or soil gas, such as, elevator shafts, stairwells, pipe chases, crawl spaces with dirt floors, underground walkways and tunnels.

Diagnostic testing shall determine the following:

- a. Relative radon concentration levels in the building.
- b. Radon entry points into the building.
- c. Effectiveness of sub-slab communication.
- d. Number and location of suction points required to reduce and maintain radon concentration levels below [148 Bq/cu m] [4.0 pCi/L].

NOTE: The number of suction points for each building specified in Attachment B are the recommended number based on existing information and are provided for pricing purposes only. The actual number of suction points required may be more or less depending on the results of the site investigations, effectiveness of sub-slab communication, diagnostic testing, and post mitigation testing and monitoring. If the final number of suction points differs from those specified, the Government will issue a modification pursuant to Contract Clause "FAR 52.243-4, Changes."

Site investigation data and results obtained from diagnostic testing shall be used to design the radon mitigation systems and shall be provided for review and approval by the Government.

As a minimum, perform the number of diagnostic tests suggested in Attachment B. Each sub-slab communication test shall include a suction hole and at least four test holes. Use non-shrink grout to repair all holes resulting from diagnostic testing and restore floor and wall finishes to match existing adjacent surfaces.

3.2 DESIGN RADON MITIGATION SYSTEMS AND SYSTEMS ENCLOSURES

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 EFD/EFA and use the unit of measure familiar to the prospective Contractors.

Design radon mitigation systems as required to achieve radon detection test results below [148 Bq/cu m] [4.0 pCi/L] based on radon diagnostic test results, [EPA 402-R-93-078](#) and the information provided herein. Design the systems enclosures to accommodate the radon mitigation systems configurations and the adjacent or surrounding walls, partitions, ceilings and roof construction.

3.3 RADON MITIGATION SYSTEMS INSTALLATION

3.3.1 Installation

Provide radon mitigation systems as indicated in the approved design drawings, as specified in [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.

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.

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.

As part of the site investigation, the Contractor shall identify furniture, carpeting or other portable materials and equipment which must be relocated to provide for the installation of the radon mitigation systems, if any. The Government will work with the Contractor to coordinate relocations.

Coordinate all work with the Contracting Officer.

3.3.2 Supervision

Installation of the radon mitigation systems shall be supervised by the RCP listed individual responsible for the design of the systems.

3.3.3 Electrical Work

NFPA 70 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.

3.3.4 Mechanical Work

ICC IMC, ICC UMC, SMACNA 1378 and EPA 402-R-93-078.

3.3.5 System Identification

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

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

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

[or as specified by the Contracting Officer.]

3.4 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.

3.5 FIELD QUALITY CONTROL

3.5.1 Radon Mitigation System Inspection

Each system shall be inspected and approved in writing by the RCP listed individual responsible for the design of the system. Verify the presence of fire stops. Deficiencies shall be corrected by the Contractor at no additional cost to the Government.

3.5.2 Post Mitigation Testing and Monitoring

Perform post mitigation radon testing in the buildings as specified in EPA 402-R-93-078 and herein.

3.5.2.1 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 EFD/EFA and use the unit of measure
familiar to the prospective Contractors.

Test each radon mitigation system for effectiveness no sooner than 24 hours
nor later than 15 days after activation of the radon mitigation system.
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.

At the end of the testing period, the Contractor shall 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
shall 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."

Radon test results above [148 Bq/cu m] [4.0 pCi/L] shall 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.

System modifications (as-built systems installations) shall be reflected in
the Contractor's design documents (drawings and design narrative).

3.5.2.2 Long 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 EFD/EFA and 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). 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.

[At the end of the testing period, the Contractor shall 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 shall 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.]

[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 shall be sent from the testing laboratory directly to the Contracting Officer with one copy to the Contractor.]

Radon test results above [148 Bq/cu m] [4.0 pCi/L] shall 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.

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 entitled "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].

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

Attachment A					
BUILDINGS AND RADON READINGS					
Contract Number:			Building No.		
LOCATION: SPACE NAME	READING ID NO.	DATE INSTALLED	DATE COLLECTED	RADON LEVEL pCi/L	REMARKS
[_____] detectors were used to record these reading.					

Attachment B Criteria Note

NOTE: The number of suction points required to reduce radon concentration levels to below 4.0 pCi/L or 148 Bq/cu m, depends largely on the size of the suction field extension achieved from one suction point. Without first performing sub-slab communication (SSC) tests, it is very difficult if not impossible to determine the distance air will flow through the material beneath a concrete floor slab.

So in order to achieve uniform pricing with respect to the number of SSC tests to be performed and the number of suction points that will be required to reduce radon concentration levels to below 4.0 pCi/L or 148 Bq/cu m, the following "rules of thumb" were established for pricing this portion of the work. After a reasonable radon mitigation project track record is established, the rates (number per area) for pricing this work may change.

For pricing purposes, specify in Attachment B the number of each diagnostic test to be performed and a recommended number of suction points to be constructed for each building based on the following:

Short Term Detectors: One detector per 186 square meters 2,000 square feet (or fraction thereof) of building foot print but not less than one detector per enclosed space, except for closets and bathrooms.

Grab Samples: One sample per 186 square meters 2,000 square feet (or fraction thereof) of building foot print.

Sub-Slab Communication: One test per 232 square meters 2,500 square feet (or fraction thereof) of building foot print. (each SSC test consists of one suction hole plus 4 test holes).

Suction Points: For slab on grade buildings, review the original building drawings to determine continuity of the capillary water barrier (CWB) beneath the concrete slab within the exterior walls. For buildings with a single continuous CWB, specify one suction point for each 929 square meters 10,000 square feet (or fraction thereof) of CWB. Where the CWB is interrupted within the exterior walls, specify one suction point for each separate area of CWB and apply the previous criteria for each area which exceeds 929 square meters 10,000 square feet.

Attachment B

DIAGNOSTIC TESTING REQUIRED AND RECOMMENDED NUMBER OF SUCTION POINTS (Quantities listed are number per building)	
---------------------------------------------------------------------------------------------------------------------	--

[illegible]

Attachment C

GRAB SAMPLE LOCATIONS AND READINGS

Contract Number:

Date:

Building No.

Project Title:

[illegible]

* Calculated

Attachment D

SUB-SLAB COMMUNICATION TEST LOCATIONS AND READINGS									
----------------------------------------------------	--	--	--	--	--	--	--	--	--

Contract Number:

Date:

Building No.

Project Title:

[illegible]

Project Title:		
Drawing Title:		
Contract No.:	Date	Building No.
Project Designer:		
Address:		
Radon Mitigation System Designer:		
RCP Certification No:	Signature:	
		Sheet ____ of ____

BID SCHEDULE ATTACHMENT

BID SCHEDULE ATTACHMENT

NOTE: Include this attachment for all lump sum
radon projects/contracts of 100,000 dollars or more.

Include page numbering (starting with Page 3) and
contract number on each page of the attachment.

Provide completed attachment with the final drawings
and specifications for inclusion by the EFD/EFA in
Standard Form 1442, "Solicitation, Offer and Award".

Page 3 of [_____]
N62472- [__] -B- [_____]

Lump Sum Bid

Item 1 (a) shall be the total price for providing all work complete in
accordance with the drawings and specification but NOT including Item 1 (b)
bonding costs for Bid, Payment and Performance Bonds.

Item 1 (a) \$ _____

Item 1 (b) shall be the total cost being charged to the bidder by the
Surety for Bid, Payment and Performance Bonds.

Item 1 (b) \$ _____

Total Lump Sum Bid \$ _____

NOTE:

Submit with your bid one (1) Northern Division Form NSF/Form BG-HR,
"Certification of Bonding Costs", contained in the document titled "Bonds
and Certificates", completed by the Surety.

-- End of Section --